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CANADA
DEPARTMENT OF MINES
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BUREAU OF ECONOMIC GEOLOGY
GEOLOGICAL SURVEY

MEMOIR 175

Portland Canal Area, British Columbia

BY

George Hanson

OTTAWA
J. O. PATENAUDE
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1935

Price, 50 cents No. 2371

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Portland Canal Area, British Columbia

CHAPTER I

INTRODUCTION AND BIBLIOGRAPHY

INTRODUCTION

The country in the vicinity of Portland canal has been known as the Portland Canal area ever since prospecting began there in 1898. The meaning of the name is here, however, extended so as to apply also to the districts bordering Alice arm, Hastings arm, and Observatory inlet (*See* Map 2362). The area as re-defined is 80 miles long from north to south and 35 miles wide. Stewart, at the head of Portland canal, Alice Arm at the head of Alice arm, and Anyox on Observatory inlet are regular ports of call for steamships sailing from Vancouver about 600 miles south. A boat runs on a regular schedule between Alice Arm and Anyox. All ordinary supplies and equipment can be obtained at either of the three places.

Portland Canal area lies in the eastern part of the Coast Range mountains and is a rugged country containing many glaciers, ice caps, and snow fields. Elevations range from sea-level to 9,750 feet. Timber-line is at 4,000 feet, below which the forest growth is heavy and the underbrush is dense. Pack trails follow the main streams entering Alice arm and afford access to this district. No pack trails nor roads lead from Anyox nor are there any trails suitable for horses on Hastings arm. The part of the area bordering Hastings arm and lying between Hastings arm and Portland canal is, therefore, very difficult of access. Along Portland canal pack trails lead into the mountains only at Marmot and Georgia rivers. From Stewart, good roads suitable for automobiles lead up Bear and Salmon River valleys and there are pack trails along the smaller streams.

The first work in the area by the Geological Survey was an exploratory trip in 1893 by McEvoy. In 1910 and 1911 R. G. McConnell carried on systematic geological work in Bear and Salmon River valleys and on Observatory inlet. Observatory inlet was visited by McConnell again in 1913 and by Drysdale in 1916. Salmon River district was re-examined in 1919 by J. J. O'Neill and in 1920 by Schofield and Hanson. All the coastal part of the area was examined by Dolmage in 1922. Detailed geological work was done in Alice Arm district by Hanson in 1921 and 1928-30 and in Bear and Marmot Rivers districts in 1926 and 1927. Exploratory work was done by Hanson in 1931 on the headwaters of Bowser river north of Salmon and Bear rivers, and in 1932 in the area between Portland canal and Hastings arm.

The mineral deposits of the area have been examined from year to year by officers of the Department of Mines of British Columbia. The neighbouring parts of Alaska have been mapped by the United States Geological Survey.

The area has also been mapped topographically by the Geological Survey by work done in 1910 by Malloch, in 1916 and 1919 by Falconer, in 1920 and 1931 by Miller, in 1925 by McDonald, and in 1928 and 1929 by Bartlett.

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CHAPTER II

GENERAL GEOLOGY

INTRODUCTION

Portland Canal area lies along a part of the eastern margin of the elongated body of the Coast Range intrusives which stretches northwestward along the Pacific coast from near the southern boundary of British Columbia to and into Yukon. In Portland Canal area the formations bordering the intrusives on the east are Mesozoic sedimentary and volcanic rocks and Tertiary lava. In previous reports dealing with parts of Portland Canal area the Mesozoic was considered to consist of, in ascending order, the Bitter Creek, Bear River, and Nass formations, and, perhaps youngest of all, bodies of augite porphyrite. From evidence collected in Alice Arm district, the writer concludes that the Bitter Creek and Nass formations are parts of a single sedimentary series, and that the Bear River volcanics and the augite porphyrite are products of local volcanic outbursts.

As the sedimentary rocks appear to be one series, neither of the two names Nass or Bitter Creek will serve for this formation. The term Bear River could perhaps be retained for all the volcanic rocks, but the name Hazelton group, used first in the vicinity of Hazelton to designate all the Mesozoic rocks older than the Coast Range intrusives, can be used with more assurance for the sediments and volcanics combined.

Table of Formations

Modern	Recent and Pleistocene	Gravel, sand, silt, varved clay, marine or estuarine clay, boulder clay, glacial drift
Tertiary		Basaltic lava flows
Early Cretaceous to Jurassic		Dykes
	Coast Range intrusives	Granodiorite
Jurassic and perhaps in part Triassic and Early Cretaceous	Hazelton group	Argillite, quartzite, greywacke, limestone, tuffaceous sediment, breccia, tuff, augite porphyrite, felsite, amphibolite, gabbro

HAZELTON GROUP

The volcanic rocks of Portland Canal area are similar in age and lithological character to those of the Porphyrite group of Dawson and the Hazelton group of Leach. The name Porphyrite group was introduced by

Dawson in 1877[1] to designate a series of igneous rocks in the vicinity of Tatlayoco lake, which he could not with assurance assign to the Cascade crystalline series, the Cache Creek group, or the Jackass Mountain series. The name Porphyrite was chosen as much of the rock was classed as porphyrite. In 1878 Dawson dealt more definitely with these rocks which he in that year referred to as the Porphyrite series. He stated that they underlay and blended with the sediments of the Jackass Mountain series and that the two members together constituted the Porphyrite series. He believed that the series bridges "to some extent the gap ordinarily found between the Cretaceous and Jurassic".[2]

In 1910 Leach[3] introduced the term Hazelton group for a series of volcanic and sedimentary rocks in Telkwa, Bulkley, and Skeena valleys which he considered to be equivalent in age to the Porphyrite group. No series known to be older than the Hazelton group occurred in the area worked by Leach, but a younger series of Cretaceous age called the Skeena series did occur. The name Hazelton group was, therefore, applied to the igneous-sedimentary group of rocks underlying the Skeena series. The name Hazelton group was introduced because although the Porphyrite group might be of the same age and, therefore, correlative, the name when applied to the rocks of Hazelton district was misleading as the rocks there were chiefly sedimentary. Leach believed that the rocks of the Hazelton group were probably chiefly Jurassic.

In 1925 Dolmage[4] examined part of the area mapped by Dawson in 1875 and collected fossils that showed that the Porphyrite group at Tatlayoco lake was at least in part of Jurassic age. He also found apparently conformable sediments shown by fossils to be of Lower Cretaceous age.

Rocks that are roughly correlative with the Hazelton group and Porphyrite group occur at many places in western British Columbia and although in some places the age of the strata can be determined precisely, nowhere are the exact age limits of the whole series known. There is in the west-central part of the province a series of rocks, the parts of which are in the main conformable, consisting mainly of volcanic rocks and clastic sediments lying between Palæozoic sediments and the Skeena series, and for which it is desirable to retain the name Hazelton group. The group can in many places be divided into parts, but in general very few of the rocks contain fossils of diagnostic value and, therefore, their age can be stated in only general terms.

The name Hazelton group was applied by the writer[5] to rocks of supposed Jurassic age of the Alice Arm district. Names of a more local nature were introduced by the writer[6] to designate the formations in part of Alice Arm district but these local names cannot be applied with their original

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[1] "Report on Exploration in British Columbia"; Geol. Surv., Canada, Rept. of Prog. 1875-1876, p. 250.

[2] Dawson, G. M.: "Report on Explorations in British Columbia"; Geol. Surv., Canada, Rept. of Prog. 1876-1877, p. 58.

[3] "Skeena River District, B.C."; Geol. Surv., Canada, Sum. Rept. 1909, pp. 63, 64.

[4] "Chilco Lake and Vicinity"; Geol. Surv., Canada, Sum. Rept. 1924, pt. A, pp. 59-75.

[5] "Reconnaissance between Skeena River and Stewart, B.C."; Geol. Surv., Canada, Sum. Rept. 1923, pt. A, pp. 29-45.

[6] "Upper Kitsault Valley, B.C."; Geol. Surv., Canada, Sum. Rept. 1921, pt. A, pp. 7-21.

meanings to the rocks in the other parts of the area and hence are abandoned in favour of the more general name Hazelton group. In reports dealing with Salmon and Bear River districts the names Bitter Creek formation and Nass formation were used to designate what appeared to be distinct series of sedimentary rocks separated by a volcanic assemblage designated the Bear River formation. It now appears that there is only one series of sediments divided locally by large bodies of volcanic rocks. The group of rocks comprising both sediments and volcanics appears to extend over the whole of Portland Canal area and is aptly named the Hazelton group. It is not, however, to be inferred that the whole of the Hazelton group is represented. Neither the top nor the base of the group has been recognized in the area and it is not known whether a large or a small part of the whole Hazelton group is represented. Fossils found in the area indicate that the rocks are, in part at least, of Jurassic age.

The Hazelton group in Portland Canal area consists of sedimentary and igneous rocks. In part of the area the sediments form a continuous series uninterrupted so far as is known by the products of vulcanism. In most of the area, however, sedimentation was interrupted by one or more episodes of vulcanism which resulted in the intrusion and extrusion of igneous matter. Igneous rocks, chiefly of a fragmental nature, occur as abruptly terminated, lens-shaped bodies many miles long and thousands of feet thick. These bodies are roughly conformable with overlying and underlying sediments and are, or have been, completely enclosed by them. Bodies of intrusive rock are more irregular in shape but are in part sill-like. They also are surrounded by sedimentary rock. Several types of intrusives may form parts of a single body.

The sediments were being deposited before vulcanism began and sedimentation continued after vulcanism had ceased. At one or more protracted intervals sedimentation was interrupted over most of the area and volcanic rocks were laid down and intrusive counterparts were emplaced.

HAZELTON GROUP SEDIMENTS

The sedimentary part of the Hazelton group includes the formations designated in earlier reports as the Bitter Creek of Bear River district, the Nass formation of Bear and Salmon Rivers districts, the Kitsault River formation of Alice Arm district, and the Goose Bay formation of Anyox district.

Sedimentary rocks extend southward and eastward from Alice arm to Skeena river. South of Alice arm and Illiance river the sediments are continuous, but to the north within Alice Arm district they are divided into northerly striking bands by three bodies of igneous rocks named from east to west the Theophilus, Kitsault, and Klayduc igneous bodies. The Klayduc and Theophilus igneous bodies terminate within Alice Arm district and are, therefore, surrounded by the sediments. The northern part of Alice Arm district is covered with ice and it is not known whether the Kitsault igneous body terminates in the north part of the district or continues into Marmot and Bear River districts. Scattered outcrops of sedimentary rocks north of Alice Arm district make it fairly certain, however, that the sediments continue north under the ice to join with the sediments

of Marmot and Bear River districts. East of Alice Arm district a broad band of the sediments underlies the country at least as far east as Nass river and extends north-northwest beyond the northern limit of Portland Canal area.

South of Illiance river and south of the Theophilus igneous body, the sediments dip about 30 degrees southward. East of the southern part of the igneous body they have an average easterly dip of 20 degrees. Northeast of the Theophilus igneous body in the vicinity of Kinskuch lake, the sediments dip in the main northeast at moderate to gentle angles. Farther north the dips of the sediments are to the east or northeast.

The eastern part of the Theophilus igneous body consists in the main of fragmental volcanic rocks in part water-sorted. They have for the most part gentle dips, but the dip observations are not sufficiently numerous to show that the fragmental igneous rocks are absolutely concordant with the sediments to the east and northeast, and at the south end of the Theophilus body the contact appears to be considerably steeper than the dip of the sediments farther south. There seems to be no doubt, however, that the eastern sediments overlie the Theophilus igneous body and where the volcanic rocks are stratified they appear to be concordant in strike and dip with the overlying sediments. These sediments, therefore, appear to belong to the upper part of the Hazelton group. East and southeast of Illiance river and also northeast of the Theophilus body, they are mostly black argillites with local interbeds of greywacke and argillaceous quartzite. The argillites for the most part consist of fairly homogeneous beds 6 inches or so thick that yield a talus consisting commonly of rectangular blocks. Immediately south of Alice Arm the sediments are typically coarse greywackes. These rocks appear to grade into the argillites a short distance east but may underlie them. To the southwest the sediments are mainly argillites. The rocks in this vicinity, however, are near the contact with the Coast Range intrusives and have been too greatly disturbed by faults to make their position in the sedimentary series readily determinable. The thickness of the sediments in the area south and east of Alice Arm probably exceeds 3,000 feet.

The sedimentary band lying west of the Theophilus body and separating it from the Kitsault body is about 20 miles long north and south. The sediments along the western edge of the Theophilus body dip for the most part about 45 degrees eastward. On the western slopes of mount Theophilus sediments and stratified volcanic rocks are interbedded throughout a thickness of 1,500 feet and at the base of the Theophilus body dip 45 degrees east. The sediments of the upper part of this thickness where interbedded with stratified tuffs are locally argillites, but in general are coarser and not black. At the base of the interbedded rocks the sediments are black argillites. Farther north on Dak river the sediments are largely argillites and the transition from sediments below to volcanics above is more abrupt, but locally there is some interbedding. At the western side of the band of sediments in the vicinity of Dak river the strata are almost horizontal. LeRoy mountain in the middle of the band and west of the head of Dak river consists of quartzite and other sedimentary rock of similar grain. These rocks do not show many features by which their attitude can

be ascertained, but judging from the strikes and dips of the rocks to the north and south it seems fairly certain that the quartzites dip east. Most of the quartzites weather light brown. The talus consists of rectangular blocks. Along the strike the quartzites change into black argillites. The body of quartzite is about 4 miles long and about 2,000 feet thick and may represent a delta formed at the time that the argillites were being laid down. North of LeRoy mountain the sedimentary band consists of argillites which in the eastern half of the band appear to have a uniform dip of 45 degrees to the east. The thickness may be as great as 2,000 feet. In the western part of the belt the dip of the argillites changes suddenly from a moderate easterly dip to a steep westerly dip.

Farther north on East creek the sedimentary band narrows to half a mile, the rocks are argillites, and the prevailing dip is eastward. From East creek to the north end of the Theophilus igneous body the sediments have in general very gentle easterly dips, but over areas a mile or more wide the rocks are horizontal. There are several isolated areas of sediments near the north end of the Theophilus body. The sediments apparently underlie a thin layer of volcanic rocks and appear where erosion has cut through the overlying volcanics. The Theophilus igneous body ends to the north by changing gradually from stratified tuffs to sediments dipping northeast. These sediments overlie and merge downward into the northern prolongation of the sediments that underlie the igneous body along its western side.

The Kitsault igneous body is mainly composed of intrusives, but the eastern part of the north end of the body consists partly of stratified tuffs which interfinger with northerly striking sediments. The most westerly band of these sediments extends several miles. It consists mainly of argillites that form a northerly plunging syncline and conformably overlie stratified tuffs. They contain fossils in a zone 200 feet thick immediately above the stratified tuffs. The band of tuff is underlain on the east by sediments that are continuous with those that underlie the Theophilus igneous body. The tuffs of the Kitsault body are, therefore, at approximately the same horizon in the sediments as are the tuffs of the Theophilus igneous body.

The sediments west of the Kitsault body are split into two bands by the Klayduc igneous body. The sediments are mostly black argillites, but beds of quartzite, greywacke, and conglomerate also occur. North of Evindsen creek, the strata near the western side of the northern part of the Kitsault body dip west at moderate to steep angles which lessen to low angles a mile to the west. The western part of the Kitsault body in this locality is formed of fragmental rocks, and tuffs and breccias are interbedded with sediments in a zone 200 feet thick that dips west under the sediments. On West creek the sediments dip south and west under the crystalline rocks of the Klayduc body. South of this the direction of dip is variable.

The sediments west of the Klayduc igneous body are chiefly black argillites. On Alice arm the sediments near the contact with the Coast Range intrusives are greatly faulted and the structure is unknown, farther east the strata exhibit westerly dips. Farther north at Klayduc mountain, the band of sediments is less than half a mile wide between granite on the west and crystalline volcanic rocks of the Klayduc body on the east and

the whole band dips 70 degrees west. North of Klayduc mountain the band broadens and in the area west of the head of Evindsen creek near the western side of the band, the sediments lie in a series of small anticlines and synclines and at the west edge dip west into the Coast Range intrusives. At the north end of the band, the sediments appear to dip away from the volcanic rocks of the Kitsault igneous body.

The strata of Alice Arm district appear to form a northerly striking anticline about 18 miles wide plunging slightly south at the south end and slightly north at the north end. The anticline is complicated by several fairly prominent smaller folds and has been disturbed by intrusions of later rocks and also to some extent by many minor faults. The thickness of the sediments in this part of the area is estimated to be at least 3,000 feet.

West of the sediments at Alice arm is a body of the Coast Range granitic rocks 5 miles or more wide. West of this intrusive, sediments occur again and occupy the low ground at the junction of Hastings and Alice arm and in the vicinity of Anyox. These sediments are bounded on the north and south by granite. They continue about 2 miles west of Observatory inlet, to where they end against a body of amphibolite. Their extent southeast of Observatory inlet is unknown. The rocks are mainly black argillites with, locally, thick beds of greywacke as at a locality a short distance northeast of Anyox where there is a thickness of 200 feet or more of greywacke. A few, thin, lens-like beds of grey limestone are also present. Over most of the area the beds are rather closely folded into minor anticlines and synclines with no prevalent trend. At Anyox one sharp anticline is overturned to the east. At the western side of the area where the sediments are in contact with amphibolite they dip east at steep angles, and strike parallel to the contact. The strike also parallels the contact of a small body of the amphibolite partly enclosed in argillite. In the Hidden Creek mine at Anyox the easterly dip at the surface changes in a depth of a few hundred feet to a steep westerly dip which seems to prevail to a depth of more than 2,000 feet. The dips of the sediments where seen in the mine appear to be concordant with the dip of the amphibolite-argillite contact. The amphibolite is an intrusive.

The sediments of Anyox district have been greatly disturbed by folding, in many places have been severely sheared, and locally have been converted into micaceous schist. The rocks have also been altered to knotted schists containing much biotite, muscovite, and quartz. Locally at the contact between the amphibolite and argillite the latter rocks have been extensively silicified. In one place a sedimentary band enclosed in amphibolit has been converted into a very light-coloured, siliceous rock. It seems probable, therefore, that the amphibolite caused part if not all of the silicification of the argillites, but judging from the general resemblance of the metamorphosed argillite of the Anyox district to that near the granite contact at Alice arm, it would seem that the general thermal metamorphism which resulted in the production of knotted schists was caused by the Coast Range intrusive.

As already stated, isolated outcrops of sediments continue northwest from the head of Kitsault river to Marmot river where they have been described as the Bitter Creek formation.[1] The sediments of this north-

[1] Hanson, George: "Bear River and Stewart Map-areas, Cassiar District, B.C."; Geol. Surv., Canada, Mem. 159 (1929).

western area belong to two bands that near Marmot river are separated by a band of volcanic rock. The southern sedimentary band is in contact with Coast Range intrusives along its southwest edge and is cut off by these intrusives before reaching Portland canal. The second band strikes northward, widens in the vicinity of Bitter and Glacier creeks, and eventually narrows and terminates in the northern part of Bear River district.

The prevailing dips in the southern band are northeasterly and the sediments apparently dip under the adjacent volcanic rocks to reappear and form the northern sedimentary band. 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 southern end of the northern band lie in a sharp anticline slightly overturned to the west and plunging under the volcanic rocks to the south. Farther north overturning is not marked but the anticline is asymmetric. Still farther north the anticline flattens and the band broadens considerably. In the broad part the general dip of the strata in the western part of the band is 35 degrees westward, the main anticline becomes two anticlines with a shallow central syncline, and the whole is complicated by minor folds. North of Bear river the sediments lie in a narrow, sharply folded anticline and plunge under volcanic rocks. At many places along the western edge of the northern band the relationship to the overlying volcanic rocks is clearly visible. The sediments underlie them 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 observed they indicated concordance between the volcanics and sediments.

The sedimentary rocks of Marmot and Bear River districts 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 1 to 2 inches thick. Light grey limestone is present in several places but usually as thin, discontinuous beds, although lenses of limestone 100 feet thick are known. Tuffs, breccias, and probably lava flows occur at several places. Locally, as on Kate Ryan creek and along Bitter creek, the rocks have been severely sheared and converted to micaceous schists. The upper 500 feet of the sedimentary division is calcareous, contains several beds of limestone, and holds numerous interbeds of tuffaceous rocks. Tuffs also occur lower in the section but probably not below the middle. Banded argillite-quartzite rocks occur from the middle of the division downward and most of the lower part consists of argillite and banded argillite and quartzite. The coarser sediments contain pebbles of tuff, cherty argillite, and crystalline igneous rock. On Kate Ryan creek the sediments are at least 3,000 feet thick.

North of Bear river the country is underlain by volcanic rocks, but for several miles along the upper reaches of American creek black, calcareous argillites and argillaceous limestones outcrop on the lower slopes of the valley up to 500 feet above the valley floor. To the north they end a short distance south of the divide at the head of American creek. The higher slopes on either side of the valley are occupied by volcanic rocks

beneath which the sediments seem to dip. At the north and south ends of the area the sediments also seem to plunge beneath the volcanic rocks, though in the north they may be in part cut off by intrusive rocks which are rather plentiful in this locality. As already stated, the sediments in the northern part of Bear River district appear to plunge northward under the volcanic rocks. The sediments in upper American Creek valley seem to occupy the same stratigraphical position and, therefore, the sediments of the two areas are correlated on structural grounds. Apparently the deep valley of American creek has been cut through the volcanics to the lower sediments.

In Salmon River district sediments occur in two northerly striking bands. The eastern band extends from Slate mountain northward to mount Mitre. The rocks are mainly argillite with minor beds of greywacke and conglomerate. The sediments of this area form a syncline. The beds dip inward at moderate to gentle angles in its southern part and at steep angles in its northern part. In the southern and southwestern part and locally along the eastern side the sediments are separated from the underlying volcanic rocks by a bed of fine pebble conglomerate. Locally this conglomerate appears to grade from the underlying volcanic rocks to the overlying argillite. In these places the lower beds of the conglomerate contain pebbles of volcanic rock and its upper part consists of coarse sediments such as grits. This conglomerate may indicate that a short period of erosion intervened between the formation of the adjacent volcanic rocks and the deposition of the sediments. Wherever dips are seen in the adjacent volcanic rocks, they are, however, conformable to those of the overlying sediments and, therefore, the erosion interval was probably very brief. As the sediments overlie the adjacent volcanics they are correlated on structural grounds with those east of the head of Bear river and east of American creek, which overlie the same body of volcanic rocks. Fossils have been found in the lower part of this sedimentary body and these show that the age is Jurassic.

The westerly band of sediments begins on the east side of Salmon River glacier near its lower end and extends north and northwest in a broadening band continuing west and southwest into Alaska and northwest over a large area west of Summit lake. The sediments are mainly black argillite. The relationship of this band to the adjacent volcanics in the south is obscure as the igneous rocks in contact with it are in the main of intrusive type. Because stratified volcanic rocks to the east at the Big Missouri mine dip west toward the sediments it appears as if the sediments occupy an overlying position. It is probable that the sediments are younger than the bedded volcanics to the east and have been cut by minor intrusions associated with these volcanics. West of Salmon glacier the sediments of the southern part of the body have a uniform, gentle, westerly dip. Farther north, from mount White-Fraser north for 8 miles, the dip is northwest at gentle to moderate angles. The thickness of the sediments on mount White-Fraser exceeds 3,000 feet. Where the sediments are in contact with crystalline rocks of the volcanic series on the east near Summit lake the contact is vertical and the sediments there have a vertical dip. No evidence of the age of these sediments is available from the adjacent part of Alaska as there the sediments are enclosed in Coast Range intrusives. The prevalent westerly dip over most of this sedimentary area suggests strongly

that the sediments overlie the volcanics to the east, and they are correlated on structural grounds with the easterly band of Salmon River district and with the upper part of the Hazelton group.

Another northerly striking band of sediments begins at the south end of Summit lake and extends in a widening band northward beyond the mapped area. This body, although argillaceous, contains much lighter coloured sediment and in many places has been severely sheared and converted into light-coloured sericite schists. The shearing and conversion to schists is, however, local and is a notable feature only in the vicinity of Tide Lake flats. Judging from the alteration exhibited it might be concluded that these sediments are older than any previously described. The attitude of the beds furnishes little reliable information, but in the northern part of the area the dips on the eastern side are away from the adjacent volcanic rocks. In the southern part the dips are vertical. The dips, therefore, suggest that the sediments occupy an overlying position with respect to the volcanics on the east. In the vicinity of Tide Lake flats the rocks of the volcanic series are in the main intrusive. Small bodies of granite also occur there and it is quite possible that the metamorphic changes in the sediments could have been affected by these later intrusives. Though this body of sediments cannot be correlated with assurance with the upper part of the Hazelton group, it is believed to form part of the group. The problem can probably be solved by geological work farther north on Bowser river.

The upper part of the Hazelton group sediments south and east of Portland Canal area is not known to contain mineral deposits. Sediments that seem to be well down in the group, however, as at Alice Arm and in Bear and Marmot Rivers districts, contain numerous mineral deposits. The western belt of sediments in Salmon river and those to the north in upper Bowser river also contain mineral deposits. The sediments east of Portland Canal area are in general farther from intrusives and their lack of mineral deposits probably depends more on their greater distance from possible mineral sources than on any innate unfavourable nature of the rocks.

The prevailing rock amongst the Hazelton Group sediments is black argillite which through addition of coarser clastic grains varies to quartzite and greywacke. The argillites are mostly black and contain as a rule pyrite in fine grains. The quartzites vary in grain from cherty rocks to coarser types which by addition of small rock fragments grade to greywacke. The quartzites commonly contain some feldspar, pyrite, iron oxide, and apatite, some contain considerable biotite, and some have much calcite cement. The rock at the falls on Canyon creek is a black quartzite holding much biotite. The greywackes commonly have a calcite cement. Many hold grains of a porphyritic rock. Others contain pebbles of argillite and chert. The fossiliferous rocks at the head of Kitsault river are calcareous greywackes.

Some of the sediments have formed very quickly and consist of rock fragments and crystals and broken crystals of hornblende, augite, feldspar, and quartz. The conglomerates carry pebbles of varous rock types usually in a sandy, argillaceous base. Conglomerates holding pebbles of slate and chert are the commonest types. On a ridge northwest of LeRoy mountain a fine pebble conglomerate has a calcareous cement. Conglomerates by admixture of volcanic ejectamenta grade into breccias.

The effect of intrusives, particularly the Coast Range intrusives, on the sediments has mainly consisted of the introduction of biotite. The argillites on Alice arm close to the Coast Range intrusives contain augite, feldspar, epidote, and lesser amounts of hornblende introduced by the intrusives. At Anyox the sediments have been extensively silicified, and knotted schists have been formed by the action of the intrusives. In the vicinity of Tide Lake flats sericite schists are common, but they may have been formed by compressive forces rather than by thermal metamorphism.

HAZELTON GROUP IGNEOUS ROCKS

The igneous members of the Hazelton group are tuffs, breccias, and crystalline rocks. They occur in irregularly shaped bodies enclosed by the sediments, or by the Coast Range granitic rocks, or lie between the Coast Range intrusives and the sediments. The different bodies may not be of one age but there is no conclusive evidence to show that they are of very different ages.

In Alice Arm district there are three main bodies roughly oblong in shape and with their longest axis parallel to the regional strike of the enclosing sediments. The three bodies are named from east to west the Theophilus, Kitsault, and Klayduc igneous bodies.

The Theophilus igneous body is about 30 miles long and 12 miles wide where widest. It differs from the other two in consisting to a great extent of fragmental volcanic rocks. The eastern boundary of the body has not been mapped in any great detail, particularly in the north, but it seems to follow a much more regular, more nearly direct course than the western boundary along which in several places the volcanics are interbedded with sediments. A small body of augite porphyrite occurs on the south slope of the most southerly peak of Theophilus mountain. It is intrusive and probably is a plug or neck of an ancient volcano. Breccias typified by fragments of augite porphyrite and holding perhaps also fragments of flows of augite porphyrite occur along the western side of the Theophilus body from Theophilus mountain to Kinskuch lake. The belt is narrow at the south end but widens rapidly and at Kinskuch lake it is 2 or 3 miles wide. At the south end it consists of augite porphyrite breccia, but farther north it contains some fragmental rocks of different type and also rocks that may be augite porphyrite flows and perhaps also intrusives. Augite porphyrite breccias and a little augite porphyrite are present on the southern part of the ridge that extends south from Illiance mountain.

The main part of the Theophilus body consists of tuffs and breccias in which the fragments are mostly of felsite, tuff, and breccia. Some thin beds of argillite occur in the bed of Illiance river north of Elevenmile. They may be interbeds in the volcanic series or they may lie just below the base of the volcanic rocks at that place. The volcanic rocks are rather well bedded and, particularly in the northerly trending part of Illiance valley, consist to a large extent of partly rounded fragments; amongst which purplish tuffs and jaspery pebbles are conspicuous. The thickness of bedded volcanic rocks may be in excess of 3,000 feet. East of the south end of Kinskuch lake is mount Lavender the highest mountain in the area. The upper part of it consists of purplish, fragmental volcanics. At the

level of Kinskuch lake the rocks are much altered, contain much pyrite and magnetite, and have been greatly shattered and break into small, angular pieces. Some appear to be tuffaceous sediment and some are fine grained and are either a lava flow or an intrusive. West of Kinskuch lake although the rocks are chiefly fragmental types with augite porphyrite fragments there are also some fine-grained, amygdaloidal, purplish, andesitic lava flows, and very fine-grained rocks and felsites.

The felsitic tuffs and breccias of the part of the Theophilus body east of the head of Illiance river lie in a northerly striking anticline at least 1 mile wide. The anticline has not been traced to the south end of the body. To the north it flattens and east of Kinskuch lake near the north end of Theophilus body the rocks dip gently east. Along the northerly trending part of Illiance river the rocks are sheared and appear to be sharply flexed. The prevailing dips along the valley are steep to the west. Farther west in the central part of the body the felsitic breccias are well bedded and over a width of 2 or more miles have gentle southerly dips. Still farther west the felsitic tuffs and breccias of Theophilus mountain and those of the mountain to the north dip east at moderate angles. Farther north in the vicinity of Kinskuch lake the dips are gentler to the east. Along the west side of the body the rocks are augite porphyrite breccias. They also dip east at moderate angles and pass under the felsitic fragmentals. The contact between the augite porphyrite breccias and the felsite breccias, etc., is very difficult of access and consequently has been examined in detail in only a few places, but there can be no doubt that the augite porphyrite breccias are the older. In the southwestern part of the Theophilus body sediments lie between the two types of volcanic rocks, but farther north the felsite breccias directly overlie the augite porphyrite breccias. Immediately west of Theophilus mountain the band of sediments is about 1,200 feet thick, but it narrows to the north and ends 2 miles north. While these sediments were being deposited it is probable that volcanic rocks were being accumulated farther north. Judging from the admixture of felsitic rock in the breccias of the augite porphyrite type, particularly near their top, it appears that there was a gradual change in type of volcanic extrusive from an early predominantly augite porphyrite type to a late dominantly felsitic type. The small stock of augite porphyrite on the south slope of Theophilus mountain intrudes the basal members of the felsite breccias and shows that although the predominant eruptive at that time was felsitic there were still local eruptives of augite porphyrite.

West of the Theophilus body, between it and the Kitsault body, are four small bodies of igneous rock. Two lie immediately south of Clearwater lake near the north end of Alice Arm district and consist of rudely bedded, felsitic, fragmental rocks. These two bodies appear to overlie the adjacent sediments and probably were formerly joined to the nearby breccias of the Kitsault body. The thickness of volcanic rocks in the bodies probably does not exceed 300 feet. Erosion has cut through them exposing the sediments below and separating these bodies from the Kitsault mass to the west. The third body lies near the western edge of the Theophilus body at the head of Dak river. This body is an intrusive stock

over a mile long and half a mile wide and consists of augite syenite that differs from the typical augite porphyrite in being even grained and somewhat darker. A tongue of the stock extends southeast for about half a mile and pinches out in the form of a dyke. The fourth body is near the eastern edge of the Kitsault body west of LeRoy mountain. It is over a mile long and a quarter of a mile wide. Parts of the body consist of what appear to be lava flows of augite porphyrite with large augite phenocrysts; other parts consist of a breccia of large and small fragments of typical augite porphyrite loosely cemented in a sand that seems to have been derived from the augite porphyrite. The body is parallel to the strike of the enclosing sediments and probably represents lavas poured out at the time the sediments were being laid down.

The Kitsault igneous body is 33 miles long in Alice Arm district and may continue much farther north. It is for the most part 3 miles or less in width but is 7 miles wide where widest. The outline of this body is much more complex than that of the other igneous bodies of the district.

The Kitsault body consists mainly of various types of intrusive rocks, but also to some extent of extrusive rocks. The northern half, except for a strip of variable width along the east side, is of intrusive origin and contains numerous inclusions or roof pendants of argillite. Many of the inclusions are a hundred yards or more in length. One large inclusion on the northern slope of the valley of the west fork of Kitsault river is roughly triangular in vertical section with the apex pointing upwards and the sides measuring half a mile. This mass was probably formerly completely surrounded by crystalline rock as the apex is below the top of the mountain to the north which consists of intrusive rock. The bottom of the inclusion is near the bottom of the valley. Large exposures of argillite seen farther north may also be inclusions or may be the prevailing rock cut by large bodies of intrusive rock half a mile thick. That part of the body crossed by Kitsault river is mainly intrusive. To the southeast between East and Goat creeks some of the rock is extrusive.

The crystalline rocks of the northern half of the Kitsault body are divisible into two main belts formerly included in the Dolly Varden formation (Hanson, 1922). One belt is locally known as the "Copper Belt" from the fact that the mineral deposits in the belt are chalcopyrite deposits. The Copper Belt is about half a mile wide. In the north it forms the eastern part of the Kitsault body and extends from the north limit of Alice Arm area south to Evindsen creek where this band ends. To the west 1,000 or 1,500 feet up Evindsen creek the Copper Belt reappears and from there continues southward forming now the western part of the Kitsault body. It loses its identity a short distance north of East creek.

The exact nature of the rocks composing the Copper Belt is unknown, but there is no doubt that much acidic feldspar porphyry much altered to sericite, calcite, and chlorite, is present in the north part and some feldspar porphyry also occurs in the southern part. Tuffs, breccias, and minor amounts of tuffaceous sediments are also present. The Copper Belt rocks are light grey to greenish grey and are more sheared and otherwise altered than the other part of the Kitsault body. They appear to contain

more pyrite than the other rocks and due to the weathering of the pyrite appear as a rusty band when seen at a distance. All the copper-bearing mineral deposits of the northern half of the Kitsault body lie in the Copper Belt and it lacks deposits of the silver-lead type typical of the adjacent igneous rocks.

The rocks of the Copper Belt, because they are in some places quite severely sheared, contrast strongly with the relatively fresh, massive, crystalline rocks that adjoin. Possibly the rocks of the Copper Belt are older than the adjacent igneous rocks and were subjected to shearing prior to the intrusion of the adjoining rocks. The break in the belt at Evindsen creek may be due to faulting that took place prior to the intrusion and eruption of the other rocks, or the belt at this place may have been cut in two by later intrusions.

The crystalline rocks of the remaining part of the northern half of the Kitsault body are divisible into dark grey to green rocks and red to purple rocks. They are less sheared than the rocks of the Copper Belt and in general are massive and fresh looking. They are feldspar porphyries of an acid type partly altered to sericite, chlorite, and calcite, and thus in mineral composition are much like the intrusives of the Copper Belt. Some contain very many fragments of similar rock type and resemble breccias. The purplish rocks appear to be mainly of fragmental nature. On Evindsen creek the interval between the two parts of the Copper Belt is occupied by red tuff. This red rock is not stratified but is clearly a fine-grained, fragmental rock. It loses its identity a short distance north and south of Evindsen creek.

West of the Copper Belt in the northern part of the northern half of the Kitsault body the rocks are mainly intrusives, but bedded fragmental rocks occur in small quantity. Locally, also, as for instance west of Evindsen creek, tuffs and breccias appear along the western side of the Copper Belt and through admixture of sedimentary matter and through interbedding gradually change to overlying argillite.

South of Evindsen creek, from the creek to the eastern edge of the Kitsault body, the rocks are hard, massive, and devoid of visible structure. Both purple and green varieties occur and although rock fragments are common in rocks of both colours it is believed that much of the rock forms the core, plug, or neck, of one or more volcanoes. The red tuffs previously mentioned may be one of the products of the volcano or volcanoes.

The Copper Belt loses its identity a short distance north of East creek. Forming what appears to be a southward continuation is a rock similar in most respects to the intrusives of the Copper Belt, but locally containing augite phenocrysts, or fragments of augite-bearing rocks. Except for the presence of augite crystals the rock would be classed as Copper Belt crystalline rock. Whether there is a gradual change from augite-free rocks to augite-bearing rocks belonging to one igneous body, or whether the two types belong to different bodies, is not known. It seems probable there are present several intrusive bodies that are very much alike but differ in some details, that rose from a common reservoir, and that merge into one another in many places. The band of this feldspathic porphyry containing locally augite phenocrysts and fragments of augite-bearing porphyry continues south from East creek to the head of Red Bluff creek,

but has not been traced by continuous outcrop. The rocks change to breccia containing fragments of augite porphyrite and the belt appears to cease in the vicinity of the head of Red Bluff creek.

Near the south end of the ridge west of LeRoy mountain felsitic rocks of the Copper Belt type appear and they make up the whole ridge between Washout and Red Bluff creeks. Locally the rock is severely altered and sheared, so much so that the original character is not always recognizable, though there is little doubt that the rock is porphyritic and of an intrusive nature. It contains much disseminated pyrite, some pyrrhotite, and locally chalcopyrite. It has been largely altered to sericite, chlorite, and calcite, and because of its mineral composition and as a result of weathering it is soft and light grey. The altered felsites continue south across Dak river and for some distance up the slopes of McGrath mountain. Farther south on McGrath mountain the rocks are augite porphyrites. The felsites resemble the augite porphyrites except for the presence of augite phenocrysts in the latter. The two rocks may grade into one another or may belong to separate intrusive bodies. The augite porphyrite also contains disseminated sulphides but is not sheared, and although altered to some extent is everywhere easily recognized as a crystalline rock. The augite porphyrite of McGrath mountain extends northward in a narrow band a short distance east of the main part of the Kitsault body. Northwards this band becomes only a dyke-like body some 100 feet wide and eventually disappears.

The southern part of the Kitsault body is divided in two by a band of sediments. The western part consists mainly of crystalline rock mostly felsite and which is probably intrusive. Locally fragmental rocks and lava flows occur. The eastern part consists of augite porphyrite.

Fragmental volcanic rocks occur at several places in the Kitsault body, but in the main are confined to its borders. In the southern half of the igneous body tuffs and breccias containing broken crystals and fragments of felsite occur locally on the ridge between Kitsault river and Red Bluff creek. West of LeRoy mountain breccias, tuffs, and flows occur at the eastern side of the body; some of the tuffs and breccias contain fragments of augite porphyrite and felsite. At East creek, the eastern part of the body consists of tuffs and breccias and overlies the sediments to the east. Northward, tuffs and breccias occur more particularly in a strip next to the argillite contact. Fragmental volcanic rocks occur in small quantity near the mouth of Evindsen creek. The part of the Kitsault body extending north from the mouth of Evindsen creek to Clearwater lake consists largely of fragmental volcanic rocks. They are roughly bedded and overlie the sediments to the east and underlie those to the west. The fragments are mainly felsite. Sediments occur to the north and there sedimentation was continuous while farther south volcanic products were building up the Kitsault igneous body. The wedge-shaped extension of the Kitsault body that continues northerly to the Kitsault glacier consists of fine-grained, bedded, red and green tuffs that pass beneath sediments on the east and west.

The Klayduc igneous body is the smallest of the three main igneous bodies of Alice Arm district. It is 18 miles long and 3 miles wide where widest. It consists mostly of intrusive rocks holding many fragments of similar rock types. The body contains also some breccias and tuffs. The

chief rock type is felsite, but other fine-grained, crystalline rocks occur. The northern part of the body consists almost entirely of greyish felsite commonly holding pink feldspar crystals. In some places the felsite is quite free of fragments, but in other places felsite fragments of varying sizes are so plentiful that the rock resembles a breccia. A small amount of breccia and tuff occurs at the north end of the body. Southward from the widest part of the body the rock appears to change gradually to tuffs and breccias, and finally, at the south end, through admixture of foreign, water-worn pebbles, the tuffs and breccias change to conglomerates and finer-grained sedimentary clastics. Fragmental rocks occur also in the lenticular area at the end of a tongue-like projection extending east from the main part of the body.

From the north end of the Klayduc body a sill extends east and for most of its length parallels the strike and dip of the sediments, but in part crosscuts the strata. The sill has been folded into a syncline and anticline.

The part of the Klayduc body that projects eastward from the north part of the body and is terminated by an area of elliptical outline may be a cross-section of a volcanic neck and the breccias of the elliptical area may be the products of the volcanic activity. The rock composing the neck-like part appears to be massive. It crosscuts the bedding of the bounding sediments, whereas the breccias of the termination are conformable to the sediments. The main part of the Klayduc body may have been the reservoir from which the extrusives were derived. The body of fluid rock constituting this reservoir perhaps reached its present position within the sediments by lateral movements. Possibly other volcanic vents existed, but the ejected matter seems to have been largely removed. Because the extruded matter lies near its source, the reservoir seems to have lain close to the surface. As the tuffs and breccias are interbedded with and grade into sediments, it appears that sedimentation and volcanic activity were contemporaneous and that the volcano or volcanoes were submarine.

In Anyox district, west of Alice arm, is another large area of igneous rocks here referred to as the Anyox amphibolite. The body is 14 miles long from north to south and 8 miles wide. It has not been examined in detail but is known to be of heterogeneous nature. It is bounded on the east by sediments of the Hazelton group and on the other sides by Coast Range intrusives.

The body consists for the most part of amphibolite locally severely sheared. The eastern half of the body is almost entirely of this nature and from a distance the rock has a characteristic green colour that makes the local name greenstone very suitable. Most of the amphibolite is of medium grain and is not porphyritic. Elongated areas up to a few hundred yards across and up to a mile or more long are of very coarse grain. The body contains many, small, discontinuous bands of sedimentary rock that are probably inclusions and roof pendants. Along the southeastern contact of the body with the adjoining sediments the intrusive nature of the amphibolite is well shown, particularly on Glacier and Cascade creeks where the amphibolite truncates the sedimentary beds in an irregular manner and wedge-like masses penetrate the sediments along the bedding

planes. The northern half of the eastern contact, however, is concordant or nearly so with the strike and dip of the adjacent sediments.

The western half of the body has not the typical green colour, but in many places both the medium- and coarse-grained types of amphibolite are easily recognized. There is more sedimentary matter in the western than in the eastern part, one band of sediments is several hundred feet wide and may be several miles long. The sediments are mainly quartzites or argillaceous quartzites, but may have been rendered more siliceous than they were originally by silicification. A limestone bed 100 feet or more thick occurs in the band of sediments and is well exposed at Swamp point where limestone was once quarried for flux.

In several places within the Anyox amphibolite body local areas a few hundred yards across appear to consist mainly of green amphibolite lavas showing a rude pillow structure. In one place near the centre of the Anyox body there is a thin band of rhyolite. The main body is probably intrusive containing older rocks as inclusions and roof pendants, and containing locally also some extrusive facies of the parent rock. Judging from the highly silicified character of some inclusions and from the silicification locally exhibited by sediments along the eastern contact, it appears that the amphibolite had a greater effect on the intruded rocks than is usually exhibited by the other similar intrusives of Portland Canal area.

A small, isolated body of amphibolite occurs south of Bonanza creek. It intrudes the surrounding sediments, but the contacts are in the main parallel to the strikes and dips of the sediments. On Glacier creek it can be seen that this body in part transgresses the sediments and in part is sill-like. It is probably an injection from the main body to the west. A few miles farther south is a third body of amphibolite several miles long.

A body of igneous rock outcrops at the head of Hastings arm. It is 3 miles long and 2 miles wide and is enclosed by Coast Range intrusives. The rock is mainly a breccia containing fragments of a holocrystalline rock resembling fine-grained diorite. Epidote is very plentiful throughout the rock, particularly between fragments and in short and narrow gash veins. The rock is quite unlike any other members of the igneous rocks of the Hazelton group seen in Portland Canal area except for a somewhat similar type on Portland canal immediately south of Bulldog creek. Except for its brecciated nature the rock resembles some facies of the Coast Range intrusives. It has been mapped as part of the Hazelton group as it is very unlike the surrounding granites and has been intruded by them. Minor quantities of argillaceous sediments with a general northerly strike and westerly dip occur in the body. They are probably interbedded with fragmental volcanic rocks.

A body of igneous rock 12 miles long and 10 miles wide occurs in Georgia River district on Portland canal. It is surrounded by Coast Range intrusives but is only 2 miles distant from the western part of the igneous rocks of the Kitsault body. The Georgia River body consists for the most part of a crystalline rock probably of intrusive nature, but fragmental volcanic rocks and sediments are also present. Though the outlines of the body are roughly known but little is known of the various

rock types present. The ridge between Portland canal and Georgia river appears to be underlain mostly by crystalline rocks, but some fragmental rocks associated with siliceous sediments occur near the head of Georgia river. In the valley of Georgia river the rocks appear to be mostly if not entirely crystalline types. At the higher elevations in that part of the body between upper Georgia river and its south fork there are some argillaceous sediments striking north and northwest and dipping west. For the most part the crystalline rocks are coarser in grain than the felsites of Alice Arm district and appear to be somewhat more basic. Locally the rock is medium grained and resembles some facies of the Coast Range intrusives. The body has been intruded by Coast Range intrusives and has, therefore, been mapped as part of the igneous rocks of the Hazelton group.

The most southerly outcrops of igneous rocks of the Hazelton group in Marmot River district are several miles from the most northerly outcrops of the Kitsault igneous body. As the Hazelton group igneous rocks form only a narrow band in the southern part of Marmot River district it may be that they do not continue much farther southeast and that they are not a northward prolongation of the Kitsault body. The northern body of these igneous rocks is of very irregular shape and includes all the volcanic rocks of Portland Canal area from Marmot river northward. The body consists of tuffs, breccias, lava flows, intrusive rocks, and thin beds of argillite, quartzite, and limestone.

In Marmot, Bear, and Salmon River districts the prevailing volcanic rock types are breccias and tuffs. Flows and intrusive bodies are not so common as in other parts of Portland Canal area. The rocks whether massive or fragmental are commonly grey or green or else are purple, red, or brown. The greenish rocks probably owe their colour to chlorite, and the colours of the purple, red, and brown rocks appear to be due to the presence of iron oxides. The flows and fragmental rocks are not easily distinguished from one another as some breccias appear to have a flow matrix and some flows contain numerous fragments. Individual flows or beds do not continue far and they merge into the adjoining volcanic rocks. The red types and the green types merge into one another regardless of whether they are fragmental or massive varieties. Breccias with reddish fragments in a green base also occur. The tuffs are mostly of intermediate grain, but some are fine-grained resembling chert. Some 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. Augite porphyrite occurs as a small body in the southern part of Marmot River district and in larger, rounded bodies and elongated masses several miles long in the eastern half of Bear River district. A stock of augite porphyrite occurs north of Long lake in Salmon River district. More basic types of intrusive rock resembling the Anyox amphibolite are present in Bear River district but are uncommon. Coarse, fragmental rocks are common on Bear River ridge. In the vicinity of the Premier mine and also in the central and lower part of Bear River valley the volcanic rocks are fine-grained tuffs that have been sheared and converted in part into chlorite schists. On big Missouri ridge and also farther east in the vicinity of

lower American creek the rocks are chiefly tuffs and breccias. On upper Bear river the rocks are for the most part roughly bedded, but sheets of crystalline rock are common. On upper American creek and north of Salmon River district the prevailing rocks are reddish or green to grey intrusive types of intermediate composition.

In the vicinity of the Premier mine there is a stock of orthoclase porphyry 2 miles in diameter. From it sill-like tongues extend north for several miles. The stock contains numerous, large inclusions of sheared tuffs. In general the porphyry is fairly even grained and consists of small phenocrysts of feldspar and quartz in a medium to fine-grained groundmass. The rock is highly altered to sericite, chlorite, and calcite, so much so that in many places the original rock texture has been obscured. Locally, the rock is strikingly porphyritic and contains phenocrysts of orthoclase up to an inch in length and smaller phenocrysts of quartz. In some places the porphyry has been severely sheared and altered and is difficult to distinguish from similarly sheared greenish tuffs. Ordinarily the porphyry is grey to light green and is easily distinguished from the darker green textureless tuffs. The Premier porphyry in texture is much like some of the reddish and grey intrusive porphyritic rocks, but they are rarely sheared and have not been so much changed by processes of alteration. Some facies of the Premier porphyry resemble phases of the Coast Range intrusives. The writer favours the view that the Premier porphyry is an intrusive similar in origin to many of the irregularly shaped intrusives of the Hazelton group and, therefore, that it is of the same general age as the rocks of the Hazelton group.

Argillaceous sediments occur in minor amount interbedded with stratified tuffs on the east side of American creek and on upper Bear river. A short bed of limestone up to 100 feet thick occurs in the volcanic rocks of Marmot River district. The thickness of the bedded volcanic rocks of the northern part of Portland Canal area is estimated to exceed 4,000 feet.

The rock varieties of the igneous part of the Hazelton group appear at first sight to be numerous yet in Alice Arm district there are only two main types, feldspar porphyry (felsites) and augite porphyrite, and the corresponding fragmental types.

The feldspar porphyry occurring on Klayduc mountain is a greyish rock with, commonly, small, pink phenocrysts of feldspar. In most places the porphyry holds rock fragments of the same type as the host. The phenocrysts are orthoclase and plagioclase ranging from albite to oligoclase. The groundmass is fine and granular. Biotite in fine-grained aggregates occurs locally in the groundmass and muscovite is present in small quantity. Apatite is an accessory mineral. Rock alteration has resulted in the formation of sericite, calcite, and chlorite. The chief variation is in size of phenocrysts and in fineness of groundmass. Similar rocks occur in other parts of the Klayduc igneous body and in many places in the Kitsault igneous body. Near Kinskuch lake a variety of the porphyry contains some hornblende phenocrysts. Feldspar porphyry occurs in many places in the Copper Belt, but in general has been more altered to sericite, calcite, and chlorite, and contains as well a fair amount of pyrite. The

porphyry is also the typical rock in the vicinity of Dak river where, particularly near Red Bluff and Washout creeks, it contains pyrrhotite as well as pyrite. Much of the breccia of the area contains rock fragments of the porphyry type and grades from extrusive, fragmental rocks to crystalline intrusive rocks. An intrusive in the Copper Belt noted between West Fork of Kitsault river and Evindsen creek may be very closely allied to the feldspar porphyry. This rock is a syenite of granular texture and contains orthoclase, some plagioclase of acid type, and also hornblende and biotite. In the vicinity of Kinskuch lake are some finer grained crystalline rocks that are probably lava flows. One such is purplish and appears to be an amygdaloidal flow. Other rocks there are also very fine grained but lack amygdules. These rocks may be very close to the feldspar porphyries in chemical composition.

The other main rock type is the augite porphyrite. Typically this rock is studded with square augite phenocrysts about an eighth of an inch across. The groundmass is typically light green and fine grained but varies to darker shades. The rock occurs mainly on McGrath mountain, but smaller bodies occur farther north. Most of the augite porphyrite contains much disseminated pyrite and some also contains much pyrrhotite. The augite phenocrysts are in general quite unaltered. Most of the augite porphyrite contains also phenocrysts of orthoclase and of acid plagioclase. In all cases noted the feldspar phenocrysts are nearly completely decomposed and in this respect contrast strongly with the fresh augite. Hornblende also occurs as phenocrysts but is rather uncommon except locally. Some of the porphyrite contains a fair amount of apatite. The groundmass where identifiable consists in part at least of very small crystals of acid feldspars and augite, but the groundmass in many of the specimens examined consists mainly of chlorite, sericite, and calcite. One or more specimens hold chlorite amygdules and may represent flows. The corresponding breccias consist mainly of augite porphyrite fragments in no way differing from the massive augite porphyrite. Pyrite and pyrrhotite have been introduced into the breccias and in several instances were noted to be associated with calcite in veinlets cutting the rock and, therefore, appearing to have been introduced at a very late stage in the alteration of the rock.

At the south end of the ridge west of LeRoy mountain a stock consists of a rock rather closely allied to the typical augite porphyrite but containing augite and orthoclase phenocrysts and also much biotite. The rock resembles a granite in grain except for the augite and orthoclase phenocrysts. The rock is an augite syenite having probably about the same chemical composition as the augite porphyrite with which it is probably closely related in origin, perhaps having come from the same general magma reservoir.

Most of the tuffs and breccias are either of the feldspar porphyry or of the augite porphyrite type. Many, though their mineral composition is the same as that of the feldspar porphyry, are purplish, whereas most of the porphyry is grey to green. The purplish colour appears to be chiefly due to red iron oxide in the cement between rock fragments. Some of the felsitic tuffs consist mainly of rock fragments, others consist mainly of crystal fragments, and all variations between the two extremes occur.

The mineral fragments are quartz, orthoclase, and acid plagioclase. One body of tuff on Evindsen creek is blood red and fine grained. The rock contains fragments of quartz, feldspar, and felsitic crystalline rocks. The red colour appears to be due to an abundance of red iron oxide in the cement around the fragments.

The bodies of feldspar porphyries and augite porphyrites apparently represent reservoirs, necks, and flows and the corresponding tuffs and breccias appear to be the products of craters now plugged by necks of crystalline rock. The slight differences existing between porphyries in different parts of the area are no greater than what might be expected to be exhibited by different parts of a magma reservoir. The differences displayed by the augite porphyrites appear to be in part a matter of degree of crystallinity and in this respect are no greater than would be expected in different parts of a single mass. Locally, however, augite phenocrysts are lacking and the rock then becomes a felsite very little if at all different in mineral composition from the porphyries, except that it contains more iron sulphide and is more altered. The augite porphyrite is not very dissimilar to the feldspar porphyry. Gradations between the two types, however, are not evident either from field or microscopic study. The two types appear to differ in age, but it may well be that they had a common origin in a single large reservoir nowhere now displayed.

In the Theophilus igneous area the main body of augite porphyrite breccias underlies the felsitic breccias, the upper members of which grade into conglomerate which in turn grades fairly abruptly into argillite. The smaller stocks in the district are probably plugs in craters which supplied the augite porphyrite breccias. The intrusives of McGrath mountain and their northward extension are probably the upper part of the augite porphyrite reservoir.

There are points of similarity between the augite porphyrite and the feldspar porphyry, particularly in the cases of the augite porphyrites and porphyries of the Copper Belt and Red Bluff types, which are altered and contain disseminated iron sulphides. South of East creek the Copper Belt appears to change gradually to a belt containing augite porphyrite breccia and massive augite porphyrite which though imperfectly traced may join with the rocks of the Red Bluff type between Washout and Red Bluff creeks and through them be linked to the augite porphyrites of McGrath mountain. Assuming that the rocks of the Copper Belt and the augite porphyrite and indeterminate rocks of the Red Bluff type are related and are older than the porphyries, it would seem that they represent a main period of augite porphyrite eruption and that as time went on the character of the eruptive materials gradually changed until finally porphyries (felsite) were the product. If the porphyries are younger than the augite porphyrites there is furnished an explanation of the interruptions in the Copper Belt which would be due to intrusions of the later eruptions.

The Hazelton group igneous rocks of Anyox district are mainly a single basic type. The rocks now consist mainly of actinolite but contain also other products of alteration such as epidote, sericite, and chlorite. About the only original constituent is plagioclase as basic as bytownite. Some facies of the rock are very coarse grained. Originally the rock was probably gabbro.

Quartz diorite porphyrite and finer-grained dacite and fragmental rocks of similar composition occur at the north end of Hastings arm and at some places in the Georgia River body. The quartz diorite porphyrite contains quartz, orthoclase, andesine, much biotite, and some hornblende and apatite. Except for its coarser grain and holocrystalline nature it is similar to some andesites of Bear and Salmon River districts.

The feldspar porphyry at the Premier mine is grey, and though locally it is decidedly porphyritic it is for the most part not noticeably porphyritic. The phenocrysts are orthoclase and quartz. The groundmass has been greatly altered in general to sericite, calcite, chlorite, and pyrite. Apatite is a common accessory mineral. Some facies of the rock, as at the Woodbine mine, contain phenocrysts of quartz instead of orthoclase, but the rock is otherwise the same. Some purplish or reddish porphyritic rocks north of Premier mine contain quartz and feldspar phenocrysts, considerable red iron oxide, and also much epidote. Except for the epidote and iron oxide the rock resembles the Premier porphyry. These rocks, also, except for their coarser grain, are very like the felsites of Alice Arm district.

Somewhat similar intrusives at Summit lake contain many phenocrysts of hornblende. Commonly the feldspars have been too greatly altered for identification, but in no case was the plagioclase found to be as basic as andesine.

A small, elongated stock of augite syenite occurs in Alice Arm district and another of the same rock also occurs in Bear River district. They may be closely allied to the augite porphyrite of the area.

It appears that in Portland Canal area east of Georgia river most of the intrusive types are alike in that the feldspars are more acid than andesine. At Georgia river intermediate types occur and at Anyox, still farther west, gabbros are typical.

STRUCTURE OF HAZELTON GROUP

East of Alice Arm district the sediments dip east. Minor folds occur along Illiance river, but as far west as LeRoy mountain the rocks either dip east or are nearly horizontal. At the head of Kitsault river minor folds are displayed. From this river westward the prevailing dips are to the west. The major structure and one that embraces the whole district, therefore, appears to be a northerly striking anticline. The east limb is clearly defined, but the western limb is plicated and broken by faults. The broad arch narrows to half its width at the north end of the district and has not been traced south of the district. In Anyox district the rocks have a clearly defined northerly trend. The sediments are severely folded and locally overturned, but no general structure has been made out. Apparently the folds are closely spaced and of minor size.

The Cambria snowfield prevents the tracing northward of the features of Alice Arm district, but west of Salmon glacier and west of Summit lake the sediments over an area of more than 20 square miles dip west and it would appear that there too the broad anticline is present. In Bear River district the anticline is fairly clearly marked but is complicated by numerous folds and later intrusions. In Salmon River district and farther north the rocks lie in several southerly trending folds. There is an anticline in Long

Lake valley followed by a syncline on Slate mountain to the west, another anticline on Big Missouri ridge and another syncline along the west slope of the ridge. This is followed to the west by a greatly disturbed anticline and the final westerly dipping limb of the main anticline.

AGE OF HAZELTON GROUP

Fossils were found east of the head of Kitsault river, at two horizons in the basal part of the sediments overlying the Kitsault igneous body. Specimens from these localities have been examined by F. H. McLearn who reports as follows:

"The specimens submitted are *Gryphaea* sp., *Oxytoma* sp., *Belemnites* sp., *Rhynchonella* sp., and *Terebratula* sp. The fauna submitted is certainly either Jurassic or Cretaceous and very probably Jurassic."

Fossils were also collected from two or three horizons close together and near the base of sediments overlying the Bear River igneous body at Divide lake, Bear River district. F. H. McLearn examined them and reports as follows:

"*Trigonia* sp. No. 1, *Trigonia* sp. No. 2, *Trigonia* sp. No. 3. Three are new species of genus Trigonia section undulatæ.

Belemnites sp., too fragmentary for identification.

Gryphaea sp., too immature to permit specific determination.

Pecten entolium sp., too poor for identification.

Cucullaea sp., probably new species.

The Trigonia specimens suggest but do not prove a Jurassic age."

Crickmay[1] has described two new species of Trigonias from Divide lake. He names them *Vaugonia veronica* and *Vaugonia mariajosephinae* and dates them as Middle Jurassic.

A fossil was collected from the sediments underlying volcanic rocks of the Bear River igneous body on Kate Ryan creek. The fossil is very poorly preserved and is placed doubtfully by McLearn in the genus Calamophyllia. The age suggested is Triassic to Jurassic. An indeterminate fossil was collected from Glacier creek, Bear River district.

COAST RANGE INTRUSIVES

The Coast Range intrusives occupy the western part of Portland Canal area and also form several small stocks in Salmon and Bear Rivers districts. The Coast Range intrusives are hard and resistant compared with the average of the other rocks and, therefore, large bodies of the intrusives form elevated tracts of country. The granite mountains seen from a distance of several miles are typically light grey in colour and can easily be distinguished from the mountains of other rocks. The granitic rocks, particularly above timber-line, break off the mountain sides along curving fractures leaving smooth, rounded outlines. On a closer view, from a distance of a mile or less, the granitic rocks are seen to be traversed by numberless cracks giving the rocks a very shattered appearance. Except for roof pendants or

[1]"The Jurassic Rocks of Ashcroft, B.C."; Univ. of California Pubs. 1930, vol. 19, No. 2, pp. 53, 54, 74, 75.

inclusions at Anyox, Hastings arm, and Georgia river, the intrusives occupy the whole of the area west of Alice Arm district. South of Alice Arm the eastern border of the intrusives runs southeast to beyond Nass river. North from Alice arm the border strikes north for 8 miles to Klayduc mountain. On the southern slope of this mountain the contact with Hazelton group sediments is very well exposed between elevations of 2,000 and 5,800 feet. The sediments there dip steeply west, strike northwest, and both along the strike and the dip have been truncated by the intrusives. In several places tongues of granite project into the sediments and for many hundreds of feet follow along the bedding planes. Beyond Klayduc mountain the eastern border follows a northwesterly course to the head of Hastings arm where it swings northeast to the Cambria snowfield. There the border turns northwest and enters the southern part of Marmot River district. In that district the contact dips northeast at nearly the same angle as the dip of the adjacent rocks. At Stewart the edge of the batholithic rocks makes an abrupt turn to the north and northeast and then back to the west and follows Salmon River valley, but has been traced only imperfectly farther northwest. At Stewart the contact also dips parallel with the dip of the intruded rock.

The rock of the batholith is on the whole massive, but locally near the contact with the Hazelton group strata it has been slightly sheared. It is grey, medium to coarse-grained granodiorite and quartz diorite. The common, dark mineral is hornblende, but biotite is usually present as well. The feldspars are orthoclase, oligoclase, and andesine. Quartz is present in all specimens examined and titanite and apatite are common accessory minerals. In some places, as at the head of Hastings arm, the rock over an area of several square miles is pink and contains large, pink phenocrysts of orthoclase in a medium-grained, crystalline base. This rock is unaltered and may be younger than the main body of batholithic rocks. Locally the pink variety contains very much quartz.

A small stock on the property of Tidewater Mines, Limited, at Alice arm near the border of the Coast Range intrusives and presumably correlative with them, is composed of granite and contains quartz, orthoclase, albite, muscovite, and, locally, molybdenite. A stock of granodiorite outcrops in Bear River valley near Glacier creek and another smaller stock occurs near the head of Bear river. A small body of white, intrusive rock outcrops below the Silverado mine, Bear River district. 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. It is at least 200 yards wide and may be much longer. It lies at the contact between the batholith and Hazelton Group volcanic rocks. Several small stocks of granitic rock occur west and southwest of Summit lake north of Salmon River district. The rock of these bodies is granodiorite but is much more altered than is usual in the case of the Coast Range intrusives of the area. The various stocks may be associated in origin with the main batholith. In Salmon River district, Alaska, however, Buddington and Chapin[1] have secured evidence of the existence

[1] "Geology and Mineral Deposits of Southeastern Alaska"; U.S. Geol. Surv., Bull. 800 (1929).

of an older batholith and some of the stocks of Portland Canal area may be associated with it.

The exact age of the Coast Range intrusives is not determinable in Portland Canal area. They intrude the Hazelton group rocks and these are probably not younger than Jurassic. The intrusive may, therefore, be late Jurassic or younger.

DYKES

Dykes cut the Hazelton group rocks and the Coast Range intrusives. The sediments of the Hazelton group are cut by more dykes than the volcanics and these by more dykes than the Coast Range intrusives. The dykes range in age from Jurassic to Tertiary, in composition from gabbro to quartz porphyry, and in width from 1 inch to 100 yards or more. They have not been studied systematically and many more types than those to be mentioned may exist. It seems fairly certain that the dykes were not all from one source.

Commencing in the western part of Salmon River district a zone of closely spaced dykes of quartz porphyry and quartz diorite extends southeastward across Bear River ridge and Bear River valley to the Cambria snowfield. This zone has a width of about 1½ miles. Outside the zone country rock predominates, whereas within the zone dykes form 50 per cent or more of the whole assemblage.

In Salmon River district the dykes in the belt are hardly as closely spaced as in Bear River valley. Where the belt traverses the argillites north of Slate mountain in Salmon River valley only about half as many dykes are present as in volcanic rocks on either side of the argillites. The tops of several dykes in the argillites can be seen, the dykes being partly roofed by argillites. These tops are very blunt. One 20-foot dyke pinches out in a distance of 3 or 4 feet. The argillites are horizontal and may not have fractured as readily as the volcanics. It is unlikely that the uppermost argillites are younger than any of the dykes.

On the upper part of Bear River ridge the individual dykes are distinct bodies separate from one another. On the lower slopes of the ridge, in Bear River valley, the dykes are more closely 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 dykes are fairly numerous and wider dykes 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 small dykes resemble gabbro.

The dykes of this zone may be the top of an elongated stock. It is possible that a zone of weakness 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.

Dykes of diorite are very plentiful in the sediments on the shores of Alice arm near the contact of the batholith. They were not studied in any quantitative way, but the general impression was gained that the dykes nearer the batholith took on more and more the look and mineralogy of the batholith itself. If this were an established fact it would indicate that the batholith was the source of the dykes. Dykes are common even at the head of Alice arm 4 miles from the contact.

Dykes appear to be more plentiful in the western half of Alice Arm district than in the eastern half and this would be a natural result if the batholith were the source of all dykes because they probably would be more numerous nearer it than farther away. On the other hand dykes appear to be less plentiful in the Copper Belt than elsewhere in the Kitsault body, thus suggesting that some of the dykes may be related in origin to some part of the Kitsault igneous body.

One dyke of fine-grained gabbro or basalt crossing Illiance river in the vicinity of Table mountain closely resembles the Tertiary lavas in general appearance and in mineral composition. It is suggested that this dyke is associated in origin with the Tertiary lava and may have been, indeed, a feeder of the flows.

Several dykes of augite porphyrite occur in association with larger bodies of the same rock. A dyke of augite porphyrite that occurs west of LeRoy mountain differs somewhat in general appearance from the larger bodies of augite porphyrite, but probably was derived from the same magma. A dyke on McGrath mountain consisting of acid plagioclase, orthoclase, and hornblende may be related to the augite porphyrite even though it differs in containing hornblende instead of augite.

Fine to coarse-grained dykes with a diabasic texture are fairly common in various parts of Alice Arm district. They are in general large dykes, 10 to 100 feet wide, and are known locally as diabase or diorite dykes. They consist chiefly of augite and labradorite. Some contain hornblende and some orthorhombic pyroxene. In some the plagioclase is andesine.

Some dykes very closely resembling the diabase or diorite dykes proved to be more acid types. They contain oligoclase-andesine, hornblende, and some orthoclase. It is quite probable that these are related to the diabase dykes and that all intermediate phases exist. The writer is inclined to believe that these dykes are related to the Coast Range intrusives. This belief is based only on indirect evidence. They do not resemble the Hazelton group igneous rocks as they probably would if they originated from them.

Dykes ranging from aplite to granodiorite occur but are not clearly one series. Aplitic dykes are uncommon. One near the wharf at Alice Arm is a white dyke containing small quartz and albite phenocrysts in a very fine-grained groundmass of muscovite, feldspar, and quartz. Another very light-coloured dyke proved to be a quartz porphyry and of somewhat coarser grain. These dykes may be related to the Coast Range intrusives.

The commonest dykes are known as lamprophyre dykes. They are younger than the quartz diorite dykes and commonly also younger than the mineral deposits. Some are very like the felsites of the district and are

presumably related to them. Most of the so-called lamprophyres are narrow, dark-coloured dykes such as are commonly present in British Columbia along the eastern border of the Coast Range batholith. Most of them may be related to the Coast Range intrusives. An uncommon type, a minette, occurs in the workings of the Silver Chord group. The dyke is 2 feet wide and intrudes argillite. It consists of biotite, orthoclase, and albite. Apatite is a common accessory.

While carrying on geological work for the Granby Consolidated Mining, Smelting, and Power Company at Anyox, Bancroft noted that dykes were more numerous in the argillites than in the amphibolite and that where the argillites are crumpled, dykes are especially plentiful. Bancroft listed the following varieties, named in order of age from youngest to oldest, as being present.

Dark-coloured basic dykes.
Light-coloured felsites and quartz porphyry dykes.
Dark-coloured diabase, diorite porphyrite, and gabbro dykes.
Dark-coloured augite and mica-bearing dykes.
Light-coloured aplite, pegmatite, and granite dykes.

Bancroft states that in general the dykes are not foliated and, therefore, are later than the deformation of the amphibolite and sediments. They are also later than the ore deposits of the Hidden Creek and Bonanza mines. He believes that the oldest dykes, the aplites, granite, and pegmatites, were associated directly with the intrusion of the Coast Range granodiorite and that the others mark the close of the Coast Range igneous activity. The present writer did not study the dykes of Anyox district in detail but did find that some dykes were foliated, and is inclined to believe that those basic dykes closely resembling the Anyox amphibolite are associated in origin with it rather than with the Coast Range intrusives.

Near the edge of the Coast Range intrusives in Anyox, Marmot, Bear, and Salmon Rivers districts, large dykes and sills of granodiorite and quartz diorite intrude the older rocks. They are very like the batholith rocks in mineral composition but most of them are somewhat different in texture, many of them being porphyritic. On mount Dolly, Bear River district, a dyke of this type cuts volcanic rocks and can be traced into the batholith where a short distance from the border it merges with the batholithic rock. These dykes are obviously associated in origin with the Coast Range intrusives.

TERTIARY LAVAS

Basaltic lavas cap Table mountain (south of Alice Arm). Four other such bodies occur between Table mountain and Nass river and presumably at one time formed a single body. The rock lies unconformably on older sediments. The lava is in horizontal beds 10 to 30 feet thick having a total thickness on Table mountain of 300 to 500 feet. The lava locally exhibits columnar jointing and the debris at the base of the lava cliffs consists of hexagonal blocks. The rock is commonly porphyritic. The phenocrysts are labradorite, enstatite, and augite. The groundmass is finely crystalline and contains plagioclase, augite, enstatite, olivine, apatite, and black iron oxide. The rock is locally amygdaloidal, the amygdules containing calcite.

PLEISTOCENE AND RECENT

Boulder clay is present in a few places in upland country, notably near the head of Goat creek, Alice Arm district; and in valleys, as along Bitter creek and upper Bear river. Much of the lower part of Cascade Creek valley, Salmon River district, is covered with boulder clay. Recent moraines built by the present glaciers exist along their sides and lower ends. Boulders or erratics occur throughout the area up to 6,000 feet above sea-level. Glacial striæ are present in many places and parallel the main valleys.

Stratified blue clays occur in Kitsault, Dak, Illiance, Bear, Salmon, and Marmot Rivers valleys. They lie at elevations of from 400 to 550 feet above sea-level. McConnell has described the clays of Bear river and by finding marine shells proved their recent age. He estimates the clays to be 155 feet thick. Clays and silts also occur on the flat on which the town of Anyox has been built, and around Carney lake at elevations of about 100 feet above sea-level. Bancroft collected marine shells from the clays at Anyox 120 feet above sea-level. He supplies the following list: *Neptuna despecta, Natica clausa, Bela turricula, Acmaea caeca, Acmaea testudinalis, fissurella, Cardium islandicum, Pecten islandicus, Mya truncata, Leda permula, Marcra ovalis, Terebratella transversa,* and fragments of serpula and a large barnacle.

Varved clays occur on Tide Lake flat at the northern end of the area. The clays cover an area of 3 or more square miles and are estimated to be about 150 feet thick at the thickest place. The clays were formed from very fine material carried into a lake by glacial streams. The top clay layer was formed about the year 1929 and it is roughly estimated that the lowest layer is 2,000 to 3,000 years old. The clays have been described by the writer.[1]

Small flood-plains of Recent gravels exist along the three main valleys of Alice Arm district. Gravel deltas exist at the mouths of the smaller streams. The flat at Alice Arm, about 2 square miles in area, has been built up of silt carried by Kitsault, Dak, and Illiance rivers. At the edge of the flat on the south side of Dak river are three gravel terraces, respectively 150, 275, and 300 feet above sea-level. At the mouth of Illiance river on the south side there is also a mound or terrace of coarse gravel about 100 feet high. On Lime creek, gravel terraces exist at about 275, 300, and 450 feet above sea-level. It is difficult to understand how the gravel terraces at the mouths of Illiance and Dak rivers could have been built unless at the time of their formation the sea stood at a higher relative elevation than now.

Coarse, bouldery gravel exists at the mouths of the streams entering Kitsault river from West creek south to Alice arm. At Klayduc creek gravels of this nature are between 150 and 400 feet thick and lie north of the junction of Klayduc creek and Kitsault river. The top of the gravel is somewhat over 500 feet above sea-level. Granite creek some years ago became partly dammed by rock debris from slides and the water

[1] "Varved Clays of Tide Lake, B.C."; Trans. Royal Soc., Canada, 1932, sec. IV, pp. 335-343.

backed up to a considerable extent before the dam broke. The water came down with great force and built up a large tract of boulder delta. It may have been through such accidents and during flood times that the gravel and boulder deltas of the tributary streams were laid down.

At the horseshoe bend on Illiance river the stream has changed its course. The bottom part of the old channel is filled with stratified gravel and sand. Kitsault river from West creek south flows in a graded flood-plain of recent gravel except for two short rock canyons apparently representing new courses taken by the stream.

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 banks undercuts them and in this way widens the treeless part of the valley bottom. The town of Stewart is situated on the seaward end of the delta. 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 streams entering Portland canal from the east are small and the deltas at their mouths are also small. The largest are at the mouths of Marmot and Georgia rivers.

At the head of Hastings arm the main stream valley is filled with gravel and silt for a distance 4 miles from the sea. Hastings creek entering Hastings arm and several creeks entering Granby bay at Anyox have deltas.

FAULTS

Faults are 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.

No faults of great magnitude were seen in Alice Arm district but faults of small offset are numerous. A fault of unknown offset strikes northeast in lower Illiance River valley. A few faults striking northeast cross Kitsault river near Evindsen creek. Most of the recognized faults were seen in underground workings. The Dolly Varden vein has been offset by a number of parallel faults striking in the main north-northwest. These faults appear to be steeply dipping, reverse faults. The eastern side of each fault has moved south with reference to the western side. The greatest horizontal offset noted was 160 feet. Some faults in the Dolly Varden mine with horizontal offsets of 50 feet have very little crushed rock along the fault plane. The surface at the Dolly Varden mine is one of moderate slope with many dry gullies 5 to 30 feet deep. Many of these gullies have been formed along the crushed outcrops of faults. A northerly striking fault crossing the LaRose mining property has a crushed zone several feet wide and may represent a considerable displacement.

In the vicinity of Anyox several faults are known to have large displacements. A northwesterly striking fault dipping steeply northeast is followed by Bonanza creek. This fault has a vertical throw of at least 800 feet; the horizontal offset is not known. The northeast side has dropped down. A northerly striking fault with a horizontal offset of 2,500 feet is followed for some distance by Falls creek. The east side has moved south with reference to the west side. Two northerly striking faults with smaller offsets are exposed in the workings of the Hidden Creek mine at Anyox.

A fault in Marmot River valley offsets a bed of limestone at least 400 feet. Many straight, narrow valleys in the Bear River district follow crushed zones but in most cases the total amount of differential movement was not discovered. The belt of dykes already referred to is apparently offset 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. The fault probably branches at American creek, the main branch following the creek. The apparent horizontal offset along this fault in Bear River valley is approximately 1½ miles. The east side has moved southward or the west side northward. In view of the fact that the apparent offset is measured by the displacement of intrusive contacts and since such contacts 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 does exist. The fact that other faults in the district 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 had been essentially vertical marked differences should exist between the mineral deposits on opposite sides of the fault and that is not the case.

The Bear River fault may branch at Stewart, one branch continuing across Bulldog creek and along Georgia river, and the other branch, if there is another, continuing along Portland canal. It is very likely that the fault along Georgia river strikes south along the south fork of the river and thence down along Falls creek. This would link up the Falls Creek fault with the Bear River fault. If these faults are part of a single fault the Bear River fault is then apparently 50 miles long.

Most of the faulting took place after the intrusion of the Coast Range batholith but prior to the intrusion of most of the dykes, for though the dykes are commonly offset by faults yet the offset is in general much smaller than the total offset along the fault. Some of the faults preceded some of the mineral deposits, but most of the known faults are later than the mineral deposits.

ORIGIN OF PHYSICAL FEATURES

The mountains and valleys of Portland Canal area are closely related to the hardness and structure of the rocks. The area in general is characterized by high, jagged mountains and is in marked contrast with the subdued mountains to the east. This difference is due in part at least to the fact that the rocks of the area are harder than those of the adjacent part of the interior of British Columbia. The main valleys and mountain ridges are parallel to the strike of the rocks, and there can be little doubt that the structure controlled the location and development of these features. The higher mountains in the area consist of rocks relatively resistant to erosion.

Detailed examination of the area suggests strongly that the location of the main valleys and inter-valley ridges was controlled by the bedrock structure and that the main features were fixed prior to the Pleistocene epoch. The effect of the Pleistocene has only been to greatly modify the shapes of the pre-existing land forms, to disorganize the drainage to some extent, and to develop many minor features, as for example glacial cirques. Erosion since the Pleistocene has formed many or all of the canyons of the area.

A plateau surface 2,000 feet high extends from Alice Arm district south to Nass river. The surface appears to rise northward and in Alice Arm district to be represented by isolated, flat or gently sloping surfaces from 3,000 to 4,000 feet high. This plateau is probably an extension into the Coast Range mountains of an old erosion surface found over a large part of the interior of British Columbia. The plateau and the Coast Range mountains probably at one time merged into one another, but very active glacial erosion in the Coast Range mountains has destroyed most or all of the plateau surface there, and has given the coast section a very youthful appearance in contrast with that of the interior.

Kinskuch lake, in the northeastern part of Alice Arm district, apparently occupies an ice-scoured basin. Upper Illiance river follows the strike of soft, sheared rocks, and the westerly part of its course is along a contact between volcanic rocks and sediments. A waterfall, 150 feet high, on the river, is caused by a wide diorite dyke that acted as a resistant dam. The canyons on Dak river occur where the stream crosses igneous rocks and the broader parts of the valley are cut through softer sediments. The tributaries of Dak river are very deeply incised, apparently because they are located in bands of sediments whereas the intervalley ridges consist of harder igneous rocks.

The two upper canyons on Kitsault river are cut in hard, igneous rocks, but the broad, open parts of the valley are in sediments. The lowest canyon is in sediments intruded by several large dykes and the assemblage is apparently more resistant than the average sedimentary rock. The valleys of most of the tributaries of Kitsault river are in sediments in their upper parts, but in igneous rocks near the main stream. The upper parts of these valleys are broad and the stream gradient is gentle, whereas the lower parts are in general canyons and the grade is steep. The hardness of the rocks has had a great deal to do with the shapes of the tributary valleys, but their hanging nature has resulted mainly from greater deep-

ening by erosion along the main stream. The lower part of the valley of East creek is unusually deep and steep sided. This stream has cut through igneous rocks to underlying sediments and in these softer rocks it has rapidly cut its way down to a normal steep gradient, whereas the upper slopes of the canyon have been worn down only a relatively small amount because the rocks are more resistant. Falls on Canyon and Falls creek are caused by horizontal beds of hard, siliceous argillites.

The course of Falls creek in the vicinity of Anyox is south parallel to the strike of the rocks. The lower 8 miles of the valley also follows a fault. The smaller streams in the vicinity are related to the bedrock structure only in a minor degree, as glacial deposits have disorganized the earlier stream pattern.

The large valley occupied in the north by American creek and lower Bear river, and in the south by Portland canal, has for most of its length the steep-sided character of a glacially modified valley. It follows the strike of the rocks for part of its length, the contact of the Coast Range intrusives for another part, and a major fault for much of its length. The valley of Upper American creek is V-shaped, and the valley takes on the glacial U-shape a short distance north of Bear river. The valley originated long before the Pleistocene but has been greatly modified by glacial erosion. The ice did not move south from the head of American creek but entered the valley from the sides mainly along upper Bear river, Bitter and Glacier creeks, and Marmot and Georgia rivers. Upper Bear River valley is a through valley between the lower Bear River valley and the Nass River drainage basin. It is not known whether this was a through valley prior to the Pleistocene or was cut largely by ice. If cut mainly by ice this could have taken place only at a time when ice covered the interior to considerable depth, for Meziaden lake lying in the valley 10 miles east of the head of Bear river is 1,200 feet or more lower than the divide.

West of Bear River ridge the north-south valley occupied by Divide and Long lakes is a through valley between Bowser river and Copper creek, a branch of Cascade creek. The divide is at an elevation of 3,500 feet and the pre-Pleistocene divide was probably lowered by ice erosion. The part of Cascade creek between Harris creek and Long lake is a recent diversion from a former course south to Cooper creek. This diversion was probably caused by glacial accumulations in the valley south of Long lake.

The Salmon River-Bowser River valley is also a north-south through valley with a present ice summit about 2,800 feet high. The valley is probably not the course of pre-Pleistocene drainage from the interior as it is not very large and has certainly been enlarged by ice erosion. Ice from the interior has not moved south along the valley to any extent, for at the southern end of the valley only the higher slopes are U-shaped.

CHAPTER III

ECONOMIC GEOLOGY

GENERAL STATUS OF MINING

Portland Canal area has been prospected for metalliferous deposits since 1898, but although possessing many deposits of merit did not receive a great deal of attention from mining companies until 1908. Various parts of the area, such as Bear River district and Alice Arm district, although adjoining are in reality divided by the physical features of the country into separate parts so that mining activity in one part is distinct from that in another. Prospecting and development of mineral properties took place first along the shores of Portland canal and Observatory inlet and very shortly after along Bear river. The more inaccessible parts such as Alice Arm district, Marmot River district, and Salmon River district were prospected later.

Staking of mining claims along Portland canal and in Bear River district began in 1898 but did not attain great proportions 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 Bear River valley was staked by 1910 and has since been held or restaked. Since the time of the first mineral strike in the district 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 Company completed the Portland Canal Short Line railway, a standard gauge railway, from Stewart to the Red Cliff mine at the mouth of American creek. The railway was never much used and is now beyond repair.

Bear River district has produced gold, silver, lead, zinc, and copper. Production began in a small way in 1909 and has been continued intermittently by several properties. The total production from Bear River district up to the end of 1932 is given below (exclusive of several hundred pounds of molybdenite).

Ore	Gold	Silver	Lead	Zinc	Copper
Tons	Ozs.	Ozs.	Lbs.	Lbs.	Lbs.
31,100	5,830	2,102,050	1,953,000	1,660,000	71,000

In Anyox district mineral claims were staked in 1898 and although the stakings prior to 1900 were developed year by year it was not until 1914 that mining and smelting began at the Hidden Creek mine. There

has been a steady annual production from Anyox district since 1914. The total production to the end of 1932 is given below. Practically all of the ore has come from the Hidden Creek mine. The next most important producing property was the Bonanza mine.

Ore	Gold	Silver	Copper
Tons	Ozs.	Ozs.	Lbs.
19,700,000	108,470	6,116,000	577,873,900

Salmon River district was early prospected to some extent, but the principal claims of the Premier mine were not staked until 1910 and it was 1917 before the property became a mine of value. Production from Salmon River district has been almost entirely from the Premier mine, only a few others, most important of which are the Big Missouri and B.C. Silver mines, have produced ore. The total production of Salmon River district up to the end of 1932 is given below.

Ore	Gold	Silver	Lead	Zinc
Tons	Ozs.	Ozs.	Lbs.	Lbs.
2,359,900	1,283,650	32,812,300	1,900,000	13,000

The first discovered deposit of value in Marmot River district, the Porter Idaho, was not staked until 1919. Marmot River district is nearer tide water than Salmon and Bear River districts, but is very difficult of access. The production from Marmot river has been almost entirely from the Prosperity and Porter Idaho mines. The total production of the district up to the end of 1932 is given below.

Ore	Gold	Silver	Lead
Tons	Ozs.	Ozs.	Lbs.
27,400	680	2,181,000	1,643,000

Seven properties of Alice Arm district have marketed ore. The Esperanza has the longest shipment record, beginning in 1911 and ending temporarily in 1927. The Dolly Varden was mined for only three years, from 1919 to 1921, but produced nearly all the silver of the district. The total production of the district is given below.

Ore	Gold	Silver	Lead
Tons	Ozs.	Ozs.	Lbs.
27,400	120	1,423,000	29,000

The total production of the whole of Portland Canal area up to the end of 1932 is given below.

Ore	Gold	Silver	Lead	Zinc	Copper
Tons	Ozs.	Ozs.	Ozs.	Lbs.	Lbs.
22,145,700	1,398,460	44,634,350	5,525,000	1,673,000	577,944,900

GENERAL CHARACTER OF THE MINERAL DEPOSITS

Portland Canal area, like other mineralized areas along the east side of the Coast Range intrusives, has a great variety of mineral deposits, but the deposits of similar nature occur in groups. The physical features of the area divide it into separate parts and geologically the area is divisible into parts conforming somewhat with the topographical divisions.

Alice Arm District

The deposits of Alice Arm district form six groups:

Molybdenite deposits.
Quartz veins containing one or more of the metals silver, lead, and zinc.
Copper-bearing deposits.
Zinc blende deposits.
Silver-barite-jasper deposits.
Silver-lead deposits.

It might be assumed that the various types of deposits are the result of zoning from a single source. But no evidence could be found of any change or gradation from one type to another nor does there appear to be any uniform change from high to low temperature varieties in any one locality as would be expected if the deposits came from a single source. Instead, types appear to be quite distinct from one another as if each such type came from a separate source.

MOLYBDENITE DEPOSITS

Two molybdenite deposits occur in the southwestern part of the district. Both are closely associated in place with small bodies of granite regarded as being part of the Coast Range intrusives. On the property developed by Tidewater Molybdenum Mines, Limited, the molybdenite occurs in pegmatitic quartz veins that appear to be offshoots from a small stock of granite. The granite locally contains patches of disseminated molybdenite. The rocks intruded by the granite and in which the veins occur are hard, argillaceous quartzites. The second deposit is not well exposed, but the molybdenite appears to be disseminated through dykes and a small body of granite intrusive into the sedimentary rocks.

On the property of Tidewater Molybdenum Mines, as well shown on the surface and in underground workings, the molybdenite occurs in thin, flaky seams distributed throughout the quartz veins. The veins strike toward the body of granite mentioned and on reaching the granite cease,

apparently as a result of merging with the granite. This evidence and also the fact that locally the granite contains disseminated molybdenite suggests strongly that the veins and the molybdenite were derived from the body of granite during its consolidation. Dolmage[1] examined the veins in 1922 and states that approaching the intrusive body they change gradually from quartz veins to aplite dykes. The average grade of the ore is probably less than 2 per cent molybdenite, but the ore is very free from other sulphides such as pyrite. The veins are up to 10 feet wide but the tonnage of available molybdenite is not great unless the veins show a marked improvement in depth.

The second deposit characterized by molybdenite disseminated in dykes and a small body of granite has not been explored sufficiently to permit estimating grade or tonnage.

QUARTZ VEINS CONTAINING ONE OR MORE OF THE METALS, SILVER, LEAD, AND ZINC

Quartz veins of this group are practically restricted to the south-western quarter of Alice Arm district. About twenty-five such veins have been opened sufficiently to show the type of mineralization. All cut sedimentary rock which at most properties consists of black argillites interstratified with argillaceous quartzites. Some veins, as for example the LaRose vein, are of good size and persist only where they penetrate the harder, competent beds. Others, like the Wolf and Esperanza veins, are of value where they cut argillite, and still others such as the main Esperanza vein are largest and richest where they have a certain attitude or structure. Some of the veins adjoin narrow lamprophyre dykes, as is the case of the Silver Chord and Wolf veins.

The veins are in general less than 6 feet wide and most of the well-mineralized veins are less than 3 feet thick. Some quartz veins in the area are barren of sulphides and one of these on the Macy claim was mined for a short time by the Granby Consolidated Mining and Smelting Company as flux for their smelter at Anyox. Most of the quartz veins contain some sulphide, chiefly pyrite, some of them contain silver minerals such as the ruby silvers and argentite and have been mined as silver ore. Most of the silver-bearing quartz veins also contain some lead and zinc sulphides. Some of the veins contain galena and sphalerite and no silver. A few contain small quantities of scheelite.

Only three of the veins have produced ore and, therefore, sufficient information to formulate any general conditions governing the formation of ore shoots is lacking. The LaRose ore shoots occur only where the country rock fractured readily and thus gave rise to larger openings. In the Esperanza vein the richest and largest ore shoots lay along the apex of the gently plunging anticlinal form that has been assumed by the vein.

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[1] "Coast and Islands of British Columbia between Douglas Channel and the Alaskan Boundary"; Geol. Surv., Canada, Sum. Rept. 1922, pt. A, p. 31.

The source of the deposits is not known, but is assumed to be underlying parts of the Coast Range intrusives.

The quartz vein deposits can provide only small tonnages. They are in general too narrow to be attractive as sources of flux and can be mined only in a small way as silver ore.

COPPER-BEARING DEPOSITS

The copper-bearing deposits are of two types: (1) vein-like replacements and veins; and (2) disseminations. Very few deposits of the disseminated type occur, but they as well as the vein or vein-like type occur in a well-defined belt known locally as the "Copper Belt". In upper Kitsault valley fifteen or more copper-bearing deposits lie in the Copper Belt and one lies in adjacent sedimentary rock. The Copper Belt is between 5 and 10 miles east of the edge of the Coast Range intrusives and is nearly but not exactly parallel to the contact. The belt is 15 miles long and about 1 mile wide.

Copper mineralization occurs also in the northeastern part of Alice Arm district, in the vicinity of Kinskuch lake, but no deposits have yet been outlined there. A few copper-bearing deposits occur in the southern part of the district in rock that appears to be a southern continuation of the Copper Belt.

The rocks of the Copper Belt proper compared with the other igneous rocks of the area are highly sheared and much altered to, or replaced by, such minerals as sericite, chlorite, calcite, and pyrite. The belt consists chiefly of fine-grained, fragmental volcanic rocks and of crystalline rocks that are probably mainly intrusive. In places the rocks could not be identified as certainly either massive or fragmental. Inclusions of sedimentary rocks in the intrusives are fairly common. Some inclusions contain considerable disseminated pyrite and chalcopyrite. The rocks are not different in mineral composition from the other rocks of the area, but the belt is distinguished by the presence of copper deposits, by the sheared nature of the rock, and by the universal presence of pyrite. The belt may continue south and the rocks may change from felsites and feldspar porphyries to augite porphyrites.

The disseminated copper deposits appear to be very low grade and have not been developed to any great extent. No definite ore-bodies have been found. If any exist they will probably be in areas where copper is more than ordinarily plentiful. The deposits were formed by the thorough soaking of the fractured rock with mineral solutions. The deposits of this type are well exemplified by those on the Red Bluff group. On this property a rock of felsite or augite porphyrite type has been sheared, shattered, altered to sericite, chlorite, and calcite, and into it disseminated pyrite, chalcopyrite, and pyrrhotite have been introduced.

The veins and vein-like replacements have received some attention and a few have been developed by adits and by diamond drilling. No considerable tonnage of copper ore has been indicated at any place, but a few, vein-like deposits several feet thick, a few hundred feet long, and containing 2 to 10 per cent copper have been encountered. The deposits

consist in the main of chalcopyrite with a variable amount of pyrite. In most cases there is very little gangue except country rock. The general character of the veins of this type of deposit is well illustrated on the Vanguard property where the chalcopyrite-bearing veins vary in width and are not in general more than 10 feet wide. The wider parts of the veins contain rock fragments and gangue minerals as well as chalcopyrite. In some places several, narrow, closely spaced veins are present instead of one large vein. Some of the narrow veins up to 2 feet wide appear to consist entirely of chalcopyrite. Locally pyrite is plentiful. At the Wildcat similar veins occur and argillite inclusions in the intrusive country rock are impregnated with pyrite and chalcopyrite.

Vein-like replacements are well exemplified by the deposits on the Red Point group. These are rather irregular in shape. Some are veins with quartz gangue and others are sulphide replacements of country rocks.

It seems probable that the intrusives of the Copper Belt are responsible for the chalcopyrite mineralization. This type of mineralization is confined to the Copper Belt and other types are lacking. If the chalcopyrite mineralization was genetically related to the body of Coast Range intrusives lying to the west it would be expected that some mineralization would be present in the area between the Copper Belt and the eastern border of the batholith, but no mineral deposits are known to occur there. Quartz-sulphide veins do occur, however, between the southern end of the Copper Belt and the eastern margin of the batholithic area. On the other hand, as already stated, on the Wildcat property small bodies of argillaceous rocks which are apparently inclusions in an intrusive rock are mineralized with pyrite and chalcopyrite and thus seem to indicate that the intrusive carried copper. Thus it appears that some of the intrusives of the Copper Belt were potential sources of copper deposits. The localization of the deposits within a definite band strongly suggests that their source was at some depth below the exposed part of the band.

The augite porphyrite body of McGrath mountain contains disseminated pyrite, pyrrhotite, and chalcopyrite. Even where the rock appears to be quite fresh the sulphides are present. It is not always possible to say whether these sulphides were introduced or are original constituents. Evidence obtained by the microscopic examination of the rock where altered suggests that the sulphides were introduced into their present position. The augite porphyrite appears to be closely related to the intrusives of the Copper Belt and may be a potential mineralizer, but there is a lack of any evidence that it should be regarded as being the source of the chalcopyrite deposits. So far as is known these deposits do not show gradations to any of the other types of mineral deposits of the area.

The commercial value of the deposits of the disseminated type is unknown. It is possible that work might outline large bodies of ore. The only reason for supposing otherwise is that no ore-body has yet been found, although the amount of prospecting and development work is perhaps sufficient to have located any existing ore-bodies.

The deposits of the vein type are of higher grade and are bounded by definite walls. None is large enough to yield a large tonnage, but several appear to have possibilities of becoming small producers.

ZINC BLENDE DEPOSITS

The zinc blende deposits, some half a dozen in number, are clustered on McGrath mountain at the edges of an irregularly shaped stock of augite porphyrite. The deposits occur in sediments, although in places the sediments are inclusions in the stock. No deposit is known to lie between walls of augite porphyrite, but at the deposits the rock is in general so altered that it is not always possible in the field to identify the wall-rocks. The augite porphyrite of the stock is composed of unaltered augite phenocrysts in a greenish grey, altered groundmass. The rock, however, presents a fresh appearance in hand specimen. Pyrite and pyrrhotite are common.

The deposits are in part vein-like, in part appear to be replacements along bedding planes in sedimentary rock, and in part have no demonstrated form or attitude. Some deposits are probably of large size, as single exposures more than 20 feet across are not uncommon, but no single large deposit has been outlined by development work. The two striking features of the zinc blende deposits are: (1) they are clustered in one place; and (2) the mineralization is resin-coloured sphalerite with practically no other sulphide. The gangue is mainly quartz and calcite. Development work on the deposits has not been at all extensive, but the results obtained suggest that the deposits farthest from the stock of augite porphyrite are the most persistent but may not be so wide as those at the border of the stock or in sedimentary inclusions in the stock.

The vein-like deposits are of quartz and calcite and some contain small shoots of sphalerite. Some of the veins are well-defined but are in general of small size. Some deposits are vein-like in that they are roughly tabular but lack definite boundaries. One such body on being followed by an adit was found to end abruptly. This body consisted solely of sphalerite. In one or two places a bed of argillite has apparently been replaced, in some parts very imperfectly and in others almost completely, by sphalerite with some calcite and quartz. A very common type of deposit is a breccia of rock fragments cemented by sphalerite. Such deposits are evidently broken or crushed zones along which sphalerite has been deposited chiefly by filling spaces rather than by replacing the country rock.

The origin of the zinc blende deposits like that of the copper deposits cannot be satisfactorily ascribed to the Coast Range intrusives because of their extremely localized occurrence and the lack of any zonal relationship to deposits of other types. The localization is what would be expected if the augite porphyrite or some unexposed phase was the source of the zinc blende. As the mineral-bearing fractures away from the stock are more persistent and tend to be narrower than those nearer the edge of the stock it might be argued: (1) that the fractures are local developments whose formation was influenced by the presence of the stock; and (2) that more mineral was available near the stock than farther away. It is conceivable, however, that the fractures are of regional origin and owe their habit to the presence of the stock which would not then be the source of the mineralization. On the other hand several deposits occur in what appear to be inclusions of argillite in the stock and if these actually are inclusions then

the zinc and sulphur surely reached the inclusions by travelling upward through the augite porphyrite and presumably came from this rock. On the whole, however, the main reason for relating the deposits to the stock is their position at the borders of the stock.

Development work on the zinc blende deposits has been so meagre that it is impossible to state the trend or width of most deposits. There are, however, a great many places where zinc blende mineralization has been found and it is reasonable to expect that moderately large bodies exist.

SILVER-BARITE-JASPER DEPOSITS

The silver-barite-jasper deposits are known to occur only in the northern part of the Kitsault igneous body where within an area 6 miles long and 1 mile wide fifteen such deposits have been found unaccompanied by any other types of mineral deposits. They occur in felsitic rocks that are mostly of intrusive, not extrusive types. The deposits are characteristically vein-like replacements and are commonly 10 to 15 feet wide but range in width from 5 to 40 feet or, as in a few instances, to as much as 75 feet. A few may be simple fissure fillings, but nearly all are mineralizations along brecciated and crushed zones where ore matter has partly replaced rock and partly filled open space. Fragments of country rock are numerous in some, whereas in others no such fragments occur. Some deposits, for example those of the Dolly Varden mine, consist of dark vitreous quartz presumably replacing country rock and containing pyrite, galena, sphalerite, tetrahedrite, and silver minerals. Most of the deposits also contain very much barite and some consist mainly of barite. Many also contain jasper or hematite-bearing quartz and in one deposit, the Toric, the vein matter is mostly barite, jasper, and hematite.

The ore is in general of moderate to low grade but where secondary enrichment has taken place, as at the Dolly Varden mine, bonanza silver ores containing up to 1,000 ounces of silver to the ton have resulted. Much of the ore contains a small percentage of galena and 5 to 15 ounces of silver a ton. Ore has been mined from three deposits of this type. One mine, the Dolly Varden, produced 1,300,000 ounces of silver that occurred chiefly as native silver, silver sulphides, and silver-bearing tetrahedrite.

Deposits of the silver-barite-jasper type do not grade into other types except that at the north end of the small area within which they are confined they appear to grade to deposits holding very little silver and containing quartz, or fine-grained galena, or a fine-grained mixture of galena and sphalerite. One of the deposits at the north end of the district that contains fine-grained galena and sphalerite holds some orpiment and realgar but no jasper or barite. This appearance of a gradational change from the silver-barite-jasper type in the south to a fine-grained, galena-sphalerite type in the north would ordinarily be interpreted as indicative of a change from deposits typical of higher temperatures to others of lower temperatures. There are, however, only two or three deposits of the lower temperature type at the north end of the belt and gradation has not been established. If it were established, it would suggest that the source of the mineralization was nearer the present surface at the south end than at the north end of the area within which the deposits occur. The source of the ores

may be intrusive rocks not exposed at the surface and if so the source probably was deeper-seated parts of the felsitic rocks in which the deposits occur, thus accounting for the fact that this type of deposit is confined to the felsites and does not occur in the neighbouring argillites nor in the rocks of the Copper Belt.

Before the drop in price of silver, deposits of the silver-barite-jasper type were the most promising deposits of the area. Some are as wide as 75 feet and contain about 15 ounces of silver a ton. Most are smaller than this yet promise considerable tonnages.

SILVER-LEAD DEPOSITS

The silver-lead deposits occur in the eastern part of Alice Arm district in Illiance River valley. Although the deposits are mainly of the silver-lead type some are of mixed sulphide, and one consists chiefly of tetrahedrite. Most of the silver-lead deposits also contain tetrahedrite and it is this mineral that contains most of the silver. The deposits occur as gashes and lenticular veins in sheared and altered tuffs and breccias. The shearing is confined to a zone some 1,000 feet wide along the bottom of the upper part of Illiance River valley. The surrounding rocks are unsheared. In the shear zone the rocks have been extensively altered, chiefly to sericite and pyrite, and are now soft, white, and fissile. Alteration and shearing have been so extensive that it is difficult to distinguish different rock types. The deposits in general contain very little gangue but what is present is quartz. The deposits are as a rule less than 3 feet wide but many are several hundred feet long. The ore is in most cases quite fine grained.

The source from which the deposits came is not evident. The mineralization appears to be allied to that of the quartz-sulphide type near the head of Alice arm rather than to any of the other types in the area and it is assumed that the source is underlying parts of the Coast Range intrusives.

When the price of silver was high attempts were made to mine silver-lead ore in upper Illiance River valley, but these attempts were unprofitable. The known ore occurrences either outcropped or lay very close to the surface and very little development work was done. The sheared area is well defined. The deposits are restricted to it and lie parallel to the shear planes. With this knowledge search for further deposits becomes simple, and development can be planned to the best advantage. If the price of silver again rises, it can be expected that the area will afford small tonnages of high-grade ore.

Anyox District

The mineral deposits of Anyox district and of the area between Anyox and Portland canal are grouped into two types: (1) chalcopyrite replacement deposits; (2) quartz veins.

CHALCOPYRITE REPLACEMENT DEPOSITS

Several deposits of this type occur and lie either in the Anyox amphibolite or at the contact between the amphibolite and the adjacent argillites. The Anyox amphibolite and closely allied rocks occupy most

of the area between Anyox and Maple bay on Portland canal. The amphibolite intrudes argillites believed to be part of the Hazelton group and is itself considered to be part of the Hazelton group. The rock is locally severely sheared. The argillites are in general sheared and folded into tight folds. Argillite inclusions are numerous in the amphibolite. Some of these inclusions have been extensively silicified and this suggests strongly that the amphibolite was the source of the silica.

The chalcopyrite replacement deposits vary in size from vein-like bodies a few feet wide and a few hundred feet long to large, irregularly shaped masses as much as 1,000 feet long and deep and as much as 200 feet wide. The deposits in the amphibolite lie parallel to the shearing and are in general unaccompanied by silicification of the walls. Those in argillite are accompanied by extensive silicification. Locally the argillite has been converted into a light-coloured siliceous rock for a distance of 100 feet from the ore-bodies and less marked silicification extends for another hundred feet or more. That the deposits were formed by replacement is shown locally where the ore exhibits structures formerly present in the rock.

The ore-bodies of the Hidden Creek mine and the Bonanza mine are of this type. The Hidden Creek mine has produced steadily since 1914 and since 1920 has produced over 30,000,000 pounds of copper a year.

QUARTZ VEINS

Quartz veins are numerous in Anyox district and on Portland canal in the vicinity of Maple bay. Some of the veins lie in amphibolite and others in argillite. The veins in the argillite are commonly parallel to the bedding, are up to 20 feet or more wide, and some in the vicinity of Anyox are gold bearing. They consist in general of milky white quartz containing very little sulphide. One such vein near Anyox is up to 6 feet wide and was mined for many years to supply quartz flux for the smelter at Anyox. The flux contained about a tenth of an ounce of gold and about a third of an ounce of silver a ton. The veins in the amphibolite are of the same size as those cutting argillite. Some of them contain sufficient chalcopyrite to give rise to a copper content as high as 5 per cent. In general the veins can be followed along the strike for many hundreds of feet and some for more than 2,000 feet.

Quartz veins in amphibolite and at the contact between amphibolite and sediments are numerous at Maple bay. The veins there commonly contain chalcopyrite but very little of any other sulphide, and very little gold and silver. One vein of this type at Maple bay was mined for a number of years and the ore averaged about 2 per cent copper. Some of the veins at Maple bay are large and persistent and with a high price for copper could probably be mined at a profit.

The origin of the replacement and vein deposits is unknown. Coast Range intrusives occur nearby and no doubt underlie the deposits. These intrusives may be the source of the deposits, but if so several facts relating to the Anyox amphibolite are not readily explainable. The amphibolite certainly caused much silicification of the intruded rocks. The silicified rock and the replacement ore deposits are closely associated in space. Quartz

veins are common in and near the amphibolite, as would be expected since the amphibolite was capable of causing much silicification of intruded rocks. The quartz veins in the amphibolite contain copper, thus furnishing evidence of the close relation existing between quartz and copper and suggesting that the silicification exhibited at the edges of the copper-bearing replacement bodies was produced as a result of ore deposition. These conditions, and the further fact that the Anyox and Maple Bay types of deposits do not occur elsewhere, but only in and about the amphibolite area, all suggest that the deposits and the Anyox amphibolite are directly connected in origin. On the other hand the ore deposits in the Anyox amphibolite occur in shear zones. The amphibolite was, therefore, subject to shearing prior to the ore deposition. This is a serious objection to the idea that the amphibolite was the source of the ore. Furthermore, the ore deposits appear to be later than the earliest dykes that may be associated with the Coast Range batholith. However, it might be that the now exposed part of the body of amphibolite was solid and capable of being sheared, whereas in a lower part the magma might still be fluid and a source of ore. The writer is inclined to the view that the source of the amphibolite was also the source of the ores. The time of ore deposition may have been as late as the intrusion of the Coast Range batholith, and indeed the Anyox amphibolite may be an early phase of the batholith. If the amphibolite is the source of the ore, search for other similar deposits should be confined to the Anyox amphibolite and the immediate vicinity of this body.

Northern Part of Portland Canal Area

On Portland canal north of Maple bay and in Marmot, Bear, and Salmon Rivers districts, the mineral deposits can be divided into the following five groups:

Deposits containing gold, silver, lead, zinc, and copper.
Gold-quartz veins.
Deposits consisting of closely spaced gold-quartz veinlets.
Gold-pyrrhotite deposits.
Copper deposits.

The gold deposits and the mixed sulphide deposits of the first four groups may grade into one another and appear to be related in origin to the Coast Range intrusives. The copper deposits on the other hand do not appear to grade into the other types. They occur in four areas separated and surrounded by deposits containing gold, silver, lead, and zinc.

DEPOSITS CONTAINING GOLD, SILVER, LEAD, ZINC, AND COPPER

The mineral deposits of this group show considerable variation, but apparently all are members of a continuous series. Gold-silver deposits by addition of lead, zinc, and copper, and by decrease in gold and silver, change to silver-lead, silver-lead-zinc deposits and types with more complex mineralization.

Gold-silver deposits are well exemplified by the deposits of the Premier mine. These are well-defined, vein-like replacements up to 60 feet wide and as much as 2,000 feet long. The ore-bodies consist in general of pyrite.

galena, and zinc blende, with minor amounts of chalcopyrite, native gold, and electrum. Much of the ore is fairly solid sulphide with interstitial quartz gangue, but locally quartz gangue is so plentiful that the body might be called a quartz vein. From the surface to a depth of 600 feet much of the ore in the Premier mine contained more than 100 ounces of silver a ton in tetrahedrite, argentite, ruby silver, native silver, and other silver minerals, and several ounces of gold a ton occurring mainly as native gold and electrum. The Premier deposits occur in orthoclase and quartz porphyry containing many inclusions of sheared and altered tuffaceous rocks. Deposits much like those of the Premier mine occur elsewhere in Salmon River district in similar rocks, but most of these other deposits contain too little gold and silver to be valuable. The high-grade gold-silver type of ore so far as is known occurs only in porphyry country rock.

By increase in the content of lead, zinc, and copper, and decrease in the gold and silver values, deposits of different appearance and as a rule much lower grade result. At the Porter Idaho and Prosperity mines of Marmot river, for example, the deposits are veins in general less than 6 feet wide and consisting mainly of high-grade silver-lead ore. The principal mineral is galena, but there is much silver in silver minerals and in tetrahedrite. Examples of veins rich in zinc are those at the Dunwell mine where gold, silver, lead, and zinc were all of value and were recovered in mining. Deposits of this mixed type are commonly rather low in grade and must be concentrated prior to shipment. An increase of the copper content, as in some of the deposits at the Big Missouri mine, results in very complex ores, none of which has yet been mined. The lead-zinc type of mineralization occurs in deposits of many sizes and shapes. Commonly they are veins with definite walls and lying in argillites or volcanic rocks. Some of the veins are essentially quartz veins and only locally contain sulphide mineralization of the pyrite-galena-sphalerite type. In some of the veins on the Harner group the principal values are in gold. In some places, as on the Ben Bolt property, the mineralization is disseminated and forms tabular bodies 100 feet or more thick very sparsely mineralized with pyrite, galena, and sphalerite.

The deposits of the gold-silver or Premier type lie in porphyry and have a distinctive siliceous, pyritic appearance. It may be that these deposits are related in origin to the porphyry, but possibly the distinctive features of this type are due to the fact that the country rock is porphyry and the writer believes that this type and other types of the group although widely distributed are related to the Coast Range batholith. It is noticeable that gold and copper are more plentiful in the deposits of this group that occur near the batholith than in those farther away. As the gold and copper-bearing minerals are considered to indicate somewhat higher temperature conditions than the other minerals in these deposits, there thus appears to be a zonal arrangement with respect to the edge of the batholith.

In Salmon River district production has been almost entirely from deposits of this group, the chief producer being the Premier mine which affords gold and silver with minor amounts of lead and zinc. In Bear River district the ore mined has been mostly from deposits of this group, and

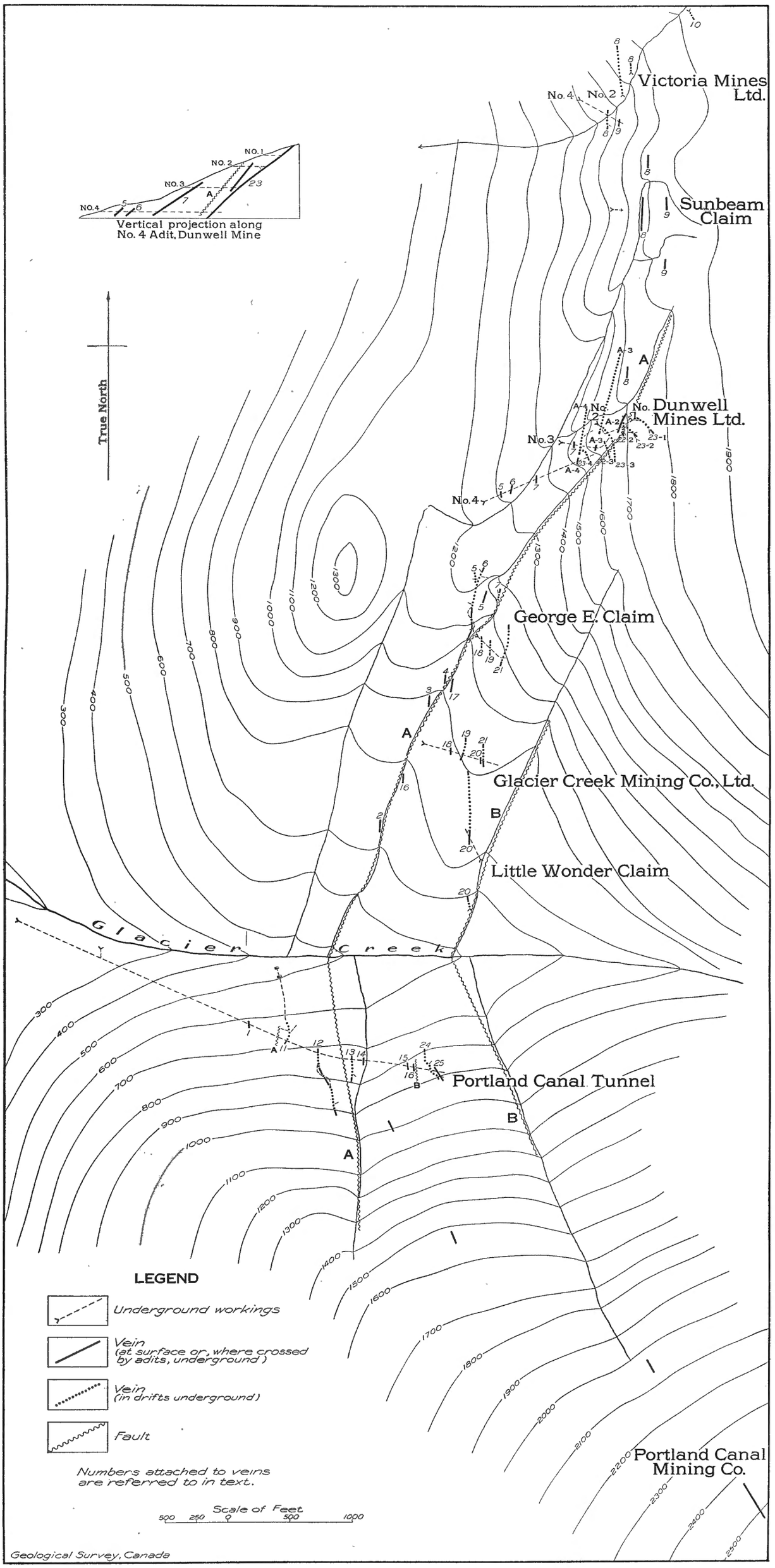

Figure 1. Northern part of Portland Canal fissure zone.

there lead and zinc were extracted as well as gold and silver. In Marmot River district the deposits mined were of the high-grade silver-lead type. With high prices for silver, lead, and zinc, many of the deposits in these districts might produce ore at a profit. Even at the present when prices are low several properties are operated at a profit.

Of special interest is the Portland Canal fissure zone, so named by McConnell after the Portland Canal mine. The fissure zone is in the upper argillites of the lower part of the Hazelton group and is characterized by shearing, faulting, and the presence of parallel, mineral-bearing veins. The width of the zone is variable and is as great as 1,500 feet in some 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 1. Only veins wider than 2 feet are represented and for simplicity some of the smaller mine workings are omitted.

The fissure zone, at Victoria Mines at its most northerly known point, lies in the argillites along their contact with overlying volcanics. Southward the zone departs gradually from the upper edge of the sediments and passes through lower members of the sedimentary series. Where the zone crosses Glacier creek it is still near the overlying volcanics, but is a few hundred feet from them. South of Glacier creek the zone diverges from the sedimentary-volcanic contact at a more rapid rate until at its most southerly known point it is well down in the sediments. The argillites strike north and dip west at 45 degrees. The strike varies to northwest or to northeast and the angle of 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 folded, sheared, and faulted. Shearing was restricted to the Portland Canal fissure zone and within it was confined to 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 the bedding planes at small angles, 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 their angle of dip in some places is steeper and in other places less steep than that of the argillites.

Two faults, perhaps formed at the same time as the narrow shear zones, follow the Portland Canal fissure zone. The faults strike north with, approximately, the average strike of the argillites, but the faults are fairly straight and crosscut the argillites at all curves or bends in the strata. These are common and, therefore, in most places the faults crosscut the beds. The angle of dip of the faults is in general steeper than that of the argillites. The narrow shear zones and the faults intersect at an angle generally less than 15 degrees but as great as 45 degrees in a few places. The angle of dip of the faults is in general steeper than that of the shear zones. After the faults and shear zones were initiated, differential movement continued along a few shear zones and along the faults.

After the formation of the faults and shear zones, the argillites were intruded by lamprophyre and other fine-grained dykes. The dykes strike north. In a few places their relations to the shear zones and the faults are known, as in the Dunwell mine where a dyke follows a shear zone, striking northwest, to a fault striking north, and continues north along the fault. After the period of dyke intrusion differential movements still continued, as is shown in the Dunwell mine, where the dyke already referred to is shattered and crushed at the junction of the shear zone and fault and here and there along the shear zone.

Later still the Portland Canal fissure zone was invaded by siliceous and ore-forming solutions. Quartz veins formed in the many shear zones and locally along the two faults. Some of the veins in the shear zones and most of the vein matter in the faults consist of barren quartz. Most of the known ore-bearing shear zones contain a dyke as well as an ore-bearing vein. For example, in the Portland Canal, Dunwell, and Victoria mines and on the Sunbeam claim the ore-bodies are along one or both sides of dykes, and in the Dunwell mine ore lies along the dyke both where it follows the shear zone and where it continues along the fault. It seems that in some way the dykes guided the ore solutions and perhaps helped to keep them within definite channels.

The veins on one side of either of the two main faults are believed to be distinct from those on the other side. The veins thus form three groups. One group consists of the veins west of the west fault; the second group consists of the veins lying between the faults; and the third group consists of the veins east of the east fault.

In the Dunwell mine the western fault (Fault A, Figure 1) is intersected by adits Nos. 2, 3, and 4, and is known as the North-South vein. On Figure 1 this vein as found on adit No. 2 level is labelled A-2, where found on adit level No. 3 it is labelled A-3, and in the case of No. 4 level, A-4. Farther south the fault is also cut by the adit known as the Portland Canal tunnel and on Figure 1 is labelled A. The eastern fault is crossed near the face of the Portland Canal tunnel and on Figure 1 is labelled B.

The most westerly vein of the group of veins west of the western fault is exposed in the Portland Canal tunnel and on the figure is vein No. 1. Proceeding northward the remaining known veins of the western group are numbered consecutively from 2 to 10. Veins Nos. 5 and 7 are exposed at the surface and also underground on the George E claim. Vein No. 5 divides underground into veins Nos. 5 and 6. The three veins crossed by No. 4 adit, Dunwell mine, are probably continuations of veins Nos. 5, 6, and 7. The vein crossed by No. 3 adit, Dunwell mine, is probably No. 7 vein. A vein exposed at the surface a short distance north of No. 1 adit, Dunwell mine, is probably east of No. 7 vein and, therefore, is called No. 8 vein. If it continues north into the Sunbeam claim it should lie very near the more westerly of the two veins on the Sunbeam claims and consequently, this vein, known as the Sunbeam vein, is considered to be No. 8 and the more easterly, the Sulphide vein, becomes No. 9. No. 8 vein projected north along its strike would practically lie in the position occupied by the most westerly (Main Reef vein) of the veins of Victoria mines, and this vein is, therefore, considered to be No. 8. The next vein

to the east on the Victoria claims would be No. 9. The next vein to the east, No. 10, has not been discovered farther south. The correlation between the veins of the Dunwell mine and those of Victoria mines may not be correct, as the veins may not continue so far or may be offset by faults. If, however, the veins continue 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, those lying between the two faults, are also numbered from south to north. Veins Nos. 11 to 16 are exposed in the Portland Canal tunnel. A vein exposed on the east bank of the creek followed by Fault A, 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 considered to be No. 16. Veins Nos. 18, 19, and 21 are exposed in the adit on the George E claim and farther south in the adit of Glacier Creek Mining Company in which No. 21 is known as the Green vein. 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. Vein No. 21 is a barren, quartz-calcite vein of exceptional size on both the George E and Glacier Creek Mining Company properties, and, therefore, the correlation of these two veins is probably correct. The veins exposed in the adits on the Little Wonder group, judging by their position, strike, and dip, are continuations of No. 20 vein. No. 22 vein, perhaps a branch of the Dunwell or No. 23 vein, is exposed in adits Nos. 2 and 3 of the Dunwell mine. No. 23 vein is exposed in all the Dunwell mine adits and on the surface.

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.

All the veins of the Portland Canal fissure zone are very much alike in most essential respects. They contain pyrite, galena, and sphalerite in a gangue of quartz and calcite. Some hold ore and everywhere the grade is low and uniform unlike the ore of nearby properties outside the fissure zone, for these exhibit marked variations in grade. Apparently all the veins in the Portland Canal fissure zone formed during one period and were produced by the same agents acting under uniform conditions.

Only a few ore-shoots have yet been discovered in the veins of the Portland Canal fissure zone and all are small. The sizes of the ore-shoots seem directly proportional to the sizes of the containing veins.

GOLD-QUARTZ VEINS

Gold-quartz veins occur mainly in Georgia River area. The country rocks are volcanic members of the Hazelton group bordered by a body of Coast Range intrusives. The veins are commonly 3 feet or less wide and locally contain several ounces of gold a ton. So far as is known the gold is largely in a free state. Locally the veins contain pyrite, galena, and other sulphides, but in general they consist of milky white quartz with very little sulphide. These veins resemble some of the quartz veins that occur near the batholith boundary in Marmot River district. Their nearness to the Coast Range intrusives and their gold content are factors

favouring a batholithic source. The writer, therefore, considers the whole of the Georgia River area of Hazelton group rocks as good prospecting ground. Some of the veins have been followed for 500 feet or more, but very little is yet known about the persistence of these veins. Only a small amount of development work has been done and, therefore, little is known of the value of the deposits.

DEPOSITS CONSISTING OF CLOSELY SPACED GOLD-QUARTZ VEINLETS

Deposits of this type are known only on the Big Missouri group of claims in Salmon River district where they occur in tuffs and breccias that strike north and dip west. Wide zones of these rocks are sparsely mineralized with disseminated pyrite, galena, chalcopyrite, and sphalerite, but this material is too low grade to be ore. The mineralized zones follow closely the strike of the tuffs but it has not been demonstrated that mineralization follows particular beds. The zones are traversed by veins of quartz and calcite mostly striking parallel to the strike of the rocks. In addition veinlets up to a few inches wide, but commonly about an inch wide and up to 50 feet or so long, are present and appear to be later than the sulphide mineralization and also later than the quartz and calcite veins. The veinlets locally contain a high percentage of native gold so that it would be possible to pick specimens giving phenomenally high assays. It seems probable that the gold values in the mineralized zones are carried almost entirely by the veinlets and, therefore, that the number and richness of the veinlets determine the grade of the mineralized zone.

GOLD-PYRRHOTITE DEPOSITS

Gold-quartz-pyrrhotite deposits occur at Summit lake north of Salmon river in an intrusive andesite porphyry. The deposits occur both as veins and as larger, tabular replacements. The veins are of quartz locally well mineralized with pyrrhotite. The replacements consist of practically solid pyrrhotite. Both the veins and the replacement deposits contain good values in gold. Granitic intrusives occur nearby and it is believed that underlying granites were the source of the deposits.

COPPER DEPOSITS

Copper deposits occur both as veins and as replacements. The deposits are for the most part in volcanic rocks, but a few are in sediments. The veins are mostly quartz veins well mineralized locally with chalcopyrite, pyrite, and arsenopyrite. Gold occurs in most of the veins, but the quantity is usually less than 0·25 ounce a ton. Jasper is a common gangue mineral in some veins. The veins are ordinarily 4 to 10 feet wide, but wider and narrower veins also occur. Many of the veins, especially those in the volcanic rocks, can be followed for a thousand feet. The replacements are in general somewhat leaner than the veins, but locally chalcopyrite may be plentiful. Gold values also appear to be lower than in the veins. The replacement deposits may locally be much wider than the veins but do not attain nearly the same lengths. The replacements in volcanic rocks commonly follow certain beds, and in general replacement has not been

thorough. Where sheared rocks are replaced the ore minerals occur disseminated in well-defined shear zones and as narrow veinlets within the mineralized zone. The copper deposits occur in four areas separated from one another by stretches holding other types of deposits.

One small group of copper-bearing deposits exists in the vicinity of the Red Cliff mine and a second group occurs in the vicinity of the Dalhousie mineral claims. The second group may extend south to include the holdings of the Prince John Mining Company. Both of these groups lie west of Bear river. A third group of copper deposits is on upper Bear river. It occurs on both sides of the valley and includes the George copper deposits. A fourth group lies on upper Bitter creek and includes the Hill 60, Sunshine, LL and H, Black Bear, and other mineral claims. Some 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 chalcopyrite deposits.

The significance of this segregation of the copper deposits is not understood. The deposits may have been derived from intrusives of the Hazelton group or they may have come from underlying granitic rocks of the Coast Range intrusives. If the source is the Coast Range intrusives it is strange that gradations from copper deposits to those of other types are not of common occurrence.

The copper deposits have been mined in a small way. The gold content of some may make mining profitable.

CHAPTER IV

DESCRIPTIONS OF PROPERTIES

ALICE ARM DISTRICT

Acadia Group (Locality 183)[1]

Reference: Annual Report of the Minister of Mines, British Columbia, 1929.

The Acadia group of two claims is on the eastern slope of mount Alice near the Esperanza mine. The mineral deposit is a 5-foot quartz vein in argillite and is mineralized with pyrite, pyrrhotite, chalcopyrite, sphalerite, and galena. Ore shoots of commercial grade have not yet been found.

Alamoza Group (Locality 179)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Alamoza group of two claims is on the southwest slope of McGrath mountain. The showings are stringers of quartz and calcite sparsely mineralized locally with sphalerite and occur in crushed argillite.

Alice Group (Locality 182)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1922, 1923, 1925, and 1929; Geol. Surv., Canada, Sum. Rept. 1928, pt. A.

The Alice group of four mineral claims lies north of the Lone Maid claim. The group is west of Kitsault river about 2 miles from Alice Arm. A trail extends from the Esperanza mine to the Alice group.

The country rock is argillite banded with argillaceous quartzite, strikes northwest and dips southwest at moderate angles. The rocks have been intruded by narrow lamprophyre dykes striking northeast.

The mineral deposit is a quartz vein varying in width from a few inches up to 3 feet. It lies parallel to the strata and has been traced along the surface for 1,500 feet northwestward from the southern boundary of the group. The metallic minerals in the vein are pyrite, arsenopyrite, galena, tetrahedrite, and silver minerals. An open-cut discloses a small shoot of high-grade silver ore, but the shoot is not present in an adit along the vein a short distance below.

The vein on the Alice group may be the northward extension of the main Esperanza vein. As it follows the bedding and is not covered by much overburden it is easy to trace and expose by open-cuts. Good silver ore occurs in the Esperanza vein and silver minerals do occur in the vein on Alice group. The property has been developed by open-cuts and four adits.

[1] This number appears on an accompanying map, where it indicates the approximate position of the property. Owing to the large number of properties, several may be indicated by a single number.

Anna Mack Claim (Locality 182)

Reference: Annual Report of the Minister of Mines, British Columbia, 1929.

The Anna Mack claim adjoins the Alice group on the southwest and is about 2 miles north of Alice Arm. An open-cut exposes a sparsely mineralized, 6-inch quartz vein in argillite.

B and C Group (Locality 157)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The B and C group of two claims is at an elevation of 1,000 feet on the north side of Granite creek about half a mile from Kitsault river. The country rock is argillite. The showing consists of a 6-inch quartz vein containing a little arsenopyrite, pyrrhotite, pyrite, sphalerite, galena, and calcite.

Basin Group (Locality 150)

References: Annual Report of the Minister of Mines, British Columbia, 1924; Geol. Surv., Canada, Sum. Rept. 1928, pt. A.

The Basin group of six mineral claims is on the grassy upland slopes at timber-line on the divide between Goat and East creeks. The property can be reached by a horse trail that ascends East creek or by a foot trail up Goat creek. There is no bridge across Kitsault river at East creek so horses must ford the stream. There is a cable ferry suitable for pedestrians across Kitsault river near the mouth of East creek, and a good bridge has been built over the river near Goat creek.

The country rock consists of augite porphyrite breccia and fine-grained, crystalline rocks. The showings are near the western edge of the Theophilus igneous body and a few hundred yards west are the underlying argillites.

Several mineral deposits are present on the property. One deposit consisting of quartz, pyrite, chalcopyrite, tetrahedrite, and sheared rock is locally 20 feet wide. It is probably a replacement along a sheared zone. Another deposit is a barren quartz-calcite vein 15 feet wide and probably more than half a mile long. Another deposit is in a flat-lying shear zone and consists of quartz, pyrite, arsenopyrite, chalcopyrite, and tetrahedrite. The exposed ore shoot is only 1 foot wide and 15 feet long but it consists of very high-grade silver ore. The property is on the outskirts of the district and because of this has received very little attention.

Beaver Extension Group (Locality 173)

Reference: Annual Report of the Minister of Mines, British Columbia, 1930.

The Beaver Extension group of six mineral claims is east of Illiance river about 11 miles from Alice Arm. Volcanic rocks on the property are mineralized with pyrite and quartz. The quartz of one exposure contains a hydrocarbon probably anthraxolite.

Bellevue Group (Locality 172)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1920, 1921, and 1930; Geol. Surv., Canada, Sum. Rept. 1922, pt. A.

The Bellevue group of five mineral claims is on Illiance river about 13 miles from the head of Alice arm. Access is furnished by a pack trail from Alice Arm and from Silver City. The elevation of the property is about 2,500 feet above sea-level.

The group was taken under option by the Alice Arm Consolidated Holdings Company, Limited, in 1920. This company did some surface work outlining surface exposures and then drove crosscut adits, totalling several hundred feet in length, to intersect the deposits at a depth of 100 feet. The results were disappointing and the property has laid idle for many years. The claims are in Illiance River valley and as the showings are not far from the bottom of the valley, development at depth is possible only by means of shafts. The country rocks are bedded tuffs and breccias and associated tuffaceous sediments. The rocks have been severely sheared in a northerly direction and the shear planes dip west at moderate angles. The mineral deposits parallel the strike of the shear planes and appear to conform also with the shear plane dip. The rocks have been whitened apparently by the mineral solutions so that all of the country rock is white or very light in colour.

The mineral deposits are of the silver-lead type and appear to be lens-like veins 3 feet or less in width containing quartz and country rock as gangue matter. In some places mineralization extends over a width of 20 feet but only a few feet of this could be classed as ore-body. The chief mineral is galena, but some pyrite, sphalerite, and tetrahedrite occur.

Mineral deposits although not individually of great length occur at intervals from one end of the property to the other, a distance of almost a mile. There is no reason to suppose that all the deposits have been discovered.

Beverley Group (Locality 187)

References: Annual Report of the Minister of Mines, British Columbia, 1923 and 1931.

The Beverley group of five mineral claims is east of the head of Alice arm and 750 feet above sea-level. The mineral showings on the property are white quartz veins, each several feet wide with very little sulphide. They cut argillaceous quartzite and greywacke. The showings are developed by adits.

Billy Barton Group (Locality 185)

Reference: Annual Report of the Minister of Mines, British Columbia, 1929.

The Billy Barton group of six mineral claims is on the easterly slope of mount Alice and 1,600 feet above sea-level. Two or more narrow quartz veins sparsely mineralized with pyrite, galena, and sphalerite cut argillite.

Billy Mac Group (Locality 178)

References: Annual Report of the Minister of Mines, British Columbia, 1927 and 1931; Geol. Surv., Canada, Sum. Rept. 1928, pt. A.

The Billy Mac group of six mineral claims is at an elevation of 2,200 feet on the southern slope of McGrath mountain. The group adjoins and lies north of the Standard group and west of the Highland group. The main McGrath Mountain trail crosses the property. Development consists of open-cuts and short adits.

The showings on the property are principally in a body of argillaceous rock about 1,000 feet broad and which appears to be an inclusion in an irregular stock of augite porphyrite. The augite porphyrite body may, however, be in the form of sills or dykes bounding the argillite mass on two sides. Some of the rock in appearance and mineral composition suggests that it was originally argillite but has been thoroughly soaked and altered by fluids emanating from the augite porphyrite. The structure of the argillite is unknown but has the appearance of being a low dome.

Sphalerite associated with quartz and calcite is exposed in a dozen open-cuts and short adits. Only one body has been traced as far as 200 feet. It is 20 feet wide, strikes northeast, and dips 30 degrees southeast. For a breadth of 5 feet along the hanging-wall the deposit is well mineralized with sphalerite; the remaining part is largely calcite containing many rock inclusions. The deposit may be the result of replacement along a crushed zone or along a particular stratum.

About 300 feet northeast of this deposit are two other exposures of vein matter. They are on opposite sides of a creek and may be parts of one nearly horizontal mineral body. The mineralization consists of quartz, calcite, and sphalerite. About 200 feet northeast of these showings are five exposures of vein matter belonging to one or more deposits of unknown size and shape. About 150 feet farther northeast is a line of open-cuts trending northeast, which may be in a single mineral body. Individual showings in these open-cuts are up to 8 feet wide and consist of quartz, calcite, sphalerite, and country rock inclusions. The mineral bodies are not well exposed. They have formed chiefly by replacement and may have formed along beds or along fracture zones.

Sphalerite is the only known mineral of possible commercial importance on the property. So far as known the best ore is of milling grade and, therefore, only if large ore-bodies are present would mining operations be warranted. As the body of sedimentary rock in which the deposits occur may be an inclusion, its depth may not be great. If the deposits extend into the augite porphyrite, they may change greatly in size.

Black Bear Group

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Black Bear group of mineral claims of McGrath mountain is now parts of other groups. In 1916 there were eight claims in the group, and the mineral showings were said to be quartz and calcite bodies of unknown size mineralized with sphalerite and some galena.

Black Diamond Group (Locality 121)

References: Annual Report of the Minister of Mines, British Columbia, 1918 and 1922.

The Black Diamond group of eight claims is north of Clearwater creek and a mile east of Kitsault river. The deposit is a quartz vein 10 to 16 feet wide cutting argillite. Metallic minerals are extremely scarce in the vein.

Blue Ribbon Group (Locality 120)

Reference: Annual Report of the Minister of Mines, British Columbia, 1921.

The Blue Ribbon group of four mineral claims is south of the west arm of Kitsault glacier and between 3,500 and 5,000 feet above sea-level. The mineral showings can be reached by a foot trail extending west from the end of the Kitsault trail at the Homestake group.

The country rock consists of felsite, some of which is intrusive. Inclusions of argillite are fairly common. An open-cut exposes a quartz vein several feet wide mineralized with pyrite, galena, and sphalerite. At another place about 4,500 feet in elevation a large argillite inclusion has been severely deformed and crushed. The argillite contains pyrite and many veinlets of calcite containing chalcopyrite, pyrite, and galena. Gold occurs in this deposit but has not yet been found in paying quantities.

Bonanza Fraction (Locality 141)

References: Annual Report of the Minister of Mines, British Columbia, 1916 and 1918.

The Bonanza fraction mineral claim is west of Kitsault river and 17 miles from Alice Arm. The mineral showing on this claim was at one time supposed to be on the Kitsaul group of claims. It was exposed by a large open-cut, is 18 feet wide, and consists of quartz and jasper with pyrite, chalcopyrite, galena, and sphalerite. The deposit is reported to hold good values in silver. Attempts to follow it along the strike have failed.

Bunker Hill Group (Locality 156)

References: Annual Report of the Minister of Mines, British Columbia, 1923, 1924, and 1925.

The Bunker Hill group of seven mineral claims is on the southeast side of Klayduc mountain and about 2,000 feet above sea-level. It is reached by a trail extending south from the LaRose mine.

The country rock is argillite and the showings are near the eastern contact of the Klayduc igneous body. The mineral deposit is a northerly striking quartz vein 2 feet wide in a narrow shear zone. The vein is mineralized with galena, sphalerite, and pyrite, and in some places is nearly solid sulphide. Dykes cut the vein, and later movement along the hanging-wall of the vein has offset the dykes. The property has been developed by open-cuts and a short adit.

Butte Claim (Locality 153)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Butte claim is on Dak river. On it there is a sparsely mineralized fissure 2 or 3 feet wide.

Camalachie Claim (Locality 133)

Reference: Annual Report of the Minister of Mines, British Columbia, 1918.

The Camalachie claim is north of Trout creek and adjoins and lies north of the Moose group. A quartz vein up to 6 feet wide, which has been traced for 300 feet, occurs along the hanging-wall of a diorite dyke. The vein is reported to contain silver.

Canyon Claim (Locality 149)

Reference: Annual Report of the Minister of Mines, British Columbia, 1924.

The Canyon claim is east of Kitsault river, 14 miles from Alice Arm, and adjoins and lies north of the Homeguard group. The mineral showing consists of a quartz vein in a shear zone 8 feet wide. The vein is mineralized locally with pyrite, chalcopyrite, and galena.

Cape Nome Group

References: Annual Report of the Minister of Mines, British Columbia, 1918 and 1919.

On the Cape Nome group of three mineral claims there are several parallel quartz veins in argillite in a zone 6 feet wide. Pyrite and sphalerite have been found in the veins but are rare.

Caribou Fraction Group (Locality 184)

Reference: Annual Report of the Minister of Mines, British Columbia, 1911.

The Caribou Fraction group of three mineral claims is on the western shore of Alice arm 1,000 feet south of the town. The deposit is in argillite and consists of a quartz vein up to 1 foot wide which contains very small shoots of silver ore.

Casey Group (Locality 179)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The mineral showings on the Casey group are a few hundred feet north of Illiance river near its mouth. The mineral deposit is a quartz-barite vein up to 4 feet wide mineralized with pyrite and galena.

Chance Group (Locality 131)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1919, 1920, 1921, 1922, 1923, and 1930; Geol. Surv., Canada, Sum. Rept. 1921, pt. A, and Sum. Rept. 1928, pt. A.

The Chance group of six mineral claims is north of Trout creek which flows into Kitsault river 19 miles from Alice Arm. The Trout Creek trail which branches off the Kitsault trail at the mouth of Trout creek passes by the Chance cabins.

The property prior to 1923 was known as the Last Chance group and then consisted of four mineral claims. It was bonded in 1919 by H. B. Price who did some diamond drilling. Clothier (Annual Report for 1923, page 59) reports that the information revealed by the horizontal drill holes was encouraging but that the other holes failed to locate the ore-body. The diamond drilling was done from a single station.

The rocks on the property are breccias and, perhaps, some crystalline rocks of the Hazelton group. The mineral showings are near the base of this particular body of volcanic rocks, which is underlain by black argillites immediately south of the showings. The principal mineral deposits are two parallel brecciated zones mineralized with copper, lead, and silver minerals. The two zones are about 100 feet apart. They strike north 75 degrees east, are approximately vertical, and may be over 700 feet long. The more northerly zone is 18 feet wide in one open-cut, and the other is about 12 feet wide. The zones consist of brecciated volcanic rock cemented and replaced by quartz, jasper, barite, calcite, pyrite, chalcopyrite, sphalerite, galena, and tetrahedrite. Oxidation has resulted in crusts of azurite and slight accumulations of black, crumbly material resembling manganese oxides. The more northerly zone where 18 feet wide contains much tetrahedrite, and picked specimens assay well in silver. The more southerly zone does not appear to be as well mineralized as the other, but picked samples yield high silver assays. The width of the zones is likely to be variable but the length should be ample for ordinary mining operations. One open-cut exposes a width of 18 feet of ore and the oreshoot here indicated merits attention. In searching for other ore shoots open-cuts should be placed rather close together as the ore shoots may be short.

Development consists of open-cuts and a crosscut adit about 120 feet long.

Climax Group (Locality 134)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1919, 1920, 1922, 1923, 1925, 1926, and 1930; Geol. Surv., Canada, Sum. Rept. 1928, pt. A.

The Climax group of two mineral claims is on the north side of Trout creek and adjoins the Moose and Silver Horde groups of claims. The workings are about half a mile from Kitsault river and 19 miles from Alice Arm. A branch of the Trout Creek trail gives access to the property.

The country rocks are tuffs and perhaps crystalline rocks of the Hazelton group underlain immediately east of the property by argillites. Unconsolidated overburden is fairly thick and makes the finding and outlining of deposits difficult. The deposit is a siliceous body 20 to 30 feet wide in fine-grained volcanic rocks. Where exposed in an adit it is 24 feet wide, strikes south 70 degrees east, and is vertical.

The deposit consists chiefly of quartz and silicified country rock, but contains also some calcite, jasper, and barite and is mineralized with pyrite, marcasite, sphalerite, galena, and tetrahedrite. The sulphides are not plentiful and the whole deposit seems rather low grade. Narrow bands of galena containing tetrahedrite and good values in silver occur locally in the deposit. A peculiarity of the mineralization is the presence of rounded pellets of marcasite. The deposit has been formed apparently by replacement and filling along a crushed and brecciated zone.

Columbia Group (Locality 122)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1919, 1920, 1921, and 1922; Geol. Surv., Canada, Sum. Rept. 1921, pt. A.

The Columbia group of five mineral claims is north of Clearwater creek and about 1½ miles east of Kitsault river. A foot trail branching from the Kitsault trail near the mouth of Clearwater creek furnishes access to the property. The principal mineral deposits on the group are two quartz veins cutting argillites. The larger vein is up to 15 feet wide and consists of white quartz very sparingly mineralized with pyrite. Development consists of adits.

Combination Claim (Locality 139)

References: Annual Report of the Minister of Mines, British Columbia, 1913 and 1916; Geol. Surv., Canada, Sum. Rept. 1921, pt. A.

The Combination claim adjoins and lies north of the Red Point group. It is north of Evindsen creek and half a mile west of Kitsault river. Access is furnished by a foot trail from the Red Point group.

The claim lies in the Copper Belt. The country rock consists of grey breccia and tuffaceous sandstone of the Hazelton group. The mineral deposit is a large vein which extends southeast into the Red Point and northwest into the Racehorse groups. The vein consists of quartz, is up to 20 feet wide, and extends across the whole of the Combination claim. It is locally well mineralized with pyrite and chalcopyrite. Locally the vein contains many rock fragments. The deposit was apparently formed by replacement and filling in a brecciated zone. The value of the deposit depends solely on the copper content (chalcopyrite). Development consists of open-cuts and an adit about 150 feet long.

Combine Fraction (Locality 142)

References: Annual Report of the Minister of Mines, British Columbia, 1930 and 1931.

The Combine Fraction claim adjoins the Red Point group on the north. A quartz vein, several feet wide and containing pyrite, pyrrhotite, and chalcopyrite has been traced for 200 feet.

Copper Cliff Group (Locality 132)

References: Annual Report of the Minister of Mines, British Columbia, 1913, 1916, 1918, 1926, and 1927; Geol. Surv., Canada, Sum. Rept. 1921, pt. A.

The Copper Cliff group of four mineral claims is west of Kitsault river and 2 miles north of Evindsen creek. Access is provided by a pack trail branching from the Kitsault trail a mile south of Trout creek.

The property is in the Copper Belt. The rock in the immediate vicinity of the deposits has not been identified with certainty but probably is an intrusive felsite. A few hundred feet west is a body of intrusive rock resembling syenite and a hundred feet east is the edge of a large body of argillite which apparently has been intruded by the rocks of the Copper Belt.

About 1917 the Granby Consolidated Mining, Smelting, and Power Company held an option on the property and did a little diamond drilling. In 1926 the Copper Cliff and other properties were optioned by the Spencer interests of Vancouver and during 1926 a short adit was driven; the option was given up in 1927.

The deposit consists of country rock locally mineralized with pyrite and chalcopyrite in a zone several feet wide. As yet very little has been done to outline individual shoots of ore on which the value of the property depends.

Copper Creek Group (Locality 175)

Reference: Annual Report of the Minister of Mines, British Columbia, 1921.

The Copper Creek group of five mineral claims is in Illiance River valley a mile below the mouth of Copper creek. The lowest exposed mineral showing is a zone of quartz gashes in argillite. A few hundred feet higher is a quartz vein several feet wide sparsely mineralized with pyrite and galena.

David Copperfield Group (Locality 147)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916, 1917, and 1919.

The David Copperfield group of two mineral claims adjoins and lies south of Dolly Varden group. The mineral deposit is a quartz-barite vein up to 15 feet wide in felsitic rocks and has been traced westward from Kitsault river for a thousand feet. The vein is very sparsely mineralized with pyrite, galena, and sphalerite.

Dolly Varden Mine (Locality 146)

References: Annual Report of the Minister of Mines, British Columbia, 1913, 1915, 1916, 1917, 1918, 1919, 1920, 1921, 1922, 1928, 1929, and 1930; Geol. Surv., Canada, Sum. Rept. 1921, pt. A; Can. Inst. Min. and Met., Trans., vol. 25, pp. 212-224.

The Dolly Varden mine is west of Kitsault river and 16 miles from Alice Arm. The principal workings are between 1,500 and 2,000 feet above sea-level. The lower camp of the mine is at the end of the narrow gauge railway from Alice Arm. The upper camp is connected with the lower camp by trails.

The Dolly Varden mineral claim was the first to be located in upper Kitsault valley. In 1915 the Dolly Varden Mines Company was organized and this company developed an ore shoot by adits and diamond drilling, and disclosed a large probable tonnage of high-grade silver ore. Prior to 1916 all supplies and machinery had to be packed in on men's backs, but in that year a pack trail was built from Alice Arm. In 1917 the Dolly Varden Mines Company entered into a contract with the Taylor Engineering Company to build a narrow gauge railway from Alice Arm to the Wolf group of mineral claims on Kitsault river 19 miles from Alice Arm. According to the contract the Taylor Engineering Company was to receive a profit of 10 per cent above cost. Construction began in 1917. The cost

of building the railway proved to be much greater than had been anticipated and as a result in 1919 the holdings of the Dolly Varden Mines Company passed into the hands of the Taylor Engineering Company. At that time 15 miles of the railway had been built. The Taylor Engineering Company then built the remaining 2 miles to the lower camp and organized the Taylor Mining Company. The company built a two-bucket tramway from the mine to bunkers at the lower camp and commenced shipments of ore. Before the end of the year the company had shipped 6,709 tons of ore containing 424,000 ounces of silver. The Taylor Mining Company carried on mining until 1921 when their operations finally ceased. Total shipments from the mine in the three years amounted to 36,609 tons of ore which yielded 1,304,409 ounces of silver.

The mineral deposit is a vein and from an elevation of 1,600 feet above sea-level it strikes west to the top of a low, wooded mountain known locally as Dolly Varden mountain. The rocks of the mountain are massive and fragmental igneous rocks of the Hazelton group cut by diabase dykes. Most of the rocks appear to be massive, are green to grey, and contain many fragments of igneous rock. Associated purple and red rocks are probably of a fragmental nature. The vein lies in grey or green rock for most of its length, but for part of its course follows the contact between grey or green rocks and purple rocks. The vein strikes west and dips north 70 degrees. It has been offset by a number of northerly striking faults with horizontal offsets of 50 to 120 feet but with probably very little vertical throw. There are also horizontal thrust faults and a few normal faults.

The vein is 5 to 25 feet wide. Quartz makes up about 70 per cent of the vein, pyrite is abundant, calcite and jasper are uncommon, barite occurs but is common only in the deeper parts of the vein. Chalcopyrite, galena, and sphalerite occur in small quantity. The valuable contents consist of tetrahedrite, native silver, argentite, ruby silver, and pearceite. Much of the siliceous vein matter mined was of a very dark shade.

Mining operations disclosed that the faulted segments of the vein outcropping between elevations of 1,850 and 1,700 feet were ore shoots. These were mined, as completely as faulted and broken ground would permit, to depths of 100 to 240 feet, but were not mined to deepest economic level. The hanging-wall of each ore-body was free from the ore, was not altered by the ore solutions, and consisted of purple tuffs. The foot-wall was grey to green rock altered by the introduction of sericite, quartz, and pyrite, and in some places was mineralized with ore minerals so that the position of the wall was determined by assay. It is probable that faulting took place along the hanging-wall after the vein was formed. Farther up the hill the vein continues as large as ever, but there no longer follows the contact between the purple tuffs and the green massive rock and so far as known does not contain any ore shoots.

The ore shoots consisted of the usual vein minerals but the silver minerals were particularly plentiful. The writer believes that the rich silver ore was of secondary origin and has presented evidence for this view.[1] In a preceding section of this report the source of the deposits of the Dolly

[1] Hanson, G.: Can. Inst. Min. and Met., Trans., vol. 25, pp. 212-224 (1922).

Varden or quartz-jasper-barite type has been discussed and the conclusion reached that the ore was derived from deeper-seated intrusives genetically related to the rocks in which the ore occurs. No evidence was obtained from the mine to favour any one source rather than another.

The mine was developed by five adits. The highest is at an elevation of 1,850 feet and the lowest at 1,410 feet above sea-level. Ore was mined from the surface down to the fourth adit at an elevation of 1,638 feet. Some high-grade ore still remains above No. 4 adit and an unknown quantity of ore of a moderate grade is present below this adit. In any search for other ore shoots the outcrop of the vein should be explored with sufficient detail so that no ore shoot would be missed. Especial attention should be given to the vein where it is crossed by faults, as shoots of secondary ore may occur there. The possible continuation of the vein on the hillside below the present lowest known point should also be investigated.

Eagle Group (Locality 154)

References: Annual Report of the Minister of Mines, British Columbia, 1926, 1927, and 1928.

The Eagle group of six mineral claims is west of Kitsault river and north of Klayduc creek. About 1,500 feet above sea-level a quartz vein 4 to 6 feet wide strikes northwest and dips 50 degrees northeast. It lies in argillite and is very sparsely mineralized with pyrite.

Esperanza Mines (Locality 183)

References: Annual Report of the Minister of Mines, British Columbia, 1911, 1916, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, and 1931; Geol. Surv., Canada, Mem. 32 (1914); Sum. Rept. 1922, pt. A, and Sum. Rept. 1928, pt. A.

The Esperanza mine is on the west side of Kitsault river about a mile from Alice Arm. The mine workings extend from 450 feet to 660 feet above sea-level. A good horse trail has been built from the railway to the mine.

The mineral claims of the Esperanza group were among the first staked at Alice Arm. Small shipments of ore were made in the early years of the history of the property, particularly in 1911. About 1916 the property was acquired by Salinas Brothers who carried on mining until 1921. Later the property was acquired by a syndicate of Anyox men who began mining in 1923. In 1927 Esperanza Mines, Limited, was organized and took over the Esperanza group of claims. Shipments of ore from 1911 to 1927 totalled 913 tons and yielded 107 ounces of gold, 68,905 ounces of silver, 1,352 pounds of copper, and 1,062 pounds of lead.

The country rock in the vicinity of the Esperanza mine is argillite intruded by narrow lamprophyre dykes. The sedimentary rocks lie in gentle, northwesterly striking folds. The dykes strike northeast. The rocks have been faulted by pre-mineral and post-mineral faults. In the northern half of the mineralized area the strata dip southwest. A synclinal axis strikes northwest through the northern part of the southern half and a parallel anticlinal axis lies near the south end. Practically all the ore mined has come from the northern half of the property.

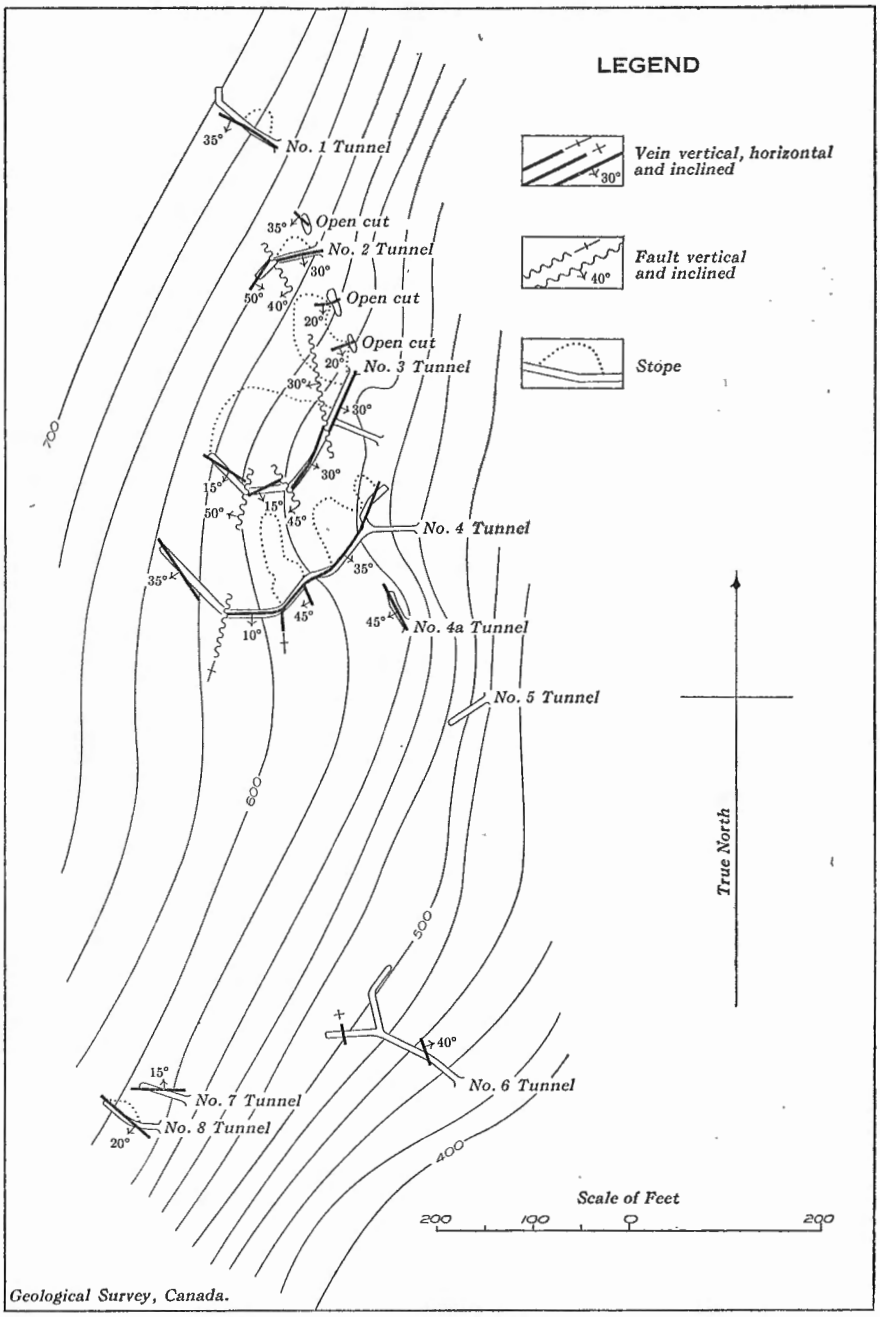

Figure 2. Plan of workings (as existing in 1928) of Esperanza mine, B.C.

The mineral deposits are silver-bearing quartz veins that contain also lead and copper minerals. Scheelite is also reported. The main ore-body is a quartz vein which for the most part lies in a fault fracture. The strike of the fracture curves from southwest to west and finally to northwest. Along the northwestern part of its course it dips southwest, coincides in strike and dip with the country rock, and tends to lose its identity. Along the part striking westerly the dip is south, and along the southwesterly striking part it is southeast. The vein that occupies the fault fracture thus has the form of a southerly plunging anticline. The vein in some places is as much as 6 feet thick but in most of the stopes it is 1 to 3 feet thick. Its greatest proved length is in No. 4 adit and is 320 feet. Its extension down the dip is known to be greater than 500 feet. The angle of dip varies from 10 to 35 degrees. The vein is crossed by normal faults of small throw. Some of the faults follow the bedding planes of the argillite and in these cases the western side of the faults has been downthrown 2 to 12 feet. Others strike approximately north. The part of the fracture followed by the vein that makes an angle with the strata is not everywhere a single fracture but in places branches. In some places, also, the fracture abruptly changes direction to follow the bedding planes for a few feet to where it abruptly changes back to its original strike. The fracture along the northwesterly course parallels the bedding in most places but here and there crosscuts the bedding at low angles. The vein follows all the changes of direction exhibited by the fracture.

The vein consists of quartz and ankerite holding arsenopyrite, pyrrhotite, pyrite, chalcopyrite, sphalerite, galena, tetrahedrite, ruby silver, native silver, probably polybasite, and other silver minerals. The ore in many places occurs in bands of almost solid sulphide that commonly lie along the hanging-wall of the vein. The high-grade ore consists of zinc blende, tetrahedrite, and silver minerals with some pyrite, arsenopyrite, pyrrhotite, and galena. The best ore shoot was located on the axial part of the fold-like structure.

The source of the mineralization is assumed to be underlying bodies of the Coast Range intrusives. Judging from the presence of scheelite the source is at no very great depth. There appear to be two types of veins present, one being barren quartz or pyrite-quartz veins and the other carrying sphalerite, tetrahedrite, and silver minerals. In No. 1 adit a 2-inch vein of typical high-grade ore cuts across, at a small angle, a barren quartz vein. It may be that there is an early series of valueless quartz veins and a later series of ore-bearing sulphide-quartz veins.

The main mine workings are adits driven west along the vein and the ore has been stoped from above them. The surface of the ground in the vicinity of the mine rises along a northwesterly direction. The axis of the fold-like structure exhibited by the main vein plunges south at an angle steeper than the slope of the valley side. As a result the axial portion of the vein approaches the surface as the hillside is ascended and it may be that the axial part of the vein outcrops above No. 2 adit. If this is so, the highest adit, No. 1 adit, has been driven along the southwest limb of the fold, that is to the west of the axial portion that at this level has been eroded away. Though the discovered ore shoot lay along the

axial part of the fold it may be that ore also occurs somewhere along the limb and might be found by extending No. 1 adit. Ore may continue along the axial part of the fold below the lowest or No. 4 adit, but to the south of this level the dip of the strata changes within a distance of 100 to 200 feet and it is likely that the attitude of the vein also changes.

Falcon Group (Locality 169)

Reference: Annual Report of the Minister of Mines, British Columbia, 1930.

The Falcon group of two mineral claims is west of Illiance river near its head. There are three parallel shear zones on the property from 2 to 5 feet wide mineralized with quartz, calcite, galena, sphalerite, and tetrahedrite.

Fox Claim (Locality 125)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1925, and 1927.

The Fox mineral claim adjoins and lies south of the Tip Top claim. It is at an elevation of 4,000 feet on the west side of Kitsault river near its head. Access is furnished by a foot trail from the end of the Vanguard trail. The deposit is a quartz-chlorite-pyrite vein containing some chalcopyrite and a little galena and sphalerite. The vein strikes southwest and dips northwest, is up to 4 feet wide, and lies in massive rocks of the Hazelton group.

Fox Group (Locality 162)

Reference: Annual Report of the Minister of Mines, British Columbia, 1929.

The Fox group of seven mineral claims is on the ridge west of Washout creek. The workings are at an elevation of 1,600 feet. Access is by a trail branching from the Dak River trail near Washout creek.

The mineral deposit is a body of quartz and barite containing pyrite, chalcopyrite, sphalerite, galena, and fragments of country rock. The size and shape of the body have not been determined. It is probably a replacement in a brecciated zone. The deposit may be of considerable size.

Glacier Claim (Locality 167)

Reference: Annual Report of the Minister of Mines, British Columbia, 1918.

The Glacier claim is on Tchitin river north of the head of Illiance river. The deposit is a quartz vein up to 1 foot wide containing silver ore of good grade.

Golden Crest Group (Locality 173)

References: Annual Report of the Minister of Mines, British Columbia, 1916 and 1918.

The Golden Crest group is east of Illiance river near the 11-mile bridge. The mineral showing consists of quartz stringers with pyrite and chalcopyrite in altered tuffaceous rock. A body of massive pyrite several feet wide is visible in one open-cut.

Grey Goose Claim (Locality 172)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Grey Goose claim adjoins and lies north of the Bellevue group in the valley of Illiance river about 14 miles from Alice Arm. The mineral deposit is a narrow vein mineralized with pyrite, sphalerite, and galena lying in a country rock of sheared and altered tuff.

Henderson's Claims (Locality 152)

Reference: Annual Report of the Minister of Mines, British Columbia, 1919.

Henderson's claims are on Kitsault river 9 miles from Alice Arm. The mineral showings are quartz-calcite veins in argillite and are sparsely mineralized with pyrite.

Highland Group, Kitsault River (Locality 129)

Reference: Annual Report of the Minister of Mines, British Columbia, 1930.

The Highland group of six mineral claims is on Kitsault river and adjoins the Tyee group. The mineral showings consist of stringers of galena irregularly scattered through volcanic rocks.

Highland Group (Locality 177)

References: Annual Report of the Minister of Mines, British Columbia, 1927 and 1928.

The Highland group of six mineral claims is on the southern slope of McGrath mountain, at an elevation of about 2,000 feet, and adjoins and lies west of the Billy Mac group. Access is furnished by a foot trail branching from the McGrath Mountain trail.

The country rock is argillite intruded to the east by an augite porphyrite stock. West of the mineral deposits a body of felsite outcrops which may also be a stock.

At least two roughly parallel mineral zones are known on the property. One strikes northeast and has been imperfectly traced by five open-cuts for a distance of 400 feet. It is a sheared and shattered zone, 20 feet wide in some places, containing irregular bodies of quartz, calcite, and sphalerite. The best mineralized matter consists of rock fragments cemented by quartz, calcite, and sphalerite. The second parallel mineralized zone lies about 300 feet northwest. It is a clearly defined fault zone holding lenticular and irregular bodies of quartz, calcite, sphalerite, and a little pyrite and galena. About 600 feet north of these two deposits is another of somewhat similar type striking east and near the south end of the two parallel deposits are other exposures of sphalerite.

Homebush Group (Locality 169)

Reference: Annual Report of the Minister of Mines, British Columbia, 1930.

The Homebush group of two mineral claims adjoins the Falcon group on Illiance river. The mineral showings are narrow quartz veins containing galena, sphalerite, and tetrahedrite.

Homeguard Group (Locality 149)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1922, 1923, 1924, 1928, and 1929; Geol. Surv., Canada, Sum. Rept. 1922, pt. A.

The Homeguard group of three mineral claims is on the east side of Kitsault river 1.4 miles from Alice Arm. The showings are in Kitsault valley and are reached from the Dolly Varden Mines railway by a bridge over the river and by a short trail.

The group was under option to the Granby Consolidated Mining, Smelting, and Power Company in 1916 and this company proved that the rather pretentious copper showings were large boulders. In 1929 the claims were prospected by a Radiore electrical survey with negative results.

The claims are in large part drift covered but there can be very little doubt that the country rock is such as occurs in the Copper Belt. The rocks strike north-northwest and occupy the ground between elevations of 800 and 1,700 feet. Below this ground the rocks are sediments and above they are felsites and breccias.

The boulders of ore vary in size from quite small to those having diameters of 15 feet or more. The ore consists of pyrite and chalcopyrite in altered rock, closely resembles the ore found in other parts of the Copper Belt, and in all likelihood has come from deposits in this belt of rocks. As the material of the boulders would be commercial ore if present in large quantity search for the source of the boulders has been prosecuted with considerable vigour. Their large size suggests that they are very close to their source which if on the Homeguard property must be between elevations of 800 and 1,700 feet. If they have been moved southward by glaciers as might be expected, the source might well be at the north end of the Homeguard group but east of Kitsault river.

Homestake Group (Locality 123)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1919, 1920, 1921, 1923, 1926, 1927, and 1930; Geol. Surv., Canada, Sum. Rept. 1921, pt. A.

The Homestake group of four mineral claims is west of the head of Kitsault river and at an elevation of over 3,000 feet. The property is about 25 miles from Alice Arm. Access is by the main Kitsault trail which ends at the Homestake.

The country rock consists of fragmental and massive rocks of the Copper Belt. On the western side of the property the rocks are intrusive felsites, but on the eastern side the rocks appear to be tuffs.

The mineral deposits lie in shear zones and brecciated zones and are quartz veins containing pyrite, chalcopyrite, and some galena, sphalerite, barite, and fragments of country rock. The deposits are up to 50 feet wide and one vein is known to be over 1,500 feet long. The principal vein strikes northwest and dips steeply northeast. It has been explored by surface cuts and adits.

Horseshoe Group (Locality 166)

References: Annual Report of the Minister of Mines, British Columbia, 1922 and 1923.

The Horseshoe group of six mineral claims is at an elevation of 4,000 feet on the south side of Theophilus mountain. The mineral showings are in breccias and augite porphyry underlain to the west by argillites. The augite porphyrite occurs as a small stock. Very little development work has been done on the property. It is reported that copper-bearing veins occur.

I.X.L. Group (Locality 163)

Reference: Annual Report of the Minister of Mines, British Columbia, 1927.

The I.X.L. group of five mineral claims is north of Dak river and about 8 miles from Alice Arm. The mineral deposit is a sphalerite-bearing quartz vein in argillite.

Ida Claim (Locality 153)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Ida claim is on McGuire mountain. The mineral showing is a horizontal quartz vein up to a foot wide mineralized sparingly with sphalerite and galena.

Independent Group (Locality 184)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1918, and 1919.

The Independent group of three mineral claims is west of Alice Arm and only a few hundred feet above sea-level. The mineral deposit is a quartz vein in argillite. The vein is up to 6 feet wide and quite persistent but is very sparingly mineralized.

Ingraham's Claims (Locality 175)

Reference: Annual Report of the Minister of Mines, British Columbia, 1922.

Ingraham's claims are on Illiance river just west of Copper creek. Seams of quartz and calcite in a porphyritic dyke and also the dyke itself are mineralized with galena.

Iron Group (Locality 173)

Reference: Annual Report of the Minister of Mines, British Columbia, 1930.

The Iron group of six mineral claims is on Illiance river near 11-Mile cabin. The mineral showing is a pyritized zone many feet wide in volcanic rocks.

Kent and Maple Leaf Claims (Locality 178)

Reference: Annual Report of the Minister of Mines, British Columbia, 1918.

The Kent and Maple Leaf claims are on McGrath mountain. The showings consist of quartz-calcite bodies containing sphalerite.

LaRose Mine (Locality 155)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1917, 1918, 1919, 1920, 1922, 1923, 1925, 1926, 1927, 1928, and 1929; Geol. Surv., Canada, Sum. Rept. 1928, pt. A.

The LaRose mine is on the eastern slope of Klayduc mountain, west of Kitsault river, and about 8 miles from Alice Arm. The mine workings are about 1,800 feet above the railway and from it can be reached by means of a good horse trail.

The property was worked in a small way by its owners who made small shipments of ore in 1918 and 1919. In 1920 the Alice Arm LaRose Mining Company, Limited, was formed to operate the mine and commenced active development in 1925. Ore was shipped in 1926 and 1927, but since then the property has remained idle. In all, 79 tons of ore have been shipped and yielded 15 ounces of gold, 15,579 ounces of silver, and 2,688 pounds of lead.

The country rocks consist of argillite and an interbedded, highly altered rock that may be a sill of fine-grained andesite. These rocks are cut by lamprophyre dykes that also cut the mineral deposit. The sediments strike northwest and dip northeast.

The mineral deposit is a vein occupying a narrow shear zone striking north and dipping steeply east. The surface expression of the shear zone is a well-marked, shallow gully along the hillside. The wall-rocks of the vein, particularly in deeper parts of the mine, are greatly sheared and especially on the hanging-wall of the vein much movement has taken place after the vein was formed. Dykes penetrating the vein from the footwall side are cut off by the hanging-wall fault. A wide, sheared zone which may be a fault with a considerable offset is exposed in a crosscut adit about 20 feet east of the vein. As the vein dips east it would meet this shear zone about 50 feet below the adit.

The vein varies from a few inches to 3 feet in width and consists of quartz, arsenopyrite, pyrite, chalcopyrite, pyrrhotite, sphalerite, galena, tetrahedrite, native silver, and probably silver sulphides. The vein crosses the strike of the formation at a slight angle. Where it lies in the highly altered, presumably igneous rock, the vein is of good size and contains small ore shoots, but where the vein departs from this rock and enters argillite it splits and ore is lacking. Ore appears to occur only in the band of harder rock and this is only 30 feet or so thick. There is reason to suppose that the vein is offset an unknown distance by the fault a short distance below the present workings.

Last Chance Group (Locality 188)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Last Chance group of two mineral claims is on the north bank of the middle fork of Lime creek. The mineral deposit is a 5-foot quartz vein in argillite and is sparsely mineralized with pyrite, sphalerite, and galena.

Left Over Group (Locality 167)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Left Over group of two mineral claims is on Tchitin river north of the head of Illiance river. The mineral deposit is a quartz vein outcropping on the side of a precipice. It is locally 5 feet wide and well mineralized with galena, pyrite, chalcopyrite, sphalerite, and tetrahedrite.

LeRoy Group (Locality 153)

References: Annual Report of the Minister of Mines, British Columbia, 1926, 1927, and 1928.

The LeRoy group of eight mineral claims is on LeRoy mountain. Access is furnished by the Dak River trail which ends at the LeRoy cabin. The property has been developed by the Kitsault Eagle Silver Mines, Limited.

The group in 1926 consisted of fourteen claims, but in 1929 these were divided into the LeRoy group of eight claims and the Canyon group of six claims. Numerous narrow quartz veins in iron-stained quartzite occur on the property. Some of the veins contain molybdenite, pyrite, pyrrhotite, and chalcopyrite. One vein contains pyrite, sphalerite, galena, and tetrahedrite.

Lone Maid Group (Locality 181)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1922, and 1923; Geol. Surv., Canada, Sum. Rept. 1928, pt. A.

The Lone Maid group of mineral claims is on the west side of Kitsault river and somewhat over a mile from Alice Arm. It adjoins and lies north of the Esperanza group. The trail to the Alice group crosses the Lone Maid claims.

The country rock on the property is argillite striking northwest and dipping steeply southwest. The mineral deposit is a quartz-calcite vein. It strikes northeast, dips steeply northwest, is 1 to 5 feet wide, and has been traced for a distance of 75 feet. Pyrite, chalcopyrite, pyrrhotite, sphalerite, and galena occur in very small amounts. The main Esperanza vein may continue north across the Lone Maid group.

Lone Star Group (Locality 179)

Reference: Annual Report of the Minister of Mines, British Columbia, 1918.

The Lone Star group of five mineral claims is on the south slope of McGrath mountain and can be reached by the McGrath Mountain trail.

The mineral deposit is a large quartz vein up to 20 feet wide, locally mineralized with sphalerite and pyrite. The vein has been traced by open-cuts and adits for a distance of 1,500 feet or more. It is very sparsely mineralized with sulphides. The vein lies in argillite near the contact with a stock of augite porphyrite.

Lucky Strike Group (Locality 126)

References: Annual Report of the Minister of Mines, British Columbia, 1922, 1926, 1929, 1930, and 1931.

The Lucky Strike group of eight mineral claims is north of the west fork of Kitsault river and west of the Vanguard group. Short trails from the end of the Vanguard trail furnish access to different mineral showings on the group.

The country rock is mainly felsite intrusive containing large inclusions of argillite.

On the Rambler claim the mineral deposit is a quartz-calcite vein up to 16 feet wide lying between breccia and argillite. It contains many fragments of rock and is mineralized with pyrite and chalcopyrite.

On the Porcupine fraction are two quartz-calcite veins each up to 12 feet wide and containing pyrite and chalcopyrite and a little galena and sphalerite.

On the Lucky Strike claim a brecciated zone 20 feet wide is cemented with quartz, calcite, pyrite, chalcopyrite, and some galena and sphalerite.

On the Silver Crown claim a 2-foot shear zone contains stringers of galena, pyrite, chalcopyrite, tetrahedrite, and sphalerite.

Lynx Group (Locality 188)

References: Annual Report of the Minister of Mines, British Columbia, 1916 and 1921; Geol. Surv., Canada, Sum. Rept. 1922, pt. A.

The Lynx group of five mineral claims is on the north fork of Lime creek and about 4 miles from Silver City. The Lime Creek pack trail from Silver City crosses the property. Prior to 1921 the group was known as the Caribou group.

The country rock in the vicinity of the property is argillaceous quartzite and argillite intruded by many dykes and perhaps a small stock of granite. The granite is riddled with narrow quartz stringers a few inches or less in width and is locally crushed and weathered so that it is soft and crumbly. The quartz stringers and granite contain disseminated pyrite and molybdenite.

Macy Mine (Locality 192)

Reference: Annual Report of the Minister of Mines, British Columbia, 1917.

The Macy mine is on the south shore of Alice arm. The deposits are large bodies of barren quartz and were at one time mined for flux for the smelter at Anyox.

Mathilda Claim (Locality 124)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1921, 1925, and 1927.

The Mathilda claim is west of the head of Kitsault river above the Homestake group. Access is furnished by a short trail from the end of the Vanguard trail.

The mineral deposits on the claim appear to occur along a brecciated zone. The main deposit is up to 30 feet wide and consists essentially of fragments of felsite cemented by quartz, calcite, pyrite, chalcopyrite, galena, and sphalerite.

Mayflower Group (Locality 186)

References: Annual Report of the Minister of Mines, British Columbia, 1917, 1918, 1926, 1929, 1930, and 1931; Geol. Surv., Canada, Sum. Rept. 1922, pt. A; Mines Branch, Pub. No. 592; Munitions Resources Commission, Canada, Final Report.

The Mayflower group of eight mineral claims is on the north side of Alice arm 4 miles from the head of the arm.

In 1916 the mineral deposit was owned by the Molybdenite Mining and Reduction Company, Limited, who in that year shipped 385 tons of ore, but the ore contained less molybdenite than had been anticipated and only a little of the ore was actually marketed. The company built an aerial tramway and a small concentrating mill but did not mine any more ore.

The country rock at the property consists of argillite and argillaceous quartzite cut by lamprophyre dykes and by a small stock of granite and accompanying offshoots of aplite and granite. The granite and offshoots contain molybdenite. Several faults of small throw occur.

The mineral deposits are a series of parallel quartz veins striking northeast up the hill and dipping steeply west. The veins are up to 10 feet wide and contain locally at least as much as 2 per cent molybdenite. Pyrite occurs only very locally and in small quantity. One vein contains a small shoot of pyrite, galena, and sphalerite. The veins disappear under drift near the edge of the stock of granite and may merge with it. Some of the veins contain much feldspar, particularly near the granite stock.

The veins have been developed by four adits. The lowest adit is somewhat more than 400 feet below the uppermost and is 1,000 feet southwest of it.

The veins are persistent but vary considerably in width. A considerable tonnage of vein matter is present.

Medallion Claim (Locality 148)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Medallion claim is on Kitsault river and adjoins and lies east of the Wildcat group. Chalcopyrite is exposed in an open-cut.

Mohawk Group (Locality 191)

References: Annual Report of the Minister of Mines, British Columbia, 1911, 1916, 1929, and 1930.

The Mohawk group of four mineral claims is on the east slope of Roundy creek and is reached by a trail from Silver City. The showings are at an elevation of 2,100 feet.

The mineral deposit is a quartz vein 2 feet wide and lies in argillite. The vein appears to be practically barren of sulphides but it is reported that a small shoot of high-grade silver ore was mined many years ago. The vein has been traced by shafts and open-cuts for more than 200 feet.

Monarch Group (Locality 168)

References: Annual Report of the Minister of Mines, British Columbia, 1915, 1916, 1918, 1919, 1920, 1921, and 1930.

The Monarch group of two mineral claims is on the east side of Illiance river near its head. Access is furnished by the Illiance trail.

The country rock consists of breccia and finer grained fragmentals of the Hazelton group. The deposit is a quartz-sulphide vein averaging about 2 feet in width but locally 5 feet wide, and is very well mineralized with chalcopyrite, chalcocite, pyrite, galena, and sphalerite. The vein has a northerly strike and westerly dip. It has apparently been faulted in two places near the south end and ends abruptly against a fault.

Open-cuts and trenches trace the vein for 300 feet. A crosscut adit 60 feet below the outcrop failed to locate the vein, but in view of the faulted nature of the rocks this is no proof that the vein does not continue downwards.

Moose Group (Locality 133)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1919, 1920, 1921, 1923, 1926, 1929, and 1930; Geol. Surv., Canada, Sum. Rept. 1922, pt. A.

The Moose group of five mineral claims is north of Trout creek and is reached by a trail branching from the Kitsault trail at the mouth of Trout creek.

In 1920 the Moose Group Mining Company, Limited, was formed to develop the property. This company did some development work in 1921 but relinquished their option in that year.

The country rock consists of breccia and of fine-grained rocks that are probably tuffs. The mineral deposit is a quartz vein 5 to 20 feet wide. The vein strikes east and dips steeply north. It has been traced for about 500 feet. The eastern end is lost in a drift cover and the western end appears to have been faulted. A 4-foot vein of similar type discovered much lower down the hill in 1929 may be the western continuation of the main Moose vein. The vein has been cut into several blocks by transverse and longitudinal faults of small throw. The vein is mineralized with pyrite, galena, and tetrahedrite and although the sulphides are not at all plentiful the silver content is comparatively high.

Muskateer Group (Locality 140)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1919, 1920, and 1922; Geol. Surv., Canada, Sum. Rept. 1921, pt. A, and Sum. Rept. 1928, pt. A.

The Muskateer group of five mineral claims is on the eastern bank of Kitsault river about three-quarters of a mile north of the Toric mine and 20 miles from Alice Arm. The Kitsault River trail passes just below the cabins and workings.

Two mineral deposits are present on the property, both in massive volcanic rocks. The main deposit is 15 feet or more wide and has been traced for a distance of 250 feet. The deposit is vertical and strikes south 60 degrees east. It consists of quartz, barite, jasper, pyrite, sphalerite, chalcopyrite, and galena, and in general appearance closely resembles the Toric deposit. In an adit the wall-rock is slightly mineralized with sulphides and contains jasper, quartz, and barite as far as 25 feet from the wall of the mineral deposit. The deposit is locally well mineralized with galena. The other deposit has been imperfectly traced by open-cuts. It appears to strike north. The most northerly open-cut is about 200 feet south of the main deposit. The two deposits are much alike. Both appear to have formed by filling and replacing a brecciated zone. The deposits have been developed by open-cuts and adits.

No Name Claims (Locality 130)

Reference: Annual Report of the Minister of Mines, British Columbia, 1923.

The No Name claims Nos. 1 and 2 are between Trout and Clearwater creeks and adjoin and lie west of the Summit group. The mineral showings are narrow stringers of quartz with some galena and lie in tuffs and breccias.

North Star Claim (Locality 145)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1918, 1919, 1920, 1921, 1922, 1928, and 1930; Geol. Surv., Canada, Sum. Rept. 1921. pt. A.

The North Star claim adjoins and lies north of the Dolly Varden group. It is reached by a short trail from the Dolly Varden mine buildings.

In 1918 the claim was taken over by the Alice Arm Silver Mining Company who in 1919 shipped 27 tons of ore which returned 968 ounces of silver. In 1921 the company made a second shipment of 86 tons which returned 1,870 ounces of silver.

The country rock consists of felsites which in the main are apparently intrusive, cut by closely spaced, roughly parallel dykes striking northeast and for the most part dipping at nearly vertical angles. The mineral deposit is a quartz-barite vein up to 20 feet wide that strikes northeast and dips northwest about 45 degrees. The strike of the vein is roughly parallel to that of the dykes, but the angle of dip is different and the dykes cut the vein in many places. The vein is locally well mineralized with pyrite, galena, sphalerite, tetrahedrite, and silver minerals. The vein has been traced by open-cuts and explored by two adits 200 and 400 feet long, respectively.

Observer Group (Locality 160)

Reference: Annual Report of the Minister of Mines, British Columbia, 1929.

The Observer group of eight mineral claims is west of Washout creek and east of the Red Bluff group.

The country rock is apparently an intrusive felsite containing locally augite phenocrysts and altered so that it is very like the rocks of the Copper Belt. The rock contains disseminated pyrite and chalcopyrite and also quartz veins holding galena and sphalerite. Very little development work has yet been done.

Ouray Group (Locality 137)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1918, and 1926.

The Ouray group of two mineral claims is west of Kitsault river and about a mile north of Evindsen creek. Access to the group is furnished by the Copper Cliff trail. The deposit consists of a quartz-calcite vein mineralized with pyrite, chalcopyrite, and galena.

Queen and Queen Fraction (Locality 131)

Reference: Annual Report of the Minister of Mines, British Columbia, 1923.

The Queen and Queen Fraction claims are north of Trout creek near the Chance group. The mineral deposits consist of quartz stringers and narrow zones of silicified rock mineralized with galena.

Racehorse Group (Locality 138)

References: Annual Report of the Minister of Mines, British Columbia, 1908, 1916, and 1921.

The Racehorse group of five mineral claims is north of Evindsen creek and adjoins and lies north of the Combination claim.

The mineral deposit is a quartz vein 10 feet wide striking northwest and has been traced by open-cuts for more than 1,000 feet. For the most part it is only sparingly mineralized with pyrite and chalcopyrite, but locally sulphides are abundant.

Red Bluff Group (Locality 161)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1922, and 1929; Geol. Surv., Canada, Memoir 32.

The Red Bluff group of mineral claims is east of Red Bluff creek and about 5 miles northeast of Alice Arm. The country rock is felsite, containing locally phenocrysts of augite that has been sheared and so altered that in places its original characters are obliterated. The felsite has been impregnated with pyrite and lesser amounts of chalcopyrite. In no place is the copper content known to amount to 2 per cent.

Red Point Group (Locality 142)

References: Annual Report of the Minister of Mines, British Columbia, 1913, 1916, 1926, 1927, and 1930.

The Red Point group of three mineral claims is north of Evindsen creek. Access is by the Red Point trail which branches from the Kitsault trail a short distance north of Evindsen creek.

In 1916 some diamond drilling was done on the group by the Granby Consolidated Mining, Smelting, and Power Company, but the results were disappointing and the option was dropped. The property was taken under option in 1927 by the Spencer interests of Vancouver, B.C., but after driving an adit 1,000 feet long the option was dropped.

The country rock consists of felsitic rocks and probably some tuffs somewhat sheared and greatly altered. The rocks contain much pyrite and oxidation has stained them red. The mineral deposits are quartz veins, up to 4 feet wide, and silicified zones, of uncertain but greater widths, mineralized with chalcopyrite and pyrite. Locally, parts a foot or so wide of a silicified band are practically solid chalcopyrite, but the whole band of rock 20 feet or so wide may be very low grade. The veins and silicified bands strike northwesterly and appear to have steep dips. The long adit was driven practically parallel to the trend of the mineral zones. If further work is done, the deposits should first be explored on the surface.

Rex Claim (Locality 149)

Reference: Annual Report of the Minister of Mines, British Columbia, 1924.

The Rex claim is on Kitsault river about 15 miles from Alice Arm. The mineral deposit on the claim is a quartz vein striking northwest, dipping southwest, and mineralized locally with pyrite.

Riverside Group (Locality 159)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Riverside group of six mineral claims is on the east side of Kitsault river about 5 miles from Alice Arm. Bodies of quartz and sulphide occur which appear to be small but which have not been outlined to show their length or width. The mineralization is chiefly zinc blende with some chalcopyrite, galena, and pyrite.

Ruby Group (Locality 144)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1920, and 1921; Geol. Surv., Canada, Sum. Rept. 1921, pt. A.

The Ruby group of two mineral claims adjoins the Toric group and is east of Kitsault river about 17 miles from Alice Arm. The mineral deposit is a vein up to 8 feet wide lying in intrusive and extrusive felsite. The vein has been traced for several hundred feet but contains little sulphide except pyrite.

San Diego Group (Locality 164)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The San Diego group of eight mineral claims is south of Dak river about 4 miles from Alice Arm. The property can be reached by a short trail branching from the Dak River trail.

The rocks on the property are sediments intruded by felsitic rocks containing augite phenocrysts in places. The igneous rocks are greatly altered. The mineral showings are in the felsite very near the contact with argillites to the west and consist of rock locally impregnated with pyrite and some chalcopyrite.

Second Thought Group (Locality 128)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1921, and 1925; Geol. Surv., Canada, Sum. Rept. 1921, pt. A.

The Second Thought group of four mineral claims is on Kitsault river a few hundred yards south of the mouth of Clearwater creek. The mineral deposits are veins lying parallel to the strike and dip of argillite. The veins are up to 8 feet wide and consist of white quartz containing numerous small inclusions of argillite. Values in silver have been reported.

Silver Bell Claim (Locality 179)

Reference: Annual Report of the Minister of Mines, British Columbia, 1918.

The Silver Bell claim is at the southwest base of McGrath mountain and adjoins and lies southwest of the Lone Star group. The mineral deposit is up to 15 feet wide and consists of stringers of quartz in argillaceous rock. The quartz carries pyrite, sphalerite, and galena. The only sulphide of any abundance is sphalerite.

Silver Bell Group (Locality 170)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1918, 1919, 1920, and 1921.

The Silver Bell group of five mineral claims is on Illiance river about 15 miles from Alice Arm. The claims are reached by the Illiance trail which crosses the claims.

The country rock consists of fragmental volcanic rocks that strike north and have been sheared along a north-south direction. Several veins are known to occur on the property. They parallel the trend of the shear planes, are up to 3 feet wide, and although they become very narrow locally they have been traced for hundreds of feet. They consist of quartz, pyrite, galena, sphalerite, and tetrahedrite, and locally are nearly solid sulphide. The ore is of a high-grade silver-lead type, but the shoots of high-grade ore are very small.

Silver Bow Claim (Locality 188)

Reference: Annual Report of the Minister of Mines, 1916.

The Silver Bow claim is near the head of Lime creek. The mineral deposit consists of quartz stringers in argillite.

Silver Chord Group (Locality 163)

References: Annual Report of the Minister of Mines, British Columbia, 1926 and 1927; Geol. Surv., Canada, Sum. Rept. 1928, pt. A.

The Silver Chord group of four mineral claims is at the north end of McGrath mountain, on Dak river about 7 miles from Alice Arm. The cabins and underground workings are about 1,200 feet above sea-level and about 200 feet above the main Dak River trail.

Development work on the group consists of two drift adits 200 feet and 600 feet long, respectively.

The country rock consists of argillite and argillaceous quartzite striking north. The rocks are probably folded into open anticlines and synclines. Narrow lamprophyre dykes cut the sediments. The known mineral deposits on the group are two sphalerite-bearing quartz veins. One of the veins outcrops a short distance above the cabins where it strikes north and is approximately vertical. One small body of sphalerite ore about 3 feet wide is exposed but is only 10 feet long. A short adit driven along the vein shows that the width is variable and the sulphide mineralization extremely sporadic.

The second vein is exposed a few hundred feet west of the cabins. It strikes north, dips steeply west, and is at least 500 feet long. It consists of gashes and stringers of quartz and calcite in a zone varying between 1 and 25 feet in width. A narrow minette dyke follows the vein, either lying within it or along one of the other walls. Where the vein is widest it consists in general of about 20 per cent vein matter and 80 per cent rock. Where it is only a few feet wide it may be mainly vein matter. Pyrite, galena, and sphalerite are present in slight amount. The vein has been deposited along a shear zone which where widest was penetrated by vein stringers and where narrowest was usually filled by a single vein. The relative ages of the dyke and the vein are unknown. Later than both dyke and vein is parallel shearing intense enough to have locally changed the argillaceous wall-rock into graphite schist and to have altered the dyke beyond easy recognition.

Silver Cliff Group (Locality 171)

Reference: Annual Report of the Minister of Mines, British Columbia, 1918.

The Silver Cliff group of four mineral claims is on the east side of Illiance river and is east of the Silver Star group. The mineral showing consists of quartz veins and quartz-barite veins in hard breccia. At least two of the veins are of good size. They contain pyrite, chalcopyrite, and galena, but sulphide mineralization is very sparse.

Silver Horde Group (Locality 135)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1918, 1922, 1924, and 1926.

The Silver Horde group of four mineral claims is on Trout creek and adjoins and lies north of the Wolf group. It is reached by a trail branching from the Kitsault trail near Trout creek.

In 1918 the Granby Consolidated Mining, Smelting, and Power Company took an option on the property, but after doing some diamond drilling relinquished their option. Country rock consists of felsite and breccia of the Hazelton group. Several quartz veins occur on the property. Early development work done south of Trout creek disclosed veins up to 20 feet wide. Later work north of Trout creek disclosed quartz veins up to 12 feet wide. The veins, like others in the vicinity, appear to represent replacements in brecciated zones and are not like the clear-cut, white quartz veins seen in the argillites. The quartz is vitreous and much of it is rather dark. Mineralization consists of pyrite, galena, and sphalerite, but very little sulphide occurs. Fair values in silver have been obtained.

Silver King and Eagle Claims (Locality 149)

Reference: Annual Report of the Minister of Mines, British Columbia, 1921.

The Silver King and Eagle claims are east of Kitsault river and half a mile south of the Homeguard group. The mineral deposit consists of several closely spaced, parallel quartz veins in felsitic rocks. The veins contain some pyrite, sphalerite, and galena.

Silver Leaf Group (Locality 174)

Reference: Annual Report of the Minister of Mines, British Columbia, 1924.

The Silver Leaf group of four mineral claims is south of Illiance river and opposite the mouth of Copper creek. The country rock is argillite striking northeast and dipping southeast. The mineral deposit is a southerly striking quartz vein containing many fragments of country rock. The quartz vein has been fractured and the fractures filled by a later 6-inch quartz vein holding some pyrite and tetrahedrite.

Silver Star Group (Locality 171)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1919, 1920, 1921, and 1930.

The Silver Star group of two mineral claims is on Illiance river and lies east of the United Metals group. The Silver Star trail branches from the Illiance trail at the United Metals cabin.

The mineral deposits are narrow quartz-sulphide veins lying in a sheared breccia. The veins strike north parallel to the shear planes and have been traced for several hundred feet. Several exposures are known of veins a foot or less wide containing quartz, pyrite, galena, and tetrahedrite. Some of the vein material is high-grade silver ore.

Silver Tip Group (Locality 146)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Silver Tip group of two claims adjoins and lies west of the Dolly Varden group. The mineral deposit is a quartz-barite vein containing a meagre amount of galena and sphalerite.

Silver Wing and Copper Crest Claims (Locality 158)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Silver Wing and Copper Crest claims are west of Kitsault river and about 5 miles from Alice Arm. The deposits lie in argillite near the contact of the Coast Range batholith. The mineral deposit on the Silver Wing consists of quartz stringers in a sheared zone. The quartz contains some pyrite, chalcopyrite, galena, and sphalerite. The same minerals occur in small quantity on the Copper Crest claim.

Speculator No. 2 Claim (Locality 155)

References: Annual Report of the Minister of Mines, British Columbia, 1925 and 1926.

The Speculator No. 2 mineral claim adjoins and lies south of the LaRose group. A pit sunk in drift disclosed a quartz-sulphide vein containing high values in silver. The vein is only a foot or so wide but contains pyrite, galena, and tetrahedrite, and resembles rather closely the LaRose vein.

Standard Group (Locality 176)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1922, 1926, and 1927.

The Standard group of four mineral claims is on McGrath mountain and adjoins and lies south of the Sunrise group. The McGrath Mountain trail passes near the Standard mineral showings. The deposit is a quartz vein mineralized with sphalerite and on casual inspection appears to be of large size. Apparently, however, the vein is nearly horizontal and its width is not nearly as great as it seems to be.

Starlight Group (Locality 138)

References: Annual Report of the Minister of Mines, British Columbia, 1913 and 1916.

The Starlight group, formerly the Prince Rupert and Vancouver mineral claims, adjoins and lies northwest of the Racehorse claim. It is reported that quartz veins holding pyrite and chalcopyrite occur.

Summit Group (Locality 130)

References: Annual Report of the Minister of Mines, British Columbia, 1921, 1923, and 1930.

The Summit group of two mineral claims is north of the Chance group between Clearwater and Trout creeks. The property can be reached by a short trail branching from the Chance trail at the Chance cabins.

The principal mineral deposit is a mineralized zone in breccias. The mineral body is several feet wide, is vertical, and strikes north-northeast. It contains some quartz but is mainly country rock mineralized with galena and sphalerite. Development work consists of short adits and numerous open-cuts.

Sunrise Group (Locality 165)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1923, 1926, 1927, 1928, and 1929; Geol. Surv., Canada, Sum. Rept. 1928, pt. A.

The Sunrise group of eight mineral claims occupies part of the southern slope and part of the flat top of McGrath mountain. The group adjoins and lies north of the Standard group and is reached by the McGrath Mountain trail. The property was acquired by the Kitsault Eagle Silver Mines, Limited, in 1928, and this company carried on active development in 1928 and 1929.

The country rock consists of argillite and associated coarser grained sediments striking north. The sediments have been intruded by an irregularly shaped stock of augite porphyry and by a number of dykes. The mineral deposits occur in fractured and brecciated zones and also as clear-cut veins in the argillite.

Many open-cuts have been made and an adit 1,000 feet long has been run, but they fail to prove any connexions between the scattered showings. The veins strike north and have steep dips. They are 1 to 6 feet wide and consist of quartz and some calcite and sphalerite. Wider deposits up to 20 feet wide formed probably in brecciated zones consist of quartz, calcite, sphalerite, and fragments of country rock. One of these bodies appears to be nearly horizontal, another appears to dip north about 30 degrees. It is likely that faults with small throw are numerous.

Sunset Group (Locality 190)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1921, 1922, 1923, 1924, 1925, 1926, 1927, and 1930; Geol. Surv., Canada, Sum. Rept. 1922, pt. A.

The Sunset group of seven mineral claims is on Roundy creek about 2 miles from Silver City. The property is reached by the Roundy Creek trail. The group in 1923 was taken under option by the Keystone Mining Company.

The rocks on the group consist of argillite intruded by the Coast Range batholith. The mineral deposit lies very close to the contact. It is a quartz vein striking south-southeast and has been traced for several hundred feet. The southern part of the vein lies in a granitic rock but the northern part is in argillite. The vein is mineralized with pyrite, galena, and sphalerite and locally contains good silver values. An adit 600 feet long has been driven under the surface showings but did not enter the vein.

Surprise Claim (Locality 147)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Surprise claim is east of Kitsault river. It is 16 miles from Alice Arm and adjoins and lies east of the David Copperfield claim. The mineral deposit is a zone 25 feet wide, striking east, and traversed by stringers and veins of barite and quartz that constitute about 75 per cent of the zone, but it appears to be barren of sulphides.

Theda Bara and Bebe Daniels Claims (Locality 189)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1923, 1924, and 1927.

The Theda Bara and Bebe Daniels claims probably include what has been described as the Basin claim. They are at an elevation of 3,900 feet on the south side of the basin at the head of the main fork of Lime creek. The country rock is argillite intruded by granite. One of the mineral deposits is a vertical vein, 8 to 30 inches wide, mineralized with pyrrhotite and some sphalerite, galena, and quartz. Another deposit is a body of pyrrhotite, probably a vein, several feet wide.

Three Mile (Locality 180)

References: Annual Report of the Minister of Mines, British Columbia, 1930 and 1931.

The Three Mile property is on Illiance river 3 miles from its mouth. Pyrite-bearing shear zones have been developed by adits.

Tiger Group (Locality 143)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1919, 1920, 1922, 1926, 1927, 1928, and 1929; Geol. Surv., Canada, Sum. Rept. 1921, pt. A; Sum. Rept. 1928, pt. A.

The Tiger group of three mineral claims is a short distance above the Toric mine. The workings and camp buildings are about a quarter of a mile east of Kitsault river and 17 miles from Alice Arm. The property is reached by a foot trail branching from the Kitsault trail at the Toric mine.

The property was staked in 1916. It was bonded in 1919 by H. B. Price who drove an adit and did some diamond drilling but relinquished his option. In 1928 the property was acquired by Utility Mines No. 1. This company carried on development for some time but work ceased in the autumn of 1929.

The claims are underlain by hard, dense, volcanic tuffs and felsite cut by several narrow lamprophyre dykes. The mineral deposit is a quartz vein 4 to 18 feet wide and has been traced on the surface for 300 feet. The vein strikes north 30 degrees east and dips steeply northwest. A transverse fault 60 feet from the north end of the vein offsets the vein 30 feet. Another parallel fault 20 feet farther north has apparently offset the vein 40 feet. The vein contains calcite as well as quartz and is mineralized with pyrite, sphalerite, galena, ruby silver, and native silver. The southern part of the vein is not well exposed on the surface, but in this part of the vein a crosscut adit exposed 6 feet of vein matter containing pyrite, sphalerite, galena, ruby silver, and native silver. In the highest adit ruby silver and native silver occur 130 feet below the surface and in No. 2 adit about 80 feet below the surface. The open-cuts show the width, length, and strike, of the vein. Nine diamond drill holes explore the vein for a length of 300 feet. Three adits at vertical intervals of 125 feet have encountered the vein.

Tip Top Claim (Locality 124)

Reference: Annual Report of the Minister of Mines, British Columbia, 1918.

The Tip Top claim is west of the head of Kitsault river and lies south of the Mathilda claim. The mineral deposits are quartz veins and mineralized zones in the igneous rocks. The deposits contain pyrite and chalcopyrite.

Titrite Group (Locality 168)

References: Annual Report of the Minister of Mines, British Columbia, 1930 and 1931.

The Titrite group of eight mineral claims is east of Illiance river near its head. Shear zones in volcanic rocks have been mineralized with quartz, pyrite, and chalcopyrite. Small quartz veins contain some galena and zinc blende.

Toric Mine (Locality 144)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1927, 1928, 1929, and 1930; Geol. Surv., Canada, Sum. Rept. 1921, pt. A; Sum. Rept. 1928, pt. A.

The Toric mine is on the east bank of Kitsault river about 17 miles from Alice Arm. Access to the mine is furnished by the Dolly Varden Mines railway to Camp 8 and from this point by a wagon road.

The Toric group of four mineral claims was explored by prospector owners for many years and they demonstrated the presence of a fairly large, low-grade mineral deposit containing shoots of high-grade silver ore. In 1924 the property was taken under option by the Consolidated Homestake Mining and Development Company, Limited, who commenced a more ambitious program of underground development. The name of the company was changed in 1927 to Toric Mines, Limited. The company in 1928 completed the construction of a mill capable of milling 50 tons a day. Operation of the mill began in the late summer of 1928. In 1928 Toric Mines, Limited, mined 1,540 tons of ore yielding 19,968 ounces of silver and 21,911 pounds of lead. In 1929 the company mined 540 tons yielding 10,565 ounces of silver and 7,196 pounds of lead. The Britannia Mining and Smelting Company acquired the mine in 1929 and organized the Torbrit Mining Company to develop and mine the mineral deposits. In 1930 the low price of silver compelled the company to cease development work.

The country rock at the mine consists of massive breccia and felsite. Because of overburden the mineral deposit is not well exposed on the surface. It is exposed best in the adit driven about 150 feet below the outcrop. On this level the deposit is 280 feet long, 80 to 120 feet wide, strikes east and dips 45 degrees north. Small faults offset the deposit slightly.

The deposit is typically a coarse-grained mixture of barite, jasper, hematite, quartz, and ankerite holding fragments of country rock and a small amount of pyrite, and galena. At least one shoot of high-grade silver ore is known. It lies near the hanging-wall of the deposit and consists of quartz mineralized with pyrite, galena, native silver, and perhaps other silver-bearing minerals. The deposit has apparently been formed by filling and replacement in a brecciated zone. The native silver seen on the surface and in the adit occurs as flakes filling small cracks and appears to be of secondary origin.

Tyee Group (Locality 129)

Reference: Annual Report of the Minister of Mines, British Columbia 1930.

The Tyee group of mineral claims is east of Kitsault river and about half a mile south of Clearwater creek. Access is furnished by a short trail branching from the Kitsault trail 1½ miles north of Trout creek.

The country rock consists of tuffs striking northeast and dipping at moderate angles northwest. The mineral deposits are narrow veins of galena 1 to 6 inches wide. One exposure shows galena scattered through rock over a much greater width, but this occurrence has not been traced beyond the exposure. The narrow veins strike north-northeast, are approximately vertical, and consist of fairly pure galena.

United Metals Mining Company, Limited (Locality 170)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1918, 1919, 1920, and 1930.

United Metals Mining Company, Limited, owns three claims in Illiance valley north of the Bellevue group and about 14 miles from Alice Arm. Access is furnished by the Illiance trail.

The deposits consist of lenticular veins that lie in sheared tuffs and breccias and strike north parallel to the shear planes of the enclosing rocks. The main showing is a vertical vein up to 3 feet wide and consisting of quartz, pyrite, galena, sphalerite, and tetrahedrite. The vein has not been traced for much more than 50 feet. It consists largely of sulphide.

Utopia Group (Locality 185)

References: Annual Report of the Minister of Mines, British Columbia, 1922, 1924, and 1929.

The Utopia group of six mineral claims is 1½ miles north of Alice Arm. Access is furnished by a trail from Alice Arm.

The mineral deposit is a light coloured aplite dyke cutting argillites. The dyke is about 10 feet wide and holds numerous narrow quartz veinlets which contain pyrite, galena, sphalerite, and tetrahedrite.

Vanguard Group (Locality 127)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1919, 1921, 1922, 1923, 1926, 1927, 1928, 1929, 1930, and 1931; Geol. Surv., Canada, Sum. Rept. 1921, pt. A, and Sum. Rept. 1928, pt. A.

The Vanguard group of four mineral claims is 3,000 feet above sea-level in the area between Kitsault river and West Fork creek. The property is 22 miles from Alice Arm. A good pack trail branches from the Kitsault River trail at the mouth of West Fork creek and crosses the Vanguard claims.

The country rock consists of felsite and dark grey tuff and breccia in contact with argillite a few hundred feet northeast of the mineral showings. Several mineral deposits are known and all contain copper minerals and values in silver and gold. The chief deposit is approximately parallel

to the contact between the igneous and sedimentary rocks. It is 15 feet or less in width and has been traced on the surfact for 750 feet where it strikes north 60 degrees west and dips steeply southwest. The outcrop inclines uphill from southeast to northwest and its upper end is 275 feet above the lower. The deposit is well mineralized with pyrite and chalcopyrite. Quartz, calcite, and barite are present but the gangue matter is probably chiefly country rock. On the whole the deposit is vein-like, but locally it consists of a strip of country rock containing many narrow stringers of chalcopyrite striking and dipping in all directions. A good shoot of ore is exposed on the surface about midway between the top and bottom open-cut. It is 3 to 12 feet wide and 200 feet or more long.

Two crosscut adits have been driven under this ore shoot. In the upper adit the shoot was encountered about 50 feet below the surface and was followed by a drift for 50 feet. Good chalcopyrite ore occurs only in the end of the drift and by its position suggests that the ore shoot plunges northwestward. In the lower adit, the deposit was encountered 185 feet below the surface and was followed northwest by a drift 85 feet long. The end of the drift is 225 feet below the surface. In this working the ore-body is locally 15 feet wide and contains several bands up to 2 feet wide of good copper ore.

The rocks in the lower adit are distinctly sheared and the shearing is parallel to the ore-body. Several ribs of quartz lying parallel with the shearing occur in the crosscut part of the adit and suggest that other mineral deposits may exist parallel to the one under development.

Vanguard Extension Group (Locality 127)

References: Annual Report of the Minister of Mines, British Columbia, 1927 and 1928.

The Vanguard Extension group of mineral claims adjoins and lies south of the Vanguard group. The main mineral body of the Vanguard group strikes toward the Vanguard Extension and may continue into that group. Pyrite and chalcopyrite have been found on the Vanguard Extension but no definite body of ore has yet been outlined.

Verona Group (Locality 188)

References: Annual Report of the Minister of Mines, British Columbia, 1921 and 1922.

The Verona group of two mineral claims is at the head of the southwest fork of Lime creek. The deposit consists of a quartz vein up to 2 feet wide adjoining a 6-foot felsite dyke in argillite. The vein contains pyrite, galena, and sphalerite.

War Dance Group (Locality 163)

Reference: Annual Report of the Minister of Mines, British Columbia, 1919.

The War Dance group of six mineral claims is on the northwest side of Dak river about 7 miles from Alice Arm. The mineral deposit consists of quartz veins up to 2 feet wide in argillite, containing pyrite, chalcopyrite, sphalerite, and galena.

Wild Cat Group (Locality 148)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1921, 1922, 1927, and 1932; Geol. Surv., Canada, Sum. Rept. 1921, pt. A.

The Wildcat group of five mineral claims is west of Kitsault river, a short distance south of Homestead creek. Access is furnished by a foot trail leaving the Dolly Varden Mines railway at the mouth of Homestead creek.

The country rock consists of felsite containing inclusions of argillite. In places the rock contains pyrite and chalcopyrite impregnations, but only vein-like deposits appear to have promise. The chief mineral deposit is a vein several feet wide, mineralized with pyrite, chalcopyrite, galena, sphalerite, ankerite, and quartz. Locally the deposit is country rock and sulphides with no apparent fissure. The body strikes northeast and dips northwest at moderate angles. Adits have been driven at elevations of respectively 30 and 230 feet below the outcrop, but do not appear to have encountered the ore-body. Dykes striking northeast are very numerous in the adits and these may have cut away the mineral deposit in some places.

Wolf Claim (Locality 184)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1925, 1926, 1927, 1928, 1929, and 1930; Geol. Surv., Canada, Sum. Rept. 1928, pt. A.

The Wolf mineral claim is on the mountain slope north of Alice Arm. The known ore deposits are at the base of the mountain near the mouth of Falls creek less than a hundred yards from the Dolly Varden Mines railway. In 1925 the property produced 17 tons of ore yielding 3 ounces of gold, 2,212 ounces of silver, and 583 pounds of lead. In 1927 a shipment of 28 tons returned 4 ounces of gold and 2,051 ounces of silver. A part of the first shipment assayed over 300 ounces of silver a ton.

The country rock is argillite and argillaceous quartzite intruded by many lamprophyre and diorite dykes. The sediments strike north and dip 20 degrees west. Most of the dykes are vertical and strike north 30 degrees east. The mineral deposits are three, narrow, silver-bearing quartz veins lying parallel with the enclosing strata and structurally about 100 feet apart. The veins are in general about 1 foot wide. The middle vein is exposed by open-cuts for a distance of 150 feet. Underground work has proved a strike length of 220 feet and a dip depth of 70 feet. The other veins have not been explored underground. The middle vein divides to the north into branches. It consists of white quartz containing some ankerite, calcite, and barite and also rock fragments, and contains bands and disseminations of silver-bearing sulphides. The sulphides are chiefly in bands along the foot-wall of the vein. These bands of sulphide are up to 8 inches thick and consist of rich silver ore. The metallic minerals are chiefly pyrite, chalcopyrite, sphalerite, galena, tetrahedrite, ruby silver, and native silver.

Wolf Group (Locality 136)

References: Annual Report of the Minister of Mines, British Columbia, 1915, 1916, 1918, 1919, 1920, 1921, and 1930; Geol. Surv., Canada, Sum. Rept. 1921, pt. A, and Sum. Rept. 1928, pt. A.

The Wolf group of four mineral claims is east of Kitsault river just south of Trout creek. The distance from Alice Arm is about 19 miles. The Kitsault River trail crosses the claims.

The group was staked in 1916 and was sold to the Dolly Varden Mining Company the same year. This company proved the presence of mineral deposits of considerable size. In 1919 the properties of the Dolly Varden Mining Company were taken over by the Taylor Engineering Company. In 1922 the mine holdings of the Taylor Engineering Company were acquired by George Wingfield who with others incorporated the Northern Mining Properties, Limited, to take over the mining properties thus acquired.

Four large quartz veins varying from 4 to 50 feet in width, and lying in tuffs and breccias, are known on the property. The veins strike northeasterly on a steep slope facing westward. No. 1 vein strikes north 70 degrees east, dips steeply north, and has been traced for 400 feet. It is 10 to 50 feet wide and is mineralized with pyrite, galena, and sphalerite. No. 2 vein is 250 feet west of No. 1 vein, strikes north 20 degrees east, and has been traced for 260 feet. It is 25 feet wide and contains less sulphide than No. 1 vein. No. 3 vein is northeast of No. 2 vein and may be its northeastern continuation, there being an unexplored gap of 300 feet between the ends of the two veins. No. 3 vein strikes north 20 degrees east and has been traced for 300 feet. It is 20 feet wide and resembles No. 2 vein in mineralization. No. 4 vein is parallel to No. 3 vein and 150 feet farther west. It is 15 feet wide and resembles the other veins except that it contains barite.

Yukon and Nome Claims (Locality 130)

Reference: Annual Report of the Minister of Mines, British Columbia, 1923.

The Yukon and Nome claims are on the mountain between Clearwater and Trout creeks and are south of the Summit group. The mineral deposit is a quartz vein, up to 6 feet wide, in a brecciated zone in volcanic rocks. No ore shoots have been found.

Zorka Group (Locality 151)

Reference: Annual Report of the Minister of Mines, British Columbia, 1926.

The Zorka group of six mineral claims is on the west side of Kitsault river a short distance north of West creek. The mineral deposits consist of narrow calcite-quartz veins well mineralized with pyrite and chalcopyrite. The veins are in general less than 6 inches wide but locally consist mostly of chalcopyrite.

GEORGIA RIVER-ANYOX DISTRICT

Anyox Extension Claim (Locality 193)

Reference: Annual Report of the Minister of Mines, British Columbia, 1916.

The Anyox Extension claim is on the north shore of Alice Arm near Way point. An open-cut exposes pyrite in mica schist included in granite.

B.C. Verde Group (Locality 104)

References: Annual Report of the Minister of Mines, British Columbia, 1921 and 1927.

The B.C. Verde group of eight mineral claims is on the ridge between Portland canal and the head of Georgia river. The workings consist of a cluster of open-cuts at an elevation of 3,200 feet on the crest of the ridge.

The mineral deposits are not clearly outlined but appear to consist of disseminations of pyrite and chalcopyrite in rocks of the Hazelton group near the contact of the Coast Range granite. It is probable that much of the mineralized rock is intrusive. Mineralization is spread over a large area.

Big Mike Group (Locality 103)

Reference: Annual Report of the Minister of Mines, British Columbia, 1926.

The Big Mike group of six claims is on the east shore of Portland canal about 6 miles from Stewart.

The mineral deposits are in diorite of the Coast Range batholith and in included volcanic rocks of the Hazelton group. The main deposit is a clean-walled, quartz vein up to 2½ feet wide striking east-southeast and dipping 50 degrees north. It is locally well mineralized with pyrite, chalcopyrite, galena, and sphalerite. The vein has been drifted on for 100 feet just above high tide. Some ore has been stoped out and sacked but no shipments have been made. A few hundred feet south is another adit following for 100 feet a barren looking shear zone that strikes southeasterly. The rock at this place is an epidote-bearing volcanic rock.

Black Bear Group (Locality 198)

References: Annual Report of the Minister of Mines, British Columbia, 1930 and 1931.

The Black Bear group is 3 miles from Anyox and adjoins and lies southeast of the Bonanza mine. A quartz vein about 12 feet wide containing a little molybdenite has been traced for 500 feet. At another place quartz gashes and stringers are exposed for a considerable width.

Bonanza Mine (Locality 198)

References: Annual Report of the Minister of Mines, British Columbia, 1900, 1901, 1902, 1930, and 1931; Geol. Surv., Canada, Memoir 32.

The Bonanza mine is on Bonanza creek ¾ mile from its mouth and 3 miles south of Anyox. The property was bonded in 1901 to M. K. Rodgers who immediately began outlining the ore-body but relinquished the option in 1902. In 1912 after the Granby Consolidated Mining, Smelting, and Power Company had acquired the Hidden Creek group they also bonded the

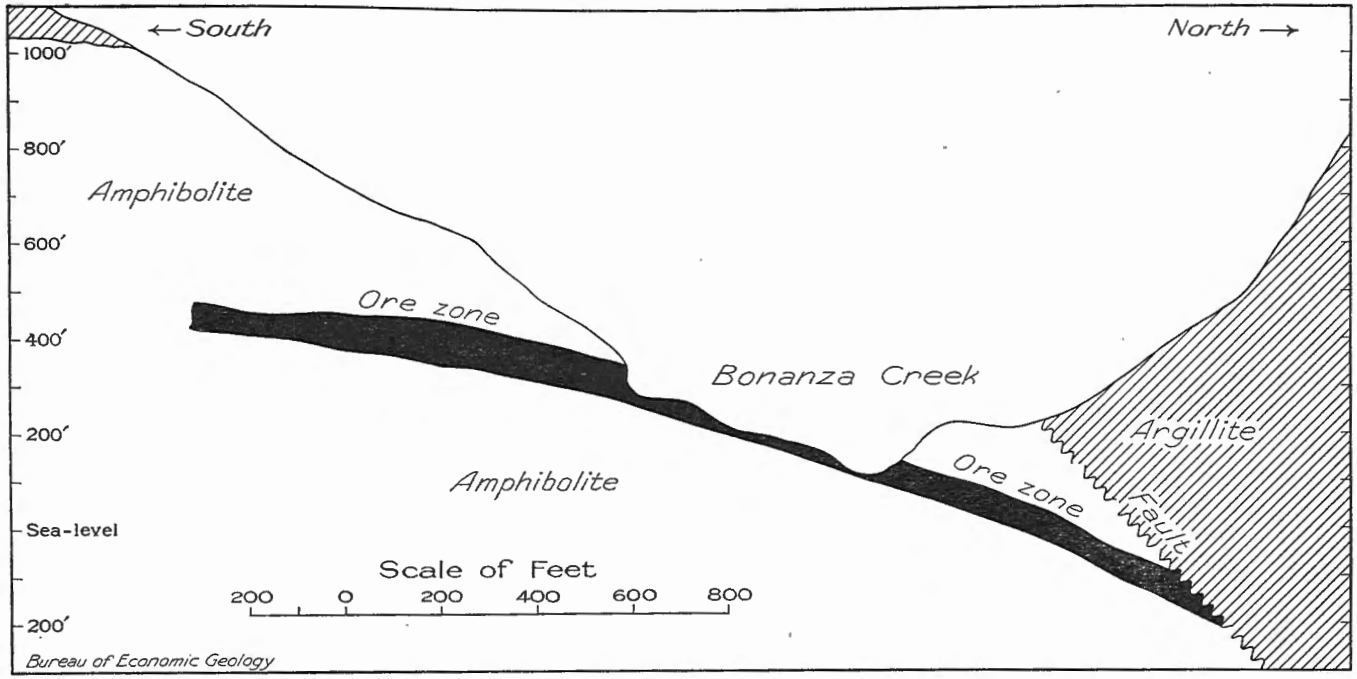

Figure 3. Vertical section through the Bonanza ore zone.

Bonanza group and acquired it in 1914. The mine began producing in 1929 and has now produced a total of 397,000 tons of ore yielding 1,560 ounces of gold, 133,000 ounces of silver, and 15,500,000 pounds of copper.

The Bonanza copper deposit lies in a shear zone in amphibolite. The amphibolite body is irregular in shape and much elongated in a southerly direction. It invades argillites and is apparently a tongue from the main amphibolite body outcropping a short distance to the west. The east and west contacts are parallel to the strike of enclosing sediments. At the north end the body plunges under sediments partly because of a large fault and partly because of a northerly pitch. The south end of the amphibolite body, as seen on the south side of Glacier creek, enters the sediments as sills and transgressing wedges and fingers. On the north side of Glacier creek the amphibolite truncates severely folded overlying sediments and shows local pillow-like structures and is locally fragmental. A long inclusion of sedimentary rock in the amphibolite on Glacier creek contains many quartz veins and has been silicified. The amphibolite in places is severely sheared and the shearing strikes west and dips 30 degrees or less north. In some shear zones biotite is very plentiful. In one or two places it was evident that this mineral could have developed by shearing of inclusions of argillite, but in other places where biotite occurred no inclusion was seen.

The ore-body outcrops in Bonanza creek and lies in a shear zone that strikes east and dips about 20 degrees north. Along the strike the shear zone is only 300 feet long but is known to extend down the dip for half a mile. It is 40 to 70 feet thick and has the shape of a very much flattened tube pitching north. At the west side the shearing turns northward rather abruptly and on the east side it turns southward. Faults are in evidence locally on the east and west sides. To the north, down the dip, the zone at a depth of 200 feet below sea-level is cut off by a fault that strikes northwest along Bonanza creek and dips 65 degrees northeast. This fault has let down the northern extension of the zone a distance of 800 feet or more. South of the outcrop in Bonanza creek the zone disappears in the south side of the valley because the slope of the hillside is steeper than the dip of the zone. The southern limits of the zone are unknown, but it has been traced to where it is 700 feet beneath the surface.

The ore-body has a strike length of about 200 feet and locally was 30 or 40 feet thick. The dip length is known to exceed half a mile and ore was continuous throughout this distance. Where the shear zone was thinner the ore-body narrowed also, but filled the whole shear zone. Where the shear zone widened the ore-body was somewhat thicker but did not fill the whole zone. Above the creek level the ore-body along its west side ends in two blunt wedges one above the other. On its east side the ore-body in most places is bounded by a minor fault, but in a few places ore of a somewhat different appearance has been mined east of the fault. Below the creek level the west side of the ore-body is bounded by a fault whose relations with the large fault at the north end of the ore-body are not known, but the large fault is probably later.

The walls of the ore-body are chlorite, actinolite, and biotite schists. Locally augite, labradorite, and enstatite can be recognized. All the shearing was accomplished before the ore minerals were deposited. All the

biotite and chlorite may be older than the ore, but some biotite flakes are not parallel to the shear planes and, therefore, are apparently later than the shearing. The ore-body is cut by many acid and basic dykes, some of which show slight offsets. One large, irregular dyke about 30 feet wide has a basic border and an acid rock interior. It rises to the shear zone but does not enter it.

The ore-body consists of copper ore of 3 per cent grade. The copper mineral is chalcopyrite and is in many places quite pure. Pyrrhotite, sphalerite, and pyrite also occur in the ore. Silver and gold values amount to a dollar or less a ton. The ore that lies in severely crushed rock or near faults and dykes is richer in copper than it is elsewhere. This increase in richness seems due to an increase in the amount of chalcopyrite at the expense of the other sulphides. Pyrrhotite is most plentiful along the hanging-wall in the form of small masses commonly separated by streaks of schist from the main ore-body. Sphalerite is less plentiful at the lower end of the ore-body than higher up. In several places in the ore-body it is evident, as shown by the preservation of rock texture and by the presence of unreplaced folia of schist, that the ore formed by replacement.

Carpenter's Claims (Locality 119)

Reference: Annual Report of the Minister of Mines, British Columbia, 1922.

Carpenter's claims are at an elevation of 3,500 feet on Kshwan river 12 miles east of the head of Hastings arm. Several quartz veins that contain pyrite and a little chalcopyrite are known to be present.

Deadwood and Quartz Groups (Locality 194)

References: Annual Report of the Minister of Mines, British Columbia, 1922, 1927, 1930, and 1931.

The Deadwood and Quartz groups adjoin and lie north of the Hidden Creek group at Anyox. The country rock consists of amphibolite bounded on the east by argillite. The contact and the sediments strike north.

On the Quartz group a vein up to 18 feet wide lies in argillite and parallels the bedding of the sediments. The vein has been traced by open-cuts for 2,000 feet. It consists of milky quartz in general barren, but locally containing a little pyrrhotite, chalcopyrite, and other common sulphides.

On the Deadwood group the mineral deposit occupies a shear zone in amphibolite. The shear zone strikes north and has been traced for a length of 1,500 feet. The zone contains quartz stringers and sparsely disseminated chalcopyrite and pyrrhotite.

Elkhorn Group (Locality 117)

References: Annual Report of the Minister of Mines, British Columbia, 1929 and 1930.

The Elkhorn group of four mineral claims is at an elevation of 3,500 feet west of the head of Hastings arm. The claims adjoin those of the Saddle group.

On this property narrow streaks of free gold occur in a silicified shear zone a few feet wide. The shear zone traverses volcanic rocks with a northerly strike and westerly dip. The extent of the zone has not been determined.

Georgia Bay Group (Locality 117)

Reference: Annual Report of the Minister of Mines, British Columbia, 1929.

The Georgia Bay group is at the head of Hastings arm. It adjoins and lies north of the Elkhorn group. Two silicified zones were discovered in 1929 but have not been developed.

Georgia River Gold Mines, Limited (Locality 113)

References: Annual Report of the Minister of Mines, British Columbia, 1911, 1912, 1914, 1915, 1916, 1917, 1918, 1922, 1923, 1924, 1928, 1929, 1930, and 1932.

The holdings of Georgia River Gold Mines, Limited, are at an elevation of about 3,500 feet on the west side of Georgia river about 10 miles from its mouth.

The country rock on the property consists mainly of fine-grained andesitic rocks and probably tuffaceous sediments locally strongly sheared. A short distance north sediments are the prevailing rocks, whereas southward crystalline volcanic types predominate. Granitic and lamprophyre dykes are common.

There are many gold-bearing quartz veins on the property, but the extensive development has been confined almost entirely to two of these veins and to two quartzose bodies, known as the Main vein. The two bodies known as the Main vein are up to 20 feet wide and each has been traced for about 400 feet. They strike northerly and towards one another but are separated by a distance of 700 feet in which vein matter has not been found. Each body consists of country rock ribboned with quartz gashes and veinlets lying parallel to the strike of the body. They are very sparsely mineralized.

The two veins on which extensive work has been done are named, respectively, the Bullion and Southwest veins. Each is up to 2½ feet wide, strikes north, and has been traced for 1,000 feet or more. The Southwest vein lies about 200 feet west of the Bullion vein. The Southwest vein extends north to the northern part of the Main vein and probably intersects it. The Bullion vein crosses the gap between the two parts of the Main vein. Both the Bullion and Southwest veins are locally well mineralized with pyrite, pyrrhotite, arsenopyrite, galena, and sphalerite. Native gold is plentiful locally and specimens have assayed several ounces of gold a ton. The veins pinch and swell and in places disappear, but the fractures continue as narrow shear zones. The highest of the five adits is at an elevation of 3,665 feet, the lowest is 500 feet below it. Three short adits aggregating 400 or 500 feet in length have been driven to develop the Southwest vein. Two long adits aggregating about 2,500 feet in length have been driven to develop the Bullion vein.

Glory Extension Group (Locality 105)

Reference: Annual Report of the Minister of Mines, British Columbia, 1927.

The Glory Extension group of eight claims is east of the head of Georgia river and adjoins and lies south of the property of the North Country Mining Company. At an elevation of about 2,800 feet a quartz vein up to 3½ feet wide strikes north and dips east. Farther south at an elevation of about 4,000 feet another quartz vein up to 2 feet wide strikes north and dips west. The veins are near the contact between the Coast Range intrusives and volcanic rocks and are sparsely mineralized with pyrite, galena, and sphalerite.

Golskeish Mines, Limited (Locality 200)

References: Annual Report of the Minister of Mines, British Columbia, 1920, 1923, and 1925; Geol. Surv., Canada, Sum. Rept. 1922, pt. A.

The holdings of Golskeish Mines, Limited, are on Deep bay 4 miles south of Anyox. A deposit on this property was mined for several years primarily as a supply of quartz flux for the smelter at Anyox. Production began in 1919 and continued to 1930. The total production was 50,000 tons, yielding 4,700 ounces of gold and 25,000 ounces of silver.

The deposit is a quartz vein about 6 feet wide in argillite. The quartz is milky white and is sparsely mineralized with pyrite, sphalerite, galena, arsenopyrite, and other common sulphides.

Granby Point (Locality 197)

Reference: Annual Report of the Minister of Mines, British Columbia, 1930.

At Granby point near Anyox quartz veins in argillite were mined for flux by the Granby Consolidated Mining, Smelting, and Power Company.

Ground Hog Claim (Locality 200)

Reference: Annual Report of the Minister of Mines, British Columbia, 1908.

The Ground Hog mineral claim is on the south side of the head of Granby bay. On it there is a quartz vein about 8 feet wide in argillite. The vein is mineralized with pyrite, galena, and sphalerite, and contains also gold and silver values.

Hidden Creek Mine (Locality 196)

References: Annual Report of the Minister of Mines, British Columbia, 1901, 1902, 1909, 1915, 1917, 1918, 1919, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, and 1932; Geol. Surv., Canada, Memoir 32, and Sum. Rept. 1922, pt. A.

The Hidden Creek mine is at an elevation of 700 feet on Hidden creek 1½ miles from its mouth at Anyox. The group of claims was staked in 1901 and in 1910 was purchased by the Granby Consolidated Mining, Smelting, and Power Company. This company in 1912 began the construction of a smelter and in 1914 mining and smelting commenced. Prior

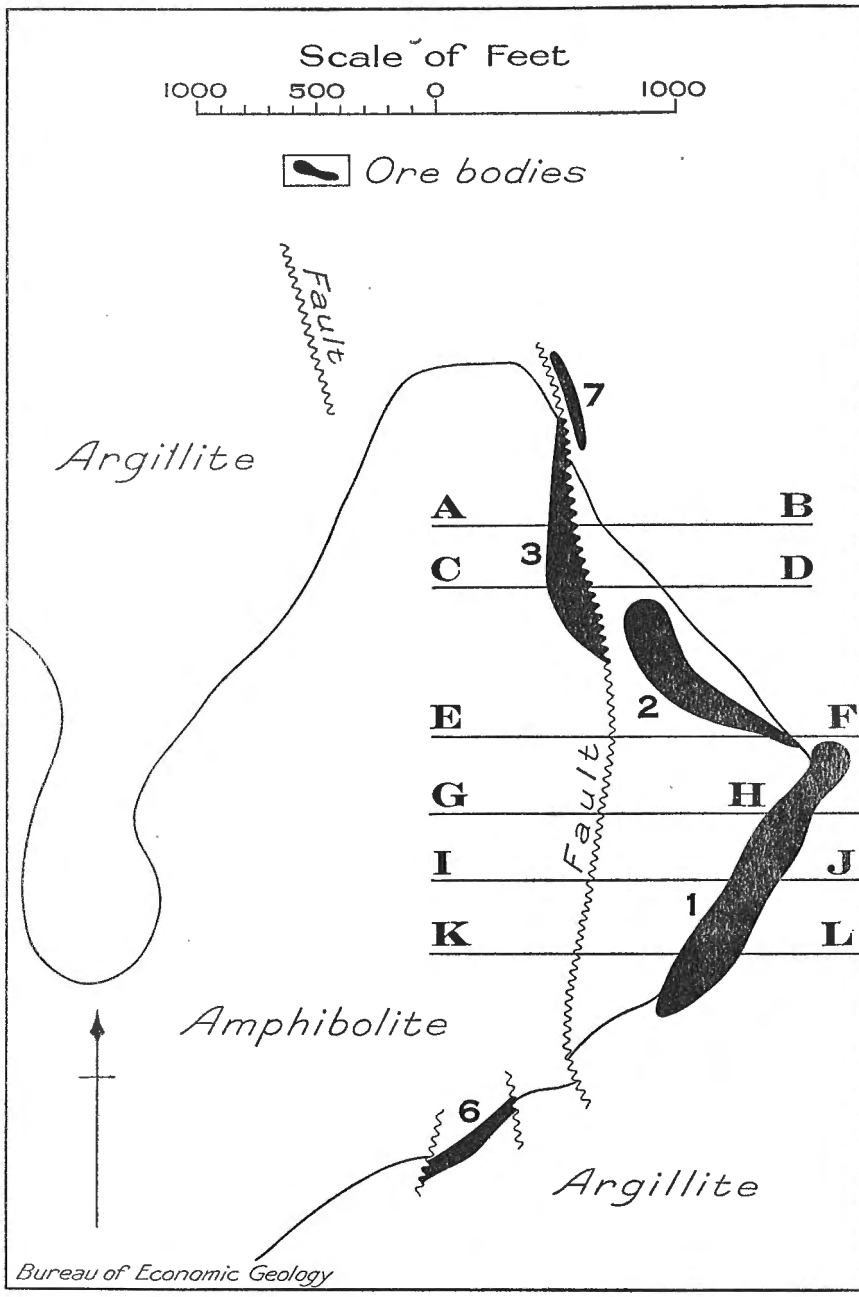

Figure 4. Generalized surface plan of Hidden Creek mine, showing amphibolite-argillite contact, main faults, and outcrops of ore-bodies (A-B, C-D, etc.: lines of section, *See* Figure 5).

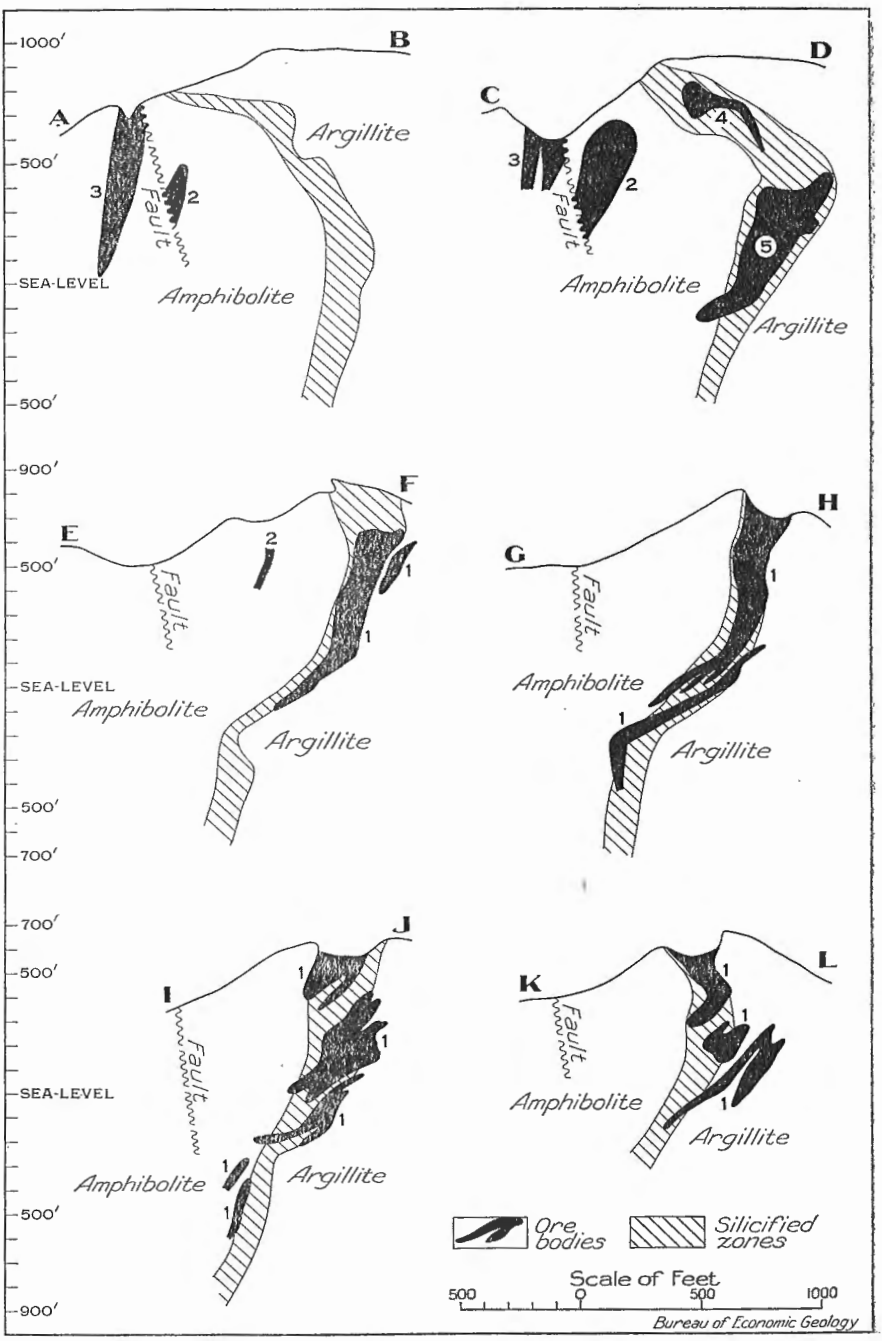

Figure 5. Vertical sections (*See* Figure 4), Hidden Creek mine.

to 1924 the ore was smelted direct, but commencing in that year the ore was concentrated and the concentrates sintered prior to smelting. The company develops hydroelectric power for its needs on Falls creek, which enters Granby bay at Anyox. At the present time the company produces blister copper containing much gold and silver and blister copper with very little gold and silver. Production has been at the rate of about 30,000,000 pounds of copper a year. The total production to the end of 1932 has been 19,400,000 tons of ore yielding 560,600,000 pounds of copper, 98,800 ounces of gold, and 5,913,000 ounces of silver.

The Hidden Creek ore-bodies are at or near the contact between a body of amphibolite on the west and argillites on the east. In the vicinity of the mine the contact curves in the form of the letter S. North and south of the curve the contact strikes north. The distance between the two ends of the curving part is more than 1 mile and the ore-bodies are situated on the eastern part of the southern half of the S-like curve. Underground work has shown that in the northern part of the mineralized area the argillite-amphibolite contact from the surface to a depth of, in places, 500 feet dips east at a moderate angle, but below swings to a steep westerly dip which holds to a depth of at least 2,500 feet. In the southern part of the mineralized area the contact dips steeply west except in some places where, at the surface, the dip is at a high angle eastward but changes below ground to a steep westward dip.

The sediments strike parallel to the contact and in the mine they in general also dip parallel to the contact. In the vicinity of the mine the argillites are closely folded, locally overturned, and locally severely sheared. At many places they have been transformed into knotted schists and near the ore-bodies they have been extensively silicified, as near No. 1 ore-body where for a distance of 100 feet outward from the contact they have been altered to a light-coloured quartzose rock and silicification is fairly strong for a further distance of several hundred feet. Silicification is also notable at other places along the contact and in argillite bodies lying within the amphibolite.

The amphibolite consists mainly of actinolite, but contains also chlorite, epidote, basic plagioclase feldspar, biotite, and magnetite. Locally it exhibits pillow-like structures and in places it has the appearance of a fragmental breccia. In the main, however, the body appears to be intrusive. A few miles south of the mine the amphibolite truncates the sediments both across the strike and the dip. In many places it holds inclusions of sedimentary rock and appears as if the body is at least mainly an intrusive. Some geologists and engineers who have studied the property are, however, of the opinion that the amphibolite is of extrusive origin.

The amphibolite is in general less sheared than the sediments. It is silicified at only a few places, as for example near some of the ore-bodies. J. A. Bancroft in a report made to the Granby Consolidated Mining, Smelting, and Power Company stated he was of the opinion that some deformation of the rocks occurred at the time of intrusion of the amphibolite, but that the main part of the deformation was associated with the intrusion of the Coast Range batholith and that it was during the later period of deformation that the basic intrusive was altered to amphibolite or green-

stone. Bancroft also believed that silicification was a continuous process beginning at a late stage in the intrusion of the amphibolite and continuing after the amphibolite had been locally sheared.

Dykes in great variety intrude the argillites and to a lesser extent the amphibolite. The dykes were intruded after the amphibolite was foliated and also after the ore-bodies were formed. There are several faults in the vicinity of the mine. Faulting preceded dyke intrusion but was later than the shearing of the rocks. Slight movements along some faults took place after dyke intrusion.

Some of the Hidden Creek ore-bodies outcropped and these appeared as large, rusty exposures and large areas of silicified rock. According to early reports the ores were locally completely oxidized to a depth of 5 feet. There was some secondary "sooty" chalcocite at the bottom of the oxide zone. Underground development work discovered ore-bodies that did not outcrop. Eight ore-bodies are known, six of which have been mined. Parts of ore-bodies Nos. 1 and 2 were visible at the surface; Nos. 3, 6, and 7 were drift covered; and Nos. 4, 5, and 8 did not reach the rock surface.

Ore-bodies Nos. 1, 4, and 5 form a fairly continuous body some 2,000 feet long on the eastern and southeastern contact of the southern half of the S-like structure. Ore-body No. 7 is a short distance north. Ore-bodies Nos. 2 and 3 lie in a shear zone within the amphibolite 100 to 300 feet west of the contact. Ore-body No. 6 is at the south end of the S-like structure, about 1,000 feet southwest of No. 1 body. Body No. 8 is not of commercial ore and lies between Nos. 1 and 6. The ore-bodies vary considerably in size. No. 1 is the largest and on some levels is as much as 1,500 feet long and 250 feet wide. It has a dip length of 1,200 feet. No. 6 ore-body is only a few hundred feet long and up to 70 feet wide.

Ore consists of solid sulphide, of amphibolite ribboned with sulphide, of highly silicified rock with sulphides, and of all gradations between solid sulphide and amphibolite ribboned with sulphide and between solid sulphide and siliceous ore. The sulphides are chalcopyrite, pyrrhotite, pyrite, magnetite, arsenopyrite, and sphalerite. The gangue consists of amphibolite, or silicified argillite, or amphibolite and small amounts of actinolite, quartz, calcite, epidote, and biotite. Locally the ore exhibits structures present in the rocks and there are local remnants of argillite and greenstone. These features show that the ore was formed by replacement. Locally chalcopyrite may be so abundant that the copper content of the ore rises as high as 10 per cent. Locally pyrrrhotite is very plentiful, and some large sulphide bodies consist almost entirely of pyrite. On the whole, however, the ore-bodies are of fairly uniform grade. The average ore contains 1·5 per cent copper, about ⅓ ounce of silver a ton, and about 10 cents in gold a ton.

Actinolite very rarely occurs in the altered argillites. A few sulphide veins of microscopic size were noted to be composed of actinolite and of pyrrhotite in which the pyrrhotite was moulded around and between actinolite crystals. Pyrrhotite, chalcopyrite, and pyrite occur in the wall-rocks. A yellow zeolite was seen only in specimens from near the surface. In sections of mineralized amphibolite the sulphides appear to be later than the rock-forming minerals. In sections of siliceous argillite the sulphides are seen to be later than the silicification.

No. 1 ore-body was a large, lenticular mass of heavy sulphide extending 1,200 feet down the dip. Its greatest strike length on any one level was 1,500 feet and its greatest width was 250 feet. The northern two-thirds of the body has a north strike and the southern third a southwest strike. The upper part of the body was vertical, but lower down it dipped west at about 70 degrees and near the bottom the angle of dip was 50 degrees. Everywhere the attitude of the body conformed to the contact between the amphibolite and the sediments and very closely if not exactly to the strike and dip of the sediments. The upper part of the body was the best ore. Downwards the body ended in amphibolite into which it projected in the form of fairly blunt wedges of low-grade, pyritic ore. The body lay mainly in the outer part of a silicified zone about 300 feet thick. Silicification of the walls is strong below the level of commercial ore. The bounding silicified sediments consist mainly of quartz but contain some sericite, chlorite, biotite, and sulphides. The amphibolite is also somewhat silicified and consists of quartz, sericite, actinolite, chlorite, epidote, biotite, and sulphides. No. 1 ore-body was made up of several closely spaced bodies separated by thin bands of silicified argillite or amphibolite.

In order of abundance the ore minerals are pyrite, pyrrhotite, chalcopyrite, and magnetite. Pyrrhotite was most abundant in the upper part of the body. Along the amphibolite hanging-wall, curves or rolls in the shearing were the loci of small ore-shoots containing more than the ordinary amount of chalcopyrite. Along the foot-wall side the ore, due to the presence of many, narrow, discontinuous ribbons of argillite, was commonly somewhat leaner than elsewhere.

Ore-bodies Nos. 2 and 3 lie within the amphibolite a short distance east of the amphibolite-argillite contact. They lie in a shear zone striking north and dipping steeply west. Both are steeply inclined. No. 3 outcrops at the surface where its eastern boundary is a fault dipping at a high angle to the east. Underground No. 3 body because it is inclined to the west departs from the fault. It is up to 175 feet wide, 600 feet long, and extends to a depth of 900 feet. No. 2 ore-body lies east of the easterly dipping fault and extends down to the fault against which it ends. No. 2 ore-body is up to 175 feet wide and is about 600 feet long. It is the upper part of No. 3 ore-body, cut off and downthrown by the fault. The movement along the fault has amounted to about 300 feet vertically and 200 feet in a southerly direction.

Wall-rock alteration in the case of Nos. 2 and 3 ore-bodies consists, almost entirely, of the development of chlorite and the amount of alteration is very slight compared with that connected with ore-bodies lying along the contact. The ore of Nos. 2 and 3 bodies is characteristically a dark greenstone schist ribboned with sulphide bands and lenses lying parallel to the shearing. The ore minerals in order of abundance are pyrrhotite, chalcopyrite, pyrite, and magnetite. The ore averages 2 to 3 per cent copper and is of higher grade than the ore of No. 1 body. Magnetite is more plentiful than in the ore-bodies at the contact and makes up about 3 per cent of the ore.

No. 4 ore-body was discovered by diamond drilling. The body was 100 feet thick and extended 500 feet down the dip. Its maximum length along the levels was 600 feet. It lay along the contact with a broad bulge at the top and tapered to a thin wedge at the bottom where it ended in silicified amphibolite. The dip at the top is 10 to 60 degrees east under the argillite roof. The wall-rocks are strongly silicified and alteration of rock is as intense where the ore-body is narrow as where it is wide, as at the top. The ore-body consisted of sulphide like No. 1 ore-body. Pyrite and pyrrhotite were about equally abundant and were much more plentiful than chalcopyrite. Shoots of pure pyrrhotite occurred on the upper side of the body at the greenstone-argillite contact.

No. 5 ore-body was discovered by diamond drilling. It was 180 feet wide and extended 700 feet down the dip. Its maximum length along the mine levels was 500 feet. It lay along the contact between amphibolite and argillite and the main part was situated where the dip of the argillites changes. The upper part of the body dips east, the lower part dips west, and the intervening greater part is vertical. At its north end the ore-body splits in two, the eastern part extending, parallel to the bedding, into slightly silicified argillite. Below, the body enters amphibolite and by a decrease in the chalcopyrite content grades into a large pyritic body. The ore is much like that of No. 4 and No. 1 bodies, being heavy sulphide in which pyrrhotite is common in the upper part but in which pyrite and pyrrhotite are both plentiful. The amphibolite and argillite of the wall-rock are intensely silicified.

No. 6 ore-body lies along the contact and in the southern part of the favourable structure. It has a maximum width of 70 feet, a depth down the dip of 300 feet, and a length along the levels of 500 feet. The body strikes northeast and is vertical, but at a depth of 150 feet turns somewhat and enters sheared amphibolite to the northwest. It ends downward at a fault dipping 45 degrees west. Silicification of the wall-rocks is strong where the body lies along the contact but is not present around the ore where it lies in amphibolite, the wall-rock alteration in those parts having resulted in the formation of chlorite. The ore is of the usual heavy sulphide contact type except in that part of the body lying in amphibolite where it consists of a greenstone ribboned with bands and lenses of sulphide.

No. 7 ore-body is of the contact type and lies north of No. 4 body. It has not yet been mined, but appears to be much smaller than the others nearby.

No. 8 ore-body is of the contact type and lies just east of No. 6. It appears to be entirely composed of uncommercial ore.

Homestake Group (Locality 195)

References: Annual Report of the Minister of Mines, British Columbia, 1927, 1931, and 1932.

The Homestake group of three mineral claims is west of Anyox and adjoins the holdings of the Granby Consolidated Mining, Smelting, and Power Company. The country rock is argillite. Boulders of copper ore have been found on the property, but are reported to have a greenstone gangue and, therefore, did not come from the area covered by the Homestake group.

M. J. Group (Locality 115)

References: Annual Report of the Minister of Mines, British Columbia, 1926, 1928, and 1931.

The M.J. Group of six mineral claims is at an elevation of 3,000 feet on the west side of Georgia river 3½ miles from its mouth. The country rock on the property is diorite sheared locally and containing much epidote. The rock does not resemble the Coast Range batholith very closely and may be an older intrusive. The mineral showings are quartz veins up to 3 feet wide and well mineralized with chalcopyrite, pyrrhotite, pyrite, and some pentlandite. The veins are well exposed in open-cuts and locally contain as much as 10 per cent copper.

Maple Bay Groups (Locality 203)

References: Annual Report of the Minister of Mines, British Columbia, 1905, 1906, 1911, 1918, 1921, 1923, 1924, and 1931; Geol. Surv., Canada, Sum. Rept. 1922, pt. A.

Four groups, the Bluebell, Comstock, Eagle, and Princess Alexander groups and the Star mineral claim are known as the Maple Bay groups. They are at Maple bay on Portland canal. In 1913 the Granby Consolidated Mining, Smelting, and Power Company took options on a number of the groups and claims now included under Maple Bay groups and in 1916 shipped a few thousand tons of ore.

The country rock is amphibolite, like that at Anyox, with bands of cherty sediments and of volcanic rocks and belongs to the same body as that occurring at Anyox.

On the Bluebell claim a quartz vein up to 5 feet wide and containing chalcopyrite and some pyrite has been developed by open-cuts and a short drift adit. A crosscut adit 360 feet long failed to locate the vein at depth.

On the Anaconda claim a narrow quartz vein striking north-northeast has been traced by open-cuts for several hundred feet. A few hundred feet east, at an elevation of 2,500 feet, a larger vein up to 10 feet wide, striking northeast and locally well mineralized with chalcopyrite, has been traced by open-cuts for 700 feet. What appears to be a continuation of this vein occurs about 1,000 feet farther northeast on the Princess May claim. On the Princess May claim the deposit consists of quartz banded with country rock across a width of 30 feet. It has been traced for 800 feet and outcrops between the elevations of 2,700 and 3,300 feet. The quartz carries chalcopyrite but appears to be of lower grade than that on the Anaconda. Assays across 10 feet of vein matter on the Anaconda claim have yielded as high as 2 per cent copper.

A quartz vein at an elevation of 4,000 feet on the Princess Alice claim strikes east-northeast and is 1,500 feet northeast of the vein on the Princess May claim. The vein has been traced for more than a thousand feet. It may be the northeasterly continuation of the Anaconda-Princess May vein. It contains chalcopyrite.

A large quartz vein on the Thistle and Rose claims adjoining the Anaconda claim on the west is up to 25 feet wide. The vein strikes north and has been traced for 500 feet. Locally the quartz is well mineralized

with chalcopyrite. In general the vein is very low grade, but assays across 18 feet of a well-mineralized part have yielded more than 2 per cent copper.

On the Eagle and May Queen claims lying north of the Princess May claim a large quartz vein, in part banded with country rock, strikes northeast. The vein is up to 35 feet wide and has been traced for 3,000 feet between the elevations of 2,200 and 3,500 feet. It is locally well mineralized with chalcopyrite and pyrite and the outcrop stands out as a rusty band. The vein was diamond drilled by the Granby Consolidated Mining, Smelting, and Power Company and it has been stated that the drilling indicates the presence of 522,000 tons of probable ore assaying 1·71 per cent copper and 590,000 additional tons of possible ore assaying 1·4 per cent copper. Local pockets, several feet across, were encountered in the drill holes, containing up to 10 per cent copper. Values in gold and silver are very low.

The Granby Consolidated Mining, Smelting, and Power Company drove a 700-foot adit on the Star claim which lies half a mile northwest of the Eagle claim. The deposit on the Star is a quartz vein several feet wide and locally well mineralized with chalcopyrite and pyrrhotite. The vein strikes north and has been traced for 700 feet. The adit, driven at an elevation of 375 feet above sea-level, disclosed an ore shoot from which the company shipped 4,000 tons of copper ore.

The vein matter on the Maple Bay groups is of a type not found elsewhere in Portland Canal area. The white quartz veins contain bunches and gashes of clean chalcopyrite and pyrrhotite. In many places the sulphides appear to occur as a filling occupying all available space left after the quartz has solidified. The veins are unusual in that in them pyrite, galena, and sphalerite are extremely rare. The origin or source of the vein matter is believed to be intrusive rocks represented on the surface by amphibolite.

Monday Group (Locality 112)

Reference: Annual Report of the Minister of Mines, British Columbia, 1931.

The Monday group is 6 miles up Bulldog creek. Considerable surface work has been done on mineral deposits containing pyrite, galena, and sphalerite.

North Country Mining Company, Limited (Locality 105)

References: Annual Report of the Minister of Mines, British Columbia, 1922, 1923, 1924, 1926, 1927, 1928, 1929, and 1930.

The holdings of the North Country Mining Company, Limited, are on the east side of Georgia river at its head. The trail to the property is up Bulldog creek. The principal holdings of the company consist of the Gloria group of claims.

The country rock is diorite with sedimentary and tuff inclusions near its contact with a large body of the Coast Range batholith to the northwest. The whole complex has been sheared locally and intruded by numerous diorite dykes.

Several adits aggregating more than 1,200 feet in length have been driven under narrow quartz veins in shear zones. The veins are very sparsely mineralized and have not been followed on the surface for any great distance.

Outsider Group (Locality 202)

References: Annual Report of the Minister of Mines, British Columbia, 1906, 1918, 1919, 1921, 1922, 1923, 1925, and 1926; Geol. Surv., Canada, Sum. Rept. 1922, pt. A.

The Outsider group adjoins and lies north of the Maple Bay groups at Maple bay, Portland canal. The property was bonded in 1905 to the Brown Alaska Smelting Company who in 1906 did considerable development work. The company produced about 500,000 pounds of copper from the property in 1906 and 1907. The property was then acquired by Spokane interests who developed the deposit to deeper levels. In 1922 the property was acquired on a royalty basis by the Granby Consolidated Mining, Smelting, and Power Company and was mined until 1926, producing a total of 96,000 tons of ore yielding 3,400,000 pounds of copper, 65 ounces of gold, and 4,600 ounces of silver.

The country rock on the group consists of amphibolite holding bands of sediments and volcanic rocks. The mineral deposit is a chalcopyrite-bearing quartz vein striking north-northeast and dipping steeply east. The vein is 2 to 12 feet wide and is splashed here and there with chalcopyrite as are the other veins in the vicinity of Maple bay. Though not as large as some of the veins on the Maple Bay groups this vein is more strongly mineralized with chalcopyrite and also apparently carries higher values in gold. The ore contains chalcopyrite and pyrrhotite but practically no pyrite or other sulphide. The vein has been traced for 3,000 feet between elevations of 900 and 2,000 feet above sea-level. On the foot-wall side a band of cherty argillite several feet thick is in contact with the vein for most of its known length and depth. Beyond the band of cherty argillite is a band about 50 feet thick of argillite. The hanging-wall of the vein is amphibolite. A dyke follows the northern half of the vein.

The vein has been developed on seven levels. The lowest level, at an elevation of 800 feet, was run from a winze below the 900-foot level. Three other main levels are adits at elevations of 1,070, 1,160, and 1,295 feet respectively. The ore-body has a known vertical depth of 500 feet. The vein has been explored underground for a length of 2,000 feet.

Pedro Group (Locality 114)

References: Annual Report of the Minister of Mines, British Columbia, 1928 and 1931.

The Pedro group of claims is east of Georgia river 5 miles from its mouth. The country rocks are mainly volcanic rocks intruded by granitic dykes. A narrow quartz vein sparsely mineralized with galena has been followed by an adit for 150 feet. At another place a quartz vein up to 4 feet wide is partly developed by two adits. This vein is sparsely mineralized and has apparently been cut off by a northerly striking fault. Near these two adits another showing outcrops on the canyon wall on the east side of Georgia river. At this place mineralization is noticeable along the cliff for a distance of 40 feet, but the strike of the mineralized body is not known. The minerals present are chalcopyrite, pyrrhotite, arsenopyrite, and sphalerite. Narrow bands of massive sulphides occur locally in the outcrop.

Redwing Group (Locality 199)

References: Annual Report of the Minister of Mines, British Columbia, 1932; Geol. Surv., Canada, Memoir 32.

The Redwing group of claims is at an elevation of about 2,000 feet, on Glacier creek 2 miles from its mouth.

The country rock is amphibolite and is part of the same body in which the Hidden Creek mine occurs. Sediments outcrop a short distance east of the property and granitic rocks of the Coast Range batholith occur a short distance west. The showing is a strongly marked, rusty, mineralized shear zone in the amphibolite. It is exposed on a very steep mountain side and parts of it are almost inaccessible. The mineralized zone consists of quartz, chalcopyrite, pyrrhotite, pyrite, and other sulphides. Locally the zone is 30 feet wide. It splits into two branches a short distance above Glacier creek. The meagre development work done on the property does not indicate the size of the deposit but does expose a good grade of copper ore.

Saddle Claim (Locality 116)

References: Annual Report of the Minister of Mines, British Columbia, 1926, 1927, 1928, 1929, and 1930.

The Saddle claim is at an elevation of 4,500 feet west of the head of Hastings arm. In 1927 it was taken over by the Silver Crest Mines, Limited, who in 1929 shipped 3 tons of ore yielding 84 ounces of silver, 84 pounds of copper, and 3,084 pounds of lead.

The country rock is mainly volcanic and is an inclusion about 4 miles long, in the Coast Range batholith.

Early development work on the property consisted of open-cuts and shallow shafts that traced a northerly striking quartz vein, up to 4 feet wide, for 300 feet. The main vein is joined by several, narrower veins. It is locally well mineralized with galena, sphalerite, and pyrite. In 1928 an adit was driven along the vein for 90 feet and an aerial tram was built from the showings down to the head of Hastings arm. In 1929 and 1930 the adit was advanced several hundred feet. The inner half of the adit has not been described, but the vein in the outer half is not as well mineralized as at the surface. The main showing on the vein is about 400 feet higher than the adit level.

Swamp Point (Locality 201)

References: Annual Report of the Minister of Mines, British Columbia, 1908 and 1916.

At Swamp point near Maple bay, Portland canal, the Granby Consolidated Mining, Smelting, and Power Company has quarried limestone for flux.

Vimy Ridge Group (Locality 118)

Reference: Annual Report of the Minister of Mines, British Columbia, 1922.

The Vimy Ridge group of four mineral claims is on the north side of Kshwan river 6 miles east of the head of Hastings arm. At an elevation of about 2,000 feet a quartz vein up to 6 feet wide and lying in a brecciated zone has been traced for 100 feet. The vein is reported to be well mineralized with pyrite, galena, sphalerite, and chalcopyrite.

BEAR-MARMOT RIVER DISTRICT

A and T Group (Locality 55)

References: Annual Report of the Minister of Mines, British Columbia, 1928, 1929, and 1930.

The A and T group of eighteen mineral claims is on the west side of Bear river south of Independence creek and lies on the southern edge of the belt of dykes crossing Bear and Salmon Rivers districts. The property was bonded in 1929 by the Consolidated Mining and Smelting Company who after doing 1,500 feet of diamond drilling relinquished the option.

At an elevation of 2,400 feet a rusty shear zone 100 feet wide, in volcanic rocks, is sparsely mineralized with pyrite and chalcopyrite. At 2,500 feet above sea-level another shear zone, interrupted by wide, granitic dykes, contains 8 feet of chalcopyrite ore assaying about 4 per cent copper. The length of this body is not known but is perhaps 100 feet or less. An ill-defined shear zone about 3,000 feet above sea-level is sparsely mineralized with iron sulphides and chalcopyrite for a width of 70 feet.

Aberdeen Group (Locality 96)

References: Annual Report of the Minister of Mines, British Columbia, 1923; Geol. Surv., Canada, Memoir 159.

The Aberdeen group of mineral claims adjoins and lies west of the Porter Idaho. The group is underlain by volcanic fragmental rocks and lava flows. They strike northeast and dip northwestward at moderate angles. Locally the rocks have been severely sheared and as a result 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 in the shear zone, but no primary sulphide is visible.

Ajax Claim (Locality 88)

Reference: Geol. Surv., Canada, Memoir 32.

The Ajax mineral claim is on the south fork of Glacier creek at the contact between a body of augite porphyrite and sediments to the west. A zone of fissuring, striking east and dipping north, contains small lenses of zinc blende with some pyrite and galena.

Albany Mining Company, Limited (Locality 88)

References: Annual Report of the Minister of Mines, British Columbia, 1925, 1926, and 1927; Geol. Surv., Canada, Memoir 159.

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 open-cuts and a short adit on a 2-foot quartz-sulphide vein. Bunches of sulphide locally distributed in the vein assay 0·2 ounce of gold, 10 ounces silver a ton, and 10 to 20 per cent lead, but are not of commercial importance.

Development work 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.

American Creek Mining Company, Limited (Locality 17)

References: Annual Report of the Minister of Mines, British Columbia, 1910 and 1930.

The American Creek Mining Company, Limited, was referred to in the report of the Minister of Mines, British Columbia, for 1910, and again in the report for 1930. It is possible that the references pertain to different companies. The claims of the earliest mentioned company lie on the west side of American creek north of the Mountain Boy group. The showings have not been described.

The holdings of the latest mentioned company consist of sixty claims on American creek and north of the Mountain Boy group. The rocks are mainly volcanic. Chalcopyrite-pyrite mineralization and quartz veins have been discovered.

American Girl Group (Locality 19)

References: Annual Report of the Minister of Mines, 1904, 1905, 1906, and 1909.

The American Girl group of claims is on American creek 4 miles from its mouth. A banded quartz vein up to 14 feet wide strikes southwest and dips southeast in volcanic rock. The vein contains galena, sphalerite, stibnite, and copper minerals. Local high values in silver are reported. At an elevation of 2,200 feet there is an adit on the vein 100 feet long.

America's Girl Group (Locality 59)

References: Annual Report of the Minister of Mines, British Columbia, 1925 and 1927.

The America's Girl group of twelve mineral claims is south of Bitter creek at its junction with Bear river. The claims are on the contact between volcanic rocks and sediments with a belt of granitic dykes. At an elevation of 1,700 feet an adit 85 feet long has been driven to develop a quartz vein about 4 feet wide in volcanic rocks. The vein is sparsely mineralized with pyrite and chalcopyrite. Another narrower quartz vein roughly parallel and 200 feet lower contains similar mineralization.

Anaconda Group (Locality 18)

References: Annual Report of the Minister of Mines, British Columbia, 1926 and 1928.

The Anaconda group of five mineral claims is on the east side of American creek and 2 miles north of the Terminus group. At an elevation of 4,700 feet a narrow band of argillite and limestone interbedded with rudely stratified volcanic rocks strikes north and dips 45 degrees east. The limestone is locally mineralized with pyrite, sphalerite, and galena.

Atlas Gold Copper Mining Company, Limited (Locality 29)

References: Annual Report of the Minister of Mines, British Columbia, 1928 and 1929.

The Atlas Gold Copper Mining Company, Limited, holdings are west of the George Copper group on Upper Bear river. The company diamond-drilled a copper-bearing deposit and by means of diamond drilling also searched for the western extension of one of the George Copper showings, but with discouraging results.

Aztec Group (Locality 58)

References: Annual Report of the Minister of Mines, British Columbia, 1920 and 1922.

The Aztec group of four mineral claims is west of Bear river opposite Bitter creek.

Two veins in volcanic rocks are exposed at several places on the hillside at elevations of 2,300 feet and higher. The " Iron vein " is up to 9 feet wide and consists of quartz containing pyrite and chalcopyrite. The " Copper vein " apparently strikes westward up Bear River ridge. It is a quartz vein mineralized with chalcopyrite and iron sulphides. Open-cuts between elevations of 2,600 and 3,800 feet exposed vein matter up to 6 feet wide believed by the owners to be on the "Copper vein." It locally contains a foot or more of very high-grade chalcopyrite ore.

Barite Gold Mines, Limited (Locality 23)

References: Annual Report of the Minister of Mines, British Columbia, 1924 and 1925.

The holdings of the Barite Gold Mines, Limited, are on the north side of Bear river near its head and at an elevation of 5,000 feet. Gash veins of barite are numerous in a zone 30 feet wide and several hundred feet long. Barite veins a foot wide occur elsewhere on the property. Another vein a foot wide is sparsely mineralized with galena.

Bayview Mining Company, Limited (Locality 74)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1920, 1922, 1924, 1925, 1927, 1928, and 1929; Geol. Surv., Canada, Memoir 159.

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

Three veins have been explored on the Bayview group. 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 are within 700 feet of the edge. The veins are 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 a ton, 16 per cent lead, 21 per cent zinc, and a little more than a dollar in gold a ton.

Bear Pass Mining Syndicate (Locality 27)

Reference: Annual Report of the Minister of Mines, British Columbia, 1928.

The holdings of the Bear Pass Mining Syndicate are on the south side of Strohn creek east of the head of Bear river. A silicified zone in volcanic rocks is up to 25 feet wide and strikes north. The mineralization consists of pyrite, sphalerite, and galena.

Bear River Canyon Mining Company, Limited (Locality 31)

References: Annual Report of the Minister of Mines, British Columbia, 1909 and 1910; Geol. Surv., Canada, Memoir 32.

The Bear River Canyon Mining Company, Limited, in 1910 explored mineral showings on the Independence and other claims situated on the south side of Bear river 1½ miles above its junction with American creek. An adit 150 feet long following a northerly striking fissure zone in sedimentary rocks encountered two galena-sphalerite lenses 8 inches wide and 20 feet and 12 feet long.

Bear River Mining Company

References: Annual Report of the Minister of Mines, British Columbia, 1908, 1910, and 1917; Geol. Surv., Canada, Memoir 32.

The Bear River Mining and Development Company was formed in 1908 to develop the London and New York claims which had been staked on a steep mountain on the south side of Upper Bear river because much chalcopyrite float was found at the base of the slope. The Bear River Mining Company in 1910 did development work on these claims. Large areas of rust-stained volcanic rock are sparsely mineralized with pyrite, pyrrhotite, and chalcopyrite. The company drove an adit 100 feet long.

Ben Bolt Group (Locality 90)

References: Annual Report of the Minister of Mines, British Columbia, 1910, 1911, 1929, 1930, and 1931; Geol. Surv., Canada, Memoirs 32 and 159.

The Ben Bolt group of mineral claims is at an elevation of 2,500 feet on the south fork of Glacier creek. The country rock is argillite of the lower part of the sediments of the Hazelton group. The sediments strike northwest and dip gently southwest near the edge of a body of augite porphyrite. Much development work was done on the property by the Pacific Coast Exploration Company from 1910 to 1912. The property is now held by the Ben Bolt Mining Company. The Ben Bolt group is at the southern end of the exposed portion of the Portland Canal fissure zone which on this group is 100 feet wide, is traceable for 2,000 feet, and consists of silicified and crushed slates holding numerous small stringers and lenses of quartz. Assays from a mineralized shoot show 10 to 15 per cent lead, 3 to 8 per cent zinc, and 5 ounces of silver a ton.

The approximate relative positions of five adits on the property are indicated in Figure 6. The mineralized zone dips southwestward at a low angle and contains much quartz in stringers and large 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. A pre-mineral dyke is exposed in the drifts of the four lower adits. In these adits the vein matter forms several ill-defined quartz veins 6 feet or so wide and occurs also in closely spaced quartz stringers. In the uppermost adit the thickness of solid quartz probably exceeds 30 feet. Mineralization is very sparse, but the quartz bodies are large.

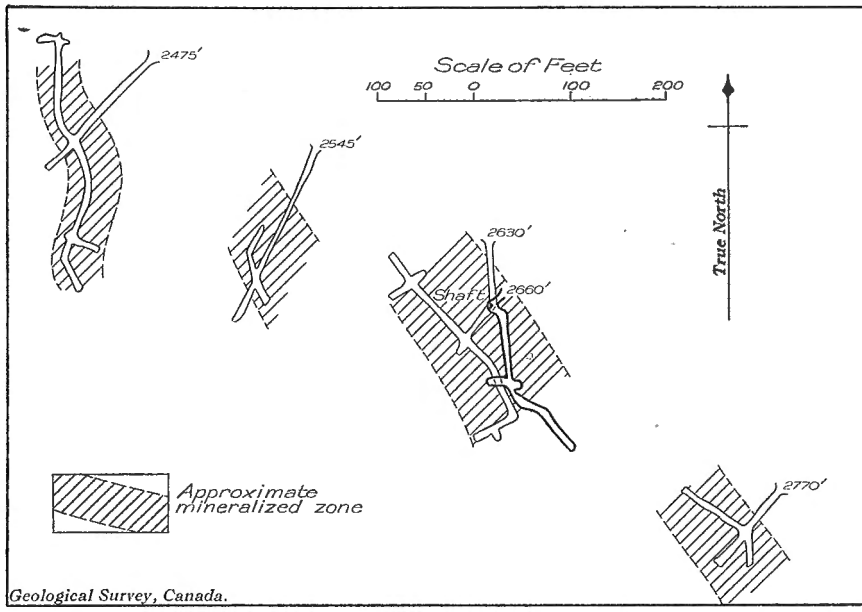

Figure 6. Underground workings on Ben Bolt group.

Big Casino Mining Company, Limited (Locality 34)

References: Annual Report of the Minister of Mines, British Columbia, 1908 and 1910; Geol. Surv., Canada, Memoir 32.

The Big Casino Mining Company, Limited, in 1910 did some development work on the Big Casino group of claims on the west side of American creek and north of the Red Cliff group. Two deposits, 15 and 35 feet wide respectively, were uncovered. They are fissure zones containing quartz and are sparingly mineralized with pyrite, chalcopyrite, and galena.

Bi-Metallic Syndicate (Locality 106)

References: Annual Report of the Minister of Mines, 1928, 1929, and 1930.

The holdings of the Bi-Metallic Syndicate consist of the Stimulator group and other claims and are on the south side of Marmot river about 3 miles from its mouth.

Several quartz veins have been discovered occupying narrow shear zones in granodiorite. The Panhandle vein is up to 6 inches wide. The

Goldpan vein is about 18 inches wide. Specimens from both veins have assayed 0·3 ounce of gold and 15 ounces of silver a ton. The McGee vein is 1 to 4 feet wide, and contains sphalerite, pyrite, galena, and chalcopyrite. An assay shows 11 ounces of silver a ton but less than 0·1 ounce in gold. The Stimulator vein is about 18 inches wide, but where sampled is of very low grade.

Black Bear Claim (Locality 87)

Reference: Annual Report of the Minister of Mines, British Columbia, 1924.

The Black Bear claim adjoins the Gypsy claim of the Portland Canal Mining Company's holding on Glacier creek. At an elevation of 1,500 feet in argillite there is a quartz vein 10 feet wide containing pyrite, galena, sphalerite, and fragments of argillite.

Black Bear Group (Locality 83)

Reference: Geol. Surv., Canada, Memoir 32.

The Black Bear group is on the west side of Bromley glacier 2½ miles from its lower end. The claims are at the contact between argillites and a belt of dykes. Several crushed zones up to 20 feet wide in the argillite are silicified and mineralized with pyrite.

Black Hill Mining Company (Locality 91)

References: Annual Report of the Minister of Mines, British Columbia, 1928 and 1929.

The holdings of the Black Hill Mining Company are on the east side of the south fork of Glacier creek and consist of the Black Hill group and other claims that are a relocation of the older Excelsior group.

The country rock is a body of augite porphyrite holding inclusions of argillite and of volcanic rocks. The edges of the porphyrite body show concordant relations in many places with the bedding of the intruded argillite.

The mineral deposits consist of two series of veins. The veins of one series strike north, are about a foot wide, consist of quartz, calcite, and barite, are well mineralized with sphalerite, galena, tetrahedrite, and jamesonite, and carry good silver values. The veins of the other series strike east, are about 8 inches wide, and consist of quartz sparsely mineralized with sphalerite, galena, tetrahedrite, and chalcopyrite.

Twenty tons of ore shipped in 1929 yielded 2,920 ounces of silver and 6,460 pounds of lead. One ton shipped in 1930 yielded 112 ounces of silver and 168 pounds of lead.

Bornite Group (Locality 24)

Reference: Annual Report of the Minister of Mines, British Columbia, 1930.

The Bornite group is north of upper Bear river and adjoins the Red Top and Barite groups. Chalcopyrite and galena mineralization is reported.

Chicago Group (Locality 90)

References: Annual Report of the Minister of Mines, British Columbia, 1911; Geol. Surv., Canada, Memoir 32.

The Chicago group of claims is north of the Ben Bolt and Jumbo claims and all three are along the same fissure zone. A quartz vein up to 20 feet wide in argillite was developed in 1911 by the Pacific Coast Exploration Company.

Coast Silver Mines, Limited (Locality 97)

References: Annual Report of the Minister of Mines, British Columbia, 1925 and 1928.

The holdings of the Coast Silver Mines, Limited, consist of the Silver Hill group. The group is 2½ miles from Stewart, lies east of Portland canal, and adjoins and lies south of the Silver Bell group. The claims are along the contact between the Coast Range batholith and volcanic rocks. Several quartz veins mineralized with pyrite, galena, sphalerite, and chalcopyrite occur on the property.

Columbia Group (Locality 86)

References: Annual Report of the Minister of Mines, British Columbia, 1906, 1907, 1908, 1909, 1912, 1913, 1919, 1922, 1925, and 1926; Geol. Surv., Canada, Memoirs 32 and 159.

The Columbia group of mineral claims is on the middle fork of Glacier creek and adjoins and lies west of the L and L group.

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 across 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. Considerable development work was done on this property in 1928, but is reported to have failed to disclose commercial ore.

In 1910, 4 tons of ore containing 0·08 ounce gold, and 375 ounces silver a ton, and 23 per cent lead, was shipped. In 1913 a shipment of 7 tons assayed $114 a ton in silver and lead.

Cook and Dobson's Claim (Locality 90)

Reference: Annual Report of the Minister of Mines, British Columbia, 1906.

Cook and Dobson's mineral claim is at the head of the south fork of Glacier creek. Stringers of quartz making up a width of 8 feet are exposed in an open-cut.

Copper Cliff Mines, Limited (Locality 92)

Reference: Annual Report of the Minister of Mines, British Columbia, 1910.

The holdings of Copper Cliff Mines, Limited, consist of three claims on the east side of Bear river 1 mile from its mouth. A vein up to 4 feet wide has been traced for 600 feet. Where exposed in an adit the vein is 2 feet wide and carries values in copper, silver, and gold.

Copper King Group (Locality 82)

Reference: Annual Report of the Minister of Mines, British Columbia, 1918.

The Copper King group of four claims is east of the Ruth and Francis group on upper Glacier creek. A vein is reported to be 10 feet wide.

Dalhousie and Rock of Ages Groups (Locality 57)

References: Annual Report of the Minister of Mines, British Columbia, 1925, 1926, 1927, and 1928; Geol. Surv., Canada, Memoir 159.

The holdings of the Dalhousie Mining Company consist of the Dalhousie and Rock of Ages groups situated 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. Development work so far has not been extensive but has been done in many places, and as a result several mineral deposits, apparently distinct from one another, are known, but no one deposit has been clearly outlined.

The ground is underlain by volcanic rocks of the Hazelton group that above timber-line strike northeast along the hillside and dip northwestward at moderate angles. Lower down the slope the attitude of the strata is unknown. A large open-cut at an elevation of 2,600 feet exposes volcanic rocks mineralized with pyrite and chalcopyrite over an area 25 feet in diameter. Similar mineralization has been found northwestward in open-cuts respectively 100 and 200 feet higher. The outlines of the mineralized area or areas have not been traced and, therefore, the length and width of the body or bodies is in doubt. Assay values of $12 in gold, silver, and copper, in samples from the lowest open-cut, have been reported.

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 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 and is clearly a replacement deposit along a particular bed of rock. Several other veins and replacement deposits occur on the property.

Docia Property (Locality 24)

Reference: Annual Report of the Minister of Mines, British Columbia, 1929.

The Docia property adjoins and lies east of the Red Top group on Bear river. A galena vein up to 14 inches wide and containing a little pyrite and chalcopyrite is exposed in two open-cuts 50 feet apart.

Dominion Group (Locality 98)

References: Annual Report of the Minister of Mines, British Columbia, 1927; Geol. Surv., Canada, Memoir 159.

The Dominion group of mineral claims is close to the glacier on Kate Ryan creek, and opposite the Porter Idaho mine. The country rocks are tuffs and lava flows of the lower part of the Hazelton group volcanic rocks. They strike northwest and dip northeast at moderate angles. Argillites 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 opencuts on the precipitous slope above the adit disclose narrow quartz veins mineralized with pyrite, chalcopyrite, sphalerite, and galena. The veins seen are chiefly narrow stringers. Between 400 and 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 beds of tuff partly replaced by ore minerals.

Dunwell Mines, Limited (Locality 78)

References: Annual Report of the Minister of Mines, British Columbia, 1920, 1922, 1923, 1924, 1925, 1926, 1927, 1928, and 1932; Geol. Surv., Canada, Memoir 159.

The Dunwell mine is on the east side of Bear river north of Glacier creek between the Sunbean claim on the north and the George E. claim on the south. In 1926 a 100-ton mill was built and connected with the mine by an aerial tramway somewhat over a mile long. Milling began early in 1927 but ceased later in the same year. The elevation of the lowest adit is 1,250 feet and of the highest 1,750 feet.

The country rock is argillite of the lower part of the Hazelton group. Several quartz-sulphide veins cross the property. One of them, the Dunwell vein, is exposed on the surface and in the four adits, and is the only ore-bearing vein so far discovered in the mine. One of the other veins occupies a fault fissure and is known as the North-South vein. The Dunwell 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 it and the continuation known as the North-South vein have a combined known length of 800 feet. The Dunwell vein has been followed down the dip for about 800 feet to a vertical depth of some 550 feet. The Dunwell vein has an average dip of 42 degrees and the North-South vein a dip of approximately 50 degrees. The Dunwell vein throughout most of its known length and depth lies on one or the other or on both sides of a dyke 6 inches to 2 feet wide, but the dyke is known to be present only below No. 1 level.

The Dunwell vein consists of quartz mineralized with pyrite, galena, sphalerite, and tetrahedrite disseminated through the quartz and in some places making up 75 per cent of the vein. On the surface and in No. 1 adit the vein is 5 feet wide, locally contains 50 per cent sulphide, but is not of commercial grade. Only one ore-shoot is known. 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 vein but extends for 20 feet or less north of the junction with the North-South vein. The vein where it holds the ore shoot and above and below the ore shoot is wider than elsewhere. The North-South vein north of the ore shoot is less than 3 feet wide. The Dunwell vein south of the ore shoot is also less than 3 feet wide.

The Dunwell vein lies in the Portland Canal fissure zone and like many of the veins and all of the known ore-bearing veins in the Portland Canal fissure zone is associated with a pre-mineral dyke that 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 probably guided or held the ore-forming solutions within certain channels, but probably had very little to do with the origin of the ore shoot.

The Dunwell vein has been entered by four adits. The highest adit, No. 1 adit, is at an elevation of 1,750 feet. No. 4 adit is the lowest and its portal is 500 feet below and 1,300 feet southwest of that of No. 1 adit. A winze has been sunk on the vein for a short distance below No. 4 adit and diamond drill holes crosscut the vein 100 feet below the adit.

The mill feed was the ore as mined and carried lead, zinc, silver, and gold. The chief mill products were: 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. The production in 1927 was 27,067 tons of ore yielding 4,805 ounces gold, 102,200 ounces silver, 1,264,700 pounds lead, and 1,608,600 pounds zinc. Part of the holdings of the company was worked in 1932 by leasers who produced 27 tons yielding 23 ounces gold, 2,495 ounces silver, 2,611 pounds lead, and 221 pounds copper.

Emma Gordon Group (Locality 102)

Reference: Annual Report of the Minister of Mines, British Columbia, 1914.

The Emma Gordon group of claims is on the east shore of Portland canal a short distance south of Marmot river. Small stringers of sphalerite, pyrite, chalcopyrite, and galena occur in diorite. A small shipment of ore assayed 0·08 ounce gold, 66·4 ounces silver, and 0·56 per cent copper.

Emperor Mines, Limited (Locality 68)

References: Annual Report of the Minister of Mines, British Columbia, 1923, 1924, 1925, 1926, and 1927; Geol. Surv., Canada, Memoir 159.

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.

Prior to 1925 the holdings were referred to as the North Line group.

The country rock is argillite of the lower part of the Hazelton group 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 fissures 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 500 feet long and reaches the smaller vein at 270 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.

Excelsior and Eagle Claims (Locality 91)

References: Annual Report of the Minister of Mines, British Columbia, 1905 and 1928; Geol. Surv., Canada, Memoir 32.

The Excelsior and Eagle claims are south of the south fork of Glacier creek. There are two roughly parallel veins, up to 2 feet wide, in augite porphyrite on the Excelsior claim. They consist of quartz and siderite carrying pyrite, sphalerite, galena, tetrahedrite, and stibnite. At another place a northerly striking shear zone up to 6 feet wide contains high-grade vein matter up to 1 foot wide.

Excelsior Prospecting Syndicate (Locality 3)

References: Annual Report of the Minister of Mines, British Columbia, 1929, 1930, 1931, and 1932; Geol. Surv., Canada, Sum. Rept. 1931, pt. A.

The holdings of the Excelsior Prospecting Syndicate consist of twenty-four claims, mainly on the east side of American creek near its head.

The main deposit has been traced by widely spaced open-cuts and is apparently 1,500 feet or more long and up to 20 feet wide. It consists of argillaceous limestone streaked and impregnated with sulphides at the contact with a large body of intrusive feldspar porphyry. The open-cuts when examined were not deep enough to expose unoxidized material, but pyrite, galena, and sphalerite could be seen in the oxidized material. Several large oxidized outcrops occur on the property. The various mineral showings contain local high values in silver and also values in lead and

gold. The valley of upper American creek appears to have been very little eroded by the last Pleistocene glaciation and, therefore, oxidized matter may be more prevalent and may extend to greater depths than in most other parts of Portland Canal area.

Fraser Group (Locality 100)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1921, 1925, and 1926.

The Fraser group of claims is on the east side of Kate Ryan creek 3 miles above its junction with Marmot river. On this property an area of volcanic rocks 1,000 feet across is heavily impregnated with pyrite, pyrrhotite, and some arsenopyrite and chalcopyrite. There are also several quartz veins in the rusty area.

Galena Farm Group (Locality 33)

References: Annual Report of the Minister of Mines, British Columbia, 1911, 1925, 1927, 1929, and 1930; Geol. Surv., Canada, Memoirs 32 and 159.

The Galena Farm group is east of American creek near its mouth. A narrow, galena-bearing quartz vein has been traced several hundred feet in argillite on the Galena Farm claim. On the Keystone claim a silicified shear zone in volcanic rocks contains some galena.

George Copper Group (Locality 28)

References: Annual Report of the Minister of Mines, British Columbia, 1914, 1915, 1917, 1918, 1919, 1920, 1922, 1925, 1926, 1927, 1928, and 1929; Geol. Surv., Canada, Memoirs 32 and 159; Econ. Geol., vol. 23, pp. 193-208.

The George Copper group of mineral claims is on a precipitous mountain slope south of upper Bear river and about 20 miles by road and trail from Stewart.

The first development work was done on the lowest mineral exposure and consisted of stripping and an adit. This deposit is of large dimensions, but the grade was not considered high enough to warrant extensive development work. Attention was then directed to mineral showings higher on the mountain side. These were explored by open-cuts. Other mineral showings of merit have not been broken into and little is known of them except that their mineralization and size approximate that of the better known veins. The Consolidated Mining and Smelting Company of Canada in the autumn of 1927 began diamond drilling and in the next two years bored several long drill holes. Nothing has been done on the property since 1929.

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

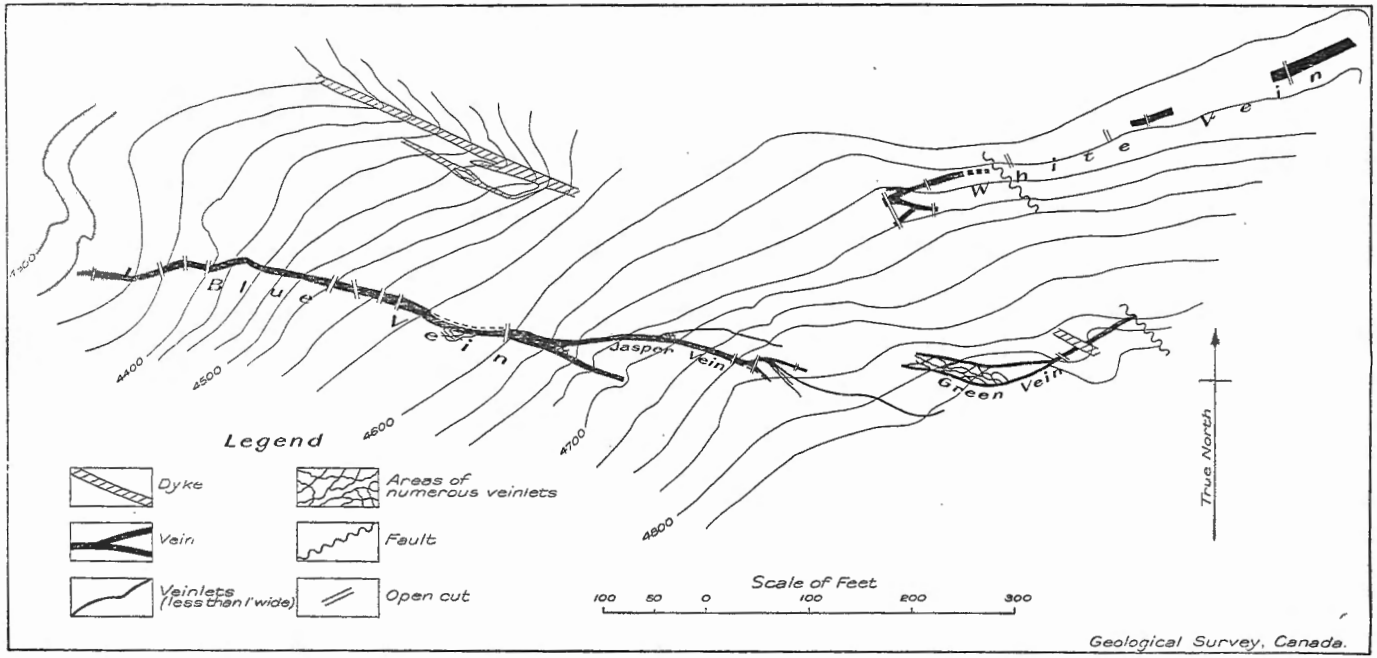

Figure 7. Surface plan of the principal mineral deposits of George Copper group.

about 60 feet thick and in this place contains disseminated pyrite and chalcopyrite.

The upper mineral zones (*See* Figure 7) are veins perhaps formed largely by replacement. They dip steeply southward into the hillside and along their easterly strike their outcrops lie at elevations that rise from 4,325 feet to 4,825 feet above sea-level in a horizontal distance of 800 feet. The veins are known as the Blue vein, Green vein, and White vein. Towards the east the Blue vein divides and one of the branches is named the Jasper vein. The Blue and Jasper veins have been proved to have a combined length of at least 700 feet and a width that locally is 10 feet but perhaps averages no more than 5 feet. The Green vein may be an eastward continuation of the Jasper vein. It is known to be at least 200 feet long, is for the most part narrower than the Blue or Jasper veins, but in a brecciated and branching part is 20 feet wide. The White vein is exposed only in a few places and is not certainly known to be a single lode. 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.

The veins have numerous branches which appear to die out or pinch to stringers within a hundred feet of the main veins. The Jasper vein and its apparent continuation, the western part of the Green vein, consist of irregular, branching veins and stringers in brecciated rock. This condition may have been due to a local difference in the intensity of fracturing or in the type of rock traversed by the main fracture zone. The chief vein minerals are chalcopyrite, pyrite, hematite, magnetite, arsenopyrite, quartz, jasper, and barite. Hematite, magnetite, and arsenopyrite are uncommon except locally. 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 20 to 50 per cent of the vein matter. Chalcopyrite is in most places 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 trace to 0·25 ounce a ton, the gold content appearing to depend on the quantity of arsenopyrite.

George E Claim (Locality 77)

References: Annual Report of the Minister of Mines, British Columbia, 1907, 1908, 1909, 1910; Geol. Surv., Canada, Memoirs 32 and 159.

The George E claim lies between the property of the Dunwell Mining Company, Limited, on the north, and the Glacier Creek Mining Company's claims on the south. The country rock is argillite of the lower part of the Hazelton group.

Most of the development work was done many years ago and consists chiefly of underground work on several parallel quartz veins. The veins strike north and dip westward at moderate angles. An adit driven southeastward crosscuts three veins known as the First, Central, and Green veins at respectively 40, 140, and 300 feet from the portal. Drifts have been driven on each of the three 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, 1 to 2 inches across, of green chlorite. West of the three veins is a northerly striking fault and a short distance west of this is a fourth vein that has been followed by a drift adit for 480 feet. Near the portal of the adit a winze 50 feep 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. It is in contact with a narrow grey dyke for most of its length in the adit. Another adit, about 300 feet north of the 480-foot adit, is 60 feet long and exposes a 2-foot barren quartz vein.

George Enterprise Mining Company, Limited (Locality 25)

References: Annual Report of the Minister of Mines, British Columbia, 1927, 1928, 1929, 1930, and 1931.

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 work, 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. The granodiorite 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 since been further explored and apparently has not been traced on the surface for more than 100 feet. In the adit it is narrower than 2 feet and is 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 unknown. No 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.

Glacier Creek Mining Company, Limited (Locality 76)

Reference: Annual Report of the Minister of Mines, British Columbia, 1910, 1924, and 1925; Geol. Surv., Canada, Memoirs 32 and 159.

The holdings of the Glacier Creek Mining Company, Limited, lie between the George E claim on the north and the Little Wonder claim on the south. The ground is traversed by the Portland Canal fissure zone. The country rock consists of argillite of the lower part of the Hazelton group, striking north and dipping west at moderate angles. A crosscut adit, 625 feet long, crosscuts four parallel quartz veins that strike north, and dip 45 to 70 degrees west. The first vein cut by the adit is 1 to 2 feet wide, the second is 3 feet wide, and the fourth is 4 to 20 feet wide. The third vein is 2 feet wide and is perhaps a branch of the fourth.

Glacier Girl Group (Locality 99)

Reference: Annual Report of the Minister of Mines, British Columbia, 1928 and 1929.

The Glacier Girl group of eight claims is on the east end of the ridge between the two glaciers of Marmot river. A large, rusty area contains pyrrhotite and silver values. Two fracture zones up to 5 feet wide have been developed by open-cuts and carry locally 20 ounces of silver a ton.

Gold Bar No. 1 Claim (Locality 59)

Reference: Geol. Surv., Canada, Memoir 32.

The Gold Bar No. 1 claim is south of Bitter creek a mile above its mouth. The claim is at the southern boundary of the belt of dykes. A quartz vein up to 10 feet wide is reported to carry gold.

Goldie Group (Locality 67)

Reference: Annual Report of the Minister of Mines, British Columbia, 1925 and 1926.

The Goldie group of claims is above the Emperor group between Glacier and Bitter creeks. Narrow, galena-bearing quartz veins cut argillites and dykes. One small shoot of galena was mined. The total of eighteen sacks of ore ran 80 per cent lead, and contained 85 ounces of silver a ton.

Gold Ore Mining Company, Limited (Locality 92)

Reference: Annual Report of the Minister of Mines, British Columbia, 1925.

The Gold Ore Mining Company, Limited, was organized in 1925 to develop the Eagle group of claims which adjoin the Silverado on the north and lie east of the mouth of Bear river. Two quartz veins in volcanic rocks are up to 9 feet wide and are sparingly mineralized with pyrrhotite and galena.

Grey Copper Group (Locality 29)

Reference: Annual Report of the Minister of Mines, British Columbia, 1917.

The Grey Copper group of claims is on the south side of upper Bear river about 5 miles above its junction with American creek. A brecciated zone, 6 feet wide, in argillite, is cemented with calcite and contains a 6-inch streak of tetrahedrite. Several tons of ore extracted from this paystreak assayed 375 ounces of silver a ton.

Hallie Claim (Locality 88)

Reference: Annual Report of the Minister of Mines, British Columbia, 1909.

The Hallie mineral claim is on the south fork of Glacier creek near the forks. A brecciated zone up to 8 feet wide in argillite is mineralized with quartz and pyrite.

Harner Group (Locality 111)

References: Annual Report of the Minister of Mines, British Columbia, 1926 and 1928; Geol. Surv., Canada, Memoir 159.

The Harner group is at an elevation of 4,500 to 5,000 feet in Magee pass, Marmot river, 1 mile east of the Washington group. The country rock is argillite and overlying volcanic rocks of the Hazelton group intruded by a stock of augite porphyrite. Coast Range intrusives outcrop half a mile west of the property.

Two veins are exposed by open-cuts for lengths of 500 feet each. The difference of elevation between the lowest and highest outcrops of each vein is 150 feet. The upper vein strikes north-northwest and dips 40 to 70 degrees east, and the lower vein strikes west-northwest and dips 40 to 70 degrees north. The upper vein is 2 to 9 feet wide. As the 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 is 1,000 feet south of the upper vein and is similar in size and appearance. A short adit driven to 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. Good values in silver and gold have been obtained from the outcrops.

Heywood Mining and Development Company

References: Annual Report of the Minister of Mines, British Columbia, 1928 and 1929.

The Heywood Mining and Development Company was organized in 1928 to develop fourteen claims on the east side of American creek north of Basin creek. It is stated that silver-lead float was found on the north side of Basin creek.

High Grade Group (Locality 111)

Reference: Annual Report of the Minister of Mines, British Columbia, 1927.

The High Grade group of mineral claims adjoins the Harner group in Magee pass, Marmot river, and is held by the Marmot River Gold Mines, Limited. There are three veins on the group, two of which are continuations of veins on the Harner group.

Hill 60 Group (Locality 65)

References: Annual Report of the Minister of Mines, British Columbia, 1910; Geol. Surv., Canada, Memoir 159.

The Hill 60 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 consists of open-cuts and an adit 300 feet long, and 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 lower part of the Hazelton group. 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 consists chiefly of quartz and brecciated argillite and 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.

Independence Gold Mining Company (Locality 35)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1920, 1921, 1923, 1924, 1925, 1928, and 1929; Geol. Surv., Canada, Memoir 159.

The holdings of the Independence Gold Mining Company are on Fitzgerald creek. The mineral deposits are situated along a zone of closely spaced quartz diorite dykes that invade volcanic rocks of the Hazelton group and strike southeast across Bear River ridge and valley. Several open-cuts and two long adits, one at an elevation of 2,950 feet and the other at 2,760 feet, have been opened on a vein that parallels the zone of dykes. The vein is at least 700 feet long and varies in width between 2 and 25 feet, expanding and contracting greatly within short distances. Several parallel veins, 2 to 6 feet wide, outcrop a few hundred feet north of the large vein. The narrower veins lie mostly along contacts between dykes and 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.

Above the portal of the upper adit the large vein has been traced for several hundred feet. Where exposed in No. 1 open-cut, 320 feet above and 450 feet northwest of the portal of the adit, it strikes northwest. It does not continue uphill on this line of strike because it is again exposed 100 feet to the north and 45 feet higher in No. 2 open-cut. In this open-cut it has the same northwest strike and from the open-cut it can be followed up hill for several hundred feet along this line of strike. The veins exposed in the two open-cuts appear to be identical and are believed to be parts of one vein offset by a fault passing between the two open-cuts.

The upper adit follows quartz stringers 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

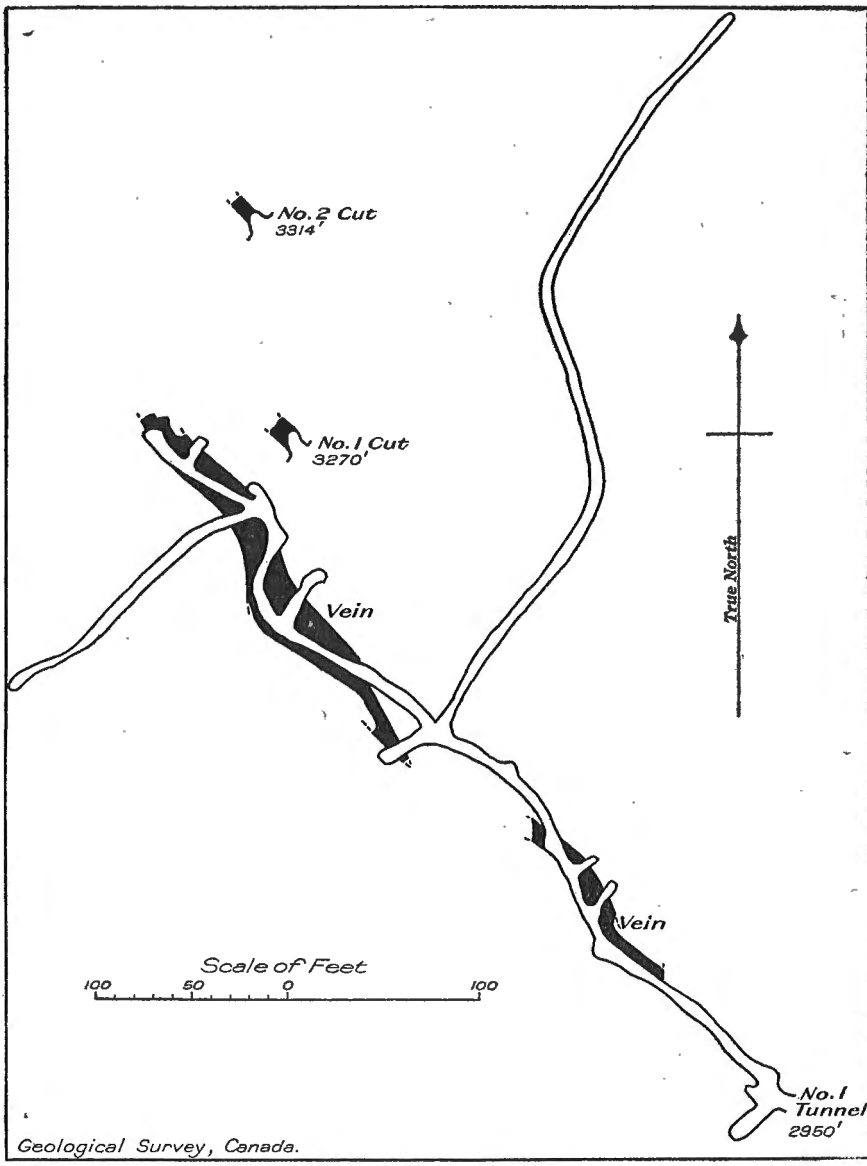

Figure 8. Main underground workings on property of Independence Gold Mining Company.

the wider parts of the vein is of much better grade than that in the narrow parts and the highest grade vein matter is displayed in the face of the adit. A long crosscut running northeastward from a point 275 feet from the portal of the adit did not reveal any parallel veins. The face of the adit is 320 feet below the vein at the surface. As some of the dykes in the zone of dykes are younger than the vein they probably interrupt it locally.

The lower adit has not been seen by the writer. It is reported that a mineralized zone up to 12 feet wide and containing low values in silver and zinc is exposed in this adit.

Initial Group (Locality 34)

Reference: Geol. Surv., Canada, Memoir 32.

The Initial group of mineral claims is west of the junction of Bear river and American creek and adjoins and lies south of the Big Casino group. Two mineralized zones 12 feet and 25 feet wide, respectively, contain pyrite, chalcopyrite, and galena.

International Portland Mining Company (Locality 58)

References: Annual Report of the Minister of Mines, British Columbia, 1910; Geol. Surv., Canada, Memoir 32.

The holdings of the International Portland Mining Company are west of Bear river, opposite the mouth of Bitter creek. On the Mammoth claim a fissured zone 18 feet wide cuts a band of argillites associated with volcanic rocks. Parts of the zone are mineralized with pyrite, galena, and sphalerite. Farther north on the Dundee claim the same band of argillites is seamed with quartz for a width of 10 feet. Sparse mineralization consists of pyrrhotite, galena, sphalerite, and pyrite. On the Ben Lomond claim, higher on the mountainside, volcanic rocks contain pyrite and chalcopyrite in rusty areas and bands.

Jutland Group (Locality 62)

Reference: Annual Report of the Minister of Mines, British Columbia, 1919.

The Jutland group of two mineral claims is on the north fork of Bitter creek and near its head. In one place, at an elevation of 3,200 feet, a quartz vein 18 inches wide contains a streak of galena and tetrahedrite with high silver values. Another narrow quartz vein 300 feet higher contains the same minerals and also high values in silver.

Kansas Group (Locality 20)

References: Annual Report of the Minister of Mines, British Columbia, 1910 and 1914; Geol. Surv., Canada, Memoir 32.

The Kansas group is east of American creek about 3 miles from its mouth. A fractured zone up to 6 feet wide in an argillaceous band in volcanic rocks is sparsely mineralized with galena but holds a band of galena and tetrahedrite up to 8 inches wide containing high silver values.

L and L Group (Locality 85)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1922, 1923, 1924, 1925, 1926, 1927, and 1928; Geol. Surv., Canada, Memoir 159.

The L and L group of mineral claims is 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 is augite porphyrite. The contact of the augite porphyrite with sediments of the lower part of the Hazelton group is on the opposite side of the glacier and appears to dip gently northward.

Development work has been concentrated on a northwesterly striking vein that 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 at least 120 feet.

Three drift adits have been run in southeasterly directions. The uppermost or No. 2 adit follows the ore-shoot for 120 feet to where, though the vein continued, the ore-shoot ended. Believing that the ore deposit at this point had been offset by a fault those responsible for the development work drove crosscuts to both sides. Eventually the drift was continued along the southeasterly course and some ore, which may be the northern end of a second ore-shoot, was found at the face of the drift. No. 1 adit is 100 feet northwest and 60 feet below the upper adit. This adit for most of its length follows the vein. The ore-shoot is only 60 feet long on this level. Stopes extend from No. 1 adit to the surface. The lowest or No. 3 adit is 320 feet northwest and 160 feet below the upper adit. It follows the vein but the ore-shoot is not present.

Evidence furnished by polished specimens of the ore suggests 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 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. It occurs 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 1928. A total of 59 tons of ore was shipped, yielding 0·1 ounce gold and 160 ounces silver a ton, and 13 per cent lead.

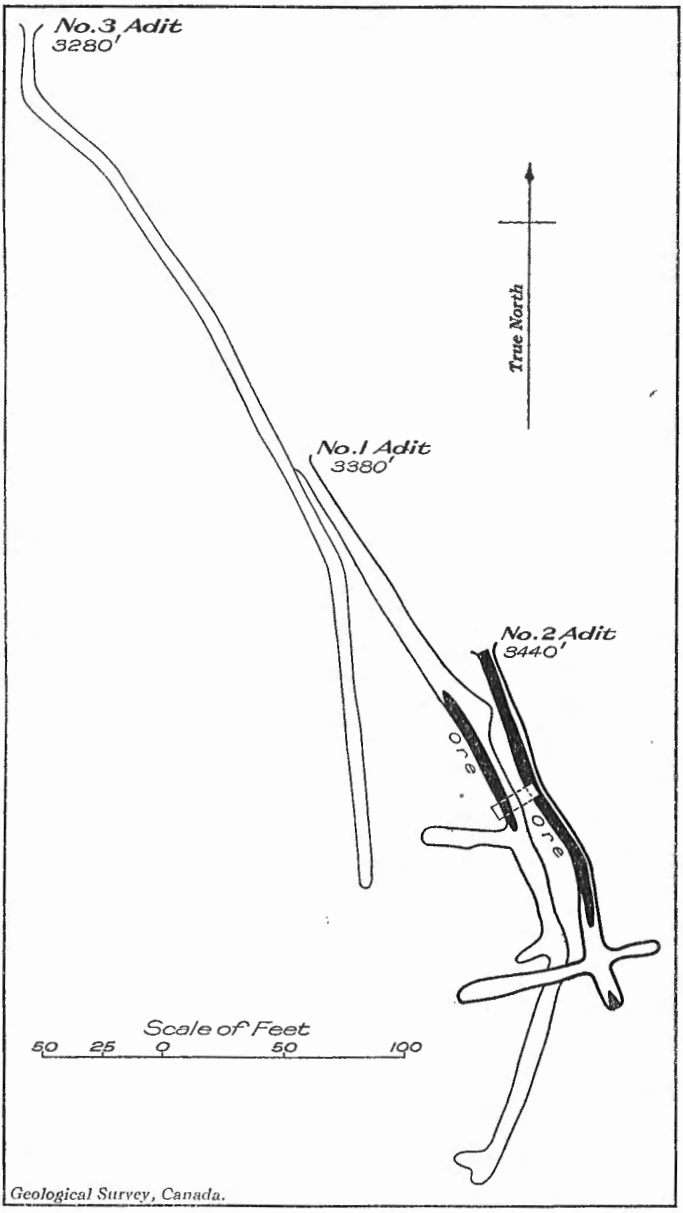

Figure 9. Plan of underground workings on L and L group.

L L and H Group (Locality 64)

References: Annual Report of the Minister of Mines, British Columbia, 1910, 1911, 1920, 1928, 1929, 1931, and 1932; Geol. Surv., Canada, Memoir 32.

The L L and H group of claims is on the east side of the lower end of Bitter Creek glacier. The country rock consists of argillite intruded by augite porphyrite. There are three fissure zones striking southeast and dipping northeast. The middle zone is 1,000 feet or more long and up to 12 feet wide. One of the other zones is about 12 feet wide. All are mineralized with quartz, arsenopyrite, galena, pyrite, chalcopyrite, and sphalerite. Development work consists of surface work and crosscut adits. Assays running several ounces of silver and up to half an ounce in gold have been obtained.

Lakeview Mines, Limited (Locality 79)

References: Annual Report of the Minister of Mines, British Columbia, 1906, 1909, 1913, 1914, 1918, 1919, 1920, 1922, 1924, 1925, and 1928; Geol. Surv., Canada, Memoirs 32 and 159.

The holdings of Lakeview Mines, Limited, are at an elevation of 2,000 feet between Glacier and Bitter creeks. The property adjoins and lies east of the Dunwell. The country rock consists of cherty quartzite and argillite of the lower part of the Hazelton group 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 that has been 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. The portal of the uppermost of three adits is 500 feet southeast of the shaft. The adit is 60 feet long and exposes in the vein another ore shoot about 3 feet wide. The portal of the next lower adit is 100 feet below and 275 feet south of the upper. It is a crosscut for 250 feet, beyond which it follows the vein 300 feet northwestward. 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 the proportion of sulphide in the vein appears lower than in the vein in the upper adit. The lowest adit begins as a crosscut 800 feet southwest of and 250 feet below the shaft. It enters the vein 750 feet from the portal, and follows it as a drift for 175 feet. The adit enters the vein directly at a point lying down the dip from the ore shoot exposed at the shaft. The vein at this level consists of drusy quartz very sparsely mineralized with sulphide.

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

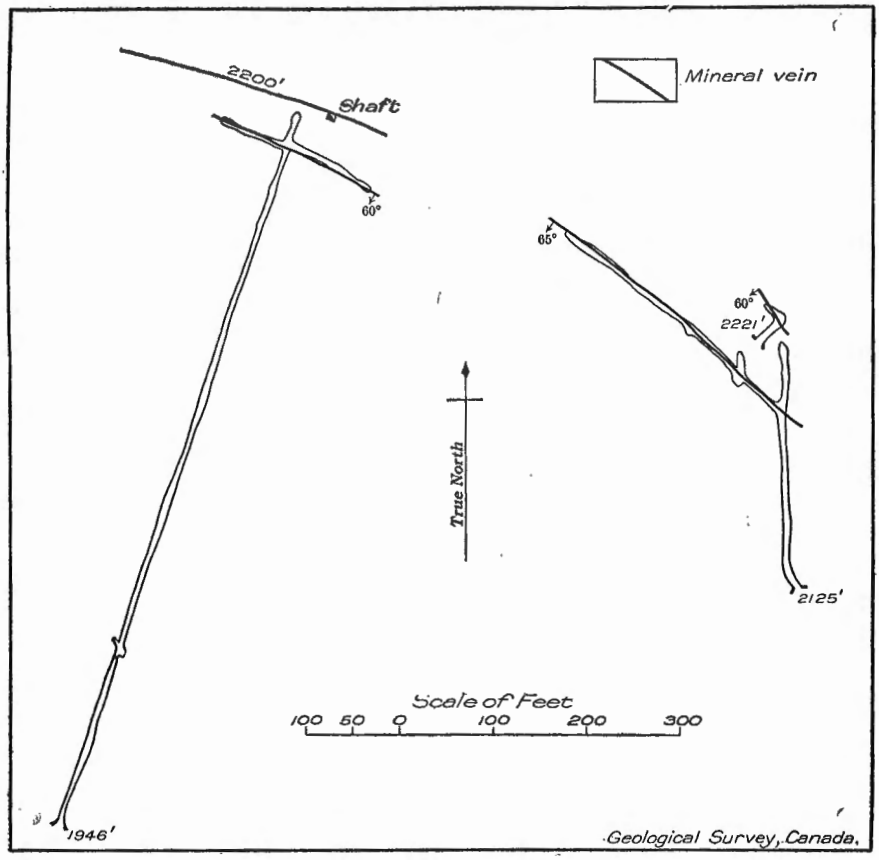

Figure 10. Plan of underground workings on property of Lakeview Mines, Limited.

Little Wonder Claim (Locality 76)

References: Annual Report of the Minister of Mines, British Columbia, 1909 and 1910; Geol. Surv., Canada, Memoirs 32 and 159.

The Little Wonder claim is in the Portland Canal fissure zone and adjoins and lies south of the holdings of the Glacier Creek Mining Company on the south. Most of the development work on this claim was done many years ago. A main adit begins as a crosscut and thereafter follows a vein 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 accompanied by some galena and sphalerite. Another drift adit has been driven on the vein 100 feet lower.

Little Wonder Group (Locality 60)

References: Annual Report of the Minister of Mines, British Columbia, 1926, 1928, and 1931.

The Little Wonder group of eighteen claims is on the east side of Bear river and adjoins and lies north of the Ore Mountain group. The claims are traversed by the contact between volcanic and sedimentary rocks of the Hazelton group near the northern border of a belt of dykes.

The mineral deposits are fracture zones mineralized with quartz, galena, sphalerite, pyrite, chalcopyrite, and tetrahedrite. One body has been traced for several hundred feet and is up to 6½ feet wide. Three other bodies, one of which is 6 to 12 feet wide, have been traced for short distances.

Lucky Date Group (Locality 62)

Reference: Annual Report of the Minister of Mines, British Columbia, 1928, 1930, and 1931.

The Lucky Date group of claims is at the head of the north fork of Bitter creek. The main vein has been traced for several hundred feet, is up to 3 feet wide, and consists of pyrite and tetrahedrite in quartz gangue. Another quartz vein is up to 2½ feet wide and contains galena, sphalerite, and pyrite.

Lucky Jim Group (Locality 19)

Reference: Annual Report of the Minister of Mines, British Columbia, 1929.

The Lucky Jim group of claims is on the west side of American creek and adjoins the Mountain Boy group. A quartz-jasper-barite vein about 7 feet wide contains galena, chalcopyrite, bornite, and tetrahedrite. A silicified zone about 13 feet wide contains chalcopyrite and bornite.

M. C. Group (Locality 54)

References: Annual Report of the Minister of Mines, British Columbia, 1921, 1922, and 1923.

The M.C. group of claims is on Bear River ridge opposite the mouth of Bitter creek. A shear zone in volcanic rocks crosses the crest of the ridge and is mineralized with pyrite, chalcocite, and other sulphides. A quartz vein containing chalcocite is exposed about 200 yards south.

Marmot Consolidated Mines, Limited

References: Annual Report of the Minister of Mines, British Columbia, 1921, 1922, 1924, 1925, 1926, and 1928.

Marmot Consolidated Mines, Limited, controls the Wire Gold, Crawford, Dwyer, and Patricia groups lying in the vicinity of the forks of Marmot river. The Wire Gold group is north of Marmot river below the forks and on it a quartz-pyrite vein in granite has been followed for 50 feet by an adit. The Crawford, Patricia, and Dwyer groups are between the north and south forks of Marmot river. On the Crawford group there are several

mineralized and silicified shear zones. A small quartz vein on the Patricia group has been followed by an adit for 100 feet. For a length of 30 feet the vein is up to 6 inches wide and is well mineralized with galena, sphalerite, and pyrite. There are also several other quartz veins on this group. On the Dwyer group, which adjoins the Patricia, there are several, large, rusty outcrops in argillites and volcanic rocks.

Marmot Engineer Syndicate (Locality 109)

References: Annual Report of the Minister of Mines, British Columbia, 1921, 1927, 1928, 1930, and 1931.

The Marmot Engineer Syndicate was organized in 1928 to develop the Engineer group of claims on the south fork of Marmot river and on which they drove an adit 230 feet long. A quartz vein, up to 8 feet wide, carries pyrite and a little chalcopyrite. Several narrow quartz veins in argillite carry galena, sphalerite, and pyrite.

Marmot Metals Mining Company, Limited (Locality 108)

References: Annual Report of the Minister of Mines, British Columbia, 1913, 1919, 1922, 1925, 1926, 1927, and 1928; Geol. Surv., Canada, Memoir 159.

The holdings of 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 overlain by volcanic rocks 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 1 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 reached it. 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 of the adit but narrows rapidly and pinches out. It consists of quartz mineralized with pyrite, galena, 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 a ton, 14 per cent lead, and 21 per cent zinc.

Recent development work has been concentrated on a different type of mineral deposit that occurs in a bed of limestone. Two faults offset the bed into three blocks each several hundred feet long. The faults strike north 60 degrees east and dip 50 degrees northwestward. 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 fault between the middle and upper limestone block is also mineralized and this indicates that the fault is probably pre-mineral.

The rusty mineral zones contain sphalerite and minor amounts of pyrite, galena, and chalcopyrite. The boundaries of the mineralized areas are quite indefinite. The sizes of the mineral bodies are unknown. The deposits may be replacements along limestone beds or along shear zones. A bed dipping down hill would have a broad outcrop in some places and a narrow outcrop in others. The variable width of the deposits suggests that they are replaced beds rather than replaced shear zones.

Mayflower Group (Locality 70)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1922, 1925, 1928, and 1930; Geol. Surv., Canada, Memoir 159.

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

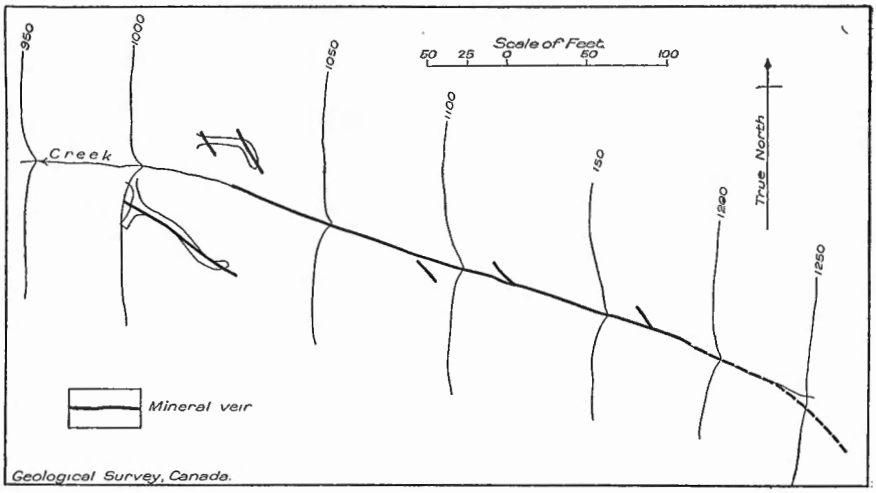

Figure 11. Plan showing vein system on Mayflower group.

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 along 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 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.

Mayou Gold Copper Company, Limited (Locality 61)

References: Annual Report of the Minister of Mines, British Columbia, 1928, 1929, and 1930.

The holdings of Mayou Gold Copper Company, Limited, consist of the Mayou group and other claims lying north of Bitter creek about 6 miles from Bear river.

The mineral deposits are narrow quartz veins in general less than 2 feet wide, in argillite. At an elevation of 5,300 feet a vein up to 18 inches wide and mineralized with galena has been followed by an adit for 120 feet. One hundred feet lower another galena-bearing quartz stringer has been followed for 130 feet by an adit. There are also chalcopyrite-bearing quartz veins on the property.

Melvin Group (Locality 95)

References: Annual Report of the Minister of Mines, British Columbia, 1926, 1928, and 1929.

The Melvin group is on Marmot river and adjoins and lies north of the Porter Idaho mine. Two veins occur on the property, one of which is about 1 foot wide. They contain galena, tetrahedrite, and silver minerals and have assayed up to 700 ounces of silver a ton.

Mimico Group (Locality 80)

References: Annual Report of the Minister of Mines, British Columbia, 1922, 1923, and 1925.

The Mimico group of claims is on the south fork of Glacier creek north of the Albany group. A quartz vein about a foot wide in argillite, contains pyrite, galena, and sphalerite.

Mobile Group (Locality 89)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1920, 1921, 1922, 1923, 1927, 1929, 1930, and 1931.

The Mobile group of mineral claims is on the south side of Glacier creek 3,500 feet above sea-level. The strata on the claims are sediments overlain by volcanic rocks on the west and intruded by a body of augite porphyrite on the east.

There are a number of mineral showings on the property, but development work has been done mainly on three roughly parallel quartz-sulphide veins striking north. The main vein has been developed by more than 500 feet of tunnelling and has been traced for 2,000 feet. This vein is in general less than 3 feet wide and is mineralized with a great variety of ordinary sulphides and also with several silver minerals whose occurrence explains the very high silver content indicated by assays of some samples. A second vein is up to 8 feet wide. The third vein shows mineralization, particularly of sphalerite, over a shattered and sheared zone locally 20 feet wide.

Molly B Claim (Locality 97)

References: Annual Report of the Minister of Mines, British Columbia, 1918 and 1930.

The Molly B claim is on the east side of Bear river 1 mile from Stewart. Part of the claim is on an Indian reserve. The deposit is a silicified zone up to 10 feet wide, contains pyrite, pyrrhotite, and molybdenite, and lies in sheared volcanic rocks near the contact with the Coast Range batholith.

Montreal Group (Locality 26)

References: Annual Report of the Minister of Mines, British Columbia, 1928 and 1929.

The Montreal group of eight claims is on the north side of Strohn creek east of the head of Bear river. A silicified shear zone in volcanic rocks contains streaks of quartz, pyrite, sphalerite, and galena across a width of 30 feet. Another narrower shear zone contains similar mineralization. Two other large, rusty outcrops exhibit nearly similar features. Values in gold and silver are low.

Morning Group (Locality 33)

References: Annual Report of the Minister of Mines, British Columbia, 1925, 1929, and 1930; Geol. Surv., Canada, Memoir 159.

The Morning group of mineral claims is on the east side of American creek north of the Galena Farm group. A showing on the Morning claim consists of calcareous tuff containing a little disseminated pyrite and sphalerite.

Morning Star Group (Locality 21)

Reference: Annual Report of the Minister of Mines, British Columbia, 1925.

The Morning Star group consists of the Morning Star claims Nos. 1 to 5. It is east of American creek and northeast of the Morning group. Volcanic rocks on the group contain disseminated pyrite.

Morning Star Group (Glacier Creek) (Locality 84)

Reference: Annual Report of the Minister of Mines, British Columbia, 1923.

The Morning Star group, consisting of Morning Star and Tommigan claims, is on Glacier creek east of the Sunshine group. A quartz vein 2 feet wide has been traced for 800 feet. It is mineralized with pyrite and chalcopyrite.

Mother Lode Claim

Reference: Annual Report of the Minister of Mines, British Columbia, 1906.

The Mother Lode claim is now probably covered by later stakings. The claim was 5½ miles from Stewart on a creek on the east side of Bear river. A quartz vein in granite 300 feet above the river, striking north and dipping 60 degrees east, contains pyrite and jamesonite.

Mountain Boy Group (Locality 19)

References: Annual Report of the Minister of Mines, British Columbia, 1910, 1919, 1922, 1928, 1929, and 1930; Geol. Surv., Canada, Memoir 32.

Several mineral deposits occur on the property in volcanic rocks. At an elevation of 2,200 feet a fissured zone is replaced by quartz, calcite, barite, sphalerite, galena, pyrite, and chalcopyrite across a width of 25 feet. This body strikes east and dips 50 degrees south. Locally silver values are high. Up hill the deposit seems to end in small stringers and down hill it is covered by talus. Another showing at an elevation of 3,000 feet is up to 8 feet wide. It strikes north and dips 30 degrees west. It consists of quartz, jasper, and barite sparsely mineralized with sulphides, but contains a streak of higher grade ore. This streak is up to 18 inches wide and contains silver minerals as well as galena and sphalerite. Four tons of picked high-grade ore has been shipped and returned about 1,100 ounces of silver a ton.

North Fork Basin Group (Locality 100)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1919, and 1924; Geol. Surv., Canada, Memoir 159.

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, Marmot river.

The claims are underlain by argillites striking north to northwest and dipping steeply westward. Two veins are exposed in the workings. One strikes north and dips 45 degrees west. An inclined shaft has been sunk 110 feet along the dip of the vein. 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 in a shear zone about 3 feet wide and consists of 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 an 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 of silver a ton, 22 per cent lead, and 22 per cent zinc. Eight tons in 1924 returned 115 ounces silver a ton, 11 per cent lead, and 13 per cent zinc.

Northern Belle Claim

Reference: Geol. Surv., Canada, Memoir 32.

The Northern Belle claim is west of the head of the north fork of Glacier creek. A quartzose zone in argillite is 5 feet wide, strikes east, and dips south 40 degrees. It is mineralized with pyrite and chalcopyrite.

North-western Aerial Prospectors, Limited (Locality 2)

References: Annual Report of the Minister of Mines, British Columbia, 1930, 1931, and 1932.

The property of the North-western Aerial Prospectors, Limited, consists of some twenty claims on the west side of American creek near its head. A deposit on the Moonlight claim is irregular in shape and may be a partly replaced sedimentary bed. It contains galena, sphalerite, and chalcopyrite. Other large and small deposits have been found and all appear to contain chiefly the silver-lead type of mineralization with appreciable values in gold.

O.K. Fraction Claim (Locality 76)

References: Annual Report of the Minister of Mines, British Columbia, 1909 and 1910; Geol. Surv., Canada, Memoir 32.

The O.K. Fraction claim is in the valley of Glacier creek 1½ miles above its mouth. An adit 150 feet long has been driven on a quartz vein up to 6 feet wide in argillite.

Old Chum Group (Locality 64)

References: Annual Report of the Minister of Mines, British Columbia, 1910; Geol. Surv., Canada, Memoir 32.

The Old Chum group of claims is east of Bromley glacier, just east of the L L and H group. There are three parallel, easterly striking quartzose zones in argillite mineralized with pyrite, chalcopyrite, sphalerite, and galena. The northern deposit is 6 feet wide, the central is 4 feet wide, and the southern is a zone of stringers 15 feet wide.

Ore Mountain Mining Company, Limited (Locality 60)

References: Annual Report of the Minister of Mines, British Columbia, 1925, 1926, and 1928; Geol. Surv., Canada, Memoir 159.

The holdings of Ore Mountain Mining Company are north of Bitter creek and 1 to 2 miles east of Bear lake. The rocks are sediments of the lower part of the Hazelton group. The contact with the overlying volcanic rocks is about 200 feet west of the lower showings and a zone of dykes 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. 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 nar-

row dyke and offsets a vein 6 feet. The vein matter is rusty and decomposed and primary minerals are rare. The veins are reported to contain good values in gold and silver. A crosscut adit 380 feet long and 150 feet below the outcrop of veins on the flat area has been driven eastward to cut the veins, but did not encounter any ore.

Palmey Group (Locality 57)

References: Annual Report of the Minister of Mines, British Columbia, 1930 and 1931.

The Palmey group is west of Bear river and adjoins and lies south of the Dalhousie group. At an elevation of 4,000 feet and occurring in tuffs, a silicified zone up to 14 feet wide contains pyrite, galena, and sphalerite. Samples assay well in lead and zinc and low in gold and silver.

Patricia Group (Locality 107)

References: Annual Report of the Minister of Mines, British Columbia, 1921, 1922, and 1925; Geol. Surv., Canada, Memoir 159.

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 edge of the Coast Range batholith, some in the batholith, some in associated granodiorite dykes, and some in adjacent argillite. Two 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 follows a vertical quartz-sulphide vein 1 foot or less in width that 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 for a short distance. The veins are well mineralized with pyrite, galena, and sphalerite, and are reported to contain good values in gold.

Phoenix Silver Mines, Limited (Locality 75)

References: Annual Report of the Minister of Mines, British Columbia, 1912, 1913, 1914, 1924, and 1925; Geol. Surv., Canada, Memoir 159.

The holdings of Phoenix Silver Mines, Limited, are in the Portland Canal fissure zone immediately south of Glacier creek. Numerous quartz-sulphide veins were known in the Portland Canal fissure zone both north and south of Glacier creek, and in 1912 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. 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 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.

Portland Canal Mining Company (Locality 87)

References: Annual Report of the Minister of Mines, British Columbia, 1906, 1907, 1908, 1909, 1910, and 1911; Geol. Surv., Canada, Memoir 32.

The Portland Canal Mining and Development Company, Limited, was organized in 1907 to develop the Gypsy and Little Joe claims on the south side of Glacier creek about 2½ miles from its mouth. The company was referred to later as the Portland Canal Mines, Limited, and finally in 1910 as the Portland Canal Mining Company. By 1910 enough ore had been developed to warrant building an aerial tram from the mine at an elevation of 2,400 feet to the mouth of Glacier creek where a concentrator was built. Mining ceased in 1911 after a production of 7,000 tons of ore, which yielded 2,000 tons of concentrates.

The property is in the southern part of the Portland Canal fissure zone and the deposits strike northwest and dip southwest, closely paralleling other deposits in the fissure zone. The country rock is argillite cut by several, narrow, lamprophyre dykes. The argillites are sheared locally and the strikes of the shearing, veins, and dykes, are all roughly parallel.

The mineral deposit consisted of a quartz vein traced on the surface for 2,000 feet or more. It was 8 feet wide and well mineralized with galena, sphalerite, and pyrite. The vein matter carried good values in silver and a persistent streak of pyrite up to 14 inches wide contained good values in gold. The average ore contained 0·12 to 0·30 ounce of gold and 5 to 25 ounces of silver a ton, and 3 to 12 per cent lead. The values depended on the proportion of sulphides in the vein. Average ore contained about 25 per cent pyrite, 5 per cent galena, and 7 per cent sphalerite. Pure sphalerite assayed 0·10 ounce of gold and 4 ounces of silver a ton. Pure pyrite assayed 0·30 ounce of gold and 17 ounces of silver a ton. Pure galena assayed 0·10 ounce of gold and 85 ounces of silver a ton.

The vein dipped 25 degrees and was developed by three drift adits 50 feet apart vertically and connected with raises. The lowest adit is at an elevation of 2,400 feet. Two ore-bodies were mined. One was 160 feet long and 2 to 10 feet thick, and extended more than 240 feet down the dip. The other was 120 feet long, and also 2 to 10 feet thick. It extended more than 150 feet down the dip.

Portland Ibex Group (Locality 30)

References: Annual Report of the Minister of Mines, British Columbia, 1910, 1911, and 1925; Geol. Surv., Canada, Memoir 32.

The Portland Ibex group of claims is east of American creek near its mouth. The property was developed in 1910 and 1912 by the Portland Bear River Mining Company. A 200-foot adit follows a small quartz vein in a brecciated zone in argillite. Samples assay 0·25 ounce of gold and 12·60 ounces of silver a ton.

Prince George Group (Locality 111)

Reference: Annual Report of the Minister of Mines, British Columbia, 1921.

The Prince George group of claims is in Magee pass on the south fork of Marmot river. A quartz vein up to 4 feet wide in granite contains pyrite, chalcopyrite, galena, and sphalerite.

Prince John Group (Locality 72)

References: Annual Report of the Minister of Mines, British Columbia, 1914, 1917, 1918, 1919, 1921, 1922, and 1923; Geol. Surv., Canada, Memoir 159.

The Prince John group is on the steep mountain slope west of Bear river opposite the mouth of Glacier creek.

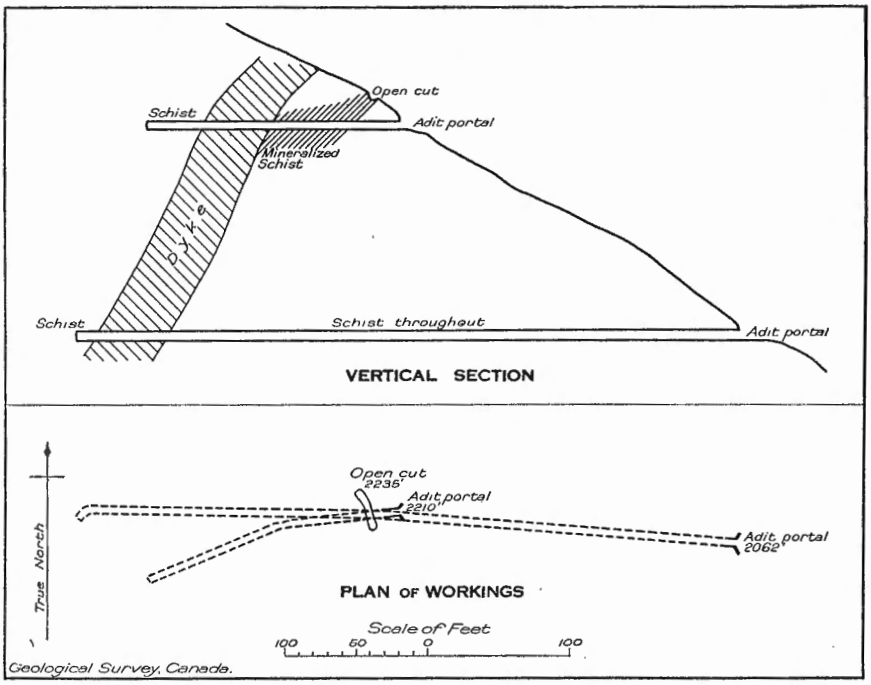

Figure 12. Plan and vertical section, Prince John group.

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 across a width of 40 feet. The length of the mineralized zone is not known. The sulphides occur in small particles through the mineral zone and also in small, lenticular veinlets and gashes paralleling the schistosity.

The mineralized zone is revealed in an open-cut at an elevation of 2,235 feet. An adit commences 15 feet below and a short distance east of the open-cut. The adit is about 180 feet long and was driven westerly.

It crosscuts the mineralized zone which on the west side is bounded by a broad dyke dipping steeply to the west. A long, lower adit at an elevation of 2,062 feet has been driven west to and through the dyke but did not encounter the mineral zone. The zone may have a lower dip than the dyke and if so and if 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 and it is possible that the mineral body cut in the upper adit is a lens and does not continue as deep as the lower adit.

Prosperity and Porter Idaho Mines (Localities 94 and 95)

References: Annual Report of the Minister of Mines, British Columbia, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, and 1931; Geol. Surv., Canada, Memoir 159.

The Prosperity and Porter Idaho mines are about 4,500 feet above

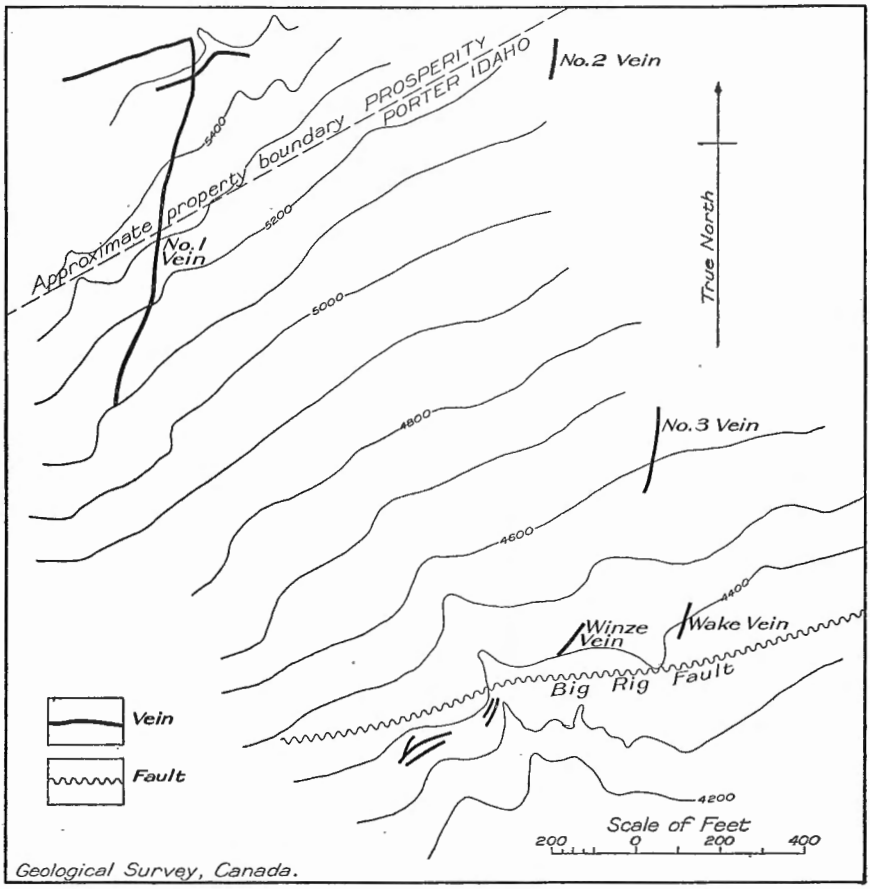

Figure 13. Plan showing known veins and faults on Prosperity and Porter Idaho groups.

sea-level on the east slope of the mountain between Portland canal and Kate Ryan creek (drains to Marmot river). The Prosperity adjoins and

lies north of the Porter Idaho. A controlling interest in the two properties was purchased in 1927 by the Premier Gold Mining Company, Limited, which soon afterwards commenced extensive underground development work and constructed an aerial tram to the mouth of Marmot river to serve both properties.

Tuffs, breccias, rhyolite, and andesite intruded by a few lamprophyre dykes underlie the claims. On the Prosperity group and from there to the top of the mountain the volcanic rocks strike northeast along the hillside and dip at moderate angles northwestward into the mountain. The dykes are nearly 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.

A fault, known locally as the Big Rig fault, 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 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 shear zone to the fault zone is not evident. They may have originated at the same time, in which case the shear zone might be considered as a branch of the fault. The fault, however, may 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 zones are known north of the fault, whereas 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 after dyke intrusion.

Several parallel, narrow, shear zones north of the Big Rig fault are occupied by ore-bearing veins. The veins vary in width from a few inches to 20 feet but in general are less than 5 feet wide. The veins show much oxidation down to a depth of 400 feet or more. The principal vein was 2 to 6 feet wide and consisted of quartz mineralized with pyrite, sphalerite, galena, tetrahedrite, ruby silver, and other silver minerals. The vein in most places is somewhat 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.

The first ore shoot discovered in the vein was about 5 feet wide and at least 50 feet long on the surface and considerably longer at depth. It consisted of very high-grade silver-lead ore containing about 400 ounces of silver a ton and 25 per cent lead. The ore shoot appeared to be simply a swell or wider part of the vein. The boundaries of the ore shoot did not

appear to be sharply defined on the sides or ends, but the contacts were largely obscured by rust. Along the strike between the ore shoots the shear zone contains rusty, sheared rock and stringers of quartz. This rusty, sheared rock holds values in silver and lead probably contained in silver and lead-bearing minerals disseminated through the sheared rock and the quartz stringers. The vein and ore shoots have the appearance of having been formed chiefly by replacement. Ore shoots have probably resulted from more thorough replacement in local areas.

A peculiarity of the veins at the Porter Idaho and Prosperity is that they are deeply oxidized. The ore as shipped in the earlier years commonly consisted of rusty material containing residual fragments of sulphide and quartzose matter. The sulphide was chiefly galena. The lowest adit exposed a 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 was still partly oxidized. Later mining disclosed oxidation down to a depth of 450 feet. In view of the deep oxidation and the presence of native silver at depth it seems very likely that some secondary enrichment of silver has taken place.

The Porter Idaho Mining Company commenced shipping ore in 1924. The shipments for three years totalled 498 tons and averaged 0·08 ounce of gold, 250 ounces of silver, and 350 pounds of lead a ton. In 1927, 125 tons of ore from a different vein averaged 0·1 ounce of gold, 519 ounces of silver, and 845 pounds of lead a ton. In 1926, 29 tons of ore were shipped from the Prosperity workings and averaged 0·07 ounce gold and 416 ounces silver a ton, and 26 per cent lead. During the years 1928 to 1930, inclusive, a total of 23,300 tons of ore were shipped and yielded 480 ounces of gold, 1,700,000 ounces silver, and 1,150,000 pounds of lead. Shipments ceased in 1930.

Radio Stewart Mines, Limited (Locality 65)

References: Annual Report of the Minister of Mines, British Columbia, 1910, 1925, and 1928; Geol. Surv., Canada, Memoir 32.

Radio Stewart Mines, Limited, holds a group of claims north of Bitter creek about 4 miles from Bear river. Three quartz veins in argillite at an elevation of 1,600 feet are up to 5 feet wide and contain pyrite and chalcopyrite. Two quartz veins at an elevation of 4,000 feet are mineralized with pyrite and chalcopyrite, but the upper veins also contain galena, sphalerite, and tetrahedrite.

Red Cliff Extension Mining Company, Limited (Locality 34)

References: Annual Report of the Minister of Mines, British Columbia, 1910; Geol. Surv., Canada, Memoir 32.

The Red Cliff Extension Mining Company, Limited, holdings are west of American creek near its mouth and north of the Red Cliff group. An easterly striking zone of fissuring in volcanic rocks is mineralized for a width of 12 feet with quartz, jasper, calcite, pyrite, chalcopyrite, and galena.

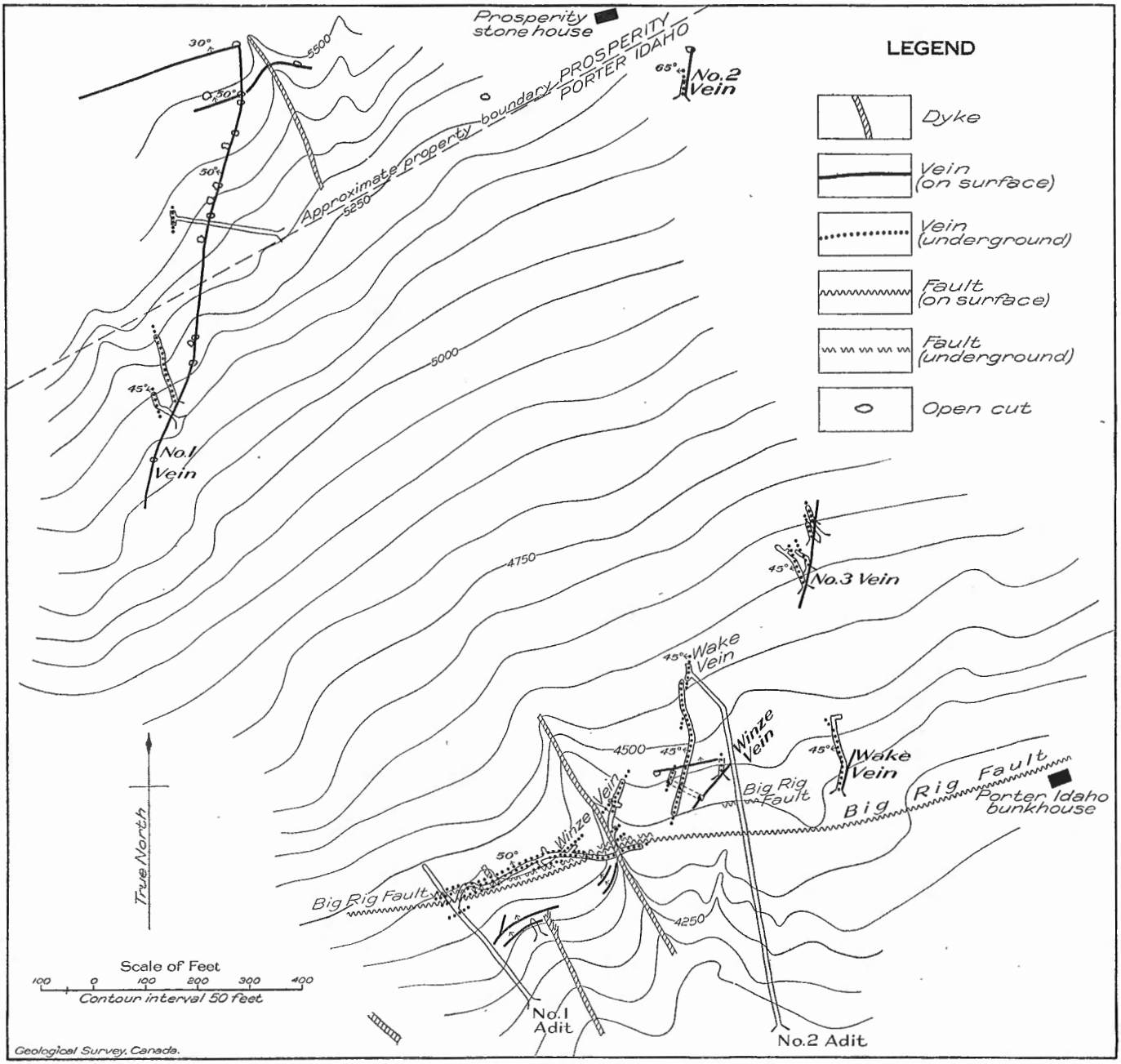

Figure 14. Plan showing workings and veins on Prosperity and Porter Idaho groups.

Red Cliff Mining Company, Limited (Locality 34)

References: Annual Report of the Minister of Mines, British Columbia, 1908, 1909, 1910, 1912, and 1921; Geol. Surv., Canada, Memoir 32.

The Red Cliff group of claims is on the west side of American creek near its mouth. Early development work disclosed moderate-sized bodies of copper ore, but as the deposits were on a very steep hillside subject to snowslides a long adit was necessary to provide safe working conditions. In 1910, 1½ tons of ore were shipped that returned 8·25 per cent copper, and 2·24 ounces of silver, and $5 in gold a ton. In 1912, 1,249 tons of ore were shipped, but as the grade of ore was rather low work was supended. Four levels 100 feet apart have been driven and several thousand feet of underground work has been done.

The ore-bodies occur in irregular masses in volcanic rocks of the Hazelton group. The largest body is 75 feet long and 5 to 17 feet wide. Another is 100 feet long and 4 to 6 feet wide. The metallic minerals are pyrite, pyrrhotite, chalcopyrite, and sphalerite. The gangue is mostly country rock, silicified to some extent and seamed locally with quartz and calcite. Deposits of similar appearance have been discovered but have not been developed.

Red Reef Group (Locality 97)

References: Annual Report of the Minister of Mines, British Columbia, 1912, 1913, and 1928.

The Red Reef group of claims is on the east side of Bear river near its mouth. Considerable development work was done on the property in 1910 and 1912. The mineral deposit is locally 100 feet wide and has been traced for 2,000 feet or more. The deposit is mineralized with quartz, pyrrhotite, and chalcopyrite. Locally the deposit is a quartz vein 25 feet wide.

Red Top Group (Locality 24)

References: Annual Report of the Minister of Mines, British Columbia, 1913, 1919, 1920, 1923, 1925, 1927, 1928, and 1929; Geol. Surv., Canada, Memoir 159.

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, respectively, and several open-cuts, has been done on a chalcopyrite-bearing replacement deposit and a vein of the silver-lead type.

The rocks traversed by the vein are tuffs and lava flows of the Hazelton group. They strike northeast, and dip gently northwestward, and are cut by dykes, some of which can be followed for distances of over a mile and vary 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 been driven 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.

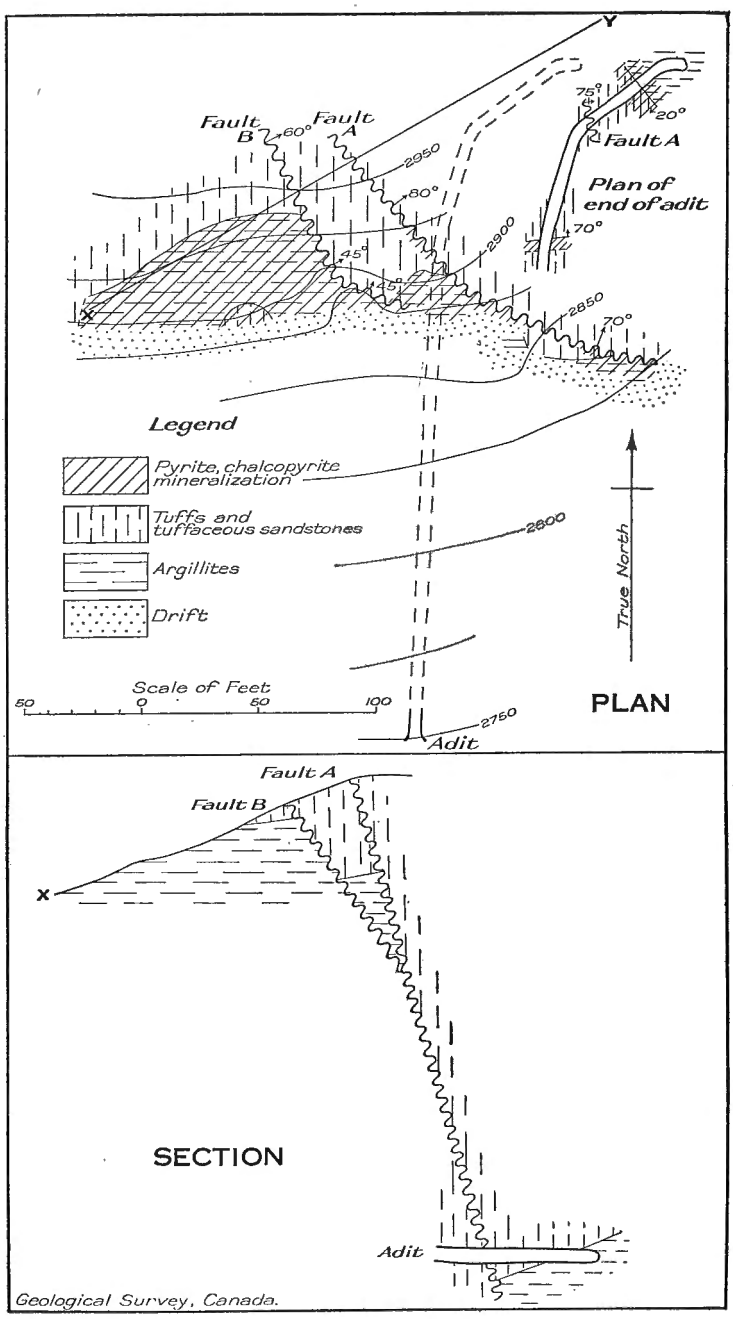

Figure 15. Plan and diagrammatic cross-section, lower showing on Red Top group.

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.

The chalcopyrite replacement deposit outcrops at an elevation of 2,900 feet. The rocks in the neighbourhood of this deposit are approximately horizontal, fragmental, volcanic rocks and possibly lava flows, and an interbed of argillite. Chalcopyrite is 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. 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 a 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. 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.

Roosevelt Group (Locality 63)

References: Annual Report of the Minister of Mines, British Columbia, 1904, 1906, 1909, and 1910; Geol. Surv., Canada, Memoir 32.

The Roosevelt group of claims is on the north fork of Bitter creek about a mile above its mouth. The country rock of argillite is intruded by many dykes and the main mineral deposit is beside a dyke. The deposit is about 5 feet wide and consists of crushed and silicified argillite carrying pyrite, chalcopyrite, and galena. The main values are probably in silver and lead but samples have assayed as much as 0·28 ounce in gold a ton.

Royal Irish Group (Locality 56)

Reference: Annual Report of the Minister of Mines, British Columbia, 1920.

The Royal Irish group is in Bear River valley between Bitter and Fitzgerald creeks. Large bodies of quartz in granodiorite contain low values in gold.

Ruby Silver Mines, Limited (Locality 32)

References: Annual Report of the Minister of Mines, British Columbia, 1920, 1924 and 1925; Geol. Surv., Canada, Memoir 150.

The property of the Ruby Silver Mines, Limited, is located on LeSueur (or Mosquito) creek which flows into Bear river just above the mouth of American creek.

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 vein 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 and pinches out near the face. The mineralization is pyrite, galena, and sphalerite in a gangue of quartz and calcite.

Rufus Argenta Mines, Limited (Locality 22)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1920, 1922, 1924, 1925, 1928, and 1929.

The holdings of the Rufus Argenta Mines, Limited, consist of the Rufus, Vetron, and Comet groups of claims which are north of Upper Bear river and west of the Red Top group. On the Vetron group, at an elevation of 3,000 feet, a 2-foot quartz vein is mineralized with pyrite, chalcopyrite, magnetite, and specularite. On the Comet group, at an elevation of 4,600 feet, a quartz-calcite vein up to 40 feet wide has been traced for several hundred feet. The vein contains galena and arsenopyrite and picked assays have given 1·6 ounces of gold a ton. Another vein known as the "Blue vein" is up to 18 inches wide and specimens from it assay up to 100 ounces in silver. On the Rufus group several large, rusty outcrops of rock are mineralized with pyrite and chalcopyrite. Two or more quartz veins up to 4 feet wide contain chalcopyrite, pyrite, and galena and a 2-foot vein containing tetrahedrite that carries good values in silver. An 800-foot adit has been driven, but no deposit of any importance was discovered.

Rush-Portland Mining Company, Limited (Locality 86)

References: Annual Report of the Minister of Mines, British Columbia, 1910 and 1913; Geol. Surv., Canada, Memoir 32.

The holdings of Rush-Portland Mining Company, Limited, are at the head of the north fork of Glacier creek. On the Katherine claim a quartz vein up to 5 feet wide contains galena, tetrahedrite, sphalerite, and arsenopyrite. The vein has been followed by an adit 110 feet long. In 1913 a shipment of twenty sacks of ore yielded $169 a ton, principally silver and lead.

Ruth and Francis Group (Locality 82)

References: Annual Report of the Minister of Mines, British Columbia, 1912, 1914, 1918, 1922, 1926, and 1927; Geol. Surv., Canada, Memoir 159.

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 group. The country rock is argillite of the lower part of the Hazelton group, intruded by numerous small and moderate sized dykes. The best-known mineral deposits are located along a creek bed following a fault. Other mineral showings exist at a higher elevation, but are not being explored. 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 deposit is a vein at least 150 feet long and in most places is 2 or 3 feet wide, but locally is as much as 7 feet wide. It consists of quartz, jamesonite, sphalerite, pyrite, chalcopyrite, tetrahedrite, and galena, but the last three minerals are rare. Two drift adits each 75 feet long, the higher 50 feet above the other, 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. The vein is less than 2 feet wide in the lower adit except at the face where it widens rapidly to 5 feet. Other veins striking at various angles to the main vein are known. 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 parts 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.

Shuniah Mines, Limited

Reference: Annual Report of the Minister of Mines, British Columbia, 1929.

Shuniah Mines, Limited, took options on a number of claims on the west side of American creek north of the Mountain Boy group. Three veins are known on the Ruby claim but only one has been explored. This is a quartz-barite-jasper vein of good size sparsely mineralized with galena, chalcopyrite, and bornite.

Silver Bell Mining Company, Limited (Locality 97)

References: Annual Report of the Minister of Mines, British Columbia, 1925, 1928, and 1929.

The Silver Bell Mining Company, Limited, was organized in 1922 to take over the Silver Bell group of claims on the east side of Portland canal south of the Silverado group. Narrow veins on the property contain pyrite, galena, and sphalerite.

Silver Bow Group (Locality 82)

References: Annual Report of the Minister of Mines, British Columbia, 1906; Geol. Surv., Canada, Memoir 32.

The Silver Bow group is on Glacier creek southwest of the Ruth and Francis group. Argillites and volcanics are interbanded and a fractured and silicified zone follows a band of volcanic rocks. The zone has been traced for 700 feet and is mineralized up to a width of 15 feet with pyrite, galena, tetrahedrite, and probably jamesonite.

Silver King Claim (Locality 85)

References: Annual Report of the Minister of Mines, British Columbia, 1906; Geol. Surv., Canada, Memoir 32.

The Silver King claim is on Glacier creek and is surrounded by the holdings of L. and L. Consolidated Mines. The vein on the Columbia group has been traced for 300 feet into the Silver King claim. It is sparingly mineralized with galena, pyrite, stibnite, sphalerite, and tetrahedrite.

Silverado Group (Locality 93)

References: Annual Report of the Minister of Mines, British Columbia, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, and 1932; Geol. Surv., Canada, Memoir 159.

The Silverado group of mineral claims is on the mountain side southeast of Stewart. The country rocks are breccias and lava flows of the Hazelton group. The rocks are sheared locally and in some places have been changed to sericite schists.

At an elevation of about 4,000 feet several quartz veins mineralized with pyrite and tetrahedrite are exposed in several adits, one of which is at least 400 feet long. Two or three of these veins, 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. The veins are richer at the surface than underground. A total of 9 tons of ore was shipped from these veins in 1921 and 1925. The ore averaged 150 ounces of silver a ton and contained 3·5 per cent copper. 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 have not been explored underground.

At least four quartz-sulphide veins are exposed at an elevation of 1,800 feet and on these mining work was centred during the period 1924 to 1927. They strike northwest and have been traced on the surface for lengths of about 400 feet. The two upper veins dip northeast and the two lower ones southwest. The largest vein is one of the two lower veins. It is 5 feet wide at its junction with a branch vein and contains quartz, pyrite, chalcopyrite, galena, sphalerite, tetrahedrite, and native silver, and at the junction with the branch vein is high-grade silver ore. A cross-cut adit driven to intersect this vein at a depth of 170 feet, although long enough to have reached the vein, did not intersect it. The other three veins are in most places less than 2 feet wide, but contain local bunches of rich silver ore.

In the autumn of 1927 four quartz-sulphide veins, some of which contain very high-grade silver ore, were discovered at an elevation of 4,000 feet and some distance north of the earlier workings. One of the veins contains a shoot of ore about 1 foot wide and 150 feet long. Ore has been shipped from two of the veins. The Premier Gold Mining Company did some 2,000 feet of underground work on the principal discoveries. This work demonstrated that the high silver values at the surface extended to only very shallow depths.

Southern Cross Group (Locality 26)

References: Annual Report of the Minister of Mines, British Columbia, 1929 and 1930.

The Southern Cross group of claims is on Strohn creek east of the head of Bear river. A number of closely spaced quartz veinlets contain chalcopyrite, tetrahedrite, sphalerite, pyrite, and galena.

St. Elmo Group (Locality 62)

Reference: Annual Report of the Minister of Mines, British Columbia, 1919.

The St. Elmo group of claims is on the west side of the glacier at the head of the north fork of Bitter creek. The veins are reported to be similar to those on the adjoining Jutland group.

Sunbeam Mineral Claim (Locality 78)

Reference: Geol. Surv., Canada, Memoir 159.

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

Two quartz-sulphide veins are known. The lower, known as the Sunbeam vein, has been traced for 600 feet. It is 3 feet wide and is locally well mineralized with galena, pyrite, and sphalerite, and contains also some tetrahedrite and native silver. The vein follows a narrow, greyish dyke. The other vein, known as the Sulphide vein, lies 200 feet east of, and parallel to, the Sunbeam vein. This vein is 2 to 6 feet wide, contains pyrite, galena, and sphalerite. A crosscut adit cuts these veins at depths of 180 and 260 feet respectively. The veins where crossed by the adit are smaller and so sparsely mineralized that they were not developed further.

Sunshine Group (Locality 84)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1919, 1923, and 1925; Geol. Surv., Canada, Memoir 159.

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 lower part of the Hazelton group and nearby is the edge of a body of augite porphyrite. The largest exposed mineral deposit 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. A sample taken at one place across a breadth of 3 feet assayed 10 per cent copper. An adit driven to pass under the deposit cross-cut chalcopyrite-bearing quartz stringers but 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 deposits are present but their boundaries have not been determined.

Superior Mines, Limited (Locality 67)

Reference: Annual Report of the Minister of Mines, British Columbia, 1925.

Superior Mines, Limited, was organized in 1925 to acquire a group of claims on Glacier creek adjoining and lying north of the Emperor group. A little work was done on two, narrow, mineral bodies on the sides of a light-coloured dyke. Good values in silver are reported.

Terminus Mines, Limited (Locality 20)

References: Annual Report of the Minister of Mines, British Columbia, 1911, 1912, 1924, 1925, 1926, 1927, 1928; Geol. Surv., Canada, Memoirs 32 and 159.

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. Active exploration began on this property many years ago and, in 1911, 12 tons of ore were sacked for an initial shipment. Poor transportation facilities prevented any shipment of ore until 1925. Development work consists of a crosscut adit 370 feet long with short drifts to either side, a raise to a sub-level 50 feet above the adit, and a shaft 50 feet deep connecting the sub-level with the surface.

The country rock consists of lava flows and volcanic fragmental rocks of the Hazelton group intruded by numerous dykes. 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 that 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 middle of the vein. The vein as revealed in the workings is in most places less than 2 feet wide. It 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 a 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.

Two parallel quartz-barite veins, each more than 10 feet wide, contain disseminated galena. They 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.

Tyee Group (Locality 71)

References: Annual Report of the Minister of Mines, British Columbia, 1909 and 1921; Geol. Surv., Canada, Memoirs 32 and 159.

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 that intrudes 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 locally assays several dollars a ton in gold.

Union Silver Mines, Limited (Locality 86)

Reference: Annual Report of the Minister of Mines, British Columbia, 1925.

Union Silver Mines, Limited, was organized in 1925 and acquired the Last Chance group of claims on the north fork of Glacier creek. This group adjoins and lies west of the Columbia group. An adit has been driven 95 feet in augite porphyrite to develop a quartz vein that proved to be barren.

United Empire Gold and Silver Mining Company, Limited (Locality 73)

References: Annual Report of the Minister of Mines, British Columbia, 1923, 1924, 1925, and 1927; Geol. Surv., Canada, Memoir 159.

The United Empire Gold and Silver Mining Company, Limited, holds the Gold Cliff group of mineral claims. These lie on the eastern slope of mount Dolly near Stewart and adjoin the holdings of the Bayview Mining Company, Limited. The lowest mineral showings are at an elevation of about 3,000 feet. 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 lies partly in granodiorite, partly in volcanic rocks, and makes a right angle with the edge of the batholith. Seventy feet above and 70 feet west of the upper exposure of this 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 prac-

tically 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 opened 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 driven to intersect the lower vein has not been driven far enough to reach its objective.

Vancouver Mines, Limited (Locality 20)

Reference: Annual Report of the Minister of Mines, British Columbia, 1925.

Vancouver Mines, Limited, was organized in 1925 and acquired the Hope group of claims adjoining the Terminus group on the east side of American creek. An outcrop containing much pyrrhotite contained no values. An adit 160 feet long follows a quartz vein found to contain nothing of value. Other large, rusty outcrops have not been developed.

Victoria Mines, Limited (Locality 69)

References: Annual Report of the Minister of Mines, British Columbia, 1909, 1921, 1924, 1925, and 1926; Geol. Surv., Canada, Memoirs 32 and 159.

The holdings of Victoria Mines, Limited, consist of the Dandy and Main Reef groups situated at the northern end of the Portland Canal fissure zone. The country rock is argillite of the upper part of the lower sediments of the Hazelton group. Volcanic rocks overlie the sediments on the lower part of the property and the lowest adit begins in volcanic rock. Two adits on the property are each 400 feet long. Seven others are individually 60 feet or less in length.

Several veins striking north and dipping west have been found on the property. The Main Reef vein 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. 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 opened by short adits exist farther up the hill. Only one of these, No. 10, is shown on Figure 1. The veins are 1 to 4 feet wide and consist of quartz mineralized with pyrite, galena, and sphalerite. The two uppermost veins contain a little chalcopyrite and arsenopyrite, as well as the usual pyrite, galena, and sphalerite.

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

Washington Group (Locality 110)

References: Annual Report of the Minister of Mines, British Columbia, 1921, 1926, and 1927; Geol. Surv., Canada, Memoir 159.

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 Hazelton group, underlain on the lower part of the property by argillites. 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 imperfectly exposed on the surface. The widths of the mineralized parts are not clearly defined, but rusty, sheared rock is 6 feet wide in some places. Pyrite, galena, sphalerite, and perhaps tetrahedrite, occur in the zones, but are not plentiful perhaps because of the oxidized nature of the outcrops.

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, 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 does not penetrate any shear zone nor any ore. The zones are either cut off by a fault or they do not extend downward as far as the adit.

Windsor Group (Locality 83)

References: Annual Report of the Minister of Mines, British Columbia, 1924 and 1930.

The Windsor group of claims is on the west side of Bromley glacier at the head of Bitter creek. The main vein is up to 18 feet wide and consists of quartz and argillite containing much pyrite and a little galena and sphalerite. Values in gold up to 0·6 ounce a ton have been obtained. Another vein, also in argillite, is up to 18 inches wide and contains galena and sphalerite. It is reported to carry good values in silver.

Wire Gold Group (Locality 101)

References: Annual Report of the Minister of Mines, British Columbia, 1912 and 1924.

The Wire Gold group of claims is on the north side of Marmot river about 2 miles from its mouth. A pyrite-bearing quartz vein in granodiorite has been followed by a 40-foot adit. The vein is up to 2 feet wide but is very sparsely mineralized.

SALMON RIVER DISTRICT

American Mining and Milling Company, Limited (Locality 5)

References: Annual Report of the Minister of Mines, British Columbia, 1920, 1922, and 1923.

The holdings of American Mining and Milling Company, Limited, consist of the Betty group north of Divide lake, the Sunrise group east of Long lake, the Daly-Sullivan group, 2 miles south of Long lake, and the Lois-Edith group northeast of Long lake.

On the Betty group a quartz vein up to 4 feet wide strikes southeast and dips 70 degrees southwest. The hanging-wall is sheared volcanic rocks and the foot-wall argillite. The vein and bordering silicified rock contain pyrite, galena, sphalerite, chalcopyrite, and silver sulphide. Picked samples have assayed 400 ounces of silver a ton. Narrow streaks of sulphide also occur following bedding planes of the argillite.

B. C. Bonanza Mines, Limited (Locality 13)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1920, 1922, 1923, and 1925; Geol. Surv., Canada, Sum. Rept. 1919, pt. B, and Memoir 132.

The holdings of the B.C. Bonanza Mines, Limited, consist of the Spider group east of Cascade creek and a mile north of Long lake, and the Web group adjoining and lying east of the Spider group.

The country rock on the Spider group is a stock of augite porphyrite intruding volcanic and sedimentary rocks. Several quartz veins lie in the augite porphyrite. The main vein is up to 20 feet wide striking northeast and has been followed on the surface for 700 feet. It is mineralized with galena, sphalerite, chalcopyrite, and pyrite where it intersects argillite inclusions in the porphyrite. The main vein is cut by a shear zone striking west-northwest. This shear zone was followed by an adit 700 feet long and found to contain small lenses of sulphides holding thin flakes of native silver and consisting mainly of sphalerite, galena, chalcopyrite, pyrite, freibergite, and argentite. Two tons of ore picked from the dump of the tunnel assayed 0·46 ounce of gold and 384 ounces of silver a ton, 9 per cent lead, and 13 per cent zinc. Five tons of ore sorted from another vein gave an almost identical assay.

B. C. Silver Mines, Limited (Locality 50)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1920, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, and 1931.

The holdings of the B.C. Silver Mines, Limited, consist of two groups of claims adjoining and lying respectively north and south of the holdings of the Premier Gold Mining Company. The company has confined its efforts almost entirely to the development of its holdings, but has made two shipments of ore totalling 1,014 tons of ore which yielded 2,000 ounces of gold and 80,000 ounces of silver.

The country rock on the property consists of sheared tuffs intruded by an irregularly shaped stock of feldspar porphyry which is also sheared locally. The whole is cut by dykes of various types. Development work has been confined almost entirely to the group of claims north of the Premier mine. The main Premier ore zone strikes northeast and passes through the north group. The surface was drift covered and the main ore-bodies were discovered by underground work. The main ore zone has been followed for a distance of 3,200 feet where it enters the ground of the Sebakwe and District Mines, Limited. At the Premier mine the ore zone is fairly regular and is accompanied on the foot-wall side by several parallel ore stringers distant 100 to 400 feet from the main ore-bodies. On B.C. Silver ground the main ore zone is not ore bearing for the whole of its length but contains a number of ore-bodies. As indicated on No. 6 level the ore zone appears to have been offset in several places by faults with offsets up to 100 feet.

The ore, like that in the Premier mine, grades from silicified rock containing pyrite and low values in gold and silver, to a heavy sulphide ore consisting of pyrite, galena, and sphalerite with good values in gold and silver. The heavy sulphide ore contains some tetrahedrite, native gold, and, locally, silver minerals. The ore zone is everywhere highly silicified. The ore-bodies appear to be largest where the wall-rocks are feldspar porphyry.

The property has been developed by No. 3 adit and No. 2 adit at elevations of 1,802 and 2,072 feet respectively. Below No. 3 adit sub-levels have been driven at elevations of 1,672 feet (No. 4 level), 1,448 feet (No. 5 level), and 1,348 feet (No. 6 level). Another sub-level 100 feet below No. 6 level has been started. Ore has been found down to the deepest level. The total length of underground work, excluding diamond drilling, shafts, raises, and stopes, approximates 4 miles. No. 6 level is at the same elevation as the Premier No. 4 level and No. 3 level at the elevation of the Premier No. 2 level.

Blue Jay Group (Locality 49)

Reference: Annual Report of the Minister of Mines, British Columbia, 1928.

The Blue Jay group of claims adjoins and lies south of the holdings of the Premier Extension Gold Mining Company. Open-cuts expose a silicified zone containing pyrite.

Boundary Group (Locality 43)

References: Annual Report of the Minister of Mines, British Columbia, 1911, 1917, 1918, and 1919.

The Boundary group of claims adjoins and lies northwest of the Indian group. A pyrite-bearing quartz vein has been traced by open-cuts and has also been crosscut by a 40-foot adit.

Buena Vista Mining Company, Limited (Locality 39)

References: Annual Report of the Minister of Mines, British Columbia, 1905, 1907, 1910, 1911, 1913, 1914, 1915, 1917, 1918, 1919, 1920, 1922, 1923, 1925, 1926, 1927, 1928, 1929, 1930, and 1931; Geol. Surv., Canada, Sum. Rept. 1919, pt. B; Memoirs 32 and 132.

The holdings of the Buena Vista Mining Company, Limited, consist of the Big Missouri group on Big Missouri ridge about 5 miles north of the Premier mine. The claims cover Harris creek and Big Missouri ridge on the west side of the creek. The claims are underlain by volcanic rocks that are for the most part rudely stratified, fragmental types. They strike north to north-northwest and lie in an anticline. On the summit of Big Missouri ridge they dip west at 45 degrees. Eastward along Harris creek the angle of dip is lower, and east of the creek they dip at gentle to moderate angles northeastward. The volcanic rocks are intruded, as for example on the E. Pluribus and on other claims farther south, by feldspar porphyry similar to that at the Premier mine. Narrow lamprophyre dykes are numerous.

Prior to 1927 mining work consisted of making open-cuts, driving short adits, and of diamond drilling. The purpose of this work was to trace mineral deposits known on the surface and in shallow workings. On Big Missouri ridge, on the Rambler, Buena Vista, Province, J. P. Fraction, Jain, Golden Crown, and Big Missouri claims, where the volcanic rocks in the main strike about north and dip west, some beds have been mineralized and others have not. The mineralized beds outcrop as long bands of rusty rock containing pyrite, chalcopyrite, galena, and sphalerite that are more abundant in some places than in others. The rocks are traversed by shattered zones and fractures and perhaps because the rocks are very much alike the fracturing is not concentrated into one main fracture zone.

On the Buena Vista claim two short adits less than 100 feet apart expose a mineralized and silicified zone up to 10 feet wide. It strikes north and dips at a moderate to gentle angle westward. Assays over widths of several feet gave values in gold up to 5 ounces a ton, in silver up to 5 ounces a ton, in lead and zinc up to 10 per cent, and less than 1 per cent in copper.

South of the Buena Vista claim, on the Province claim and on the northern part of the Jain claim which is south of the Province, more than thirty open-cuts expose sulphides in an area 800 feet in diameter. This mineralized area is 1,500 feet distant from that on the Buena Vista and is not connected with it. The rocks are somewhat sheared locally, the planes of shearing strike north-northwest and dip about 45 degrees west. In the open-cuts the rocks are silicified, are ribboned with quartz stringers trending north to north-northwest, and hold pyrite, sphalerite, galena, and chalcopyrite. In places bands of fairly heavy sulphide up to 3 feet wide strike north to northwest, but in general the mineralization is more disseminated with here and there quartz-sulphide veinlets. Locally sphalerite is rather plentiful. Open-cuts and a short adit near the southwest corner of the Province claim and open-cuts for several hundred feet to the east reveal massive pyrite, sphalerite, galena, and chalcopyrite. The mineral bodies on the Province appear to be irregular lenses striking north to

northwest and dipping in general west, and between the higher grade lenses much rock has been silicified and pyritized. Clothier states that an average of the results of assays of hundreds of samples from the Province claim would be about 60 cents in gold, about 2 ounces of silver, 2·16 per cent lead, 0·53 per cent copper, and 5 per cent zinc.

The Golden Crown claim is south of the Jain. On it two short adits explore a mineral zone up to 10 feet wide that in places contains gold values up to 0·2 ounce a ton. This showing is not connected with those on the Province and Jain claims.

The Big Missouri claim is 1,500 feet southwest of the Golden Crown claim. On it a large area is mineralized with pyrite and within this area patches are silicified and well mineralized. One of these is about 8 feet wide, 50 feet or more long, strikes north, and dips 70 degrees west. Picked samples assay up to 0·2 ounce of gold and 4 ounces of silver a ton, lead runs up to 4 per cent and zinc to 10 per cent.

Showings on the Laura and E. Pluribus claims are mainly east of Harris creek. On these claims the angle of dip of the rocks is lower than on Big Missouri ridge and to the east on the adjoining Mineral Hill group, where the volcanic rocks are overlain by sediments, the dip is to the east.

On the Laura a silicified zone with pyrite, galena, sphalerite, and chalcopyrite strikes north and crosses Harris creek. This is known as the Creek ore-body. It is at least 150 feet long and is up to 10 feet wide. It dips west about 35 degrees. Samples from this showing assay less than 0·1 ounce of gold and about 1 ounce of silver a ton. Lead runs about 3 per cent and zinc up to 6 per cent.

On the E. Pluribus much of the rock is feldspar porphyry and deposits in this rock have been explored by open-cuts, diamond drill holes, and by 2,500 feet of near surface adits. West of, but near, Harris creek are two or three cuts and short adits known as the Calcite cuts. They are in a shattered zone cemented by quartz, calcite, pyrite, and sphalerite. The main showings on the E. Pluribus are mineralized silicified zones. One is 6 feet wide and has been traced for several hundred feet. It strikes northeast and dips steeply southeast parallel to the shearing that is exhibited in places by the rocks. This silicified zone contains the same minerals as the other showings and also carries tetrahedrite and silver minerals. Picked samples assay 300 ounces of silver a ton, but the gold values are in general less than 0·1 ounce a ton. A diamond drill hole driven through this body affords samples that assayed as high as 2½ ounces of gold and about 20 ounces of silver a ton. This zone and another that is well mineralized only locally have been explored by about 2,500 feet of adits.

Since 1927 development work has been concentrated on the west side of Harris creek. The Province adit, beginning at an elevation of 2,900 feet, was driven north 60 degrees west for 2,700 feet and passes directly under the great cluster of open-cuts on the Province claim, some of which are as much as 600 feet above the adit. Judging from the strike and dip of the rocks the outcropping mineral deposits should dip west and, therefore, mineralization found in the adit 600 feet below and directly under the cuts is not necessarily the downward continuation of the surface deposits. If

a mineral zone found in the adit does continue to the surface it will, presumably, have a westerly dip and will outcrop well to the east of a point vertically above its position in the adit.

Mineral deposits discovered in the Province tunnel were explored by some 8,000 feet of tunnelling and by diamond drilling. A silicified zone was encountered 1,650 feet from the portal. The zone is up to 400 feet wide and has been followed by drifts for a length of 1,200 feet. It is in general well silicified and pyritized and locally contains sphalerite, a little galena, and more pyrite than the general average. The zone and the neighbouring rocks are cut by numerous, narrow quartz veins and also by calcite veins commonly striking about north. Among the youngest veins are veins up to 2 inches wide that can be followed for only 50 feet or less. Parts of such veins carry much free gold. Some specimens show plates of gold an eighth of an inch thick. These veinlets appear to be confined to the silicified zone. They strike north to northwest and dip from vertical to 45 degrees southwest. The veinlets consist of quartz banded with thin seams of chlorite. In general the free gold is fine but locally is quite coarse. The narrow gold-quartz veinlets are cut by black and white calcite veins. In the Province adit two other silicified bands parallel the main one. They are less than 100 feet wide, more than 1,000 feet long, and are also characterized by narrow quartz veins carrying gold.

The rocks in the adit are rudely stratified, volcanic fragmental rocks that strike north to northwest and dip 45 degrees to 70 degrees westerly. Individual beds cannot be followed far along the strike. They show considerable variation in lithology and thickness. The silicified zones appear to follow certain beds that apparently served as the best channels for the ore solutions, perhaps because of their greater porosity. The value of these deposits depends on the number and richness of the narrow gold-quartz veins. To determine the value of the deposits, the silicified zones were mined from the crosscuts, drifts, and from experimental stopes and the ore produced was milled. The results of this test have not been published.

Bush Consolidated Gold Mines, Limited (Locality 42)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1925, 1926, 1927, and 1928.

The holdings of the Bush Consolidated Gold Mines, Limited, consist of the Border and Sunshine claims, Exchange group, Extenuate group, Start group, Cobalt group, and Maple Leaf group. Most of this ground lies on the east side of Cascade creek and Harris creek between Long lake on the north and the Northern Light group on the south.

The Start group is at the northern end of Slate mountain. A quartz vein locally 6 feet wide and mineralized with galena and sphalerite has been followed about 200 feet by an adit. The Extenuate group is south of the Start group. Mineral deposits discovered so far are of low grade. On the Border claim on Cascade creek at the International Boundary a mineralized zone in feldspar porphyry contains quartz, pyrite, and sphalerite. On the Sunshine claim, south of Long lake, a sheared zone in tuffs contains very sparsely distributed pyrite, sphalerite, and galena.

Cascade Falls Mining Company, Limited

References: Annual Report of the Minister of Mines, British Columbia, 1911, 1912, and 1913; Geol. Surv., Canada, Memoir 32.

Cascade Falls Mining Company, Limited, carried on development work from 1911 to 1913 on claims east of Cascade creek about a mile from the International Boundary line. McConnell mentions an easterly striking mineralized and silicified zone up to 30 feet wide. He records one assay of a sample of 8 feet of the zone that showed 0·14 ounce of gold, 7 ounces of silver a ton, and 7·60 per cent lead.

Eldorado Gold Mines Consolidated, Limited (Locality 9)

References: Annual Report of the Minister of Mines, British Columbia, 1923 and 1925.

The holdings of Eldorado Gold Mines Consolidated, Limited, consist of four claims that lie west of Salmon glacier and adjoin the Outland Silver Bar group. The mineral deposits are narrow quartz veins in argillite cut by the belt of dykes. Open-cuts and adits have shown shoots of high-grade vein matter consisting of tetrahedrite and galena. Samples carried good values in gold and up to 600 ounces of silver a ton.

Forty Nine Mining Company, Limited (Locality 10)

References: Annual Report of the Minister of Mines, British Columbia, 1917, 1918, 1919, 1920, 1923, and 1925; Geol. Surv., Canada, Memoir 132.

The holdings of the Forty Nine Mining Company consist of the Forty Nine group of claims east of the Salmon River glacier, on the western slope of mount Dilworth. The claims are mainly underlain by volcanic fragmental rocks striking north to northwest and dipping at variable angles westward. Dykes striking north to northwest are common. At least two beds of tuff have been mineralized with pyrite and outcrop as rusty bands. A number of quartz-sulphide veins strike north to northwest. Some of the veins hold shoots of high-grade silver ore.

On the Oxedental, the most southerly claim of the group, quartz veins up to 3 feet wide strike northwest and one such vein has been followed by open-cuts and has been explored by an adit 120 feet long. The vein in the adit is about 1 foot wide and is locally well mineralized with tetrahedrite, galena, and silver minerals.

Quartz veins also occur on the Forty Nine claim situated north of and adjacent to the Oxedental. Three of the veins strike northwest and have been traced for almost a mile across the Forty Nine claim and the adjacent Yellowstone group. A sample representing a width of 8 feet across one vein and associated rock with disseminated sulphide assayed 0·16 ounce in gold and 19 ounces of silver a ton. Adits totalling about 300 feet in length have been driven on the Forty Nine claim.

On the Chicago claim several veins strike northwest and have been traced for several hundred feet.

Some of the veins were further explored by the Premier Gold Mining Company, Limited, by means of diamond drilling. Six holes on the Forty Nine claim passed under good surface showings but failed to strike anything of value. Seven on the Chicago claim did not locate ore at depth. Three on the Oxedental claim struck only a few spots running up to $5 in gold and silver a ton.

Glacier Group (Locality 46)

References: Annual Report of the Minister of Mines, British Columbia, 1920 and 1925.

The Glacier group of claims is on the east side of Salmon River glacier at its lower end. A quartz vein up to 5 feet wide strikes east and dips 45 degrees south. The vein is mineralized with pyrite, chalcopyrite, and galena. Picked specimens have yielded high values in gold and silver.

Hercules Mines, Limited (Locality 16)

References: Annual Report of the Minister of Mines, British Columbia, 1910, 1912, 1914, 1917, 1918, 1919, 1920, and 1923; Geol. Surv., Canada, Memoirs 32 and 132.

The holdings of the Hercules Mines, Limited, consist of the Martha Ellen group of claims adjoining and lying northwest of the Big Missouri group. The rocks on the property are rudely bedded tuff and breccia striking north and dipping gently west. A bed of tuff has been mineralized with pyrite, chalcopyrite, sphalerite, galena, and quartz. The mineralized body is up to 25 feet wide and has been traced from south to north across two full claims. Samples taken over fair widths have shown good values in gold. A quartz vein similarly mineralized strikes northeast, is 1 to 8 feet wide, and has been traced for several hundred feet.

High Ore Gold Mining Company, Limited (Locality 53)

References: Annual Report of the Minister of Mines, British Columbia, 1931.

The holdings of the High Ore Gold Mining Company, Limited, consist of the High Ore group situated at an elevation of 4,000 feet at the International Boundary south of the Premier mine. The property is underlain by volcanic rocks that strike northerly and have been sheared along planes also striking northerly. A silicified zone mineralized with pyrite and trending north has been traced by open-cuts.

Hollywood Mines, Limited (Locality 8)

References: Annual Report of the Minister of Mines, British Columbia, 1923, 1924, and 1925.

The holdings of the Hollywood Mines, Limited, consist of the Hollywood group of claims west of Salmon River glacier. It is reported that high-grade silver ore has been found on the property.

Indian Mines Corporation, Limited (Locality 45)

References: Annual Report of the Minister of Mines, British Columbia, 1910, 1912, 1913, 1917, 1918, 1919, 1920, 1922, 1923, 1924, and 1925; Geol. Surv., Canada, Memoirs 32 and 132.

The holdings of the Indian Mines Corporation, Limited, consist of the Indian or Portland group and the adjoining Morning mineral claim, on the west side of Cascade creek a mile from the International Boundary. Operations have been confined almost entirely to development work, but 30 tons of ore were shipped in 1925 yielding 1 ounce of gold and 371 ounces of silver, 17,000 pounds of lead, and 8,325 pounds of zinc.

On the property porphyry of the Premier type intrudes volcanic rocks and a northerly striking band of cherty argillite and quartzite. All these rocks are cut by dykes of various types. The mineral deposit is a northerly striking, irregular zone locally 25 feet wide. It outcrops between elevations of 2,200 and 2,525 feet and has been traced for 1,200 feet on the Indian group claims north to where it enters the Morning mineral claim. Three adits at elevations of 2,243, 2,191, and 2,033 feet, respectively, and having an aggregate length of somewhat more than a mile, follow the mineral zone. It is silicified and locally is well mineralized with pyrite, galena, and sphalerite that in places constitute nearly the whole width of the zone. In places the zone splits into separate fractures and loses its identity. Some of the fractures are mineralized but where followed became unattractive.

The adit at an elevation of 2,191 feet was driven under the best surface showings, but although it disclosed narrow bands of sulphide 3 feet or less wide, nothing found is comparable in size with the surface showings. In the uppermost adit at 2,243 feet, six main shoots were found having a total length of 700 feet and varying in width from a few feet to 20 feet. Locally galena is very plentiful. The best material carries low values in gold and somewhat less than an ounce of silver a unit of lead. The lowest adit (elevation 2,033 feet) disclosed a few narrow bands of mineralized rock but no ore of any consequence.

International Group (Locality 52)

References: Annual Report of the Minister of Mines, British Columbia, 1918, 1919, 1920, and 1922; Geol. Surv., Canada, Memoir 132.

The International group of claims is at the International Boundary line, west of Cascade creek and about 2,200 feet above sea-level. Open-cuts expose a silicified zone mineralized with pyrite, up to 10 feet wide, lying in a narrow body of feldspar porphyry. Both the porphyry body and the silicified zone strike north. A crosscut adit 150 feet below the open-cuts has not been driven far enough to intersect the zone.

Last Chance Group (Locality 41)

Reference: Annual Report of the Minister of Mines, British Columbia, 1927.

The Last Chance group of claims is on the west side of Salmon River glacier at the International Boundary line. The mineral deposit is a quartz vein up to 1½ feet wide in granite. The vein contains some pyrite, galena, and sphalerite.

Lion Group (Locality 12)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1922, 1926, and 1927.

The Lion group of claims is on the southern slope of mount Dilsworth and is crossed by the belt of dykes. A vein crosses one of the dykes but does not extend beyond the dyke walls and consequently has a length of only 20 feet.

Mineral Hill Mines, Limited (Locality 38)

References: Annual Report of the Minister of Mines, British Columbia, 1917, 1918, 1919, 1922, and 1925; Geol. Surv., Canada, Memoir 132.

The holdings of Mineral Hill Mines, Limited, consist of the Mineral Hill group. This lies east of Harris creek and adjoins the E. Pluribus, Laura, and Golden Crown claims of the Big Missouri group.

The mineral deposit is a northeasterly striking quartz-sulphide zone which may be a continuation of the main showing on the E. Pluribus claim of the Big Missouri group. Open-cuts disclosed some very high-grade silver ore, but in an adit passing below them only low-grade mineralization was found. The deposit lies in feldspar porphyry similar to that at the Premier mine. Lamprophyre dykes are numerous in the adit.

Montana Fraction (Locality 16)

Reference: Annual Report of the Minister of Mines, British Columbia, 1923.

The Montana Fraction claim adjoins and lies east of the holdings of Hercules Mines, Limited. Three quartz veins on the property are mineralized with pyrite, galena, and sphalerite. One of the veins is up to 15 feet wide.

Munro Mining Company, Limited (Locality 40)

References: Annual Report of the Minister of Mines, British Columbia, 1920, 1922, 1925, 1926, and 1928.

The holdings of the Munro Mining Company, Limited, consist of the Munro group and lie west of Salmon River glacier opposite the property of Hercules Mines, Limited. Two quartz veins on the Munro group have been explored. The lower vein is horizontal and has been followed by two adits 100 feet above the glacier. The vein contains some very high-grade silver-lead ore but is very narrow.

Outland Silver Bar Mines, Limited (Locality 9)

References: Annual Report of the Minister of Mines, British Columbia, 1922, 1925, 1926, 1927, 1928, and 1929.

The holdings of Outland Silver Bar Mines, Limited, consist of the Outland Silver Bar group on the west side of Salmon River glacier opposite the Forty Nine group. Two tons of ore were shipped in 1926 and returned a total of 51 ounces of silver and 747 pounds of lead.

The rocks on the property are argillaceous sediments cut by the belt of dykes. The mineral deposits are veins and replacements. A silicified area several hundred feet across is mineralized with pyrite, pyrrhotite, chalcopyrite, galena, and sphalerite. Several adits show mineralized rock similar to that on the surface. Southwest of the silicified area several narrow quartz veins have been followed by adits. The veins are mineralized with pyrite, galena, sphalerite, and tetrahedrite. One vein is mineralized chiefly with arsenopyrite. The most promising vein strikes north, is 4 feet wide, and has been traced for several hundred feet. It has been explored by two adits. The mineralization on the group is of the silver-lead type with local good values in gold.

Payroll Group (Locality 44)

References: Annual Report of the Minister of Mines, British Columbia, 1918 and 1919.

The Payroll group of claims is on Big Missouri ridge and adjoins and lies north of the holdings of the Indian Mines Corporation, Limited. A northerly striking and easterly dipping quartz vein has been traced for 1,000 feet. In places quartz and brecciated argillite make up a width of 12 feet, but in general the vein is narrower. The vein is mineralized with pyrite, galena, and sphalerite.

Pioneer Group (Locality 1)

References: Annual Report of the Minister of Mines, British Columbia, 1927 and 1930.

The Pioneer group of claims is on the west side of Tide Lake flats about 10 miles north of the Big Missouri group. The ground is underlain by light-coloured altered rocks that probably are calcareous tuffs and tuffaceous sediments. The rocks strike north to northeast and have steep dips mainly to the west. They are rather strongly sheared in a northerly direction across a width of 2,000 feet or more. The rocks contain disseminated pyrite and locally hold seams of quartz with galena, sphalerite, tetrahedrite, silver minerals, and native gold.

Premier Border Mining Company, Limited (Locality 47)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1927, 1928, 1929, and 1930.

The holdings of the Premier Border Mining Company consist of the Northern Light group of claims lying east of Cascade creek and west of the holdings of the B.C. Silver Corporation.

Several silicified zones in porphyry outcrop and one or more hold low values in gold and silver. The latest exploratory work is an adit at an elevation of 1,100 feet and 1,650 feet long in a southeasterly direction. The adit ends about 200 feet away from B.C. Silver Corporation ground. The adit to a point 800 feet from the portal penetrates porphyry similar to that at the Premier mine, beyond this point it lies in greenstones or tuffs. A few, narrow, silicified bands in the porphyry may carry low values. A narrow galena-bearing vein outcrops near the portal.

Premier Extension Gold Mining Company, Limited (Locality 49)

References: Annual Report of the Minister of Mines, British Columbia, 1923, 1925, 1926, 1927, and 1929.

The holdings of Premier Extension Gold Mining Company, Limited, consist of part of the Vancouver group of claims lying west of Cascade creek and adjoining and lying north of the Woodbine claim. A silicified zone 9 feet or less wide, in feldspar porphyry similar to that at the Premier mine, carries low values in gold and silver.

Premier Gold Mining Company, Limited (Locality 51)

References: Annual Report of the Minister of Mines, British Columbia, 1911, 1912, 1915, 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, and 1932; Geol. Surv., Canada, Sum. Rept. 1919, pt. B; Memoirs 32 and 132; Min. and Sci. Press, vol. 119, pp. 670-672; Econ. Geol., vol. 21, pp. 586-604; Can. Min. Inst., Trans., vol. 23, p. 391; Can. Inst. Min. and Met., vol. 25, pp. 225-232; Can. Min. Jour., 1920, pp. 454-458.

The holdings of the Premier Gold Mining Company, Limited, are on the east side of Cascade creek 1 to 2 miles from the International Boundary. The claims extend from Cascade creek almost to the top of Bear River ridge.

The annual production of the Premier mine is given in the following table.

Year	Tons of ore	Gold, ounces	Silver, ounces	Lead, pounds	Copper, pounds
1918	26	182	182		
1919	488	3,209	108,285		
1920	799	2,283	77,180		
1921	18,750	40,104	1,177,987		
1922	102,334	123,527	4,261,368		
1923	145,665	117,293	2,746,551	62,191	
1924	159,014	139,288	3,015,382	452,010	
1925	168,557	118,448	2,363,556	785,330	
1926	230,987	122,228	2,920,492	443,088	
1927	244,172	117,098	3,126,655	2,299,991	125,407
1928	275,811	130,294	2,368,458	2,933,599	207,632
1929	266,972	96,636	2,258,729	2,110,789	129,847
1930	256,836	87,031	2,542,668	1,230,272	50,639
1931	242,317	79,302	1,508,369	1,176,516	3,671
1932	221,718	76,010	1,561,484	1,109,290	34,686
Total	2,334,446	1,252,933	30,037,356	12,593,076	551,682

The country rock at the mine is feldspar porphyry holding many large inclusions of sheared volcanic rocks altered to greenstones or green schists holding abundant chlorite. Rocks at a distance of a quarter of a mile from the porphyry contact, although locally sheared, are the usual green-grey or purple volcanic rocks. The feldspar porphyry forms a stock of very irregular shape and measuring about 1½ miles by 3 miles. Tongues of porphyry extend from the stock for distances of 1 or 2 miles and for the most part parallel the regional structure. The porphyry is sheared locally and pyrite, sericite, and chlorite have been introduced. Phases of the porphyry hold orthoclase phenocrysts an inch or more long, but the

bulk of the rock is light green and not porphyritic. Narrow, dark, lamprophyre dykes are common in the vicinity of the mine, but are uncommon in the mine workings.

Fractures or shear zones penetrating the porphyry and the large inclusions of greenstone appear to be larger and more persistent where they traverse porphyry than where they cut greenstone. The ore-bodies occupied fractures, and fracture or shear zones, and most of the ore lay in porphyry near the southwestern, southern, and southeastern contacts of the body.

The Premier ore-bodies are on the east side of Cascade creek between the elevations of 700 feet and 2,100 feet. The main ore zone strikes southwest but down hill swings from southwest to west to northwest. The northeasterly striking part of the zone is from 1,500 to 2,000 feet long in Premier ground, the northwesterly striking part is about 3,000 feet long.

Most of the ore-bodies bottomed above the lowest adit level, No. 6, at an elevation of 773 feet, but some ore has been stoped down to this level and an unknown quantity has recently been discovered 150 feet below No. 6 level. A large part of the northeasterly striking part of the zone was a wide body of solid ore. The northwesterly striking part of the zone was of much lower grade and only a few ore-bodies were found in it. The ore-bodies were in general 30 feet or less in width, except at the bend where a width of more than 50 feet was mined. Several parallel ore-bearing veins a few inches to 6 feet wide were found 300 feet or less south of the bend in the zone and of the northeasterly striking part of the zone.

The northeasterly striking part of the zone was mostly ore with several higher grade bodies, from the surface downward to below No. 4 level (1,329 feet), but not as far as No. 5 level (1,076 feet). The upper part of the zone dipped about 70 degrees northwest and the lower part about 45 degrees northwest. The ore shoots plunged steeply to the southwest. The strike length of the ore-bearing part of the zone was greater on the second and third levels than at the surface or at greater depth. Only a few short ore shoots reached No. 5 level and only one as far as No. 6 level. The newly discovered ore-body, 150 feet below No. 6 level, may be part of a shoot not found in higher levels. At the bend the whole zone was an ore shoot from some distance above No. 3 level down to No. 5 level where it was considerably shorter than elsewhere. The ore shoot dipped about 80 degrees and plunged steeply to the west. The northwest zone dipped steeply northeast and the few ore shoots plunged steeply northwest. These ore shoots did not go far below No. 4 level (1,329 feet).

The ore was, for the most part, fairly solid sulphide consisting at depth of pyrite, galena, and sphalerite with minor amounts of chalcopyrite. From a short distance below No. 3 level to the surface the ore contained important amounts of polybasite, ruby silver, argentite, native silver, electrum, native gold, and tetrahedrite, some of which contained much silver. Locally in the northeastern sector of the zone the ore consisted of quartz containing disseminated ore minerals. At the ends of most ore shoots ore gradually gave way to silicified country rock containing disseminated pyrite and narrow streaks of ore minerals. The ore of the upper part of the mine was probably finer grained than that in the lower part.

At least some of the galena on No. 3 and No. 4 levels was coarser grained than that at higher levels. The newly discovered ore below No. 6 level, however, is reported to be moderately fine grained.

The walls of the ore zone are silicified, sericitized, and impregnated with pyrite to distances of 10 feet or more from the ore-bodies. Burton reports the presence of adularia in the rocks immediately adjacent to the ore.

Some of the ore from near the surface contained many ounces of gold a ton, one of the early shipments ran 7 ounces to the ton. The quantity of gold gradually decreased with depth until at No. 4 level the average was somewhat less than ½ ounce a ton. At greater depths the ore averaged less than 0·4 ounce a ton. Near the surface some ore ran many hundreds of ounces of silver a ton, and one of the early shipments held 220 ounces a ton. The quantity of silver decreased with depth at a greater rate than

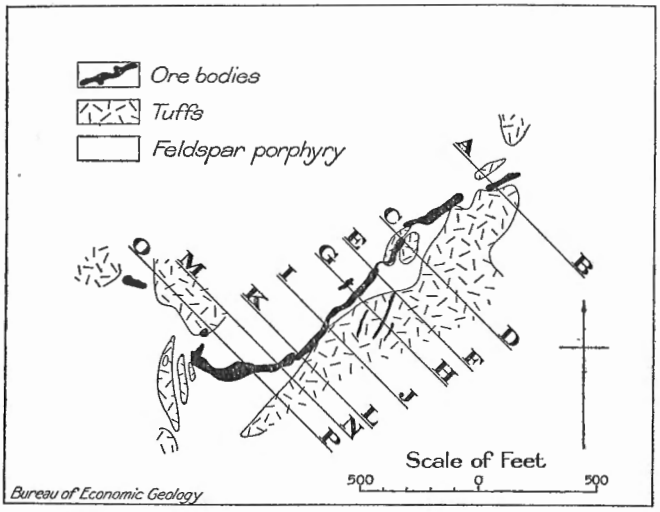

Figure 16. Plan of No. 3 level (elevation 1,550 feet), Premier mine (A-B, C-D, etc.: lines of section, *See* Figure 17).

that of the gold. On No. 4 level the silver averaged 4 ounces or less, and at greater depth less than 2 ounces a ton. An indication of the change in the ratio of gold to silver in the ore is given by the average assay values of the ore produced each month. In stopes 1A, 1B, and 1C above No. 1 level the ratio of gold to silver was between as 1 is to 40 and as 1 is to 60. In the same stopes just above No. 2 level the ratio dropped to between as 1 is to 30 and as 1 is to 55. Below No. 2 level the ratio changed gradually until on No. 3 level it was between as 1 is to 12 and as 1 is to 25. On No. 4 level the ratio was between as 1 is to 10 and as 1 is to 14. At No. 5 level the stopes converged to form one stope and the ratio changed gradually until at No. 5 level it was approximately as 1 is to 5. Another set of stopes continuing from No. 1 level down to a single stope on No. 5 level showed a gradual change in the gold-silver ratio from about as 1 is

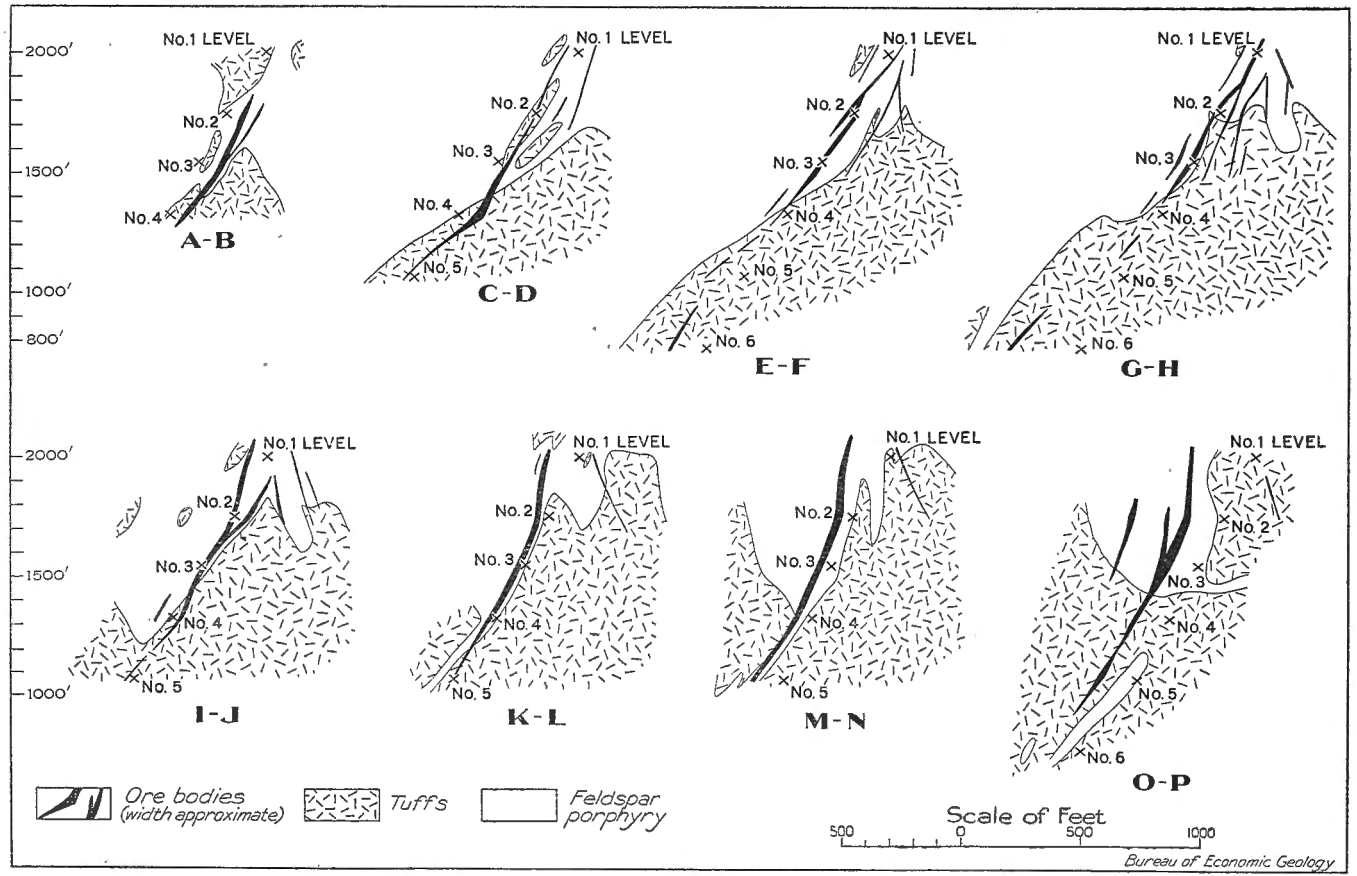

Figure 17. Vertical sections (*See* Figure 16), Premier mine; widths of ore-bodies approximate only.

to 30 on No. 1 level, to as 1 is to 20 on No. 2 level, to as 1 is to 10 on No. 3 level, to from as 1 is to 5 to as 1 is to 12 on No. 4 level, to as 1 is to 5 on No. 5 level. In the case of another ore-body extending from about No. 2 level to No. 4 level, the ratio changed from about as 1 is to 12 on No. 2 level, to about as 1 is to 9 on No. 3 level, to a varying ratio on No. 4 level that averaged about as 1 is to 9. The three ore-bodies referred to occurred in the northeast sector. In the case of an ore-body extending from No. 5 to No. 6 level and possibly not occurring in the northeast zone, the ratio changed from about as 1 is to 6 on No. 5 level to as 1 is to 3 or as 1 is to 4 on No. 6 level.

In addition to the main ore zone there are four veins spaced somewhat less than 100 feet apart south of the point where the strike of the main ore zone changes from southwest to west. The veins extend northeastward and join the northeast sector at small angles. The longest vein is about 1,500 feet long. The veins dip steeply southeast unlike the roughly parallel northeast sector of the main ore zone which dips northwest. The veins consist mainly of pyrite in a quartz gangue. Free gold is not uncommon but for the most part is invisible. Locally the gold content is as high as 100 ounces of gold a ton. In general the gold content is high enough to warrant mining veins somewhat less than 1 foot wide. The ratio of gold to silver is commonly about as 1 is to 1, but in some places it is as 2 is to 1.

At the surface on the foot-wall side of the main ore zone a band of tuff separates two bodies of porphyry. This band is a few hundred feet thick where it roughly parallels the northeastern third of the northeastern sector of the ore zone and slopes gently northwest. At about No. 4 level the band of tuff intersects the ore zone and the ore zone there is relatively unproductive. To the southwest the band of tuffs becomes much thicker and has a steeper dip at the surface, but the dip, at depth, decreases so that the ore zone intersects the tuffs near No. 5 level. This part of the ore zone is also unproductive. The dip of the ore zone decreases to about 45 degrees before the zone enters the tuffs. At the surface the southwestern two-thirds of the northeastern sector of the ore zone and the adjacent part of the northwestern sector of the zone are in porphyry 50 to 100 feet above the edge of the tuff band. It seems as if the body of tuffs was of sufficient size to influence the location of the fracture zone which later was filled with ore. At several places in the mine the ore zone crosses small inclusions of tuff and there the zone is narrower than where it lies in porphyry on either side of the inclusion. This condition seems to indicate that the tuffs yielded to fracturing less readily than the porphyry. The tuffs are less brittle than the porphyry, and under stress may have sheared rather than fractured like the porphyry.

The lower edge of the tuff band where it borders the northeastern ore sector is highly irregular due to wedges and tongues of porphyry projecting upward into the tuffs. The overlying tuffs, therefore, vary greatly in thickness in short distances. This variation may have been a prime factor in permitting fractures to penetrate the tuffs and thus to give rise to the veins that, as already described, occur in this section.

St. Eugene Group (Locality 7)

Reference: Annual Report of the Minister of Mines, British Columbia, 1927.

The St. Eugene group of claims is on the east slope of August mountain, west of the northern part of Salmon River glacier. Four parallel northeasterly striking quartz veins in volcanic rocks are mineralized with pyrite, galena, sphalerite, chalcopyrite, and tetrahedrite. Three of the veins are 25 feet apart and the fourth is 150 feet farther east. The veins are 5 feet or less wide. A sample across a 2-foot section of one vein ran a trace in gold and 11 ounces of silver a ton, 18 per cent lead, and 8 per cent zinc.

Salmon Gold Group (Locality 4)

References: Annual Report of the Minister of Mines, British Columbia, 1930, 1931, and 1932; Geol. Surv., Canada, Sum. Rept. 1931, pt. A.

The Salmon Gold group of claims is west of Summit lake at the north end of Salmon River glacier. The principal deposits are at an elevation of about 3,800 feet or 1,000 feet above the lake.

The claims are underlain by augite andesite, an intrusive member of the volcanic series, invaded north of the mineral deposits by a small, irregularly shaped stock of granodiorite and by dykes of various types.

The largest deposit is a silicified zone containing much pyrrhotite and some arsenopyrite, sphalerite, and chalcopyrite, and probably native gold. The zone is up to 25 feet wide, but the average width is less than 10 feet. It has been traced in a northwesterly direction for 300 feet up to the lower end of a glacier. The zone appears to be approximately vertical. Drill holes crossing the main zone at shallow depth indicated spotty values in gold and the highest assays of drill samples were less than 1 ounce of gold a ton.

The main zone is joined by several westerly striking quartz veins that curve to the northwest as they join the larger body. These veins have been traced for several hundred feet and are in general less than 5 feet wide. They dip steeply north. The veins hold much more quartz, more pyrite, and much less pyrrhotite than the main zone. On the surface values in gold are in general somewhat lower and in silver a little higher than those present in the main zone. Diamond drill holes at shallow depth disclosed spotty values in gold rarely as high as 0·5 ounce, and less than half an ounce of silver a ton.

Salmon River High Grades, Limited (Locality 6)

Reference: Annual Report of the Minister of Mines, British Columbia, 1925.

The Salmon River High Grades, Limited, own the Daisy group of claims east of the north end of Salmon River glacier. Two small quartz veins sparsely mineralized with tetrahedrite occur in contorted sediments.

Sebakwe and District Mines, Limited (Locality 48)

References: Annual Report of the Minister of Mines, British Columbia, 1916, 1918, 1919, 1920, 1922, 1923, 1925, 1926, 1927, 1928, 1929, and 1930.

The property of Sebakwe and District Mines, Limited, adjoins the holdings of B.C. Silver Mines, Limited, and Premier Gold Mining Company, Limited.

On this property feldspar porphyry is somewhat less extensive and purple and green volcanic rocks more plentiful than on the properties of Premier and B.C. Silver Mines. Over much of the area the rocks are severely sheared, the shear planes striking northeast and dipping 45 degrees northwest.

The first discovered mineral deposits are closely spaced silver-bearing stringers in tuffaceous rocks and lie northeast of discoveries made after 1925. The efforts of the present owners of the property were directed to searching for a northeasterly continuation of the ore zone of the Premier mine which was known to extend from the Premier property into B.C. Silver ground. A crosscut adit was driven southeastward at an elevation of 1,663 feet, the same as that of the B.C. Silver No. 4 level. At a distance of 1,100 feet an ore-body was encountered that proved to be 250 feet long and about 15 feet wide. The strike of the body was northeast and the dip about 45 degrees northwest. The crosscut was driven through purple and green tuffs, but the ore-body lay in a band or wedge of porphyry striking northeast and dipping 45 degrees or less northwestward beneath the tuffs. The porphyry body was encountered near its top and the ore-body did not extend upward into the tuffs. In depth the porphyry body widened. The ore-body extended down to No. 6 level at an elevation of 1,369 feet. It plunged steeply to the southwest. The ore consisted of pyrite, galena, and sphalerite in quartz and silicified porphyry. It was similar to the ore in the Premier and B.C. Silver Mines in that it graded from a heavy sulphide ore to silicified porphyry. The values were in gold and silver.

Silver Group (Locality 1)

Reference: Annual Report of the Minister of Mines, British Columbia, 1927.

The Silver group of claims is south of the Pioneer group on the west side of Tide Lake flats a few miles north of Summit lake. Several veins, 3½ feet or less wide, are known and one contains massive sulphide. A sample of this vein assayed 0·30 ounce of gold and 148 ounces of silver a ton, 30 per cent lead, and 4 per cent zinc.

Silver Basin Group (Locality 16)

Reference: Annual Report of the Minister of Mines, British Columbia, 1929.

The Silver Basin group of claims is on the east side of the Salmon River glacier and adjoins and lies west of the holdings of Hercules Mines, Limited. A shattered zone in argillites contains stringers of quartz mineralized with galena, sphalerite, and pyrite.

Silver Crest Mines, Limited (Locality 14)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1920, 1922, 1924, 1925, 1926, and 1927.

The holdings of the Silver Crest Mines, Limited, consist of the Silver Hill group of claims on the southeastern slope of mount Dilworth. The claims are underlain by argillite cut by dykes of many types. Most of the larger dykes are of quartz porphyry. The deposits are mainly confined to the quartz porphyry or other acidic types of dykes. Some are pegmatitic phases of the dykes containing well-crystallized ore minerals and quartz. Others are quartz gashes containing pyrite, sphalerite, galena, chalcopyrite, polybasite, and native silver. The occurrences suggest strongly that the ore minerals are end products of crystallization of the dykes in which they are found. The deposits appear to be small and sporadically distributed in the dykes. A small shipment of ore returned 257 ounces of silver to the ton. Underground work consists of two adits with a combined length of over 500 feet.

Silver Tip Mining and Development Company (Locality 15)

References: Annual Report of the Minister of Mines, British Columbia, 1917, 1919, 1920, 1922, 1925, 1926, 1927, and 1928.

The holdings of Silver Tip Mining and Development Company consist of the Silver Tip group of claims south of mount Dilworth between the Unicorn group and the holdings of Silver Crest Mines, Limited.

The property is underlain by the belt of dykes. Some of the deposits, as in the case of those on the Silver Crest group, are in quartz porphyry or other acid types of dykes. Others are in volcanics and sediments intruded by the dykes. One of the earliest discoveries was a galena vein about 18 inches wide and containing 120 ounces of silver a ton. Another vein lies between a quartz porphyry dyke forming the foot-wall and argillites forming the hanging-wall. The vein strikes east, dips 35 degrees south, and is about 4½ feet wide. It contains galena, and samples assay up to 100 ounces of silver a ton. Two similar but somewhat narrower, parallel veins occur a few hundred feet away between porphyry dykes and other rocks. Several other veins occur in quartz porphyry dykes.

Silverton Group (Locality 1)

The Silverton group of claims is west of Tide Lake flats, adjoins the Silver group, and lies several miles north of Summit lake. The mineral deposits are reported to be similar to those on the Silver group.

Troy Group (Locality 6)

References: Annual Report of the Minister of Mines, British Columbia, 1924, 1925, 1926, 1927, and 1930; Geol. Surv., Canada, Sum. Rept. 1931, pt. A.

The Troy group of claims is east of the northern end of Salmon River glacier. Two veins occur in the lower beds of a series of argillites overlying volcanic rocks to the northwest. The argillites strike north to northeast and dip east. The veins are up to 3 feet wide and lie in narrow shear zones. They contain quartz, pyrite, sphalerite, galena, tetrahedrite, and chalcopyrite. Samples give high assays in silver. Silicified zones with pyrite occur in the volcanic rocks.

Unicorn Mining Company, Limited (Locality 37)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1922, 1923, 1925, 1928, 1929, 1930, 1931, and 1932.

The holdings of Unicorn Mining Company, Limited, consist of the Unicorn group of claims adjoining and lying east of the northern claims of the Big Missouri group.

The claims are underlain mainly by tuffs and other types of volcanic rocks near the top of the volcanic series. Overlying sediments occur a short distance east. Most of the bedded rocks are nearly horizontal. Feldspar porphyry extending northward from the Big Missouri group outcrops over part of the western half of the Good Hope claim. Most of the showings are on the Good Hope claim directly north of the Union and Laura claims of the Big Missouri group. The line of strike of the deposit found in the Province tunnel of the Big Missouri group passes well to the west of the Good Hope claim.

At the eastern boundary of the Good Hope claim are two easterly striking veins and two that strike northwest. The two northwesterly striking veins are of quartz containing pyrite, sphalerite, and galena. They are about 3 feet wide and have been traced for 100 and 250 feet respectively. Samples assay up to 0·2 ounce in gold and 30 ounces in silver a ton. On the western half of the Good Hope claim there are four easterly striking deposits and two striking north to northwest. Most of these deposits are veins 3 feet or less wide, and consist of quartz with pyrite, sphalerite, and galena. The values approximate 0·2 ounce in gold and 10 ounces in silver a ton, but occasional high gold assays have been obtained. One of the easterly striking bodies is a shear zone up to 50 feet wide, sparsely mineralized and carrying low values in silver and gold. There are three adits 200 feet, 380 feet, and 590 feet long respectively.

Woodbine Gold Mining Company, Limited (Locality 49)

References: Annual Report of the Minister of Mines, British Columbia, 1919, 1920, 1922, 1923, 1925, 1926, 1927, 1928, 1929, and 1930.

The holdings of the Woodbine Gold Mining Company, Limited, consist of the Woodbine and other claims adjoining and lying south of the Premier Extension Gold Mining Company's holdings. The property is west of Cascade creek half a mile from the International Boundary line.

The country rock consists of quartz and feldspar porphyry in general similar to the fresher and less sheared phases of the Premier porphyry but containing more quartz. There is some volcanic rock which may occur as inclusions in the porphyry. The whole is cut by several large granite dykes striking northwest.

Deposits on the property have been explored by two adits, a number of diamond drill holes, and surface cuts. The upper adit at an elevation of 1,260 feet does not disclose ore. The lower adit at an elevation of 1,000 feet is about 3,000 feet long, including drifts and crosscuts. This adit discloses a large area, 900 feet long in a northeasterly direction and

about 400 feet wide, that is mainly silicified and pyritized porphyry, but consists in part of silicified green rocks that may be volcanic, and it is also crossed by granitic dykes. Picked samples are reported to contain high values in gold. The adit lies approximately in the projected position of the northwesterly striking sector of the ore zone of the Premier mine.

A silicified and mineralized zone outcropping above the upper adit is 20 feet wide, strikes northeast, and dips about 60 degrees northwest.

Yellowstone Group (Locality 11)

References: Annual Report of the Minister of Mines, British Columbia, 1911, 1914, 1917, 1918, 1919, 1920, and 1923.

The Yellowstone group of claims is east of Salmon River glacier and adjoins and lies west of the Forty Nine group. Three or more quartz veins have been traced from the Forty Nine group across the Yellowstone group. The veins are up to 8 feet wide and locally assay 0·4 ounce or more in gold.

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