

BRITISH COLUMBIA DEPARTMENT OF MINES

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BULLETIN No. 20—PART III.

LODE-GOLD DEPOSITS
Central Southern British Columbia

by

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VICTORIA, B.C. :

Printed by CHARLES F. BANFIELD, Printer to the King's Most Excellent Majesty.
1945.

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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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 trans-

portation 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 chalcopryrite, 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 chalcopryrite 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-Ironsidles* 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 north-eastward 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 $\frac{1}{2}$ 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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VICTORIA, B.C.:

Printed by CHARLES F. BANFIELD, Printer to the King's Most Excellent Majesty.
1945.