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BULLETIN No. 20—PART II.

LODE-GOLD DEPOSITS

South-eastern British Columbia

by

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PREFACE.

Bulletin 20, designed for the use of those interested in the discovery of gold-bearing lode deposits, is being published as a series of separate parts. Part I. is to contain information about lode-gold production in British Columbia as a whole, and will be accompanied by a map on which the generalized geology of the Province is represented. The approximate total production of each lode-gold mining centre, exclusive of by-product gold, is also indicated on the map. Each of the other parts deals with a major subdivision of the Province, giving information about the geology, gold-bearing lode deposits, and lode-gold production of areas within the particular subdivision. In all, seven parts are proposed:—

PART I.—General *re* Lode-gold Production in British Columbia.
PART II.—South-eastern British Columbia.
PART III.—Central Southern British Columbia.
PART IV.—South-western British Columbia, exclusive of Vancouver Island.
PART V.—Vancouver Island.
PART VI.—North-eastern British Columbia, including the Cariboo and Hobson Creek Areas.
PART VII.—North-western British Columbia.

By kind permission of Professor H. C. Gunning, Department of Geology, University of British Columbia, his compilation of the geology of British Columbia has been followed in the generalized geology represented on the map accompanying Part I. Professor Gunning's map was published in "The Miner," Vancouver, B.C., June–July, 1943, and in "The Northern Miner," Toronto, Ont., December 16th, 1943.

CONTENTS.

SOUTH-EASTERN BRITISH COLUMBIA.

INTRODUCTION.

South-eastern British Columbia for the purpose of this publication consists of the whole of Golden, Revelstoke, Lardeau, Slocan, Ainsworth, Fort Steele, and Nelson Mining Divisions, and of Trail Creek Mining Division except for a small area east of Paulson which is treated in Part III.—Central Southern British Columbia.

In the period from 1900 to 1943, inclusive, South-eastern British Columbia is credited with a total recovery of 3,860,000 oz. of gold from lode deposits out of a total of 11,323,000 oz. for the Province. Trail Creek Mining Division produced 2,603,900 oz., of which more than 98 per cent. came from mines in the Rossland camp, which also produced important quantities of silver and copper. The adjoining Nelson Mining Division is credited with a recovery of 1,220,000 oz. of gold, more than 99 per cent. of which was from ore valued primarily for its gold content.

Production of gold from lode deposits of other mining divisions in South-eastern British Columbia amounted to less than 38,000 oz., of which slightly more than half came from Lardeau Mining Division. Deposits valued principally for their gold content have been mined in Lardeau and Slocan Mining Divisions, but a considerable part of the lode gold from these mining divisions and most of the lode gold from the Golden and Fort Steele Mining Divisions was recovered as a by-product in the mining of silver-lead-zinc ores.

The following notes are based on studies of various publications, principally those of the British Columbia Department of Mines and of the Geological Survey of Canada. Some general information for each mining division is given under the name of the division. For several mining divisions notes regarding lode-gold camps within the division follow the general information. The figures after the name of a camp indicate the latitude and longitude of the south-eastern corner of the one-degree quadrilateral, and the letters indicate the quadrant of the quadrilateral in which the camp lies. At the end of each section a list of references is given. Those interested in a particular area would be well advised to consult the Annual Reports of the Minister of Mines for information about properties, and to study the maps and reports dealing with the area.

TRAIL CREEK MINING DIVISION.

INTRODUCTION.

The mines centring in the city of Rossland have produced almost 99 per cent. of the total gold production of the Trail Creek Mining Division. The Rossland camp, from an area about 1 mile long and ½ mile wide, has produced more than 2,900,000 oz. of gold and substantial quantities of silver and copper, much more gold than has been produced by any other camp in the Province.

The other camps of the Trail Creek Mining Division—O.K. Mountain, 1½ miles south-west of Rossland; the Velvet-Portland, 6 miles south-west of Rossland; and near Paulson, 12 miles north-west of Rossland—were all discovered in the '90's and have yielded about 50,000 oz. of gold since that time

Gold-bearing veins east of Paulson in the Trail Creek Mining Division and deposits in the Burnt Basin camp, west of Paulson, in the Greenwood Mining Division, are the subject of a note in Part III.—Central Southern British Columbia.

ROSSLAND CAMP (49° 117° S.W.).

History.—The discovery of the lead-silver ores of Ainsworth on Kootenay Lake in 1883 and of the silver-copper lode of the *Silver King* near Nelson in 1886 attracted prospectors to the West Kootenay area and by the early '90's the gold lodes of the Rossland camp had been discovered and staked. It was not until the completion of rail communications with Trail and Spokane in 1895 and 1896, however, that major operations at Rossland commenced. By 1902 that camp attained its peak production of 126,000 oz. of gold, 373,000 oz. of silver, and 11,667 lb. of copper from about 330,000 tons of ore. From that time till 1916 the annual production of gold remained between 94,000 and 145,000 oz. After 1917, shortages in supplies and then decline in ore reserves brought about a very marked drop in annual output, which by 1923 had fallen to less than 7,000 oz. of gold. All but a small part of the ore was smelted directly, most of it at Trail, although for a few years some ore was smelted at Northport, Washington. In 1924 the Consolidated Mining and Smelting Company, which by that time had assumed control of all of the larger mines, attempted concentrating the ores before smelting, but the experiment was not continued. Mining ore at a reduced rate and exploration continued till about 1928. In the early '30's the Consolidated Mining and Smelting Company leased parts of its holdings to individuals or groups of miners and this move, coupled with the rise in the price of gold, led to an increase in production to over 25,000 oz. of gold in 1934, obtained from ore in surface exposures, in the upper workings of the old mines, and in the old dumps. This ore was smelted in one of the lead-furnaces at Trail, some of it after successful concentration in the company's mill. In the late '30's all the lead-furnaces were required for lead-smelting; the Rossland production had therefore to be reduced, and from 1936 to 1939 averaged about 9,000 oz. of gold annually.

Economic Geology.—The oldest rocks of the Rossland camp are sediments and pyroclastics of Palæozoic age. These have been extensively intruded by sills of dark grey to greenish-black augite porphyry, by granodiorite with offshoots of diorite porphyry, and by an irregular mass of monzonite. The gold ores, which contain subordinate values in copper and silver, occur in replacement veins along fissures or shears, cutting the intrusive rocks and having a general easterly strike and a high northward dip. Smaller amounts of gold ore occur in fractures meeting these veins at high angles. The main veins are, in general, confined to the brittle competent intrusive rocks. Shears in the incompetent sediments and schistose rocks were apparently unfavourable for the deposition of ores. The veins generally follow the contacts between the augite porphyry and any one of the other intrusive rocks. Some of the veins are very persistent, extending for as much as 4,000 feet along the strike and mining has been carried on down their dips to more than 1,500 feet below the surface. They are, however, commonly offset by faults, some of which are occupied by later lamprophyre dykes. The vein-widths vary from a few inches to a maximum of 130 feet. Within the veins there are ore-shoots from 50 to over 500 feet long, from a few feet to 130 feet wide, and as much as 750 feet in pitch length. These shoots pitch steeply, either to the east or west. Some are developed along the foot-walls of cross-cutting dykes, others along the intersections with mineralized cross-fractures. Some wall-rocks, notably the more sodic diorite, were apparently more favourable for replacement than others, and in these the ore-bodies are wider and richer than elsewhere. Mineralization consists of pyrrhotite and chalcopyrite with smaller amounts of pyrite, arsenopyrite, and molybdenite in a gangue of altered wall-rock and quartz. In the southern part of the camp galena and sphalerite are present in significant amounts. In places the ores may be almost solid sulphide, elsewhere rich gold ore may be nearly barren of sulphides. Wall-rock alteration includes the development of aggregates and grains of quartz, together with biotite, hornblende, and, less commonly, pyroxene. Surface oxidation does not continue to depths of more than a few feet, except along major fissures.

O.K. MOUNTAIN (49° 117° S.W.).

The gold ores of O.K. Mountain, 1½ miles south-west of Rossland, occur in quartz-filled fractures cutting altered basic and andesitic volcanics overlying a body of serpentine. All the gold production has been from veins not more than 1,000 feet from the serpentine. The veins, which are up to 2 feet wide, strike easterly and dip at moderate to steep angles southward towards the serpentine. At the serpentine contact, however, they invariably die out. Ore-shoots consist of parts of the veins which are richer, but not necessarily wider, than elsewhere, and in some cases ore-shoots occur where veins and cross-fractures intersect. The veins are composed of quartz with minor amounts of pyrite, chalcopyrite, and galena. Production to 1943 amounted to 30,000 oz. of gold, mainly from the *I.X.L.* and *Midnight* mines, from a little more than 8,000 tons of ore.

VELVET-PORTLAND (49° 117° S.W.).

The gold ores of the *Velvet-Portland* mine, 6 miles south-west of Rossland, occur in northerly-trending replacement veins dipping steeply to the west and cutting altered volcanics. Ore-shoots occur at the intersections of the veins with crosscutting dykes or faults. Mineralization includes copper and iron sulphides, and molybdenite in a gangue of altered wall-rock and quartz. Production to 1943 has amounted to 17,000 oz. of gold from about 58,000 tons of ore.

MISCELLANEOUS.

Outside of the above-mentioned camps, gold production from the Trail Creek Mining Division has been negligible. A few ounces of gold have been produced from the *Mighty Midas* property at Violin Lake, 6 miles south-east of Rossland, and a few ounces have been recovered as a by-product of copper and silver production from the *Mountain Chief* mine near Renata on Arrow Lake.

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Annual Reports of the Minister of Mines, B.C.

NELSON MINING DIVISION.

History.—During the latter part of the last century placer gold was recovered from several streams in the Nelson Mining Division. In 1886 the *Silver King* mine, a silver-copper lode deposit situated a few miles south of Nelson, was staked. The construction of the Nelson and Fort Shepherd Railway in 1893 made the area more accessible, and when the boom in the near-by Rossland camp had subsided intensive prospecting for lode deposits was carried on. In the period from 1896 to the turn of the century most of the deposits which became the larger gold producers were discovered. From 1890 to 1916 mining yielded a total of about 350,000 oz. of gold. At that time much of the gold was recovered by amalgamation, and difficulties were encountered once the oxidized ores of the upper parts of the veins were exhausted; a large number of the veins that were again to prove profitable were then abandoned. During the First Great War many of the mines were closed because of rising costs. For the following ten years there was little gold-mining activity, except at a few properties from which siliceous ores, desired as flux, were shipped to the smelter at Trail at favourable treatment rates. Interest in lode-gold mining increased from 1926 onward and from 1932 to 1938 production grew steadily, reaching a total of 332,000 tons, yielding almost 125,000 oz. of gold in 1938. Approaching exhaustion of some of the deposits brought a reduction of output in 1939 and the difficulties of operating under war conditions have reduced the output still further. A feature of the revival of lode-gold mining was a general improvement in milling, the mills being of larger average capacity than in the earlier period, having superior grinding equipment, and using cyanidation or cyanidation with flotation instead of cyanidation as an adjunct of amalgamation. In this revival Sheep Creek, Ymir, and Erie Creek again became important lode-gold camps, and production was begun at the *Bayonne* and *Alpine* properties in sections from which there had not previously been important production.

Economic Geology.—In the Nelson Mining Division gold mineralization is more widespread than in any other part of the Kootenays. An area 10 to 20 miles wide, extending from the Kootenay River at Nelson southward for about 40 miles to the International Boundary, contains between 100 and 150 deposits from which gold has been produced. Virtually all this production has been from quartz veins of varying habits and relationships. Within the area, however, there are several clusters or concentrations of gold deposits, in each of which the gold deposits show certain similarities to one another. General descriptions of the deposits in these different clusters are given below. The Ymir and Sheep Creek camps have been the most productive and are described first. Available information concerning some of the other camps and deposits is, in general, less complete.

YMIR CAMP (49° 117° S.E.).

The greater part of the gold production of the Ymir camp has been from quartz veins in a northerly-trending belt east of the Salmo River near the western contact of a part of the Nelson batholith. The rocks in which the veins occur are steeply dipping schistose sediments, having a general strike of a few degrees east of north, and cut by sills of granodiorite, offshoots of the larger mass to the east. The veins occupy north-westward-dipping fault-fissures which strike from north 60° east to east diagonally across the sediments and sills. Faults striking from a few degrees east of north to north-east, generally parallel to the schistosity, cut or terminate the veins, and may be occupied by mineralized veins which so far have not been productive. Within the productive diagonal veins individual ore-shoots tend to follow the intersections of the vein fractures with sills. In addition the ore-zone, or zone of ore-shoots, pitches steeply to the east. Mineralization consists of galena, with which the gold is in many cases associated, pyrite, sphalerite, and in some cases pyrrhotite, in a gangue of quartz. To 1943, veins of this type in the *Ymir, Goodenough, Yankee Girl, Dundee,* and *Centre Star* (*Wesko*) mines have yielded more than 250,000 oz. of gold from about 840,000 tons mined.

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SHEEP CREEK CAMP (49° 117° S.E.).

Gold production from the Sheep Creek camp has been almost exclusively from quartz veins cutting a dominantly quartzitic part of a succession of sedimentary rocks striking north-north-east across the upper part of Sheep Creek. A few miles to the south, west, and north-west, stocks or cupolas of the Nelson batholith, cutting the sediments, are exposed at the surface. The quartz veins occupy fault-fissures which strike north of east diagonally across the bedded rocks. In this camp the veins are vertical or dip steeply southward. In general, ore is found in important quantity only where the veins cut brittle quartzites. Ore-shoots, therefore, tend to follow the intersections of the veins with particularly favourable beds. The productive parts of veins are found cutting dark quartzites, mapped as the Reno formation, and in the upper part of the Quartzite Range formation which consists of white quartzite. The veins, where mined, rarely exceed 5 feet in width and average slightly less than 2 feet wide. In places they branch and two sub-parallel fractures may then contain ore. Ore-shoots range up to several hundred feet in length. The veins have been productive within a comparatively restricted vertical range, between 5,000 and 6,000 feet above sea-level at the northern end of the camp and between 2,500 and 4,000 feet at the southern end. As in the Ymir camp, the veins are mineralized with pyrite, pyrrhotite, galena, and sphalerite, but the average sulphide content is less. Gold is usually associated with the pyrite but, in general, gold values also accompany the sphalerite and galena. Chalcopyrite, bornite, and tungsten minerals are present in some ore-shoots. Production to 1943 from these veins has been 678,220 oz. from slightly over 1,500,000 tons of ore.

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NELSON AREA (49° 117° S.E.).

Within a radius of 8 miles south and west of Nelson there are many gold-bearing veins. Most of this area is underlain by volcanic rocks, now altered to greenstones and chlorite schists, intruded, especially in the northern part, by a number of granitic tongues and satellites of the Nelson batholith. The gold occurs either in quartz-filled fissure veins with more or less clearly defined walls or in shear-zones where the mineralization extends into the walls for some distance from the quartz veins. Veins occur both in the volcanics and in the granitic rocks. In the former they may cut across or conform with the planes of bedding or schistosity of the enclosing rocks. The attitudes of the veins vary widely. Even in a single vein the attitude is not constant, indeed, where it crosses a contact from one type of rock to another the strike and dip may change abruptly, as at the *Athabasca* mine where the vein passes from granite to chlorite schist. Many normal faults, some occupied by lamprophyre dykes, cut the veins and add difficulties to their development. The veins range in width from a few inches to almost 8 feet but are generally narrow. In general only the wider veins constitute ore but in some cases veins as narrow as 1 foot have been mined. In few cases has there been sufficient development and study to determine the structures localizing the ore-shoots. In addition to quartz and gold the mineralization includes pyrite, galena, sphalerite, chalcopyrite, as well as rarer sulphantimonides and oxidized ore minerals. The gold production of the camp, mainly from the *Granite-Poorman* and *Athabasca* mines, has totalled over 75,000 oz. from 175,000 tons mined up to 1942.

This has been represented on the map accompanying Part I. by two symbols—one centring on Toad Mountain, the other on Hall Creek.

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DOMINION MOUNTAIN (49° 117° S.E.).

Another group of properties occurs on Dominion Mountain, 7 miles north-west of Ymir, those of its western slope being accessible by way of Erie Creek and those of its eastern slope by way of Barrett Creek. All but one of these properties lie within a belt of volcanic rocks, now greenstones and green schists, containing minor amounts of intercalated sediments. Within 2 miles to the north-west and west of this area of volcanics is a large body of granitic rock, another part of the Nelson batholith. The most important gold-bearing quartz veins, those of the *Second Relief* and *Porto Rico* mines, strike north-easterly and dip north-westward at moderate to high angles. In both mines the main veins, for considerable parts of their lengths, follow the walls of dykes—in the former a dyke of diorite porphyry and in the latter of lamprophyre. The influence of wall-rocks is important. Where the veins follow the dykes through brittle greenstones they are wider or richer than in less competent volcanics or the slates. The widths of the veins vary from a few inches to almost 15 feet, but where mined average about 2 feet. Almost the full length of the *Second Relief* vein, over 1,000 feet, has been mineable. Mineralization includes pyrite, pyrrhotite, chalcopyrite, and gold. Production from this area, mainly from the *Second Relief* mine, has exceeded 103,000 oz. of gold from slightly less than 250,000 tons of ore mined.

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KEYSTONE (MINERAL) MOUNTAIN (49° 117° S.E.).

On Keystone (Mineral) Mountain, about 3 miles north of the town of Salmo, several gold-producing properties, notably the *Arlington, Keystone,* and *Clubine-Comstock* mines, are situated in the southward continuation of the belt of volcanics of the Nelson and Dominion Mountain areas. In this locality there is a considerable proportion of sediments associated with the volcanic rocks. A large granodiorite intrusive extends eastward from the eastern slopes of Keystone Mountain. The gold occurs in quartz veins occupying fissures or shears in the sediments and volcanics. The productive veins of this area have diverse strikes but all have low dips. The most important vein follows a granite sill, another productive vein follows the foot-wall of a lamprophyre dyke. Mineralization consists of quartz, pyrite, gold, some galena and sphalerite, and occasionally chalcopyrite. Production, mainly from the *Arlington* mine, has amounted to over 53,000 oz. of gold from 29,000 tons of ore mined. Most of this ore has been mined selectively and shipped to Trail to be smelted.

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BAYONNE AREA (49° 116° S.W.).

The gold deposits of the Bayonne area, which lies from 5 to 7 miles east of the Sheep Creek camp, occur within two granodiorite or quartz-diorite stocks. The gold occurs in quartz veins which have a north-easterly to easterly strike and high dips to the south. Vein-widths rarely exceed 3 feet. Mineralization consists of quartz with pyrite, galena and sphalerite. Lenses of almost pure galena occurring within the veins carry moderate values in silver but very little gold. Production, mainly from the *Bayonne* mine, has amounted to over 40,000 oz. of gold from about 84,000 tons of ore mined.

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SITKUM CREEK AREA (49° 117° N.E.).

At the head of Sitkum Creek, 13 miles north of Nelson, there are a number of gold prospects of which one, the *Alpine*, came into production within the last five years. Gold from this deposit occurs in a quartz vein striking east-north-east, dipping at low angles to the north and cutting granite of the Nelson batholith. The vein is lenticular, ranging in width up to at least 7 feet. Mineralization includes pyrite and a small amount of galena and sphalerite. Production has amounted to about 10,000 oz. of gold from 20,000 tons of ore mined.

REFERENCE.

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MISCELLANEOUS DEPOSITS (49° 117° S.E.).

In recent years very minor amounts of gold ore have been shipped from properties in the western and southern parts of the Salmo area. Of those near the upper part of Beaver Creek and west of the Salmo River there is little information available. About 100 oz. of gold have been produced from the Rosebud Lake area, east of Salmo River, from quartz veins following shears in schists, argillites, and limestones.

Several thousand ounces of gold have been produced at the *Durango* (*Howard*) mine, 5 miles south-east of Ymir, from a northerly-striking replacement fissure-vein cutting quartzites and granite, and containing pyrrhotite, pyrite, sphalerite, galena, and quartz.

A small amount of gold has been produced from granitic areas not treated elsewhere, notably from the area a few miles north-east of Ymir on Ymir Creek. The gold in these deposits occurs in quartz veins of various attitudes mineralized with pyrite, pyrrhotite, galena, and sphalerite. Total production from these sources has amounted to about 9,000 oz. from about 19,000 tons of ore mined. On the map accompanying Part I. nearly all this production is included with the Ymir camp.

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CONTACT METAMORPHIC DEPOSITS.

A small number of contact metamorphic deposits in limestones exist throughout the Nelson Mining Division. In the majority of these lead and zinc contribute the principal value of the ore and gold is of minor importance. From these deposits slightly more than 1,000 oz. of gold have been produced as a by-product of the mining of over 100,000 tons of ore.

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SLOCAN MINING DIVISION.

The Slocan Mining Division now includes the areas formerly known as Slocan, Slocan City, and Arrow Lakes Mining Divisions.

History.—Prospecting in the Slocan area began with the discovery of the lead-zinc lodes of Payne Mountain in 1891. The search for more lodes was rapidly extended and in 1893 the gold deposits of Lemon and Springer Creeks were discovered. The silver-gold deposits of Carpenter Creek were located at about this same time. From 1895 on, a small gold production has been maintained, a considerable part of it as a by-product of lead, zinc, and silver mining.

LEMON CREEK-SPRINGER CREEK AREA (49° 117° N.E.).

In the south-eastern part of the Slocan Mining Division, a few miles from Slocan City, in the drainage basins of Lemon and Springer Creeks, gold-bearing quartz veins cut granite of the Nelson batholith. These veins have widely varying strikes, many of them have low dips, and their widths range from a few inches to about 4 feet. In many cases they are interrupted by post-vein faults. The mineralization includes pyrite, pyrrhotite, chalcopyrite, arsenopyrite, galena, sphalerite, tetrahedrite, and, in some cases, native silver and silver sulphantimonides. The gold is generally associated with pyrite or arsenopyrite in rusty or rose-coloured quartz. In the southern part of the area and at the head of Sitkum Creek in the adjacent Nelson Mining Division gold values average about 0.4 oz. per ton. On the northern side of Springer Creek silver values predominate and gold is generally a by-product. The production from this area between 1895 and 1943 amounted to about 2,750 oz. of gold.

AYLWIN CREEK AREA (49° 117° N.E.).

Gold deposits, notably the *L.H.* and *Little Daisy,* similar in character to those of the Slocan City area are found in a small roof pendant area near Aylwin Creek, north of Enterprise Creek. Between 1904 and 1943, 250 tons of ore mined from these deposits yielded about 200 oz. of gold.

CARPENTER CREEK AREA (49° 117° N.E., 50° 117° S.E.).

In the part of the Slocan silver-lead-zinc camp near New Denver and Three Forks several deposits contain values in both silver and gold. These deposits consist of veins of quartz with some calcite and siderite cutting either a granitic stock situated north-east of New Denver, or sediments. The veins vary widely in the attitude, range from a few inches to about 4 feet in thickness, and are mineralized with pyrite, galena, sphalerite, and silver minerals. Production, mainly from the *Molly Hughes* and the *Monitor* and *Ajax* mines, since 1896 has amounted to about 2,000 oz. of gold from about 9,000 tons mined.

Other production from the Slocan silver-lead-zinc camp has amounted to about 2,000 oz. of gold as a by-product of the mining of lodes whose values are essentially in lead, silver, and zinc.

ARROW LAKES AREA (50° 117° S.W., 50° 118° S.E.).

A total of 357 oz. of gold has been recovered from the Arrow Lakes area, from the *Millie Mack* and *Chieftain* properties on Caribou Creek, east of Burton, and from the *Paladora* mine near the head of Fire Valley, west of the Arrow Lakes. Very little information is available on these properties.

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AINSWORTH MINING DIVISION (50° 117°).

Only two localities in the Ainsworth Mining Division have produced gold, except as a by-product of silver-lead-zinc mining. Near the head of Woodbury Creek, north-west of Ainsworth, quartz veins yielded about 250 oz. of gold in the period from 1898 to 1906. The veins cut the Nelson batholith and contain pyrite, galena, and sphalerite. Difficulties in transportation evidently led to the abandonment of these properties. The *Highland Surprise* mine, near the head of Lyle Creek, has produced in the period from 1938 to 1941 more than 1,500 oz. of gold from north-westerly-striking, steeply dipping vein-zones cutting schistose volcanics adjacent to a serpentine body. The veins are composed of quartz with pyrite, chalcopyrite, and small amounts of galena and sphalerite. High-grade shoots may occur along the intersections of the vein-zones with cross-fractures. Since 1893 lead and zinc mines on upper Kaslo Creek have produced almost 1,500 oz. of gold as a by-product.

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Annual Reports of the Minister of Mines, B.C.

LARDEAU MINING DIVISION (50° 117° N.).

Although some prospecting was carried out in the Lardeau area as early as 1865, it was not until the early '90's, after the subsidence of the gold-rushes to French and McCulloch Creeks, 100 miles farther north, that a careful study of this area was made. Attention was first focused on the area north-east of Trout Lake and soon led to the discovery of the lead-silver-gold deposits of Silver Cup Mountain and Ferguson. In 1899 the gold ores of Camborne were discovered and a rush followed. By 1904 several properties in this area came into production, but the operations were unsuccessful and in 1909 all were closed down. Since then, however, two properties in the Camborne area have been worked and more than 9,000 oz. of gold extracted. During the past fifty years intermittent operations at several properties in the Ferguson-Silver Cup Mountain area yielded more than 6,000 oz. of gold, in addition to silver, lead, and zinc. Rich pockets of gold were found in the vicinity of Poplar Creek in 1903, but the deposits proved to be very small and a very minor production resulted.

Economic Geology.—Virtually all the lode-gold production of the Lardeau area has come from the so-called Central Mineral Belt—about 45 miles long and rarely over 2 miles wide, extending north-westerly from Poplar Creek to the Incomappleux River along the strike of folded sediments. Within this belt the gold production has come principally from two areas—one in the vicinity of Camborne, the other on Silver Cup Mountain. Some of this gold has been produced as a by-product of silver and lead mining.

The gold deposits of the Camborne area occur in fissure-veins and lodes, usually having south-westerly strikes and steep dips, cutting argillaceous and graphitic schists and carbonatized greenstone dykes. In some cases some replacement and mineralization has taken place in the vein-walls. The veins may be very persistent, with widths varying from a few inches to about 20 feet. Ore-shoots are in some cases localized at intersections with cross-veins. Mineralization consists of pyrite, galena, and sphalerite in a gangue of quartz with some ankerite and siderite. Production has amounted to 18,254 oz. of gold from 100,804 tons mined.

As in the Camborne area, the gold of Silver Cup Mountain and Ferguson occurs in quartz fissure-veins and lodes of varying strikes and dips, cutting argillaceous and graphitic sediments and carbonatized greenstone dykes. Some wall-rock replacement has been noted. Mineralization includes galena and sphalerite, tetrahedrite, and some chalcopyrite with the main values in silver and lead. Production has amounted to 7,224 oz. of gold from 46,489 tons mined.

The gold in the Poplar Creek area occurs in quartz veins cutting argillaceous and graphitic schists and carbonatized greenstone dykes. Mineralization includes pyrite, arsenopyrite, some galena, sphalerite, and chalcopyrite. High-grade pockets are said to occur at some vein intersections. Production has amounted to less than 100 oz. of gold.

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REVELSTOKE MINING DIVISION (51° 117°, 51° 118°).

Lode-gold production of the Revelstoke Mining Division has amounted to about 20 oz., all of it a by-product of the mining of lead and silver. On the upper part of McCulloch Creek, the scene of a placer-gold rush in 1865, several gold-bearing quartz veins were staked, including the *Ole Bull* and *Orphan Boy* claims. Several other gold prospects on the western slope of the Selkirk Mountains have also been staked, but in no case has any gold production been recorded.

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GOLDEN MINING DIVISION (50° 116°, 51° 117°).

Lode gold produced in the Golden Mining Division up to 1943 has amounted to about 140 oz., all as a by-product of the mining of lead and silver. In a few prospects in the upper Spillimacheen area gold values are sufficiently high to attract interest, but these lie in relatively inaccessible parts of the Purcell Mountains.

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FORT STEELE MINING DIVISION (49° 115°, 49° 116°).

The recorded production of gold between 1907 and 1940 from lode deposits in the Fort Steele Mining Division amounted to about 2,500 oz., of which 80 per cent. was a by-product of the zinc and lead recovery from the tailings of the *St. Eugene* mine at Moyie. The remaining production has been from quartz veins cutting argillites and quartzites and containing pyrite, chalcopyrite, galena, and sphalerite in several localities in the mining division.

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PROSPECTING POSSIBILITIES.

In a summary of the lode-gold prospecting possibilities of South-eastern British Columbia several points should be made clear. The gold production to date has been almost entirely from areas in which ore deposits were exposed at the surface. With a few important exceptions the deposits were discovered during the intensive prospecting at the end of the last century. In these areas, therefore, it is probable that most of the surface showings have been thoroughly examined several times during the past fifty years. Moreover, in these camps much of the ground is still held either by location or by Crown grant, but some claims have reverted to the Crown. The increased price for gold, improvements in mining and milling techniques, and skilful search for ore have given some properties, once abandoned, a new lease of life. Careful study of the ground and of available information, followed by drilling or other exploratory work, beyond the capacity of the individual prospector, may well lead to the discovery of hidden ore-bodies.

In parts of the Ainsworth and Slocan Mining Divisions and in some other areas numerous silver-lead-zinc ore deposits have been found, indicating that these sections have been prospected carefully. Gold contributes small but appreciable values to silver-lead-zinc deposits in parts of the Slocan-Ainsworth area. On the outskirts of the silver-lead-zinc areas, generally in or approaching granitic bodies, deposits essentially barren of lead-zinc values carry important values in gold. It may be that prospecting in or near these or similar sections will reveal the presence of other lode-gold deposits.

Prospecting over much of the East Kootenay area, especially in the Golden Mining Division, has disclosed silver, lead, and zinc deposits, but gold is scarce or absent.

Areas between the gold-producing camps of the Nelson, Slocan, and Trail Creek Mining Divisions may be geologically favourable and have not been as intensively prospected as the camps themselves. Such areas can, therefore, be recommended for gold-prospecting. The prospector in his search should pay special attention to the structures and host-rocks which have proved favourable in the near-by productive camps.

More remote areas, principally in the Revelstoke, Slocan, Golden, and Fort Steele Mining Divisions, which have not been prospected closely may be favourable for the occurrence of lode-gold deposits. Areas recently made more readily accessible by construction of roads, such as the Big Bend Highway and the road to the *Bayonne* mine, should be considered. However, except in the vicinity of Fort Steele, neither placer nor lode gold has been found in the area east of the Rocky Mountain trench, and this area cannot be recommended to individuals prospecting for lode-gold deposits.

The presence of placer gold suggests the possibility of lode-gold sources. Although placer gold has been known in certain areas for a very long time, the fact that economic lode-gold sources have not been discovered does not entirely eliminate the possibility that lode-gold sources might still be found. Areas near the sources of placer-bearing creeks may, therefore, be worthy of prospecting. Most of the placer gold from Revelstoke Mining Division has been recovered from French Creek and McCulloch Creek; some placer gold has also been recovered from Camp Creek. The three creeks are southerly-flowing tributaries of Goldstream. Some placer gold has been recovered from the east side of Columbia River, up-river from Goldstream. Some lode-gold prospects have been located in the area drained by the streams mentioned. Downie Creek and Carnes Creek in the Revelstoke Mining Division also yielded some placer gold. Completion of the Big Bend Highway has made this area more accessible and therefore more attractive for prospecting.

Placer gold has been recovered near Whatshan Lake in Slocan Mining Division, from Quartz and Ptarmigan Creeks in Golden Mining Division, and in Fort Steele Mining Division from Wildhorse Creek and west of Cranbrook between St. Mary and Moyie Rivers from tributaries of both rivers. Placer gold recovered in small quantity from other streams generally can be attributed to areas known to contain lode-gold deposits.

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HON. E. C. CARSON, *Minister* JOHN F. WALKER, *Deputy Minister*

BULLETIN No. 20—PART III.

LODE-GOLD DEPOSITS

Central Southern British Columbia

by

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PREFACE.

Bulletin 20, designed for the use of those interested in the discovery of gold-bearing lode deposits, is being published as a series of separate parts. Part I. is to contain information about lode-gold production in British Columbia as a whole, and will be accompanied by a map on which the generalized geology of the Province is represented. The approximate total production of each lode-gold mining centre, exclusive of by-product gold, is also indicated on the map. Each of the other parts deals with a major subdivision of the Province, giving information about the geology, gold-bearing lode deposits, and lode-gold production of areas within the particular subdivision. In all, seven parts are proposed:—

PART I.—General *re* Lode-gold Production in British Columbia.
PART II.—South-eastern British Columbia.
PART III.—Central Southern British Columbia.
PART IV.—South-western British Columbia, exclusive of Vancouver Island.
PART V.—Vancouver Island.
PART VI.—North-eastern British Columbia, including the Cariboo and Hobson Creek Areas.
PART VII.—North-western British Columbia.

By kind permission of Professor H. C. Gunning, Department of Geology, University of British Columbia, his compilation of the geology of British Columbia has been followed in the generalized geology represented on the map accompanying Part I. Professor Gunning's map was published in "The Miner," Vancouver, B.C., June–July, 1943, and in "The Northern Miner," Toronto, Ont., December 16th, 1943.

CONTENTS.

CENTRAL SOUTHERN BRITISH COLUMBIA.

INTRODUCTION.

As outlined in this publication Central Southern British Columbia includes Vernon, Nicola, Similkameen, Osoyoos, and Greenwood Mining Divisions, and part of Kamloops Mining Division. It also includes a small part of Trail Creek Mining Division which lies within the Paulson camp.

The lode deposits of Central Southern British Columbia have produced 2,320,000 oz. of gold. Of this total more than 1,000,000 oz. came from the gold deposits at Hedley which, in addition, have yielded some silver, copper, and arsenic. The copper mines of the Boundary camp and of Copper Mountain have yielded, roughly, 1,000,000 oz. from deposits which have been mined primarily for their copper content, although the precious metal content added materially to the value of the ore. The remainder of the lode-gold production has been recovered from several dozens of deposits of which the most productive, the *Cariboo-Amelia* at Camp McKinney, yielded about 70,000 oz. Most of the smaller deposits were mined primarily for their gold content, but in some the gold contributed only a small or moderate part of the total value.

This bulletin deals mainly with mineral deposits in which the chief value is in gold, although not all of those mentioned could be mined for their gold content alone. The large low-grade copper deposits are excluded because the gold recovered, though large in total amount, was only a by-product in the mining of copper. The development of the copper deposits in the Boundary district, however, aided gold production from other properties.

For some years following discovery of copper at Phoenix and Deadwood in the '90's that section of the country received much development. Smelters were built at Grand Forks and Greenwood and were in operation between 1900 and 1919 and a third smelter at Boundary Falls treated a smaller amount of ore between 1900 and 1910. These smelters were in need of certain ores in addition to those from the copper mines to serve as fluxes and in part to furnish sulphur, and a preferential treatment rate was accorded them. As a consequence of low treatment and transportation costs a number of near-by properties were able to ship ore that was distinctly low in grade.

At the present time a preferential treatment rate is accorded siliceous ores by the Trail smelter, a fact which has enabled many low-grade quartz veins to be mined. There are now no copper-smelting facilities in the Province and copper ores are exported for treatment to the Tacoma smelter. Ores rich in arsenic also go to Tacoma.

In 1933 the increase in the price of gold and the favourable rate offered for the treatment of siliceous ores greatly stimulated activity in the old camps. Between that date and the start of the war most old properties were re-examined, some were revived, and a few already in operation increased their rate of output. Many old properties were leased by individuals and by small syndicates and were worked in a small way. Parts of the abandoned copper ore-bodies at Phoenix which contained relatively high values in gold were mined selectively and were milled at Greenwood. This thorough re-examination of old properties was accompanied by some prospecting in and about the old camps, and prospecting activity in the region at large became greater than it had for years past.

Central Southern British Columbia, in comparison with other parts of the Province, is well provided with transportation facilities. The region is crossed by railways and highways and by numerous secondary roads and trails, with the result that transportation costs for mining and prospecting are, in general, relatively low. On the other hand, this ease of access has permitted many parts of the region to be carefully examined and it is unlikely that large areas of wholly unprospected country remain.

Placer gold has been found at many points, chiefly in Kettle, Okanagan, Similkameen, Tulameen, and Thompson Rivers, and in McRae, Pass, Fourth of July, Boundary, Rock, Jolly, McKinney, Cherry, Siwash, Mission, Harris, Hedley (Twenty Mile), Hefley, Hobson, Tranquille, Eakin, Louis, and Scotch Creeks. Placer deposits are formed by the concentration of gold released by weathering from gold-bearing rocks, and the presence of a placer deposit suggests, but by no means proves, that gold-bearing deposits exist somewhere near-by. It is likely that the placer gold of some streams was derived from many small gold-bearing veins too small and erratic to be mined. In other cases lode-gold deposits have been found which appear sufficient to account for the presence of the placer, but on other streams either no lode deposits have been found or those known are not commensurate in size with the placer deposits. The smallness of the amount of placer gold attributable to the major lode-gold deposits at Hedley may be accounted for by the facts that few of the ore-bodies reach the surface, and the gold contained in them is exceedingly fine-grained.

The areas in which placer deposits occur should be prospected, since gold-bearing deposits of some sort must have provided the gold. However, there is no certainty that if found the lode deposits would prove rich enough to be mined, and one should note that most of the placer-bearing streams found in this part of British Columbia were worked in the early sixties and the basins of many of them may well have been prospected for lode gold.

Prospecting possibilities may be considered under three main headings: (1) Within the old camps; (2) at the margins of old camps, on extensions of structures and rock-masses which have proved to be favourable; and (3) in the region at large.

The old camps were discovered and developed at a time of great activity many years ago and were for the most part thoroughly prospected. In 1933 and for a few succeeding years there was a second and, in some cases, a third or fourth wave of prospecting activity. Although most of the old camps have been well prospected, it cannot be said that all possibilities have been exhausted. In 1943 a new discovery was made in the Hedley camp which resulted in a sale, and further development on the showings is contemplated in 1945; this is in an area that probably had been staked many times before. One difficulty in the old camps is that much ground has been held for years by Crown grant, and there may be only small and scattered sections of open ground within the camp. One advantage is that, should a find be made, the geology is usually well enough known that the value of the find can readily be assessed and, if it is promising, disposal to some mining company is relatively simple. In a well-known camp proof of the extension of a favourable structure may lead to immediate diamond-drilling, whereas in a new area drilling is usually not undertaken until an actual mineral deposit has been found.

The margins of old camps are in much the same category, with the advantage, in one respect, of having more ground open to prospecting. Work in such places, if to be done to best advantage, must be based on a thorough knowledge of the camp itself.

Little positive information can be given regarding prospecting in parts of the region at some distance from the known mining camps and centres of mineralization. Much of the country has been geologically mapped on various scales by the Geological Survey of Canada, and study of these maps will enable the prospector to avoid many areas of little promise. In general, it has been found that lode-gold deposits do not occur in the Tertiary volcanic and sedimentary rocks and that little mineralization of consequence occurs in a vast area of metamorphic and igneous rocks, known as the Shuswap complex, lying mainly east of the Okanagan Valley and in the vicinity of Shuswap Lake. The centres of the larger areas of granitic rocks have not proved favourable, except where roof-pendants occur. The outer parts of intrusives, on the other hand, have been found favourable to the occurrence of deposits. Search can be largely restricted to areas of pre-Tertiary volcanic and sedimentary rocks and to the margins of intrusive bodies.

The following notes are based in large part on information contained in various publications, particularly those of the Geological Survey of Canada and of the British Columbia Department of Mines. Information concerning some properties is incomplete, either because they have long since been abandoned or because their workings have not been adequately described in published reports.

Each note deals with a particular camp or area in which lode deposits occur that are of interest primarily because of their gold content or because gold is an important by-product. The numbers following the name of a camp refer to the latitude and longitude of the south-east corner of the one-degree quadrilateral in which the camp lies, and the letters indicate the particular quadrant. The notes have been kept brief, and are designed to give the salient facts to one interested in prospecting in each area. The production figures are of net recoveries after deductions for treatment losses, and in no instance are assays of crude ore. The figures include all officially recorded production up to the end of 1943. For more detailed descriptions the reader is referred to the list of publications at the end of each section. A great deal of information contained in the Annual Reports of the Department of Mines of British Columbia could not be given specific mention.

PAULSON (49° 118° S.E.).

Paulson is a station on the Kettle Valley Railway, 19 miles north-east of Cascade. It can also be reached by a poor road which follows up the valley of McRae Creek for a distance of 9 miles from Christina Lake.

Veins on several properties east of Paulson, including the *Berlin* and *Alice L.* and the *Cascade-Bonanza* on the ridge between McRae and Big Sheep Creeks, have been mined at times in the last forty years. Production has amounted to 5,414 tons, yielding 1,408 oz. of gold, 8,633 oz. of silver, and 1,535 lb. of copper. Production from a replacement deposit at the *Molly Gibson* in Burnt Basin, 4½ miles south-west of Paulson, has totalled 316 tons, yielding 332 oz. of gold and a smaller amount of silver.

East of Paulson, greenstones, tuffs, and some sediments of the Rossland Volcanic group form an irregular, discontinuous, easterly-trending belt. The belt, varying from less than a mile to almost 5 miles in width, has been intruded by Nelson granite on the north and by Rossland alkali-granite and syenite on the south. Dykes which are generally porphyritic and dominantly syenitic are common.

The ore deposits east of Paulson consist of quartz veins and lenses containing sparse pyrite, galena, sphalerite, and chalcopyrite, in shear-zones cutting greenstones, limy greenstones, and some granitic rocks. The veins and lenses strike northward and in general dip at steep angles. Veins of commercial or almost commercial grade, accessible for sampling in 1936, ranged from several inches to a few feet in width. Most of the veins are short and commonly they are faulted.

West of Paulson in the vicinity of Burnt Basin the Rossland Volcanic group contains limestone and argillaceous sediments which have been highly altered. The mineralization in this area is of diverse character, and in most of the known deposits gold values are low. At the *Molly Gibson* gold occurs in silicified lenses containing pyrrhotite, and lesser amounts of chalcopyrite and pyrite, in a layer of highly altered limy sediment. This layer strikes northward and dips eastward in conformity with the regional attitude and is traceable for 2,100 feet. The total production of 316 tons has been obtained from several very small lenses.

In general, rock exposures in the Paulson area are good, though in some places the overburden is thick. A considerable number of claims in the district have been Crown granted. In several cases shear-zones east of Paulson containing mineralized quartz are marked at the surface of the ground by shallow draws.

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LOWER GRANBY RIVER (49° 118° S.E.).

This area, 2 to 12 miles north of Grand Forks and 1 to 2 miles on either side of the Granby River, is easily accessible. Roads connecting with the Southern Trans-Provincial Highway at Grand Forks lead up both sides of the river. The Kettle Valley Railway, passing through Grand Forks, runs northward for 8 miles along the western side of the Granby River Valley.

Discoveries were made in the vicinity of Lower Granby River during the middle '90's and some production was obtained before the turn of the century. During the past forty-five years shipments made from six properties total 7,159 tons, yielding 4,670 oz. of gold and 10,439 oz. of silver. Three of these properties have contributed some copper, and small amounts of lead and zinc have been recovered from the others.

The rocks, chiefly greenstones with some tuffs and several irregular bands of limestone, are cut by small masses of granodiorite and by many porphyry dykes. A body of syenite, about 7 square miles in area, lies to the east and another much larger body lies to the north of the area. Granodiorite forming part of an extensive granitic batholith lies to the north.

The copper-bearing deposits occur in silicified zones following fractures or bedding planes in limestone. Old reports indicate that there has been some secondary enrichment.

The other deposits are quartz veins occurring in greenstones and, in one case, in granodiorite. The mineralization consists mainly of pyrite, galena, sphalerite, and chalcopyrite. In addition to these minerals, tetrahedrite and argentite have been reported from the *Yankee Boy* on Hardy Mountain. The most productive vein in the area, the *Yankee Boy,* strikes eastward across greenstones and varies from a few inches to a few feet in width.

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FRANKLIN CAMP (49° 118° N.E.).

Franklin Camp is situated on Burrell Creek, a branch of the Granby River, 43 miles by road north of Grand Forks.

The first discoveries in Franklin Camp were made in 1896 and the first shipments of ore were made in 1913. During the period 1913–20 the *Union* mine produced 3,535 tons of high-grade silver-gold ore, but no shipments were made from the property during the next decade. The period of greatest activity was from 1930 to 1935, when a large tonnage of gold ore containing lesser values in silver was produced. The total production from the *Union* mine, with 500 tons from the *Homestake,* has amounted to 168,400 tons of ore, from which 55,097 oz. of gold, 1,337,962 oz. of silver, and relatively unimportant amounts of copper, lead, and zinc were recovered.

The oldest rocks in the area, greenstones, quartzites, and some limestone, are intruded on all sides by granodiorite which is part of an extensive batholith. These old rocks are also intruded by small, irregular bodies of syenite and are overlain in places by Tertiary sedimentary and volcanic rocks.

Franklin Camp, a quadrangle 4 miles square which has been mapped in detail (Drysdale, 1915), is underlain mainly by the pre-granitic rocks, and several smaller areas of similar rocks have been mapped to the south and west (McConnell and Brock, 1904). It is probable that other small bodies of these rocks are to be found in the surrounding region, which is shown by reconnaissance geological mapping to be underlain almost entirely by granitic rocks.

The *Union* deposit is an irregular, westerly-striking quartz vein following a brecciated zone in highly silicified greenstone. The mineralization includes pyrite, sphalerite, galena, chalcopyrite, hæmatite, and some ruby silver. Some relatively high-grade shoots containing abundant sulphides are found, but in general the sulphide content is low and the value of ore can be determined only by assay. A westerly-raking shoot containing relatively rich gold ore over a width of 1½ feet was reported to have a pitch length of 320 feet. Lower grade ore has been mined over considerably greater widths. Post-mineral faults are numerous and have made exploration and mining difficult.

Prospectors have been active at times in Franklin Camp and vicinity since the '90's. It should be pointed out that although the *Union* was one of the first claims to be located in the camp its worth was not at first recognized and it was allowed to lapse. Moreover, in spite of the fact that ore shipments began in 1913, it was not until 1930 that substantial production was obtained.

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JEWEL LAKE CAMP (49° 118° S.W.).

Jewel Lake camp, lying mainly on the south-eastern side of Jewel Lake, is 8 miles by road north-east of Greenwood and 4 miles by road west of Eholt. Greenwood and Eholt are on the Southern Trans-Provincial Highway and on the Kettle Valley Railway. A branch of the West Kootenay Power and Light Company, Limited, transmission-line reaches the camp.

Veins were discovered near Jewel Lake in 1895 and were being actively developed at the turn of the century. The camp lay idle from 1916 until 1926 and had a period of marked activity between 1933 and 1937.

The total production from the camp has amounted to 139,054 tons, yielding 39,392 oz. of gold, 243,037 oz. of silver, and some lead, zinc, and copper. Of this production 94 per cent. of the tonnage and 97 per cent. of the gold came from the *Jewel* vein. Before 1916 the vein was worked by Jewel-Denero Mines Company and from 1933 to 1937 by Dentonia Mines, Limited, who operated a 100-ton mill. Shipments by lessees have been made since 1938.

The rocks in the area are mainly highly altered micaceous quartzites, and greenstones, intruded by granodiorite. The quartzites, occurring in the northern part of the camp, strike north-westward and dip steeply to the north-east. The greenstones, occurring chiefly in one broad band, are intruded along a north-westerly-trending line by granodiorite which lies in the south-western part of the camp. This granodiorite extends 2 miles southward and represents an irregular, easterly-projecting lobe of a large batholith extending far to the north. The rocks are cut by many dykes, the most common variety of which is syenite porphyry.

Filled fissures, with walls which have been replaced locally, occur in the quartzites, greenstones, and granodiorite. The veins consist of quartz containing pyrite, galena, sphalerite, chalcopyrite, telluride, and free gold.

The *Jewel* vein cuts granodiorite in the south, quartzites in the north, and the intervening band of greenstones in the middle. Underground it strikes about north 20 degrees east on the average, ranging from north 10 degrees west to north 50 degrees east, and dips 30 to 60 degrees south-eastward. It has been traced on the surface for more than a mile and has been developed underground for a length of about 2,400 feet and to a maximum depth of 500 feet. The vein was about 3 feet wide in many mined sections. One stope had a maximum width of 16 feet, but 9-foot widths of quartz found in other parts of the vein were barren. On the average the vein was a little stronger in the granodiorite than in the greenstone.

The ore appears to occur in shoots containing relatively abundant sulphides. In general, galena is considered to be an indicator of good values. The greater widths of quartz, whether or not well mineralized, tend to occur in sections of the vein which strike more north-easterly than northerly. Apparently the ore-shoots pitched directly down the dip of the vein and tended to occur in its flatter sections.

A large part of the ore from the *Jewel* vein came from a section within greenstones where a great width of quartz may have been related both to a bend to the north-east and to a split in the vein-structure. Parts of the vein in granodiorite produced ore but most of the vein in the quartzites at the northern end of the workings did not prove to be mineable.

Shipments have been made from the *North Star–Gold Drop* vein, a sub-parallel vein east of the *Jewel*, and from the *Amandy* and *Rhoderic Dhu* on the western side of the lake.

Jewel Lake camp has been prospected during the past fifty years and most of the ground is now held by Crown grant. It is likely that all the surface showings have been carefully examined several times during this period. Large pieces of well-mineralized float have been found to the south-east of the *Gold Drop*, but much stripping has been done in this locality without exposing any vein.

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GREENWOOD AREA (49° 118° S.W.).

Greenwood is in an area about 10 miles square, which includes the formerly important *Phoenix* and *Deadwood* copper camps and several gold and gold-silver mines which have been worked at intervals since 1900. The Southern Trans-Provincial Highway and the Kettle Valley Railway pass through Greenwood, which lies in the valley of Boundary Creek. Good roads lead from the highway to the principal properties in the region. A transmission-line of the West Kootenay Power and Light Company, Limited, passes through Greenwood and through the Phoenix and Wellington camps.

In 1891 large, low-grade copper deposits were discovered near Phoenix and Deadwood. While ore from these camps was being smelted at Grand Forks and Greenwood (1900–19) and at Boundary Falls (1900–10), siliceous or sulphide ores were offered low treatment rates in order to obtain flux and sulphur. As a result of these favourable rates and low transportation costs, several near-by properties produced low-grade ore which yielded values principally in precious metals. In 1919 the copper-mining and smelting ceased. From 1920 until 1933 mining activity in the region was sporadic and was limited to development-work on a few of the gold and silver deposits. Since 1933 ore from some of the properties has been shipped directly to the smelters at Trail and Tacoma and some ore has been milled at Greenwood.

The largest of the gold-mines in the Greenwood area has been the *Winnipeg*, which produced 58,772 tons of ore, yielding 11,675 oz. of gold, 36,536 oz. of silver, and 189,597 lb. of copper during the years 1900–03 and 1910–12. The production from other properties in the Greenwood area has totalled 51,155 tons, yielding 18,255 oz. of gold, 1,630,180 oz. of silver, and relatively unimportant amounts of lead, zinc, and copper. Of this tonnage 86 per cent. came from the *Athelstan-Jackpot*, *No. 7*, and *Providence* mines.

The geology of the Greenwood area is complex and is difficult to interpret because of the widespread metamorphism. The oldest rocks in the area are mainly andesite and latite flows, commonly referred to as greenstones, and argillite and limestone. The structure of these rocks has not been determined. These old volcanic and sedimentary rocks have been intruded by several relatively small bodies of serpentine, pyroxenite, gabbro, diorite, and granodiorite. A stock of granodiorite, about 4½ square miles in area, is exposed on the steep valley-walls of Boundary Creek at Greenwood. A much larger body of granodiorite occurs north of the Greenwood area. Dykes of several types and various ages are common in the district; one of the most abundant types is syenite porphyry of post-mineral age. Tertiary volcanic and sedimentary rocks cover a small area in the vicinity of Phoenix and Tertiary lavas cover a large region west of the Greenwood area.

In many places in the district the pre-Tertiary igneous and sedimentary rocks have been highly altered. Granitic rocks near the margins of veins have been highly sericitized in places to produce chalky white rock, or chloritized in other places to produce green schistose rock. In some localities serpentine has been altered to rusty-weathering talc-carbonate rock susceptible to replacement by gold-bearing sulphides.

Limestone, argillite, and greenstone have undergone various types of silicification and limestone has been altered to skarn which locally contains copper ore. At Phoenix and Deadwood widespread silicification of limestone and of some argillite and greenstone has produced much jasperoid, a breccia-like rock consisting mainly of fragments of chert and jasper.

Ores mined chiefly for their gold or gold and silver content in the Greenwood area have been found in quartz veins and in replacement deposits.

Quartz veins ranging in width from a few inches to several feet are common throughout the area, but are particularly numerous in and around bodies of granodiorite and diorite. The veins are mineralized, as a rule sparsely, with pyrite, galena, sphalerite, chalcopyrite, and arsenopyrite in various proportions and in some places with lesser amounts of ruby silver, tetrahedrite, telluride, gold, and silver. Some of the veins are highly irregular and most are offset by faults and cut by post-mineral dykes.

In the *Providence* mine, about a mile north of Greenwood, a high-grade gold-silver vein lies chiefly in sheared and silicified argillites and volcanics at the northern contact of the granodiorite stock. The vein, which strikes north 50 degrees east and dips 40 to 65 degrees south-eastward, cuts across the north-easterly-dipping argillites. It has been traced underground for over 1,200 feet and ranges from less than an inch to 2½ feet in width. In some places it widens slightly at its intersections with pre-mineral faults, but it pinches in passing from silicified rock to chloritic schist and appears to be more persistent in silicified rock than in granodiorite.

The No. 7 vein, in the Central camp near the International Boundary, follows a north-easterly-dipping contact between altered serpentine and argillite. Granite porphyry occurs in the serpentine on the foot-wall and numerous dykes of lamprophyre and felsite occur in the vicinity of the vein, especially close to or along the serpentine-argillite contact. The vein, which has been traced for almost 1,000 feet on the surface and ranges from several inches to 5 feet in width, has not been located beyond a fault exposed in the south-eastern end of the 300-foot level. The most productive section of the vein was between the 180-foot level and the surface.

Little information is available regarding the most productive gold-mine in the district—namely, the *Winnipeg*—in the Wellington camp, 2 miles south-east of Phoenix. The mine is situated close to the western margin of a small body of diorite which intrudes greenstones. Judging from the dumps, the deposit was a replacement body containing abundant pyrrhotite and some chalcopyrite in chloritic rock. In recent years lessees shipped about 200 tons of ore from surface workings on a quartz vein which is not known to have any relation to the ore mined formerly on this property.

The *Athelstan-Jackpot* ore-bodies, 2½ miles south-east of Phoenix, are gold-bearing arsenopyrite and pyrite replacement deposits in conspicuous brown-weathering talc-carbonate rock formed by the alteration of serpentine. The serpentine is an irregular body about ½ square mile in area; the total extent of the talc-carbonate rock is unknown. In the vicinity of the mine small bodies of quartz diorite and quartz feldspar porphyry intrude the talc-carbonate rock. Stopes in the *Jackpot* are known to range from several feet to 25 feet in height and to have a length of at least 100 feet and a width of at least 40 feet. They are crescent-shaped in plan and plunge eastward at 10 to 40 degrees. Gossans of limonite and white arsenious oxide, formed by weathering of the deposits, have been mined in places and shipped to the Tacoma smelter.

The copper deposits of the Boundary district consist essentially of disseminated chalcopyrite, pyrite, magnetite, and hæmatite in skarn. Prior to 1919 the recovered gold content of these ores averaged about 0.03 oz. per ton. Some ore remaining in the *Brooklyn* and *Knobhill-Ironsides* mines in Phoenix was found to have a considerably higher gold content than the average of the camp and was milled at Greenwood between 1936 and 1942.

Rock-exposures in the Greenwood area are good along the walls of Boundary Creek valley and along the interstream ridges, but elsewhere they are poor. It is estimated that about 50 per cent. of the area is covered by drift. The region has been carefully prospected on several occasions and most of it is covered by Crown-granted claims.

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CAMP McKINNEY (49° 119° S.E.).

Camp McKinney is 9 miles north of the International Boundary and 16 miles by road north-west of Rock Creek Station, on the Kettle Valley Railway. It is 6½ miles by branch road from the Southern Trans-Provincial Highway. The transmission-line, of the West Kootenay Power and Light Company, Limited, passes through the camp.

This camp, discovered in 1887, is one of the oldest in the Province. The *Cariboo-Amelia* mine, the main producer, was in operation from 1894 to 1902, but since then only a small amount of work has been done. The workings were unwatered in 1939 but were allowed to fill again. Since that year lessees have made shipments from near-surface workings. The early production from the mine was 123,457 tons, which yielded 69,581 oz. of gold; in comparison, later production has been insignificant.

The ore deposits of Camp McKinney lie mainly within a small area underlain by quartzites, greenstones, schist, and some limestone. The rocks in this area are folded and much faulted. In the western part of the camp they are folded into an irregular overturned syncline; elsewhere they strike north-westward in general and dip steeply to the north-east. A body of granodiorite, which is 18 miles long and up to 3 miles wide, extends along the western side of the camp in a north-westerly direction. Tertiary lavas lie 1 mile to the east and a large area of granite and granodiorite lies 4 miles to the north.

Quartz veins cut both the sedimentary and igneous rock, but one type of rock has proved most favourable to the occurrence of ore-bodies. This is a banded calcareous greenstone in which beds of "lime" alternate with beds of andesitic material, sometimes on an extremely fine scale. Locally, "lime" forms such a high proportion of the rock that it is best termed an impure limestone. The rock is probably a strongly altered tuffaceous sediment.

The *Cariboo-Amelia* ore-bodies lie in a vertical, easterly-striking, quartz vein which cuts across the sedimentary formation. Most of the vein is from 1 to 5 feet wide and the best ore is between walls of calcareous greenstone. The mineralization consists of pyrite, sphalerite, galena, and chalcopyrite in small amounts. Much free gold is reported to have been recovered in early operations, particularly from a dense bluish variety of quartz. It has been found that higher than average values occur in well-banded sections of the vein and in quartz containing prominent amounts of sphalerite and galena.

The *Cariboo-Amelia* vein has been offset by many faults, some of which are flat thrusts of about 400 feet displacement, and as a result exploration in this ground has not been easy. The mine-workings extend for 2,000 feet horizontally and to a depth of 530 feet. There are other workings over an additional length of about 3,000 feet on what is perhaps the *Cariboo-Amelia* vein, and sub-parallel veins are known.

Some veins cutting granitic rocks occur to the south-west of the *Cariboo-Amelia*. There are old workings 2 to 3 miles east and south-east of Camp McKinney proper on quartz veins in sedimentary rocks and greenstones. Still other quartz veins are reported from a section a few miles north of Camp McKinney and extending as far as the Kettle River, but there is no definite information concerning them.

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KETTLE RIVER (49° 118° S.W.).

The principal mineralized section near the Kettle River is on Horseshoe Mountain, on the west side of the river, 23 miles north of Westbridge. A branch road climbs about 2,000 feet in 4 miles from the river road to the *Mogul* claim on the top of the mountain. Westbridge is on the Kettle Valley Railway and is connected by 9 miles of road with the Southern Trans-Provincial Highway at Rock Creek.

Horseshoe Mountain was actively prospected during the late '90's and many claims were staked, but, by 1901, activity had waned and the ground lay idle until 1928. Hand-mining on several properties between 1936 and 1941 resulted in the shipment of a few cars of ore yearly. The total production from the area has amounted to 1,031 tons of ore from which 932 oz. of gold and a smaller amount of silver have been recovered.

Horseshoe Mountain lies just within the eastern boundary of the Beaverdell map-area. The ground to the east and south has not been mapped. On Horseshoe Mountain rocks of the Wallace group, consisting of highly altered volcanics and sediments, are intruded by small irregular bodies of quartz diorite. Tuffs with some normal sedimentary rocks occur mainly on the upper and northern slopes, and andesitic rocks with some tuffs predominate nearer the Kettle River. The rocks of the Wallace group and the quartz diorite are cut by many andesitic to syenitic porphyry dykes, mostly of post-mineral age. About 1 mile to the north-east syenite and granitic rocks are exposed, the latter being part of a body of granite and granodiorite extending over an area of at least 350 square miles to the north, west, and south of the Beaverdell region. Part of this body was mapped as quartz monzonite by Reinecke.

The deposits are mineralized fracture-zones occurring in both the Wallace group and in the quartz diorite. They are extremely irregular in form; in part they are vein-like and in part are shapeless fillings of breccia zones. The deposits generally strike north-eastward and dip steeply. Mineralization extends over widths of a few inches in the case of the veins and over widths of several feet in the case of the breccia fillings.

The fracture-zones are silicified and, in some places, intensely altered. The mineralization consists of varying amounts of pyrite, pyrrhotite, arsenopyrite, chalcopyrite, sphalerite, and galena with very little true vein quartz. A peculiar variety of pyrite with an open "lacy" texture is usually gold-bearing; some arsenopyrite contains high gold values but some is almost barren. The gold is believed to be associated largely with pyrite and sphalerite.

The country in the vicinity of Horseshoe Mountain is rocky and exposures are plentiful. Geological conditions similar to those on Horseshoe Mountain extend for 6 miles to the west, as far as the Beaverdell silver camp.

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CARMI-BEAVERDELL (49° 119° S.E.).

In the Carmi-Beaverdell camp, famous for its silver production from the mines on Wallace Mountain, a few gold-bearing deposits are found in the section extending from the vicinity of Beaverdell north-westward to the village of Carmi on the West-kettle River. Both Beaverdell and Carmi are on the Kettle Valley Railway and the latter is 35 miles by road from the Southern Trans-Provincial Highway at Rock Creek.

The *Carmi*, the most important of the gold deposits, was located in 1896 and ore was shipped in 1901. Most of the other properties were also staked prior to 1900. The total production from properties mined primarily for their gold values has amounted to 3,046 oz. of gold and 10,843 oz. of silver, recovered from 5,613 tons of ore, chiefly from the *Carmi* mine.

In the vicinity of the deposits, an irregular body of rocks of the Wallace group, about 2 square miles in area, is intruded by a batholith composed mainly of quartz diorite and diorite. At Beaverdell and 3 miles south-west of Carmi, the batholith is intruded by small bodies of Tertiary granitic rock; to the north, west, and south it is flanked by a vast area of granite and granodiorite which forms part of the Shuswap complex. The tertiary intrusive at Beaverdell was termed quartz monzonite by Reinecke.

The mineral deposits occur in both the quartz diorite and the rocks of the Wallace group. The *Carmi* and *Butcher Boy* appear to be on the same much-faulted vein following a shear-zone in quartz diorite. The shear-zone strikes eastward and dips southward at 45 to 60 degrees and can be traced for over 1,800 feet on the surface. The vein ranges from a few inches to 7 feet in width; one ore-body near the surface on the *Carmi* was reported to be about 250 feet in length. The mineralization consists of sphalerite, chalcopyrite, pyrite, galena, molybdenite, and ankerite.

Other gold-bearing showings in the area include vein-like deposits in the quartz diorite and highly irregular deposits in the Wallace group. In the latter, pyrrhotite is the most abundant mineral and in some places gold appears to be associated with "lacy"-textured pyrite.

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FAIRVIEW CAMP (49° 119° S.W.).

Fairview camp, about 3 miles west of Oliver, in the Southern Okanagan Valley, is easily accessible. It is on a road which connects the Similkameen Valley with the Southern Trans-Provincial Highway at Oliver.

A branch line of the Canadian Pacific Railway runs through Oliver and the transmission-line of the West Kootenay Power and Light Company, Limited, passes through the camp.

Fairview is one of the oldest lode-gold mining camps in the Province. Many of the claims were located in the early '90's and a large part of the early production came before 1900. The *Stemwinder, Morning Star,* and *Rattler* were the principal producers in past years. It is reported that several hundred tons of rich ore were mined from the outcrop of the *Morning Star* vein. The camp was revived in 1934, after having been inactive for many years. Recent production came principally from the Fairview Amalgamated Gold Mines, Limited, which was worked from 1935 to 1939. The total production from the camp has amounted to 149,686 tons of ore, yielding 16,992 oz. of gold and 162,680 oz. of silver.

Most of the veins occur in a north-westerly-trending irregular belt, about 2½ miles long and 1,500 to 5,000 feet wide, underlain chiefly by metamorphosed sedimentary rocks. These rocks, consisting of micaceous or graphitic quartzites, mica-schists, and minor amounts of crystalline limestone, strike north-westward and dip north-eastward. From the ends of this belt similar rocks continue north-westward along the strike for about 3 miles and south-westward for over 1 mile.

The belt is flanked on the south-west by the Fairview intrusive, which is an irregular stock, 4½ square miles in area, consisting of somewhat gneissic granodiorite and quartz diorite. The Oliver intrusive, consisting chiefly of granite, forms the north-eastern margin of the belt. The Oliver granite extends for more than 13 miles as a north-westerly-trending irregular body up to 3 miles in width.

Dykes and sills consisting mainly of quartz porphyry, or quartz and feldspar porphyry, are fairly common in the area.

Correlation of the veins between the properties has not been possible since the veins are lenticular and are not completely exposed. However, it is known that there are at least three parallel veins. On the productive properties the veins, which are up to 30 feet wide, strike north-westward and dip north-eastward generally paralleling the schistosity of the sedimentary rocks. In some places the veins cut the schistosity and bedding at small angles. The veins appear to have formed, partly by replacement, along fault-fissures which conform closely to the schistosity of the sediments and to the contacts of the granitic bodies. In several places post-mineral movement has occurred along faults which are generally normal and of small displacement.

The veins consist of quartz containing sparse pyrite, galena, sphalerite, arsenopyrite, and chalcopyrite. The concentrating ratio at the Fairview Amalgamated mill was nearly 100 to 1. The average gold content of the veins is very low. In general the gold is associated chiefly with galena and sphalerite, and not with pyrite.

The ore is reported to occur in shoots having lengths of the order of about 200 feet. These shoots may be wide or narrow parts of the veins separated by stretches of similar vein-matter which is below commercial grade. Some high-grade, galena-rich shoots are reported to have been mined in the *Morning Star.*

In addition to the veins paralleling the schists, veins of minor importance have been found which crosscut the schists or cut the granite at a variety of angles.

Small shipments of ore from veins within a few miles of Fairview camp have amounted to 1,279 tons, yielding 327 oz. of gold and 2,007 oz. of silver.

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DIVIDEND CAMP (49° 119° S.W.).

The Dividend camp is in the Southern Okanagan Valley, about 1 mile north of the International Boundary. A road connects the camp with the Southern Trans-Provincial Highway which passes through Osoyoos, 2 miles to the north-east. Branches of the Canadian Pacific Railway and of the West Kootenay Power and Light Company, Limited, transmission-line reach Osoyoos.

The *Dividend-Lakeview* property was first opened in 1901, considerable development was done in 1908 and small shipments of ore were made in 1911 and 1913. A stamp-mill built on the *Dividend* property by former operators was reconditioned in 1935 and milling continued from 1936 to 1941; a cyanide plant was added in 1937. The total production from the property has amounted to 105,661 tons of ore, from which 16,197 oz. of gold and small amounts of silver and copper have been recovered.

The ore deposits occur in rocks of the Kobau group consisting of micaceous quartzite, mica and chlorite schist, crystalline limestone, and greenstone. Altered diorite, somewhat similar in appearance to the greenstone, is abundant in the area. An irregular granitic body which intrudes the rocks of the Kobau group lies 800 to 2,500 feet north of the various deposits. This intrusive, composed of granodiorite and quartz diorite which are generally gneissic, is a north-westerly-trending body more than 6 miles long and more than a mile in average width. Syenite, which forms a somewhat larger body at the margin of a granodiorite batholith, is exposed 2½ miles to the west of the deposits.

The ore-bodies are replacement deposits in limestone and greenstone which have been largely altered to silicate minerals such as garnet and epidote; ore has not been found in schistose rocks which underlie the massive host-rocks of the ore-bodies. The deposits occur mainly as irregular bodies but also as vein-like masses along fissures. Mining has been chiefly in a body of altered limestone on the *Dividend* claim, close to the surface; faulting and erosion have either obscured or removed continuations of this body. At one place an ore-shoot about 50 feet long and from a few feet to 20 feet thick has been stoped for a depth of about 60 feet on the pitch.

The principal metallic minerals in the ore are pyrrhotite, magnetite, chalcopyrite, and some arsenopyrite. Arsenopyrite is believed to contain the greater part of the gold. Higher than average values are also associated with chalcopyrite and with pyrite in a gangue of coarsely crystalline calcite. Although pyrrhotite is the most abundant metallic mineral, the gold values associated with some of it are very low.

Little work has been done on other replacement deposits in altered limestone and greenstone occurring on ground near the *Dividend* and *Lakeview* claims. Many quartz veins, some of which cut the granitic rocks, are known in the general vicinity.

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TWIN LAKES CAMP (49° 119° S.W.).

The Twin Lakes camp, ranging in elevation from 4,000 to nearly 5,000 feet, is on Oro Fino Mountain, 4 miles north-west of Fairview camp and 20 miles by road south of Penticton.

The first claims in the camp were staked in 1898. The principal mines, the *Grandoro* and *Twin Lakes,* have produced sporadically and several other claims have been worked in a small way. In the past nine years mining has been confined largely to the activity of lessees. The production from the camp has amounted to 8,858 oz. of gold and a little silver, recovered from 24,058 tons of ore.

The ore deposits occur in an area about 4 square miles in extent underlain by irregular, easterly-trending belts of greenstone, sedimentary rocks, and highly altered dioritic rocks of uncertain origin. These rocks are intruded by a few small bodies of diorite, granodiorite, and granite, and are in contact on the south with the Oliver granite. On the north, Tertiary volcanics of considerable thickness are faulted against the older rocks and, on the west, the volcanics overlie them.

The mineral deposits consist of quartz veins which are for the most part lenticular. None of the veins is known to be very extensive along the strike and none has been deeply developed. The veins strike northward to north-eastward; the *Twin Lakes* main vein dips at a low angle and rolls gently, but other veins in the camp dip steeply.

Mineralization consists of pyrite and locally a little galena, and free gold is common in the higher grade shoots. Some quite rich pockets have been discovered in veins which were relatively barren elsewhere. The principal ore-shoots generally contained more sulphides than the other parts of the veins. Shallow ore-shoots, attributed to enrichment, were found in oxidized parts of veins near the surface.

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HEDLEY CAMP (49° 119° S.W., 49° 120° S.E.).

The long-established mining camp at Hedley, on the Similkameen River, is 25 miles east of Princeton and 50 miles west of Penticton. It is served by the Southern Trans-Provincial Highway and by a spur line of the Great Northern Railway. The transmission-line of the West Kootenay Power and Light Company, Limited, passes through Hedley.

The two producing mines, *Nickel Plate* and *Hedley Mascot,* are on Nickel Plate Mountain and develop what are, in general, the same ore-bodies. The *Nickel Plate,* now owned and operated by Kelowna Exploration Company, Limited, is one of the oldest mines in the Province and was, for a time, the largest gold producer in Canada.

During the early '60's gold was recovered in the Hedley district from relatively small placer deposits near the mouth of Hedley (Twenty Mile) Creek. This activity was short-lived and it was not until 1894 that the first claims on Nickel Plate Mountain were recorded. The mineralized outcrops on these first claims were low in grade and the rich showings on the *Nickel Plate* claim were discovered in 1898. Milling at the *Nickel Plate* commenced in 1904, continued until a shut-down in the spring of 1931, and was resumed in the autumn of 1934. The *Hedley Mascot* has been in production since the spring of 1936. The combined production from the two mines until the end of 1943 amounted to 2,483,103 tons, from which 1,015,701 oz. of gold and some silver, copper, and arsenic have been recovered.

The rocks of Nickel Plate Mountain consist of a thick series of sediments of Triassic age cut by dykes, sills, and irregular masses of diorite and gabbro and by dykes of granodiorite. To the south and south-east there is a large and highly irregular mass of granodiorite and to the north there is a body of granite about 20 square miles in area and a much more extensive area of granodiorite.

The sedimentary rocks dip north-westward at 25 to 30 degrees in general but they are strongly crumpled and are cut by many faults. Locally they are altered to an intense degree, particularly above the Sunnyside limestone. Diorite and gabbro sills and dykes are numerous, and impart a striped appearance to the rocks when seen from a distance. The structure in detail is exceedingly complex.

Structure similar to that on the productive part of Nickel Plate Mountain extends over an area of about 15 square miles on the northern side of the Similkameen River, bounded on the north, north-west, and south by granodiorite and granite. To the east and south-east outcrops are in general much fewer and the rocks have not been so carefully subdivided in the geological mapping. Although there are similar sedimentary rocks for some miles, the mapping shows no concentration of diorite and gabbro such as that north of Hedley.

One of the most striking features of the Hedley camp is the extreme alteration of the rocks. Impure limestones and limy argillites have been converted to skarn and garnetite in a broad zone above the Sunnyside limestone. This intense alteration is related to the intrusive activity and, in general, follows the bedding but locally cuts across it. The numerous ore-bodies lie within the zone of intense alteration, generally close to its lower margin. The irregular but well-defined boundary zone between skarn and limestone is called the "marble line."

The ore is of high temperature replacement type (termed by some writers contact metamorphic) and consists of sulphide minerals distributed through a gangue which is composed of rock-forming silicate minerals, but is lacking in quartz. The sulphide minerals include arsenopyrite, pyrrhotite, chalcopyrite, sphalerite, and pyrite. Arsenopyrite, the gold carrier and the earliest sulphide, was deposited at approximately the same time as some of the silicates. Some pyrrhotite appears to be gold-bearing but microscopic study shows that it contains extremely fine grains of arsenopyrite, which is the true gold carrier. There is a close association between arsenopyrite and the mineral scapolite.

Part of the geological sequence of events on Nickel Plate Mountain appears to have been as follows: A complex boxwork of diorite-gabbro sills and dykes intruded and sliced the limy argillites. Following these intrusions, solutions invaded the entire rock-mass, altering the sediments and, locally, the dykes. These solutions produced skarn in the limy argillites and converted some of the diorite dykes to a peculiar pale gabbro; the solutions came up definite channels but also penetrated the rocks between and surrounding the channels and were in part controlled or deflected by the dykes. Sulphide mineralization closely followed the formation of the silicate minerals, the first sulphide formed being arsenopyrite. The ore-bodies, which have been found through a vertical range of more than 2,100 feet, were formed in certain beds, in angles between dykes and beds, and against sills, and their positions were further controlled by folds in the sedimentary rocks. There were thus formed a series of ore-bodies, dipping in general with the bedding flatly towards the west, and following rolls in the bedding as well as dykes and sills of diorite-gabbro. The details of the localization of ore are very complex and much careful geological mapping is an essential part of the mining operations.

Mineral deposits of a similar type were explored in the *Canty* mine, 1½ miles east of the *Nickel Plate,* and a small amount of ore was mined. On Apex Mountain, 5 miles east of Nickel Plate Mountain, similar deposits were explored, but no ore was mined. The sedimentary rocks on Apex Mountain are of a somewhat different age and character, but the general geological conditions appear similar to those on Nickel Plate Mountain.

Mineralization of a somewhat similar type has also been found on the southern side of the Similkameen River, but has been explored only by surface workings.

A few quartz veins in and near the camp have been explored. In 1943 examination of scheelite-bearing skarn on the *Good Hope,* 2 miles south-east of the *Nickel Plate* mine, led to the discovery of a new gold prospect. In this showing gold associated with bismuth telluride occurs in skarn. In many places the skarn is a coarse-grained, pyroxene-rich variety containing much "watery"-appearing quartz. Exploration was done on the prospect during 1944 and it is reported that the results justified continuance of the work.

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SIMILKAMEEN RIVER (49° 120° S.W.).

A few small veins, locally containing high values in gold, have been found in the Similkameen Valley in the region about the mouths of Copper Creek and of the Pasayten River. The showings are 25 to 40 miles south of Princeton and are close to the Hope-Princeton Highway, now under construction.

Prospecting in the general region began in 1860 with the discovery of placer gold in the Similkameen River near the mouth of the Tulameen. In the following years gold was recovered from the Similkameen and some of its tributaries, as far up as the mouth of the Pasayten. The most productive deposits were those on Whipsaw and Lamont Creeks and on the Similkameen River below the mouth of Whipsaw Creek.

Lode deposits were first discovered in the area during the early '80's. Production of gold ore from the region has amounted to a few tons of carefully selected material.

The valleys of the Similkameen and Pasayten Rivers in the vicinity of the gold deposits are underlain by northerly-striking Triassic volcanic and sedimentary rocks which are highly schistose in places. Three miles above the mouth of the Pasayten River the Similkameen Valley is crossed by a north-westerly-trending body of gneissic granodiorite, 2 miles in width, which is referred to as the Eagle granodiorite. This body is known to extend from the International Boundary for 100 miles to the north-west and, throughout much of this distance, the rocks lying in a zone 4 to 5 miles wide along its north-eastern margin are intensely sheared. Tertiary lavas cover large areas of the upland west of the Similkameen River and east of the Pasayten River.

A small number of non-persistent veins only a few inches in width cut the schist north-east of the Eagle granodiorite. The veins contain arsenopyrite or bornite which locally have a considerable amount of gold in close association. Telluride has been reported from one vein. Quartzose replacement deposits containing pyrite and chalcopyrite but only low gold values have been found in the area. Quartz veins mineralized with galena, sphalerite, pyrite, and minor amounts of other sulphides which locally contain gold values occur in sheared Triassic rocks on Whipsaw Creek.

The Similkameen area has been actively prospected in years past, but overburden, which is locally very thick, makes thorough prospecting difficult. The distribution of the few known deposits suggests that the broad belt of highly sheared Triassic rocks along the north-eastern margin of the Eagle granodiorite is the part of the area most favourable to prospecting.

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TULAMEEN RIVER (49° 120° N.W. AND S.W.).

The principal gold-bearing section of the Tulameen district is on Grasshopper Mountain, which lies on the north side of the Tulameen River, 5 miles from Tulameen. The village of Tulameen is on the Kettle Valley Railway and is connected by fair roads with the Southern Trans-Provincial Highway. A road leads south-westward from Tulameen for a distance of 23 miles to Summit Camp, near the headwaters of the Tulameen River.

Small amounts of placer gold were recovered on the Tulameen River in the years following 1860, but large production was not obtained from the area until 1885, when gold was discovered on Granite Creek. Shortly before 1900 many prospectors began searching for lode deposits but only small and weakly mineralized veins were found in the vicinity of Granite Creek. Veins discovered on Grasshopper Mountain have produced shipping ore amounting to 1,400 tons, from which 1,065 oz. of gold and a small amount of silver have been recovered.

Grasshopper Mountain lies within the belt of sheared rocks flanking the Eagle granodiorite on the north-east. The western part of the mountain is composed of a body of peridotite and pyroxenite which terminates on the north-western slopes and extends south-eastward for 14 miles as a belt up to 3½ miles wide. The eastern part of the mountain is underlain by volcanic and sedimentary rocks of the Tulameen group of Triassic age, consisting of interbedded andesite, schist, argillite, and limestone. These rocks strike a few degrees west of north and dip steeply. The eastern contact of the Eagle granodiorite lies close to the western part of Grasshopper Mountain. A small stock of granite, about 1 square mile in area, intrudes rocks of the Tulameen group, 2 miles to the north.

Quartz veins ranging up to 8 feet in width occupy fracture-zones in sheared rocks of the Tulameen group on the eastern side of Grasshopper Mountain. The veins have a variety of attitudes and vary considerably in width over short distances. Mineralization, nowhere known to be abundant, includes chalcopyrite, pyrite, galena, sphalerite, hæmatite, telluride, and free gold; iron-bearing carbonate is common as a patchy constituent of the veins. Pockets of high-grade ore have been found locally.

Small gold values occur in the silver-lead mineralization found at Summit Camp and in the copper mineralization found along the lower part of the Tulameen River and at Law's Camp and the *Independence* mine north-west of Grasshopper Mountain. Gold-bearing quartz veins which are known to cut all pre-Tertiary rocks have been found in the district at other places.

Most of the Tulameen area has been carefully prospected in past years. Available information suggests that the schistose rocks occurring in a belt along the north-eastern margin of the Eagle granodiorite are the most favourable to the discovery of ore deposits.

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MONASHEE (50° 118° S.E. AND S.W.).

This area, 30 to 50 miles east of Vernon, includes Monashee Mountain, the drainage-basin of Cherry Creek, and the headwaters of the Kettle River and of several streams flowing into Upper Arrow Lake. It is a mountainous region traversed by the Vernon–Edgewood Highway.

The area has been actively prospected at times for both placer and lode deposits. Placer-gold production from Cherry Creek began in 1876 and work was done on a near-by silver deposit prior to 1874. The *Monashee* and *St. Paul* gold properties were developed during the early '90's and have been worked at intervals since then. The production from these deposits has amounted to 2,729 tons of ore, yielding 503 oz. of gold and a small amount of silver.

The area, which has not been completely mapped geologically, is underlain by sedimentary and volcanic rocks of various sorts, with argillite and greenstone the commonest. Alteration of these rocks has been relatively intense. Crystalline schists, gneisses, and intrusive rocks of the Shuswap series, which continue far to the north of the area, extend from the mouth of Cherry Creek and the basin of Sugar Lake south-eastward to the north end of Whatshan Lake. To the south are granitic rocks which underlie the upper stretches of the Kettle River and extend eastward beyond Lower Arrow Lake.

Veins have been found containing several metals, of which gold and silver are the most important. Information regarding the *Monashee* is very meagre. Most of the *St. Paul* veins lie within or close to the southern margin of a narrow southward-dipping body of diorite. The veins range from 1 to 4 feet in width and generally dip gently southward. They consist of quartz and in some places altered diorite, mineralized chiefly with arsenopyrite, pyrite, jamesonite, stibnite, and pyrrhotite.

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NORTH OKANAGAN (50° 119° S.E. AND S.W.).

Vernon, on branch lines of both the Canadian National and Canadian Pacific Railways, is the centre for the North Okanagan area. This district is also well served by roads and trails.

Gold-bearing quartz veins have been known for many years about the northern end of Okanagan Lake, from Shorts Creek, 15 miles south-west of Vernon, to the vicinity of Lumby, 13 miles east of Vernon. About 200 tons of ore mined in past years came from Okanagan Landing, but the principal production has come from the *Kalamalka* mine at Lavington and the *White Elephant* mine near Shorts Creek. The total, 13,076 tons of ore, yielded 4,976 oz. of gold and some silver.

East of Vernon the rocks form a complex largely of crystalline schists and gneisses with a few small intrusives which are chiefly granitic. West of Vernon the rocks are less completely metamorphosed, consisting mainly of sedimentary and volcanic rocks intruded on the south by granite. Tertiary lavas cover large areas to the west and to the south-east of Vernon.

Quartz veins of diverse attitudes cut the older rocks and, at the *White Elephant*, cut granite. The veins range in width from a few inches to 100 feet, tend to be lenticular, and are much faulted. Mineralization is in most places sparse and is known to include telluride in a few instances; gold-bearing pockets or shoots may occur within relatively barren vein sections.

Information regarding the *Kalamalka* is incomplete. It is reported that quartz veins containing pyrite, galena, and free gold occur in shear-zones at the contacts of sediments and a body of diorite. The *White Elephant*, occurring in an extensive body of granite, consists at the surface of a quartz-lens 60 feet or more long and about 50 feet wide striking northward and dipping eastward. Underground the quartz widened to 70 feet and contained an ore-shoot 15 to 25 feet in width. The mineralization includes pyrrhotite, pyrite, chalcopyrite, and bismuth telluride.

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STUMP LAKE (50° 120° S.E.).

Stump Lake camp is on a secondary highway, midway between Merritt and Kamloops, in an open, rolling "dry-belt" region. Veins in the region were staked in the '80's and have been mined periodically since then mainly for their silver and lead content. Some of the veins, however, contain shoots relatively rich in gold. The total production of the camp, amounting to 69,630 tons of ore, has yielded 8,510 oz. of gold, 259,043 oz. of silver, 2,201,223 lb. of lead, and 40,800 lb. of copper.

The rocks in the general vicinity of the deposits are mainly greenstones, together with tuffs, breccias, and narrow bands of sedimentary rocks, all belonging to the Nicola group. Mafic dykes of post-mineral age are found in the area. The major structure of the region is a syncline with an axis trending about north 20 degrees east.

The veins occupy fracture-zones or shear-zones in greenstone, most of which strike from north 45 degrees west to north 25 degrees east and dip from 45 to 90 degrees eastward. The *Enterprise* vein, the most productive of the camp, strikes northeastward in its northern part and north-westward in its southern part and dips eastward at 40 to 80 degrees. The veins, ranging in width from a few inches to 10 feet, probably average less than 2 feet wide. The *Enterprise* vein which has an average width of slightly more than 2 feet, has been followed for 1,800 feet and has been proved to a depth of over 1,000 feet. Buff weathering, bleached greenstone containing abundant carbonate and pyrite, extends for a maximum distance of 15 feet from the deposits. The veins consist of quartz and, in a few places, calcite, irregularly and sparsely mineralized with pyrite, galena, sphalerite, tetrahedrite, chalcopyrite, bornite, arsenopyrite, pyrrhotite, and scheelite. Gold values are generally highest in sections which contain tetrahedrite. The ore occurs in shoots within the veins separated by narrow or low-grade stretches. In the *Enterprise* vein the ore-shoots, on a major scale, appear to rake to the south.

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KAMLOOPS AREA (50° 120° N.E.).

Several properties within a 15-mile radius of Kamloops have produced gold-bearing ore since the late '90's. However, the chief mineral output of the area has been copper from the *Iron Mask* mine, which produced 189,230 tons of ore, yielding 3,630 oz. of gold, 14,292 oz. of silver, and 5,194,871 lb. of copper. Ore of higher gold content was obtained from the *Copper King*, which produced 7,491 tons, yielding 1,183 oz. of gold, 2,180 oz. of silver, and 391,381 lb. of copper. Seven other properties produced a total of 427 tons yielding 264 oz. of gold.

The mineralization south and west of Kamloops occurs mainly in shear-zones and fracture-zones in the outer part of the *Iron Mask* batholith. This body, composed chiefly of diorite and gabbro, extends for about 20 miles as a north-westerly-trending belt up to 3 miles wide. It intrudes greenstones of the Nicola group which form the north-eastern limb of a syncline and it is overlain in places by Tertiary volcanic and sedimentary rocks.

The mineralization at the *Copper King* occurs in a northerly-striking vertical fracture-zone which was stoped in one place for a length of 140 feet across a maximum width of 25 feet. The ore contains chalcopyrite, bornite, pyrrhotite, and magnetite, but practically no quartz. Other deposits in the batholith contain more magnetite and less bornite and gold. In many cases the ore is highly oxidized at the surface. In places the wall-rock of the deposits contains conspicuous epidote and pink feldspar which may be useful guides in the search for other ore-bodies.

Elsewhere in the area prospecting has been done on quartz veins in Nicola greenstones and in older sedimentary rocks. In general, the rock-exposures in the Kamloops area are good and the region has been carefully prospected.

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WINDPASS (CHU CHUA) (51° 120° S.E.).

The *Windpass* mine is 7 miles north-east of Chu Chua, on the east side of the North Thompson River, about 55 miles north of Kamloops. The Canadian National Railway and fair roads follow the valley of the North Thompson and a road leads to Dunn Lake, which lies about 1½ miles west of the mine.

The *Windpass* property, staked in 1916, was worked at times during the '20's and a small flotation-mill was in operation between 1933 and 1939. The recorded production from the mine totals 84,059 tons, from which 34,246 oz. of gold, 1,568 oz. of silver, and a relatively unimportant amount of copper were recovered.

The *Windpass* occurs in quartz diorite which forms the upper part of a sill on the hanging-wall contact of which are thinly bedded cherts dipping steeply to the west. Pyroxenite, which forms the lower part of the sill, is intruded by granite and granodiorite which lie near the western end of a large body of granitic rocks. The western contact of the granite, where exposed, dips westward at 35 to 50 degrees. The quartz diorite-pyroxenite sill has been mapped as a northerly-trending belt more than 4 miles long and 1 to 1½ miles wide.

Mineralization at the *Windpass* occurs in a northerly-dipping shear-zone which cuts quartz diorite. Near the surface the western part of the deposit is a quartz-fissure filling and the eastern part is a series of replacement lenses containing abundant magnetite. At the western end, where the vein passes into the thinly-bedded cherts on the hanging-wall of the sill, it splits into narrow stringers which are of low grade. The deposit contains magnetite, chalcopyrite, pyrite, pyrrhotite, cobaltite, bismuthinite, and native bismuth. Some of the massive magnetite contains high values in gold and, in many cases, bismuth minerals indicate high-grade ore. Some of the stopes are up to 10 feet wide and it appears that irregular, pod-like ore-bodies have been mined from them.

Some production has been obtained from the *Sweet Home* vein, situated about ½ mile south of the *Windpass* deposit. This quartz vein, which strikes westward and dips northward, contains pyrite, pyrrhotite, chalcopyrite, and native bismuth. Upon passing from the sill to the chert on the hanging-wall, the vein becomes narrower and lower in grade.

Other prospects in the area have received a small amount of attention. Most of the known veins are in greenstone and in sedimentary rocks.

Prospecting is difficult in the region because of the thick mantle of drift and the dense forest-cover. Geophysical exploration has been done on the *Windpass* property. A dip-needle might aid in the search for deposits high in magnetite in the general area.

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BRITISH COLUMBIA DEPARTMENT OF MINES

HON. R. C. MacDONALD, Minister JOHN F. WALKER, Deputy Minister

BULLETIN No. 20—PART IV.

Revised November, 1946

LODE-GOLD DEPOSITS

South-western British Columbia

(Exclusive of Vancouver Island)

By

J. S. STEVENSON

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CONTENTS.

PREFACE.

Bulletin 20, designed for the use of those interested in the discovery of gold-bearing lode deposits, is being published as a series of separate parts. Part I. is to contain information about lode-gold production in British Columbia as a whole, and will be accompanied by a map on which the generalized geology of the Province is represented. The approximate total production of each lode-gold mining centre, exclusive of by-product gold, is also indicated on the map. Each of the other parts deals with a major subdivision of the Province, giving information about the geology, gold-bearing lode deposits, and lode-gold production of areas within the particular subdivision. In all, seven parts are proposed:—

PART I.—General *re* Lode-gold Production in British Columbia.
PART II.—South-eastern British Columbia.
PART III.—Central Southern British Columbia.
PART IV.—South-western British Columbia, exclusive of Vancouver Island.
PART V.—Vancouver Island.
PART VI.—North-eastern British Columbia, including the Cariboo and Hobson Creek Areas.
PART VII.—North-western British Columbia.

By kind permission of Professor H. C. Gunning, Department of Geology, University of British Columbia, his compilation of the geology of British Columbia has been followed in the generalized geology represented on the map accompanying Part I. Professor Gunning's map was published in " The Miner," Vancouver, B.C., June-July, 1943, and in " The Northern Miner," Toronto, Ont., December 16th, 1943.

SOUTH-WESTERN BRITISH COLUMBIA.

INTRODUCTION.

Prospecting may be more intelligently undertaken and a greater measure of success assured if the prospector, scout, or engineer has some knowledge of the mining history, general geology of an area, and of features of the known gold properties, both producers and non-producers, in an area. A knowledge of the many features common to gold-quartz veins in the south-western part of the Province will also be useful.

One of the best ways to prepare for prospecting in an area about which little is known is first to study the known ore deposits in a mineralized area near-by. A knowledge of the mineralogy, structure, and rock associations of proven gold deposits permits intelligent search for similar conditions in undeveloped areas. A knowledge of how veins look when high-grade, marginal, or non-economic is also of value to the prospector. With this in mind, the geology and gold deposits of the various mineralized areas in the south-western part of the Province are described in detail, so that the prospector or scout may have the pertinent information on the area nearest to the one he intends to prospect. Areas beyond the known mineralized areas where further prospecting might be carried on are also described.

In this publication a brief general statement concerning the geography and the lode-gold production of South-western British Columbia is followed by some general conclusions about the occurrence of gold-quartz veins in relation to batholith areas and some ideas about prospecting near them. More detailed discussion of the geology and mineral deposits follows under four main headings, referring to four principal regions into which South-western British Columbia is subdivided for convenience in this discussion. For each region, areas or belts regarded as of interest to those searching for lode-gold deposits are discussed and references are made to many of the prospects in the less well-known sections.

Lode deposits of South-western British Columbia have yielded more than 2,000,000 oz. of gold, of which more than 80 per cent. has come from the Bridge River camp, now the most productive lode-gold camp in the Province. Gold recovered as a by-product from copper ore of the Britannia mine has amounted to about 14 per cent. of the total, and the copper-gold ores mined between 1896 and 1919 at Vananda on Texada Island account for more than 3 per cent. of the total. The Vidette mine has produced more than 1 per cent. of the total, and several other properties have produced smaller amounts of gold.

South-western British Columbia, as discussed in this publication, lies between 49° and 52° north latitude, includes the mainland coast and adjacent islands, but not Vancouver Island, and extends east to an irregular line which forms the eastern boundary of the Clinton, Ashcroft, and New Westminster Mining Divisions. It includes the Clinton, Lillooet, Ashcroft, New Westminster, and Vancouver Mining Divisions and some islands in the Nanaimo Mining Division. For convenience in the following discussion South-western British Columbia is divided into four main regions—the coast and islands, the lower mainland, the eastern flank of the Coast Range, and the region east of the Coast Range; which will be discussed in that order.

MAPS.

Lithographed Maps.—The lithographed maps listed in the following table show the geography of South-western British Columbia, and may be obtained from the Chief Geographer, Department of Lands and Forests, Victoria, B.C.

Map No.	Year of Issue.	Title of Map.	Scale.	Per Copy.
		GEOGRAPHIC SERIES.		
1K	1925	South-western Districts of British Columbia, Commercial and Visitors	7.89 m. to 1 in.	$0.50
		LAND SERIES.		
2B	1914	New Westminster and Yale Districts	4 m. to 1 in.	.50
2C	1929	Northerly Vancouver Island (shows adjacent mainland)	4 m. to 1 in.	.50
2D	1923	Powell Lake	4 m. to 1 in.	.50
2E	1924	Bella Coola (preliminary)	4 m. to 1 in.	.50
		PRE-EMPTORS' SERIES.		
3F	1934	Chilcotin	3 m. to 1 in.	Free
3G	1935	Quesnel, contoured	3 m. to 1 in.	Free
3K	1938	Lillooet	3 m. to 1 in.	Free
		DEGREE SERIES.		
4Q	1939	Hope-Princeton (contoured)	2 m. to 1 in.	.50
		MISCELLANEOUS.		
PWD	1946	Highway and Travel Map of British Columbia	20 m. to 1 in.	.35
....	....	Contoured maps of parts of South-western British Columbia.	....	....

Departmental Reference Maps.—These maps, with a few exceptions, are on a scale of 1 mile to 1 inch and show, among other features, surveyed lands, Crown-granted lands, timber licences and timber sales. The maps covering the areas described in this bulletin have been referred to under appropriate geographic headings in the text by the abbreviation Ref. Map, followed by the number of the map. Blue prints or Ozalid prints may be obtained for $1 by ordering by map number from the Surveys Division, Department of Lands and Forests, Victoria, B.C.

Departmental Mineral Reference Maps.—These maps are on a scale of 1,500 feet to 1 inch and show surveyed mineral claims. As with the reference maps, they have been been referred to in the text under appropriate geographic headings but by the abbreviation Min. Ref. Map, followed by the number of the map. Blue prints or Ozalid prints may be also obtained for $1 each by ordering by map number from the Surveys Division, Victoria.

Maps showing Mineral Claims held by Location.—Maps that show the approximate position of mineral claims held by location are kept up to date by the British Columbia Department of Mines. Copies of these maps may be seen at the offices of the Department in Victoria or in the Federal Building, Vancouver.

GENERAL FEATURES OF A FAVOURABLE PROSPECTING AREA.

Most of the gold-quartz veins in the south-western part of the Province, in common with most gold-quartz veins elsewhere in the world, are found either in or close to batholiths or stocks of granitic rocks. This common association of gold-quartz veins and intrusive rocks supports the theory that the gold-bearing solutions, from which the vein-matter was deposited, originated in the intrusive rocks or in related sources deeper in the earth's crust. The actual source is hard to prove, and although in some places granitic rocks close to quartz veins have been proven to be the actual sources of the vein-solutions, a source much deeper within the crust is generally accepted as more probable. Whatever the actual source, the close relationship of gold-quartz to small batholiths and stocks is almost universal. It does not follow that gold-bearing deposits occur in or near all small granitic batholiths or stocks, but the presence of such intrusives indicates that conditions may have been favourable for the production of vein-solutions. Therefore, search should be made in and close to such intrusives for " colours " or " float " and for an environment of rock-types favouring the development of breaks in which vein-matter could have been deposited from the solutions.

Breaks, either fractures or shear-zones, which veins may follow, tend to form where rock-types of different competency or physical characteristics are found. The breaks may follow or may cross the contacts of the different rock-types. The nature of a break which crosses a contact may differ in the different rock-types; it may be a wide shear-zone in a weak rock such as schist or schistose greenstone, and a narrow shear in a stronger rock such as a granite.

Rocks of different physical characteristics are common in the contact areas of batholiths, both within and on the outer side of a contact. On the batholith or inner side of the contact, older rocks may be found as inclusions or pendants in the batholith, giving a physical contrast in rock-types. Outward from the contact (away from the batholith) stocks and dykes cutting the older rocks give the contrasts in physical characteristics of rocks necessary for the formation of good breaks. The favourable zone is apt to be wider on the outer than on the batholith side of the contact, since in general a batholith contact dips outwards towards the older rocks, and therefore a heterogeneous assemblage of rock-types tends to extend a greater distance from the contact into the older rocks than into the batholith.

Experience has shown that the full length of any contact-zone will not be productive. After a mining camp has been established and numerous underground workings are available for study, correlation of studies of the surface and of the underground workings frequently demonstrates why producers are concentrated at one or several places but are not found continuously along the contact-zone. Before the controlling factors have been recognized, there may be little to guide the prospector to the most favourable parts of a contact-zone. However, it can be said that, in general, an embayment or the vicinity of a bend is more favourable than a section in which the contact is approximately straight.

COAST AND ISLANDS.

This part of South-western British Columbia extends southerly from Seymour Inlet to Howe Sound, and includes the mainland coast and the coastal islands, but not Vancouver Island.

Steamers of the Union Steamship Company and of the B.C. Coast Service of the Canadian Pacific Railway call regularly at many ports at which small boats may be hired for local transportation. Short stretches of road are found about the more populous centres.

The topography is rugged and in general is characterized by steep mountains rising from the shore, which is indented by deep narrow inlets. The larger stream-valleys found at the heads of the many inlets give access for several miles inland.

The climate is mild. The average annual precipitation ranges from 35 to 95 inches. The hillsides are covered with a heavy growth of timber, and mine-timber is abundant.

Properties on or close to tide-water have the advantage of being able to ship by water to the Tacoma smelter. The demand of this smelter for siliceous flux has occasioned search for siliceous ore of shipping grade, but the quantity shipped has not been great.

SEYMOUR INLET.

(Ref. Map 3.)*

At the Silta (Nugent) property, on the south side of Seymour Inlet, some small high-grade lenses of gold-quartz ore have been found in argillaceous sediments. Several veins have been explored by surface workings, largely made in 1938, and subsequently some ore was mined. The workings are not extensive, but the property is reported to have produced more than 600 oz. of gold.

LOUGHBOROUGH INLET-PHILLIPS ARM.

(Ref. Map 4 and Min. Ref. Map 5T280.)*

This area includes a part of the coast and adjacent islands that extends south-easterly from Loughborough Inlet past Phillips Arm to Frederick Arm and includes East Thurlow Island and Sonora Island. Production has come principally from the western side of Phillips Arm and the northern part of East Thurlow Island.

History.—Prospecting and mining activity was greatest in this section between 1897 and 1899. At the time a few mills operated in the area and one property, the Doratha Morton, has the distinction of having the first cyanide-mill in the Province.

In 1898 activity began to decline with prospectors leaving this section, probably for the Klondyke, and there was little activity until the thirties, when prospecting, development, mining and milling were again renewed on several properties.

A 10-ton mill was built in 1934 and two small lots of concentrates were shipped to Tacoma in 1935 and 1936 from the property of the Thurlow Gold Mines, Limited. A 25-ton mill was built at the Douglas Pine in 1940 and a small tonnage was treated.

Production.—Total production from seven properties has amounted to 5,821 oz. of gold from 13,702 tons of ore; that is, ore with an average grade of 0.42 oz. of gold per ton. Shipments from individual properties ranged from 2 to 10,000 tons. The most recent activities were in 1940 when a small amount of stoping was done on the Alexandria and small amounts of ore were mined and milled on the Douglas Pine.

Geology and Gold Deposits.

Map 65A, Coast and Islands, by J. A. Bancroft, published in 1915 by the Geological Survey, Canada, in Memoir 23, and Map 196A, Vancouver Sheet, published in 1928, also by the Geological Survey, represents the geology of this part of the coast. The mapping does not extend far inland from the shore-line.

This part of the coast is well within the western margin of the Coast Range batholith. Several isolated areas of older rocks are shown in a belt, about 5 miles wide, which extends north-westerly from Sonora Island to Loughborough Inlet a distance of 18 miles. These areas of older rocks probably represent the roots of roof-pendants now largely destroyed by erosion.

The older rocks include argillaceous sediments and volcanics that have been minutely folded, and in many places the argillites in particular have been changed to schistose rocks. Limestone pods, found at several points, have been changed by contact metamorphism to rocks consisting mostly of sulphides and high-temperature silicates. The foliation of the rocks strikes north-westerly to westerly with the trend of the belt.

The rocks of the batholith, intrusive into the older rocks, are all granitic, ranging from granite to diorite, with quartz diorite the common type.

Mineralized Belt.

In this part of the coast there is a concentration of gold-bearing lode deposits, which coincides with the belt of older rocks and was no doubt localized by them. The

* *See* p. 10.

deposits are veins in fractures and shear-zones along which there has been more or less replacement of wall-rock. Not all the deposits are in roof-pendant rocks, but those in the granitic rocks are not far from the contacts.

The mineralized belt probably represents a zone of weakness, along which faulting has occurred, between the incompetent rocks of the roof-pendant, now represented only by its roots, and the adjacent massive batholithic rocks. Bancroft (1913, p. 111) states that the Alexandria and Doratha Morton are on a north-westerly-striking fault which intersects the granite of that district.

Veins.

Gold is found in quartz veins, usually associated with small quantities of sulphides, and is rarely found if sulphides are not present. Pyrite is the commonest and usually the most abundant sulphide; small amounts of chalcopyrite, sphalerite, and galena are sometimes found. Samples of relatively pure pyrite have assayed as much as 5.5 oz. of gold per ton.

Most of the deposits are bedded quartz veins striking west-north-westerly with the formations. The vein-minerals occur in lenticular masses, one of which may die out along the strike and another may shortly come in.

Environment of Veins.

The gold-quartz veins may lie wholly within granitic rocks of the batholith, along the contact of granitic rocks with intruded rocks or dykes, or wholly within the argillites or greenstones of the roof-pendant areas.

Wholly in the Batholith.—Quartz veins and lenses striking west-north-westerly in granodiorite are found on the property of Thurlow Gold Mines, Limited, where they attain widths of 3 to 7 feet, and on the White Pine property, where they attain widths of 6 to 20 feet. A quartz vein 2 to 5 feet wide is found as an offshoot from a pegmatite dyke in granitic rocks on the property of the Hayden Bay Gold Mines, Limited, on Heydon Bay. Some of the widest veins are barren, but some of the narrower veins carry more sulphides and better gold values.

At Contacts of Dykes with the Batholith.—Quartz veins, striking north-easterly, are found in fractures and narrow shear-zones along the contacts of hornblende diorite of the Coast Range batholith and acidic dykes on the property of Loughborough Gold Mines, Limited. It may be noted that these are the only north-easterly-striking veins of consequence so far found along the mineralized belt. This property lies towards the south-western margin of the belt and the north-easterly-trending breaks, occupied first by the acidic dykes and followed later by the vein-quartz, may represent branches from the general west-north-westerly lines of shearing of the main belt.

At Contact of Argillites and Granitic Rocks.—On the Enid-Julie property numerous quartz bands and lenses alternating with schist are found over a width of 35 feet in a marginal contact-zone between granodiorite and argillites and greenstone schists. The individual quartz lenses attain widths of 2 to 5 feet and may extend several hundred feet along the strike, which is west-north-westerly.

Wholly in Argillites.—On the Doratha Morton property lenses and stringers of quartz are found along a north-north-westerly-striking shear-zone 100 feet wide that follows the contact between argillaceous schists and granitic rocks of the Coast Range batholith. Individual quartz lenses are from 1 foot to 5 feet wide.

Lenses of quartz of very great width are found bedded with argillites on the Blue Bells property. The amount of quartz is very large, but the mineralization slight and gold values low. In 1919 the Ladysmith Smelting Corporation investigated the property as a possible source of siliceous flux, hoping to find quartz with sufficient gold values to pay the cost of mining and handling.

Suggestions for Prospecting.

The several properties found to date, some of which have produced, suggest the possibility that other, perhaps better, properties may exist along the same structural feature that has determined the position of the known properties. The structural feature here is the west-north-westerly-trending belt, about 5 miles wide, characterized by many small areas of greenstones and associated sediments. Easily recognizable geological features or structures that serve to localize the known mineral deposits in the belt have not been found; however, the nature of the known properties may be used indirectly in determining where to prospect along the belt.

Production has been greatest at Loughborough Inlet and in the vicinity of Phillips Arm. South-easterly from Phillips Arm production has been smaller and prospects seem less promising. As localizing factors have not been recognized at Phillips Arm and Loughborough Inlet, it may be that the north-westerly part of the belt is more favourable than the remainder; therefore, the writer suggests prospecting along the belt between Phillips Arm and Loughborough Inlet. It is possible that a change in economic conditions may improve the ore positions of some of the former producers, on some of which a fair tonnage of low-grade material has been indicated.

References.

BANCROFT, J. A. (1913): Geology of the coast and islands between the Strait of Georgia and Queen Charlotte Sound, B.C.—*Geol. Surv., Canada,* Mem. 23.

LEROY, O. E. (1908): Preliminary report on a portion of the main coast of British Columbia and adjacent islands—*Geol. Surv., Canada,* Publication No. 996.

O'GRADY, B. T. (1936): Mainland coast and islands—*Minister of Mines, B.C.,* Ann. Rept., pp. F 17–F 25.

RICHMOND, A. M. (1934): Shoal Bay—Phillips Arm Section—*Minister of Mines, B.C.,* Ann. Rept., pp. F 7–F 11.

QUADRA ISLAND.
(Ref. Map. 4A.)*

Quadra Island lies immediately east of Campbell River on Vancouver Island. It is best known for the several small copper properties and prospects found mainly along what is known as the lime-belt. Of the two dozen properties on the island half are in the lime-belt.

A production of 248,848 lb. of copper and 239 oz. of gold has been recorded from six properties. These include four copper properties; one copper-gold property, the Lucky Jim; and one gold, the Geiler. The approximate grade of the three types of ore from these properties is as follows: Copper ore, 2½ per cent. copper; copper-gold ore, 2½ per cent. copper and 0.45 oz. gold per ton; and the gold ore, 0.51 oz. gold per ton.

Both the gold properties, the Lucky Jim and the Geiler, are in the lime-belt. This belt extends for 10 miles north-westerly across the island from Open Bay to Granite Bay, with an average width of 1 to 2 miles. It consists mainly of limestone with small amounts of intercalated greenstone. The lime-belt is flanked on the north by granitic rocks of the Coast Range batholith and on the south by greenstones.

The Lucky Jim, along with the many copper properties in the belt, is a contact metamorphic type of deposit, in limestone close to granitic rocks. It is characterized by irregular lenses of sulphides, usually not more than 2 feet wide, containing abundant pyrrhotite with lesser amounts of chalcopyrite and pyrite. Of the many contact metamorphic deposits in the belt, the Lucky Jim is the only one carrying gold.

The Geiler belongs to a group characterized by small gold-quartz veins found in shear-zones in the greenstones of the belt. A small quantity of ore, averaging slightly over ½ oz. of gold to the ton, has been mined.

* *See* p. 10.

Several copper properties have been found on the east and west coasts of the island south of the lime-belt. These consist mainly of chalcopyrite or chalcocite in shear-zones in greenstones. They do not contain any gold of significance.

Reference.

CAIRNES, D. D. (1913): The lime belt, Quadra (South Valdes) Island, B.C.—*Geol. Surv., Canada,* Sum. Rept., pp., 58–75.

TEXADA ISLAND.

(Ref. Map 5 and Min. Ref. Map 17T269.)*

Distribution of Properties.

The part of the island lying north of a line between Gillies Bay on the west and Pocahontas Bay on the east coast has been extensively prospected. At least thirty-seven mines and prospects are found in the northern part of the island, which has an area of 36 square miles. In the southern part of the island, measuring 85 square miles, only one prospect has been reported.

Southern Part of the Island.—The rugged and heavily wooded southern part of the island is served by few trails and no roads. It is underlain mainly by greenstone, with two small areas of quartz diorite, one near Pocahontas Bay, 1½ square miles in area, and the other near Long Beach, 2½ square miles in area. Certain features of the geology suggest that the southern part of the island could be prospected to advantage. Difficult access, however, is a serious drawback.

Northern Part of the Island.—Much less rugged and not so heavily wooded as the southern part, the northern part of the island is served by numerous roads and trails. It is underlain by greenstone, a belt of limestone 1 to 2 miles wide, and numerous small areas of intrusive rocks. The geology of this part of the island is represented on a map (scale, 2 miles to 1 inch) which accompanies Memoir 58 (McConnell, 1914), and on a more detailed map by Mathews (1946).

Copper mines which have produced gold as a by-product comprise most of the mines on the island. Only a few gold-quartz veins have been found, and the gold production from them has been very small. Three large magnetite-iron deposits are found on the west coast of the island.

Copper-Gold Deposits.

The principal gold-copper mines include the Cornell, Copper Queen, Little Billie, and Marble Bay, all of which are near the town of Vananda on the east coast of the island. The deposits are of the contact metamorphic type and are found in limestone adjacent to intrusives related to the Coast Range batholith. The ore minerals are mainly bornite and chalcopyrite, accompanied by a gangue consisting mainly of the high-temperature silicates wollastonite, garnet, and actinolite. The ore is usually in the form of chimneys.

History.—The copper-gold properties on Texada Island were worked actively in the 1890's and 1900's, but intermittent production was maintained until 1929, by which time they had all become virtually inactive; however, during recent years some of the former producers have been dewatered and explored further. In 1943 the Little Billie was dewatered to the bottom level and a programme of development by diamond-drilling commenced; underground work started then is still being carried on. In 1944 the Copper Queen was dewatered and diamond-drilled, but allowed to fill up shortly thereafter. In 1945 the Marble Bay was dewatered to just below No. 7 level and diamond-drilled, but this work was stopped in August, 1946, and the mine allowed to fill up with water. Also in 1945 the Loyal property, near Blubber Bay, was diamond-drilled from the surface, but no further work was done.

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* *See* p. 10.

Production and Grade.—The copper-gold mines on Texada Island have produced 18,451,730 lb. of copper, 487,020 oz. of silver, and 66,974 oz. of gold from 366,925 tons of ore. This represents production from eight copper properties; of these properties, six produced between 3,000 and 300,000 lb. of copper and two, the Cornell and Marble Bay, 3,017,070 lb. and 14,967,786 lb. of copper respectively. The average grade of ore for the total production is 0.18 oz. of gold per ton and 2.5 per cent. copper, but the grade has ranged from 6.6 per cent. copper and 0.4 oz. of gold for the small producers to 2.3 per cent. copper and 0.16 oz. of gold for the larger producers. The gold content was approximately proportional to the copper content.

Gold-quartz Veins.

A few gold-bearing quartz veins have been found on the island, but the veins are small and low grade; consequently, the production has been small. A few of the prospects have yielded a few hundred pounds of bonanza ore each, but further search has failed to produce comparable ore in important quantity.

The deposits are quartz veins and silicified shear-zones, mainly in greenstone. The few known veins are small, some attaining widths of 3 to 5 feet, and widely separated; no localizing structural controls of the gold veins are evident. The veins contain, in addition to free gold, small amounts of pyrite, chalcopyrite, sphalerite, magnetite, and galena.

History.—The gold-quartz properties were found in the 1890's as a result of the success that was then attending the development of the gold-copper properties. The work on the gold-quartz veins at that time consisted mainly of trenching and the sinking of shallow shafts on approximately eleven properties. As a result of the recent interest in the Little Billie and Marble Bay mines, several of these gold-quartz properties have been restudied during the past two years. The Gem was dewatered and examined in 1945, but allowed to fill up again; the Red Hawk was trenched, and two shear-zones on Surprise Mountain were drilled and trenched by Surprise Gold Mines, Ltd.

Production.—At least eleven prospects have been found, and a small production is reported from four of them. The production from two properties, slightly over 300 tons, is reported to have yielded about 160 oz. of gold. Excepting on the Gem and Marjorie, the amount of underground work on these properties is small.

It is reported that $2,000 was recovered from a shallow working on the Gem (Nutcracker) in 1896. This property is developed by a 150-foot shaft with crosscuts and drifts on the veins, but no quantity of ore has been found. A 200-ton mill was built in 1926 but never operated. On the Marjorie, free-gold ore taken from a hole 7 feet square by 6 feet deep is reported to have yielded $6,500 in gold.

Suggestions for Prospecting.

As mining activity in the producing section dates back to 1896, it is probable that the surface outcrops in the vicinity of the producing copper-gold mines have been examined many times. Probably future finds in this section will be made as a result of dewatering the old copper-gold mines and carrying on underground exploration by diamond-drilling and the driving of levels; surface prospecting by individual prospectors is less likely to be successful.

The work on the known gold-quartz veins has not been very successful. Rock-outcrops are fairly numerous on the island, and the north end in particular is not difficult to prospect. It is doubtful if further surface prospecting will find other gold-quartz veins of mineable width and grade.

References.

MATHEWS, W. H. (1946): Geology of the limestone deposits of the northern part of Texada Island, B.C.—*Western Miner*, Vol. 19, No. 2, p. 39; and Bull. 23, *B.C. Dept. of Mines*, on press.

McCONNELL, R. G. (1914): Texada Island, B.C.—*Geol. Surv., Canada,* Mem. 58.

STEVENSON, J. S. (1944): Little Billie Mine, Texada Island—*Minister of Mines, B.C.,* Ann. Rept., pp. A 162–A 174.

LASQUETI ISLAND.

(Ref. Maps 5 and 108.)*

Lasqueti Island, just off the south-western end of Texada Island, has an area of 25 square miles, consisting chiefly of low, rounded, well-wooded but rocky hills.

History.—The properties on Lasqueti Island have been prospected intermittently from the early 1900's, and between 1909 and 1940 several small shipments have been made. Since World War II., interest has been renewed, and several of the properties have been prospected by surface work, diamond-drilling, and some underground work.

Production.—Production, mainly from three copper-gold properties, has amounted to 831 tons, averaging 3.9 per cent. copper and about 0.2 oz. of gold per ton. Some ore shipments have been as high as 0.7 oz. of gold per ton and 16 per cent. copper. The gold values are proportional to the copper content.

Geology.—Greenstones underlie the greater part of Lasqueti Island, but quartz diorite, 2 miles long and 1 mile wide, extends northerly from Scottie Bay to False Bay.

Location of Properties.—The known properties lie towards the north end of a tongue of quartz diorite where it projects into the greenstone. Some properties are in the quartz diorite practically on the contact, others are in the greenstone a short distance from it.

Nature of Mineralization.—Lenses and stringers of chalcopyrite and pyrite replacing crushed rock are found in shear-zones, which range from a few inches to several feet wide and may be traced for several hundred feet. Although lenses of chalcopyrite up to 4 feet wide have been found and stoped, most lenses are much narrower, and the distribution of high-grade ore along the shears is so erratic that as yet only a small amount of ore has been found.

Mackenzie (1921, p. 56) describes a persistent shear-zone, 2 to 4 feet wide, that has been traced nearly continuously for 900 feet cutting through both quartz diorite and greenstone. This zone lies about 1,500 feet south-easterly from the workings on the Venus. It trends north by east and locally is mineralized with chalcopyrite.

Because of similarity in strike and mineralogy to the mineralized zones on the other properties, further prospecting of this shear might be warranted.

Suggestions for Prospecting.

Search for ore-bodies by further exploration of the known shear-zones has some prospect of success. The north-north-easterly-striking shear-zones in or close to the contact of the quartz diorite seem to hold most promise.

Reference.

MACKENZIE, J. D. (1921): Lasqueti Island—*Geol. Surv., Canada,* Sum. Rept., p. 50.

LOWER MAINLAND.

The part of the lower mainland between Harrison Lake and Jervis Inlet contains numerous copper properties and one very important producer. Of the gold prospects, only the Ashloo, north of Squamish, has produced gold in any quantity.

Access.—The southern and eastern parts of the lower mainland are accessible from the Fraser River, Harrison Lake, and Lillooet Lake, and the western part from the coastal waters. From Squamish, at the head of Howe Sound, the Pacific Great Eastern Railway runs north-easterly through the area.

* *See* p. 10.

General Geology and Mineralization.—Geologically, the area represents a section across the main Coast Range batholith. Much of the bed-rock is granitic, but there are also many pendant-areas of rocks older than the intrusives. The older rocks, which include sericite and chlorite schists, greenstones, tuffaceous sediments, and lenticular bodies of limestones, are irregularily scattered and do not form extensive well-defined belts.

The copper deposits are either replacements along drag-folds and shear-zones in schistose rocks, closely related to feldspar porphyries, or high-temperature replacements of limestone at contacts with batholithic or stock-like bodies. The principal ore mineral is chalcopyrite. Mineralized drag-folds and shear-zones have so far proven to be the most productive.

SQUAMISH-PEMBERTON.

(Ref. Maps 5B, 5C, 62, 63, and Min. Ref. Maps 12T286, 1T294.)*

Belt along Pacific Great Eastern Railway between Pemberton and Squamish.

The Pacific Great Eastern Railway between Squamish and Pemberton cuts across the main Coast Range batholith and any west-north-westerly-trending structures associated with the batholith. The ruggedness of the country and numerous ice-fields have prevented prospecting north-westerly and south-easterly from the railway.

Geology.—The rocks of this area consist mainly of Coast Range granitic rocks and narrow bands of older stratified rocks that include schists, quartzites, argillites, limestones, and greenstones. Tertiary and recent lavas are common.

Mineralization.—About ten properties have been found and worked in this section but, excepting one gold property—the Ashloo—they are all either lead-zinc or copper prospects.

The Ashloo property, on Ashlu Creek, is about 28 miles by road and trail north-north-west of Squamish. It is in an area of strong relief in which the mountain-sides are steep, heavily wooded, and the streams characterized by many canyons.

The deposit lies well within the Coast Range batholith, and consists of bands of quartz in a long, wide shear-zone in the granodiorite of the batholith. The shear strikes north-north-easterly and dips 23 degrees westward, tending to follow an irregular lens of basic dyke-rock. The quartz ranges from a few inches to 6 feet in width and the shear is of comparable width; the shear is not continuously quartz-bearing. The quartz contains intermittent concentrations of pyrite, chalcopyrite, and occasionally pyrrhotite. The gold content of the vein is proportional to the sulphide content and assays of several ounces in gold have been obtained from sulphide-rich vein-matter.

In the period 1932–1939 ore mined amounted to 15,047 tons and yielded 6,396 oz. of gold, 7,154 oz. silver, and 66,187 lb. copper.

The property has been explored by surface workings and by underground workings with a total length of several thousand feet, including an adit, several other levels, connecting winzes, and a raise. A 25-ton mill was built in 1936. The mine closed down in 1939.

Reference.

O'Grady, B. T. (1935): Annual Report, Minister of Mines, B.C., pp. F 1–F 6.

AGASSIZ.

(Ref. Map 86.)*

Many copper prospects, but no gold prospects, have been found in the vicinity of Agassiz. The deposits are mainly small iron and copper sulphide replacements in limestone lenses, close to bodies of intrusive rocks, with the principal values in copper. Ore has been shipped from one property—the Empress—from which 100 tons, shipped in 1917, contained 14,000 lb. of copper.

* *See* p. 10.

On the Lucky Four group, near Wahleach Lake, high in the Cheam Range, south-easterly from Agassiz, chalcopyrite mineralization has been found in metamorphosed limestone. The information available does not indicate that appreciable gold values accompany the copper mineralization.

HARRISON LAKE-FIRE LAKE.

(Ref. Maps 5C, 86, and 87.)*

Harrison Lake extends for about 35 miles northerly to north-westerly from Harrison Hot Springs, due north of Agassiz. Fire Lake is about 12 miles north-westerly from Tipella, near the northern end of Harrison Lake. The original Cariboo Road was built up the Lillooet River from Douglas, near the northern end of Little Harrison Lake, and the surrounding country was prospected many years ago.

Gold has been found at the Providence (Province) property, on the west side of Harrison Lake about 28 miles northerly from Harrison Hot Springs, and at several properties on the north side of Fire Lake.

Somewhat indefinite statements indicate that ore from the Providence, shipped to smelters at Tacoma and Everett about 1897 and 1898, averaged \$20 to \$34 per ton in gold and silver. From the brief descriptions of the property available, it appears that quartz veins containing some pyrite were found. The property has been explored by a shaft and several adits.

The Fire Lake area is reached by 16 miles of trail north-westerly from Tipella at the northern end of Harrison Lake. About 40 years ago the finding of scattered bunches of high-grade ore in veins north of Fire Lake started a short period of intense prospecting and on the Money Spinner a 50-ton concentrator was built. It is reported that only 50 tons of ore was milled. Since then activity in the area has been slight, except between 1930 and 1934, when several men did surface prospecting on four properties and underground work on one.

The low values obtained from the numerous samples taken indicate that though quartz veins are abundant and of a fair width their gold content is small.

Several properties have been staked on the northern side of Fire Lake, mostly on well-defined gash-veins in massive greenstone. The gash-veins range up to 2 feet in width and up to 80 feet in length and strike from north-easterly to easterly. A well-defined fissure-vein on the Money Spinner, striking north-south, averages 4 feet in width and has been traced by underground and surface workings for several hundred feet. The quartz in these veins is slightly mineralized with pyrite and chalcopyrite and samples across mining widths assay from traces to less than ¼ oz. of gold per ton.

CHILLIWACK RIVER.

(Ref. Map 86.)*

The Mountain Goat and the property of the Sleese Creek Mining and Development Company, Limited, on Slesse Creek are gold prospects. On the Mountain Goat the gold is found associated with pyrrhotite in narrow quartz veins that cut sediments near their contacts with a stock of diorite. High-grade mineralization is very erratic and continuous ore has not been found. The property of the Sleese Creek Mining and Development Company, Limited, is close to the western border of a large area of batholithic rocks and includes granodiorite and quartz diorite, in which narrow quartz veins containing pyrite and small amounts of gold have been found.

The fact that small amounts of very rich gold ore have been found on the Mountain Goat, and that over a period of years high-grade ore was shipped from the Boundary Red Mountain Company's mine on Slesse Creek, just across the border in the United States, suggests the advisability of further prospecting in the area, particularly northerly and southerly along the contact-zone of the large area of granodiorite which lies east of Slesse Mountain.

* *See* p. 10.

Molybdenite has been found at the north-western end of Chilliwack Lake, and the Dolly Varden, a lead-zinc prospect, is at the southern end.

HOPE.

(Ref. Map 86.)*

In the area about Hope two gold properties of some promise have been found:—

On the Aufeas, on Silverhope (Silver) Creek, about 6 miles south-west of Hope, quartz veins contain abundant arsenopyrite, with which gold is associated. The veins are found in quartz diorite in a large area of batholithic rocks some distance from the contact with the older rocks. Further prospecting is warranted in a direction eastward towards the older rocks.

On the Hillsbar Creek gold claims, 14 miles north of Hope, north-westerly-striking quartz veins have been found bedded in slates at distances between 100 and 200 feet from a granodiorite contact. The veins pinch and swell, and range in width from a few inches to 3 feet. Some free gold has been found, but the mineralization is scanty. Very little development-work has been done on the property.

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EASTERN FLANK OF COAST RANGE.

SIWASH CREEK, COQUIHALLA RIVER, SKAGIT RIVER.

Delineation of the Area.—This area, lying along the eastern flank of the Coast Range, extends south-south-easterly from Siwash Creek, near Yale, across the Coquihalla River, to where the Skagit River crosses the International Boundary. This area, 42 miles long by about 15 miles wide, includes the Siwash Creek, Coquihalla Gold Belt, and Skagit River mineralized sections.

GENERAL GEOLOGY.

Siwash Creek and Coquihalla River Sections.

Some of the geological features found in this area may represent the southerly extension of similar features found in the Bridge River area. The gold mineralization does not duplicate that found in the Bridge River, but it is similar in that it is found

* *See* p. 10.

close to the eastern margin of the Coast Range batholith and mainly where a change takes place in the trend of the formations. However, any correlation between the two areas must bridge a large gap of country in which the geology is imperfectly known, and in which no important gold mineralization has been recorded.

Sediments.—The oldest rocks consist mainly of andesitic lavas, intercalated with argillites and ribbon-chert, all of which strike northerly. They resemble the rocks variously referred to as the Fergusson or Bridge River series in the Bridge River area and the Cache Creek series throughout Central British Columbia.

To the north-east, the oldest rocks in this area are overlain by a wide belt of black, slaty rocks, comprising the Ladner slate-belt, which is overlain by tuff, agglomerate, sandstone, and argillite of the Dewdney Creek group, overlain in turn by conglomerate of the Jackass Mountain group.

Serpentine Belt.—A narrow belt of rocks in which serpentine is a conspicuous member lies between rocks of the Cache Creek series to the south-west and rocks of the Ladner slate-belt on the north-east. This belt, referred to as the "serpentine-belt" and grouped with the Cache Creek series, is of special significance because many of the gold deposits of the area are found along the contact bodies of serpentine and other members of the belt.

The belt does not exceed a mile in width, averaging about half a mile, and extends north-north-westerly from a point 12 miles south-west of Jessica nearly to Boston Bar, a distance of 39 miles. It ranges in strike from north-north-westerly at the south to north-westerly at the north. The main gold properties in the serpentine-belt are found a few miles north-west of Jessica, where the strike of the belt changes from north-westerly to north-north-westerly.

Along the belt, serpentine forms a close succession of dyke or sill-like masses in andesitic volcanics, tuffaceous sediments, and intrusive porphyries.

Cairnes thinks (1929, p. 178) that the serpentine represents peridotite that, prior to its serpentinization, was intruded as a sill-like mass or succession of masses along a zone of weakness or shearing. The shear formed within a zone of relatively incompetent volcanics and tuffaceous sediments at the top of the Cache Creek series where they lay against a more competent set of rocks composed chiefly of strong ribbon-cherts. The intrusion of this rock marked the beginning of the long line of Coast Range intrusions, which included the various batholiths, porphyry dykes, and, lastly, mineralizing solutions.

Granitic Rocks.—The granitic rocks of the area include a notably crushed and foliated gneissic granite and granodiorite locally known as the Custer granite, and younger granitic intrusions, consisting of massive granite, granodiorite, quartz diorite, and diorite. The gold deposits lie 2 to 5 miles easterly from the eastern margin of these intrusives.

Porphyries.—Many smaller acid intrusives, mainly porphyries, are found as dykes and sills in sedimentary rocks. Some of the intrusives are Jurassic in age and contribute granite detritus to the early Lower Cretaceous Jackass Mountain conglomerate, others may be of Tertiary age. The intrusives trend north-westerly and many have gold deposits associated with them.

General Structure.—The folds in the stratified rocks, faults in both stratified and massive rocks, and foliated structures in some of the granitic rocks all have a general north-westerly trend like that of the eastern contact of the Coast Range batholith. The contact lies west of Harrison Lake and Lillooet River.

Rocks up to and including the early Lower Cretaceous are highly deformed, but the younger rocks are not.

SIWASH CREEK SECTION.
(Ref. Map. 87.)*

Several prospects, including the Roddick, Jubilee, Coronation, British Gold, and Golden Eagle, are found at the bend of Siwash Creek, in an area 6 miles long by 5 miles wide.

This section is reached by a cable crossing over the Fraser River near Yale, thence by trail up Siwash Creek for about 4 miles.

On Siwash Creek, as has been the case elsewhere, placer-miners who had been washing stream-gravels for gold found gold-bearing lode deposits. The discoveries made about 1891–92 were quartz veins in and near porphyry dykes. In 1896, early in the prospecting of these properties, a 3-stamp mill was built, and in 1905 two larger mills were built. A renewal of activity occurred in 1911, but little has been done since.

The rocks include slates, garnet-schists, mica-schists, siliceous schists, quartzites, and crystalline limestone, all cut by Coast Range intrusives and acid dykes. A band of serpentine 400 feet wide can be traced for 3 miles.

Gold-bearing quartz veins have been found in porphyry dykes and at the contacts of the dykes with slate. The distribution of the gold within the veins is very erratic. The quartz contains small amounts of pyrite, chalcopyrite, and galena. Parts of the known quartz veins are rich, but are not continuous enough to make ore.

Suggestions for Prospecting.—Knowing that rich gold-pockets have been found in the veins of the district, it is reasonable to search for additional veins, hoping that in some may be found rich pockets sufficiently closely spaced to make ore. Inasmuch as the veins are definitely related to porphyry dykes, areas in which porphyry dykes are numerous should be studied. Because of the close spatial relationship of the gold deposits with both the porphyry dykes and the serpentine-belt in the Coquihalla gold-belt to the south, areas of porphyry dykes where close to, or in, serpentine should be examined. Quartz veins found in such an environment might yield gold ore. Because of a distinct bend in the serpentine-belt between Siwash Creek and Jessica on the Coquihalla gold-belt, the writer suggests prospecting between Siwash Creek and Jessica.

COQUIHALLA GOLD-BELT.
(Ref. Maps 86 and 87.)*

This section crosses the Coquihalla River near Jessica station on the Kettle Valley branch of the Canadian Pacific Railway and extends north-westerly for 5 miles and south-easterly for 3 miles.

The various properties on the belt are reached by short roads and trails from Jessica, which is 15 miles by railway from Hope.

History.—Before the discovery of the gold properties in the serpentine-belt, quartz veins and siliceous zones in both the Ladner slate-belt to the north-east and the rocks of the Cache Creek series to the south-west had been prospected for several years, and from 1916 there had been small intermittent production. In 1928, high-grade gold ore was found on the Aurum in a talcose-shear along the north-easterly contact of a band of serpentine. Other discoveries related to serpentine bodies were made north-westerly and south-easterly, and for some time the area was actively prospected; but many prospects were promoted beyond their merits, more energy and money being spent in promoting them than in actual prospecting. Between 1916 and 1942 five properties produced ore amounting to 3,102 tons and containing 3,912 oz. of gold, an average of 1.2 oz. of gold per ton.

Properties.—The properties on the belt north-west of the Coquihalla River include the Aurum, Emancipation, Pipestem, Hope Gold Mines, Ltd., South Fork group, Montana group, Spider Peak group, the Spencer holdings, the Keystone group, the Mammoth Holdings, Ltd., and south-east of Coquihalla River the properties of the Columbia Metals, Ltd., Reward Mining Company, and the Dalhousie Mining Company.

* *See* p. 10.

Types of Ore Deposits.

The ore deposits of the belt may be divided into two groups: (1) Those characterized by gold and sulphides associated with "talc" at the contact of serpentine and other rocks, as exemplified by the Aurum deposit, and (2) Gold-bearing quartz veins found mainly in the Ladner slate-belt close to the serpentine-belt, as exemplified by the Emancipation deposit.

To date the second type has produced the larger amount of gold.

Associated with Talc.—In several places along the belt the serpentine near its contact with the older rocks has been sheared and largely replaced by talc. The talcose shear, ranging in thickness from less than a foot to several feet, contains several gold-ore bodies. The gold is very unevenly distributed, being found in clusters or veinlets and quite often as polished films along slickensides. The polished films are exceedingly thin and contain a deceivingly small amount of gold. Concentrations of gold or small ore-shoots are related to irregularities or rolls along the contact surface of the serpentine body.

Most of the gold in the talcose shear is free, but in some places it is associated with sulphides, which include pyrite, chalcopyrite, arsenopyrite, pyrrhotite, and nickel sulphides. A small amount of quartz and calcite gangue may be present. Of the sulphides, arsenopyrite is most commonly associated with gold.

The gold-bearing talc is found in or near serpentine contacts, in some places on the north-eastern and in other places on the south-western contact. Since the gold is so erratically distributed, finding commercial ore depends on finding a sufficient number of rich shoots closely enough spaced to make some tonnage with payable values.

After the recognition or discovery of gold along serpentine contacts, the serpentine-belt was boomed and many short-lived companies were formed. It is to be inferred from this that considerable prospecting has been done along the serpentine contacts, but it is not known how thoroughly this was done. The Aurum, towards the north-western end of the line of properties on the belt, is the one producer from the talc-seam, and its production has been small.

Quartz Veins.—The second type of deposit in the belt—namely, gold-bearing quartz veins in the Ladner slate-belt—is the more important. Many quartz veins have been found and prospected, and production from two properties has amounted to 2,226 tons of ore containing 3,117 oz. of gold, or an average content of 1.4 oz. of gold per ton.

The veins contain free gold, arsenopyrite, pyrrhotite, pyrite, and chalcopyrite in small amounts, range in width from a few inches to 10 feet, and strike north-north-westerly with the formation.

In the principle example of this type of deposit, the Emancipation (Dawson), a low-grade foot-wall vein 10 feet wide and a relatively high-grade, narrow, hanging-wall vein up to 2 feet wide are found along a sheared belt of rocks 50 feet wide between slates of the Ladner slate-belt and Cache Creek volcanics and tuffs. The rocks between the veins are laced with many quartz veinlets. An important ore-shoot was found where a flat cross-section intersected the hanging-wall vein.

The quartz veins of this type are often close to or in porphyry dykes or sills. They are similar in this respect to those of Siwash Creek.

Origin of Quartz Veins and Relation to Serpentine-belt.—The proximity of these veins to the gold occurrences in the talc-seams of the serpentine-belt is probably because both types of deposit are related to a zone of shearing between competent cherts and incompetent upper tuffaceous rocks of the Cache Creek. That is, the mineralizing solutions that resulted in the gold-quartz veins of the Ladner slate-belt close to the serpentine-belt found access by way of the same general zone of shearing that gave access to gold-bearing solutions that deposited gold in the talcose-shears along serpentine-contacts. The two types of deposits are different because of the different response by the two physically different host-rocks, serpentine and slate, to the same deforming and fracturing forces.

Suggestions for Prospecting.

The extent of the serpentine or gold belt south-easterly across the Coquihalla River was prospected following the discovery of high-grade ore, but very little was found. It should be noted that placer gold has been found on Sowaqua Creek right where the creek crosses the serpentine-belt. Probably this placer gold came from veins along the belt, and the veins, if found, might contain ore. However, Cairnes (1929, p. 176) suggests that some of the gold is from reworked glacial debris of the main Coquihalla Valley glacier and that the rocks which supplied the gold may have originated, in part, entirely outside the basin of Sowaqua Creek.

The only producers in the Coquihalla gold-belt are at the north-western end of the belt near the Aurum, and nothing has been found farther to the north-west. It is possible that the section between the Aurum and Siwash Creek has not been thoroughly prospected. As previously noted on page 21, the strike of the serpentine-belt changes from north-westerly to north-north-westerly a few miles north-westerly from Jessica, near the Aurum. Inasmuch as ore deposits are commonly found where marked changes in structures of the enclosing rocks take place, the general area of the change in the strike of the serpentine-belt, near the Aurum and north-westerly towards Siwash Creek, offers possibilities of finding some mineralization.

Skagit River Section.

(Ref. Maps 6c and 86.)*

A large mineralized area is found in part of the Skagit River drainage-basin in British Columbia, in the vicinity of the 23-Mile Camp at the junction of the Sumallo and Skagit Rivers and southerly to the International Boundary. The ores are mainly those of silver, copper, lead, and zinc; however, some of the deposits carry gold in quantities which, though small, might aid in making a property workable. Lack of transportation is a main drawback. Access is by way of the western end of the Hope-Princeton Highway, for 23 miles by road from Hope to 23-Mile Camp. The southern part of the area is reached from the highway by pack-trails.

History.—The area first gained prominence in 1910, when a couple of prospectors fraudulently reported finding high-grade gold ore on Steamboat Mountain, south of Shawatum (10-Mile) Creek. This stimulated prospecting in the area, and since then many prospects of silver, copper, lead, and zinc have been found and have been worked intermittently; small shipments have been made from two silver-lead-zinc properties.

Interest was recently aroused in the area when, in 1945, the Skagit River Development Company did some diamond-drilling on the Invermay Annex, a silver-lead-zinc property on Daisy Creek, 4 miles from the Skagit River Road.

Production.—The Skagit River section has produced, over a period of years, 125 tons of ore containing 11,477 oz. of silver, 26,541 lb. of lead, and 12,163 lb. of zinc. The amount is small, but it must be remembered that the ore was taken out partly by pack-horses and then by truck over 23 miles of poor road.

Geology.—The rocks comprise southerly-trending belts of sedimentary and volcanic rocks, including the Hozameen series, exposed on both sides of the Skagit River valley, and the Dewdney Creek group lying east of these. The Hozameen rocks include greenstone, chert, slate, and limestone. The limestone, though not as abundant as the other rock-types, is important because it is the host for replacement deposits of the area.

* *See* p. 10.

The rocks of the Dewdney Creek group consist mainly of tuffaceous sediments.

Three masses of granitic intrusive rocks are found in the area; they are mainly granodiorite and quartz diorite. What may be considered to be the eastern contact of the main area of the Coast Range batholithic rocks lies about 10 miles west of the main northerly-trending mineralized belt. Small masses of ultra-basic rock have been recognized north of 23-Mile Camp and north of Shawatum (10-Mile) Creek.

The rocks are folded in north and north-north-westerly-trending anticlines and synclines.

Replacement Deposits.—In the Dewdney series at the A.M. property, south-east of the head of Silver Daisy (24-Mile) Creek, pyrite and chalcopyrite with quartz and calcite replace the matrix, in a bed of breccia, and carry values in copper, gold, and silver. In the Hozameen series limestone lenses are replaced by various sulphides, forming different types of deposit. One type, characterized by pyrite, chalcopyrite, sphalerite, arsenopyrite, and galena, with values principally in copper and silver, is represented by the Silver Bell, near Silver Daisy Creek, and the Sunset, on Galena Creek. Another type, characterized mainly by pyrrhotite, usually contains some chalcopyrite and may contain sphalerite, pyrite, and galena; the values in copper, silver, and gold are low, but the gold is more constant than in the other type. Many deposits in the Shawatum (10-Mile) Creek section belong to this group.

Veins.—Mineralized quartz veins, less than 2 feet wide, found in greenstones, cherts, and granitic rocks, carry values mainly in silver and lead, but gold is known to occur associated with arsenopyrite. The veins on which most development-work has been done, and from which small shipments have been made, are found in the 23-Mile Camp and in an area of intrusive rocks just east of the camp.

Suggestions for Prospecting.

Prospecting in the area should be devoted to looking for gold-bearing replacement deposits because, from the nature of the finds so far made in the area, it appears that only in this type of deposit is there any hope of finding a sufficiently large tonnage of ore to warrant improving the transportation facilities.

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ANDERSON LAKE-TATLA LAKE.

Delineation of the Belt.—A belt of country extending along the eastern flank of the Coast Range from Anderson and Seton Lakes north-westerly for 150 miles to Tatla Lake contains isolated mineral deposits, some of which are near the flank of the Coast Range and others as much as 30 miles east of it. This belt includes the Bridge River area with two major producing mines and other areas in which prospects have been found. The several areas are as follows. The Bridge River area; areas north-west of Bridge River, including the Upper Taseko River, Taseko Lake, Tatlayoko Lake, Perkins Peak, and Blackhorn Mountain sections; and areas east and south-east of Bridge River, including the Cayoosh Creek and Duffey Lake sections.

Access.—The southern part of the belt is reached from Shalalth by motor-road and the northern part from Williams Lake by the Chilcotin road. Shalalth and Williams Lake may be reached from Vancouver by motor-road or by the Pacific Great Eastern Railway from Squamish.

Topography, Forest-cover, and Climate.—Inasmuch as the full length of the belt is along the eastern flank of the Coast Range, it is extremely rugged. Altitudes range from the following lake elevations: Anderson Lake, 777 feet; Gun Lake, 2,908 feet; Taseko Lake, 4,400 feet; and Tatlayoko Lake, 2,717 feet, to the mountain-tops, some of which are over 9,000 feet and many over 8,000 feet in elevation. North-east of the headwaters of Tyaughton Creek and of the northern ends of Taseko and Chilko Lakes the mountains give way to the level country of the Interior Plateaux, an extensively lava- and drift-covered area, and therefore generally unsatisfactory for prospecting.

The Plateaux area is sparsely wooded with conifers, but the areas which are closer to the mountains, and therefore at slightly higher elevation, are more thickly wooded.

In general the climate is agreeable, the summer months warm and dry and the winter months moderately cold. Snowfall is slight and rainfall moderate.

History.—The history of gold-mining along the length of the belt has hinged mainly on developments in the Anderson Lake-Bridge River section, and therefore the history of the belt is largely the history of these two sections.

As is not unusual, the lode discoveries followed placer operations. Placer was discovered in the Fraser at Lillooet in 1859 and shortly thereafter in Cayoosh Creek, Bridge River, and some of its tributaries.

Lode gold was first discovered on the Hurley River in 1882, and in 1896 on Cadwallader Creek on the Forty Thieves group. Between 1897 and 1900 most of the better-known properties in the Bridge River area were staked, including the Lorne, Coronation, Pioneer, and Wayside. From that time to the present the district has gone through several periods of activity and inactivity in prospecting and mining developments.

From the time of discovery until about 1915 desultory mining and milling were carried on at several properties. The first milling was done in home-made arrastras. It is interesting to note that for the ten years prior to 1911, one man—E. H. Kinder—mined Pioneer ore, milled it in a home-made arrastra, and is reported to have made very good wages. Later, milling on some of the properties was done in stamp-mills. At various times mills up to 10-stamp size operated on the Lorne, Coronation, Pioneer, and to the south-east on the property of the McGillivray Creek Gold Mines, Limited. This represents the first period of activity.

Between 1917 and 1924 very little was done. The present era of mining and milling was begun at the Pioneer and was confined to that property for several years. Credit for getting the Pioneer started is due largely to Dave Sloan. The first brick of gold produced from the Pioneer mine under his management was poured in 1924. Until about 1928 Pioneer used a 30-ton amalgamating mill left by earlier operators, in 1928 a 100-ton cyanide-mill was installed, and in 1932 the mill was enlarged to 300 tons.

Interest in the area grew with the increasing success of the Pioneer Company. Large-scale developments at the other main producer in the region, the Bralorne mine, followed those at Pioneer. The present Bralorne mine includes several former properties, the original being the Lorne. Hand-work and milling in stamp-mills had been done on the Lorne prior to 1928, when Lorne Gold Mines, Limited, was incorporated. Large-scale development was begun in 1928, and after a period of inactivity was resumed in 1931. The present company, Bralorne Mines, Limited, was formed in 1931. Milling began late that year, and in 1933 large extensions of the King vein were found, demonstrating the importance of the property.

In the period 1932–35, work was undertaken on many properties, including several on Bridge River below the mouth of Hurley River. In the period 1934–37, mills were operated on the Pioneer, Bralorne, Wayside, and Minto properties. By 1938 mining and milling had stopped at the Minto and Wayside, and prospecting and exploration in the area reached a low ebb. However, Pioneer and Bralorne not only continued production, but in 1939 reached all-time highs in milling, Pioneer milling 375 tons daily and Bralorne 500 tons. During World War II. these mines mined and milled at reduced rates, but during the past two years they have started to increase these rates to pre-war levels. Since the war, interest has been renewed in many of the other properties in this section, and as a result development-work is currently in progress on the P.E., Holland, Native Son, and Short O'Bacon (Pinebrayle); B.R. Jewel, Grull-Wihksne, Golden Ledge, B.R.X., Bridge River Consolidated, Wayside, Congress, Pilot, Minto, Olympic, and Bristol. Work is also being done on showings of high-grade sulphides on the Ranger (Truax) property discovered in 1944. Surface prospecting and a little underground work is being done on several of the properties up Cadwallader Creek, south of Pioneer towards the McGillivray Creek section.

In the McGillivray Creek section the National mine, also known as the McGillivray Creek mine, produced 9,190 tons of ore, containing 681 oz. of gold, between 1900 and 1910. Since then some exploratory work has been done on the property.

The Eldorado Creek and Bonanza Creek sections were most actively prospected in 1911 and 1912, and many of the present showings found. Since then work has been intermittent on properties in these basins and in the adjacent Taylor basin; other areas tributary to the main camp have been prospected, and development-work has been done on many properties, none of which have as yet become producers.

Production.—The Bridge River area, which includes two of the Province's largest gold mines, has been by far the most productive area in the Anderson Lake-Tatla Lake belt, having produced to the end of 1945, 1,797,965 oz. of gold and 488,884 oz. of silver from 3,443,359 tons of ore. Taken together, the other areas in the belt have produced 1,924 oz. of gold from 14,092 tons of ore (0.137 oz. of gold per ton).

Geology.

The discussion of the general geology and ore deposits is based largely on information abstracted from publications of the Geological Survey of Canada and Minister of Mines for British Columbia and from papers in technical journals. These are listed in the references on page 35 of this publication. Much of the discussion on the geology and, in particular, the nomenclature of the geological formations is based on material in the latest comprehensive reports on the Bridge River area by Cairnes (1937 and 1943). The writer acknowledges these sources of information, but accepts responsibility for generalizations made, particularly those concerning prospecting. The Bridge River mining area is the most important along the belt and has for that reason been most intensively studied, and parts of it have been mapped several times.

The formations, both igneous and sedimentary, trend north-westerly with the trend of the belt which lies along the eastern flank of the Coast Range batholith. This batholith is a group of intrusives rather than a single uninterrupted batholith. The mineral deposits are distributed in the rocks along the flank and locally are associated with minor intrusives belonging to the general Coast Range group of intrusives.

The various rock formations are described according to their age from oldest to youngest and under the formation names most commonly and most recently assigned to them. This method makes for an orderly description, and the use of formation names will aid the reader when referring to other reports on individual areas or mines.

Palæozoic Rocks.

Fergusson Group.—The oldest rocks in the area comprise the Fergusson or Bridge River series, late Palæozoic in age. They consist of interbedded sediments and volcanics. The sediments are mainly highly contorted, thin-bedded ribbon-chert with argillite partings between the ribbons. The chert is light to dark grey in colour, the argillite greenish-grey to black. The chert-ribbons range from a fraction of an inch to 3 inches thick; the argillite partings may or may not be thicker than the chert. Short lenses of grey to white limestone are found in the Fergusson series.

Fine-grained, greenish volcanic rocks, ranging from andesites to basalts in composition are intercalated with these sediments. Amygdaloidal textures and pillow or ellipsoidal structures are common features of the volcanics. Greenstones of the Fergusson series are characterized by the occurence of small limestone pods from a few inches to 50 feet in length.

Mesozoic Rocks.

The Palæozoic, Fergusson or Bridge River rocks are overlain by Triassic rocks which have been subdivided into a lower group of sediments, the Noel formation; a middle group of volcanics, the Pioneer formation; and an upper group of sediments, the Hurley formation.

The *Noel formation* consists of well-banded argillites and tuffs with only minor amounts of conglomerate, chert, and volcanics. In general they range from light to dark grey in colour.

The *Pioneer formation,* also known as the *Pioneer greenstone,* consists of both extrusive and intrusive rocks. The extrusive or flow-rocks are mainly light to dark green, fine-grained rocks of andesitic composition. Amygdaloidal textures are common, but ellipsoidal structures are not. The intrusive phases of the greenstone are very similar lithologically to the flow-rocks. Pyroclastics, ranging from coarse breccias to fine tuffs, have been found associated with the greenstone.

The *Hurley formation* consists essentially of sediments and some volcanics. The sediments include limestones, argillites, tuffs, and conglomerates. As compared with the Noel rocks and the younger Eldorado rocks, the Hurley rocks are distinctly limy. Andesitic flows a few feet thick and irregular bodies of chert are common. A limestone conglomerate is a conspicuous member.

Hurley sediments resemble strata described from the Eldorado series of upper Jurassic and lower Cretaceous age.

The *Tyaughton formation,* lying above the Hurley, consists of sediments which include sandstone, shale, grit, conglomerate, and limestone but no tuffaceous types, and comprises a distinctive assemblage of upper Triassic marine formations.

Sediments above Tyaughton.—A succession of sedimentary rocks with minor amounts of volcanic material lies above the Tyaughton formation. These rocks range in age from lower Jurassic to upper Cretaceous and include groups which have been recently redefined and named as follows: Taylor, Eldorado, and Leckie groups (Cairnes, 1943).

Members of this younger, mainly Cretaceous, series of sediments and volcanics extend north-westerly from near Tyaughton Lake, past the northern ends of Taseko, Chilko, and Tatlayoko Lakes, and as far at least as Kleena Kleene, a distance of about 120 miles.

The rocks of this late Mesozoic series are relatively unmetamorphosed as compared with the older rocks. They are very similar lithologically, consisting of repeated conglomerate, sandstone, shale, limestone sequences with intercalated volcanics. In many places the different groups can be recognized only by their fossils.

The *Bralorne intrusives,* including the Bralorne diorite and the Bralorne soda-granite, are often referred to in the district as augite diorite. They are important rock-types because they are the host-rocks for gold-bearing quartz veins in the Cadwallader Creek area.

The Bralorne diorite is typically a greyish-green, medium-grained rock almost always cut by minute veinlets of such secondary minerals as epidote, zoisite, carbonate, and quartz. In some places the diorite is indistinguishable from the Pioneer greenstone and seems to grade into rock which is definitely Pioneer greenstone. These two rocks are probably closely related in age and origin.

Rocks of somewhat similar appearance and composition, but containing an abundance of quartz, are found closely associated with the diorite. Some of these rocks merge into the augite diorite with indistinguishable contacts and are known as quartz-diorite phases of the diorite. Other areas of these quartz-bearing rocks are definitely intrusive into the diorite and are known as soda-granite. These more acidic rocks are very closely related both in distribution and in origin to the augite diorite. The important gold veins in the district are found in areas where the Bralorne diorite is associated with the quartz-diorite or soda-granite phases.

Diorite stocks similar to those of the Cadwallader Creek gold camp are known (Walker, 1933) to the south-east near the headwaters of Cadwallader Creek and beyond the southern end of Anderson Lake.

Fairly large areas extend to the north-west as far as the eastern end of Gun Lake, and a smaller area of what is thought to be similar rock has been found in the vicinity of the Lucky Strike property at the head of Taylor Creek.

The belt of diorite intrusives has a length of at least 28 miles and possibly 34 miles, extending from Anderson Lake on the south to Taylor Basin on the north.

Serpentine.—North-westerly-trending areas of serpentine are common. The serpentine is considered to have formed from ultra-basic rocks such as pyroxenites, peridotes, and dunites. Some areas of relatively unserpentinized ultra-basic rocks are found. In some places the serpentines have been further altered to cream-coloured, carbonate-silica rocks, often mottled with a light green, micaceous mineral resembling mariposite. Although some of the serpentine may be extrusive, much of it is intrusive, and where in contact with other rocks the serpentine is usually sheared. The serpentine does not grade into Bralorne diorite, but the two rocks may be related.

The *Coast Range intrusives,* in the Bridge River areas known as Bendor intrusives, are light-coloured, massive, medium- to coarse-grained rocks, ranging from granodiorite to diorite in composition, but mainly either granodiorite or quartz diorite. In distribution and general shape of the individual areas the intrusives trend north-westerly with the grain of the country. They intrude rocks ranging in age from Palæozoic to early Mesozoic, and are themselves post-lower Cretaceous in age.

General Discussion.—Metamorphism of the older rocks by the Bendor intrusives is pronounced. The effects are strong for several hundred yards from the contacts and minor effects are noticeable for a mile or so from contacts. The extensive metamorphism of contact areas indicates that the Bendor intrusives were particularly juicy and that the metamorphosed rocks are above cupolas. In places rocks of the Fergusson or Bridge River series have been changed to schistose rocks in the contact areas. Knowledge of the results of metamorphism may be of assistance in determining the proximity of the metamorphosed rocks to batholithic rocks, and therefore may be useful in prospecting.

The eastern contact of the main batholith extends north-westerly from Gun Lake. The rocks in this batholith are mainly quartz diorite and granodiorite; however, one large area of white granite has been described from near the head of Bridge River, west of Gun Lake (Dolmage 1928, p. 86); this granite intrudes rocks of the main batholith. It is younger than the main body of the Coast Range batholith and may be late upper Cretaceous or Tertiary.

The intrusives along the eastern flank of the batholith are post-lower Cretaceous, as deduced from evidence found in the Tatlayoko Lake, Taseko Lake, and Bridge River districts (Dolmage 1925, p. 161).

Areas of Coast Range Intrusives within the Belt.—The areas of Coast Range intrusives adjacent to the eastern flank of the Coast Range within the Anderson Lake-Tatla Lake belt are as follows:—

(1.) An area north-west and south-east of Anderson Lake, 33 square miles in extent.

(2.) An area of granitic rocks lies south-westerly from the headwaters of Cadwallader Creek, the known area as mapped is 23 square miles but its south-western boundary is not known.

(3.) A large area lying north-easterly from the Cadwallader Creek Gold Camp, referred to as the Bendor batholith, covering about 51 square miles.

(4.) An area, extending from Mission Mountain north-westerly to Rex Peak, in the Bridge River district, measuring 20 miles in length and 27 square miles in area.

(5.) An area of granodiorite and quartz diorite measuring approximately 3 square miles extends from Taylor basin across to Bonanza basin.

(6.) An area of white granite, 3 miles long, surrounds Lorna Lake at the headwaters of Big (Church) Creek.

The eastern contact of the main Coast Range batholith extends north-westerly from Gun Lake and past the southern end of Taseko Lake. Westerly from this contact the rocks are those which comprise the batholith, mainly quartz diorite and granodiorite.

Minor Intrusives.

Dykes and small intrusives are very common and are of considerable variety. They range from light-coloured acidic to dark-coloured basic rocks, and range in age from Mesozoic to Tertiary.

Tertiary Lavas.

Extensive flows of flat-lying basalt are found easterly and northerly from the area. These lavas are usually highly vesicular and are mainly black basalt. Columnar jointed, amygdaloidal basalt is common. Some tuff is found. In much of the Interior Plateaux region the Tertiary lavas are exposed only on the sides of the stream-valleys, forming " rim-rocks."

Small areas of more acid extrusives and associated intrusives of late Cretaceous or Tertiary age have been found in the belt.

Structure.

Except where disturbed by folding and faulting, the rocks, volcanics and sediments, strike north-westerly. The rock units trend, as well as strike, north-westerly.

In places steep, overturned folds and extensive faulting are common.

According to Cairnes (1937) the general structural feature of the Cadwallader Creek-Gun Lake area is a syncline within a major anticlinal arch trending north-westerly. Bodies of Bralorne intrusives and of serpentine have been intruded either along the synclinal axes or along lines closely parallel to these axes. From south to north, from the headwaters of Cadwallader Creek to Gun Lake, the rocks swing from north-west to nearly north, a curvature which roughly parallels the south-western border of the Bendor batholith. Close to the batholith the rocks are closely folded, dip at high angles and may be overturned.

North-westerly from the Bridge River area the general structures are the same, with close folds striking westerly and north-westerly. The less competent beds, such as the argillites, are intensely sheared in places.

Faults are numerous and well developed in rocks older than the Bendor batholith.

Where detailed work has been done in the Cadwallader Creek section, two main groups of faults have been recognized. One group cuts the formations at a small angle and the other group parallels the formation. Crosscutting faults cut the more competent rocks and displace them as much as several hundred feet. Parallel faults cut the less competent rocks and form shear-zones, along which the aggregate movement has amounted to more than 2,000 feet.

These faults are known best close to the Bralorne diorite, partly because underground workings are more extensive, and consequently opportunities for three-dimensional geological mapping have been better there than elsewhere.

Lode-gold Deposits, Bridge River.

(Ref. Maps 24A, 27C, 60, 61, and Min. Ref. Maps 21T269, 24T269, 25T269, and 8T332.)*

In the following discussion of the lode-gold deposits of the belt the writer will use a modified form of the classification used by Cairnes (1937) in describing the Cadwallader Creek deposits. The same classification will be used in describing the deposits along the length of the belt from Anderson Lake to Tatla Lake. Knowledge of the vein-types and their rock associations in proven deposits will help the prospector in the search for other gold-quartz veins and in evaluating veins which he finds.

In areal distribution the gold-quartz veins of the district are all associated with igneous intrusives and fall into three groups according to the type of intrusive. Whether the association is because of structural or of genetic relationship is of small importance to the prospector. These groups of veins are as follows:—

(1.) Those found associated with the Bralorne intrusives.
(2.) Those found associated with porphyry dykes.
(3.) Those found associated with areas of Coast Range intrusives.

Deposits, other than lode-gold, include silver-copper veins, antimony-bearing veins, and copper replacement deposits, all associated with Coast Range intrusive rocks. Small amounts of chromium have been found in the ultra-basic rocks. Inasmuch as this is a lode-gold bulletin, these deposits will not be mentioned further.

Gold-quartz Veins associated with Bralorne Intrusives.

The distribution of deposits of this type is restricted to areas in which Bralorne intrusive rocks are found. In the following description of the veins of this group the veins of the Bralorne and Pioneer mines will be used as typical. As prospecting in the Bridge River area continues, other areas of similar rocks and associated veins may be found.

The veins in the Bralorne and Pioneer mines are found in and associated with a mass of Bralorne intrusives in which the rocks show a great variation from basic to acidic types. The rocks in the mineralized areas range from augite diorite containing numerous masses of soda-granite to soda-granite almost without rock of other type.

* *See* p. 10.

The vein-fissures extend from the augite diorite into the adjoining rocks, and the nature of a vein depends on the nature of the wall-rocks. The veins have been persistent in strong, massive, Pioneer greenstone, but much less so in the weaker, thinly bedded sediments. The veins and vein-fissures have tended to feather out entirely in the serpentine.

Vein-structure.—The vein-bearing fissures related to the main area of Bralorne intrusives on Cadwallader Creek, strike east-west and lie partly within and partly beyond the north-westerly-striking masses of these intrusives.

The veins dip northward. Movement along them has been such that the northern side moved westerly, the displacement ranging from a few to several hundred feet. The veins are cut by northerly-trending faults, which dip eastward and westward; on these the western side has moved northerly up to 400 feet. In the Bralorne mine the faults are thought to be hinge faults, with the centres of rotation near the surface.

The veins tend to be well defined, fairly regular, and steep in the more massive rocks such as the augite diorite, soda-granite, and Pioneer greenstone, but are tight and poorly defined in the sediments, particularly if the sediments are thinly bedded, and lie at a small angle to the strike of the fissure. In schistose greenstone and in serpentine the fissures tend to split and to die out.

The veins associated with the Bralorne intrusives are lenticular. The pinching and swelling is proportional to the variation in strike and dip. Concerning the continuity of veins, Cairnes (1937, p. 52) wrote in part: "At places, where the fissures curve along their strike or dip, widths of as much as several times the average may occur, whereas at other places the vein-matter may pinch to a small fraction of its normal size. Such features are characteristic of vein-bearing fissures that are not straight and along which faulting has occured. A pinching of a vein need not in consequence necessarily discourage further exploration. especially in a fissure that has elsewhere yielded substantial vein deposits. Where, however, a fissure occurs in, or passes into, less competent formations and develops greater widths of sheared ground at the expense of cleaner fissuring, vein-matter is generally discontinuous. As a rule the vein deposits are essentially continuous where fissuring is well defined and become discontinuous where shearing predominates."

The vein-matter tends to be abundant only where the fissure is well defined, and less abundant and discontinuous where the breaks are weak and become dissipated into a number of closely spaced shears.

Vein-matter.—The vein-matter consists mainly of milky-white quartz with only small amounts of the metallic minerals; a maximum of 3 per cent. sulphides has been estimated.

A conspicuous feature of the veins in the Bralorne and Pioneer mines is the ribboning parallel to the strike and dip of the vein. In such material the quartz ribbons, ranging up to several inches in thickness, are separated by thin, dark-grey films of ground-up sulphides, sericite, white mica, and gouge, and occasional slickensided free gold. The vein breaks readily along these films and often reveals striated walls of quartz or small areas of striated sulphides. Ribbon structure is due to movement that occured within the vein in part during and, in part, after formation of the vein. It may be confused with a sheeted structure where both the vein and wall-rock are equally sheared.

The gangue minerals include mainly quartz, locally abundant calcite, and minor amounts of sericite, chlorite, mariposite, scheelite, dolomitic and ankeritic carbonates. Of these, mariposite (a chrome-potash mica) is conspicuous, not so much because of its abundance, but because of its brilliant green colour and flaky habit. At various times during the history of the Bridge River camp mariposite has been used as a criterion of a promising gold-quartz vein, but more complete information has shown that many of the veins have the requisite mariposite but very little gold. Statistics of association of mariposite with gold-bearing quartz show that the presence of the mineral cannot be used indiscriminately as indicative of a good gold vein. Scheelite, usually widely scattered, has been found in a great many of the gold-quartz veins. In the Bralorne mine a small shoot of vein-matter, rich enough to be called tungsten ore, was found.

Although they make up a small part of the vein-matter, eleven or more metallic minerals are found, including native gold, arsenopyrite, pyrite, chalcopyrite, galena, sphalerite, stibnite, tetrahedrite, marcasite, and a telluride, thought to be either sylvanite or calaverite.

The native gold is frequently scattered indiscriminately in white quartz, but is also found with sulphides. Arsenopyrite is commonly associated with gold, but both sphalerite and galena are also mentioned as common associates.

Wall-rock Alteration.—Fresh and altered wall-rock may be observed in many places. The alteration varies from slight to intense. Its recognition is important, in that its presence, particularly where intense, indicates that a large volume of mineralizing solutions has travelled along the vein-fissure. The evidence of the passage of these solutions increases the probability that gold also travelled and was deposited in the fissure.

Wall-rock alteration usually means a bleaching of the rock adjacent to vein-fissures for distances ranging from a few inches to several feet. The intensity and nature of wall-rock alteration depends on both the nature of the altering solutions and on the character and composition of the rocks.

In general, the Bralorne intrusives and greenstones have been more altered than the sediments. Carbonatization has been the dominant process, with up to 75 per cent. of the greenstone being altered to ankeritic carbonate. Fine, scaly micas are characteristic, white sericite mica in the acid rocks, and mariposite in the more basic types. Disseminated pyrite crystals are characteristic of altered wall-rock. Some of the altered phases of augite diorite and the greenstone, immediately adjacent to the veins, are very difficult to tell from similarly altered albitite dykes. The term albitite has been used in describing dykes and what may or may not be merely altered wall-rock, thereby leading to much confusion.

Outcrops of altered wall-rock are usually stained brown or rusty because of the oxidation of the abundant ankeritic carbonate in the altered phase.

The alteration of serpentine by vein-solutions is very conspicuous and common. It should be mentioned, however, that the alteration is not always present near veins. The alteration has been complete over large areas and the serpentine in the altered areas changed from a blackish-green rock to a light cream-coloured rock speckled with flecks of brilliant green mariposite; weathered outcrops are usually a deep reddish-brown. The altered serpentine consists of ankeritic carbonate cut by a network of veinlets and irregular masses of milky-white quartz, the whole flecked with brilliant green mariposite.

Examples.—Veins of the first group (associated with Bralorne intrusives), found on the Pioneer and Bralorne properties and on most of the smaller properties near by, are related to the main area of Bralorne intrusives. Veins on some of the properties on McGillivray Creek are close to hornblende diorite intrusives that are somewhat similar to the Bralorne intrusives. North of the Cadwallader Creek section, veins on the B.R.X., Bridge River Consolidated, Wayside, and Veritas properties are related to areas of augite diorite differentiated in part to granitic phases that are comparable to the Bralorne intrusives up Cadwallader Creek.

Gold-quartz Veins associated with Porphyry Dykes.

Many veins are found close to and in dykes and small irregular masses of feldspar porphyry and hornblende porphyry where the porphyries cut massive rocks such as greenstone or even highly altered serpentine. In the Bridge River area the porphyries are found mainly in massive greenstone of the Fergusson or Bridge River series which lie north-easterly from the north-westerly-trending line of the Bralorne intrusives and easterly margin of the Coast Range batholith. These porphyries are undoubtedly closely related in time of origin to the Coast Range intrusives.

The mineral deposits consist of veins in fissures accompanied in part by extensive replacement of the wall-rock. The formation of such veins is favoured by a rock which will fracture well and be readily replaceable by mineralizing solutions. Massive greenstone, rather than bedded sediments, particularly thin-bedded sediments, best fits these requirements.

As contrasted to the Pioneer-Bralorne type of vein, the fissure-veins related to porphyry dykes are characterized by a high percentage of sulphides in the quartz. The replacement veins, either where the vein is formed wholly by replacement or where it is formed in part also by fissure-filling, are characterized by dense ankeritic carbonate and finely disseminated, small crystals of pyrite and arsenopyrite. Quartz and stibnite are conspicuously absent from replacement masses.

Examples.—Gold-quartz veins, many characterized by heavy sulphides, that are in or close to porphyry dykes are found on the properties up Cayoosh Creek, on the Congress, Golden, Dauntless, Peerless, Kelvin, and Olympic, in or close to the Bridge River valley, and on the Lucky Strike in Taylor Basin. The country rock, apart from the porphyry dykes, is massive greenstone on most of these properties.

Gold-quartz Veins associated with Coast Range Intrusives.

This group includes a wide range of mineral and structural types. Structurally most are wholly filled fissure-veins or veins which may be filled fissures, but are accompanied by much replaced and mineralized wall-rock. Mineralogically the deposits consist mainly of quartz gangue with abundant sulphides; the sulphides antimony and cinnabar are absent. The proportion of sulphide to gangue is usually much higher than in the Pioneer-Bralorne type of vein. The Pilot property on Gun Lake, where sulphide-poor quartz veins are found in the batholith, is an exception.

Disseminations and small lenticular masses of sulphides are found near the borders of the intrusions, as on the Gem on Roxey Creek, where lenses of cobalt-sulphides carrying a little gold are found.

Examples.—Veins either in or close to areas of Coast Range intrusives are found at many places in the belt. In the Bridge River area they are found at the Pilot, Bridge River Pacific, Gem, Jewel, Lucky Gem, Northern Light, and Robson. The veins on these properties are rarely more than 2½ miles from the contact and tend to be farther on the greenstone-sediment than on the granite side of the contact.

Suggestions for Prospecting.

Although the Cadwallader Creek-Bridge River section has been rather well prospected and covered by many claims, more intense prospecting of the staked ground by the owners or optionees of the claims may well be advisable. Much of the ground is covered by a heavy mantle of drift, and it is probable that on such ground only diamond-drilling or actual underground work will yield further discoveries of productive veins.

The area north-westerly from Bridge River, from Gun Lake to the basin areas at the heads of Taylor, Tyaughton, and Bonanza Creeks, offers the best chances in areas that are neither covered by drift nor as thoroughly prospected as the Cadwallader Creek section. Search should be made for the three types of gold-quartz veins previously described, bearing in mind that the most important veins in the area have been found in " augite diorite." The general suggestions about favourable prospecting areas given on pages 10 and 11 of this bulletin hold here as well as elsewhere.

Search should be made for those Bralorne intrusives characterized by areas of rocks which show a marked variation from dioritic to granitic rocks. The best veins have been found where the rocks range from augite diorite containing numerous areas of granitic rocks to areas consisting almost wholly of granitic rocks (soda-granite).

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MINERALIZED AREAS NORTH-WESTERLY FROM BRIDGE RIVER.

Because they are generally less known, brief descriptions will be given of properties in areas north-westerly from and separate from the more thoroughly prospected Bridge River area. Proceeding north-westerly, veins, in or at no great distance from bodies of Coast Range intrusives (granitic to dioritic), have been found on the Taylor-

Windfall on Upper Taseko River, on the Hi Do south of Taseko Lake, on the Morris south of Tatlayoko Lake, and on properties in the Blackhorn Mountain and Perkins Peak sections. Veins on the Vick, Viccal, and Mary Stuart, north of Taseko Lake, are in or close to diorite and feldspar porphyry.

Taseko Lake.
(Ref. Map 60.)*

There are several prospects in the vicinity of Taseko Lake, north of the Bridge River district, and a little gold has been produced from the Taylor-Windfall property, on upper Taseko River south-easterly from the lake. This section is accessible by road and boat from the north via Williams Lake and Hanceville and from the south by pack-trails over high passes from Gun and Tyaughton Creeks, in the Bridge River district, to the head of Taseko River and down the latter to the southern end of Taseko Lake.

Access to the Taylor-Windfall property from Hanceville, 60 miles west of Williams Lake, is by way of 55 miles of poor motor-road to the northern end of Taseko Lake; thence by water 9 miles southerly to the narrows, from which 12 miles of road to the property was built in 1939. By pack-horse trail, usable only in the summer months, the distance from the Bridge River is 38 miles. On this property some gold was recovered from rich gold-bearing eluvium, discovered in 1920 on the hillside sloping into Battlement Creek; and some gold has been recovered by milling ore from small but rich gold-quartz veins (or pockets) found in tuffs close to quartz diorite. No production has been recorded since 1934. Two diamond-drill holes, the result of which were inconclusive, were drilled on the property in 1945.

Several low-grade copper prospects are found in the Coast Range intrusives just north-west of the Taylor property.

At the Hi Do (Pellaire Gold Mines, Ltd.) property, discovered in 1936, west of the Lord River, a few miles south of Taseko Lake, five gold-bearing quartz veins strike north-east and dip steeply in the granodiorite which here trends easterly. Since 1944 this property has been under development by Pellaire Gold Mines, Ltd. In 1945 the company diamond-drilled two of the five veins on the property, and in 1946 started to crosscut the downward extensions of these veins. In 1946 the company bulldozed a "cat-road" around the west side of Taseko Lake from the Hanceville Road, to connect with a short stretch of truck-road that takes off the Taylor-Windfall Road at the narrows. This road was built in the same year by the company in conjunction with the Provincial Government.

At the Vick, about half a mile northerly from the northern end of Taseko Lake, south-westerly-striking fissure-veins up to 20 inches wide are found associated with diorite dykes in andesites and tuffs. The vein-matter consists of quartz mineralized with small amounts of chalcopyrite and pyrite. High gold assays have been found, but little work has been done on the showings.

On the Viccal and Mary Stuart groups, 10 miles north of Taseko Lake, pyrite veinlets, carrying low values in gold, are found in diorite and in feldspar porphyry.

Tatla Lake.
(Ref. Maps 32A and 71.)*

In three sections accessible from Tatla Lake Post-office, gold-bearing veins have been found and have been explored by surface and some underground workings. The three sections are in the eastern part of the rugged Coast Range, and each is no more than a few miles from the eastern contact of the Coast Range batholith. The discoveries on Blackhorn Mountain were made about 1936; discoveries in the other sections were earlier, some in the Tatlayoko Lake section being made in 1907.

* *See* p. 10.

A motor-road running westerly from Williams Lake reaches Tatla Lake Post-office in a little less than 150 miles. A pioneer road continues north-westerly, passing through Kleena Kleene, on One Eye Lake, about 15 miles from Tatla Lake. From Kleena Kleene, trails running south-westerly reach Perkins Peak about 20 miles distant. The route from Tatla Lake to Blackhorn Mountain follows a local road for about 15 miles to the northern end of Bluff Lake, from which a pack-trail about 17 miles long is followed southerly. The northern end of Tatlayoko Lake is reached by a local road 24 miles long, which leaves the main road a short distance easterly from Tatla Lake.

Tatlayoko Lake.—On Morris's property, about 3 miles south-easterly from the southern end of Tatlayoko Lake, several veins have been found in argillaceous rocks not more than 400 feet from the margin of dioritic bodies and in the dioritic bodies themselves. Sulphide minerals found in the vein consist principally of stibnite, arsenopyrite, and pyrite, in that order of abundance, with minor amounts of sphalerite and tetrahedrite. The averages of samples taken by O'Grady (1935, p. F 32), representing short to moderate lengths of the No. 1 vein, ranged from: Width, 2 feet 8 inches—gold 0.18 oz. per ton, silver 1.5 oz. per ton; to width, 3 feet 6 inches—gold 0.38 oz. per ton, silver 3.0 oz. per ton.

The Langara, Standard, and Argo groups are 9 to 10 miles by trail north-westerly from the southern end of Tatlayoko Lake. Several veins have been found in diorite and metamorphosed siliceous sediments, and replacement deposits in metamorphosed argillites. The veins range from a few inches to 5 feet in width, and the replacement deposits to 11 feet. Sulphide minerals include pyrite and arsenopyrite, and on the Argo galena, sphalerite, chalcopyrite, and pyrrhotite are also found. Assays quoted by O'Grady (1935) from veins on the Langara ranged: Gold 0.9 to 0.18 oz. per ton, silver 0.4 to 8.2 oz. per ton; and from replacement deposits on the Standard: Gold 0.36 to 0.44 oz. per ton, silver trace to 0.6 oz. per ton. Little work had been done on the Standard and Argo.

Blackhorn Mountain.—In this section work has been concentrated on Blackhorn Mountain, which is on the western side of the upper part of Razor (Wolverine) Creek. The rock exposed consists principally of thin-bedded black argillites, overlain by green conglomerate, overlain in turn by greenstone. The three members are cut by numerous granitic dykes and sills. Parts of the conglomerate are schistose, and parts of it and of the greenstone are represented by sericite schist. For 1,000 feet along the strike the argillite is interrupted by massive greenstone. The sediments strike north-westerly and dip south-westward at small angles. Numerous quartz stringers and lenses are found generally in the schistose sediments just below greenstone, in a distance of about 3 miles along the strike. Much of this quartz is barren, but at some points it carries visible gold. Samples from points where sulphides are present have yielded moderate assays in gold. Galena, sphalerite, chalcopyrite, and arsenopyrite are found in quartz. Some of the quartz-lenses reach widths of as much as 6 feet. Much of the quartz is barren; more promising showings carry values which range from 0.15 to about 1.5 oz. of gold per ton. A vein from 1½ to 2½ feet wide, in the adit-level on the property of Homathko Gold Mines, Limited, appeared to have a chance of continuing downward in massive greenstone. The most recent work on this property has been surface work done during the summer of 1946 by the E. M. Thompson interests, Vancouver.

Perkins Peak.—The rocks of this section include easterly-striking and southward-dipping sandstones and argillites cut by much-altered basic dykes.

On the Mountain Boss property (Sargent, 1938, pp. F 38–F 41) quartz-lenses have been found in shear-zones that strike easterly and dip southward with the bedding of the enclosing argillites, and quartz veins have been found cutting silicified sandstone. Arsenopyrite and a little pyrite are found as lenses in the silicified zones and in vein-quartz. The contact of the batholith, striking north-easterly, lies about 2 miles north-westerly. Very little underground work has been done. The bedded veins in weak and incompetent sediments do not lend encouragement to prospecting, but higher grade mineralization in veins cutting silicified sandstone is more promising.

The showings on the Bluebird group to the west of the Mountain Boss are similar to and may be a continuation of those on the Mountain Boss. In 1945 a crosscut was driven below the main showing and is reported to have intersected the vein at 125 feet.

Suggestions for Prospecting.

Much of the country along the eastern flank of the Coast Range north-westerly from Bridge River is extremely rugged; consequently, transportation is difficult, costly, and time-consuming, reducing time and money available for actual prospecting in the area.

The several mineralized areas are found at widely scattered places along this north-westerly part of the belt, and therefore it is best to start prospecting from one of the several mineralized areas and work along the general contact-zone of the batholith, preferably in areas of greenstone, rather than of sediments.

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MINERALIZED AREAS EASTERLY AND SOUTH-EASTERLY FROM BRIDGE RIVER.

Cayoosh Creek.
(Ref. Maps 24A and 63.)*

The Cayoosh Creek area is about 12 miles by motor-road south of Lillooet.

As it is convenient to Lillooet, the area was prospected very early in the gold-mining history of the Province. Following placer-mining on Cayoosh Creek, shortly after the discovery of placer at Lillooet in 1859, lode gold was found in vein-quartz on the Bonanza claim in 1887. Since then other properties have been intermittently prospected, but without much success. The only production recorded from the area was from the Golden Cache (Ample) between 1897 and 1901, when about 3,000 tons of ore, treated in a 10-stamp mill, yielded 807 oz. of gold or 0.26 oz. per ton. Work has been done on the Bonanza Cache and Golden Cache, relatively old properties, and on the Morning Glory and Marygold, staked in the '30's.

The deposits consist of gold-quartz lenses and stringers which are bedded with north-westerly-trending argillites. Carbonaceous to limy argillites predominate in the region, but in places they are cut by dykes and sills of diorite (possibly quartz

* *See* p. 10.

diorite) and hornblende diorite. The nearest known area of Coast Range batholithic rocks lies 10 miles westerly on Lost Creek, where an area of quartz diorite 33 square miles in area extends north-westerly across Anderson Lake.

The veins contain quartz and small amounts of pyrite.

Considerable underground work has been done on the Bonanza Cache and the Golden Cache, but the veins have so far not proven large enough or of sufficiently good grade to mine profitably.

Suggestions for Prospecting.—The numerous lenses of mineralized quartz that have been found afford evidence that mineralizing solutions permeated the area. So far the discoveries have been lenticular lenses and veins that follow the bedding of the argillites, and no vein-filled fissures crossing the bedding have been found. The argillaceous rocks have proven too weak to carry strong, clean-cut breaks, and it is suggested that areas of more competent rocks such as greenstone be sought for and those areas prospected for veins.

The rocks in the area have been mapped mainly as sediments. They may represent the south-easterly continuation of the Fergusson-Bridge River series from the Upper Bridge River. In the Upper Bridge River this series contains massive greenstone, and it is possible that the same group of rocks in the Cayoosh Creek area may also carry some greenstone. Inasmuch as greenstone is a more favourable host-rock than sediments for the formation of veins, an area in which it is found is more favourable for prospecting than an area consisting wholly of sediments.

Duffey Lake.

Quartz-tetrahedrite veins carrying up to a few hundred ounces of silver per ton have been found near Duffey Lake, about 20 miles easterly by trail from the south end of Anderson Lake. The gold content is insignificant.

Occurrences of granitic rocks mineralized with disseminated molybdenite near the headwaters of Texas Creek represent the north-easterly limit of known mineralization in the general Anderson Lake-Tatla Lake belt.

Little is known about the mineral possibilities of the very mountainous and relatively inaccessible country which extends south-easterly to the Fraser River. The lack of information about mineralization may be because of the lack of prospecting.

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AREA EAST OF THE COAST RANGE.

ANDERSON LAKE TO KAMLOOPS LAKE.

Few gold properties appear to have been found between the Anderson Lake-Tatla Lake belt and the Vidette Lake area. The Grange (Big Slide) mine, on the Fraser River, 30 miles north of Lillooet, is the only one on which much work has been done.

At the Grange mine a lenticular quartz vein in a small stock of granitic rock has been explored in underground workings and there has been some production at different times, but the values are apparently too low for successful operations. This is one of the oldest lode-gold properties in the Province. It was discovered by an Indian in 1872; in 1881 an arrastra was built, followed in 1886 by a 10-stamp mill which operated for only three to four months. The mine was closed down in 1887. It was reopened in 1928, and after underground exploration a 25- to 50-ton mill was built in 1934, but only operated for about a year. Very little work was done on the property after 1934 until 1946, when Rusdon Gold Mines, Limited, started a diamond-drilling programme; the results of this work are unknown at present.

VIDETTE LAKE.

(Ref. Map 11A.)*

Location and Access.—The Vidette Lake Camp may be reached by 43 miles of automobile-road northward from Savona, a small settlement at the western end of Kamloops Lake on the Cariboo Highway, the Canadian Pacific and the Canadian National railways.

History.—The main properties in this camp were staked in 1931 and 1932. Development-work followed immediately. A small mill built on the Vidette in 1932 was enlarged to 50 tons daily capacity in 1933. Operations continued on the properties of the Savona Gold Mines, Limited, and Hamilton Creek Gold Mines, Limited, until 1938. Mining and milling continued on the Vidette until 1940, when the mine was closed and the plant and equipment were put up for sale.

Production.—The production in the area, mainly from the Vidette mine, has amounted to slightly more than 54,000 tons, averaging a little more than ½ oz. of gold per ton.

Mineralized Area and Properties.—The developed area is at the north-western end of the lake and includes the property of the Vidette Gold Mines, Limited, immediately adjacent to the lake; that of Savona Gold Mines, Limited, the workings of which are in a direction north 20 degrees west from the head of the lake; and that of the Hamilton Creek Gold Mines, Limited, whose workings are on the Hamilton Creek scarp, south-westerly across the valley from those of the Savona Gold Mines. These companies have driven adits and inclines into the steep valley-walls bordering Hamilton Creek and Vidette Lake, whose common valley has been sharply incised to depths ranging from 250 to 400 feet in the extensive Bonaparte-Tranquille Plateau.

Geology and Mineralization.—The rock formations include greenstone, small stocks and dykes of feldspar porphyry, and, on the plateau above and beyond the workings, basaltic lavas.

The granitic rocks found both on the surface and underground at the Vidette and Savona properties may be called feldspar porphyries.

The veins are of the quartz-filled fissure type, and may or may not be accompanied by extensive shearing of the wall-rock. They range from a knife-edge to 4 feet wide, and all strike north-westerly and dip north-eastward. Mineralization has resulted in the development of pyrite, smaller amounts of chalcopyrite, and reported tellurides; gold frequently accompanies the above minerals, local experience indicating that the values are best where chalcopyrite accompanies the pyrite. Replacement of the wall-rock, though undoubtedly present, is not important, and leaching of the wall-rock is rare, dark-green andesite being commonly in immediate contact with the quartz veins.

Faulting of varying ages is prevalent. Pre-vein fissuring, intra-vein faulting, both during and after the mineralization period, and post-vein, transverse faulting, are all present.

Suggestions for Prospecting.

Vidette Lake, in the region of the Interior Plateaux, occupies the largest valley in the vicinity, and one of the few places where incision has exposed the underlying greenstones or granitic rocks. Except where valleys have been incised through the lava-flows, lava and drift mask the underlying rocks in most of this area. The chances of finding exposures of greenstone and granite outside of the Vidette Lake-Deadman River valley are few because there are few other valleys of comparable size. However, a few prospects have been found at isolated places on the plateau east of Vidette Lake, where the bed-rock is not completely covered by lava. Because of the isolated nature of the greenstone and granite exposures, the only suggestion that can be made is to search for these exposures in the hope that the ones found may contain veins.

* *See* p. 10.

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HIGHLAND VALLEY (SOUTH-EAST OF ASHCROFT).

Highland Valley, about 20 miles south-east of Ashcroft, is an area of copper mineralization. Gold values, when present, are too low to be important. The copper production has been small. At least eight properties have been found within a radius of 10 miles of the divide between Pukaist and Witches Creeks. The ground has, therefore, been fairly thoroughly prospected and copper and some molybdenum found, but no gold mineralization.

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HON. R. C. MacDONALD, Minister JOHN F. WALKER, Deputy Minister

BULLETIN No. 20—PART V.

(Revised November, 1946)

LODE-GOLD DEPOSITS

VANCOUVER ISLAND

by

J. S. STEVENSON

VICTORIA, B.C.:
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PREFACE.

Bulletin 20, designed for the use of those interested in the discovery of gold-bearing lode deposits, is being published as a series of separate parts. Part I. is to contain information about lode-gold production in British Columbia as a whole, and will be accompanied by a map on which the generalized geology of the Province is represented. The approximate total production of each lode-gold mining centre, exclusive of by-product gold, is also indicated on the map. Each of the other parts deals with a major subdivision of the Province, giving information about the geology, gold-bearing lode deposits, and lode-gold production of areas within the particular subdivision. In all, seven parts are proposed:—

PART I.—General *re* Lode-gold Production in British Columbia.
PART II.—South-eastern British Columbia.
PART III.—Central Southern British Columbia.
PART IV.—South-western British Columbia, exclusive of Vancouver Island.
PART V.—Vancouver Island.
PART VI.—North-eastern British Columbia, including the Cariboo and Hobson Creek Areas.
PART VII.—North-western British Columbia.

By kind permission of Professor H. C. Gunning, Department of Geology, University of British Columbia, his compilation of the geology of British Columbia has been followed in the generalized geology represented on the map accompanying Part I. Professor Gunning's map was published in "The Miner," Vancouver, B.C., June–July, 1943, and in "The Northern Miner," Toronto, Ont., December 16th, 1943.

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LODE-GOLD DEPOSITS, VANCOUVER ISLAND.

BY

J. S. STEVENSON.

CHAPTER I.

INTRODUCTION.

The general geology and features of the known gold prospects on Vancouver Island will be discussed at some length, and, based on this discussion, areas for further prospecting will be suggested.

Although the geology is discussed in detail, only those features that are readily distinguishable in the field and are likely to be of use in determining favourable and unfavourable rocks or rock associations will be described. By going thus into the geology the writer hopes to answer some of the questions of interpretation that may confront the prospector or scout in the field.

MAPS.

Lithographed Maps.—The maps listed in the following table, showing the geography of Vancouver Island, may be obtained from the Chief Geographer, Department of Lands and Forests, Victoria, B.C.:—

Map No.	Year of Issue.	Title of Map.	Scale.	Per Copy.
		GEOGRAPHIC SERIES.		
1K	1925	South-western Districts of British Columbia, Commercial and Visitors	7.89 m. to 1 in.	$0.50
		LAND SERIES.		
2A	1938	Southerly Vancouver Island	4 m. to 1 in.	.50
2C	1929	Northerly Vancouver Island	4 m. to 1 in.	.50
		MISCELLANEOUS.		
PWD	1946	Highway and Travel Map of British Columbia	20 m. to 1 in.	.85
		Contoured maps of parts of the Island	Various scales	....

Departmental Reference Maps.—These maps, with a few exceptions, are on a scale of 1 mile to 1 inch and show, among other features, surveyed lands, crown-granted lands, timber licences and timber sales. The maps covering the areas described in this bulletin have been referred to under appropriate geographic headings in the text by the abbreviation *Ref. Map,* followed by the number of the map. Blue-prints or Ozalid prints may be obtained for $1 each. Maps should be ordered by number from the Surveys Division, Department of Lands and Forests, Victoria, B.C.

Departmental Mineral Reference Maps.—These maps are on a scale of 1,500 feet to 1 inch and show surveyed mineral claims. As with the reference maps, they have been referred to in the text under appropriate geographic headings but by the abbreviation *Min. Ref. Map,* followed by the number of the map. Blue-prints or Ozalid prints may be also obtained for $1 each from the Surveys Division, Victoria.

Maps showing Mineral Claims held by Location.—Maps that show the approximate position of mineral claims held by location are kept up to date by the British Columbia Department of Mines. Copies of these maps may be seen at the offices of the Department in Victoria or in the Federal Building, Vancouver.

GENERAL TOPOGRAPHY AND MEANS OF ACCESS.

A backbone of high mountains with much permanent snow extends from Quatsino Sound south-easterly to Alberni Canal. North-westerly from the sound and south-easterly from the canal, the hills are lower and towards both ends of the island become gently rolling. Along the eastern side the island is plain-like for distances of from 1 to 10 miles back from the coast. Because climate and topography are more favourable, the eastern side and southern end of the island are more thickly populated and better served by roads than the western coast and northern end.

The western side of the island is rugged and has a typical fjord coast-line. Two limited parts are served by roads, one from Victoria to Jordan River and one from Nanaimo to Port Alberni on Alberni Canal. The several ports are served by Canadian Pacific Steamship service on an eight-day schedule from Victoria and Port Alberni. Places on Alberni Canal have a tri-weekly mail-boat service from Port Alberni, and a stage running to Tofino connects with mail-boat at Ucluelet. Several points on the western coast also have regular airplane service from Vancouver. Because of the rugged fjord-like nature of the coast-line, no trunk roads have been built along it. Short isolated sections of road have been built from Ucluelet to Tofino, up Tranquil and Bulson Creeks, up the Bedwell and Zeballos Rivers, and from Port Hardy to Quatsino Sound.

CLIMATE.

The climate of the island in general is mild. The annual precipitation ranges from about 30 inches on the eastern coast to more than 110 inches on the western coast. The snowfall is light on the southern and eastern coast and on the immediate western coast, but becomes more abundant as the mountains, a few miles inland from the western coast, are approached.

HISTORY OF MINING.

Although lode gold had been discovered in 1851 on the Queen Charlotte Islands and small amounts were found around Nanaimo, it was not until the '60's that commercial quantities of gold, as placer, were recovered on Vancouver Island. In the '60's the placer deposits on the Leech, Jordan, and Bedwell Rivers, and China Creek were worked. Copper showings were found and worked as early as 1874 on the Sooke peninsula, and silver ores carrying some gold had been produced as early as 1880 from the Sterling claim on the Koksilah River, but it was not until 1892 that gold-quartz veins were found on the island. The first discovery was on China Creek, followed in 1898 by discoveries on Kennedy (Elk) River and on the Bedwell River.

Activity in prospecting for gold and gold-mining in the western part of the island had subsided by 1900 and little was done until 1933 and 1934, when the first discoveries were made and ore was shipped from rich gold-quartz veins in the Zeballos River area on the west coast. At practically the same time, finds were made at Herbert Arm and up Bedwell River. Since 1934 the western coast, represented chiefly by the mines in the Zeballos area, has produced about 270,000 oz. of gold to the end of 1945. In the period from 1898 to 1909, and again in 1943, copper and later copper-zinc mining at Mount Sicker, near Duncan, yielded gold as an important by-product. The total gold recovery from this camp has exceeded 36,000 oz.

CHAPTER II. GEOLOGY.

INTRODUCTORY STATEMENT.

The discussion of the geology which follows represents an abstract of information contained in several Geological Survey of Canada reports by Gunning and Bancroft and in Department of Mines of British Columbia reports by Sargent on areas in the northern part of the island, and of information in Geological Survey of Canada reports by Clapp and Cooke on the southern part of the island. These reports and others are listed in the bibliography on page 16 and in lists of references found after the description of mineralized areas. Acknowledgment is made of these sources of information. The present writer accepts responsibility for many of the generalizations made, particularly on the geology in areas not covered by geological maps.

The general geology of Vancouver Island and adjacent coast, as known in 1928, is shown on the Vancouver sheet, Map 196A, published by the Geological Survey of Canada on a scale of 8 miles to the inch. This map is out of print, but copies of it may be seen in the libraries of the joint offices of the Geological Survey of Canada and the British Columbia Department of Mines in the Federal Building, Vancouver, and of the British Columbia Department of Mines in Victoria.

For convenience in discussing the general geology, the island will be divided into two parts, Northern and Southern Vancouver Island. These parts are separated by a line which, from Cape Beale at the southern side of the entrance of Barkley Sound, follows the south-eastern side of the sound, thence runs northerly up Alberni Canal and to a point a few miles past the northern end of the canal, and thence due east to the eastern coast of the island.

This subdivision of the island does not extend into the more particular discussion of areas and mineral deposits.

In the southern part of the island a few formations have been mapped, which have not been recognized in the northern part, largely because the southern part has been more thoroughly mapped and therefore greater opportunity has been afforded to distinguish between and correlate a greater number of rock-types.

Most of the gold properties have been found in the northern part of the island. In the southern part, from the 49th parallel southward and from the Nitinat River eastward, about twenty-five copper, four copper-zinc, two molybdenum, one antimony and one zinc-lead, and four iron (magnetite) properties are known; but no gold-quartz veins of importance. Excepting for the copper-zinc-gold properties on Mount Sicker, the production of metal from this part of the island has been small.

NORTHERN VANCOUVER ISLAND.

A small area of Palæozoic rocks has been recognized, but most of the rocks have been mapped and described as belonging to three major groups; namely, Mesozoic greenstone and related rocks of the Vancouver group, granitic rocks of the Coast Range intrusives, and shale, sandstone, and conglomerate of the Cretaceous period.

Palæozoic Rocks.

The Palæozoic rocks have been mapped from Buttle Lake southward to Big Interior Mountain and Upper Drinkwater Creek, and consist principally of a thick series of andesite and basalt flows, tuffs, and coarse breccias. In the Buttle Lake area, the Palæozoic rocks include three interbedded limestone members and minor amounts of argillite and quartzite. In the Bedwell River area the several isolated masses of limestone are thought to belong to one horizon (Sargent, 1941, p. 17). Of these rock types, the limestone, though not the most abundant, serves as the best horizon-marker, rocks below it being Palæozoic in age, except for basalt intrusive into the limestone and granitic dykes, which are still younger. The basalt is probably related to the lowest member of Mesozoic volcanic rocks (Vancouver group) overlying the limestone. The granitic dykes are related to the Coast Range intrusives. The Palæozoic rocks have not yet been found elsewhere in the northern part of the island, but further mapping may show them to be of greater extent than known at present.

Mesozoic Rocks.

Vancouver Group.

Mesozoic rocks belonging to the Vancouver group are the most widely distributed on the island. These rocks include both volcanic and interbedded sedimentary rocks, but the volcanic rocks are the more abundant.

The volcanic rocks include both flows and pyroclastics. The flow-rocks range mainly from andesite to basalt; the more acid types such as dacite and rhyolite are not abundant. Andesites are the most abundant. They are dense to finely crystalline rocks, light to dark green in colour. The basalts are more black than green and are commonly amygdaloidal. Flow-structures, so common in the more basic rocks in Eastern Canada, are found, but are not common, in the Vancouver Island basalts. Greenstone intrusives are found commonly cutting the flow-rocks. The intrusives are lithologically very similar to the flow-rocks and are not easily distinguished from them. This similarity introduces problems in working out structure. Green to black porphyry dykes, some of which have distinct white feldspar laths up to 1 inch in length, cut the flow-rocks.

The volcanic fragmental rocks include breccias and tuffs. The breccias consist of green to grey, and frequently reddish, fragments, which range from ¼ inch to at least 2 feet in diameter. The larger fragments are set in a finer-grained ground-mass of similar colour. Bedding is seldom seen in the coarser fragmental types. Tuffs, representing the finer-grained equivalents of the breccias, range from grey-green to black rocks which may more properly be called tuffaceous argillites. The tuffs are very frequently well banded.

The sediments include limestone, argillite, quartzite, and tuffaceous argillite, variously interbedded with the volcanic rocks at different horizons. Of these rock-types, limestone is the most abundant. It ranges from finely to coarsely crystalline and from white to grey and buff in colour. Limestone-beds range from a few feet to 2,000 feet in thickness. The sediments are found in well-defined zones that may be traced for considerable distances, though individual beds are lenticular.

A threefold division of the Vancouver group has been made and found to be quite generally applicable to the northern part of the island (Gunning, 1929). The division is made on the basis of those volcanics and sediments, the Karmutsen formation, which lie below a conspicuous limestone zone, the Quatsino formation, and those which lie above it, the Bonanza formation.

The Quatsino Formation.—Mapped mainly in the area from Zeballos north-westerly to Quatsino Sound, the Quatsino formation consists of several hundred feet of fine- to coarse-grained crystalline limestone, dark grey to white, and minor intercalations of green flows, and fine-grained grey or green tuffs. Massive grey-white crystalline limestone is the most abundant rock-type. It is a good marker and, as such, it is important in studying the areas along the west coast of the island.

Bancroft (1937, p. 7) has noted that the Quatsino limestone is found, despite interruptions by intrusives, folding, and faulting, quite consistently 20 miles from the west coast, paralleling it from Quatsino Sound to Tlupana Arm, and he notes that other limestone south-easterly from Tlupana Arm and at the same distance from the west coast, may belong to the same formation. Limestone which may belong to the Quatsino formation is found on the Moyeha River, 20 miles from the coast on Flores Island, and in the canyon 8 miles up Kennedy River from Kennedy Lake. Several scattered areas of limestone, much of which has been contact metamorphosed by adjacent intrusives, are found between the south end of Henderson Lake and Alberni Canal. It is possible that the Quatsino limestone may continue south-easterly across Alberni Canal as the Nitinat limestone, though offset by faulting and (or) folding.

Karmutsen Formation.—A great assemblage of volcanic rocks, which have been called the Karmutsen volcanics by Gunning (1931, 1932), lie below the Quatsino limestone. These consist of andesitic to basaltic flows, volcanic breccias and tuffs, and some interbedded limestone. In the Zeballos area, the flows are characterized by a large proportion of amygdaloidal and pillow lava. Flows, rather than pyroclastics, predominate.

Bonanza Formation.—A succession of flows, fragmental rocks, and interbedded sediments, collectively called the Bonanza group by Gunning (1931, 1932), lies above the Quatsino limestone. Amygdaloidal and pillow lava are not found in the Bonanza formation, instead massive, fine-grained, grey and green andesite and light-coloured types predominate among the flows. Breccias and tuffs are very abundant, crystal tuffs are common. The sediments include thin beds of limestone, argillite, and quartzite.

Coast Range Intrusives.

Rocks of the Vancouver group are intruded by stocks, dykes, sills, and irregular bodies of granitic rocks. These granitic rocks were probably intruded at the same time as those of the Coast Range batholith on the mainland. They have been referred to as "the Coast Range intrusives" by Gunning (1929). The larger bodies are accompanied by basic and acidic dykes. The Coast Range intrusives are not known to cut the Upper Cretaceous rocks.

In general the mineral deposits of Vancouver Island are in or close to Coast Range intrusives. For this reason the intrusives are important. It is immaterial whether the relationship of the mineral deposits with the intrusives is genetic or structural.

The Coast Range intrusives are well-crystallized granitic rocks, and include the following types: granite, granodiorite, quartz diorite, diorite, and gabbro; quartz diorite and granodiorite being the most common. Quartz-porphyry and feldspar-porphyry dykes commonly found in the vicinity of the intrusives represent differentiates from the same parent magma as the larger bodies.

These intrusives are cut in many places by relatively late, green to black lamprophyre dykes.

The Coast Range intrusives have altered the adjacent wall-rocks to a varying extent, dependent on the nature of the wall-rock. The limestones are locally recrystallized to coarser-grained rocks and in places are replaced by contact metamorphic silicates such as garnet, diopside, and wollastonite. The volcanic rocks are less altered, and may be sheared, and only epidotized near a granitic contact. Argillites and quartzites have been mainly baked and sheared.

Tertiary Rocks.

In many places, bodies of igneous rocks have been observed cutting Upper Cretaceous sediments. These rocks include sills and irregular bodies of granodiorite and quartz diorite. They are usually much lighter in colour than the bulk of the Coast Range intrusives and tend to be porphyritic in texture, although even-grained types are found. It is possible that these rocks may be correlated with lower Oligocene intrusives of Sooke at the southern end of the island. In the northern part of the island the associated mineralization consists of small numbers of calcite stringers containing a little pyrite and chalcopyrite. Near Sooke a moderate amount of chalcopyrite mineralization is associated with Tertiary intrusives of gabbroic composition.

Structure.

The determinable structures of most importance in connection with the gold deposits on the island are found only in rocks of the Vancouver group. The Cretaceous rocks do not form the host-rocks for important deposits of lode-minerals and structures in these rocks are of no significance in a discussion of the lode-gold deposits. Structures in the Coast Range intrusives, apart from faults and shears, are too indefinite and indeterminable to be of use in the field.

Folds.—In general the rocks of the Vancouver group strike north-westerly and dip south-westward. However, variations from this strike and dip are common and are indicative of folds. The formation of these folds is related to forces accompanying the emplacement of bodies of the Coast Range intrusives. In general, the axes of these folds strike northerly or north-westerly; they may be vertical or slightly overturned. Both open and tight folds are found.

Folds of local development have been recognized and described for many areas. Tight folds which are slightly overturned to the east are common near Kathleen and Victoria Lakes in the Quatsino Sound area (Gunning, 1929); the formation of these folds has been definitely related to intrusives. It may be noted that important mineral deposits both of gold and copper are found in this vicinity.

In the vicinity of Nimpkish and Bonanza Lakes a large synclinal structure striking north-westerly is found (Gunning, 1929). Local intrusives have superimposed close folding and faulting on this larger fold.

In the vicinity of Buttle Lake the rocks are folded into a broad anticline pitching north, with two minor synclines on the anticline (Gunning, 1929). These folds are quite open with dips ranging from 30 degrees to less.

In the Zeballos area a tight syncline striking north-westerly is found along the Zeballos River (Gunning, 1932).

A minor syncline is reported from the head of Herbert Arm (Bancroft, 1937, p. 11.).

Sediments south of Della Lake in the Bedwell River area have been folded in a small open syncline whose axis trends north-westerly (Sargent, 1941, p. 26).

Faults.—Pre-mineral faults cut the folded rocks and associated batholiths, and in many places form major breaks and shear-zones, many of which are mineralized. Displacements range from a few feet to hundreds and perhaps thousands of feet. Attempts have been made to establish fault patterns and to establish a significance between the pattern and the local ore deposits.

SOUTHERN VANCOUVER ISLAND.

The geology of this part of Vancouver Island differs somewhat from that of the northern part. Some formations, present only in minor amounts in the northern part, are quite abundant in the southern, and some not represented in the northern are present in the southern.

Palæozoic Rocks.

Leech River Formation.—The oldest rocks are Palæozoic in age and comprise the Leech River formation. This formation consists of a metamorphic group of schistose, fine-grained sediments, associated with which is a series of volcanics, largely fragmental, described as the Malahat volcanics. The Leech River rocks are considered to be of Carboniferous age, but are of different type from the Palæozoic rocks of the Buttle Lake area, and definite evidence of their Palæozoic age is lacking.

The Leech River rocks are thought to be overlain by Mesozoic rocks of the Vancouver group.

Mesozoic Rocks.

Vancouver Group.—As in the northern part of the island, a threefold subdivision has been made of the Vancouver group into a middle limestone member, the Sutton formation, and lower member, the Vancouver volcanics, and upper member, the Sicker series. A widespread limestone member, the Nitinat limestone, described as being not definitely Mesozoic and possibly Palæozoic in age, is found on the west coast and is also included with the Vancouver group.

The rocks of the Vancouver group in the southern part of the island are lithologically similar to the volcanics, sediments, and limestones of the same group in the northern part of the island.

The Sutton formation consists of numerous lenses of limestones, up to 600 feet thick, which are intercalated with upper beds in Vancouver volcanic members. Bodies composed of contact metamorphic silicates have been formed in the limestone close to intrusive rocks.

Sicker Series.—The Sicker series consists of both volcanics and overlying metamorphosed sediments, closely associated with acidic and basic intrusive rocks. The acidic intrusives are known as the Tyee quartz-feldspar porphyry and the basic intrusives as the Sicker gabbro-diorite porphyry. The volcanics are mainly andesitic rocks. The sediments comprise cherty tuffs and black slates.

Coast Range Intrusives.—The Coast Range intrusives include a variety of igneous rock-types. These have been studied in considerable detail in the Sooke and Duncan areas and subdivided into several groups (Clapp, 1913 and 1914; Clapp and Cooke, 1917).

Detailed studies of these rocks in the area south of Duncan reveal that they were intruded in a definite sequence which resulted in rocks that range from basic to acidic in composition. This sequence of igneous rock-types includes the Wark gabbro-diorite gneiss, the Colquitz quartz-diorite gneiss and the Saanich granodiorite.

The Wark and Colquitz gneisses are local and form a single batholith extending from Shawnigan Lake to Victoria.

The Saanich granodiorite is of largest areal extent and forms many small batholiths and stocks from Alberni Canal south-easterly to the southern end of the island. A basic phase, the Beale diorite, is closely associated with the Saanich granodiorite where it intrudes the Nitinat formation. The Beale diorite forms around the periphery of the granodiorite, and inasmuch as it is commonly brecciated by the granodiorite, it probably was intruded before the granodiorite.

The Tyee quartz-feldspar prophyry and Sicker gabbro-diorite porphyry are confined to the Sicker series and form sills, dykes, and irregular masses in these rocks. Much of the Tyee quartz-feldspar porphyry has been altered to sericitic schist.

Gabbro and anorthosite intrusives, known as the Sooke gabbro, cut Tertiary volcanic rocks at the southern end of the island. The Sooke gabbro forms four stocks between the south end of Sooke Lake and the south tip of the island.

Cretaceous Rocks.

Upper Cretaceous sediments, comprising conglomerates, sandstones, and shales, are widely developed along the eastern coast of the island, but are confined largely to two basins, a southerly, the Cowichan basin, and a northerly, the Nanaimo basin. These Cretaceous rocks contain the coal-seams found on the island.

Tertiary Rocks.

Eocene Metchosin Basalt.—A thick series of basalts of Eocene age, termed the Metchosin volcanics, is found at the southern end of the island.

Tertiary Sediments.—Coarse detrital sediments Oligocene to Miocene in age are found on the coastal plain that extends along the west coast and around the southern end of the island.

Structure.

The Leech River slates have been closely folded into folds that strike east-west.

As in the northern part of the island, rocks of the Vancouver group have been deformed into folds that in general strike north-westerly. However, local variations from this general trend of the folds are found.

Two major synclines trending north-westerly have been described from the Duncan and Sooke areas. The south-westerly syncline involves rocks of the Leech River, Malahat, Vancouver, and Sutton formations and the north-easterly rocks of the Sicker series.

The Cretaceous rocks have also been folded, but, inasmuch as Cretaceous rocks do not form the host-rocks for any of the gold ores, folds in these rocks are of no significance in searching for lode gold.

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CHAPTER III. LODE-GOLD DEPOSITS AND FAVOURABLE PROSPECTING AREAS.

Recent lode-gold production on Vancouver Island has come principally from gold-bearing quartz veins. Copper-zinc replacement deposits at Mount Sicker have produced by-product gold and silver in important quantity and formerly produced most of the island's precious metal. Gold-bearing quartz veins have been found in the western part of the island, principally in the Zeballos River, Bedwell River, and Herbert Arm areas, and there are more scattered occurrences between these areas and north of Zeballos. Veins have also been found east of Alberni Canal and west of Nanaimo.

GENERAL FEATURES OF A FAVOURABLE PROSPECTING AREA.

Study of the various gold-quartz veins has revealed many common features of occurrence, a knowledge of which may be used in future prospecting on the island. Therefore a more detailed discussion of the geology and deposits will be preceded by some general conclusions about the occurrence of gold-quartz veins on the island in relation to the batholith areas and will present ideas about prospecting near them.

Most of the gold veins on the island, and elsewhere, are found either in or close to batholiths or stocks of granitic rocks. Because of this common association of gold-quartz veins and intrusive rocks, the gold-bearing solutions from which the vein-matter was deposited must have originated either from the associated, visible intrusive rocks or from a common source much deeper in the earth's crust. The actual source is hard to prove, and although some visible granitic rocks close to quartz veins in Eastern Ontario have been proven to be the source of the vein solutions, a source much deeper within the crust is most generally accepted as the more probable. Whatever the actual source, the close relationship of gold quartz to small batholiths and stocks is almost universal. Therefore, where an area is characterized by small batholiths or stocks of granitic rocks, conditions may be assumed to have been favourable for the production of vein solutions either from the visible igneous rocks or from deeper in the crust at that point. It is necessary then to find an environment of rock-types in or close to areas of intrusive rocks that will give breaks or fractures suitable for the deposition of vein-matter from the vein solutions.

Breaks, either fractures or shear-zones, which veins may follow tend to form where rock-types of different competency or physical characteristics are found. The breaks may follow or may cross the contacts of the different rock-types. Breaks which cross contacts may differ in the different rock-types. A break may be a wide shear-zone in a weak rock such as schist or schistose greenstone but may be a narrow shear in a stronger rock such as a granite.

Rocks of different physical characteristics are more apt to be found in the contact areas of batholiths. In such areas not only the batholith itself is in contact with the older rocks, but the many stocks and dykes accompanying the batholith cut the older rocks. On the batholith side of the contact the older rocks may be found as inclusions or pendants in the batholith. Therefore, within a batholith, if not too far from the contact, a physical contrast in rock-types is found.

It may be noted that outwards from the batholith one may prospect at considerable distances from the contact and still not be far above the actual batholith. An area which is close to a batholith, either horizontally or vertically, is usually characterized by numerous dykes and small stocks of granitic rocks, mainly feldspar or quartz porphyries, that are related to the main batholith. The porphyry dykes, cutting the older rocks (frequently greenstone on Vancouver Island), achieve the contrast in physical features of rock-types necessary for the formation of good breaks. This desired contrast in physical features tends to extend farther into the greenstone area from the batholithic contact than into the main mass of the batholith. In relation, therefore, to batholithic contacts, favourable prospecting areas extend farther into the area of older rocks than towards the centre of the batholith.

Experience has shown that the full length of any contact-zone will not be productive. After a mining camp has been established and numerous underground workings are available for study, correlation of surface studies with studies of the underground workings is frequently able to demonstrate why a concentration of producers is found at one place and not at others along the contact-zone. But until such time as the controlling factors have been recognized there may be little to guide the prospector to the more favourable sections of a contact-zone.

One of the best ways in prospecting is first to study the known ore deposits in the mineralized area nearest to the area to be prospected. A study of the mineralogy, structure, and rock associations of proven gold deposits should be made, so that search for duplicates of favourable conditions, if only in part, can be made intelligently in undeveloped areas. A knowledge of how veins look when high grade, marginal, or non-economic is also of value to the prospector. With this in mind, the geology and gold deposits of the various mineralized areas on the island are described in some detail, so that the prospector or scout may have the pertinent information on the areas nearest to the area he intends to prospect.

DESCRIPTION OF MINERALIZED AREAS.

Properties North of Zeballos.

(Ref. Maps 3A, 3D, and Min. Ref. Map 4T294.)*

In general, copper and lead-zinc, rather than gold prospects, have been discovered in this area. About fifteen copper, five lead-zinc, and three or four gold prospects have been reported.

On the Quatsino King property on the western side of Neurotsos Inlet a north-westerly-trending zone or stockwork of quartz veinlets cuts a variety of greenstones. The stockwork consists of many closely spaced quartz veinlets over a width of 16 feet and a known length of about 300 feet. The quartz contains small amounts of pyrite, sphalerite, and chalcopyrite, and a little gold. The wall-rock consists of greenstone tuff and breccia cut by numerous granodiorite dykes. The gold values in this deposit, as developed to date, are low. At one time the Granby Consolidated Mining, Smelting and Power Company, in search of siliceous flux for their Anyox smelter, did exploratory work on this deposit hoping that the quartz would carry enough gold to pay for mining and handling.

At the Patmore Gold mine,† on Deep Inlet in Kyuquot Sound, at least five different quartz veins have been found in granodiorite; only one has been opened up by adits. This vein consists of quartz up to 1 foot wide in a well-defined shear-zone which follows a narrow lamprophyre dyke. The quartz is massive, and contains free gold but very little sulphide. The property was originally located in 1938 and has been under development since that time, but no ore shipments have been reported.

Zeballos Area.

(Ref. Maps 3C, 2, and Min. Ref. Map 10T332.)*

The general geology of the area has been described by Gunning (1932) and Bancroft (1940). A geological map on a scale of 1½ miles to 1 inch accompanies Gunning's report.

The main gold-producing properties and many other non-producers have been described by Bancroft (1937 and 1940), Stevenson (1935 and 1939), Stevenson and Maconachie (1938), and Patmore (1938). Much of the following discussion has been abstracted from these publications; however, the present writer accepts responsibility

* *See* p. 9.

† H. C. Hughes, personal communication.

for the generalizations made about the ore-deposits and particularly about suggestions for prospecting.

Location and Access.—Zeballos is a small mining community on the western coast of the island, about 195 nautical miles north-westerly from Victoria. The Canadian Pacific Steamship Company maintains service from Victoria or Port Alberni up the western coast and calls in regularly at Zeballos. Canadian Pacific Airlines maintains a tri-weekly air service from Vancouver to Zeballos. Jitney service connects the mines with the town.

The Zeballos lode-gold area at present includes the valley of the river and its watersheds. The area in which the most important properties have been found lies in the angle between the main Zeballos River and the Nomash River and an east-west line 1½ miles northerly from tide-water; this area includes the valleys of Van Isle, Spud, and Gold Valley Creeks and the headwaters of the Little Zeballos River.

Access within the immediate area is by a truck-road which leads up the main river valley 4½ miles to Privateer mine and then for 2½ miles to Mount Zeballos and Spud Valley mines. From the Privateer it goes for 3 miles to the Central Zeballos mine. The road extends for about a mile beyond the Central Zeballos and from the end of it trails lead up the North Fork and up the Nomash (South Fork) Rivers.

Topography.—The country is extremely rugged. The hillsides are heavily wooded but steep, and often the dense growth of timber serves only to obscure unscalable rock bluffs. The floor of the main valley, where not bluffy, ranges from one-eighth to one-half mile in width. The tributary creeks flow in narrow valleys and join the main valley on steep gradients ranging from 600 to 800 feet per mile.

Mining History.—Although small amounts of placer had been obtained from the Zeballos River as early as 1907, it was not until 1924 that the first gold vein, on the Tagore property, was staked. Two years later the King Midas was staked, and by 1929 forty claims had been staked in the valley. In that year the first shipment of ore was made from the valley. It consisted of 2 tons of high-grade ore, mined from the Tagore. A period of inactivity followed until 1934, when the first of the rich gold-quartz veins that were to make the Zeballos camp an important producer in a very short time were found.

Lode-gold mining really began in the winter of 1934–35 with shipments of high-grade ore from the property of the White Star Gold mines. In 1936 the main high-grade vein on the Privateer was found and shipments of high-grade ore were made from it in 1937. Milling started in standard-sized mills later. In 1938 the Privateer 75-ton amalgamation-cyanide mill and Spud Valley Gold mines 50-ton amalgamation-flotation mill began operating. The tonnages of these mills were stepped up to 85 and 70 tons respectively in 1938. In 1938, thirty properties, employing nearly 400 men, were active in prospecting, development-work, and actual mining. In 1939 a 50-ton mill was built at the Mount Zeballos and a 40-ton mill at the Central Zeballos, and in 1941 a 25–50-ton mill at the Homeward. About the middle of 1942 shortage of men and supplies because of war forced all but the Privateer and the Prident to close down, and in October, 1943, these properties also were forced to close "for the duration." However, during the winter of 1945–46, Privateer, Prident, Central Zeballos, and Spud Valley gold mines resumed operations.

Production.—Gold-quartz ore mined from fifteen properties in the Zeballos area to the end of 1945 has amounted to a total of 344,722 tons. Of this total, 335,000 tons came from four properties, for which production has ranged from 35,000 to 137,000 tons, and the remainder from properties with production ranging from 1 ton to a few thousand tons. The total gold recovered has amounted to 261,613 oz., an over-all average of 0.76 oz. per ton mined, and has ranged from 0.4 to 5 oz. per ton. Silver has been recovered approximately in the ratio of 1 oz. silver to 2½ oz. gold. The returns for ore, shipped from several properties to the smelter, have included credit for lead and in some cases for copper.

Geology.—The general geology of the region has been described by Gunning (1932). The main feature of the geology is a northwesterly-southeasterly trending belt of granitic rocks, called by Gunning the Zeballos batholith. The rocks range in composition from gabbro to quartz monzonite, but within the area under consideration quartz diorite is most common. The batholith ranges in width from approximately 2 miles near the headwaters of Gold Valley Creek to three-quarters of a mile where it crosses the Zeballos and widens out from there as it extends north-westerly from the river. The Zeballos batholith has intruded Mesozoic volcanics and sediments of the Vancouver group that Gunning has divided into three groups—a lower assemblage of volcanic rocks called the Karmutsen volcanics; a middle limestone member, the Quatsino limestone, both groups lying north-east of the batholith; and an upper volcanic group, the Bonanza group, lying south-westerly of the granodiorite. These rocks are similar to those found elsewhere on the northern part of the island and have already been discussed on pages 11–13 of this publication.

To date the greater number of properties lie within either the quartz diorite or the volcanics and associated sediments along the south-western contact. There are a few properties, however, in the volcanics at distances from 2 to 3 miles from either contact.

Gold Deposits.

High temperature replacement deposits of iron and of copper and gold-quartz veins are found in the Zeballos area. The copper deposits are small and unimportant. One large and several smaller magnetite (iron) deposits have been found which may prove to be of considerable importance. However, because this publication is concerned only with lode-gold deposits, the copper and iron deposits will not be described.

Strike Groups.—Nearly all the gold-quartz veins in the Zeballos camp strike in the north-east quadrant. They are either vertical or have very steep dips. On the basis of their strike, the veins may be divided into three groups; both the group that strikes easterly and the group that strikes north-easterly include important producers; a third group, found outside the main productive area, consists of veins striking nearly north-south which have not been productive.

The veins in the easterly striking group range in strike from 10 degrees north of east to 7 degrees south of east, and in dip from vertical to steep northward or southward. This group includes the veins on the Privateer, Prident, Central Zeballos, Rimy, Homeward, and Monitor properties, of which the Privateer and Prident are close to the western contact of the Zeballos batholith and the remainder are near the eastern contact. All of these properties, excepting the Monitor, have produced gold, three of them over 1,400 oz., and the total production has been 165,071 oz. to the end of 1945 (this includes production from the north-easterly striking veins on Prident). One of them, the Privateer, has been the major producer in the camp.

The veins in the north-easterly striking group, ranging in strike from north 30 degrees east to north 55 degrees east and dipping steeply on either side of the vertical, are found in three main areas. In the greenstone area south-west of the main Zeballos batholith, north-easterly striking veins are found on the Tagore, Van Isle, and Friend properties. On the quartz-diorite side of the contact, north-easterly striking veins are found on the Prident, White Star, Zeballos Gold Peak, Spud, Britannia " M," and Mount Zeballos properties. Production from the White Star, Spud, and Mount Zeballos properties has been 143,000 oz. of gold, and production from the north-easterly veins on the Prident has been considerable, but as Prident production figures are incorporated in the Privateer figures, and therefore in the total production from the easterly striking group above, they are not included in the above amount. No production has as yet been made from the Zeballos Gold Peak and Britannia " M " properties. Towards the centre of the batholith, north-easterly striking veins are found on the B. and Wet claims, C.D. (Rey Oro), I.X.L., and Big Star properties.

Neither group of veins possesses any easily discernible common relationship to the structure, texture, mineralization, or wall-rock.

The main producing veins of the camp are: Easterly striking veins found close to both the west and east contacts of the batholith, and north-easterly striking veins found close to the south-west contact. To date the production has come largely from veins of both groups near the western contact, either in the greenstone or in the granite.

Vein-structure.—Most of the gold-bearing veins consist of quartz-sulphide filling in well-defined fault-fissures, rarely more than a foot wide, that maintain a fairly uniform strike and dip over considerable distances. In places the quartz-sulphide vein-matter may be lacking, and only sheared rock present. The walls of the quartz-sulphide veins are marked by films of gouge; frozen walls are not common.

Some of the gold-quartz veins occur in sheeted zones up to 4 feet wide. These zones consist of joints spaced 2 to 8 inches apart and contain either gouge films or 1/8 to 1 inch quartz-sulphide stringers. Along the strike a sheeted zone may change into a single, narrow shear containing a lenticular quartz-sulphide vein. The Goldfield vein on Spud Valley property is an example. Sheeted zones are not common.

Wide shear-zones containing mineralized veinlets of quartz are not common. However, a shear-zone about 50 feet wide has been found on the Big Star property of the Spud Valley Gold Mines, Limited, and promises to be of some importance.

Vein-texture.—Most of the Zeballos gold-quartz veins are banded either by an alternation of quartz and sulphides or by an alternation of the different sulphides themselves. Comb-texture, so called because of the comb-like appearance of pyramid-shaped quartz crystals that project inward from either side of the band, is common. The spaces between the crystals are commonly filled with sulphides.

The vein-filling consists of quartz, some carbonate, and sulphides. The sulphides, though in some veins unimportant, are very abundant in most of the Zeballos veins. They range from a small fraction to one-half of the vein-matter, and probably average about one-quarter of the vein-matter.

Listed in order of abundance the sulphides are pyrite, sphalerite, arsenopyrite, chalcopyrite, galena, and pyrrhotite.

Occurrence of Gold.—Gold is visible in much of the vein-matter, but commercial ore may contain no gold recognizable with the unaided eye. Specimens of crystalline gold have been found at Privateer and Spud Valley mines. Large masses of hackly gold have been found on the Privateer.

The relationship of the gold is fairly constant. The amount of gold is not only proportional to the sulphide content, but is also dependent on the presence of sphalerite and galena. The reason is not obvious. It is most likely that the gold, though slightly later in time of deposition, came in with the surge of mineralization that brought in the galena and sphalerite. The galena and sphalerite, though not necessarily abundant, are nevertheless significant as indicators of gold. Quartz veins that contain either pyrite or arsenopyrite alone do not as a rule contain much gold.

Zones of crushed rock which may lie immediately adjacent to gold-bearing veins, and which may contain disseminated crystals of pyrite, are usually very low in gold. Good gold values are not found in the crushed rock and gouge of a shear-zone even though found in quartz-sulphide ribbons or lenses of the same shear-zone.

The wall-rock of the veins contains no gold of economic importance.

Suggestions for Prospecting.—The present producing area is in and close to the part of the Zeballos batholith that lies south-east of the Zeballos River. In this section the batholith is about three-quarters of a mile wide. To the north-west it widens to 4 miles in the Kaouk River valley and to the south-east it widens to 2 miles near the head of Spud Valley Creek. The areal extent of the batholith is unknown to the north-west beyond the Artlish River, and also relatively unknown to the south-east beyond the head of Spud Valley and Gold Valley Creeks.

A fair amount of prospecting has been done north-west of the Zeballos River in the Kaouk and Artlish River valleys, but without any marked success. However, the country is very rugged and difficult of access, so that the amount of time spent in actual prospecting for quartz veins is small in proportion to the time spent in travel and in the back-packing of supplies.

South-easterly from the Zeballos River the extension of the batholith has been prospected, at least as far as the Little Zeballos River. Though perhaps less so than the Kaouk-Artlish country, this section is still difficult of access, everything having to be back-packed from tide-water. Little of this section has been thoroughly prospected in the few years since the Zeballos area came into prominence.

The properties from which ore has been mined are near the north-eastern south-western contacts of the Zeballos batholith, south-easterly from the constriction of the batholith at the Zeballos River, with most of the production coming from the south-western contact. These facts suggest that the most favourable prospecting ground lies south-easterly from the river, along both contacts of the batholith, but especially along the south-western contact. It may be that gold-quartz veins as rich as those already known will not be found until another constriction in the batholith is found. However, should the batholith taper to a point in going south-easterly, the tapering might be as favourable as a constriction for the localization of rich gold-quartz veins.

The writer suggests prospecting the south-easterly extent of the batholith, either from the Little Zeballos side or from the Nomash (South Fork, Zeballos River) side. It is not necessary to stay close to the area of batholithic rocks. Greenstone cut by late dykes, granitic or otherwise, is sufficiently heterogeneous in physical characteristics, and therefore in response to fracturing forces, to permit the development of breaks suitable for vein-formation. (*See* pages 17 and 18 of this publication for a discussion of favourable prospecting ground.)

It may be that the localization of the rich gold-bearing veins is related, directly or indirectly, to some feature transverse to the batholith, either to a north-south pre-mineral line of major faulting or weakness or to a transverse depression in the original roof of the batholith. However, even if this proves true, it is still worth while to prospect the continuation of the batholith area for a repetition of whatever transverse conditions caused the localization of the known gold deposits.

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NOOTKA SOUND AREA.

(Ref. Map 2.)*

Five gold properties are found in this area: the Independence, 2 miles up the Tahsis River; the Oh Boy, on the western side of Tlupana Inlet; the Baltic and the Ash, on the south side of Muchalat Arm; and the Burman River Gold Syndicate property, at the head of the arm. On the Independence and Oh Boy, quartz veins

* *See* p. 9.

mineralized with chalcopyrite, pyrite, and sphalerite follow shears in greenstone. On the Baltic a sulphide vein, 4 to 12 inches wide, consists mainly of pyrite, chalcopyrite, and sphalerite, and follows a shear in granodiorite. On the Ash a quartz vein, 3 to 6 inches wide, contains chalcopyrite and free gold, and follows a break in quartz diorite.* On the Burman River Gold property a strong shear in greenstone contains lenses of chalcopyrite, of sphalerite, and of quartz with chalcopyrite and pyrite. The combined production from these properties is approximately 150 tons of ore, containing 190 oz. of gold and 325 oz. of silver.

No shipments have been made from the Burman River Gold Syndicate property.

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BANCROFT, M. F. (1937): Gold-bearing deposits on the west coast of Vancouver Island between Esperanza Inlet and Alberni Canal—*Geol. Surv., Canada*, Mem. 204, pp. 18–20.

HERBERT ARM AREA.
(Ref. Map 1B.)†

Location, Access, and Names of Properties.—Herbert Arm is reached by Canadian Pacific steamer from Victoria or Port Alberni to Ahousat, thence by launch for 12 miles to the head of the arm. Most of the properties are close to tide-water, at the head of the arm.

The properties on which gold-bearing veins have been found include the Abco, Big Boy, Moyeha, and Tyee.

History.—Activity in this area began in 1933, and the gold finds were staked that year. Prospecting and development-work continued until 1935. In 1938 Premier Gold Mines, Limited, did considerable underground work on the Abco. In 1945 Berton Gold Mines, Limited, acquired the property and by the end of the year had done 44 feet of drifting. In 1941 a small shipment of ore was made from the Big Boy.

Production.—The total production, from the Abco and Big Boy, has amounted to 135 tons, containing 334 oz. of gold.

Geology.—On the Herbert Arm properties gold-bearing quartz veins, both of the replacement and fissure type, occur in greenstones that have been cut by dykes and irregular masses of granitic rocks.

Veins.—Quartz is the predominant vein-filling and sulphides, including pyrite, chalcopyrite, and galena, are present, but seldom in large amounts. The veins differ from the Zeballos veins in the smaller sulphide content.

Both simple-fissure and shear-zone deposits are found. Production has come from a narrow shear-zone striking north-westerly on the Big Boy and on the Abco property from a wider shear-zone, which strikes north-easterly. The Abco shear-zone, at least 4 feet wide, contains parallel quartz veins, which seldom exceed 8 inches in width.

The vein-matter must be mined selectively as the wall-rock does not carry gold.

Suggestions for Prospecting.—The area at the head of Herbert Arm has not been mapped geologically, so that the relative extent of greenstone and batholithic rocks is unknown. However, the presence of many feldspar-porphyry dykes suggests that the batholithic rocks are close. Granodiorite has been mapped from the Cotter Creek divide, extending down Penny Creek in the Bedwell River area, and is part of a body which continues on the Cotter Creek slope, only 2 miles from the head of the arm. Prospecting in this direction would lead towards the intrusive and in so doing probably would go through areas of greenstone cut by abundant porphyry dykes; if so, the area easterly would be likely prospecting ground.

The north-westerly extension of the main Bedwell River batholith crosses the Moyeha River probably about 8 miles from the head of Herbert Arm. It is doubtful if prospecting would yield much, except near the batholith, and it is uncertain where,

* W. S. Hamilton, personal communication.
† See p. 9.

along the contact zone of the batholith, one may find a repetition of the gold-quartz mineralization found in the Bedwell River section.

Because the distances between accessible points are shorter and problems of transportation less, the writer would suggest working north-westerly from the head of the arm towards the head of Shelter Inlet, a distance of about 6 miles, and south-easterly towards the head of Bedwell Sound, also about 6 miles. The presence of small quartz veins, carrying a little gold, in granodiorite on the High Boy property on Shelter Arm, indicates the existence of gold mineralization in this direction. Numerous gold-quartz veins found in the Bedwell River area are discussed on pages 24–28.

When considering prospecting up the Moyeha River towards the Bedwell batholith, *it is to be remembered that the absence of a road and good pack-trail necessitates* spending much time back-packing supplies.

References.

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BEDWELL RIVER AREA.

(Ref. Map. 1B.)*

The geology and ore deposits of the Bedwell River area have been described in detail in two bulletins by Sargent (1940 and 1941). The following discussion represents an abstract of the information contained in these bulletins, with some generalizations contributed by the present writer.

Location and Access.—The Bedwell River area is on the western coast of the island, about 70 miles down the coast from Zeballos or 20 miles up the coast from Clayoquot and Tofino. Clayoquot and Tofino are served by the Canadian Pacific Steamship Company steamer on an eight-day schedule. Passengers and freight are conveyed in launches and scows from Tofino.

A truck-road extends for about 7 miles up the river and serves the Musketeer and Buccaneer properties. Trails lead from this truck-road to the various properties and a trail continues up the main valley to the You and Casino properties. It is possible to follow a difficult route over Bear Pass to Della Lake and thence to Drinkwater Creek. The Big I, Della, and Sherwood (Cangold) properties are in this section. However, these latter are reached more easily from the Drinkwater Creek side by a route from Port Alberni via 10 miles of road to Great Central Lake, thence by boat up the lake. A truck-road, completed in 1946, extends from the western end of the lake for 8½ miles to the mill-site below the Sherwood workings.

Topography.—As is characteristic of the western coast, the Bedwell River area is rugged and mountainous. The valley-bottom of the Bedwell River is on the average about one-quarter mile wide and, excepting for about 1½ miles at its mouth, has an average gradient of about 80 feet per mile. Most of the tributary streams are in deep narrow canyons. The forest-cover of conifers is abundant and mining timber plentiful.

History.—As has been the case elsewhere, the discovery of lode-gold deposits in this area was preceded by placer-mining. Chinese worked gravels on the river for placer gold as early as the '60's but appear to have left the country in the '80's.

Several years later, between 1898 and 1903, gold-quartz veins and copper replacement deposits were found at several places between the mouth of the river and Big Interior Mountain at its head. Locations during this period include the Seattle, Annex, Belvidere, Galena, Avon, Prosper, and the part of the present Musketeer-Buccaneer ground covered then by the Corona claim.

* See p. 9.

Activity was slack in the period 1903 to 1912. In 1912, English interests purchased copper claims on Big Interior Mountain, covering discoveries made as early as 1899. Work was started on the construction of a road up Bedwell River valley to connect with a proposed aerial tram down the mountain from the showings. Only 7 miles of the 13 miles required had been built when work was stopped at the outbreak of World War I. With the exception of some diamond-drilling in 1916, very little further work has been done on the copper showings.

Excepting work on the You property, very little was done in the area between 1914 and 1938. In 1933 a small cyanide-mill was built on the You property, but shortly after the mill had been built two large bridges across the Bedwell River washed out, thereby destroying access by road to the You. Consequently operations on the property ceased.

In 1938, probably as a result of the discoveries just made in the Zeballos area, interest in the area was renewed. Prospectors were very active during 1938 and 1939, many gold-quartz veins were found, and much of the ground extending up the river and over the divide into Drinkwater Creek was staked.

The Musketeer property was optioned by Pioneer Gold Mines, Limited, and Anglo Huronian Company, Limited, and the Buccaneer by Bralorne Mines, Limited.

Underground work was done, mainly on the Musketeer and Buccaneer, and mills were built on these properties. Largely because of the shortage of labour and materials as a result of World War II., operations at most of the properties had ceased by July, 1942. However, during 1946, S. D. Craig mined 15 tons of shipping-ore from the Buccaneer, of which he is the owner. Cangold Mining and Exploration Company, Limited, acquired the Sherwood early in 1945, and since then have been preparing the property for production.

Production.—The production from the Bedwell River area has been mainly from the Buccaneer and Musketeer properties, although a small tonnage was produced from the Prosper, Della, and Sherwood (Cangold). Over the main producing period of two years, 1941 and 1942, the production amounted to 10,059 tons of ore, from which about 5,000 oz. of gold were recovered. The grades of mill-feed over yearly periods averaged between 0.26 and 0.84 oz. of gold per ton.

Geology.—A summary discussion of the distribution of rock-types follows, but for more detailed knowledge the reader should refer to the description and coloured map on a scale of 1 mile to the inch in Bulletin No. 13 by Sargent (1940).

Greenstone is found from the head of Bedwell Sound for about 1½ miles upstream as far as Penny Creek. Here a tongue of granitic rocks, 1¾ miles wide on the western side of the main valley extends for an unknown distance north-westerly in the direction of the head of Herbert Arm. Greenstone again is found from near Penny Creek up the main valley for about 2½ miles to the south-western contact of the Bedwell batholith just beyond Noble (Clarke) Creek. The greenstone belt extends an unknown distance north-westerly and south-easterly. The batholith, 6 miles wide where cut by the river, extends unknown distances north-westerly and south-easterly from it. A large area of greenstones and limestone extends easterly from the batholith, continuing beyond the eastern boundary of the area mapped geologically.

Replacement Deposits.—Copper-bearing replacement deposits, which do not carry enough gold to make that metal an important part of any possible production, have been found in two localities. The deposits consist of silicates and sulphides replacing limestone lenses and greenstone near bodies of granitic rocks. Pyrite, chalcopyrite, sphalerite, and magnetite are the common sulphides. Copper replacement deposits are found on the Avon, Seattle, and Galena properties, close to an area of intrusive rocks mapped as the Penny Creek intrusive. Chalcopyrite is found replacing volcanic rocks and limestone on the Ptarmigan and Big I properties on Big Interior Mountain. So far, development-work has not disclosed commercial ore-bodies of either copper or of copper and gold.

The Bedwell River area is important because of its gold-bearing quartz veins. Gold-quartz veins have been found on fourteen properties, and on two properties—the Musketeer and Buccaneer—moderate tonnages of ore have been mined and milled.

Strike Groups.—The gold veins all strike in the north-easterly quadrant. They fall into two groups, those striking close to north 20 degrees east and those with strikes close to north 65 degrees east. On any one property, veins of two strike groups may be found. Veins of the first group are found on the Musketeer, Buccaneer, Avon, Noble, and Noble B., Casino, Della, P.D.Q., and veins of the second group are found on the Musketeer, Trophy, Thunderbird, Prosper, O.K., You, Casino, and Sherwood (Cangold). Veins from both strike groups contain high-grade gold-bearing quartz and have produced ore.

Concerning dips of the two strike groups, Sargent (1940, p. 28) has made the observation that veins of the " north 20 degrees east " strike group are nearly vertical or dip steeply eastwards in the western part of the area and dip less steeply westward in the eastern part. He also observes that almost all the veins of " north 65 degrees east " strike group seen by him, dip from 45 to 70 degrees northward.

Structural Types.—Most of the quartz veins belong to one of the three following structural types: simple fissure-veins, sheeted zones, or wide shear-zones.

Simple fissure-veins are characterized by a single quartz vein which is usually bordered by a film of gouge or a narrow width of sheared wall-rock. Veins with frozen walls do occur but are not common.

A sheeted zone consists of several parallel or sub-parallel fissures, over a width of 1 foot to several feet, which have been filled with narrow quartz stringers ranging from a fraction of an inch to a few inches wide. Along strike a sheeted zone may grade into a narrow shear containing a single quartz vein.

The shear-zone type of deposit consists of one or perhaps two lenses or lenticular veins of quartz lying in a zone of sheared rock, which is usually several times the width of the contained quartz vein-matter.

Simple fissure-veins, veins in sheeted zones, and veins in wide shear-zones are found at various places in the area. Simple fissure-veins are the most common and have been found on the Musketeer, Trophy, Thunderbird, Noble and Noble B., O.K., and Casino. Sheeted zones of several narrow quartz veins are found on the Thunderbird and Musketeer. Veins in shear-zones are found on the Buccaneer, Sherwood, Della, Prosper, and Avon.

Many of the veins have branches which lead from the main vein into the walls. The vein-matter is usually wider than average at the junction of the branch and main vein.

Vein-texture.—Much of the quartz in the gold veins of the area is in narrow plates separated by thin partings or layers of pulverized wall-rock or vein-matter, either as gouge or cemented by later vein-filling, and may contain a concentration of sulphides. Partings parallel the dip and strike of the vein.

A common type of vein-matter consists of large, well-shaped quartz crystals surrounded by abundant sulphides. This material is only loosely coherent and can be easily shattered by a hammer-blow. In some veins most of the quartz crystals are arranged roughly perpendicular to the walls of the vein and produce a comb-like texture in the vein-matter. Massive white quartz without characteristic texture is found in some veins, but ribboning and often a loosely aggregated texture is characteristic of most of the veins.

Vein-matter.—The vein-matter consists of quartz, carbonates, and sulphides. The sulphides include pyrite, sphalerite, chalcopyrite, and galena. Pyrrhotite and derived marcasite are found in some veins.

Arsenopyrite in an appreciable amount has been found in a vein near the eastern and in another vein near the western contact of the Bedwell River batholith.

The total amount of sulphides in the vein-matter ranges up to at least 50 per cent. "Although the gold is associated with the sulphides, between pieces of vein-matter which give the same gold assay there may be a marked difference in sulphide content; this statement applies to mineralization from the same vein but the difference is more striking when mineralization from certain near-by veins is compared." (Sargent, 1941, p. 23.)

It may be noted that whereas the sulphide content of better sections of the Musketeer veins ranges from 3 to 10 per cent. of the vein-matter, the better sections of the Buccaneer veins average a fraction of 1 per cent. The Musketeer and Buccaneer veins differ, not only in total sulphide content, but also in the proportions of the different sulphides present. Concerning the two properties, Joubin (1942, p. 9) says that in most of the veins on the Musketeer the main sulphides are pyrite, sphalerite, with minor amounts of chalcopyrite and galena, whereas in the veins on the Buccaneer the main sulphides are chalcopyrite and galena, with very minor amounts of pyrite and sphalerite.

In general it may be said that the richest veins are those high in sulphides, in which both galena and sphalerite are present. Though the galena and sphalerite may not be as abundant as pyrite in a rich gold vein, they still are in appreciable quantities. Quartz veins in which pyrite is the only sulphide do not so frequently carry good gold values. In general, veins carrying good gold values contain galena and sphalerite in addition to pyrite.

The wall-rock of the veins is seldom mineralized by sulphides and does not carry important gold values. It is frequently bleached for several inches on either side of the vein. This bleaching is most common if the wall-rock is sheared and if it is greenstone rather than quartz diorite.

Rocks associated with Gold Veins.—The gold-quartz veins of the area are found in granitic rocks of the Bedwell River batholith or of the Penny Creek intrusive mass, in greenstones, or along and close to contacts of the two rock-types.

Veins in which the wall-rock is quartz diorite, the prevailing granitic rock in the area, are found on the Musketeer, Trophy, Thunderbird, Avon, O.K., and Casino.

Veins in greenstone, mainly andesitic volcanics, are found on the Prosper, Avon, Noble, and Noble B.

Several gold-quartz veins are in areas characterized by an alternation of greenstone and quartz diorite, between which the contrast in physical characteristics is sufficient for breaks to form in the weaker rock of the two—namely, greenstone. The heterogeneity has been achieved by virtue of andesitic dykes in an area of quartz diorite or by granitic dykes in an area largely of greenstone. The vein-fractures tend to follow the contacts, but may cut across the contact and be found in either rock close to the contact. An area in which a heterogeneity of rock-types exists is usually favourable for prospecting.

Veins that follow or cut across the contacts of greenstone dykes in quartz diorite are found on the Musketeer, Buccaneer, and You properties. Veins in or close to contacts of granitic dykes in greenstone are found on the Della, Sherwood, and P.D.Q. properties.

A more constant relationship exists between the structural nature of the vein and the nature of the wall-rock than between the strike group and the wall-rock. Simple fissure-veins and sheeted zones are most common in the quartz diorite. Shear-zones are commonest in greenstones, or along contacts of greenstone and granitic rocks, one or other being rock in the dyke form.

Suggestions for Prospecting.—It should be borne in mind that the gold-quartz veins are related to the Bedwell River batholith and the Penny Creek intrusive. Whether the relationship is genetic or structural is immaterial, the areal relationship exists.

With reference to the contact of the Bedwell River batholith, the properties found to date are not more than 1½ miles from the contact on the batholith side of the contact nor more than 2½ miles from the contact on the greenstone side. Though such properties as the Sherwood (Cangold) and P.D.Q. in the greenstone area are from 2 to 2½ miles from the contact of the batholith, they are in an area characterized by numerous granitic dykes and therefore where there is physical contrast in rock-types, a factor that markedly favours the formation of vein-fractures.

Reasoning from the principles outlined in the section on the features of a favourable prospecting area on pages 17 and 18 of this publication, and from the distribution of properties in the Bedwell River area the writer suggests prospecting the contact areas of the Bedwell River batholith for up to 2 miles from the contact on the batholith side and for up to 3 miles from the contact on the greenstone. The same procedure may be followed with respect to the Penny Creek intrusive, but the width of the effective contact area will be narrower because of the smaller size of the intrusive.

Our knowledge of the area is still insufficient to tell why the best properties in the Bedwell River are where they are with respect to the north-westerly trend of the batholith, or whether similar veins occur at other points along the contact-zone. In lieu of such knowledge, one can only prospect the length of the contact-zone, hoping to find rich veins.

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TRANQUIL CREEK-WARN BAY AREA.

(Ref. Map 18.)*

by W. J. Lynott.

Location and Access.—The Tranquil Creek-Warn Bay area is on the western coast of the island, about 15 miles north-easterly by water from Tofino, the nearest base for supplies and transportation.

Tofino is served on an eight-day schedule three times a month by ships of the Canadian Pacific Steamship Company, intermittently by Frank Waterhouse ships, and semi-weekly by Canadian Pacific Airlines. The M.V. "Uchuck" sails three times weekly from Port Alberni to Ucluelet and is met by motor-vehicle carrying light freight and passengers to Tofino over some 26 miles of good gravel road. Motor-boats may be chartered to run between Port Alberni and Ucluelet.

A launch or small boat may be taken from Tofino to the head of Tranquil Inlet or Warn Bay. A boat capable of passing the bars at the mouth of Tranquil Creek, where the depth of water at high tide is about 4 feet, may continue half a mile up-stream to the beach camp. From the camp a tractor-road extends a further 1½ miles up the western side of Tranquil Creek. Rough trails extend from the end of the tractor-road about 1½ miles farther up the valley to the Fandora and Gold Flake properties, and about 5 miles up the valley towards the headwaters of the two main forks of Tranquil Creek.

One mile of truck-road leads from the beach at the head of Warn Bay to the Moscena camp-site. Rough trails branch from the road bridge to various other discoveries near Bulson Creek. Other rough trails extend from Warn Bay to the Freegold and Gold Flake properties.

Topography.—The Tranquil Creek-Warn Bay area is rugged, mountainous, and heavily wooded on the steep bluffy slopes from the valley-bottoms to most of the ridge-tops. The highest peak in the area is just over 4,400 feet above sea-level.

* *See* p. 9.

Tranquil Creek is fed by tarn lakes at its headwaters and has a steep gradient down canyons to the junction of its two main forks about 3½ miles from the head of Tranquil Inlet. The average gradient of the valley-bottom from the forks to the mouth is less than 100 feet per mile. Down-stream from a 50-foot waterfall, about 2 miles from tide-water, the width of the valley-floor increases gradually from a few hundred feet to half a mile.

Bulson Creek, within the area, flows through a narrow canyon and has an average gradient of 200 feet per mile to its mouth at the head of Warn Bay.

History.—Several mineral claims were staked in the late '90's. Nineteen of them, on the eastern side of Tranquil Creek valley about 3 miles north of the head of Tranquil Inlet, were Crown-granted between forty and fifty years ago and were in good standing in 1946. On these claims, lenticular bodies of low-grade copper ore have been explored by surface and underground workings. Most of this work was done before 1904, but some further work has been undertaken from time to time.

In the late '30's several auriferous quartz veins were discovered, claims staked, trails put in, and development-work undertaken. Development-work continued for several years. Surface-stripping and some underground development by the Maple Leaf Syndicate in 1941 disclosed interesting possibilities on a property now owned by Moscena Mines, Limited (N.P.L.), near Bulson Creek, 1 mile north of Warn Bay. Surface-stripping and underground development on the Fandora property by E. G. Brown and P. Donahue exposed narrow but fairly rich and continuous vein-matter in a sheared andesite dyke. Little was done during the later war years, but work was resumed in 1946 on the Moscena and Fandora properties.

Production.—From the Hetty Green property on Tofino Creek, just east of the present area of production, was recorded, in 1905, 214 tons containing: Gold, 2 oz.; silver, 168 oz.; copper, 29,379 lb.

In 1940 production of approximately 35 oz. of gold and some silver was recorded from three properties—the Gold Flake, Maple Leaf, and the Yankee Boy.

Geology.—Granitic rocks, cut by a few large andesitic dykes, underlie most of the area examined north of Warn Bay. Pendants and numerous small inclusions of older altered volcanics and (or) sediments occur in scattered zones and patches. Altered andesitic volcanics, cut by fresh andesitic dykes and small bodies of feldspar porphyry, are found in the area north-westerly and easterly of Warn Bay.

A large area underlain mostly by granitic rocks, gneissic near the contact zone, lies immediately south of Virge Creek. The approximate greenstone-" granite " contact runs easterly from the mouth of Virge Creek, over the divide, down Goldflake Creek, and across Tranquil Creek at a point approximately 2 miles up from the head of Tranquil Inlet.

Altered volcanics with small scattered lenses of altered sediments, crystalline limestone, and garnetiferous rocks underlie almost the entire western valley-side of Tranquil Creek north of Goldflake Creek. The older rocks are cut by numerous andesitic to basaltic dykes, by numerous small bodies of fresh feldspar porphyry, and by a few isolated bodies of granitic material found along the ridge-tops. North-easterly to south-easterly of the junction of Tranquil Creek forks, granitic rocks predominate. Numerous pendants and breccia zones of altered volcanics and (or) sediments in granitic material give evidence that much of the above area is near the roof contact of the underlying batholith. Fresh feldspar porphyry, found throughout the area in dykes and small masses, is believed to be a fine-grained phase of the granitic rock, with which it was not seen in contact.

The volcanic rocks are cut by numerous steeply dipping to vertical fractures trending north 65 degrees east to due east, reflected topographically by deep narrow gashes and gorges cutting transversely the northerly trending ridges and steep valley-sides. Fairly flat-lying fractures are numerous, often marked by cave-like openings under precipitous bluffs climbing step-like up the steep valley-sides. Many fractures striking north 35 degrees west and dipping steeply are found in the area.

Gold-quartz mineralization post-dates the granitic rocks and the fresh andesite dykes. It apparently occurred in two stages: first, the introduction of quartz with sparse sulphides into narrow continuous fissures, and, second, after small movement parallel to the walls, the introduction of sulphides and gold into sheeted zones within the quartz.

Gold Deposits.

The Fandora, Gold Flake, and Tofino groups, held under option by Privateer Gold Mines, Limited, and the Moscena property, owned by Moscena Mines, Limited (N.P.L.), were being developed in the summer of 1946. Other discoveries in the area lie within the following mineral claims: Freegold, Eldorado, 3 J's, and King.

Strike Groups.—The gold-quartz veins of the Moscena property in granitic rocks north of Warn Bay strike north 40 to 45 degrees west and dip 85 to 90 degrees north-eastward.

The gold-quartz veins on the Fandora property strike north 72 degrees east and dip 60 to 70 degrees northward.

Structural Types.—The veins all occur in narrow continuous fissures in granitic rock, andesite dyke, or altered volcanics. The veins are usually sheeted, have free walls, and often grade longitudinally into zones of gouge and small fragments of quartz and altered country rock.

A barren sheeted zone, some 200 feet wide, of quartz within altered volcanics is exposed on the Leviathan No. 1 Mineral Claim. The quartz bodies, apparently up to 15 feet wide, appear to strike north 35 degrees west and dip steeply north-eastward. The exposure outcrops on a steep bluff. Longitudinal extensions, if they exist, are covered by overburden.

Vein-texture.—The veins of the Fandora property consist of thin plates of quartz separated by thin partings of rust-coloured fine material. Finely disseminated sparse sulphides are visible in zones free of oxidation. Movement along the vein shear produces wide zones of gouge containing angular oxidized fragments of mineralized quartz and country rock.

The veins of the Moscena property are ribboned and contain varying amounts of sulphide often distributed in bands parallel to the walls, which are often separated from the vein by thin parting of gouge and iron oxide.

Vein-matter.—The vein-matter consists of quartz, carbonates, occasional chloritic material, and sulphides. The sulphides include pyrite, chalcopyrite, arsenopyrite, sphalerite, and galena.

The uncrushed ore material of the Fandora veins contains less than 1 per cent. of finely crystalline pyrite with occasional chalcopyrite, galena, and sphalerite. Although panning of crushed vein-matter may show many small colours, free gold is rarely visible in hand specimens.

Sulphides are coarser and more abundant in the ore material of the Moscena property, and consist of pyrite, chalcopyrite, sphalerite, galena, and, occasionally, small amounts of arsenopyrite. Small specks of free gold, associated with fine disseminated galena, were seen in one specimen from the shaft dump.

Mineralization in the form of sulphides is sparse in granitic wall-rock, although alteration close to the veins is evident. The andesite dyke wall-rock, of the main Fandora vein is unaltered, except within the shear, where it is crushed and considerably softer than fresh material of the exterior walls.

Rocks associated with Gold Veins.—The gold-quartz veins are associated with granitic rocks, either massive or gneissic, fresh andesite, altered volcanics, or in breccia composed of granite and altered volcanics and (or) sediments.

Veins in which the wall-rock is granitic are found on the Moscena group, where the vein shears also are cut altered sediments and fresh andesite, on the Yankee Boy, and on showings in the following mineral claims: Eldorado No. 5, 3 J's, and King. Gold values in grab samples from the last three claims assayed trace to 0.02 oz. gold per ton.

Veins in which the wall-rock is fresh late andesite dyke-rock are found on the Fandora property.

Veins in which the wall-rock is altered volcanic are found on the Gold Flake group and on the Fandora group and environs.

The vein shears in the area examined appear to have marked continuity longitudinally in spite of their narrow width, particularly when they fill fissures in competent fresh unaltered rock, either andesitic or granitic, rather than in altered volcanics or sediments.

Suggestions for Prospecting.—Two prospects of economic interest have already been found in the Tranquil Creek-Warn Bay area; each is in a different geological setting, although both are near the contact-zone of a large mass of granitic rock.

In view of the known facts the near-contact zone of the granitic rocks, both in the greenstone and in the granite, appear to be the most likely sites for new discoveries. The well-developed tributary drainage above the main valley-bottoms affords excellent opportunity for sampling the country by float and panning.

The north-westerly vein-bearing fractures in the Moscena showings are reflected topographically by long narrow parallel guts, probably scoured out by glacial or fluvioglacial erosion.

The east-northeasterly shear on the Fandora property is similarly marked by a straight, narrow, stream-worn, steep-walled gut.

Similar topographic features within the area of the near-contact zone might well mark the sites of other veins.

Kennedy (Elk) River Area.

(Ref. Maps 1A, 1B.) *

Location and Access.—The Kennedy River-Taylor River section lies between Great Central Lake and the west coast.

Kennedy River may be reached by a 30-mile water route from Tofino via Kennfalls, Kennedy Lake to Kennedy River. Another route is from Tofino or Ucluelet via truck-road and pack-horse trail which follows the south-eastern side of Kennedy Lake and Kennedy River. Taylor River is reached from Port Alberni via motor-road to Sproat Lake, and by boat up the lake to Taylor River. A pack-horse route leads up Taylor River and over a low divide into Kennedy River.

History.—Interest was shown and work done in the area in the late '90's, when a 4-stamp mill was operated on the Rose Marie for a couple of seasons; the only properties upon which work has been done recently are the Leora, Rose Marie, and Tommy K.

Production.—About nine gold properties and prospects, including the Blue Bird, Gold Queen, Gold King, Golden Glove, Grant, Jo-Jo, Leora, Rose Marie, and Tommy K., have been staked and prospected on Kennedy River. These properties, including a small gold-copper prospect, are all north of Kennedy Lake. Production from the Tommy K. (belonging to Kennedy Lake Gold Mines), the Leora (largest producer), and the Rose Marie properties is reported to be 436 tons, containing 312 oz. and an average of 0.71 oz.

Geology.—The area has not been mapped geologically, and only the geology adjacent to the properties is known. The area is largely underlain by greenstone, with a small granodiorite stock about 5 miles up Kennedy River.

Gold Veins.—The veins occupy either narrow shear-zones or tight fractures in greenstone, or, in the case of the Jo-Jo, in a small granodiorite stock. The vein-matter, consisting of quartz and sulphides, is narrow, 10 inches being a good average width, although one vein reaches a width of 2 feet. The sulphides include pyrite with small

* *See* p. 9.

amounts of chalcopyrite, sphalerite, and galena. In some veins pyrite is abundant. One vein, the Rose Marie, is strongly ribboned, 1-inch plates of quartz are separated by paper-thin layers of schistose greenstone. The veins range in strike from north-easterly to easterly. Most of the veins, as known at present, are either too narrow or too low in gold to yield mineable ore.

Gold has been found 20 miles west of Port Alberni, 4 miles west of the western end of Sproat Lake, on the property of the Taylor River Gold Mines, where quartz veins up to 3 feet wide have been found in greenstone. Assays up to 1 oz. across 4.6 feet have been reported. There is no record of any shipments.

Suggestions for Prospecting.—The writer makes the customary suggestion to prospect carefully the immediate area of known mineral occurrences and to work out gradually from such areas. Most of the known properties are in the lower 5 miles of Kennedy River valley and one in the Taylor River valley.

Within the past few years this country has been opened up by a pack-horse trail, and it is possible to get to Taylor River from Kennedy River. Based only on the fact that gold prospects have been found both on Kennedy and Taylor Rivers, the suggestion is made that the area between be prospected. The gold veins so far found on either river have not proved to be economic, and something considerably better on the surface would have to be found to warrant expenditure of money on transportation facilities and development-work.

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ALBERNI CANAL.

(Ref. Map 45.)*

The country adjacent to Alberni Canal is extensively mineralized. The southern section south of the Nahmint River and on both sides of the canal is characterized by a copper mineralization of the contact metamorphic type. About twelve copper properties have been found on the western side of the canal and five on the eastern side, but of these only six have produced. This production has amounted to 4,240 tons, containing 646,229 lb. of copper, or ore of an average grade 7.6 per cent. copper and negligible gold.

Gold mineralization is characteristic of the country east of the northern part of the canal, but except for one copper prospect, the Dauntless, no mineral of value has been found on the western side.

East of the canal eight gold properties are found within an area that extends southerly from the Vancouver Island Gold Mines property on China Creek 11 miles to the W.W.W. property on Corrigan Creek. As far as known at present, this mineralized area extends easterly from these properties for 6 miles to the Nitinat River valley.

Access.—All the properties in this section are reached from Port Alberni. The properties of the Vancouver Island Gold Mines, Limited, and Havilah Gold Mines, Limited, on Mineral and McQuillan Creeks respectively, are reached by motor-road from Port Alberni up China Creek. The properties up the Franklin River and at the head of the Nitinat River—namely, the Thistle, Black Panther, and Black Lion—are reached from Underwood Cove, 8 miles down the canal from Port Alberni, and thence by 12 miles of auto-road to the Thistle. The Black Panther and Black Lion are reached by about 8 miles of truck-road that leaves the Thistle road about 6 miles from Underwood

* *See* p. 9.

Cove. The W.W.W. on Corrigan Creek is reached by about 10 miles of logging-railroad and trail from Franklin River, which is about 12 miles down the canal from Port Alberni.

History.—The gold-quartz veins in the China Creek area were found subsequent to early placer operations in China Creek. Considerable activity in placer-mining was carried on as early as 1862, principally by the Chinese. The creek was reported to have been staked for hydraulic leases for 12 miles in the '90's. The total placer production is unknown, but exceeds $40,000.

Prospecting for lode gold was active between 1892 and 1900. By 1895 gold-quartz veins had been found and staked on Mineral Creek, in King Solomon basin at the head of McQuillan Creek, and in the Golden Eagle basin at the head of China Creek. The W.W.W. property at the head of Corrigan Creek was staked in 1898. In 1898 an 8-stamp mill was built on Mineral Creek to treat ore from the veins on the Alberni Consolidated property (Vancouver Island Gold Mines, Limited, property), but only two clean-ups were made.

Activity had died down by 1900 and little was done in the area until 1933, when Vancouver Island Gold Mines, Limited, began to explore the veins on the Alberni Consolidated ground on Mineral Creek. This company worked for three years and built a 35-ton pilot-mill in 1936, but closed the mill the same year and work on the property ceased. However, in 1936 gold-quartz veins above King Solomon basin were opened up by the Havilah Gold Mines, Limited, and a small quantity of ore was shipped between 1936 and 1939. Since 1936 mining activity in the area has been intermittent.

Between 1938 and 1942 a small tonnage of high-grade ore was shipped from the Thistle on Franklin River and from the W.W.W. on Corrigan Creek.

During 1941 active prospecting was carried on by Pioneer Gold Mines, Limited, and by Bralorne Gold Mines, Limited, on the Black Panther and Black Lion prospects at the headwaters of the Nitinat River. The Black Lion is now idle, but since 1944 the Black Panther has been under development by the Nitinat Golds, Limited, of Vancouver.

Production.—Gold ore amounting to 8,432 tons, containing 3,700 oz. of gold, has been produced from four properties; the ore from one of them, the Thistle, also yielded copper amounting to 626,556 lb. The average grade of the total production is 0.44 oz. gold per ton; this ranged from 0.25 to 4 oz. of gold per ton for the total production of the lowest and highest grade producers.

Geology.—Three large areas of granitic rocks are found in the China Creek area. An area about 1½ miles wide extends south-easterly from Port Alberni for 5 miles to China Creek and beyond a short distance. The second area begins about 2 miles south-east of the first and extends south-easterly for at least 7 miles. This area is 2½ miles wide where it crosses Franklin River, but it narrows to one-half mile wide at Corrigan Creek. A third large area or belt of granitic rocks, mainly dioritic in composition, extends 1 mile northerly and 4 miles southerly from Mount McQuillan, which is east of the head of McQuillan Creek. This belt of diorite, only one-half mile wide, has been intruded along a well-defined north-south fracture-zone. Much of the rock is a fracture-breccia. Three small stock-like areas of feldspar porphyry, ranging from ¼ to 1 mile in maximum diameter, are strikingly aligned along a course that trends south 15 degrees east, from west of the head of McQuillan Creek to the middle fork of the Nitinat River, a distance of 5 miles. Elsewhere in the area the rocks consist mainly of a variety of greenstones, cut when close to granitic areas by feldspar porphyry dykes.

Gold Veins.—The ore deposits of the area are found in areas of greenstone, but most of them are close to areas of granitic rocks.

With the exception of the Thistle, the deposits are gold-quartz veins that contain variable amounts of pyrite, galena, and sphalerite. Good gold values are found in places, but nothing so spectacular as in the Zeballos camp.

In general the veins follow well-developed shears that range in strike from north-westerly to north-easterly. The veins, where well developed, are tabular and the quartz conspicuously ribboned. The widths commonly range from 2 inches to 2 feet.

The wall-rocks include andesite flow-rocks, tuffs, diorites, and feldspar porphyry. A variety of rock-types characterizes the individual properties. At the property of the Vancouver Island Gold Mines, Limited, the wall-rocks include flows and tuffs; at the property of the Havilah Gold Mines, Limited, flow-rocks cut by feldspar porphyries; and at the Black Panther and Black Lion properties, andesite and diorite.

The Thistle deposit at the head of Franklin Creek consists of chalcopyrite replacement mineralization along a major shear-zone in andesite and altered limestone. The limestone has been largely replaced by such high-temperature minerals as garnet and diopside.

The most conspicuous feature of the mineralization in the area is a carbonatized shear-zone that follows south from the headwaters of McQuillan Creek, over the divide and down the Nitinat River. This zone of shearing follows the contact between a north-south elliptically shaped area of diorite, 5 miles long by one-half mile wide, on the east and andesitic greenstone on the west, and is about 1 mile east of the line of feldspar-porphyry stocks mentioned previously. At several places along its strike this carbonatized shear-zone contains narrow ribbons and lenses of quartz mineralized with a small amount of pyrite and galena, and some gold.

The showings on the Black Panther and Black Lion are at two places along the carbonatized shear-zone, where the mineralization has been strong enough to warrant prospecting.

On the Black Panther quartz vein-matter, as discontinuous lenses, 6 to 14 inches wide, is found in a shear-zone ranging from a few inches to 4 feet wide. A considerable amount of underground work was done in 1941 on this property, but no ore was shipped. At the Black Lion, on the same shear-zone, the quartz is narrower and less abundant. Some surface work was done on this property in 1941.

Suggestions for Prospecting.—The writer suggests that prospectors direct their attention to the periphery of the area of diorite and allied rocks that extends northerly and southerly from Mount McQuillan. Mineralized quartz veins have been found on both sides of this intrusive mass on the Havilah, Black Panther, and Black Lion on the west, and on the Golden Eagle and B. and K. on the east.

The line of feldspar-porphyry stocks lying about 1½ miles west of the diorite at Mount McQuillan trends east of south and in going south approaches the diorite. Three miles south of Mount McQuillan a feldspar-porphyry stock is less than one-half mile from the diorite. Because of the nearness of the porphyry to the diorite at this south end and because of the marked heterogeneity of the rock-types, diorite, andesite, and feldspar porphyry, in a small area, breaks capable of receiving quartz vein-matter are apt to form. The area south from Mount McQuillan appears therefore attractive for prospecting.

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NANAIMO AREA.

(Ref. Map 108.)*

Westerly from Nanaimo gold has been found in quartz veins on the Georgina at Nanoose Bay and on the Vulcan, northerly from Nanaimo Lakes.

* *See* p. 9.

On the Georgina a quartz vein, 12 to 14 inches wide, containing some chalcopyrite and some gold has been found west of and next to a fault separating greenstone from Cretaceous conglomerate. Values up to 1.5 oz. in gold are reported. On the Vulcan property, 3 miles north of the second Nanaimo Lake, a well-defined shear-zone, 1 to 3 feet wide, contains two discontinuous ribbons of quartz from 2 to 6 inches wide. The quartz contains abundant sulphides and gold values up to 3.25 oz. have been reported.

The area between the Georgina and Vulcan has not been mapped geologically, but it is probably mainly greenstone with small areas of granitic rocks. Because good gold values have been found both at the Georgina on the north and the Vulcan on the south, it is suggested that the country between might be favourable to prospecting for gold-quartz veins.

Prospecting Possibilities elsewhere on Vancouver Island.

Gold in gravel deposits on Nanaimo and Oyster Rivers on the eastern side of the island may have come from lode deposits in the same localities and, if found, such deposits might be of commercial value.

Veins discovered in 1940 on Mount Washington contain gold rather intimately associated with sulphide mineralization. Moderate gold values have been found in fine-grained sulphide replacement deposits on the Dorlon property east of Nahwitti Lake, near the northern end of the island.

These occurrences of placer gold, and rather recently discovered gold-bearing lode deposits in localities which previously had received little attention, suggest the possibility that other localities on the island may also be found to contain gold-bearing deposits.

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BRITISH COLUMBIA DEPARTMENT OF MINES

HON. E. C. CARSON, *Minister* JOHN F. WALKER, *Deputy Minister*

BULLETIN No. 20—PART VI.

LODE-GOLD DEPOSITS

North-eastern British Columbia and Cariboo and Hobson Creek Areas

by

S. S. HOLLAND

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PREFACE.

Bulletin 20, designed for the use of those interested in the discovery of gold-bearing lode deposits, is being published as a series of separate parts. Part I. is to contain information about lode-gold production in British Columbia as a whole, and will be accompanied by a map on which the generalized geology of the Province is represented. The approximate total production of each lode-gold mining centre, exclusive of by-product gold, is also indicated on the map. Each of the other parts deals with a major subdivision of the Province, giving information about the geology, gold-bearing lode deposits, and lode-gold production of areas within the particular subdivision. In all, seven parts are proposed:—

PART I.—General *re* Lode-gold Production in British Columbia.
PART II.—South-eastern British Columbia.
PART III.—Central Southern British Columbia.
PART IV.—South-western British Columbia, exclusive of Vancouver Island.
PART V.—Vancouver Island.
PART VI.—North-eastern British Columbia, including the Cariboo and Hobson Creek Areas.
PART VII.—North-western British Columbia.

By kind permission of Professor H. C. Gunning, Department of Geology, University of British Columbia, his compilation of the geology of British Columbia has been followed in the generalized geology represented on the map accompanying Part I. Professor Gunning's map was published in "The Miner," Vancouver, B.C., June–July, 1943, and in "The Northern Miner," Toronto, Ont., December 16th, 1943.

CONTENTS.

NORTH-EASTERN BRITISH COLUMBIA.

INTRODUCTION.

The part of the Province treated as North-eastern British Columbia in this publication lies to the east of a rather indefinite line extending south-eastward from Teslin Lake past the south end of Dease Lake, the south-western end of Thutade Lake to the head of Takla Lake; thence down Stuart Lake and River and south-eastward up the Fraser River to Yellowhead Pass. The region is divided into two distinctly different parts by the Rocky Mountain Trench which extends in an almost straight line from Lower Post on the Liard River to Tete Jaune near the head of the Fraser River. The Trench is a continuous, major valley occupied from north to south by the Kechika, Fox, Finlay, Parsnip, and Fraser Rivers.

In the area immediately east of the Trench, the Rocky Mountains occupy a belt having a maximum width of about 75 miles and extending north-westward from Yellowhead Pass to their northern termination near the Liard River. The northern continuation of the Plains Region of Alberta lies to the east of the mountains. The surface of the high plains stands at an elevation of 4,000 to 4,500 feet near the mountain front but farther to the east becomes progressively lower.

The Cassiar-Omineca Mountain system lies to the west of the Trench. The mountains of this system extend north-westward from the Nation Lakes, through the headwaters of the Finlay, Stikine, Turnagain, and Dease Rivers to the east side of Teslin Lake. The eastern margin of the system is sharply bounded by the Trench, whereas on the western side the margin is less known and less sharply defined and the mountains become progressively lower, merging by transition into other mountains extending farther westward or into high plateau areas.

The mountain system between Teslin and Nation Lakes occupies a belt about 50 to 60 miles wide and about 450 miles long. Some summits, in the highest part of the system between the head of the Finlay and the Turnagain Rivers, have elevations in excess of 8,000 feet.

ACCESSIBILITY.

It is possible one way or another to reach most parts of the whole region. On the other hand pack-trails are few, the distances from organized transportation by road, rail, or boat are generally large, and the slowness and difficulty of travel make transportation costs high. It is well, therefore, to consider this one factor " transportation " before selecting any area for prospecting. Moreover, it should be realized that the high cost of transportation necessitates the prospecting for deposits only of the highest grade or of sufficient size to justify the improvement of present facilities.

A large part of North-eastern British Columbia is accessible from the travel route along the Rocky Mountain Trench. Summit Lake, at the head of the Crooked River, is reached by 32 miles of road from Prince George. From Summit Lake power-driven, shallow-draught boats may be taken down the Crooked, Pack, and Parsnip Rivers to Finlay Forks; thence up the Finlay River to Fort Ware at the junction of Fox River. At certain stages of water a half-mile portage must be made at Deserters Canyon, about 25 miles north of Fort Grahame. Fox River is navigable with difficulty for 23 miles above its mouth. From Fort Ware a good pack-horse trail runs northward along Fox River to Sifton Pass, elevation 3,273 feet; thence down Kechika River to the junction of the Turnagain River. There the trail crosses to the west side of the Turnagain and continues through to Lower Post on the Liard. From Lower Post boats may be taken down the Liard River to the mouth of the Turnagain River, up the Turnagain to the junction of the Kechika, and then up the Kechika to Driftpile Creek only 5 miles north of Sifton Pass. The Turnagain is navigable for only a few miles above its junction with the Kechika.

From the Trench at Chee House at the mouth of Kechika River an old pack-horse trail crosses the mountains to Muncho Lake, and formerly ran through to Fort Nelson. A second trail crosses the Rocky Mountains running from Fort Ware up Kwadacha River; thence through the mountains to the head of the Muskwa River where it joins a pack-horse trail, used by hunting parties, that runs northward from the Peace River.

It is possible to travel westward from the Trench along several routes. The Ingenika River is navigable by boat for 30 to 40 miles above its mouth. A pack-horse trail runs westward through the mountains up Bower Creek to Fishing Lake; thence farther west to connect with a trail running through to Telegraph Creek. Another trail runs up Turnagain River, from its junction with the Kechika, to Deadwood Lake, whence one branch trail leads to McDame Creek and the other continues up to the head of the Turnagain River and through to Dease Lake.

The Alaska Highway affords access to a considerable area not readily reached formerly. The Alaska Highway starts at Dawson Creek, the northern terminus of the Northern Alberta Railways, about 500 miles by road from Edmonton. From Dawson Creek the highway runs 49 miles north to Fort St. John; thence a farther 256 miles northward along the east side of the Rocky Mountains to Fort Nelson at the junction of the Muskwa and Fort Nelson Rivers. From Fort Nelson the highway runs westward up the Muskwa and Tetsa Rivers to Muncho Lake and down Trout River to the Liard River bridge at Mile 210 from Fort Nelson. From the Liard River bridge the highway runs along the north side of the river to Lower Post; thence westward to Teslin Post on the east side of Teslin Lake. The highway between Lower Post and Teslin Lake is close to the north-eastern side of the Cassiar Mountains.

Another route, used to gain access to the Cassiar Mountains, is by way of coast steamship to Wrangell, Alaska; thence up the Stikine River to Telegraph Creek, the head of navigation. From Telegraph Creek a pack-horse trail runs east and south, making it possible to take pack-horses through along the western flank of the mountains to the head of Takla Lake. A truck-road runs from Telegraph Creek to the head of Dease Lake, whence boats may be taken down Dease Lake and Dease River to Lower Post. Lower Post is on the Alaska Highway, about 650 miles from Dawson Creek.

In the Omineca area a road runs 140 miles north from Fort St. James to Germansen Landing on the Omineca River; whence a winter road has been cut through to Aiken Lake, about 95 miles farther north.

COUNTRY LYING TO THE WEST OF THE ROCKY MOUNTAIN TRENCH.

Geology.

A batholith intrusion belt coincides approximately with the central part of the Cassiar-Omineca Mountain system. Starting with the batholith exposed to the south of Germansen Lake other areas of batholithic rocks are known to outcrop by Silver Creek on the Omineca River, at the heads of the Osilinka, Mesilinka, and Ingenika Rivers, and at Fishing Lake near the head of Finlay River. The extent of the Cassiar batholith is somewhat better known. The eastern contact is mapped from a point close to Sifton Pass to Cottonwood River (a tributary of Dease River), and the western margin from the head of Turnagain River to Teslin Lake.

The batholith belt is not completely mapped, but present knowledge suggests that it is a zone of intrusives of different kinds and ages, that there are outlying satellitic bodies associated with it, that batholithic rocks are not continuously exposed from one end of the belt to the other, and that the batholith rocks contain extensive roof-pendants of older sedimentary and volcanic rocks.

The intrusive rocks are exposed across widths of 20 to 25 miles. They range in type from granite through granodiorite and quartz diorite to diorite and minor amounts of more basic rocks. The granitic intrusives cut both Palæozoic and Mesozoic sedimentary and volcanic rocks. Few, if any, Cretaceous rocks are known, and Tertiary and later volcanics and sediments are all younger than the batholiths. The batholiths are considered to be mainly or entirely Mesozoic. The granitic rocks are flanked by a considerable variety of types. In many places along the eastern margin, from Wolverine Mountains to the head of Jennings River, the older sediments and volcanics are metamorphosed to slates and schists and gneisses of various kinds.

Evidence of Mineralization.

Mineralization has been found at various places in the Cassiar-Omineca Mountain system and is considered to have accompanied the batholithic intrusions. No lode-gold mines have been developed and even the number of known mineral occurrences is small in comparison to the size of the area.

Claims near Uslika and Aiken Lakes have been staked on veins carrying values in gold, copper, silver, lead, and zinc. Of eight properties, all held by the Consolidated Mining and Smelting Company, the *Croydon* at Aiken Lake has had the most exploratory work done on it.

Farther north a number of lead-zinc deposits in limestone centre around the *Ingenika* mine (*Ferguson*) on the lower part of the Ingenika River. Gold-bearing quartz veins are reported in the neighbourhood of Thutade Lake and a number of veins have been found by prospectors on Bower and Ruby Creeks at the head of the Finlay River.

Copper-bearing float has been found at various places along the eastern contact of the batholith between Sifton Pass and Turnagain River and along the western contact between Teslin River and Tanzilla River. Gold-bearing quartz veins have been found on McDame Creek.

Placer-gold deposits result from the preservation of gold concentrated during the erosion and weathering of gold-bearing rocks. Although gold placers by no means indicate the existence of high-grade gold-bearing veins, nevertheless they do point to the existence of gold mineralization in the areas in which the placers are found.

By far the richest gold placers were those on McDame, Dease, and Thibert Creeks. Other gold-bearing placers have been worked at the following places: Goldpan, Wheaton (Boulder), and Walker Creeks in the Cassiar; at McConnell Creek near the head of Ingenika River; at Jimmay Creek; and at Vital, Tom, Germansen, Slate, and Manson Creeks in the Manson Creek belt; and bar gold has been found in the Kechika, Finlay, Mesilinka, Osilinka, and Omineca Rivers.

Actually it is only at McDame Creek that gold-quartz veins have been found close to related gold-bearing placers. These veins range in width from 1 to 9 feet, are of quartz carrying small amounts of pyrite, chalcopyrite, tetrahedrite, and specks of free gold. They are in sedimentary and volcanic rocks near the eastern margin of the Cassiar batholith and up-stream from the rich placer section of the creek.

Other gold-quartz veins are described from the *Croydon* group near Aiken Lake.

Prospecting Possibilities.

It is not possible, in the light of a few imperfectly known lode-gold deposits, to make any generalizations of specific value regarding the occurrence of lode-gold deposits in the Cassiar-Omineca system. Nor is it possible to point to particular areas that have greater known prospecting possibilities than others. Actually the more accessible, more prospected, and better known areas, on the basis of known discoveries, do not appear overly attractive for lode-gold prospecting. Yet it should be pointed out that only a very few parts of the whole area have been prospected and, of these, few places have received intensive prospecting, so that much virgin ground awaits the prospector's attention. These least prospected areas are also the least accessible; accordingly, under present conditions mining operations would be expensive or probably prohibitive, unless extraordinarily rich or very large deposits were found.

The two most accessible areas are adjacent to the Omineca River and Manson Creek road, and adjacent to Dease Lake and Dease River. These are old placer areas where hundreds of placer prospectors were active sixty to seventy years ago. It would take exceedingly close prospecting to make a discovery that had not previously been found since placer prospecting began.

COUNTRY LYING TO THE EAST OF THE ROCKY MOUNTAIN TRENCH.

GEOLOGY.

The Rocky Mountains consist of an exceedingly thick succession of folded and faulted sedimentary rocks ranging in age from possibly Precambrian to Cretaceous. The plains to the east are underlain by flat or gently eastward-dipping Cretaceous and Tertiary sedimentary rocks. With the exception of some basaltic dykes observed by McConnell on Liard River, between the Turnagain and Rabbit Rivers, there are no known intrusive rocks in the Rocky Mountains north of Yellowhead Pass. The only rocks that suggest that intrusives might be near-by are the schists mapped by Dolmage along the east side of Finlay River, between Finlay Forks and Fox River.

EVIDENCE OF MINERALIZATION.

There is very little evidence of ore mineralization in the rocks of the area east of the Trench. Known occurrences are of small lead-zinc veins just south of Grant Brook, near Yellowhead Pass, and copper veins east of the Trench about 20 miles north of Fort Grahame (small copper veins are reported in the area between Akie River and the head of the Ospika). Copper mineralization is reported to have been found near the mouth of Gataga River, and an unpublished map showing the explorations of E. B. Hart in 1913 and 1914 indicates that copper and galena float were found on Toad River, 15 to 20 miles south of Muncho Lake.

Although placer gold has been found on the bars of the Parsnip, Finlay, and Peace Rivers, no placer gold is known in any of the tributaries draining into them from the Rocky Mountains. Moreover, it is reported that no colours are found by panning creeks draining the east side of the Rocky Mountains in British Columbia.

No mineralization is known to occur in the Plains Region east of the Rocky Mountains.

The absence of known placer- and lode-gold deposits in the Rocky Mountains and Plains, together with the lack of known intrusive rocks, indicate that the part of British Columbia lying east of the Rocky Mountain Trench between Lower Post and Tete Jaune is not an attractive region for lode-gold prospecting.

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CARIBOO AND HOBSON CREEK AREAS.

CARIBOO.

The bulk of the placer- and lode-gold production of the Cariboo has come from the area around Wells, Barkerville, and Keithley Creek. The area described in the following summary is about 30 miles long, from Willow River and lower Lightning Creek south-eastward through to Cariboo River, and about 20 miles wide, from Quesnel Forks north-eastward to Cunningham Creek. In this area are the two producing gold Mines of Cariboo Gold Quartz Mining Company, Limited, and Island Mountain Mines Company, Limited, near Wells, as well as the former producer of Cariboo Hudson Gold Mines, Limited, 18 miles south-east of Barkerville. It is a mountainous area, having summits rising to elevations of 6,000 feet or more lying in the transitional belt between a range of higher and more rugged mountains to the east and a lower more subdued plateau area to the west. The relief is only about 2,000 feet, but the extensive mantle of drift and the vegetation obscure much of the bed-rock, so that natural exposures are not abundant and prospecting is difficult.

Accessibility.

The area is reached from Quesnel by motor-road, 59 miles to Wells; thence 21 additional miles to the Cariboo Hudson mine camp, whence a tractor-road leads across the Snowshoe Plateau to Yanks Peak, which is connected by a tractor-road with Keithley Creek. A motor-road runs from Williams Lake, 74 miles, into Keithley Creek. Much of the area is readily reached from the existing main roads and those into mine camps. A considerable number of trails ran through other sections, but through disuse have fallen into various stages of disrepair.

History.

The mining history of the Cariboo area began with the discovery of rich, gold-placer deposits at Quesnel Forks, Keithley Creek, and Antler Creek in 1860, and on Williams and Lightning Creeks in 1861. Once the discovery of these four most important creeks was made, thousands of miners found their way into the country over the trail from Quesnel Forks up Keithley Creek and across the summit to Antler Creek; thence through to Barkerville and Stanley on Williams and Lightning Creeks. They prospected and worked the placer ground and in the course of their prospecting for placer found many gold-bearing quartz veins.

Between 1875 and 1895 many gold-quartz veins were found and staked, and mining companies were formed to work them. Stamp-mills were erected to treat the ore. These included a 4-stamp mill at Richfield on Williams Creek, a 10-stamp mill on Island Mountain near Jack of Clubs Lake, a Government reduction plant treating custom ore, and an arrastra on Lightning Creek treating ore from Burns Mountain. In the next few years interest waned and for three decades little was done on gold-quartz veins of the Cariboo. In the preceding period several veins had been explored by underground workings, but no profitable mine had been developed.

The Cariboo Gold Quartz Mining Company, Limited, was organized in 1927 to explore the veins on Cow Mountain south-east of Jack of Clubs Lake. The favourable development of this mine, together with the increased price of gold, brought a renewal of interest in the possibilities of the area, resulting in much prospecting and development between 1933 and 1938. The Cariboo Gold Quartz mine began producing gold in

1933 and the Island Mountain mine in 1934 and have operated continuously since then. The Cariboo Hudson mine produced gold in 1938 and 1939. Since 1933 more than 1,000,000 tons of ore averaging 0.41 oz. gold per ton have been mined, resulting in a total production of 465,000 oz. of gold. This amount, however, is only about one-sixth the total placer-gold production of the same region.

GEOLOGY.

The productive areas of the Cariboo are underlain by a thick succession of Precambrian sedimentary rocks called the Cariboo series, comprising the Richfield, Barkerville, and Pleasant Valley formations. The oldest formation, the Richfield, contains all the gold-quartz veins of importance. The Richfield formation is composed of quartzite, argillite, limestone, and rock-types gradational between them that have been metamorphosed to sericite schists, quartz sericite schists, graphitic schist, and slate. The Barkerville and Pleasant Valley formations which lie above the Richfield are composed largely of limestone and black argillite respectively.

The Cariboo series has been folded into a major anticline whose axis runs from Mount Borland on the east side of Cariboo Lake to Dragon Mountain near Stanley. A synclinal fold axis lies parallel to it and about 12 miles to the north-east. Jurassic volcanics and sediments of the Quesnel River group overlap the south-western limb of the anticline along a line running from Wingdam south-eastward through to Likely and Cedar Creek.

The most important development in the knowledge of the Cariboo geology has been the recognition and mapping of distinct members which make up the upper parts of the Richfield formation. From Island Mountain south-westward to Grouse Creek, five members—the Baker, Rainbow, B.C., Lowhee, and basal member—have been mapped. The Rainbow member consists of interbedded argillite and quartzite. On the Hudson claims and Roundtop Mountain four members—the Lostway, Roundtop, Bee, and Hudson—have been mapped. The middle part of the Hudson consists of impure quartzite. These lithological subdivisions are important because most of the productive veins between Island Mountain and Grouse Creek are found in the Rainbow member, while on the Cariboo Hudson claims the productive veins are in the middle part of the Hudson member.

On the north-east late Palæozoic sediments and volcanics of the Slide Mountain series lie on the north-eastern limb of the anticline and in the trough of the north-westerly plunging syncline.

The intrusive rocks of the area mainly lie to the east of the Barkerville gold belt. They are quartz porphyry and felsite sill and dykes of the Proserpine intrusives which cut the Cariboo series but are older than the Slide Mountain series; the Mount Murray diabase, gabbro, and diorite sills and dykes in the Slide Mountain series north of Mount Murray; and one large and several small quartz monzonite and diorite stocks intruding the Cariboo series east of Cariboo River.

It is not possible to correlate the members of the upper Richfield at Roundtop Mountain with those north-west of Grouse Creek. The rock-types undergo a lithologic change along their strike reflecting different conditions of sedimentation. Moreover, because of the changes in lithology that are known to have taken place along strike, there is no reason for believing that the Rainbow member will extend unchanged north-west of Island Mountain nor that the Hudson member will continue unchanged to the south-east of Cariboo River. Nevertheless, rocks of similar character or competency may be found to the north-west or to the south-east.

STRUCTURE.

The major structural element of the area is a broad anticlinorium whose axis trends north-west and runs from Mount Borland, past the east side of Yanks Peak to Mount Burdett; thence through Mounts Agnes, Pinkerton, Amador, and Nelson to

Dragon Mountain. In the section by Mount Pinkerton the anticlinal axis is nearly horizontal but farther to the north-west it plunges 10 degrees north-westward and at Dragon Mountain plunges 20 to 40 degrees north-westward. On the limbs are minor drag-folds of varying amplitude whose axial planes are overturned. Generally higher dips prevail on the north-east limb than on the south-west one.

Of minor importance is the synclinal axis, about 12 miles north-east of Mount Borland, trending north-westward by Kimball and Limestone Creeks east of Cariboo River.

The rocks are cut by north-easterly-striking and north-westerly-dipping normal faults, some of large displacement; e.g., the Willow River fault displaces the Cariboo-Slide Mountain contact 4 miles.

Strike-faults are the commonest type. They parallel the dip and strike of the beds, are of the normal type, and have a throw of 25 feet or less.

A number of northerly-striking faults cut the Cariboo series. These faults dip about 60 degrees east and offset the beds as much as 1,300 feet in the case of the Lowhee fault. Others recognized are named the Rainbow, Grouse, and Aurum faults.

Cleavage is developed in the rocks for the most part parallel to the regional strike and specifically parallel to the axial planes of the drag-folds.

Of most importance are pre-mineral fractures, many of which are occupied by quartz veins. The fractures are more abundant in certain of the more competent rocks—e.g., the Rainbow member. These fractures are grouped into three sets: those striking north-east, at right angles or transverse to the strike of the rocks; and those striking north-west parallel to the strike of the rocks. All the fractures parallel to and diagonally crossing the beds are occupied by quartz veins whereas not all, but many, transverse fractures are quartz-filled.

MINERAL DEPOSITS.

Mineral deposits in the Cariboo are of two types: quartz veins and replacement deposits in limestone. At the Island Mountain mine a pyritic replacement in limestone is mined; similar pyritic replacements on the Cariboo Gold Quartz ground are not mined; and elsewhere replacement deposits in limestone carrying mixed sulphides such as galena, sphalerite, pyrrhotite, etc., have been neither large enough nor valuable enough to be mined. Gold-bearing quartz veins constitute the bulk of the mineable mineral deposits of the Cariboo. The total of somewhat more than 1,000,000 tons to date has yielded 0.41 oz. of gold per ton.

The quartz veins are in Precambrian rocks (Richfield formation of the Cariboo series) and are pre-Mississippian (older than the Slide Mountain series) in age. The veins contain gold, pyrite, galena, arsenopyrite, scheelite, sphalerite, pyrrhotite, and also cosalite and bismuth-lead sulphide in a quartz and ankerite gangue. The gold content is not directly proportional to the amount of pyrite, but higher values in gold occur with the larger amounts of pyrite. Gold is especially abundant in the nests of bismuth-lead sulphide.

The veins occupy fractures that have developed in the host-rocks. Transverse veins are the most numerous, most are less than a foot wide but they range up to 6 feet in width. In general they are less than 150 feet long and rarely exceed 200 feet. Diagonal veins are less numerous, most are less than a foot wide. The average width of veins more than a foot wide is about 3 feet. They are somewhat longer than the transverse veins but rarely exceed 300 feet. Both vein types are vertical or steeply dipping.

The quartz veins are not related to the contact-zone of any exposed batholith, though a granitic intrusive may be buried at some depth beneath the region. The veins however do occur in belts. This idea was proposed by D. Lay (Annual Report, Minister of Mines, B.C., 1933), who on the basis of observed occurrences of known gold-quartz veins and on the distribution of the rich gold-bearing placers recognized two belts. One extends from Island Mountain through Cow Mountain and Proserpine Mountain to Roundtop Mountain. Between Burns Mountain and Yanks Peak a second belt was proposed.

Why the veins are found in belts is not definitely known, but the first follows certain favourable members (Rainbow and middle Hudson) near the top of the Richfield formation, and the second lies close to and slightly east of the axis of the anticlinorium.

A detailed study of the first belt between Island Mountain and Grouse Creek has shown that the argillaceous quartzites have fractured more readily than other types of rock, consequently most of the quartz veins are in the Rainbow member. Similarly at the Cariboo Hudson mine the middle Hudson member is the one that fractures most readily. The character of the rock, together with that of the adjacent rocks, appears to be the controlling element in the localization of the quartz veins. Secondarily the development of local drag-folds or faults has localized fracturing in parts of the favourable members. The possibility is suggested that the localization of fractures within the belts may be related to cross-structures such as the Aurum, Lowhee, and Rainbow faults. Furthermore the transverse and diagonal veins at the Island Mountain and Cariboo Gold Quartz mines are well mineralized: the strike veins are not necessarily well mineralized, and in many instances may be barren. Veins occupying northerly-trending fault-zones are the best mineralized in the Keithley Creek area. The reason why some veins contain mineable amounts of gold while others are poor or barren has not been satisfactorily explained.

The hypothesis of a second belt extending between Burns Mountain and Yanks Peak is based on the occurrence of gold-quartz veins at both places, but none are known nor are any placer creeks found between them. It is possible that former gold placers were dispersed by glacial erosion, but that is unlikely. The existence then of a second belt is less certain than of the first.

Gold-quartz veins at Burns Mountain and Yanks Peak are in rocks of various kinds, not being restricted to a mapped or recognizable member of the Richfield formation. They are, however, close to the axis of the major anticline and consequently the fracturing may in some way be related to it.

Prospecting Possibilities.

The most favourable prospecting ground in the Cariboo is considered to be along the two belts, particularly in the sections where the richest gold placers were worked. However, Burns Mountain, Yanks Peak, and the entire belt from Island Mountain to Roundtop Mountain have been staked; therefore these sections contain very little open ground.

The extensive drift-cover makes prospecting difficult, particularly when further prospecting must rely on information gained from geological studies made by the prospector himself. It should be emphasized that previous prospecting involving the search for quartz outcrops has resulted in the finding of most exposures. Any further work must be directed towards the discovery of veins or vein zones that do not outcrop, either because they are blind or are covered by overburden. Consequently, further prospecting must be founded on sound geological principles and must be much more detailed than that already done.

Outside the two belts already mentioned the possibilities appear less attractive, mainly for the reason that no rich placers have been found elsewhere. Nevertheless, the main anticlinal structure does extend farther in both directions and on that basis should be worth investigation, but it must be realized that there is no assurance of the Rainbow member extending unchanged north-west of Island Mountain, nor the Hudson member extending unchanged south-east of Cariboo River.

Until information to the contrary is known the area adjacent to the several diorite and monzonite stocks by Black Stuart Mountain east of Cariboo River should be regarded as worth investigation.

Other places that offer prospecting possibilities of varying degrees of attractiveness are near the placer occurrences at Wingdam and Cedar Creek, and around Spanish Mountain.

The country between the productive area of the Cariboo and the mineral showings (Blue Ice property) at the head of Hobson Creek is largely unknown geologically. Nevertheless, it is fairly certain that the belt of Precambrian sediments extends between the two places. Despite the lack of known placer creeks in the area and without any knowledge to what extent the country has already been prospected it is believed that this intervening country is worth prospecting on the chance that there will be a repetition of geological and structural conditions favourable to the occurrence of gold mineralization.

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HOBSON CREEK.

Gold mineralization has been found across the summits between the headwaters of Hobson Creek and Azure River. The first discoveries were made about 1914, and there has been a small amount of development but no production. The region is extremely rugged, with ice-capped peaks rising to elevations of more than 8,000 feet. The known showings can be reached by two routes: from Gosnell on the C.N.R. by 45 miles of trail up the North Thompson River valley and across a high pass to Azure River, or by about 18 miles of trail up Hobson Creek from Hobson Lake. A third possible route is up the Raush River about 50 miles, but a trail built some years ago is now largely obliterated.

The rocks are Precambrian sediments, chiefly quartzites, but including phyllites, argillites, and one or two bands of limestone. The rocks are compressed into north-westerly-trending folds but, as at the head of Azure River, there is some complex folding and perhaps major faulting. A body of granodiorite cuts these rocks about 2 miles south of the known mineralization.

The mineral deposits include quartz veins and replacement deposits in limestone. The veins are irregular and tend to be lenticular, but follow a clearly recognizable pattern in most instances. Where a stockwork or intersecting pattern of quartz veins occurs, the higher values are found to favour one direction of fracturing. At the head of Hobson Creek (Blue Ice property) the vein pattern is similar in general to that in the producing mines in the Cariboo, although here the rock is an impure quartzite. At the same locality there are replacement bodies of pyrite in a band of limestone. In the quartz veins there has been proved in a few instances an association of gold with sphalerite and galena, even though the amount of these minerals is extremely small.

In some parts of the area the size of the quartz veins varies greatly with the character of the wall-rock, this is particularly noticeable when the rocks are inter-bedded quartzites and phyllites. In other parts the rock section is uniform and the veins, although irregular, are apt to persist. It seems probable that certain belts of rock and certain parts of the folded structures are the best mineralized.

These deposits have some features in common with those of the Cariboo. The pattern of the quartz veining is not the same nor are the rocks identical, but there appears to have been a general similarity of conditions in the formation of the veins. Geological mapping is not complete and it is impossible to correlate directly the rocks at Hobson Creek with those in the Cariboo some 30 miles to the north-west. The conditions known to exist in the Cariboo and Hobson Creek areas suggest that the intervening ground is worth prospecting.

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