

BRITISH COLUMBIA DEPARTMENT OF MINES

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LODE-GOLD DEPOSITS OF BRITISH COLUMBIA

COMPILED BY

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*To the Hon. W. A. McKenzie,
Minister of Mines, Victoria, B.C.*

SIR,—I beg to submit herewith a special bulletin on Lode-gold Deposits of British Columbia. This bulletin has been issued to supply the keen demand for information regarding lode gold in the Province. The potentialities for successful gold-mining in the Province are greater than has been generally recognized and it is believed that the compilation of all material information in one publication will stimulate the exploitation of the latent gold resources of the Province. The reports by the Resident Engineers on their respective districts outline attractive opportunities for capital in the opening-up of known properties, and give much information regarding likely areas for the gold prospector.

I have the honour to be,

Sir,

Your obedient servant,

JOHN D. GALLOWAY,
Provincial Mineralogist.

*Bureau of Mines,
Victoria, B.C., February 1st, 1932.*

LODE-GOLD DEPOSITS OF BRITISH COLUMBIA.

GENERAL SUMMARY.

By JOHN D. GALLOWAY, PROVINCIAL MINERALOGIST.

INTRODUCTION.

Owing to the conditions attending silver and base-metal mining at the present time, renewed interest is being taken all over the world in gold-mining, and this is most noticeable in this Province. Lode-mining in British Columbia began with lode-gold production from various districts. For many years past, however, gold-mining has not been as important as lead, copper, zinc, and silver mining in the Province. Will the attention now being paid to the search for gold result in a considerable increase in gold production in the Province? Are the probabilities and possibilities promising? What are our reasonable probabilities in dormant properties and our possibilities in the unprospected and partially prospected areas of the Province? This bulletin has been prepared to present the available facts with the objective of stimulating the more rapid investigation of the latent gold possibilities of British Columbia.

The essential feature of the bulletin consists of the reports by the Resident Engineers on their respective districts. These have been written so as to direct attention to dormant properties and favourable prospecting areas, rather than to elaborate historical and other data regarding old and steady gold-producers—the facts about which are well known.

Much of the material contained in this report is contained in the Annual Reports of the Department extending back for many years, but it is believed that the inclusion in one bulletin of all important known information regarding lode-gold deposits will be of decided use and benefit. Much of the material has been condensed in so far as practical, but geologic and mineralogic information of value to scouting engineers and prospectors has been elaborated as seemed advisable.

HISTORICAL SUMMARY.

Despite the belief that gold was first obtained in British Columbia from the placer deposits which were opened by the miners who rushed in from the south in 1858 and the following years, it is a fact that gold was mined from a lode deposit nearly six years earlier. References to this first mining of gold are found in the records of the Hudson's Bay Company. In 1852 an expeditionary party was conveyed in the company's brigantine "Una," Capt. Wm. Mitchell, to Mitchell harbour, on the north-west coast of Moresby island, one of the Queen Charlotte group, for the purpose of mining a gold-quartz vein which had been reported by Indians in 1851. Captain Mitchell mined more than \$1,000 worth of ore from this vein. His attempts to bring away the ore were frustrated by the Indians, who stole it as fast as collected, and the party returned empty-handed to Victoria.

News of the incident soon got abroad and it was reported that large numbers of adventurers were making for the new goldfield. H.M.S. "Thetis" was thereupon dispatched from Esquimalt to protect British interests. This constituted the first gold-rush to that part of the Pacific north-west which is now British Columbia. On March 26th, 1853, James Douglas, Lieutenant-Governor of the short-lived Queen Charlotte Island Crown Colony, issued the first mining law, a Proclamation setting forth the terms and licence under which the digging or mining of gold could be carried on in the Queen Charlotte islands.

The discovery of placer-gold fields in 1855 and the following years caused an influx of placer-miners from the south. These men, being interested only in placer, directed their attention to the rivers and creeks which promised profitable returns in gold-dust. Lode-mining was in consequence not referred to again until 1860, when William Downie, who had been exploring along the Coast for the Government, reported having staked free-gold quartz claims on Kitimat arm. Other deposits may have been noted as the Coast was being then explored carefully, but no records are preserved on the subject.

After some years the richest and more easily worked placers were beginning to show signs of exhaustion and some of the miners began to consider the possibilities of finding the source of the gold in veins which were assumed to be in the hills bordering the creeks. Since practically the whole population was living in and around the placer deposits on the creeks, the prospecting

spread out from thence. At Barkerville the Government Assay Office, built in 1862, undertook experimental work on quartz ores from the neighbourhood.

In 1872 F. W. Foster, of Lillooet, was recorded as the locator of the *Big Slide* mine on the Fraser river north of Lillooet. He set up an arrastra for the reduction of the quartz, but the results did not come up to expectations. The construction of stamp-mills now began in earnest and in 1876 a 4-stamp mill was at work at Richfield, while a 10-stamp mill erected by the B.C. Mining and Milling Company and a 5-stamp mill by Beedy on Burns mountain were running in 1878. Prospecting for lode deposits was carried out in the vicinity of the placers of the lower Fraser and reference is made to Siwash creek in 1876. Interest in quartz-mining in the Cariboo must have died down in 1880, for the *Enterprise* was the only mine working, and the Government Agent at Barkerville in his report for that year speaks of the "undue quartz excitement of 1877-78."

Construction-work on the Canadian Pacific transcontinental railway having now been commenced, many miners were employed on the rock-work and tunnels along the Fraser canyon and this led to a noticeable delay in lode-mining. Incidental prospecting was carried out in the vicinity of Yale and ore yielding \$9.45 in gold and \$16.60 in silver to the ton was reported by assayers.

Vancouver island now appears on the records, for ore from Koksilah river, assayed at the U.S. Assay Office, New York, gave \$6.20 in gold to the ton, \$69.83 in silver to the ton, and 28½ per cent. lead. This, by the way, is the first reference to assays having been made on galena ore.

Assays made in Portland, New York, San Francisco, Montreal, and London having given results varying from \$10 to \$100 to the ton in gold on ore from the *Big Slide*, this property was again the centre of attraction. A furnace and grinding plant were erected in 1881, but no success was obtained through this work. It is interesting to note that this property in the area west of Lillooet came under observation during 1885 and 1886, and McGillivray, Bridge, Cayoosh, Leon, and other rivers and creeks were prospected by Ward and Gould, assisted prospectors. These men considered that Bridge river and its upper reaches, Cadwallader and Hurley creeks, would become the "Comstock" of British Columbia. Although placer-miners had passed by the mouth of Cayoosh creek ever since 1858, the creek had not been examined even for placer until 1886. There was then a rush to the deposit and the lodes were staked, including the *Bonanza*, which created much interest.

Hixon creek, Stump lake, Scotch creek, Kamloops, and the Big Bend were reported on as to the lode-gold possibilities, and in the south the Tulameen area was gone over.

The quartz-miners in the Cariboo persisted in their work, and in 1886 William Craib, reporting to the Government Agent at Barkerville, stated: "However, up to date I have made twenty-two assays of ore from the different ledges in this vicinity and the lowest was \$27 and the highest \$75.23, average \$46.30."

The report made to the Geological Survey of Canada by Amos Bowman in 1887-88 discussed the quartz-mining possibilities of the Cariboo very fully, and, probably as a result of this, many small attempts were made to test the quartz, including an arrastra on Lowhee creek and a 4-stamp mill of the Boyce Company. This activity led to the reopening of the Government Assay Office at Barkerville, and it was finally decided in 1888 to build the Government reduction-works, in charge of E. A. Martin, also at Barkerville.

The completion of the Canadian Pacific Railway gave a great impetus to mining in the southern and eastern part of the Province, where the production was chiefly from silver-lead-zinc mines. The McMurdo Creek area, near Golden, however, created an excitement at this time owing to reports on assay results showing good gold values, one such assay indicating \$164.41 in silver and \$48.23 in gold to the ton and 46 per cent. copper. The Nicola Valley properties, which had been favourably reported on by G. M. Dawson, were extensively prospected and assays reported indicating 1½ to 2¼ oz. gold to the ton.

The late Wm. Sutton stated in his report as Government Assayer in 1888: "A number of free-gold quartz ledges have been discovered, but the majority contain more or less pyrite or arsenopyrite, the rock of the whole country being heavily charged with iron sulphides.

The year 1889 was one of importance in mining history, for the Kootenay Lake area became a centre of activity owing to the extensive discoveries of silver-lead-zinc mines. Some of the properties exploited turned out to be straight gold-mines, notably on Cottonwood and Eagle creeks near Nelson. Miners from the south soon spread over the country and the hills west of

the Columbia along the boundary-line, in the area soon destined to become a great mining camp, were staked from top to bottom. Next season more men came and brought in machinery to open up the properties, which was done with great speed. Mills were erected at the *Poorman* near Nelson and in the Sheep Creek area, while every promising lead was staked. In the north prospecting was still carried on along the Hyland, Liard, and other rivers, and the McMurdo area held its interest. The reduction-works at Barkerville was kept going during these years, and in 1892 the McArthur-Forrest cyanide process was introduced and used on *Black Jack* ore, which was said to yield \$5.23 in gold to the ton. Another stamp-mill was set up on Island mountain.

The Fairview camp, Similkameen, came suddenly into prominence in 1892 as a gold-producer, many claims being located in the vicinity of Keremeos creek. One property, the *Rattler*, was advanced enough to warrant the erection of a 5-stamp mill, in which ore yielding \$5 to \$50 in gold to the ton was treated. The adjoining camp at McKinney was also developed and some remarkable quartz veins opened up.

Previous to this date lode-mining consisted mostly in prospecting, with a few rich deposits receiving attention, but with the opening of the Osoyoos, McKinney, Greenwood, Grand Forks, and Rossland camps the industry became of great importance and the mines of these areas produced large tonnages of ore from the very start. Government statistics were now necessary, and in the Annual Reports of the Minister of Mines the Provincial Mineralogist, beginning in 1896, published tables giving the figures relating to the production from lode mines. Capital and miners poured into the country from the United States and Europe and the properties in Rossland, Greenwood, and Grand Forks were exploited to the fullest extent.

A smelter was built at Trail in 1896 for the treatment of the ores mined at Rossland, to which camp a narrow-gauge railway was laid. In his first report as Provincial Mineralogist in 1896, W. A. Carlyle states that the first furnace was fired at this smelter, with the following results:—

Tons smelted to July 1st, 1896	27,085
Ounces of gold produced	45,234
Ounces of silver	67,793
Pounds of copper	1,265,362

which gives a good idea of the relations of the gold content to the silver and copper contents.

In the Annual Report for 1898 the ores were spoken of as follows: "The ores of the Rossland camp may be more appropriately classed as gold ores than as copper ores, inasmuch as the values of the former metal are proportionately much greater. The output of Trail Creek Division is almost entirely from the ores of this character, sulphides of copper and iron carrying gold and silver." The 1897 figures for this camp show 1.46 oz. of gold to the ton in a production of 128,428 tons of ore. Mills were built in the Nelson and Lillooet areas and the Clearwater, Kamloops district, received its first locations.

Mines in many parts of the Province were now in the shipping stage and some were producing straight gold quartz, while the ore from the others was going to the smelters. The *Nickel Plate*, in the Similkameen valley, destined to become at one time the largest gold-mine in Canada, was staked in September, 1897. A Morrison patent cyanide-mill was erected at the *Doratha Morton* mine on the Coast. The International Exposition held in Paris, France, in 1900 gave a fine opportunity for the exhibition of British Columbia ores and a large exhibit was sent over. The lode-gold specimens from Nelson, Trail Creek, and the Big Bend were specially notable.

The Columbia and Kootenay Railway was pushed through to Grand Forks and Greenwood and the mines of that area, together with those of the Rossland camp, created a necessity for smelters, with the result that plants were erected at Greenwood, Grand Forks, and Boundary Falls. A smelter was also put up at Northport, Wash., to which the *LeRoi* ore was diverted from Trail.

In 1901 the lode mines of the Province produced \$4,348,603 in gold, an increase over the previous year of \$895,222, or 26 per cent. When it is remembered that this increase followed an increase in 1899 of 30 per cent. and in 1900 of 21 per cent., a fair idea may be formed of the development and growth of the industry. This great increase was due, first and chiefly, to the development of the Boundary mines; and, secondly, to the Rossland camp and Nelson camp. The Rossland camp had then produced 420,010 tons, which yielded 376,362 oz. of gold, from its gold-copper ores, while Nelson supplied the free-milling ore.

During the following years several mills were erected in widely separated parts of the Province, notably at the *Engineer*, Atlin; *Ymir*, Nelson; *British Empire*, Vernon; Mount Baker and Yale Company, New Westminster; and the *Nickel Plate*, Similkameen. The last one was said by Charles Camsell in 1911 to be the largest gold-producer in Canada. The smelter at Trail was taken over by the Consolidated Mining and Smelting Company, Limited, in 1906 and greatly enlarged, as many small mines were providing ore for treatment.

The industry now settled down to a steady output and there was little change in the number of mines or of the amount of ore produced. On the Coast the mines of Texada island helped to make an increase in the production of gold, and in the Boundary, although the tonnage treated was less, the recovery of gold was greater. In 1909 86.5 per cent. of the gold produced came from the smelting of gold-copper ores and the remainder from stamp-milling operations. The largest mill, that at the *Nickel Plate*, produced 16,200 oz. of gold from 31,000 tons of arsenical-iron ore.

The Rossland and Boundary camps in 1910 were producing about the same amounts of gold as each other and production varied up and down for some years, the advent of the Great War finally causing a severe decline in 1914 as a result of the closing of the smelters. A new smelter was built at Anyox by the Granby Consolidated Mining, Smelting, and Power Company, which was changing its sphere of activities from Grand Forks to its *Hidden Creek* property at Anyox. This mine, together with several smaller ones, warranted the construction of a large smelter.

The coal strikes and consequent lack of coke at the Trail smelter resulted in a decreased production from the Rossland and Boundary fields, as the smelters had to close down for six months. These two fields in 1916 produced 93 per cent. of the total lode gold of the Province and the proportion of lode gold from smelters was, in the following year, about 65 per cent. of the total.

At Surf inlet, Princess Royal island, a remarkable property was opened up and a mill erected which produced in four months 3,000 oz. of gold. In the Portland Canal camp the *Premier* had been developed to the milling stage and a mill was erected to treat the silver-gold ore.

From 1917 to 1920 the production of lode gold in the Province was only one-half that of the years before the war and showed that gold-mining in the Province had, as elsewhere in the world, been adversely affected by the conditions of rising costs of production and a standard price for the product. The destruction by fire of the *Britannia* mill and the closing-down of the *Nickel Plate* caused a decrease in 1921.

Successful operations at the *Premier* showed this mine to be one of first importance in the production of gold and silver. By 1927 the *Premier's* gold-output was over 70 per cent. of the total for the Province, making up for the decrease caused by the practical cessation of production from the gold-copper camp at Rossland.

In the notes for 1893 on the gold-mining industry it was mentioned that at that time a severe depression occurred in the silver market and that thereby was created a lively demand for gold, which in turn engendered active prospecting for new mines and the reopening of old properties. This same situation has again come about during 1930-31 and at the present time there is keen interest taken in anything pertaining to the production of gold.

STATISTICAL INFORMATION.

The total production of lode gold in British Columbia is shown in the following table. This is taken from official records, which include estimates made for the early years. It is possible that the production in early years was greater than shown, but the figures are probably very close and substantially accurate since 1896.

PRODUCTION OF LODE GOLD, 1893 TO 1931.

Year.	GOLD.		Year.	GOLD.	
	Oz.	Value.		Oz.	Value.
1887	.....	.....	1911	228,617	\$4,725,513
1888	.....	.....	1912	257,496	5,322,442
1889	.....	.....	1913	272,254	5,627,490
1890	.....	.....	1914	247,170	5,109,004
1891	.....	.....	1915	250,021	5,167,934
1892	.....	.....	1916	221,932	4,587,334
1893	1,170	\$23,404	1917	114,523	2,367,190
1894	6,252	125,014	1918	164,674	3,403,812
1895	39,264	785,271	1919	152,426	3,150,645
1896	62,259	1,244,180	1920	120,048	2,481,392
1897	106,141	2,122,820	1921	135,663	2,804,154
1898	110,061	2,201,217	1922	197,856	4,089,684
1899	138,315	2,857,573	1923	179,245	3,704,994
1900	167,153	3,453,331	1924	247,716	5,120,535
1901	210,384	4,343,603	1925	209,719	4,335,269
1902	236,491	4,888,269	1926	201,427	4,163,859
1903	232,831	4,812,616	1927	178,001	3,679,601
1904	222,042	4,589,608	1928	188,087	3,888,097
1905	238,660	4,933,102	1929	145,339	3,004,419
1906	224,027	4,630,639	1930	160,778	3,323,576
1907	196,179	4,055,020	1931 (estimated)	152,000	3,142,137
1908	255,582	5,282,880			
1909	238,224	4,924,090	Totals	6,977,728	\$144,010,148
1910	267,701	5,533,889			

It seems to be a general opinion that lode-gold production in British Columbia has been mainly as a by-product of other mining operations; this idea, however, is incorrect. The most important gold-producing camp of the Province has been Rossland, which, contrary to popular impression, was essentially a gold camp and not a copper one. Similarly, the *Premier* mine is essentially a gold-mine rather than a silver-mine. "By-product gold" is the term used to define gold recovered from base-metal operations, where the value of the gold is less than that of the other metals.

Of the total production of lode gold to the end of 1931 of \$144,010,148 (1931 estimated), approximately \$115,900,000, or 80 per cent., has come from gold-mining and the remainder as a by-product from base-metal mining. The largest producing camp has been Rossland, with an output valued at approximately \$59,300,000, followed by the *Premier* mine. During the last five years by-product gold has only amounted to about 19 per cent. of the Provincial total.

Final figures are not yet available for the 1931 gold-output, but a decrease of about \$181,440 as compared with 1930 is estimated, the output amounting to about \$3,142,137. The biggest drop was in by-product gold, with the closing-down of the *Copper Mountain* mine and *Britannia* and *Anyox* producing less than the previous year. In the gold-mine class the *Premier* produced less and *Nickel Plate* none at all; this was largely offset by increases from *Pioneer*, *Union*, and *Reno*. By-product gold in 1931 only amounted to about 8 per cent. of the total, showing a steady decrease in the last five years.

It is interesting to note that the *Premier* gained its greatest fame as a silver-mine from the high-grade secondary silver ore mined in the upper levels. With the gradual lowering of the silver content of the ore year by year, and now the heavy decline in silver prices, the backbone of the mine is its gold content. In 1931 gold will account for about 75 per cent. of the gross value of the *Premier* production. Only in one year, 1922, did the value of the silver production from the *Premier* exceed that of gold. Of the total value produced to the end of 1930, gold amounts to approximately 60 per cent. Similarly, the *Union*, in Grand Forks Division, started two years ago as a silver-mine, may to-day be rated as a gold-mine.

PRESENT STATUS OF GOLD-MINING IN BRITISH COLUMBIA.

As will be seen from the table, lode-gold production has fluctuated from \$3,000,000 to \$4,000,000 a year in the last six years. During this period the mainstay of production has been

the *Premier* mine at Stewart, with 60 per cent. of the five-year output (1927 to 1931, inclusive). During this time the *Pioneer* mine, in Lillooet Division, has come into important production and now gives promise of increasing output and a fairly long life. The 1930 figures show that of the output of 160,728 oz., 85 per cent. was produced by gold-mines and 15 per cent. as by-product gold. Of the production of 136,708 oz. from gold-mines, nearly all was contributed by five mines—namely, *Premier*, *Pioneer*, *Nickel Plate*, *Union*, and *Reno*. Of these, *Premier* has only a somewhat limited life, failing new discoveries; *Nickel Plate* is closed, although some further possibilities exist which will probably be explored in 1932; *Union* reserves are not fully explored, but some important discoveries in 1931 are being energetically developed; *Reno* is a small operation which may continue for some time; and, finally, *Pioneer* is a new star on the horizon, promising a splendid career.

The small portion of gold from gold-mines other than the above five was contributed by a few small properties. In the aggregate these have possibilities for some expansion in the future. The percentage of by-product gold has been decreasing in the last five years and it is unlikely that increased output from this source will take place in the near future. The best that can be hoped for is that present production will be maintained for the next few years, as expansion of base-metal mining is uncertain owing to conditions rather than ore reserves.

In order to maintain output at present levels, expansion is necessary in some quarters to take care of declining output from others; while increased yearly figures will only be possible by bringing in new mines and the most hopeful field is in the development of straight gold-mines.

SOME GEOLOGIC IDEAS.

A considerable literature exists on the geology of the various lode-gold deposits of the Province. No general summary can be attempted, as it would have no practical value on account of the wide variety of geologic and mineralogic types of gold occurrences that are found. There are innumerable reports and references to gold-mining in the reports of the Geological Survey of Canada on British Columbia, the Annual Reports of the Department of Mines of British Columbia, in the technical journals and the bulletins of the Canadian Institute of Mining and Metallurgy.

The most productive gold areas of the Province have been the Rossland camp, Phoenix-Greenwood camps in the Boundary district, the *Premier* mine, and the *Nickel Plate* mine. Rossland, *Premier*, and *Nickel Plate* are considered gold-mines, whereas the Boundary district was essentially a copper camp. These deposits are distinctly not the quartz-vein types, but are essentially replacement or contact ore-bodies of various kinds. The widest distribution of gold in the Province, however, is in the quartz-vein type of ore-body and a number of important ones occur, such as the *Ymir*, *Motherlode*, and others at Nelson, Fairview, and Camp McKinney, *Pioneer* and others at Bridge River, and less important deposits. Quartz veins are numerous in British Columbia where no productive mines have been developed. This is particularly true of the Central Belt of British Columbia, containing the Columbia and Interior systems of mountain ranges and plateaus. This includes the East Kootenay, Cariboo district, Manson area, and farther north to Atlin. This great belt of quartz veins has no lode-gold production from quartz veins of importance as yet, but it is the belt that has produced the bulk of the \$79,000,000 of placer gold that the Province has yielded. Furthermore, geologic evidence clearly shows that the bonanza placers of this area were mainly formed in the rivers and creeks from the erosion and concentration of gold from quartz veins.

The idea that may be drawn from this is that much more intensive investigation of quartz veins in the Central Belt is justified than has yet been given to them. While it is true that barren outcrops of these numerous quartz veins are frequent, still it is quite probable that zones and horizons of these veins are auriferous. A more or less casual inspection and random sampling is not sufficient. Under the system in British Columbia, the Geological Survey of Canada does the areal geology of the Province, while the Provincial Department of Mines issues much information regarding actual mineral occurrences and prospects. The work of intensive economic geologic investigation of small areas is, however, also required. In instances it is done by the Government services and also by private companies, but more is required if the believed latent gold resources are to be discovered and exploited.

It should be recognized that the finding and making of new mines is not going to be easy, and but little result will be achieved, unless systematic, co-ordinated use is made of geologic

knowledge, coupled with every other scientific tool available. It is noteworthy in this connection that more expert knowledge and methods are being used in placer exploration than ever before in the Province.

The reports of the Resident Engineers show plainly that there are still many gold prospects in the Province which have had but little development done on them, although located for many years. Others were partially developed long ago and have remained dormant for years. It is quite apparent that a thorough appraisal of these known properties, and intelligent development of those that warrant it, is quite as promising a field for the bringing-in of new mines as in extensive prospecting in virgin areas.

The mineralized areas of the Province, however, present many favourable opportunities for the prospector. Particularly should it be emphasized that known areas, where productive gold-mines have been operated, still are fertile fields for careful and thorough prospecting. Many large, virtually unprospected areas still remain in Northern British Columbia where easily discovered outcrops may be expected. The experience to be gained from a study of known gold areas is available in this bulletin in the geologic discussions on properties and areas by the Resident Engineers. Useful information is also given in their reports regarding favourable prospecting areas.

TECHNICAL AIDS TO GOLD-MINING.

In comparatively recent years many technical improvements have been made in the mining and milling of various kinds of metalliferous ores. These improved practices all show the possibility of mining ore-deposits at a profit, which formerly, for one reason or another, could not be undertaken. These refinements of technique range through the whole scale of mining and metallurgical problems.

British Columbia is now accomplishing some remarkable records in mining and milling of low-grade ores. These show conclusively that under certain conditions, where large daily tonnages could be treated, that \$1.50 to \$2 gold ore might be handled at a profit. It should, of course, be realized that this does not apply to ordinary operations, but it should stimulate intensive prospecting and testing of possible large low-grade deposits.

At the other end of the scale, most efficient milling apparatus has been developed for small-scale operations. Small compact and inexpensive mills are available for 25- to 50-ton-a-day operations which will give a high extraction of the contained gold values. Properties that are small and at some distance from railway transportation may therefore be profitably operated by individuals or syndicates if intelligently managed and unnecessary overhead eliminated. It may be safely stated that almost any type of complex gold ore can now be treated by a combination of milling processes to yield a high percentage of the contained gold. In this connection much useful work is now being done by the Mines Branch at Ottawa in testing complex ores and advising as to the most efficient treatment. Many small owners are benefiting by this expert advice. Information regarding this service can be obtained by addressing the Director, Mines Branch, Ottawa.

SYNOPSIS OF ACTS RELATING TO LODE-GOLD MINING.

The following synopsis of the mining laws will be found sufficient to enable the miner or intending investor to obtain a general knowledge of their scope and requirements; for particulars, however, the reader is referred to the complete Mining Acts, which may be obtained from any Mining Recorder, or from the King's Printer, Victoria, B.C.

FREE MINERS' CERTIFICATES.

Any person over the age of eighteen, and any joint-stock company, may obtain a Free Miner's Certificate on payment of the required fee.

The fee to an individual for a Free Miner's Certificate is \$5 for one year. To a joint-stock company having a capital of \$100,000, or less, the fee for a year is \$50; if capitalized beyond this, the fee is \$100.

The Free Miners' Certificates all expire at midnight on May 31st in each year. Certificates may be obtained for any part of a year, terminating on May 31st, for a proportionately less fee.

The possession of this certificate entitles the holder to enter upon all lands of the Crown, or upon any other lands on which the right to so enter is not specially reserved, and to prospect for minerals, locate claims, and mine.

A free miner can only hold, by location, one mineral claim on the same vein or lode, but may acquire others by purchase. In the case of placer claims, only one claim can be held by location on each creek, ravine, or hill, and not more than two in the same locality, only one of which shall be a "creek" claim.

In the event of a free miner allowing his certificate to lapse, his mining property (if not Crown-granted) reverts to the Crown, but where other free miners are interested as partners or co-owners the interest of the defaulter becomes vested in the continuing co-owners or partners *pro rata*, according to their interests.

It is not necessary for a shareholder, as such, in an incorporated mining company to be the holder of a Free Miner's Certificate.

MINERAL CLAIMS.

Mineral claims are located and held under the provisions of the "Mineral Act."

A mineral claim is a rectangular piece of ground not exceeding 1,500 feet square. The angles must be all right angles unless the boundaries, or one of them, are the same as those of a previously recorded claim.

No special privileges are allowed for the discovery of new mineral claims or districts.

A mineral claim is located by erecting three "legal posts," which are stakes having a height of not less than 4 feet above ground and squared 4 inches at least on each face for not less than a foot from the top. A tree-stump so cut and squared also constitutes a legal post.

The "discovery post" is placed at the point where the mineral in place is discovered.

Nos. 1 and 2 posts are placed as near as possible on the line of the ledge or vein, shown by the discovery post, and mark the boundaries of the claim. Upon each of these three posts must be written the name of the claim, the name of the locator, and the date of location. On No. 1. post, in addition, the following must be written: "Initial post. Direction of Post No. 2 [*giving approximate compass bearing*] ——— feet of this claim lie on the right and ——— feet on the left of the line from No. 1 to No. 2 posts."

The location-line between Nos. 1 and 2 posts must be distinctly marked—in a timbered locality by blazing trees and cutting underbrush, and in bare country by monuments of earth or rock not less than 2 feet in diameter at the base, and at least 2 feet high—so that the line can be distinctly seen.

Mineral claims must be recorded in the Mining Recorder's office for the mining division in which they are situate within fifteen days from the date of location, one day extra being allowed for each ten miles of distance from the recording office after the first ten miles. If a claim is not recorded in time it is deemed abandoned and open for relocation, but if the original locator wishes to relocate he can only do so by permission of the Gold Commissioner of the district and upon the payment of a fee of \$10. This applies also to a claim abandoned for any reason whatever.

Mineral claims are, until the Crown grant is issued, held practically on a yearly lease, a condition of which is that during such year assessment-work be performed on the same to the value of at least \$100, or a payment of such sum be made to the Mining Recorder. Such assessments must be recorded before the expiration of the year, or the claim is deemed abandoned. If, however, the required assessment-work has been performed within the year, but not recorded within that time, a free miner may, within thirty days thereafter, record such assessment-work upon payment of an additional fee of \$10. The actual cost of the survey of a mineral claim, to an amount not exceeding \$100, may also be recorded as assessment-work. If, during any year, work is done to a greater extent than the required \$100, any further sum of \$100—but not less—may be recorded and counted as further assessments; such excess work must be recorded during the year in which it is performed. As soon as assessment-work to the extent of \$500 is recorded and a survey made of the claim, the owner of a mineral claim is entitled to a Crown grant on payment of a fee of \$25, and giving the necessary notices required by the Act. Liberal provisions are also made in the Act for obtaining mill-sites and other facilities in the way of tunnels and drains for the better working of claims.

"TAXATION ACT."

A preliminary note is essential to the understanding of this Act. As the law has stood, a Crown-granted mineral claim on which taxes were in arrears for a number of years was offered for sale by the Government at a *tax* sale, with arrears of taxes plus interest and charges and Crown-grant fees as an upset price. If no sale was made the property remained in the hands of the Assessor until desired by some one, when it could only be purchased by tender. It was not open to location under the "Mineral Act" and a prospector had no protection, and to relieve the situation an amending Act was passed.

Under the amended Act such reverted Crown-granted mineral claim may be obtained by any person under a lease for one year upon payment of \$25, and a renewal of such lease may be granted upon payment of further \$25 for a further period of one year, but no longer. During the period of such lease the lessee has the right to enter, prospect, and mine on such mineral claim, save for coal, petroleum, and natural gas, and during such time the lessee has the option to purchase such Crown-granted mineral claim upon payment of all taxes, costs, and interest which remained due and unpaid on such claim on the date of its forfeiture to the Crown, together with an amount equal to all taxes and interest which, except for its forfeiture to the Crown, would have been payable in respect thereof from the date of the lease to the date of application for a Crown grant.

A person may only obtain a lease, or any interest in a lease, of two such claims in the same Mining Division.

Such leases are not transferable and are subject to the rights any person may already hold to any portion of the surface of such Crown-granted mineral claim.

REPORTS BY RESIDENT MINING ENGINEERS.

In the following reports by the Resident Mining Engineers it has been necessary to condense much material that is available regarding various lode-gold deposits in the Province. Information about long-dormant gold properties is contained in the Annual Reports issued in past years, but to many these old reports are not available. It is hoped that all those who are interested will write freely for any further information that may be desired. Such inquiries should be directed to the Resident Engineers of the respective districts or, if general with regard to the Province, to the Provincial Mineralogist, Victoria, B.C. The Resident Engineers have maps and plans of many gold properties and trail maps of prospecting areas which have not been printed in the bulletin. Copies of those that are available will be supplied on request to the Resident Engineers. It should be noted that a well-equipped office is maintained by the Department of Mines in the Workmen's Compensation Building, Vancouver, as the headquarters of the Resident Engineer for the Western Mineral Survey District (No. 6). All technical inquiries relating to the mineral industry of the Province should be addressed to the Provincial Mineralogist, Victoria, B.C. Mineral samples for determination should be sent to the Bureau of Mines, Victoria, B.C. Geologic maps and reports of British Columbia are available from the Officer in Charge, Geological Survey of Canada, 510 Winch Building, Vancouver, B.C., as well as at Ottawa, Ont.

It is not intended that this bulletin on Lode-Gold Deposits will be reprinted in the Annual Report for 1931, which is now being prepared; it should therefore be preserved by those who desire a permanent file of the publications of the British Columbia Department of Mines.

NORTH-WESTERN MINERAL SURVEY DISTRICT (No. 1).

REPORT BY J. T. MANDY, RESIDENT MINING ENGINEER (HEADQUARTERS, PRINCE RUPERT).

INTRODUCTION.

In this report only those lode-gold deposits with predominating gold values, or with appreciable gold values in a complex ore, are referred to. It must be borne in mind, however, that, besides these, appreciable gold production is potential to copper and complex sulphide deposits containing only low gold values, but which is recovered as an adjunct to the mining of these ores.

To achieve clarity on the subject by a systematization, and for the purpose of directing the attention of prospectors and operators to definitely indicated geological, petrological, geochemical, structural, and genetical associations, a subdivision of the district into belts in accordance with these associations has been attempted. As is pointed out, this belting is not clean-cut, and as developments and exploration of this extensive area proceed it may need to be modified or readjusted from time to time. Little detailed work has as yet been attempted in this district with regard to the important aspect of genetic association and classification.

Attention to this phase of the mining industry and the elucidation of its many intricate problems is of undoubted economic consequence. It is hoped that with this initiation of belting and classification with regard to lode-gold mining in this district, this phase of the industry can be progressed by the gradual accumulation and application of facts to the ultimate achievement of definite clarity. From this will undoubtedly result a greater efficiency in the important initial operations of the industry and a more rapid development of the mineral potentialities of the district.

From what is known in a general way regarding gold occurrences in other parts of British Columbia, it is suggested that the belting and classification it may be possible to achieve in these various sections may be applied and correlated with one another, so that eventually it may be possible to arrive at a relative correlation of the lode-gold occurrences of the Province as a whole. In this way much information of practical importance in some distant section could be beneficially applied in some other.

In the belt classification of individual properties and deposits in this report, only those on which development-work shows these characteristics to be definitely or appreciably apparent are mentioned. In some belts where several occurrences show these characteristics, only those on which most development-work has been accomplished and which are considered to be the best examples to illustrate the type are mentioned or described. Many other prospects in the various belts on which the limited amount of work accomplished, or concerning which not sufficient evidence other than their geographical position is apparent to justify their inclusion in the classification, are not mentioned. Eventually, with more work accomplished, many of these prospects may show these characteristics. It is suggested, however, that in the field activities of examining engineers these properties be not neglected. Results from work on such properties could be quickly achieved, the picture could possibly be changed overnight, and geological and genetical characteristics not evident to one engineer may be apparent to another.

Under the subheading of "Mining Divisions" detailed descriptions of properties not hitherto described in other reports will be found. For purposes of ready reference, a table of the distribution of properties is included. In this, reference is made to reports in which detailed descriptions of various properties and the associated geology will be found.

SUMMARY AND CONCLUSIONS.

North-western Mineral Survey District (No. 1) contains comparatively pronounced lode-gold potentialities. These are as yet largely unexploited. Extensive areas of favourable ground are still unprospected. A decided tendency to localization is apparent, and this fact should not only assist in the efficient exploration and development of working properties, but its study should aid in the more efficient operations of prospectors. Much still remains to be worked out in this respect.

The tendency to a more conservative and correct measure of the potentialities of possible small-tonnage producers and their exploration, financing, and development in accordance with

this measure is becoming more apparent. This will not only tend to make successes of what would otherwise be failures, but will remove the handicap that possible small-tonnage producers have hitherto been subjected to. In this way, and with modern additions to technical facilities, such as improved metallurgy and efficient small-tonnage mills, the possibility of production from small-tonnage operations, which in the aggregate can become appreciable, holds promise of a brighter future and a possible appreciable addition to the gold production of the district.

Improved technical facilities and their skilled application to exploration, development, and mining, with a resultant marked possible reduction of operating costs, together with advances in geological knowledge, indicate possibilities in large-tonnage low-grade profitable operation that were not apparent in the past. In this category many areas in this district possess topographical features favourable to outstanding low-cost achievement, and in which efficient transportation could be introduced in the event of such operations being indicated.

With the steady improvement of transportation facilities by the Department of Mines and the Department of Public Works, favourable areas are being gradually brought within the reach of prospectors and within the operating scope of mining.

During the season of 1931, which was a period of acute general depression, interest in lode-gold prospecting has been increasing in the district. During the trying period of depression lode-gold production in the district has been well sustained. Exploration activities on several properties by sound companies and their active interest in this type of deposit holds promise of early possible addition of gold-producers.

The future of the district holds promise of a sustained lode-gold production and a gradual enlargement of the field. As a general industrial stabilizer and antidote for depression, no effort should be neglected to bring this phase of the mining industry of the district to substantial fruition.

GENERAL DISCUSSION.

Lode-gold deposits of the North-western Mineral Survey District (No. 1) can be broadly classified as follows: (1) Free-gold occurrences; (2) gold-bearing pyrite and copper ore; (3) gold associated with silver, lead, zinc, and other sulphide ores.

The gold occurrences of the district appear to have an intimate genetic relationship to the Coast Range granodiorite batholith, its satellites and differentiation derivatives. In view of this, and as a guide to discovery, intensive effort should be devoted to determining a possible relative localization of these deposits to some particular phase of the batholith intrusion.

For the proof and elucidation of this relationship, geochemical, structural, and petrological factors are important. First, what is the source of the gold? From the evidence of numbers of assays of granitic rock which almost invariably show traces of gold, it may be concluded that certain phases of the batholithic magma contained gold in comparatively even though widely dispersed distribution. The batholith itself may consequently be assumed to be the original source of the gold which by process of differentiation and activity of mineralizers has been concentrated in solution ready for deposition where congenial conditions prevailed. Secondly, what conditions are congenial to the deposition of gold values from these solution concentrations? In this, factors of structure governing temperature and depth of deposition below surface, coupled with chemical composition of enclosing rocks, would appear to be determining influences.

With regard to the wall-rock and structural factors, no absolutely definite criterion has yet been established, but it is hoped this phase will be concentrated on by the Geological Survey of Canada. There does, however, appear to be in certain localities a decided affinity of pronounced gold values for the roof phase of the batholith itself, particularly that part which has assumed a marked basicity from the absorption of overlying roof-rocks. How far this condition can be correlated into the roof-rocks themselves, and although those of appreciable ferro-magnesian content seem to be congenial, what composition of roof-rock, if any, can be definitely cited as congenial, is not yet established.

ECONOMIC GEOLOGY.

The Coast Range granodiorite batholith and its satellites, such as that which is known as the Cassiar batholith, and numerous spurs and outlying bosses and stocks seem to be definitely genetically relative to the lode-gold deposits of the district. This intrusive mass strikes through the district with its long axis, striking in a general north-westerly direction. The main mass, that of the Coast Range batholith, attains a maximum width of about 160 miles. Its intrusion corresponds to about the Lower Jurassic period and probably extended into about Tertiary

time. This batholith reaches its apex in the high-altitude, central, or Coast Range area. Its eastern flank plunges steeply under the sedimentary and igneous rocks of the eastern contact margin bordering the Interior plateau. Westward of the apex it undulates gradually through the low-lying coastal area and plunges steeply beneath the sedimentary and igneous rocks of the Queen Charlotte islands, the most westerly land-mass of the Dominion.

Erosion, particularly that of the glacial epoch, has played an important part in carving the present surface contour and exposing the present rock types. The degree of erosion is of prime importance in computing ore potentialities of various occurrences in the district. In places great areas of the original ancient surface have been denuded down to the underlying batholithic rocks, exposing extensive outcroppings of the granitic complex. In other sections only a thin shell, or small isolated patches of the older rocks, with numerous granitic apophyses and satellitic dykes cutting through them in all directions, are left superimposed on or included in the underlying batholith. Other sections of the central batholithic zone comprise numerous extensive pendant and inclusion areas of the older formations.

Along these marginal zones of the easterly and westerly plunge of the batholith flanks, especially that of the eastern flank, numerous spurs and bosses, satellitic to the main batholith mass, intrude the appreciable thickness of overlying older formations that spread easterly through the Interior plateau to the Height of Land between the Pacific and Arctic drainage.

In the north-eastern section of the district, and occupying approximately the Height of Land area, the so-called Cassiar batholith of uncertain Lower Cretaceous age crosses into Yukon territory, trending north-west and approximately parallel with the Coast Range batholith. This with its outlying stocks and bosses is probably relative and satellitic to the main Coast Range batholith, representing a remote effusion from the main batholithic magma.

It must be stressed that the relative batholiths, spurs, stocks, and bosses are not composed of one single and homogeneous igneous mass. What is represented is a series of intrusive activities spread over a long period of time and punctuated with periods of quiescence of varying duration. Some of these igneous magmas may be gold-bearing, and some not. Geologists have placed this procedure as having commenced at about Lower Jurassic time, and continued to at least Lower Cretaceous time, possibly much later. This would allow a time interval of at least 40,000,000 to 50,000,000 years for the processes involved to be completed, and a further period from about middle Cretaceous to the present time, or about 90,000,000 to 100,000,000 years, for the deposits to be exposed as we see them to-day.

In accordance with rapidity or slowness of cooling and its effect on differentiation within the involved magmas have resulted a complicated series of rocks, varying from the first or oldest differentiation products with a basic tendency, to the youngest or extreme alkali-siliceous rocks. In this way, starting from the first differentiates, have resulted gabbro, diorite, quartz diorite, granodiorite, quartz monzonite, and granite as representing the major rocks of the main batholith.

Due to local variations in tectonical and erosional conditions, rate of cooling and intermittent igneous injection, no undisturbed rule of geographic or physiographic localization of the various rocks of the batholith can be set. There does, however, appear to be a marginal basic tendency conforming to a rapid cooling influence, and a central or core localization of true granite type due to slow cooling conditions. According to this reasoning, the first differentiate facies of the magma, or rocks of dioritic type, should be localized on the lateral rims and roof margins of the batholith closest to the source of injection, and those of true granite tendency within the area of the core or at localities removed from the source of injection.

With this complicated condition prevailing, it is evident that whereas a geographical belting of the gold-deposits according to type can be worked out, no absolutely clean-cut rule of genetic association and geographical distribution for these deposits relative to the compounded batholith can be set. What might appear to be an exception in the occurrence of remarkably rich gold-bearing pyrite ores and their localization to certain roof areas within the batholith of the coastal section may simply be due to the ease of accessibility of this section, and its consequent more intensive prospecting as compared with possible similar areas of the interior, and to the fact that batholithic sections of the interior are generally avoided by prospectors.

LOCALIZATION.

Whereas no definite genetic relationship of the lode-gold deposits to any one particular age of the batholithic intrusions has as yet been absolutely established, there does appear to be

such a relationship, and it is hoped this may in time be definitely worked out as an indication to more certain localization of these deposits as a guide to prospectors. There is indicated an influence of certain phases of the batholith affecting the localization of gold-bearing ores. Certain characteristics also seem to distinguish them in accordance with their structural position of occurrence relative to the batholith and its associated intrusives. These factors are apparent in:—

(1.) Occurrence in or in the vicinity of rocks of dioritic type, or of pronounced ferro-magnesian mineral content.

(2.) Occurrence in the contact vicinity of alkali-siliceous rocks (granite, granodiorite) of the latest batholithic effusion.

(3.) Divergence of character in conformity to structural conditions governing the temperature of deposition.

With reference to (1), certain points of probable importance emerge. Whereas, on account of their field distribution, an affinity of relation of gold-bearing veins for the dioritic type of the batholith seems possible, it cannot be taken that such lodes owe their origin to the immediate magma which gave birth to these rocks. On the contrary, several instances, observed in the field, of richly auriferous pyrite veins occurring in the dioritic rocks themselves are contradictory to this, and point to the possibility that these rocks, with their decided ferro-magnesian contents, have merely acted as a congenial medium for gold precipitation and deposition.

From the reasoning covering the batholith intrusion already elaborated, viewed generally, the dioritic or basic phase represents the marginal differentiation derivative of the first or oldest injection, and the alkali-siliceous phase, which includes granite proper, with its quartz-porphyry, pegmatite, aplite, felsite, etc., derivatives, represents the younger phase.

The richly auriferous pyrite veins that occur in quartz diorite at Surf inlet, Porcher island, Khutze inlet, and other localities in the coastal area are definitely younger even than the majority of the pegmatite and aplite dykes typical of these localities. On the *Hunter* group, in the Khutze River section, a siliceous granitic rock intrusive into the quartz diorite is cut by aplite and pegmatite dykes, and the whole series is in turn cut by the auriferous veins. This association indicates, in these occurrences at least, that the gold mineralization is related to the last or granitic injection of the batholith, and represents the very last activity of this stage, accompanied and assisted by a preponderance of sulphurous gas and aqueous mineralizers, and the dioritic rocks represent merely a congenial medium for gold-deposition.

This supposition is strengthened by an apparent increase in gold content and ore-shoot occurrence where the enclosing rocks assume a greater ferro-magnesian mineral content, such as hornblende or biotite, either inherent or induced through absorption of contacting roof-rocks. On the *Hunter* group, hornblende and appreciable biotite mica, either inherent or induced through roof absorption into the wall-rock, accompanies ore-shoot development; at Porcher island, appreciable hornblende with some biotite mica is associated; small occurrences on Pitt island have similar mineral associations; at the *Drum Lummon*, appreciable biotite mica in the metalliferous pegmatite dykes as well as an enclosing quartz-diorite wall-rock accompanies lenticular development of ore; at Surf inlet, Dolmage cites affinity for gold-bearing pyrite in proximity to inclusions in the veins of sericitized quartz diorite and also mentions a tendency to increased gold values in the pyritic mineralization of the veins where they approach the vicinity of small roof-rock inclusions. Numerous instances of similar associations are cited by Buddington and Chapin (Bulletin 800, U.S. Geological Survey) in south-eastern Alaska. The Juneau gold-belt, Alaska, is in proximity to quartz diorite, and at the *Alaska Treadwell*, on Douglas island, Alaska, gold-bearing veins occur in highly altered dioritic dykes. All this evidence may surely be more than mere coincidence.

Having intimated an indicated congeniality of gold concentrations for a ferro-magnesian mineral association, the question arises which element or elements might form a possible index of congeniality. Invariably accompanying the above types of gold-bearing veins directly associated with a ferro-magnesian phase of wall-rock is a marked sericitization of the wall-rock, especially in the neighbourhood of ore-shoots. Sericite also frequently occurs as an alteration product in the veins themselves. This suggests a robbing of the enclosing rock of its iron and magnesium contents. Chlorite frequently forms a minor gangue constituent, and chloritization is sometimes pronounced in the wall-rock. Ankerite is a minor though very general gangue constituent, and in the *Alaska-Juneau* mine in Alaska is a remarkable index of high gold values. Dolomite is also sometimes a minor gangue constituent.

Projecting this affinity into the overlying roof-rocks an interesting correlation also becomes apparent. In the Atlin section gold-bearing quartz veins occur in typical association with markedly magnesium-rich rocks, such as magnesite and dolomite. In the same area and also in the Dease Lake, Dease River, and Liard River areas, quartz veins, the eroded upper sections of which in all probability gave birth to the rich gold placers, predominantly occur in or close to rocks of high magnesium content. In the Portland Canal area the general association of gold-bearing ore-bodies with the magnesium-rich rocks of the andesite and porphyrite group in such deposits as the *Premier* and *B.C. Silver*, and the apparent affinity of sustained values for the flow-rocks of andesitic type rather than the clastic or tuff rocks, is remarkable. In the eastern Canadian deposits the sericitization and accompanying dolomite and chlorite in the Kirkland Lake occurrence and the associated dolomite, ankerite, and chlorite at Porcupine may be mentioned. In many other gold occurrences in different parts of the world, gold occurs in similar association.

From the foregoing it would seem that there is at least a suggestion that the magnesium element or a reactionary activity of both the iron and the magnesium of the ferro-magnesian rocks might have a definite bearing on conditions favourable to gold mineralization and may afford at least a contributing index to congeniality for deposition. In this respect it must be recognized that the chemical reactions accompanying the gold-deposition can become extremely complicated and involve many elements and compounds contained in the wall-rocks, pre-existing veins, and hypogene solutions as contributory reagents. However, with continued detailed research in this sphere of gold-ore genesis in this district, its correlation with facts and data from other areas, it may be possible to arrive at some index or guide not only to a more definite localization of commercially valuable lode-gold deposits in the district, but also to the discovery of further ore-bodies and ore-shoots in properties already under development.

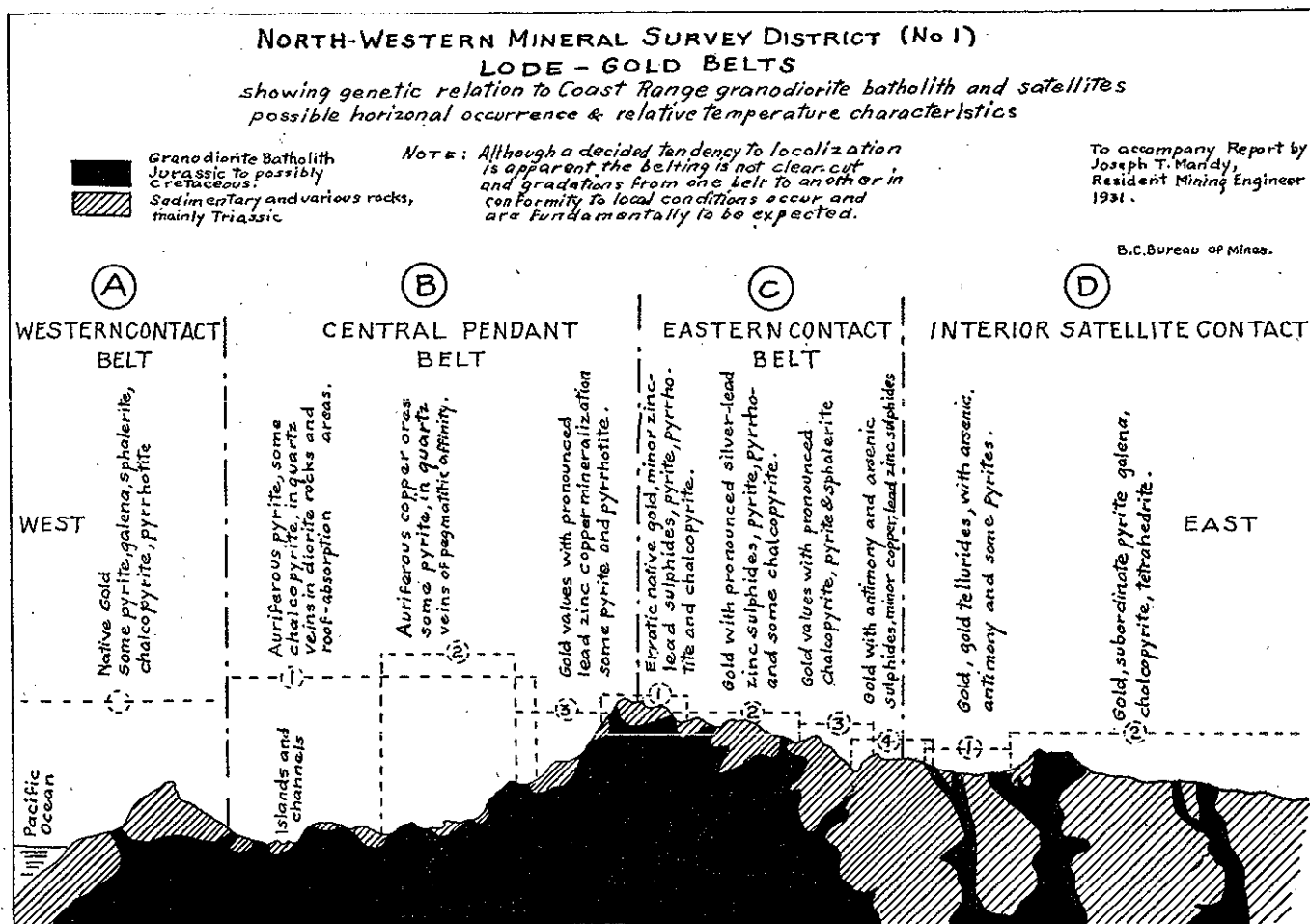
With regard to item (2), the probable association of richly auriferous pyrite with late granitic injections in the coastal area has been referred to. The richly auriferous sections of the eastern contact area in proximity to granodioritic spurs from the main batholith is also remarkable. The characteristic gold tendency of the Interior Plateau section evidenced not only by placer remnants of ancient lodes, but also by many present-day instances of lode-gold occurrences, in an area characterized by late satellitic injections of granitic or granodioritic type such as the Cassiar batholith and numerous bosses and stocks, is decidedly remarkable. All this evidence in support of item (2) is also probably of greater significance than mere coincidence.

With regard to item (3), structural factors have largely governed the temperature of deposition, which is reflected in accompanying mineralization. This is primarily dependent on the depth at which deposition took place below the ancient roof-surface, and the thickness at that time of the ancient roof-covering above the intruded batholith. Influencing this have been direction of intrusion and effects of uplift or depression preceding or accompanying periods of mineralization. Of primary importance to the economic aspects of present-day ore-exposures are influences of uplift and depression, and effects of erosion subsequent to mineralization. These structural conditions are indicated in the generalized section accompanying this report. In this section attention is particularly directed to the indicated relationship between the extant structural conditions and the temperature characteristic of the various deposits exemplifying the different belts. The height of the horizontal dotted lines above the base-line in this section is in accordance with the indicated increase or decrease of deposition temperature as exemplified in the mineral associations of the deposits. From a study of this a remarkable concordance of temperature-structure relationship emerges, and is particularly consistent in the various cupola areas, such as those around the apex of the main batholith.

The application of this reasoning is, then, that lode-gold deposits are probably genetically associated with the last or granitic phase of the batholith injection, and that rocks rich in magnesian or ferro-magnesian elements are probably most congenial to deposition or precipitation of commercially important gold values. Gold-deposits should consequently be preferably sought for in, or near, rocks rich in the magnesian or ferro-magnesian minerals, either of the batholith itself or of the superimposed roof, in proximity to the granitic injection phase of the batholith or its satellites.

CLASSIFICATION.

Lode-gold deposits of the district may be broadly classified into four main and ten subsidiary belts, each distinguished by an inclination to a certain type of mineralization. It must be



stressed, however, that this belting or belt-localization is by no means clean-cut, and gradations from one belt to another occur and are fundamentally to be expected. At best there is evident, therefore, only an inclination, but a marked inclination, to belt-localization. Throughout this belting, however, the factors tabulated as (1), (2), and (3) are outstanding and apparently controlling.

The belts are relative to the batholith and can be tabulated as follows:—

- (A.) The Western contact-margin belt (sub-belts submerged by Pacific ocean).
- (B.) The Central pendant belt, with three sub-belts.
- (C.) The Eastern contact-margin belt, with four sub-belts.
- (D.) The Interior satellite contact-margin belt, with two sub-belts.

Generally a gradation from high to medium or comparatively low-temperature types of mineralization is apparent in these belts from (A) to (D), or from west to east. This is probably due to a structural depression on the west and a structural elevation on the east at the time of batholithic injection.

(A.) WESTERN CONTACT MARGIN BELT.

This belt embraces the Queen Charlotte Mining Division and comprises the Queen Charlotte Islands group and adjacent islands.

The western margin of the Coast Range batholith plunges steeply beneath a thick roof-covering of sedimentaries and volcanics. No intensive uplift, in comparison to that of the eastern margin, has affected this area; erosional influences are consequently comparatively subdued. Batholithic injection continued from Jurassic to possibly well into Cretaceous or early Tertiary times.

Gold metallization does not predominate in the area, and is probably associated with a subdued later period of batholith injection. A medium-high temperature accompanied this type of mineralization in this belt. Gold occurs in generally narrow quartz veins in Triassic roof-rocks of andesitic type. Mineralization consists of free gold associated with minor quantities of pyrite, chalcopyrite, some pyrrhotite, galena, and zinc-blende. Values are generally spotty and in short high-grade shoots.

In 1852 the first lode-gold discovery in British Columbia was made at Thetis cover, Mitchell inlet, on the west coast of Moresby island. From this the Hudson's Bay Company is reported to have extracted some remarkably rich ore. This property, the *Early Bird*, has been profitably mined in a small way intermittently by the present owners, who have equipped the property with a small stamp-mill driven by water-power. Further profitable production is possible if carried out by individuals using careful selective methods of mining.

Free gold in quartz veins has also been discovered on the old *Blue Mule* property at Kootenay harbour, west coast of Moresby island, and at Shuttle island, on the east coast, from which deposit a small amount of gold was produced by the owner. At the *Southeaster*, on the east coast of Graham island, some exploration and development has taken place on quartz veins carrying free gold in association with galena, chalcopyrite, zinc-blende, and pyrite, occurring in a wide shear-zone. Some small rich shoots and pockets have been mined from this deposit by individuals. The property is at present being explored by the Kitsault Eagle Silver Mines, Limited.

Recommended for intensive prospecting is the area lying west of a line drawn from the south arm of Kootenay harbour to Peel inlet off Inskip channel. The area east of the granitic contact behind Van harbour, west coast of Graham island, north of Skidegate channel, is also worthy of intensive search. The area of Triassic volcanics constituting the south-westerly quadrant of Graham island should also be gone over in detail, particularly in the neighbourhood of granitic contacts such as exposed in the vicinity of Van harbour. These suggested areas are thickly covered with timber and underbrush and, in prospecting, creek exposures should be taken advantage of and free use made of the pan.

(B.) THE CENTRAL PENDANT BELT.

This belt embraces the coastal and island area included in the Bella Coola, Skeena, Nass, and Portland Canal Mining Divisions, and a small segment of the Atlin and Stikine Divisions, roughly west of a line running north-westerly from about 20 miles east of Kimsquit, at the head of Dean channel, through Terrace on the Skeena river, the head of Alice arm, to Stewart at the head of Portland canal. North-westerly of Portland canal, this belt, with the exception

of a strip 10 to 20 miles wide and 60 miles long, east of the International boundary in the Stikine Division and the Rainy Hollow section of the Atlin Mining Division, is embraced by Alaskan territory. The biggest proportion of the belt is composed of batholithic rocks overlying and included in which are many roof-pendant and inclusion areas of varying size.

Gold mineralization occupies a low horizon in the overlying roof-rocks, or is confined to the roof phase of the batholith itself. In the nature of this mode of occurrence high to medium-high temperature conditions prevailed during ore-deposition, and is reflected in types of mineralization suggesting a generally diminishing temperature condition from west to east.

Primary free gold occurs sometimes in this belt, but is not typical. Generally, and particularly in the southerly section of the belt, native gold is confined to the oxidized or alteration zone of the deposits, and is resultant from the alteration of gold-bearing sulphides. Broadly, three types of gold-bearing mineralization typify the belt:—

- (1.) High-grade auriferous pyrite, sometimes with minor quantities of intimately intermixed chalcopyrite, in quartz veins, occupying cooling-contraction fissures and sometimes shear-zones in dioritic rocks of the roof phase of the batholith itself.

This type is represented by occurrences on the *Hunter* group, *Khutze River* area; *Surf Inlet*, *Wells*, *Cordilla*, and other groups, *Princess Royal* island; *Rowe* group, *Pitt* island; *Eddy Pass*, *Eagle*, *Trixie (Surf Point)*, *I.X.L.*, and possibly the *Copper Coin* groups, *Porcher* island; *Kalum Lake Mines, Limited*, *Kitsumgallum lake*, *St. Paul*, *Gold Nib*, and other groups, *Thornhill* mountain near *Terrace*, all in the *Skeena* Division; *Bi-Metallic*, *Marmot river*, and *Mayflower* group, *Portland Canal* Division; and the *Gold Cord* group in the *Rainy Hollow* section, *Atlin* Division.

In these deposits values up to over 6 oz. of gold to the ton occur. The contraction-fissure veins are generally narrow and lenticular with short high-grade ore-shoots. Small-tonnage profitable production from these is possible at handy locations, with the inauguration of economically conducted selective mining operations by individuals, leasing syndicates, and small companies. The shear-zone type, such as the deposit originally mined at the *Belmont-Surf Inlet* mine, is of greater dimensions and continuity and possesses potentialities of larger tonnages.

The area embracing this belt is practically unprospected for this type of deposit. The type shows a decided localization at the roof margin of the batholith, particularly in areas of diorite and especially localities of roof-rock absorption by the batholith. They should be prospected for in these types of rock in the neighbourhood of roof-pendants, and especially where there has been a late injection of granitic rock as indicated by the presence of pegmatite and aplite dykes. Such favourable areas are frequently erosional depressions or embayments within the batholithic rocks, and can thus be readily distinguished in the general topography. An immense area of the *Bella Coola*, *Skeena*, *Nass*, and *Atlin* Divisions is totally unprospected for this type of deposit. Attention of prospectors is especially directed to the *Pitt* island, *Princess Royal* island, *Khutze Inlet* and *Khutze River*, and *Porcher* island areas.

- (2.) High-grade copper ores with appreciable gold values, with which is sometimes associated richly auriferous pyrite.

These deposits are restricted to pegmatite dykes, and to quartz veins possibly closely related to pegmatite injections, occurring in dioritic rocks of the batholith. High-temperature conditions accompanied the mineralization, which consists of gold-bearing chalcopyrite, bornite, chalcocite, covellite, and pyrite. Native gold sometimes occurs as a product of alteration from the gold-bearing copper ores. The *Western Copper* deposit, *Khutze river*, represents a gradation from type (1) to type (2) of this belt. The *Drum Lummon* deposit represents the typical aspects of this type.

Mineralization of this type occurs in short shoots and erratic, bunchy distribution. If attacked in the right way by individuals, small syndicates, or economically constituted small companies, using careful economy and selective methods of mining, profitable small-tonnage production is possible.

- (3.) Gold values associated with more or less pronounced lead, zinc, copper mineralization.

These deposits occur in quartz veins and small replaced sheared zones in the roof-rocks of pendant or inclusion areas within the batholith towards the easterly border of this belt. They probably represent metallic differentiate depositories from cupola phases of the batholith in

a thick or high covering of roof-rocks. A condition of medium-high to moderate temperature prevailed during mineralization. Gold-bearing mineralization shows affinity for roof-rocks of either slaty, argillaceous, or andesitic character. Although crystalline schists (in part altered sediments) and limestones of the Prince Rupert series (Triassic to possible Carboniferous) have a wide pendant and inclusion distribution in this belt, it is observed as a remarkable fact that no tendency to gold metallization occurs in them; in fact, they seem to be decidedly uncongenial to concentrated gold-value deposition.

Mineralization consists of galena, zinc-blende, pyrite, some chalcopryite and pyrrhotite. Gold is probably associated with pyrite, but shows accentuation where galena and zinc-blende are present. Native gold sometimes occurs, but is not typical.

The type is represented by the *Maloya, Lake Shore, Black Wolf, Hawk, Bear, Gold Cap*, and *Alice* groups in the Maroon Mountain-Kitsumgallum Lake area, Skeena Division; *St. Paul* and *La Libertad* groups, Thornhill Mountain area, Terrace, Skeena Division; *Golskeish* and *Elkhorn* groups in the Observatory Inlet area, Nass Division; *Pedro Georgia* group and Georgia River Gold Mines, Limited, Georgia river, Portland Canal area, Portland Canal Division.

The veins are characterized generally by good horizontal continuity, but with an inclination to lenticular structure. Vertical continuity is possibly dependent on the thickness of the uneroded roof-covering. Commercial-grade mineralization is characterized by generally short shoots. This type of deposit possesses the possible potentiality of small to fair tonnage production, if attacked by economically constituted companies using skilled methods of exploration and development.

The pendant area lying between the Kitsault river, Hastings arm, and the Georgia river is worthy of prospecting for the discovery of deposits of this type, as is also that part of this belt in the Stikine Division adjacent to the International boundary.

(C.) THE EASTERN CONTACT MARGIN BELT.

This belt embraces the eastern contact margin of the Coast Range batholith for a width of from 30 to 50 miles east of belt (B) to about latitude 59° north at the junction of the Skoko and Taku rivers. Northerly of this area the Coast Range batholith plunges, and the area merges with a series of outlying satellites which is embraced by belt (D). Included in this belt is a small strip of the easterly side of the Bella Coola Mining Division, the easterly half of the Nass Division, practically the entire Portland Canal Division, the westerly side of the Stikine Division up to belt (B), and the westerly side of the Atlin Division to the 59th parallel.

The belt is generally composed of sedimentary and volcanic roof-rocks with intrusion-spurs and offshoots of granodioritic rocks, satellitic to the Coast Range batholith. Deposits occur generally in quartzose replacement zones, shear-zones, and sometimes in quartz-filled fissure-veins, generally always with some calcite, siderite, or other carbonate gangue. The mode of the occurrence signifies appreciable possible tonnage, and the belt is consequently the most important in the district from the aspect of production.

Conditions of temperature and pressure, dependent on structure and horizontal deposition, have been important influences on the character of mineralization, which displays a wide diversification. As with the other belts, effects of erosion are of prime importance from an economic aspect. Native gold occurs, but is not typical of the belt. Where it does occur as typical of some deposit its distribution is extremely erratic, and its presence is probably due to horizontal deposition, governed by structure such perhaps as cupola association, combined with some geochemical factor not yet established. Generally, gold values are associated with metallic sulphides either in a state of very fine mechanical mixture or possibly colloidal or chemical combination. Sustained ore-shoot concentrations display an affinity for andesitic flow-rocks and are generally subdued by the andesitic clastic type.

Broadly classified, four types of gold-bearing mineralization are characteristic of this belt:—

- (1.) Native gold in quartzose replacement zones or in quartz veins and stringers, or a compounding of both, associated with minor zinc-lead sulphide mineralization, with pyrite, pyrrhotite, and some chalcopryite and low-grade gold values, occurring in andesitic tuffs and flows and sometimes in argillaceous rocks.

This type is represented by the *Big Missouri, Unicorn*, and possibly other groups in the upper Salmon River area, Portland Canal Division. In these the mode of occurrence seems to

differ from type (2) of this belt, in that an abundance of tuffaceous rocks is present, temperature characteristics seem to be increased, and quartzose replacement is comparatively subdued. In the Stikine Division the mode of occurrence of gold-bearing quartz veins and stringers in argillite on the *Lucky Strike* group, situated on the right bank of the Stikine river, 2 miles south of Jackson's Landing, can be correlated with this type.

In this type, mineralization is bunchy, dispersed, and very erratic. The character, mode of occurrence, and aspects of localization appear to represent a gradation between type (3), the easterly extremity of the (B) or pendant belt, and type (2) of the (C) or eastern contact belt. Possibly the type represents a deep higher-temperature mineralization horizon of cupola areas of the immediate eastern contact or apex of the batholith. This type of deposit has a possible potentiality of either large-tonnage low-grade operations or small-tonnage selectively-mined production.

- (2.) Gold values associated with pronounced silver-lead-zinc sulphide mineralization, with pyrite, pyrrhotite, and some chalcopyrite, occurring in replacement and sheared zones in andesitic rocks.

This type has so far proved the most important from the standpoint of production. It is represented by *Premier, B.C. Silver, Premier Extension, Woodbine, Premier Border, Salmon Gold*, and several other groups in the Salmon River area of the Portland Canal Division. In the same Division a somewhat subdued gold-value tendency accompanied by more accentuated base-metal association occurs in argillaceous rocks of the Bitter Creek area on the *L.L. & H.* and *Windsor* groups. In the Alice Arm area, Nass Division, the *Kitsault River* and *Homestake* groups possess features that correlate them with this type. In the Stikine Division the *Glenora* and *King* groups, situated on the north slope of Glenora mountain about 7 miles westerly of Telegraph creek, can be included in this type.

An extensive area of No. 1 District conducive to the deposition of this type of deposit is still unprospected. Favoured localities would be along the eastern contact of the Coast Range batholith, especially those areas of andesitic flow-rocks into which are injected small spurs of granodiorite or granitic rock as offshoots from the main batholith. In this connection attention is particularly directed to the upper Kitsault River area west of the Kitsault glacier, Nass Division, and the continuation of the Salmon River contact area through the Unuk and Whiting River drainage-basins.

- (3.) Gold values associated with pronounced chalcopyrite-pyrite-sphalerite disseminated mineralization with minor quantities of galena, occurring in quartz-carbonate-barite replacement shear-zones in andesitic tuffs and lavas.

These deposits are typified in the *Manville* and *Tulsequah Chief* groups, Taku river, Atlin Division. The ores of these deposits assay about: Gold, 0.12 to 0.2 oz. to the ton; silver, 2 to 7 oz. to the ton; copper, 1.5 to 5 per cent.; zinc, 5 to 15 per cent. The gold is probably associated with the pyrite or chalcopyrite. The ore-bodies are medium to low temperature deposits occupying a comparatively high horizon in the roof-rocks above the plunging batholith contact, and probably represent a gradation facies between the eastern contact belt (C) and the interior satellite belt (D). This type has possible potentialities of appreciable tonnage of complex gold ore.

- (4.) Gold values associated with antimony, arsenic, and iron sulphides, with very minor quantities of copper, lead, and zinc mineralization, in quartz-carbonate replacement shear-zones in andesitic lavas.

This type is represented by the *Whitewater, Silver Bird, Golden Star, Mineral Mountain*, and possibly other groups situated in the Taku River area, Atlin Division. The deposits are probably of low-temperature origin occupying a high horizon in the roof-rocks above the batholith.

Sulphide mineralization is not pronounced, and it would seem that the gold values are partially associated with finely divided acicular mispickel crystals, possibly also with some of the finely divided pyrite, and also in a finely divided free state. The mode of occurrence and character approaches more nearly that of the belt (D) interior satellite area and ore-bodies of this type may possibly be found in that belt. They probably represent a still closer gradation into belt (D) than shown by type (3).

The area from the 59th parallel to the Whiting and Unuk rivers, which is practically virgin ground, should be favourable for the discovery of similar ore-bodies.

(D.) INTERIOR SATELLITE CONTACT MARGIN BELT.

This belt embraces the Stikine Division east of a line drawn from about Echo lake to Telegraph Creek, the entire Liard Division, the Atlin Division east of belt (C), north of the 59th parallel and east of Rainy Hollow section. It is geologically characterized by a thick covering of roof-rocks varying from probably pre-Cambrian (Yukon series) to Tertiary and Recent. Numerous granodioritic and granitic satellites (alkali-siliceous) are intrusive into the formations up to probably slightly later than Lower Cretaceous.

Gold-bearing deposits of this belt occur generally in quartz and quartz-calcite veins or quartzose-carbonate replacement zones in Jura-Cretaceous shales, slates, greywackes, andesitic tuffs, amphibolites, hornblende-schists, hornblende diorite, and magnesian rocks. The quartz of the gangue is milky, well crystallized, sometimes drusy or vesicular, occasionally banded and with comb structure, and in places markedly chalcedonic in texture.

Mineralization is typified by native gold, with gold telluride in places, associated generally with subdued galena, pyrite, chalcopryrite, and some tetrahedrite mineralization. The deposits are probably of intermediate to low temperature origin, occurring at a high horizon in the roof-rocks above the main batholith-mass and in proximity to what are probably the cupola areas of granitic satellites of the deeply buried main batholithic mass. In the cited areas a wide distribution of quartz veins occurs, especially in those sections characterized by placer-gold deposits, and are probably the lodes from which these placer deposits originated. Although, on account of the long process of erosion and concentration which has resulted in these placer deposits, it is not essential for the lodes from which they originated to have originally contained commercial gold values, it is also not improbable that in some sections or horizons they did. Although generally the present outcrops of these veins may only contain low-grade and sparse gold values, and as some indications of free gold have been found in them, it is not improbable that with further investigation and prospecting with systematic sampling, commercial shoots may be found in them along the present outcrops and along some deeper unexposed horizons of their vertical projection. Barren and low-grade ore horizons intervening between horizons of commercial grade are characteristic of many lode-gold deposits in various parts of the world.

Two types of ore-deposit occur in this belt:—

- (1.) Native gold and gold telluride with some pyrite, occasionally some allemontite, and practically a total absence of other sulphides.

This type is represented by the *Engineer*, *Gleaner*, *Kirkland*, and *Happy Sullivan* groups, all situated at the south end of Taku arm, Tagish lake, Atlin Division.

The gold occurs in pockets and small shoots generally in the form of very thin scales, thin leaves, fine dendritic forms, and sometimes peppered through the quartz in fine grains. Cairnes has specified the gold telluride as probably mainly calaverite. The wall-rock is slate, shale, and in the case of the *Happy Sullivan*, what is probably an altered water-lain tuff. In the small quartz veins and stringers some very rich small pockets of ore occur in erratic distribution. In the brecciated replaced shear-zone type a generally low-grade gold tenor prevails. From the *Engineer* a limited tonnage of rich ore has been mined and shipped from pockets in the small veins, but a possible mill-grade potentiality of this and adjoining properties from the large replaced shear-zones has not yet been proven and still remains to be adequately explored.

- (2.) Native gold in quartz veins with a very subordinate accompanying mineralization of pyrite, galena, chalcopryrite, and some tetrahedrite.

The wall-rock of this type is generally hornblende-schist, hornblende diorite, and magnesian rocks that are possibly altered volcanics. The gold occurs generally in erratic distribution, with a tendency to sometimes form small ore-shoots where the sulphide mineralization is more pronounced. The veins vary in width from about 1 to 6 or 8 feet.

The type is represented by the *White Moose*, *Rupert*, and *Bighorn* groups, situated on the west side of Taku arm, Tagish lake, Atlin Division, and the *Imperial*, *White Star*, *Lake View*, *Rosadie*, and *Hudson Bay* groups, situated in the Pine Creek valley near Atlin, Atlin Division.

Very little exploration-work has been carried out on this type of deposit and their economic aspects are generally still undetermined. Some of them possess characteristics indicating possible small-tonnage mill-grade ore operations and as such are worthy of further exploration. In this respect the attention of examining engineers is, for instance, directed to the *Imperial* group, which at least warrants a complete and closely spaced systematic sampling.

The bulk of the area embraced by the belt (D) is entirely unprospected for lode-gold deposits. This is perhaps due to activities being concentrated on placer-gold operations in the belt areas and the absence of adequate transportation facilities for lode-mining at the time attention was directed to placer deposits. Transportation facilities have been markedly improved since then and are steadily advancing from year to year. Numerous quartz veins varying from stringers to several feet in width, and also mineralized shear-zones of appreciable width, occur in the known placer-gold areas and will probably also be found beyond these areas of the Atlin, Stikine, and Liard Mining Divisions. For reasons already referred to, it should not be taken for granted that these quartz veins are entirely barren or low grade throughout their outcrop exposures or at lower horizons. Even if gold is not visible to the eye, it may be present in commercial quantities in an extremely fine state of division that will only be discovered by systematic panning or sampling. Although in the nature of the occurrences pay-shoots of gold may be small and erratic, yet some of sufficient extent may be found to make profitable mining possible. These veins and zones warrant systematic investigation.

The extensive cited areas of this belt offer one of the best virgin territory opportunities in the district to the lode-gold prospector. The attention of prospectors is especially directed to the easterly and westerly contact areas of the Cassiar batholith. This batholith cuts through the belt with its westerly margin at approximately the north end of Dease lake, paralleling the drainage-basin of Thibert creek, and its easterly margin at about the south end of Cottonwood lake on the Dease river, paralleling the drainage-basins of the Cottonwood river and McDame creek. These drainage-troughs and that of the Eagle river which dissects the Cassiar batholith from south to north to the east of Dease lake would seem to afford the best access to both these contact margins. The pendant and inclusion areas lying in the interior of this batholith, some of which appear to be of appreciable dimensions, also warrant intensive prospecting. The attention of prospectors is also especially directed to the numerous quartz veins and mineralized shear-structures of the McDame Creek area, particularly those of Quartz creek. In the latter area a wide shear-structure containing sparse pyrite and acicular mispickel mineralization was grab-sampled by the Resident Engineer and assayed: Gold, 0.1 oz. to the ton; silver, 0.1 oz. to the ton; arsenic, 3.6 per cent. This is an interesting indication. Pannings made by a local prospector from quartz vein-float also showed a rich content of free gold. The upper reaches of the Quartz Creek and Trout Creek troughs of the McDame Creek area also warrant thorough prospecting.

LODE-GOLD PRODUCTION AND MINING.

Lode gold was first discovered in the North-western Mineral Survey District in 1852, at Thetis cove (Mitchell inlet) on the west coast of Moresby island, Queen Charlotte islands. This discovery also has the distinction of being the first chronicled discovery of lode gold in the Province of British Columbia. The first lode-gold mining in the Province was carried out on this deposit and some very rich ore was produced from open-cuts on small shoots in a small vein by the Hudson's Bay Company. Reports vary regarding the amount of gold recovered, but according to accounts it was comparatively appreciable and ceased when these pockets had been "gophered" out or the cuts flooded by tide-water. In recent times this deposit has been mined spasmodically in a small way by individuals and some gold recovered.

The first impetus to important lode-gold mining operations in the district came with the discovery of the *Premier* mine in the Portland Canal Mining Division about 1909 and the inauguration of profitable production from this property in 1918. Since that time a total of 1,870,411 tons of ore yielding 1,097,621 oz. of gold and 26,969,570 oz. of silver has been produced from this property, and over \$16,000,000 in dividends disbursed to the shareholders of this company. This mine has for a number of years held the position of the largest producer of gold in the Province.

Since this development, search for gold-deposits has been intensified and exploration and development of likely prospects has been active. Although as yet nothing comparable to the richness and extent of the *Premier* deposit has been discovered, and important lode-gold production in the district has come solely from this property, other promising prospects that may eventually be brought to the stage of profitable production have been discovered. With improvements to transportation facilities into formerly inaccessible regions, advances in technical aids to prospecting, exploration, mining and metallurgy, advances in geological knowledge regarding gold-ore deposits, their nature and association of occurrence, and the pronounced trend towards

sound financing and technically skilled operation, the field for new gold discoveries and possible profitable operations has been gradually but surely enlarging. Hand-in-hand with these advances it has become apparent that this district contains widespread lode-gold potentialities of probable importance.

Although it is probable that the gold-output of the *Premier* mine will decline in future years, the encouraging possibilities for production from other properties, for expansion in other sections of the district, the intensification in lode-gold prospecting, and the acute interest of operating companies in this type of deposit gives promise of a sustained future gold production from the North-western Mineral Survey District.

The important growth of lode-gold production from this district is well illustrated in the following table:—

GOLD PRODUCTION, NORTH-WESTERN MINERAL SURVEY DISTRICT (No. 1).

Atlin Mining Division.

Year.	Oz.	Year.	Oz.
1911	3	1917	1,000
1913	1,355	1925	1,878
1914	1,000	1926	7,737
1915	875	1927	2,030
1916	736	1928	193

Atlin, Stikine, and Liard Mining Divisions.

1918	446	1923	1
1921	3	1924	5
1922	3		

Liard, Stikine, Skeena, Queen Charlotte, and Portland Canal Mining Divisions.

1911	500	1915	5,034
1912	197	1916	3,806
1913	29	1917	9,805
1914	2,884		

Skeena, Nass River, Portland Canal, and Queen Charlotte Mining Divisions.

1918	48,016	1920	54,531
1919	60,076	1921	85,182

Skeena, Queen Charlotte, and Bella Coola Mining Divisions.

1922	35,081	1924	34,673
1923	29,660		

Skeena Mining Division.

1925	35,086	1928	139
1926	11,128	1929	69
1927	56		

Nass River Mining Division.

1922	9,125	1927	4,960
1923	8,077	1928	5,100
1924	6,323	1929	4,671
1925	7,484	1930	3,207
1926	7,906		

Portland Canal Mining Division.

1922	123,537	1927	122,242
1923	117,293	1928	130,304
1924	139,462	1929	96,676
1925	118,469	1930	87,492
1926	124,207		

The groupings of Mining Divisions in this table follow those in the earlier Annual Reports.

In analysing this table it should be pointed out that gold recovered from the mining of the *Hidden Creek* copper ores is included, and under the heading of the Skeena Division constitutes the bulk of the gold production in the district between 1914 and 1917. Subsequent to that date this base-metal operation is included in the Nass Mining Division and its gold-output included

in the gold production from that Division. However, as these ores only contain about 0.005 oz. gold to the ton, from 1918 on, when the *Premier* mine came into production, the influence of the *Hidden Creek* gold-output, although appreciable, is a proportionally small amount of the whole output of the district.

The influence of gold-output from the *Surf Inlet* mine, operated on a large scale by the Belmont-Surf Inlet Mines, Limited, from 1917 to 1926, is noted in the production credited to the Skeena Mining Division for those years. The marked influence of gold-output from the *Premier* mine is noted in production credited to the Portland Canal Mining Division from 1918 to the present time.

It will be noted that the first appreciable lode-gold production in the district commenced in 1913 with an output of 1,355 oz. from the *Engineer* mine, Atlin Mining Division, which property produced a fair amount of gold to 1917, and again between 1925 and 1928.

With appreciable production commencing from the *Premier* mine in 1918, however, increased attention has been attracted to the lode-gold potentialities of the district, and the scope of mining, exploration, and prospecting has been continuously extended.

During 1931 lode-gold production of the district shows a slight decline, due to a lowered output from the *Premier* mine owing to slightly lower-grade ore.

Owing to the world depression prevailing during 1930 and 1931, a decided impetus in the search for profitable lode-gold deposits has materialized, and exploration and prospecting has been active in this district. With the continued improvement of transportation facilities by the Department of Mines and the Department of Public Works, favourable areas are being gradually brought within the reach of prospectors and within the operating scope of lode-mining.

During the trying depression period of 1931, lode-gold production from the district has been well sustained, and exploration activities on several properties by sound companies holds promise of additional gold-producers. Several of these activities carried on during 1931 are of special interest.

In the Portland Canal Division, operations at the *Premier* mine, although curtailed by one day a week, have been sustained. Some new ore-bodies lateral to the main ore-zone have been discovered on the upper levels, including a promising offshoot lateral to 4H stope. The *B.C. Silver* ore-bodies have been resampled and their contained values verified. This may possibly lead to a more certain aspect of the active and productive operation of this property. The energetic and systematic exploration of the *Big Missouri* by the Consolidated Mining and Smelting Company of Canada has been ceaselessly continued, with a view to overlooking no possibility that may lead to the successful development of either a large-tonnage low-grade or a medium-tonnage medium-grade producer. The gold tenor of the indicated ore was sampled on a large scale with a 100-ton mill erected on the property, and at the completion of this a campaign of further diamond-drilling was commenced for the purpose of proving continuity and of correlating the possible commercial aspects indicated by this sampling. On the *Unicorn* property, adjoining the *Big Missouri*, underground exploration of a deposit similar to that of the *Big Missouri* was continued by the Unicorn Mining Company, Limited. Diamond-drill exploration of the *Salmon Gold* group by the Premier Gold Mining Company was also undertaken towards the close of the season. This was carried out by twelve short diamond-drill holes, with a portable equipment. Operations were suspended at the freeze-up and it is understood the option by the Premier Company has been relinquished. It would seem, however, that the nature of this deposit and the values indicated warrant at least some further depth-drilling. In the Unuk River section some further prospecting has resulted in discoveries carrying interesting gold values. A greater and more concrete interest in this section is becoming evident, and, it is hoped, may lead to the opening-up of this promising belt by the provision of transportation facilities in co-operation with the Alaskan Government.

In the Queen Charlotte Division active exploration of the *Southeaster* group by the Kitsault Eagle Silver Mines, Limited, has continued. Towards the close of the year encouraging gold values and vein-widths were reported to have been encountered for the first time on the 100-foot level of this property. Further discoveries of encouraging gold values are also reported from the west coast of Moresby island by S. K. Larson, of Prince Rupert.

In the Skeena Division further work was carried out on the auriferous sulphide veins of the *Hunter* and *Western Copper* groups in the Khutze River area and the *Surf Point* and *Eddy Pass* groups on Porcher island. These properties have potentialities of possible small-tonnage profitable production. It is hoped recent activities may lead to the correct and conservative

appraisal of these potentialities that will remove the handicap hitherto afflicting this type of deposit and result in production from them.

In the Stikine Division further prospecting of the *Lucky Strike* group was carried out by the Barrington interests. General prospecting was also more active in the interior sections, and in the region towards the headwaters of the Chutine (Clearwater) river several reconnaissance expeditions have resulted in the selection of favourable territory that will be intensively prospected during the coming season.

In the Liard Division interest in prospecting for lode-gold deposits is being aroused, and on the *Keystone* group, in the Thibert Creek area, Homer Ficklin, of Porter Landing, reports encouraging gold values in a zone of quartz stringers. In the McDame Creek area some superficial prospecting of the many possible gold-bearing quartz veins has also been carried out and resulted in encouraging indications. In this Division some prospectors have also undertaken extensive reconnaissance expeditions and selected favourable areas for intensive prospecting.

In the Atlin Division some further work was carried out by the owners on the *Imperial* and *Hudson Bay* groups, Atlin section, that should materially facilitate their appraisal by examining engineers. In the Rainy Hollow section further prospecting of the *Gold Cord* group was carried out by William Bunting and additional veins discovered. In the Taku River section an energetic campaign of diamond-drilling exploration on the *Whitewater* and several neighbouring groups by Noah Timmins, Incorporated, has given encouraging results, and may lead to more extended exploration of these properties during the coming season. In the same area the Alaska Juneau Gold Mining Company again entered the field late in the season, and commenced surface exploration of the *Silver Bird*, *Golden Star*, and *Mineral Mountain* groups, which will be continued in the 1932 season. On account of these activities constructive prospecting in this area has been stimulated and the chance for further discoveries is consequently improved.

The activity of examining engineers during 1931 indicates that the lode-gold potentialities of the district are being more generally recognized and discoveries of interest will be readily taken up for exploration by technically and financially sound organizations.

LODE-GOLD DISTRIBUTION IN MINING DIVISIONS.

The North-western Mineral Survey District comprises Bella Coola, Queen Charlotte, Skeena, Nass River, Portland Canal, Stikine, Liard, and Atlin Mining Divisions. It embraces the Pacific drainage area of the Province from Seymour inlet to the Yukon boundary and all of the Arctic drainage area of the Province north of the Peace river and its boundaries. In these Divisions an area of approximately 125,000 square miles is embraced.

For purposes of geographical clarity regarding the location of various occurrences, in the following data, sections of the various Divisions are enumerated as follows:—

Bella Coola Mining Division.

Queen Charlotte Mining Division—Graham Island section; Moresby Island section.

Skeena Mining Division—Coast section; Kitsumgallum Lake section; Lakelse section.

Nass River Mining Division—Observatory Inlet section; Kitsault River section.

Portland Canal Mining Division—Georgia River section; Marmot River section; Bear River section; Salmon River section; Unuk River section.

Stikine Mining Division—Stikine River section.

Liard Mining Division—Dease Lake section; Dease River section.

Atlin Mining Division—Taku River section; Rainy Hollow section; Atlin Lake section.

For convenient reference regarding the various lode-gold properties, deposits, their belt distribution, type, mode of occurrence, location, and source of information regarding them, these data are summarized in the following table:—

BELLA COOLA MINING DIVISION.

Section.	Belt.	Properties.*	Character of Deposits.	Mining Conditions, Production, or Potentiality.	Minister of Mines' Annual Report.	Geological Survey of Canada and other Reports.
	B 1-3; C 1, 2	Very little prospecting in this area	Very little prospecting	B 1, 2, 3, accessible to seaboard; low costs. C 1, 2, partly accessible to seaboard by road and trail; partly remote; costs moderate to high; small to appreciable tonnage	1917-30	Sum. Rep., 1908, 21, 25.

QUEEN CHARLOTTE MINING DIVISION.

Moresby Island	A	Early Bird (I.) Blue Mule (I.) Shuttle Is. (I.)	Quartz veins in Triassic volcanics and sediments; rich pockets	Accessible to seaboard; low costs; small tonnage; small company, lessees, or syndicate; some limited production	1917, 18 1920, 22, 23 1919	1878, 1887; Sum Rep., 1913, 14; Mem. 88, 1916; C.M.I., 1910.
Graham Island	A	Southeaster (E.D.)	Replacement shears in Triassic volcanics; native gold, sparse pyrite, galena, sphalerite, chalcopryrite, and pyrrhotite; rich pockets, short shoots	Accessible to seaboard; low costs; medium tonnage; company; some production from individuals	1918, 19, 29-31	Same as for Moresby Island.
	B 1	Surf Inlet (I.) Wells (I.) Cordilla (I.)	Quartzose shears in quartz diorite; auriferous pyrite and chalcopryrite	Accessible to seaboard; low costs; appreciable tonnage; company; appreciable production from Surf Inlet	1917-25, 30 1920 1922	Ditto.

SKEENA MINING DIVISION.

Coast	B 1	Eddy Pass (E.) Surf Point (E.D.) Eagle (E.) I.X.L. (E.) Rowe (E.) Copper Coin (E.) Hunter (E.)	Narrow quartz veins in quartz dioritic and batholith roof-absorption rocks; auriferous pyrite, some chalcopryrite; short shoots; high grade	In part accessible to seaboard; moderate costs, when accessible to ocean; small tonnage; small companies, syndicates; some production	1930 1917, 19-25, 27-30 1919, 29, 30 1928, 30 1925, 29, 30 1930 1930, 31	Mem. 23; Sum. Rep., 1921, 22.
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* (I.)=Idle; (E.)=Exploring; (E.D.)=Exploring and developing; (P.)=Producing.

SKEENA MINING DIVISION—Continued.

Section.	Belt.	Properties.*	Character of Deposits.	Mining Conditions, Production, or Potentiality.	Minister of Mines' Annual Report.	Geological Survey of Canada and other Reports.
Coast.....	B 2.....	Western Copper (E.D.) Drum Lummon (I.)	Pegmatite and quartz veins of pegmatitic affinity; auriferous copper ores, some pyrite; high-grade pockets and short shoots	In part accessible to seaboard; medium-high to high costs; small tonnage; small companies and syndicates, or individual lessees; some production	1925, 27-29, 31..... 1917-20, 22-24, 29, 30	Mem. 23; Sum. Rep., 1921, 22.
Kitsumgallum Lake	B 3.....	Mayola (E.)..... Lake Shore (E.) Black Wolf (I.) Hawk (E.) Bear (E.) Gold Cap (E.) Alice (E.)	Narrow quartz veins and small replaced shears in Triassic sediments; gold with galena, pyrite, sphalerite, some chalcoppyrite and pyrrhotite; short shoots	Small to moderate tonnage; small companies, syndicates; limited production; moderate costs; accessible to C.N.R. at Terrace via lake and road	1918..... 1921, 25, 27, 28, 30 1928, 30 1920, 23, 30 1920, 28 1924, 30 1930	Sum. Rep., 1923, 24.
	B 1.....	Kalum Lake (E.D.)	Narrow quartz veins with auriferous pyrite in quartz diorite; short shoots	Small tonnage; small company or syndicate; moderate costs; accessible to C.N.R. via lake and road	1924, 25, 27, 28, 30	Sum. Rep., 1923, 24.
Lakelse Lake.....	B 1-3.....	Star (E.)..... A. and B. (E.) Society Girl (E.) St. Paul (E.) La Libertad (E.)	Quartz veins in dioritic rock; auriferous pyrite, some galena, chalcoppyrite, and sphalerite; short shoots	Accessible to C.N.R.; low to moderate costs; small to moderate tonnage; some production from rich pockets	1925, 28..... 1928 1918, 30 1925, 29, 30 1929, 30	Sum. Rep., 1923, 24, 26.

NASS RIVER MINING DIVISION.

Observatory Inlet	B 3.....	Golkeish (P.)..... Elkhorn (E.)	Quartz veins in Triassic sediments and volcanics; free gold, some galena and sphalerite, pyrite, and chalcoppyrite	Accessible to seaboard; low to moderate costs; moderate tonnage; low-grade or rich pockets; production from Golkeish for flux	1920..... 1929, 30	Sum. Rep., 1922.
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Kitsault River..	B 1-3; C 1-3	Bunker Hill (E.)..... Lucky Strike (E.) Combine (E.) Homestake (I.) Kitsault River (E.)	Largely undeveloped; fissure- veins and replacement zones; in Triassic sediments and vol- canics; galena, sphalerite, pyr- rhotite, some chalcopryrite	Accessible to seaboard via road and narrow-gauge railway and trail; moderate costs; moder- ate tonnage; no production; limited exploration	1917..... 1929, 30 1930 1918, 21, 28, 30 1925, 27, 30	Sum. Rep., 1921-23, 28.
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PORTLAND CANAL MINING DIVISION.

Georgia River...	B 3.....	Georgia River (E.D.) Pedro Georgia (E.)	Replacement zones; in Triassic sediments and volcanics; ga- lena, sphalerite, pyrrhotite, some chalcopryrite; short shoots	Fairly accessible to seaboard; costs moderate; moderate ton- nage	1917, 22, 28-31..... 1928, 31	Mem. 32, 132, 159; Sum. Rep., 1918, 23; Econ. Geol., Vol. 21; U.S.G.S., Bull. 722.
Marmot River...	B 1.....	Bi-Metallic (E.).....	Narrow quartz veins in granitic rock; native gold and pyrite	Accessible to seaboard via road and trail; costs moderate; small tonnage or selective	1929, 30.....	Ditto.
Bear River.....	B 1.....	Mayflower (E.).....	Quartz veins in quartz diorite; auriferous pyrite	Accessible to seaboard by road and trail; small tonnage; bunchy shoots	1918, 25, 28, 30.....	Ditto.
	C 2.....	L.L. & H. Windsor	Shear and replacement zones in Triassic sediments and volcan- ics; galena, sphalerite, pyrite	Accessible to seaboard by road and trail; moderate to appre- ciable tonnage	1920, 29..... 1924, 30	Ditto.
Salmon River...	C 1..... C 1..... C 1(?).....	Big Missouri (E.D.) Unicorn (E.) Forty-nine (I.)	Quartz stringers and replace- ment zones; erratic native gold, pyrite, pyrrhotite, some galena, sphalerite, and chalco- pyrite	Accessible to seaboard via road and trail; costs low to moder- ate; large tonnage low grade, or medium tonnage medium grade; erratically distributed values	1917-31..... 1919, 25, 28-31	Ditto.
	C 2.....	Premier (P.)..... B.C. Silver (I.) Sebakwe (I.) Premier Border (I.) Woodbine (I.) Premier Extension (I.) Indian (I.) Salmon Gold (E.)	Replacement zones in Triassic volcanics; gold with pronoun- ced silver-lead-zinc sulphides, pyrite, pyrrhotite, some chalco- pyrite	Accessible to seaboard by aerial tram, road, and trail; costs low to moderate; appreciable tonnage, good grade; large pro- duction from Premier; no other regular production	1919-31..... 1919-31 1919-31 1927-30 1927-30 1928, 25, 27, 29 1917-25 1930, 31	Ditto.
Unuk River.....	C 1-3.....	Largely unpros- pected	Cursory prospecting indicates possible deposits of C 1 and C 2 type	At present inaccessible except by river navigation	1901, 03, 11, 29, 30	U.S.G.S., 1905; U.S. G.S., Bull. 347.

* (I.)= Idle; (E.)= Exploring; (E.D.)= Exploring and developing; (P.)= Producing.

STIKINE MINING DIVISION.

Section.	Belt.	Properties.*	Character of Deposits.	Mining Conditions, Production, or Potentiality.	Minister of Mines' Annual Report.	Geological Survey of Canada and other Reports.
Stikine River.....	C 1.....	Lucky Strike (E.)....	Quartz veins and stringers in Triassic sediments; native gold, pyrite, pyrrhotite, some sphalerite and galena	Accessible to river transportation; medium-high costs; small selective tonnage; syndicate or small exploration company	1929-31.....	Sum. Rep., 1928, 29.
	C 2.....	Glenora King (I.)....	Replacement in Triassic volcanics; pyrrhotite, chalcopryrite	Accessible to river transportation by trail; high costs	1930.....	Sum. Rep., 1928, 29.

LIARD MINING DIVISION.

Dease Lake, Dease River	C 4; D 1, 2....	Not prospected.....	Areas not prospected.....	Remote; river and road transportation; high costs	1929-31.....	1876, 77, 87; Sum. Rep., 1925, 28, 29.
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ATLIN MINING DIVISION.

Taku River.....	C 3.....	Manville (E.)..... Tulsequah Chief (I.)	Replacement shears in Triassic volcanics; pyrite, chalcopryrite, sphalerite, galena, barite	Comparatively remote; river transportation to seaboard; appreciable tonnage; medium-high costs; company	1929, 30..... 1923, 28-30	Sum. Rep., 1929.
	C 4.....	Whitewater (E.D.).. Silver Bird (D.) Golden Star (E.) Mineral Mountain (E.) Little Wonder (E.) Canyon (E.)	Shears in Triassic volcanics; mispickel, stibnite, pyrite, some nickel-chromium silicate	Comparatively remote; appreciable tonnage; river transportation to seaboard; moderately high costs; company	1929-31..... 1930, 31	Sum. Rep., 1929.
Rainy Hollow....	B 1.....	Gold Cord.....	Quartz veins in quartz diorite; sparse pyrite, chalcopryrite, pyrrhotite	Fairly remote; accessible to seaboard by road and trail; moderate tonnage; fairly high costs; company	1927, 29-31.....	U.S.G.S., Bull. 699.

Atlin Lake.....	D 1.....	Engineer (I.)..... Gleaner (I.) Kirkland (E.) Happy Sullivan (I.)	Quartz veins and replacements in Palaeozoic to Mesozoic sedi- ments and volcanics; free gold, gold telluride, pyrite, some alle- montite; rich pockets	Lake and rail transportation to seaboard; selective; small or medium grade; appreciable ton- nage; syndicate or company; high costs	1918, 24, 25, 27, 29, 30 1918, 25 1918, 25 1918, 27, 30	Ann. Rep., 1899; Mem. 37; Sum. Rep., 1925.
Atlin Lake.....	D 2.....	White Moose (I.)..... Rupert (I.) Bighorn (I.) Imperial (I.) White Star (I.) Lake View (I.) Hudson Bay (E.) Relief (E.)	Quartz veins in Palaeozoic to Mesozoic volcanics; free gold, minor pyrite, galena, chalco- pyrite, tetrahedrite	Lake, road, and rail transporta- tion to seaboard; selective; moderate tonnage; syndicate or company	1918, 31..... 1918, 31 1921, 31 1918, 31 1918, 31 1918, 31	Ann. Rep., 1899; Mem. 37; Sum. Rep., 1925.

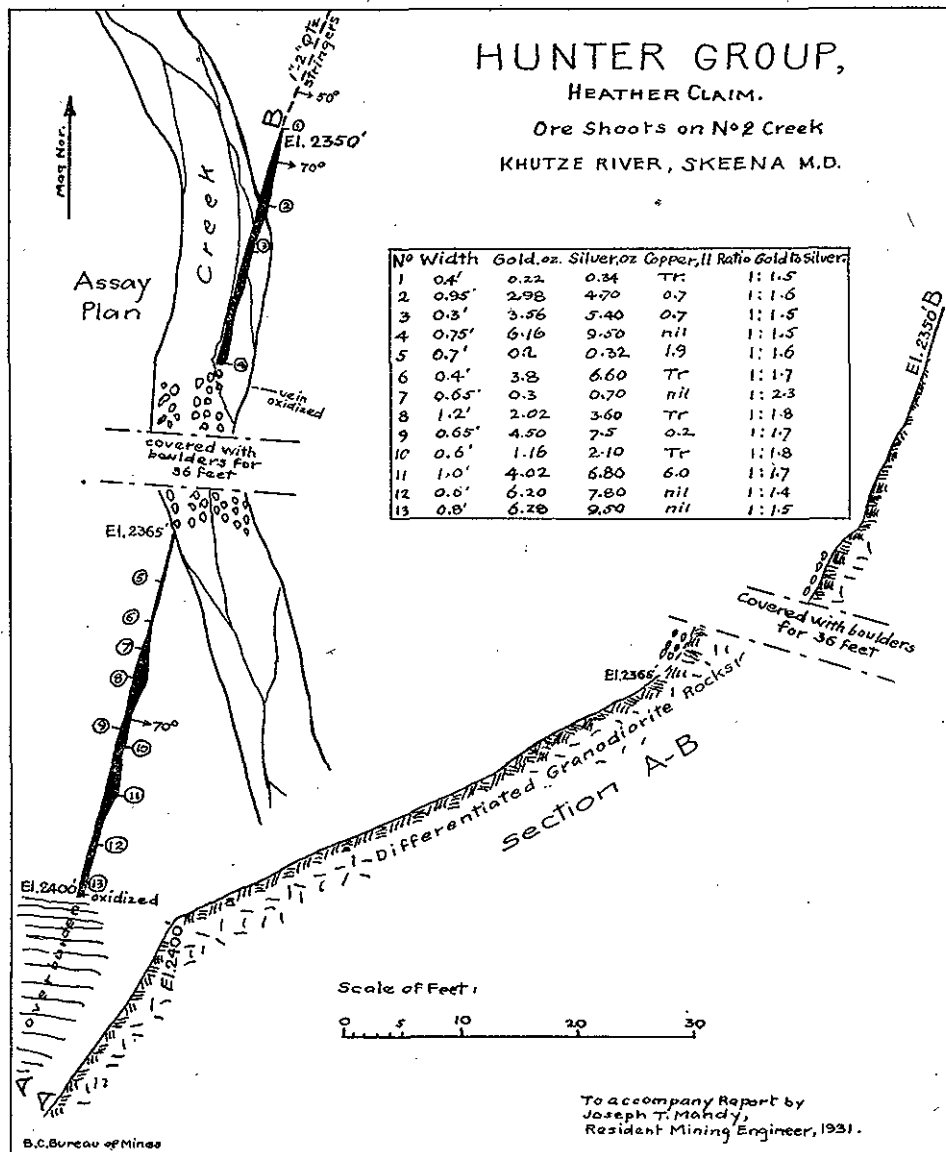
* (I.)=Idle; (E.)=Exploring; (E.D.)=Exploring and developing; (P.)=Producing.

In the following descriptions only those properties are mentioned which have not been described in former reports or on which further important developments have taken place.

SKEENA MINING DIVISION.

Hunter.

The ore-deposit on this group is described in detail as it is a good example of type (1) in belt (B) and well illustrates the roof-absorption phenomena of this type. The group of twelve claims is owned by C. W. Meldrum and



associates, of Vancouver, and the property is being explored by Vancouver interests. Very little development has been carried out so far, as operations have been practically confined to trail and camp construction. The property is situated about $8\frac{1}{2}$ miles up the North fork of the Khutze river, and about 13 miles from seaboard at the head of Khutze inlet, about 100 miles south of Prince Rupert.

The ore-deposit consists of narrow and erratic quartz veins mineralized with high-grade gold-bearing pyrite in erratic and lenticular distribution, in a country-rock of differentiated biotite quartz-diorite intruded by granitic injections, at a top horizon of the once deeply buried Coast Range granodiorite batholith.

The Khutze River section is situated in the heart of the Coast Range granodiorite batholith. Biotite and biotite-hornblende quartz diorite of probably Upper Jurassic age characterize the batholithic rocks of the area. Small isolated areas and segments of older roof-rocks composed of limestone and altered sediments of probable Triassic age that have been protected from the intense erosion are sometimes seen superimposed on the granitic basement. A typical roof-rock remnant can be seen covering the lower altitude of the southerly slope of Hyas mountain. A wide distribution of aplite and pegmatite dykes, intense differentiation, absorption areas, and sometimes roof-breccias, characterize the section generally as a high or roof horizon of the batholith. The general coarse-grained texture of the dioritic rocks indicates a former thick or high roof-covering since eroded and beneath which the batholith was deeply buried. The occurrence, however, of zones of fine-grained, tough, and extremely siliceous granite or granodiorite indicate granitic intrusions within the batholith of widely divergent age and varying extremes of temperature and pressure.

In the southerly area around the junction of the East and North forks of the Khutze river major jointing striking N. 60° to 70° E. and dipping 15° to 20° S. is pronounced. In the area of the North fork jointing is not characteristic.

Biotite quartz-diorite comprises generally the formation of the *Hunter* group. Intensely differentiated sections, aplite and pegmatite dykes, dark absorption and semi-absorbed patches, and sometimes roof-rock breccias indicate a high roof-horizon of the batholith at practically the contact of the batholith with the now completely eroded roof-rocks. Flow-structure, streaks, schlieren, and crenulation zones indicate the rocks to have been subjected to movement whilst still in a heated and plastic condition. The general absence of marked cleavage-structure coupled with the above characteristics indicate the area to have occupied a deep horizon on the border of the zone of flowage and the zone of cleavage, and to have been subjected to intense erosional influences that have removed the thick covering of roof-rocks down to practically the horizon of the batholith with the ancient overlying roof. It is in this horizon that the known veins are confined on the *Hunter* group.

With the increase of altitude towards the south on the *Hunter* group, and approaching the outstanding high bluff-ramparts which rise abruptly from elevation 2,600 feet, differentiation and roof phenomenon decrease in intensity, indicating a gradual increase in erosional intensity towards this locality. Although this bluff area is completely bared, no veins have so far been discovered in it, nor can continuity of the known vein-structure be seen to pass into it.

The lithologic and physiographic structure described indicates the veins to be confined to the immediate differentiated roof-absorption area of the batholith contained in a steeply plunging trough or embayment. In this structure vertical continuity of the veins will be governed not only by the restricted depth to which fracturing can persist in this low semi-flowage horizon, but also by the contact-line of the subjacent igneous mass proper and by the intensity of erosion. Although the details of these factors are not known, appreciable depth-continuity is not indicated. Narrow and erratic widths and marked lenticular vein-structure, with marked lenticular development of the mineralization, are also indicated by these geological conditions.

The quartz veins cut the pegmatite and aplite dykes. Ore-development generally favours an intensification, either inherent or through absorption, of the more basic sections of the wall-rock. The veins probably occupy cooling or contraction fractures which were filled shortly after the consolidation of the batholith. The quartz and pyrite were probably the last products of gaseous and aqueous differentiation, generally related to the latest granitic effusion.

The mineral occurrence consists of two systems of quartz veins varying from ½ to about 18 inches in width, one striking north-easterly and dipping between 30° and 80° E., the other striking approximately northerly to slightly west of north and dipping from 50° to 80° E.

Mineralization consists of crystalline gold-bearing pyrite in isolated patches, scattered blebs and streaks, and some concentration lenses up to 34 feet in length. Exposed sections of the veins show an estimated pyrite mineralization of from 1 to 5 per cent. in patches, blebs, and streaks, and from about 10 to 75 per cent. in the concentration lenses or shoots. The sulphide mineralization generally favours a pronounced development of ferro-magnesian minerals, either through differentiation or absorption, of the wall-rock. The wall-rock is generally sericitized for a few

inches in the neighbourhood of ore-shoots. Metasomatic wall-rock replacement by sulphide minerals is practically absent and cannot be looked on as a source of ore. Gold values are restricted to the pyrite in the quartz veins. Some finely divided chalcopyrite is sometimes, though not always, intimately intermixed with the pyrite, but does not seem to have any effect on the gold contents of the sulphides. The quartz gangue of the veins is barren of commercial gold values, and these can only be expected where the veins carry pyritic sulphide mineralization.

The following is a list of assays from samples taken by the Resident Engineer:—

SUMMARY OF ASSAY DETERMINATIONS.

Hunter Group.

Location.	Width.	Sulphide.	Sp. Gr.	Au.	Ag.	Cu.
<i>Hunter Claim.</i>						
		Per Cent.		Oz. to Ton.	Oz. to Ton.	Per Cent.
500 ft. north of camp.....	1 in.	.....	.....	1.92	0.40	.....
500 ft. north of camp.....	4.5 in.	.....	.....	0.35	0.10	.....
No. 9 O.C. at river.....	2.5 in.	6.7	2.80	0.80	0.60	Trace
No. 3 cut, alt. 975 ft., dump.....	Vein in cut = 8 in.	10.0*	.....	1.48	0.70	<i>Nil</i>
No. 4 cut, alt. 980 ft., dump.....	Vein in cut = 3.5 in.	14.6	2.83	2.02	1.20	Trace
Vein crossing river, dump.....	Vein in cut = 5.5 in.	44.0	3.37	6.70	3.20	Trace
<i>Grizzley Claim.</i>						
200 ft. north of camp, elev. 885 ft.	11 in.	.....	.....	6.75	2.80	3.2
No. 1 creek, alt. 1,720 ft.....	1.40 ft.	7.7	2.78	0.28	0.40	Trace
<i>Bear Claim.</i>						
Branch vein, elev. 1,875 ft. from lens 6 ft. long	1.10 ft.	.....	.....	2.00	1.60	Trace
<i>Heather Claim.</i>						
Lower shoot, No. 2 creek (see blue-print)						
Elev. 2,350 ft.....	0.40 ft.	.....	.....	0.22	0.34	Trace
Elev. 2,352 ft.....	0.95 ft.	40.7	3.22	2.98	4.70	0.7
Elev. 2,355 ft.....	0.30 ft.	.....	.....	3.56	5.40	0.7
Elev. 2,360 ft.....	0.75 ft.†	41.4	3.33	6.16	9.50	<i>Nil</i>
Upper shoot, No. 2 creek (see blue-print)						
Elev. 2,365 ft.....	0.70 ft.	.....	.....	0.20	0.32	1.9
Elev. 2,367 ft.....	0.40 ft.	20.0	3.00	3.80	6.60	Trace
Elev. 2,370 ft.....	0.65 ft.	5.6	2.75	0.30	0.70	<i>Nil</i>
Elev. 2,375 ft.....	1.20 ft.	45.1	3.15	2.02	3.60	Trace
Elev. 2,380 ft.....	0.65 ft.	.....	.....	4.50	7.50	0.2
Elev. 2,382 ft.....	0.60 ft.	.....	.....	1.16	2.10	Trace
Elev. 2,387 ft.....	1.00 ft.	.....	.....	4.02	6.80	6.0
Elev. 2,393 ft.....	0.60 ft.	50.7	3.60	6.20	7.80	<i>Nil</i>
Elev. 2,400 ft.....	0.80 ft.†	.....	.....	6.28	9.50	<i>Nil</i>
<i>Cratg Claim.</i>						
Elev. 2,580 ft.....	0.50 ft.	15.0*	.....	1.40	2.40	<i>Nil</i>
Elev. 2,475 ft.....	0.70 ft.	25.0*	.....	2.16	.....	.....

* Estimated.

† Vein oxidized.

Exceptionally high gold values feature the pyrite, which will assay from about 3 to 19 oz. of gold to the ton of pure pyrite. There is, however, a wide variation of the gold contents of the pyrite and no definite ratio between the two. An admixture of chalcopyrite which is sometimes present shows no bearing on either the gold or silver contents of the ore. The ratio of gold content to the pyrite varies from 0.036 to 0.19 oz. gold to the ton per unit of sulphide.

Remarkable features characterize the gold-silver ratio. Whereas this seems fairly constant in individual veins and sections of these veins, there is a remarkable variation in this ratio in

accordance apparently with the location of the veins or sections of them. In general this seems to be dependent on the elevation of the occurrence, with a gold to silver ratio of from 1:1.5 and 1:1.8 at higher elevations, as compared to 1:0.5 and 0.6 for the lower elevation occurrences. It is interesting to note that in similar occurrences on Porcher island the ratio of gold to silver varies from 1:0.35 and 1:0.23. This phenomenon is probably related to the degree of absorption of roof-rocks associated with the locality of the occurrence in such a way that the high silver ratio may conform to localities or horizons of absent or depressed basic absorption towards or at the contact of the basal magma; and the low silver ratio at the localities or horizon of more intense basic roof-rock absorption or in the roof-absorption horizon proper. It may be possible that observation and gathering of further data relative to the gold-silver ratio may lead to a criterion of the horizon of deposition, intensity of erosion, and possible depth-continuity.

At least nine veins and stringers are exposed between altitudes 900 and 2,700 feet. With the exception of a few open-cuts, these have been traced by natural exposure for distances varying from about 40 to about 400 feet. In some cases, as in the main vein on "No. 2 creek," where exposures of vein occur along an approximately aligned strike for about 1,100 feet, appreciable gaps between the exposures preclude the definite correlation of the different exposures. Widths vary from a fraction of an inch to about 18 inches. Commercial aspects are indicated in several short ore-shoots up to about 32 feet long. The attitude, frequency, and continuity of ore-shoots will have to be determined by development.

The property is worthy of a limited expenditure on exploration in order to determine definitely the indicated potentiality at present of a small-tonnage high-grade operation that might be operated at a profit by a small syndicate or a few individuals exercising great economy and carefully conducted selective mining methods at a minimum cost of equipment installation.

This property of forty-seven Crown-granted claims is owned by syndicate **Western Copper** called the Western Copper Venture, of Vancouver. It is situated on the East **Venture.** fork of the Khutze river, about $4\frac{1}{2}$ miles from the head of Khutze inlet and about 100 miles south of Prince Rupert. The claims cover the area from the river-bed at altitude 200 feet to beyond the crest of the south-side ridge, about altitude 5,000 feet. It is reached by steamer service to Butedale and from thence 14 miles by launch to Khutze inlet. From the head of the inlet the lower or main camp is reached by a narrow-gauge railway covering a distance of $4\frac{1}{2}$ miles. The main or railway terminus camp is situated at elevation 200 feet, the so-called Tunnel camp at elevation 1,560 feet and the upper Operating camp at elevation 2,300 feet. The Operating camp is reached by a precipitous trail on the latter part of which thirty-seven ladders are necessary to traverse intervening bluffs and two suspension bridges to cross intervening canyons.

During former operations an aerial tramway with a capacity of 500 tons in twenty-four hours was constructed from the river camp to the Tunnel camp. A jig-back tram also extends between these two camps. The Tunnel camp and the Operating camp are also connected by a jig-back tram. Large bunk-houses, wash-house, dining-rooms, large store-houses, power-houses, blacksmith-shops, cabins, etc., have been constructed on the property and extensive power machinery installed. Much of the plant and machinery would have to be carefully overhauled for efficient utility.

The rocks of the locality consist of granodiorite of the Coast Range batholith, of Jurassic age. These rocks are intruded by numerous aplite and pegmatite dykes. Glacial erosion has been intense. The principal ore occurrence is a long, flatly dipping quartz vein, striking N. 70° E. and dipping from 20° to 30° S., which outcrops along the precipitous side of the mountain and traverses several steep canyon-draws. The country-rock is biotite granodiorite, in which major jointing is pronounced, striking N. 50° to 70° E. and dipping flatly south.

The vein is a replacement along a major joint-plane, along which some movement or shearing has taken place. Metasomatic replacement of the wall-rock is sometimes evident in a quartzose sericitization, but replacement by economic minerals is practically non-existent in the wall-rock. Excellent and accurate reports describing the ore occurrence are published in the Annual Reports for the years 1926, 1927, and 1928. From these a sound and clear appraisal of the potentialities of the property can be formed. The present detailed examination confirms the substance of these former departmental examinations, and it is deemed unnecessary to recapitulate the details of these reports.

The present examination shows the vein to vary in width from a mere crack or stringer to from 5 to 7 feet in a few places. In a few places lenses of copper and iron sulphides over

widths of from 6 to 18 inches of massive ore, and 4 to 5 feet of sparsely disseminated ore, occur over lengths from 20 to 40 feet, with extensive stretches of barren vein-matter or pinched vein between them. The present workings have exposed five such showings that can definitely be termed indicated ore-shoots, in the actual outcrop length of over 4,000 feet traversed, on both the east and west sides of the canyon. These indicated lenses occur at widely scattered spots from about the apex of the canyon and along its west side along an outcrop distance of about 1,300 feet. A sample across 2.4 feet of oxidized vein-matter, 11 feet east of the east end of the canyon, assayed: Gold, 0.12 oz. to the ton; silver, 0.16 oz. to the ton; copper, trace. Along the outcrop, and in the workings on the east side of the canyon for a distance of 300 feet, nothing of commercial importance from the aspect of tonnage is indicated.

At various places scattered streaks and patches of sulphides occur. Whereas high assays are obtained from selected samples taken in these localities, the aggregate is not sufficient to constitute tonnage from the aspect of commercial ore-shoots. They may, however, sometimes constitute pockets that might be profitably selectively mined in a small way. On the east side pyrite constitutes the chief mineral in the occurring patches and streaks, and generally contains good gold values; but whereas the mineralization is too scattered to be of commercial importance from the aspect of tonnage, some of these streaks may lead to small rich pockets. A sample of a streak of sulphide 1 inch wide on the hanging-wall and a width of 1 inch of oxides on the foot-wall of the quartz vein, 14 inches in width, on the north side of the old *Shannon* tunnel-drift, assayed: Gold, 7.06 oz. to the ton; silver, 2.2 oz. to the ton; copper, 2.6 per cent. A sample of the 14-inch vein-width with 1 inch of oxides on the foot-wall taken about 10 feet south of this assayed: Gold, 0.34 oz. to the ton; silver, 0.34 oz. to the ton; copper, *nil*. A sample of sulphide streaks showing in an old prospect-tunnel about 200 feet east of the old tent camp assayed: Gold, 1.36 oz. to the ton; silver, 0.6 oz. to the ton; copper, trace. On the west side, chalcopryite, some chalcocite and covellite occur in appreciable quantities with the pyrite, and constitute the chief ore in the small shoots, carrying also appreciable gold values. Generally, where the ore does occur, it is high grade.

The outcrop has been explored by numerous open-cuts and short tunnels. Underground exploration has been carried out by about 1,200 feet of drifting and crosscutting, 750 feet of shaft-sinking, and about 60 feet of raising. In the underground work only one probable ore-shoot of about 35 feet length, which, however, appears to carry high-grade ore, has been definitely indicated. This is in the raise and sub-level off the 350-foot level from the incline shaft. A sample across 2 feet of the sub-level south face assayed: Gold, 0.16 oz. to the ton; silver, 6.2 oz. to the ton; copper, 15.5 per cent. The underground exposures of the vein show the same extremely erratic conditions of width and mineralization as exposed in the surface exposures.

Should further work be carried out, it is suggested that where the incline shaft intersects the vein at about 75 feet below the 350-foot level the vein be drifted on in a south-westerly direction. This intersection shows 2.9 feet of mineralized vein. A sample across this width of 2.9 feet assayed: Gold, 0.32 oz. to the ton; silver, 10 oz. to the ton; copper, 1 per cent.

It may be possible that with the present installed transportation and mining facilities some profit might be won by a small leasing syndicate of a few individuals from the selective mining of the known ore-shoots and the discovery of other small high-grade ore-shoots that may occur in selected portions of the vein.

This property is described in former reports cited in the table. It was
Surf Point. formerly known as the *Trixie*, owned by Frank Patterson, of Porcher island, and some shipments of rich ore were made by the original owner during initial exploration. It is now being developed by the N. A. Timmins Corporation. During 1931 operations were continued until April, when they were closed down. Three trial scow-loads of ore were shipped to Anyox. These showed good values in gold, that would indicate a high milling-grade ore. During the year's operations a winze 20 feet deep was sunk off the second drift south of No. 1 tunnel and is reported to show good ore on the bottom. Work was also carried out on veins showing some good-grade ore in four raises from No. 1 and No. 3 tunnels. Late in the fall the property was examined by Alphonse Paré, of N. A. Timmins Corporation, and some thorough sampling carried out with a view to determining possible future development.

This property possesses possibilities for a selective-mining, small-tonnage, high-grade milling profitable operation if economically conducted with minimum stope-widths and a minimum outlay on overhead, machinery and equipment installation. On the adjoining properties, such

as the *Eddy Pass*, *I.X.L.*, and *Eagle*, similar possibilities are indicated. On the *Copper Coin*, about 1 mile south, an interesting diamond-drilling exploration proposition is indicated to determine a possible gold-bearing content of the mineralized shear-zone as it passes from the schist, in which it outcrops, to the underlying quartz diorite. Intensive prospecting of Porcher island for high-grade gold-bearing veins is also well warranted.

PORTLAND CANAL MINING DIVISION.

This property is described in former reports cited in the tabulated summary, **Georgia River Gold Mines, Ltd.** and more recently in those for the years 1928, 1929, and 1930. During 1931 operations were resumed on September 23rd with a crew of seven men and were suspended on November 12th. Work was concentrated on the extension of the *Bullion* tunnel (elevation 3,350 feet) with the objective of intersecting the south-west vein showing in the upper tunnel (elevation 3,665 feet) near its possible junction with the main or "Georgia" vein. It is estimated that about 80 feet further crosscutting should reach the objective. A crosscut was also commenced in No. 3 tunnel (elevation 3,179 feet), south of the raise connecting this tunnel with the *Bullion* tunnel, to explore the possibilities of the country towards the possible extension of the "Georgia" vein east of the present workings.

In the work completed since that described in the 1929 Annual Report, No. 3 tunnel has been continued over to the *Bullion* vein on this horizon and extended about 900 feet in a north-easterly direction and connected with the *Bullion* tunnel by a raise to the *Bullion* tunnel winze from a point about 80 feet south of No. 3 tunnel-face. The *Bullion* tunnel has been advanced about 300 feet, gradually turning west to get below the upper tunnel. In this work the drift on the *Bullion* vein on No. 3 level shows a well-defined shear-structure of varying but appreciable width carrying quartz lenses and stringers, with some pyrrhotite, pyrite, and occasionally sphalerite, in a black to brownish arenaceous argillite. Although this does not show the type of ore generally associated with high-grade values in this deposit, the structure should be systematically sampled to determine the possibility of shoots of mill grade. A crosscut to the west from No. 3 tunnel under the surface cuts in the south-west vein, and also one to the east, failed to pick up the vertical extension of this vein. In the face of No. 3 tunnel a pronounced transverse shear-structure striking N. 35° W. (mag.) intersects with the *Bullion* structure at an angle of 15°. At the intersection pronounced crushing and dragged quartz is evident, suggesting a possible dragging or partial dislocation of the *Bullion* vein north of No. 3 tunnel-face. This may possibly be correlated with similar evidence in the raise and winze connecting No. 3 tunnel with the *Bullion* tunnel, 80 feet south of No. 3 tunnel-face. Constructive information could be derived by extending the No. 3 tunnel-drift on the *Bullion* structure. This would not only explore this area and the possible extension of the *Bullion* structure on this horizon, but would also give about 170 feet additional back on the *Bullion* vein. It is also suggested that useful information with regard to possible mill-grade values could be derived from a systematically spaced sampling of the exposed vein-structures in the No. 3 and *Bullion* tunnels and also in the connecting raise. As the future of this property is dependent on a sufficient tonnage of mill-grade ore which might be found to occur in short shoots in the vein-structures, such information is of vital importance.

This property, also known as the Buena Vista Mining Company, which is **Big Missouri.** being intensively explored and developed by the Consolidated Mining and Smelting Company of Canada, has been described in detail in former reports cited in the table. Exploration has consisted of diamond-drilling, crosscutting, drifting, and, during 1931, sampling by means of a 100-ton mill erected on the ground, for the purpose of determining possible commercial aspects of gold values erratically distributed in the quartz stringers and quartzose replacement of a quartz replacement zone in andesitic tuffs and flows.

During 1931 the mill-sampling exploration constituted the most important work. For this purpose crosscuts and drifts were excavated in drilled areas that showed encouraging values. In the most promising sections wide stope-sills were breast-stopped to a height of about 16 feet and mill-runs were carefully tabulated to correspond with mine localities. Important geological work was also carried out. Exploratory mining and test-milling was continued to about the middle of September with a crew of sixty-five men, when it was suspended to resume further diamond-drilling for the purpose of exploring for possible continuity of sections of possible commercial-grade ore indicated. No possibility that may lead to the development of either a large-tonnage low-grade or a medium-tonnage medium-grade gold-producer is being overlooked.

This property, described in the 1920 Annual Report, was optioned by the **Salmon Gold**. Premier Gold Mining Company in the late fall of 1931. Exploration by means of twelve short diamond-drill holes with a portable equipment, some open-cutting and stripping was carried out. Results of this work did not meet the requirements of the Premier Company and at its completion the option was relinquished. The year's work resulted in extension of surface continuity of the known zones and in the discovery of additional zones showing good gold values. Five open-cuts on the main zone, eight on No. 3 vein, and seven on No. 1 vein showed an average of very encouraging gold values over appreciable lengths and widths. Diamond-drilling, although showing some encouraging gold values across encouraging widths, especially in No. 1 vein, did not hold up to the average values indicated by surface sampling. The drilling was conducted at practically one horizon, the longest hole being flat and about 72 feet in length. None of the veins have so far been explored at any appreciable depth below surface.

ATLIN MINING DIVISION.

RAINY HOLLOW SECTION.

This property, formerly known as the *Stampede*, is owned by William Bunting, of Vancouver. It comprises the *Gold Cord* Nos. 1 to 8 and the *Yellow Jacket* mineral claims. It is situated in what is known as the Rainy Hollow section, in the extreme north-westerly corner of British Columbia. The ore occurrence has been well described in the 1927 Annual Report.

The property is reached from Haines, Alaska, by 42 miles of automobile-road up the Chilkat and Klehini rivers to Pleasant camp, at elevation 850 feet on the boundary. At Pleasant camp the Klehini river is crossed by a cable-tram, from where there is a good pack-horse trail for 3 miles to the half-way camp-site at elevation 1,700 feet. From this point the trough of Stampede creek is followed, and a glacier at its head is crossed to the top of the divide at altitude 4,600 feet to the Jarvis Glacier trough. The southerly slope of the divide to the Jarvis glacier is then descended to 4,400 feet, where the camp is located. At the time of examination (August 14th, 1931) snow completely covered this route from the half-way at altitude 1,700 feet to the camp. This is, however, an exceptional condition.

It has been suggested that the property could be more easily reached from the Klehini by a trail following the Jarvis Glacier slope. This terrain is, however, very precipitous and unstable and great expense would be entailed in trail construction and upkeep. The camp consists of a stone-walled, tarpaulin-roofed cabin. There is no available timber on the Jarvis Glacier slope, the nearest being on the slope to the Klehini, at about altitude 1,500 feet. With the exception of a small amount of wood that is packed up to the camp, gasoline is used for fuel.

The rocks comprising the area consist of a dioritic rock, intrusive into limestones and ferruginous argillite that are probably of Triassic age. Basic dykes satellitic to the diorite also intrude the overlying sedimentaries. On the north slope of the Jarvis glacier the intrusive contact plunges steeply south under a roof of sedimentaries, which quickly increases in thickness to form the outstanding mass and peaks of Mount Leland, altitude 7,434 feet. Towards the north several small segments of inclusions and pendant sedimentaries occur.

During 1928-29, the property, then known as the *Stampede* group, was under option to the Alaska-Juneau Gold Mining Company, which carried out extensive exploratory work in the form of stripping, open-cutting, and shaft-sinking on the main vein system. The option was dropped at the completion of this work. Since that time the present owner has carried out further prospecting, and has discovered several small quartz veins on the *Yellow Jacket* claim, at a lower altitude from the main vein. These outcrop in a thin layer of limestone which roofs the diorite at this horizon and strike and dip towards the main vein. At the time of examination the main vein system was deeply buried in snow and could not be seen. For a description of this readers are referred to the 1927 Annual Report.

The exploratory work of the Alaska-Juneau Gold Mining Company indicates generally low-grade and erratic gold values over erratic widths in the open-cuts, and the same condition in the shafts. An occasional but erratic high gold assay can be obtained at surface in the oxidized material. Widths vary from 0.1 to from 2 to 5 feet. Values vary from 10 cents to from \$2 to \$15, with an occasional high erratic assay.

The shaft-work gives some criterion of widths and values, and the following is a condensed analysis of the results obtained:—

Shaft No. 25, sunk to depth of 16 feet, showed widths averaging 0.56 foot, and gold assays to the ton of \$295.61 at surface, \$1.86 at 10 feet down, and 62 cents at 16 feet down.

Shaft No. 26, sunk to a depth of 22 feet, showed an average width of 0.95 foot, averaging about \$5.37 in gold to the ton.

Shaft No. 27, sunk to a depth of 14 feet, showed an average width of 0.87 foot, averaging about \$4.20 in gold to the ton.

Shaft No. 21, sunk to a depth of 20 feet, showed an average width of 1.6 feet, averaging about 50 cents in gold to the ton, with the vein pinching out to a gouge-streak at the bottom.

Shaft No. 12, sunk to a depth of 8 feet, showed an average width of 1.3 feet, and gold per ton assays of \$2.48 at surface, \$19.85 at 5 feet down, and \$3.72 at 8 feet down.

Average widths and proportionate average values of Alaska-Juneau samples taken at intervals at 5 feet in the two main shafts, the *Alta* and *Eldorado*, sunk to depths of 40 and 74 feet respectively, adequately demonstrate the widths and values characteristic of the mineral occurrence.

Alta Shaft; Depth, 40 Feet.—West wall: Average width, 1.6 feet, averaging \$4.30 in gold to the ton. East wall: Average width, 1.9 feet, averaging \$8.07 in gold to the ton.

Alta shaft averages: Width, 1.12 feet; \$6.62 in gold to the ton.

Eldorado Shaft; Depth, 74 Feet.—West wall: Average width, 1.7 feet, averaging \$4.60 in gold to the ton. East wall: Average width, 1.9 feet, averaging \$3.32 in gold to the ton.

Eldorado shaft averages: Width, 1.8 feet; \$3.87 in gold to the ton.

This Alaska-Juneau Gold Mining Company exploratory work embraced thirty open-cuts and seven shafts.

Since this work was completed, the owner, William Bunting, has spent the seasons of 1930 and 1931 in carrying out some stripping and open-cutting on the several oblique veins outcropping in the limestone between altitude 4,100 and 4,600 feet, over a distance of about 2,000 feet. At the time of examination a crew of three men was engaged on this work. There are about fifteen or sixteen of these veins varying in width from 6 to 18 inches. They strike between north and north-westerly and dip at between 30° and 70° into the hill. The veins consist of white quartz with very sparse sulphide mineralization consisting of an occasional patch or bleb of pyrrhotite and rare grains of chalcopryite. The veins are generally appreciable distances apart. Low gold values up to \$1.20 are claimed by the owners to occur in these veins. Before the close of the 1931 season the owner reported the discovery of additional subsidiary veins of fairly appreciable width.

TAKU RIVER SECTION.

The ore occurrence on these claims is described in the Summary Report, 1930, **Whitewater.** Part A, G.S.C., the 1929 and 1930 Annual Reports, and in Bulletin No. 1, 1930. During the 1931 season this group and the adjoining *Silver King*, *Blue Bird*, *Motherlode*, and *Silver Queen* groups were optioned by the N. A. Timmins Corporation, of Montreal. About mid-season energetic preliminary exploration by diamond-drilling, trenching, open-cutting, and stripping was commenced and continued until late in December, when weather conditions necessitated closing for the winter.

Besides the original showings described in former reports, several other similar zones carrying good gold values across appreciable widths on the surface have been discovered. Five diamond-drill holes in the area of the original *Whitewater* showings have given encouraging results. The drill was then moved to the vicinity of additional showings discovered about 300 feet southerly and five holes drilled in this area. During this drilling surface-trenching had uncovered mineralized zones about 500 feet south-westerly, and drilling was commenced in this area with hole No. 11. Other drilling has been completed subsequent to hole No. 11.

Details regarding values determined in this initial diamond-drilling exploration are not yet available, but it is understood that encouraging results have been achieved. Dependent on the results of this preliminary exploration, extended exploratory operations are planned for the 1932 season.

The gold in this deposit or an appreciable proportion of it is probably in a very finely divided free state, accompanied by a dissemination of very fine acicular crystals of mispickel with a trace of antimony and bismuth, and also finely disseminated pyrite and some stibnite. It is interesting to note that the massive stibnite characterizing some of the surface outcrops

diminishes markedly with depth. It is also remarkable that high gold values seem to be restricted to the presence of the small acicular mispickel crystals which have so far persisted in the depth sections intersected by diamond-drilling. This phenomenon would suggest possibilities for gold values at depth in several shear-zones carrying massive stibnite-outcrops, but with no gold values, which occur in this area, and indicates that such shear-zones may warrant diamond-drilling. A peculiar characteristic of all these zones, whether gold-bearing on surface or not, is the presence of a greenish insoluble silicate coloured by nickel and chromium.

These groups, comprising twenty claims owned by R. G. Wilms and associated, of Tulsequah, are situated about 2 miles south-westerly of the **Mineral Mountain**, **Silver Bird**, **Whitewater** group. They are located on the north side of the North fork of Canyon creek, which flows into the Tulsequah river near its confluence with the Taku river. Late in the 1931 season discoveries of ore similar to that occurring on the *Whitewater* were made on the *Silver Bird* No. 5 claim. Samples of these ores submitted by the owner to the Resident Engineer for examination assayed:—

- (1.) Gold, 1.1 oz. to the ton; silver, 0.3 oz. to the ton; arsenic, 11.3 per cent.
- (2.) Gold, 0.42 oz. to the ton; silver, 0.4 oz. to the ton; arsenic, 3.4 per cent.

Late in the season these groups were optioned by the Alaska-Juneau Gold Mining Company, and stripping operations commenced which will be continued in the 1932 season.

NORTH-EASTERN MINERAL SURVEY DISTRICT (No. 2).

REPORT BY DOUGLAS LAY, RESIDENT MINING ENGINEER (HEADQUARTERS, HAZELTON).

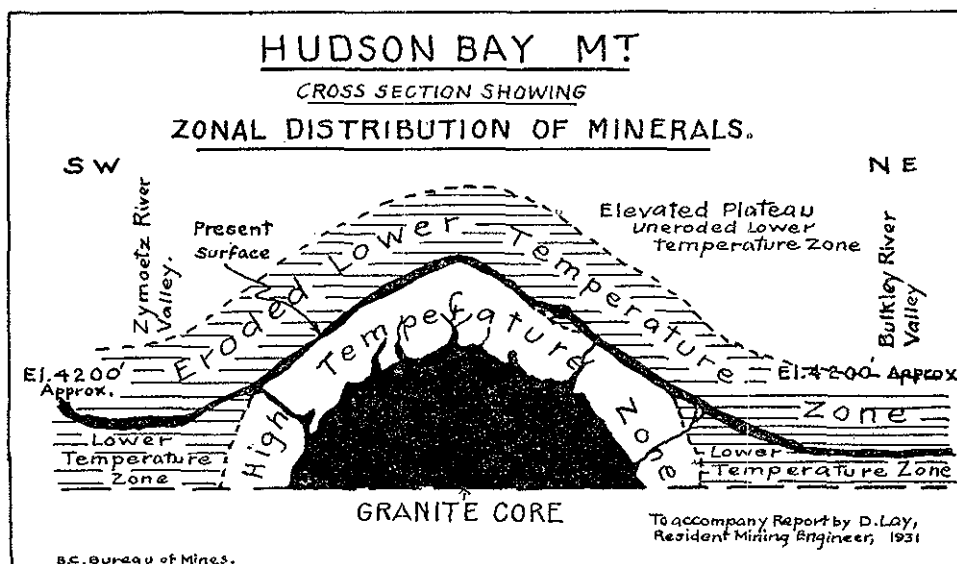
INTRODUCTORY GEOLOGIC DISCUSSION.

Although this report deals only with lode-gold occurrences, which in many instances are controlled or affected by local geologic features subsequently discussed in detail, it is important to keep the master-features of the economic geology of the district as a whole well in mind. Each year brings some additional information, and whereas hitherto it has been possible to distinguish only two parallel batholiths crossing the district in a north-westerly and south-easterly direction—namely, the Coast Range batholith and the south-eastern portion of the Cassiar-Omineca batholith (sometimes referred to as the Omineca batholith)—it is now readily possible to discern a third batholith, situated between and parallel to these two, which will be referred to as the Central batholith. In the south-western portion of the district is the Coast Range batholith with its satellites. The orogenic forces in operation at the time of formation of the Coast range would seem to have been, in effect at any rate, such as to create an immense wave in the batholithic magma travelling from west to east. It is therefore entirely reasonable to suppose that similar and parallel lesser waves would be caused in the magma at points east of that at which the orogenic forces exerted their maximum effect, and, presumably the Central and Cassiar-Omineca batholiths are manifestations of such lesser waves. Distant about 175 miles from the Coast Range batholith, the Cassiar-Omineca batholith, parallel to the latter, crosses the district. It appears first at the headwaters of the Finlay and Ingenika rivers, and by Thutade lake, outcrops extensively east and south of the Omineca river, continues in a south-easterly direction between the Manson and Nation rivers, and outcrops on Mount Milligan west of Rainbow creek.

So far as is known at present, the north-western extremity of the Central batholith is to be found on both shores of the North-west arm of Takla lake, about 4 miles from the head of the arm. The south-eastern extremity in this district is to be found in the region of Boss mountain, in the Quesnel Mining Division. The outcrop in this region covers several hundred square miles and extends without the confines of the district, and has been locally named the "Boss Mountain" batholith, but the regularity with which granitic rocks of Jura-Cretaceous age outcrop, and the size of some of the outcrops, at intermediate points between the north-western and south-eastern extremities mentioned, strongly suggest a continuous batholith. Outcrops intermediate between the extremities mentioned are: At the south end of Babine lake (extensive); south of Fraser lake and in the vicinity of the west end of Francois lake (extensive outcrops); the extensive

granitic outcrops in the vicinity of Sinkut mountain south of Vanderhoof are quite possibly portion of this batholith, although the age has not been positively identified; on Hixon creek, and west of the Fraser river in this region; east of the Fraser river in the neighbourhood of Marguerite, and in the vicinity of Bunting lake (where a large acid dyke is quite possibly a tongue of this batholith).

The Coast Range batholith is of Jura-Cretaceous age extending into Tertiary, and it is probable that to it the other batholiths mentioned are satellitic. It should be understood that while the Coast Range batholith forms a definite mountain range continuous for many hundreds of miles, such is not the case with the other batholiths, portions of which are quite inconspicuous features of the topography. Their course is, however, very plainly indicated by the detached outcrops of granitic rocks of contemporaneous age which are distributed along a definite direction. Many outlying satellites of these batholiths are known to occur; for example, the igneous cores of Rocher Déboulé and of Hudson Bay mountains are satellites of the Coast Range batholith; and the granitic intrusive west of the North arm of Quesnel lake is a satellite in all probability of the Central batholith. Doubtless many satellites remain to be discovered with which mineral occurrences will be found to be associated, but it is the batholiths which are the master-mineralizers of the entire region west of the Rocky Mountain trench. And it is the



aureoles of these batholiths that offer the most attractive field to the prospector, by whom their location and significance should be closely studied. All lode-mineral occurrence within the region west of the Rocky Mountain trench, with one important exception, is to be assigned to the mineralizing influence of these batholiths. The important exception mentioned is the lode-gold occurrence in the Barkerville and more immediately surrounding area, which is a very much older mineralization, assigned to a pre-Mississippian age by the Geological Survey of Canada, and which presumably is due to a concealed unroofed batholith, the presence of which is inferred from the occurrence of numerous dykes and sills and from the mineralization itself.

As to that portion of this district which lies to the east of the Rocky Mountain trench, comprising merely a small strip of the Omineca Mining Division, a portion of the Cariboo Mining Division, and the whole of the Peace River Mining Division: Whatever igneous intrusions accompanied the Eocene Laramide revolution, when the Rocky Mountain range was formed, so far as is now known, have not been unroofed in this district. The presence of deep-seated concealed intrusions is, however, suggested by the fact that mineralization of importance is known to occur east of the Finlay river, at the Wedge group on Pesika (Wedge) creek. Less important mineralization occurs at other points east of the Finlay river. Generally speaking, however, the region east of the Rocky Mountain trench, even in the immediate vicinity of the Rocky

mountains, is of altogether subordinate importance, from the lode-mineral standpoint, to that west of the Rocky Mountain trench. The geology of the portion east of the Rocky mountains is that of the Great Plains, wherein lode-mineral promise is not indicated.

From the foregoing description it will be apparent that, inasmuch as this district is crossed from practically north-western extremity to south-eastern extremity by three parallel batholiths, a widespread distribution of mineralization and diversification of types is indicated.

A feature of the eastern contact-zone of the Coast Range batholith, as is well known, is the general prevalence of silver-lead-zinc mineralization, save in the immediate vicinity of the batholith or its satellites; but it is to be borne in mind that this condition, being dependent upon temperature conditions and the wholly fortuitous factor of surface erosion, will not necessarily prevail in the aureoles of the other batholiths.

Gold-quartz veins are associated with comparatively high-temperature conditions; consequently they should be sought in the immediate vicinity of the batholith or their satellites. There is hardly one example of a quartz vein showing promising gold values in this district that is unaccompanied by some prominent granitic intrusion in the immediate vicinity. While attention is drawn in the body of this report to all areas of known importance in which lode gold has been found, it should be understood that there are many other points in the aureoles of the batholiths, as yet undiscovered, where the possibility of its presence is indicated from general geologic considerations. For example, there is evidence of quartz veins at the south end of Babine lake and south of Fraser lake. Further prospecting in these regions may disclose quartz veins with promising gold values. It is quite evident that in mountainous regions the zonal distribution of minerals, coupled with surface erosion, are factors which should be closely studied in connection with lode-gold deposits, and detailed reference to this will be found under "*Mamie*" in this report.

MODES OF OCCURRENCE OF LODE GOLD.

The following different modes of occurrence of lode gold are exemplified in this district:—

(1.) In quartz veins—a mode of occurrence which is likely to prove by far the most important.

(2.) In certain high-temperature veins, dependent upon local geology, on Rocher Déboulé and Hudson Bay mountains, in which gold seems likely to be the chief constituent value. Examples are: *Hazleton View* (Aurimont Mines, Limited), on Rocher Déboulé mountain; *Mamie, Victory* (upper portion of vein system only), and *Last Chance* and *Silver King* claims ("Matus property"), on Hudson Bay mountain.

(3.) In acid igneous tongues, in association with tetradymite (telluride of bismuth), at the *Glacier Gulch*, Hudson Bay mountain.

(4.) In the form of disseminated free gold in country-rock. On the *Cayenne* group, Hixon creek, there is some evidence of such a mode of occurrence, but careful investigation is required to determine the matter more fully, likewise commercial possibilities. A dissemination of slightly auriferous sulphides, which seems to have originated a placer-gold deposit, occurs in the "porphyry dyke" at Bob creek, near Houston, on the *Horseshoe* group. A description of this property will be found in the Annual Report for 1928, page 172, and also in the Summary Report, G.S.C., 1929, Part A, page 93 A.

(5.) In the form of fossil placers (auriferous alluvials consolidated to form rock). Of this class the *Tertiary* mine on the Fraser river (see "Placer-mining in British Columbia," Bulletin No. 1, 1931) is an example, but inasmuch as by using a moderately high explosive the gold contents are freed, and so rendered recoverable in a sluice-flume, this property is classified as a placer-gold property. Another example is "Hobson's Horsefly" mine, near Horsefly, where a stamp-mill was erected to treat the ore, but it is to be noted that in this instance it is quite possible that the cementing of the gravels is only local. A full description of this property as a placer mine will be contained in the forthcoming Annual Report for 1931. The Cretaceous conglomerates exposed at Takla lake (see 1929 Annual Report, pages 186 and 187) probably represent an ancient river-channel. Sampling over considerable widths indicates that these beds are only slightly auriferous. Detailed sampling might possibly disclose pay-streaks. The quartzite-beds and quartz veins therein on Mount Selwyn, in the Peace River Mining Division, have aroused attention in the past (see 1928 Annual Report, pages 186 and 187). The gold present is quite possibly of alluvial origin, but there is no evidence that it occurs to a commercial extent.

AREAL DISTRIBUTION OF QUARTZ VEINS.

Of the last four mentioned modes of occurrence it will be appreciated that no broad areal classification can be given inasmuch as they are due to purely *local* causes. The areal distribution of quartz veins, so far as is known at present, is as follows:—

(1.) In the placer-gold sections proper of the Cariboo, Quesnel, and Omineca Mining Divisions.

(2.) Within a belt of country extending westwards from the headwaters of the Telkwa river to and across the Skeena river, and approximately bounded on the south by the Zymoetz river, and extending north probably as far as Pacific.

(3.) The region north of Pacific immediately west of the Skeena river included by the drainage areas of Fiddler, Lorne, Porcupine, and Mosquito creeks.

(4.) In other smaller areas, of which the most important is Dome mountain, near Telkwa (see Annual Reports for the years 1918, 1922, 1923, and 1924). Slightly auriferous quartz veins are also known to occur on Sibola mountain (see page 153, Annual Report for 1927); in parts of the Cariboo Mining Division outside the placer-gold belt at the south end of Babine lake; and just south of Fraser lake.

REVIEW OF AREAS; SCOPE FOR PROSPECTING.

(1.) THE PLACER-GOLD SECTIONS PROPER OF THE CARIBOO, QUESNEL, AND OMINECA MINING DIVISIONS.

Although placer-gold deposits are not necessarily indications of commercial lode-gold deposits in the same region, still lode gold and placer gold are in large measure interdependent; that is to say, inasmuch as the ultimate source of the latter is the former, the most natural place for the prospector to look for lode gold is in a region where important placer deposits have been found. It is, however, necessary to bear several things in mind. In the first place, it should be understood that by "placer sections proper" is meant those sections in which there is definite evidence that the placer deposits are of local origin; the obvious indications of such being the occurrence of coarse placer gold in and on true bed-rock and the presence of some quartz veins in the region. Again, the existence of an important placer area indicates one which has been subjected to prolonged pre-Glacial surface erosion. Consequently those portions of the veins which remain may contain mere traces of gold, and may be mineralized with sulphides of lead and copper, to the values of which those of gold are subordinate, or the veins may be entirely barren. Even in a comparatively rich placer section all creeks are not equally rich. This may be due partly to the fact that local alpine glaciation has wholly or partly removed placer deposits originally formed, or to the fact that the richest quartz veins follow a certain belt or belts. It would, at any rate, seem advisable in the absence of any good surface outcrop to prospect and investigate first the veins in the immediate vicinity of creeks yielding the best placer gold.

As a general rule, veins which cross the formation would seem to be of greater commercial importance than those which strike with the bedding-planes of the enclosing country-rock, except where the latter are crossed by veins of the former class, as was pointed out originally by the late W. L. Uglow. As is well known, quartz veins which contain any material amount of pyrite generally show rusty, iron-stained outcrops. Not infrequently, however, it is observed that the outcrop of such veins shows a barren snow-white appearance, and a few feet below the surface the vein is heavily stained. This phenomenon is probably due to reducing and decolorizing agents present in atmospheric waters. A barren outcrop does not therefore necessarily indicate a barren vein.

In the sections of the report which follow, attention is more particularly drawn to certain areas which appear to offer promise, and undoubtedly there is ample scope for prospecting. At the same time, it should be clearly understood that in certain localities—for example, in the Barkerville area and at other points—prospecting and underground development have already afforded definite evidence of commercial possibilities. Several properties justify intelligent development on a scale which is quite beyond the means of the prospector and which he cannot be expected to undertake.

Omineca Mining Division.

The placer section proper of the Omineca Mining Division is the Manson section. This may be defined as a strip of country about 55 miles in length and 15 miles in width, extending

in an east-and-west direction immediately south of the Omineca river, which forms the northern boundary. This area extends from Boulder creek on the east to Quartz creek on the west, and includes Germansen and Manson rivers and their tributaries in its eastern confines, and Silver creek and tributaries, and also Quartz creek (a tributary of the Fall river which flows into the Omineca river), in its western confines. Full accounts of the routes into this section will be found in the Annual Reports for 1924 and 1927. To better improve transportation facilities, a wagon-road is now in process of construction from the end of the motor-road 27 miles north of Fort St. James to the Nation river.

This strip of country immediately adjoins the eastern flank of the Cassiar-Omineca batholith, and prominent geologic features are the extensive outcrops of granitic rock which occur immediately north of the Omineca river at the western extremity and immediately south of the eastern extremity, both north and south of the Manson river. Within the area mentioned schistose sedimentary and volcanic rocks of Carboniferous age are of universal distribution. These are seen to be intruded at various points by various differentiate phases of granitic rock. It is therefore to be inferred that to the intrusives mentioned is to be assigned the mineralization in the numerous quartz veins, both large and small, which outcrop on every placer creek of importance at a great many different points.

It is to be noted that in the Manson section important occurrences of placer are confined to two comparatively small areas lying at the eastern and western extremities, and which may respectively be described as the Germansen and Manson River subsection and the Tom and Quartz Creek subsection. No important discovery of placer has yet been made east of Silver creek and between that creek and the Germansen river. This does not necessarily signify that this region is devoid of quartz veins. It may mean that any placer deposits therein have been eroded by glaciation, in which case prospects for lode gold should be as good as at other points. On the other hand, the absence of placer may signify the absence of auriferous quartz veins, and it would seem advisable first to prospect those regions of placer importance.

The typical quartz veins of the section vary in size from a few inches to many feet in width. Some strike more or less parallel to the bedding-planes of the enclosing country-rock; others cross the latter and seem to be just as large. The largest veins are developed on Boulder creek; where at one point a width of 75 feet of practically continuous quartz is exposed, made up apparently of three large individual veins with intervening bands of country-rock.

Mineralization observed is chiefly pyrite, pyrrhotite, galena, zinc-blende, and chalcopyrite, although all these minerals were not seen in every vein. Veins on Lost and Boulder creeks and on Blackjack mountain show a noticeable amount of galena.

Veins of another type occur on the Germansen river, on the *Mother Lode* and *P.E.M.* groups of the Germansen Development Syndicate; these seem to be localized by quartz-feldspar sills, and to be of the gash-vein type and to occur in certain altered zones.

Samples taken from a number of typical veins from creeks in various parts of the section, both by J. D. Galloway, Resident Engineer, in 1924, and by the present Resident Engineer in the years 1927 and 1931, unfortunately did not disclose commercial gold values. In fact, assays demonstrated that from the practical standpoint the typical veins are of either the silver-lead or silver-lead-zinc class. The most promising appears to be the vein system of the *Black Hawk* group (property of Germansen Development Syndicate), which shows by far the highest silver ratio. Good silver values were noted in pyrrhotite at this property, a somewhat unusual silver association. The type of quartz vein on the *Mother Lode* and *P.E.M.* groups, referred to above, showed encouraging gold and silver values, but falls in the gold-silver-copper class.

While no positive evidence of commercial gold values has been obtained from the typical quartz veins to date, that is quite possibly due to lack of thorough prospecting, and such would seem to be justified by the fact that the surrounding geologic features are entirely favourable. Valuable discoveries may be made even although they do not fall within the lode-gold class.

Cariboo and Quesnel Mining Divisions.

Viewing these Mining Divisions as a whole, it is possible to discern within them evidence of three distinct comparatively narrow belts, in which are contained the richest occurrences of placer gold. While there are many other quartz veins and placer occurrences without these belts, such occurrences are less rich. Without in any way disregarding the possible effect of glacial erosion on placer deposits, it is a reasonable assumption that the veins within these belts, which furnish the placer gold, are richer than those without. It is therefore logical to

investigate such veins first. These belts are approximately parallel and have a north-westerly and south-easterly trend, and are the following:—

Belt No. 1.—This may perhaps best be termed the "Barkerville belt" and is the most northerly. It extends with remarkable continuity from somewhat north of Island mountain to Cunningham creek. Included in it are the *Aurum* group (owned by C. J. Seymour Baker, of Barkerville) on Island mountain (formerly the property of Island Mountain Mining and Milling Company); the property of Cariboo Gold Quartz Mining Company, Limited, on Cow mountain; *Myrtle* group (owned by E. E. Armstrong, of Barkerville) and adjoining claims on Barkerville mountain; *Black Jack* group (owned by F. J. Tregillus and T. A. Blair); *Proserpine* group (owned by C. J. Seymour Baker, of Barkerville), *Kitchener* group (owned by F. J. Tregillus and T. A. Blair, of Barkerville), and *Independence* group (owned by A. E. Armstrong, of Barkerville), all on Proserpine mountain; and the *Hudson* group (owned by the late I. E. Moore and F. M. Wells, of Barkerville) on Cunningham creek. Repetition of good gold values occurs for a length of about 25 miles.

Belt No. 2.—This may be termed the "Hixon Creek-Stanley-Yanks Peak belt." There would seem to be a break in this belt between Amador mountain and Yanks peak, but the country north-west of Stanley as far as Hixon creek is well worth close prospecting. Within this belt occur the property of Quesnel Quartz Mining Company on Hixon creek (under option to Cariboo Lode Mines, Limited), on which a stamp-mill was erected in the late sixties or early seventies; the *Cayenne* group on Hixon creek (owned by E. Hann and J. Strbac, of Hixon); the *Perkins* group (owned by Clarence Fuller and associates, of Quesnel) on Burns mountain, Stanley; *Yanks Peak* group (owned by H. Talbot and J. Larson, of Keithley); *Midas* group (owned by O. J. Pickering and J. Glover and associates, of Keithley); and *Jane* group (owned by R. Reinhold, of Keithley), all situated on Yanks peak.

Belt No. 3.—The Likely-Horsefly belt includes Black Bear creek, Cedar creek, and the headwaters of the Horsefly river. The lode-gold possibilities of this belt have received but little attention, but from what is known of the quartz veins at the headwaters of the South fork of the Horsefly river, and the Crooked river, and the mineralizing agency there evident, the south-eastern extremity of this belt is marked down as a promising region fully justifying close prospecting. Prospecting north-west of Likely would also seem warranted.

It is not suggested that there is evidence of an uninterrupted continuation of the richer quartz veins within these belts, but rather that the better veins are likely to be found at intervals within these belts rather than without them. Evidence of repetition is very marked in the case of belt No. 1.

It seems of particular importance to bear in mind, in connection with the gold-quartz veins of the Cariboo and Quesnel Mining Divisions, that it was the high values in the outcrops of certain of the veins which attracted attention in the very earliest days, and led to those operations which were the earliest attempts in lode-mining and milling in the history of the Province. The earliest operators, therefore, had something tangible in the form of rich outcrops to commence with, which after all is the pith and marrow of justification for the initiation of any lode-mineral enterprise. It seems quite likely that those early attempts would have been carried much further had it not been for the milling difficulties encountered, with which the milling knowledge of that day could not successfully cope, but which do not seem likely to cause trouble to operators of the present time.

The presence of known intrusives, with which the mineralization of the veins at various points is in all probability genetically associated, will be indicated in the text following. It is, however, evident that inasmuch as mineralizing agencies differ materially at different points, it is unsafe to assume that features of mineralization rendered evident by development at one point will be found characteristic of all points of the areas under review. But from recent development at the property of the Cariboo Gold Quartz Mining Company, Limited, evidence has been obtained which permits of certain generalizations which apply not only to that property, but also to a large portion of belt No. 1, and quite possibly to portions of belt No. 2. It has also, as a result of that development, been rendered evident that existing views concerning the Barkerville area vein system must be modified in the light of recent development.

Much useful work has been accomplished by local prospectors, notably by

Belt No. 1. E. E. Armstrong, the late A. W. Sanders, F. J. Tregillus, and T. A. Blair, in **Barkerville Belt.** bringing to light facts which indicate the continuity of this belt. A detailed account of the geology will be found in "Placer and Vein Gold Deposits of

Barkerville, Cariboo District, British Columbia," by W. A. Johnston and W. L. Uglow, Memoir 149 of the Geological Survey of Canada.

From the foregoing it will be noted that all the veins of belt No. 1 occur in pre-Cambrian rocks, which are intruded at a number of different points in the vicinity of Barkerville by acid igneous tongues of the quartz-feldspar type originating from an assumed underlying and deep-seated batholith, which has not been unroofed by erosion at any point, but to the emanations from which the mineralization in the veins is due. The age of the mineralization is ancient and is by the authors of the above-mentioned memoir classified as evidently pre-Mississippian.

As is well known, acid dykes represent the end phases of batholithic activity and originate from the uppermost portion of the batholithic magma. Inasmuch as there is no evidence of basic dykes within the area under review, the inference is that the plane of surface erosion is parallel to the roof of the batholith and normal to the vertical axis of the latter. That being the case, the veins within the area intruded by the acid igneous tongues mentioned will be all more or less of the same temperature class at any given horizon. Further, inasmuch as the veins in the area are directly over the roof of the batholith, they are in the most favourable position for mineralization—a fact which may account for the extremely heavy sulphide mineralization manifested in the workings of the Cariboo Gold Quartz Mining Company. For the reasons given, it is a reasonable assumption that the features of mineralization disclosed by recent development at the property of this company will characterize not only the veins at other points of this company's property, but quite possibly also the veins of the adjoining area in belt No. 1. A full account of the property of the Cariboo Gold Quartz Mining Company is given in this report under "Activities of the year 1931." Sulphide mineralization is also heavy on the *Hudson* group, and close to the latter on the *Homestake* is a galena-zinblend-pyrrhotite replacement shear-zone.

Apart from the recent development at the property of the Cariboo Gold Quartz Mining Company, no appreciable amount of underground development has taken place at any other property in this belt. Accounts of the properties therein will be found in the Annual Reports from the years 1917 to 1931, and also in Memoir 149 of the Geological Survey of Canada. Many of these properties exhibit showings which, *per se*, justify development, apart altogether from the fact that recent developments at the property of the Cariboo Gold Quartz Mining Company, which throw fresh light on the mineralization generally, greatly strengthen heretofore existing reasons for development. With the exception of one, the *Hudson*, all these properties are very accessible. A car can now be taken to within 9 miles of the *Hudson*, to which a good pack-trail leads from the end of the road.

As previously mentioned, similar features of mineralization may be found at properties in the region of Stanley and at Yanks peak, but the geology of this belt north-west of Stanley differs from the south-eastern portion and has not been studied in detail. On Hixon creek, at the falls, and above this point, the schists are intruded by granitic rock classified by the Geological Survey as augite syenite, with which the mineralization in the quartz veins of the Quesnel Quartz Mining Company and neighbouring properties is quite possibly genetically associated. Granite outcrops higher up Hixon creek, but its age relative to neighbouring rocks has not been determined.

Numerous well-mineralized quartz veins are known to occur between the headwaters of Hixon creek and the Willow river and in the vicinity of Ahbau lake, and prospecting in this region in a south-easterly direction towards Stanley would seem to be well justified.

The property of the Quesnel Quartz Mining Company, Limited, which consists of six Crown-granted claims, is situated on Hixon creek, about 4 miles distant from the main Prince George-Quesnel highway, and exemplifies one of the earliest lode-mining and milling operations in the history of the Province. According to old records, 239 tons assaying \$20.91 a ton were milled, but the shaft and workings therefrom which yielded this ore are now, and have been for many years, under water, so that just what is disclosed by these workings is largely a matter of conjecture. In 1929 Cariboo Lode Mines, Limited, obtained an option on this property and cleaned out one of the adit-tunnels, but nothing further has been done. An account of this is to be found in the 1929 Annual Report and mention of earlier work in the 1918 Annual Report. It is stated that there is evidence on this property that a wide belt of the schist country-rock is auriferous. While this matter has not been investigated by the Resident Engineer, it would seem to merit attention in view of the fact that on the adjoining *Cayenne* group there is evidence

of such. It is understood that an option on the property of the Quesnel Quartz Mining Company is still held by Cariboo Lode Mines.

The *Cayenne* group, owned by E. Hann and J. Strbac, of Hixon, adjoins the property of Quesnel Quartz Mining Company. There is some evidence of a dissemination of free gold in the decomposed schist country-rock. Further investigation, which is merited, is required to determine the matter. An account will be found in the 1929 Annual Report. The tunnel on this property has been sampled by several engineers at different times, and the general experience seems to be that while erratic results of assays of samples taken at the same place may be obtained, and "spottiness" may even extend to different portions of the same sample, nevertheless thorough investigation is warranted to determine commercial possibilities. It seems doubtful if a definite conclusion can be arrived at unless some very material quantity of the country-rock, say 100 tons, is shipped to some outside point and actually treated in a mill, or unless such quantity is treated in a small experimental pilot-mill erected on the property. There seems to be a large number of very small quartz veinlets running through the schist, and this, apart altogether from definite quartz veins and stringers, might explain the presence of the gold.

An account of the *Perkins* group, on Burns mountain, near Stanley, will be found in this report under "Activities of the year 1931."

Properties at the south-eastern extremity of this belt on Yanks peak (a description of which will be found in the 1929 Annual Report) merit further investigation.

It may be noted that owing to the presence in this belt of several ancient master-watercourses, notably the Tertiary Horsefly river, the probability is that in places the placer gold has been transported by the agencies mentioned to points somewhat south-west of the lode-gold belt. The strong evidence of the local origin of the placer gold on Cedar creek justifies prospecting for lode gold in this region. Encouraging values were found on the *Wonder* group on Cedar creek, described in the 1923 Annual Report, but so far as is known no further work has been done on that property.

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Numerous veins outcrop on Black Bear creek. These are noteworthy on account of the size of some of them and the large lenses of galena occurring within them, and by reason of the comparatively high silver ratio which the galena shows—namely, about 2 oz. of silver to the unit of lead. A shipment of about 10 tons of galena was made from the *Black Bear No. 1* in 1926 (see Annual Report for that year). Appreciable gold values have not, however, so far been disclosed in these veins.

Prospecting north-west of Likely in the direction of, and in the region of, Kangaroo creek would seem justified.

The importance of thoroughly prospecting the south-eastern extremity of this belt in the region of the South fork of the Horsefly river and the Crooked river, and tributaries of these streams, is very strongly indicated. This region is within the aureole of the Boss Mountain batholith, which occupies a triangular area several hundred square miles in extent between McIntosh and Crooked lakes and Forest Grove. To this intrusion is undoubtedly due the mineralization of the many quartz veins in the area mentioned, and there is every reason to suppose that these quartz veins originated the more important placer-gold deposits of the Horsefly section. Further, assays of samples of these veins taken by W. Fleet Robertson in 1902 indicate that the sulphides carry unusually high values in gold. The veins in this section are thus described by W. Fleet Robertson in the 1902 Annual Report:—

"Fraser creek is the last creek flowing from the south-east into the South fork. It is from 3 to 4 miles long, the stream-bed rising in that distance from 650 feet to a basin almost circular in shape and half a mile in diameter. The basin is surrounded by walls which rise at an average angle of 45° to a height of 1,500 to 2,500 feet, and are composed of slates, shales, and sandstone, usually dark, but towards the higher elevations showing a light-coloured bed containing much silica, the whole being much metamorphosed, and having here a somewhat uniform dip to the west of from 30° to 60°. These shales are cut by a main series of quartz veins having a N. 75° W. strike and nearly vertical dip, and are accompanied by innumerable parallel veinlets. The main series shows three or four veins cutting the formation, and these, as exposed, seem to pinch and swell, forming lenses of nearly solid white quartz from 30 to 40 feet wide, and probably 300 to 500 feet long. This series of lenses appears to have great strength and continuity, as

from the summit of the hills, by the aid of a field-glass, its outcroppings can be seen in line for 4 or 5 miles to the eastward, crossing the valley of the main creek and up the opposite range of hills. To the westward the quartz is visible on that side of the basin to within from 300 to 500 feet of the top, where it and its containing shales are capped with a volcanic rock, basaltic in character, and showing porphyritic structure in places, evidently a remnant of a basaltic capping which covered a large area of country, as other isolated cappings of a similar character are noted on other peaks of about the same altitude (7,500 feet). Continuing westward, these quartz veins are seen in the adjoining basin of Slide creek and cross over into the next basin at the head of Eureka creek.

"About the whole length of these exposures has been covered by mineral locations, but upon none of them has any development been done. Through the quartz are scattered masses of iron pyrites, which so far have not been proved to occur in such quantity as to amount to more than 1 or 2 per cent. of the quartz as it would have to be mined. A number of assays have been made on samples from the various quartz-outcroppings, and show the rock to contain from 40 cents to \$3.60 per ton in gold, while an assay of concentrates panned in the Government Laboratory gave an assay of 16 oz. per ton in gold.

"To the south of the range forming the southern watershed of the South fork is the valley of Crooked river, along both slopes of which similar quartz veins are reported, showing similar mineralization. Samples were obtained for assay and gave like results."

(2.) THE REGION WEST OF THE HEADWATERS OF THE TELKWA RIVER, TO AND ACROSS THE SKEENA RIVER.

This region is approximately bounded on the south by the Zymoetz (Copper) river and extends north probably as far as Pacific. It immediately adjoins the eastern flank of the Coast Range batholith, contains many spurs and satellites of the latter, and even a small pendant and inclusion area. The western portion contains many intrusions of aplite.

From the description, therefore, it is apparent that mineralization of a comparatively high temperature is to be expected. In the western portion a copper mineralization predominates in the quartz veins, and in this portion also are exemplified typical gold-quartz veins, wherein base-metal values are insignificant compared with those of gold. In the eastern portion the quartz veins show a mineralization of sulphides of copper, lead, zinc, and iron. A complete account of the geology of this area, with maps, will be found in the Geological Survey of Canada Summary Reports, Part A, for the years 1923 and 1925, under the respective titles: "Reconnaissance between Skeena River and Stewart, B.C.," and "Reconnaissance in Zymoetz River Area, Coast District, B.C.," the author in each case being George Hanson.

The most important property is that of the Columario Gold Mines, Limited, comprising the *Valhalla* and *Kleanza* groups near Usk. This property has reached an advanced stage of development, which is fully described in this report under "Activities of the year 1931."

The *Dardanelle*, owned by A. Carmichael and S. McNeil, of Usk, like the above-mentioned property, exemplifies typical gold-quartz vein occurrence and would seem to merit further investigation. Accounts of it will be found in the Annual Reports for 1914, 1918, 1921, and 1927.

Auriferous quartz veins mineralized with sulphides of lead, copper, zinc, and iron are exemplified by several properties situated on or near Milk creek, at the headwaters of the Telkwa river. Among these may be mentioned: The *Kitchener* group, owned by J. B. Goodwill and associates, of Telkwa (see Annual Report for 1925); the *Grandview* group, owned by T. Riley and associates, of Smithers (see Annual Report for 1929, and also 1920, under "Surprise"); and the *Big Four* group, owned by Alex. Chisholm, of Smithers (see Annual Reports for 1914, 1917, 1920, 1926, and 1929).

Auriferous quartz veins mineralized mainly with chalcopyrite occur on the *Toulon* group, owned by Major McConnell (see 1929 Annual Report); and on the *Grotto* group, owned by George Alger and associates, of Usk, an account of which will be found under "Activities of the year 1931" in this report.

Properties on which much development has already been done, and which merit further investigation, and which are but a short distance from the railway-track at Usk, are the *Lucky Lake*, owned by L. E. Moody and R. Lowrie, of Usk (see Annual Reports from 1918 to 1925), and the *Cordillera* (see Annual Reports for 1917 to 1923, under "Kitsalas Mountain Copper Co., Ltd.," and 1930 under "Cordillera").

It would seem reasonable to anticipate that search in, or in the immediate vicinity of, the Coast Range batholith, its spurs and satellites, should result in the discovery of additional typical gold-quartz veins and close prospecting is justified.

(3.) THE REGION IMMEDIATELY NORTH OF PACIFIC, COMPRISING THE DRAINAGE AREAS OF FIDDLER, LORNE, PORCUPINE, AND MOSQUITO CREEKS.

This area undoubtedly contains a very large number of quartz veins, and there is every reason to suppose that had it not been for active glaciation it would have constituted an important placer area. Of this, Lorne creek, protected by local topographic features from active erosion, is striking proof.

The geology of the area may be briefly described as consisting of a widespread, if not universal, distribution of thickly bedded sedimentary rocks of the Hazelton series, mainly with low angles of dip, intruded by numerous granitic stocks and dykes, and to such intrusions the mineralization is to be assigned.

At only one property in this area, the *Fiddler* (fully described in the 1925 and 1926 Annual Reports) near Dorreen, has any material amount of work been done, and encouraging gold values have recently been found in a vein on the *Bermaline* group, described in this report under "Activities of the year 1931." Indications generally entirely justify close prospecting of this area. In particular, it is recommended that particular attention be paid to that portion immediately adjacent to the railway between Lorne creek and Dorreen, which is extremely accessible, and evidence has been afforded at the *Fiddler* and groups below this of good gold values. It is important that the prospector should bear in mind that veins in this area which up to the present have shown promising gold values occur in the immediate vicinity of granitic tongues.

Valuable geological information will be found in the Geological Survey of Canada Summary Report, Part A, 1923, page 42.

(4.) OTHER SMALLER AREAS.

Of these, the most important is Dome mountain, near Telkwa, of which full accounts will be found in the Annual Reports for 1918, 1922, 1923, and 1924. But little activity has transpired here since 1924, beyond the efforts of a few prospectors, but the region well merits further investigation.

Slightly auriferous quartz veins are also known to occur on Sibola mountain (see Annual Report for 1927), and also in parts of the Cariboo Mining Division outside the placer-belt; at the south end of Babine lake; and just south of Fraser lake.

GOLD OCCURRENCE IN VEINS OTHER THAN QUARTZ VEINS.

While it is possible to readily discern a gradual change in the character of mineralization, consequent upon decrease of temperature, as distance from the Coast Range batholith increases, nevertheless, owing to the presence of outlying satellites at some distance from the batholith, there are local departures from the silver-lead-zinc type of mineralization generally characteristic of the eastern contact-zone.

Important examples are afforded by Rocher Déboulé and Hudson Bay mountains, both of which have igneous cores, and where the local effects of the satellitic intrusions are very marked. In the case of both these mountains, generally speaking, the lower portions being farther from the igneous core than the upper portions, the latter exhibit a higher-temperature character of mineralization than the lower. There are local variations of course, due to the fact that surface erosion has not yet entirely removed the outer and lower-temperature zone from upper portions of the mountain at all points. Zonal distribution of minerals is strikingly illustrated on Hudson Bay mountain at the *Victory*, at which property the mineralization of the main vein shows a marked change from silver-lead-zinc in its lower portions to arsenopyrite-sphalerite in its upper portion, with consequent marked increase in gold values. The effects of surface erosion in removing, either partially or completely, the outer and only slightly auriferous lead-zinc zone should be clearly appreciated, and is a factor of high importance in the development of properties on Hudson Bay mountain.

Examples of gold properties on Rocher Déboulé mountain are afforded by the *Hazelton View* and *Red Rose*. The *Hazelton View*, owned by Aurimont Mines, Limited, contains a remarkable association of minerals—arsenides, arsenopyrite, and molybdenite. Selected ore assays about 5 oz. of gold to the ton; arsenic, 50 per cent.; cobalt, 4 per cent. Cobalt contents constitute a valuable by-product. An account of it will be found in Memoir 110 of the Geological Survey

of Canada by J. J. O'Neill, and in the Annual Reports for 1927 and 1928, under "Aurimont Gold Mines, Ltd."

The minerals occur mainly in a compact seam from 3 to 18 inches in width, but to some extent are distributed throughout the filling of the shear-zone. Hitherto mining has been confined to the shoots of high-grade ore only, which are "bunchy." In view of the high values, this property would seem to merit close examination and systematic sampling to ascertain any further possibilities.

The *Red Rose* is owned by Chas. Ek, of Hazelton, and a description of it will be found in Memoir 110 of the Geological Survey of Canada by J. J. O'Neill, and also in the Annual Reports for 1914 and 1916. Tungsten minerals also occur in the vein. Nothing has been done on this property for some years, but it would seem to merit further investigation. There would also seem to be justification for further search on this mountain on the eastern slopes in the vicinity of the headwaters of Mud and Porphyry creeks for auriferous quartz veins.

WESTERN SLOPE OF HUDSON BAY MOUNTAIN.

The *Mamie* is an example of an auriferous vein on Hudson Bay mountain. This property is owned by the estate of the late J. Aldrich, represented by L. S. McGill, of Smithers. A full description of this property will be found in the Annual Report for 1922, and on page 132 of the Summary Report, G.S.C., Part A, 1925. The main showing is the outcrop of a shear-zone which has been well stripped for some 300 feet. It is well mineralized for the greater portion of this length and the width varies from 6 to 8 feet. Mineralization is essentially of the arsenopyrite-sphalerite type, with subordinate amounts of chalcopyrite, and the chief constituent value is gold. This outcrop shows considerable strength and is an impressive mineralization. One shallow shaft has been sunk in the upper portion of the outcrop, and one adit has been run at the bottom of the outcrop for a distance of 165 feet, from which two winzes were sunk, 50 feet apart, to depths of 33 feet and 42 feet respectively. At a vertical depth of approximately 130 feet below this adit, another adit about 700 feet long was driven on the general strike of the vein; this tunnel shows but indifferent mineralization. A still lower crosscut tunnel was originally started from Henderson Creek gorge and continued for about 200 feet.

It will therefore be noted that development to date has been entirely directed to ascertaining the fate of this property *below* the horizon of the outcrop. It would seem of major importance to develop *at and above* the latter horizon for two reasons:—

(1.) On general geologic grounds. One of the most pronounced features of mineralization on the western slope of this mountain is *zoning*, which is due to the igneous core of the mountain, the original focus of heat, creating more or less concentric temperature zones, which become successively cooler as distance from the source of heat increases. These are characterized by mineralizations inherent to and compatible with the respective temperature zones. On this slope of the mountain surface erosion has entirely removed the outer and cooler silver-lead-zinc zone of relatively low gold content down to an elevation of about 4,200 feet, and consequently above this horizon the higher temperature zone of pronouncedly auriferous content is exposed on the surface. It will be understood, therefore, that workings below this horizon may have to be driven a very considerable distance, which becomes increasingly greater as the vertical depth below the critical horizon increases and the slope of the mountain flattens, in order to penetrate the pronouncedly auriferous high-temperature zone. Should a vein continue in both lower- and higher-temperature zones, as is quite likely, below the critical horizon mentioned, at points anywhere near the surface, mineralization in it will be characteristic of the silver-lead-zinc zone, in which good gold values are not to be expected. Reference to the map of claims published in the 1927 Annual Report, page 136, will show the position of the *Mamie*, *Victory*, *Henderson*, and neighbouring groups. The level of No. 4 tunnel on the main vein of the *Victory* immediately adjoining the *Mamie* on the west is 4,315 feet; that of the upper adit on the *Mamie* at the lower end of the outcrop is 4,385 feet. Mineralization in the *Victory* No. 4 tunnel shows distinct evidence of a change in the type of mineralization below this point and pronounced gold values; therefore it is probably situated at about the critical horizon. In the light of available data, therefore, it would seem safer in the first instance to develop the *Mamie* at and above the main outcrop, by continuing the upper adit, rather than below this horizon.

(2.) On specific grounds. The mineralization on the surface exhibits strength above the horizon of the upper adit rather than below this point. There is ample scope above this level, and the topography is by no means unfavourable and contributes to economic mining. It would

therefore seem advisable to continue the adit started at the lower end of the outcrop. While mineralization in this tunnel does not appear as strong as on the surface, it is premature at present to draw an unfavourable inference therefrom.

This property was again visited in 1931, and the following samples were taken from the surface outcrop:—Across 7 feet, upper side of shallow shaft, assay: Gold, 0.30 oz. to the ton; silver, 6.2 oz. to the ton; copper, 1 per cent.; zinc, 10.2 per cent. Across 6 feet, just above upper adit, assay: Gold, 0.34 oz. to the ton; silver, 2.2 oz. to the ton; copper, trace; zinc, 14.6 per cent. The outcrop on this property exhibits decided strength and merits further investigation by advancing the adit.

It would seem of considerable importance to pay particular attention to the question of zoning, in the development of this and other properties in the near-by region at the same elevation.

The *Victory* group is owned by Donald C. Simpson, of Smithers, and a description of it will be found in past Annual Reports. This property, which was examined again in 1931, has hitherto been considered in connection with its silver-lead zinc possibilities, but recent work by the owner in and near No. 4 tunnel on the main vein suggests that investigation of the upper portion of this vein above No. 4 tunnel with a view to determine gold possibilities is justified.

Systematic sampling by the examining engineer of one of the large operating companies indicates an ore-shoot in the immediate vicinity of No. 4 tunnel, 60 feet in length, 3.7 feet in width, assaying: Gold, 0.44 oz. to the ton; silver, 10.45 oz. to the ton; lead, 7.10 per cent.; zinc, 5.49 per cent.

Two samples were taken by the Resident Engineer just below No. 4 tunnel from the surface outcrop, with the following results:—Across 4.5 feet, assay: Gold, 0.40 oz. to the ton; silver, 12.0 oz. to the ton. Across 4.75 feet, 5 feet north of above, assay: Gold, 0.54 oz. to the ton; silver, 3.5 oz. to the ton.

The change in character of mineralization at and above this point (elevation 4,315 feet) from silver-lead-zinc to arsenopyrite-sphalerite indicates that No. 4 tunnel is at about the critical horizon above which surface erosion has removed the lower-temperature zone minerals and exposed those of the more pronouncedly auriferous higher-temperature zone. This is evident from the various open-cuts on the vein at intervals on the surface between No. 4 tunnel and elevation 4,725 feet, at which point another vein, known as No. 3, appears to join the main vein. At elevation 4,460 feet on the right bank of Halley creek, the main vein outcrops on some steep bluffs and shows a characteristic higher-temperature mineralization of arsenopyrite and sphalerite. A sample taken across 2 feet at this point assayed: Gold, 0.70 oz. to the ton; silver, 8 oz. to the ton; zinc, 5.2 per cent.

There are several veins east of the main vein besides the No. 3 vein already mentioned. These have a somewhat more westerly strike than that of the main vein. One of these is exposed, as a small vein showing arsenopyrite, on the east bank of Halley creek, and it is said that free gold can be obtained from it by panning. This small vein intersects a mineralized region in the volcanics about 30 feet in width, which is exposed at one point by open-cut, but has not been further investigated. Mineralization is on the whole sparse, although fairly heavy at some points. Further work is necessary.

The main vein seems by far the most important, and further investigation of this above No. 4 tunnel would seem well justified. There is abundant scope above No. 4 tunnel and considerable promise is indicated.

EASTERN SLOPE OF HUDSON BAY MOUNTAIN.

At several properties on this slope of the mountain there is evidence of appreciable gold values and of the higher-temperature class of mineralization at points from vertical elevation of about 4,300 feet upwards. On this side of the mountain, at elevations of from 6,500 to 6,800 feet, the elevated plateau on which is situated the *Silver Lake* and adjoining groups evidently represents in part a portion of the lower-temperature silver-lead-zinc zone, which erosion has failed to remove. Immediately below this plateau, at about 1,500 feet lower vertical elevation, high-temperature mineralization is in evidence at the *Silver Creek* and neighbouring groups (Schufer property). At other points on this slope of the mountain there are other smaller uneroded lower-temperature areas at points above 4,300 feet.

Among properties which show mineralization of the high-temperature class in veins may be mentioned the *Yukon* (see Annual Report for 1928); the *Jessie* (see Annual Report for 1928);

and the *Silver King* and *Last Chance*, which comprise the property known as "The Matus Property." This latter property is owned by J. Matus, of Telkwa. The situation of the claims is shown on the map on page 165 of the 1928 Annual Report. It is on the right bank of Toboggan creek in immediate proximity to the "Big Toboggan" glacier, and is reached by following a branch trail about 1 mile in length which leaves the Toboggan Creek trail just below Schufer lake.

At elevation 4,575 feet, a tunnel about 100 feet long has been driven in a heavily stained and mineralized band of sedimentary rocks which strikes S. 25° W. (mag.) and dips south-east. The mineralization consists of arsenopyrite, pyrrhotite, chalcopyrite, sphalerite, and pyrite. A selected sample of this assayed: Gold, 0.6 oz. to the ton; silver, 0.32 oz. to the ton. Unfortunately, on the date of inspection, June 30th, entrance to the tunnel was impossible owing to the depth of snow. Somewhat east of the above, at elevation 4,350 feet, a similar mineralization is partially exposed. This strikes about S. 85° W. (mag.) and dips south-east at a low angle. A sample of a selected portion of this assayed: Gold, 0.56 oz. to the ton; silver, 0.36 oz. to the ton. This property merits further investigation.

Note re certain Properties in the Babine Mountains.—Certain properties in the Babine mountains near Smithers contain noteworthy values in gold, although they cannot be properly classified as lode-gold properties. These are: *Rainbow*, owned by James Wright, of Smithers (see 1929 and 1930 Annual Reports); *Silver King*, owned by Omineca Silver King Mines, Limited (see Annual Reports for 1926, 1929, and 1930); *Victoria*, owned by Lorraine Copper Silver Mines, Limited (see Annual Reports for the years 1918, 1922, 1926, 1928, 1929, and 1930); *Hyland Basin* and *Little Joe*, owned by T. King and Martin Cain, of Smithers (see Annual Reports for 1922 and 1926); and *Silver Saddle*, owned by B. F. Messner and A. T. Harner, of Smithers (see Annual Reports for 1926 and 1929).

GOLD OCCURRENCE IN ACID IGNEOUS TONGUES.

An interesting example is afforded by the *Glacier Gulch* on Hudson Bay mountain, owned by S. F. Campbell and Grover Loveless, of Smithers. Gold values, which are in places high, but vary very considerably, are associated with tetradyomite (telluride of bismuth). At an elevation of about 3,200 feet in the sedimentary rocks which comprise the coal-measures of the Lake Kathlyn coalfield occur several acid tongues in a zone about 175 feet in width. These tongues are more or less mineralized with tetradyomite, but their width varies greatly from a few feet to a few inches within a distance of a few feet. The strike of the larger dykes is about S. 47° E. (mag.) and the dip about 50° to the south-west. The dykes cut the sedimentary host-rocks of similar strike, but which dip at about 30°. The strike and dip of the mineralized zone as a whole appears to be coincident with that of the individual dykes, which are more or less parallel to one another. It is apparent that the dykes represent the concluding and final stages of batholithic intrusion. From some of the tongues quartz veinlets branch in all directions. It is evident that in some cases mineralization filled pre-existing fractures, because "comb-structure" is well developed, and quartz crystals of appreciable size are formed together with tetradyomite crystals of much larger size than those present in the portions of the dykes where replacement mineralization is in evidence. In places the tetradyomite shows a tendency to assume pseudomorphic form after quartz. As in the case of mineralization on Hudson Bay mountain generally, it is apparent that the mineralizing solutions were of a reducing character, one of the dykes showing a segregation of ferro-magnesian silicate minerals, which has been bleached and almost entirely decolorized.

The owners worked at their property all last winter, running an adit-tunnel a distance of 48 feet following one of the smaller dykes. The dyke gradually pinched out, and for the last 12 feet of the total length of 60 feet the adit was swung to the north-east to penetrate the downward continuation of a well-mineralized dyke exposed on the surface about 50 feet above this point. Quite possibly the tunnel was not continued far enough to reach the objective, but the continuity of individual dykes is a somewhat uncertain factor, and greater hopes lie in the mineralization as a whole. Before doing further underground work it is suggested that it would be advisable to strip off the moss and light surface soil in the neighbourhood of present exposures, in the hope of disclosing additional showings. There seems to be no reason to think that the dykes will not be found to occur beyond the present region of exposures. The property well merits further investigation to ascertain commercial possibilities.

While it is possible to obtain high gold values in selected samples, the best representative sample so far obtained by the Resident Engineer was one across a width of 7½ feet, which assayed: Gold, 0.43 oz. to the ton; silver, 0.10 oz. to the ton; bismuth, 2.2 per cent. A sample taken across 15 feet at another point assayed: Gold, 0.18 oz. to the ton; silver, 0.22 oz. to the ton. Further particulars concerning this property will be found in the Annual Reports for 1929 and 1930.

ACTIVITIES OF THE YEAR, 1931.

SUMMARY.

Although lode-gold mining is as yet quite in its infancy in this district, nevertheless the developments at the only two lode-gold properties at which any material amount of development-work has been carried out—namely, those of the Columario Gold Mines near Usk and the Cariboo Gold Quartz Mining Company near Barkerville—justify the expectation that the district will not be long in arriving at the production stage in the case of this class of property.

The results obtained at the property of the Cariboo Gold Quartz Mining Company, Limited, are of particular importance, because they do not affect that property only. Certain features of mineralization manifested will probably be found to occur at other properties in the vicinity. These results, moreover, indicate very definitely that certain of the views generally held concerning mineralization in the Barkerville area must be modified in important respects.

The discoveries of prospectors during the year, notably those of E. E. Armstrong, of Barkerville, on his *Myrtle* group on Barkerville mountain, and of August Johnson, of Ritchie, on his *Bermatine* group at the headwaters of the North fork of Lorne creek, near Ritchie, are of an encouraging nature and a stimulus to others.

Among other activities may be mentioned: The small-scale development carried out by C. J. Seymour Baker, of Barkerville, at his *Proserpine* group on Proserpine mountain, and at his *Aurum* group (formerly the property of Island Mountain Mining and Milling Company) on Island mountain, near Barkerville; the development started at the *Perkins* group, near Stanley, by J. H. Johnson, of Prince George; and that carried on by Germansen Development Syndicate at its properties, the *Black Hawk*, *P.E.M.*, and *Mother Lode* groups, in the Manson section. In addition, a certain amount of work was carried out at the *Kitchener*, *Grandview*, and *Rob Roy* groups, at the headwaters of the Telkwa river, by the respective owners. Further work was also carried out at the *Glacier Gulch*, Hudson Bay mountain, by the owners, S. F. Campbell and G. Loveless, of Smithers; and on the *Midas*, Yanks peak, near Keithley, by the owners, O. J. Pickering and J. Glover, of Keithley; and on the *Jane*, Yanks peak, near Keithley, by the owner, R. Reinhold, of Keithley.

OMINECA MINING DIVISION.

This company has been carrying on development at its property, the *Valhalla* and *Kleanza* groups, near Usk, for some considerable time past. Accounts of **Columario Gold Mines, Ltd.** this property will be found in past Annual Reports. This year a total development footage of 415 feet was carried out by this company, comprising 210 feet of drifting in the *Dakota* tunnel on vein No. 6, 40 feet of drifting in the Middle tunnel on vein No. 6, 30 feet of drifting in the Lower tunnel on vein No. 6, and 135 feet of drifting in the tunnel on vein No. 7.

This done, W. G. Norrie, consulting mining engineer, of Vancouver, was retained to make a detailed examination of the property. The gist of the conclusions arrived at by this engineer is that the appearance of the property warrants development on a larger scale than has heretofore been carried out, and also the erection of the first unit of a mill. He therefore recommends construction of an aerial tram, installation of the necessary air-compressing and power plant for the more rapid opening-up of the mine, and the construction of the first unit of a mill. The following is an excerpt from his report:—

"*Summary and Conclusions.*—The Columario system of veins has a possible vertical range of over 4,500 feet and a horizontal extent of over 12,000 feet. Within this range concentrated exploration and development has shown up eight ore-shoots aggregating 518 feet in length, with an average width of 22 inches and an average value of \$12.30 to the ton in gold, to which should be added about 50 cents to the ton for silver.

"This ore has been demonstrated to occur between elevations 1,885 feet on the *Tenderfoot* tunnel and 2,295 feet on the upper No. 4 level, a total vertical distance of 410 feet, and a length

along the slope of the veins of between 500 and 700 feet, depending on the dips of the individual veins. This ore has been shown up on different veins and at various horizons, and it is therefore impossible to make a definite calculation as to ore tonnage. The best that can be done at this stage is to state that a rough calculation indicated that between the *Tenderfoot* tunnel and the No. 4 Upper tunnel it will be possible to develop approximately 75,000 tons of ore from the known ore-shoots. In addition to this, other ore-shoots, at present unknown, may be uncovered."

It is understood that the management has under consideration a scheme of construction involving erection of mill and power plant on the west side of the Skeena river, on the Canadian National Railway tracks, and an aerial tram thereto from the mine. Such would seem to offer such very great advantages that it calls for detailed investigation.

This group, owned by G. Alger, J. Bell, Lee Bethurem, and associates, of Usk, is situated on Hardscrabble creek, about 1½ miles distant from Pitman flag-station on the Canadian National Railway. It immediately adjoins the *Diorite* group on the west. A good wagon-road leads from Pitman to the *Diorite*, from which a pack-trail has been constructed to the *Grotto*.

On the *Diorite* occurs an extensive intrusion of aplite which shows a promising copper mineralization (see 1929 Annual Report). On the *Grotto* also occur several intrusions of aplite, which are mineralized, although not to the same extent as on the *Diorite*.

At several different points on the *Grotto* are developed well-mineralized quartz-filled shear-zones, the largest of which is of a maximum width of 4 feet. Minerals observed are chiefly chalcopryite, pyrite, and specularite. Encouraging gold and silver values are also present. These veins, of which there are quite possibly more than those already exposed, seem to be approximately parallel, strike somewhat east of north (mag.), and dip at about 50° north-west. They cross Hardscrabble creek diagonally and can be well developed by adit-drifts run in the banks of the creek.

One such is exposed on the left bank of the creek and shows a well-mineralized outcrop, 4 feet in width, at a point close to the creek. A sample taken across this width assayed: Gold, 0.34 oz. to the ton; silver, 21.4 oz. to the ton; copper, 1.8 per cent.

A short distance vertically below this outcrop an adit-drift has been run a distance of 42 feet (as on April 12th), and the face has advanced somewhat beyond the mineralized outcrop above referred to. Unfortunately, the vein was found to pinch at the horizon of the adit, and at 23 feet from the portal was interrupted by a cross-shear, or incipient fault, which latter was followed north-westward for a distance of 15 feet, the main adit being continued a distance of 19 feet beyond the cross-shear and showing a little quartz in the face. It would seem advisable to continue the main adit in the direction of the vein-strike following the quartz, in anticipation of finding another ore-lens. The mineralized outcrop may represent the lower limits of an ore-lens which has been almost entirely removed by surface erosion. The elevation of this adit is 540 feet as determined by aneroid. The country-rock on the foot-wall of this vein is altered granodiorite; that on the hanging-wall is volcanic rock.

About 200 yards up-stream from this adit, on the right bank of the creek, another adit-drift has been run following a well-mineralized quartz vein about 1 foot in width for a distance of 24 feet. At this point vein-continuity is interrupted by cross-shearing, but it is likely that by continuing the drift in the direction of the vein-strike the vein will be recovered.

About 100 feet down-stream from this last-mentioned adit, on the same bank of the creek, another shear-zone is exposed, which shows two seams of quartz, each well mineralized. The strike of this shear is much the same as that of the first mentioned, to which other shears are approximately parallel.

About 400 feet up-stream from the last-mentioned exposure, on the right bank of the creek, and about 300 feet vertically above the latter, occurs an intrusion of aplite in the volcanic flow-rocks. The aplite shows over a width of between 10 and 12 feet a sparse mineralization of chalcopryite. A sample of selected portions of the aplite assayed: Gold, trace; silver, 0.2 oz. to the ton; copper, 1 per cent.

Granodiorite also outcrops at several points in this region, which is very accessible and merits further intelligent prospecting, in the expectation that further auriferous quartz veins will be discovered.

Bermaline. This group, owned by August Johnson and associates, of Ritchie, is situated at the headwaters of the North fork of Lorne creek, at the western extremity of the Omineca Mining Division; in fact, some of the claims of the group are

in the Skeena Mining Division. The property is distant about 16 miles by a fair trail from Ritchie flag-station.

Mineral-showings consist of several quartz veins, mineralized with chalcopryrite, pyrite, galena, and zinc-blende, of varying width up to 4 feet, which occur in the sedimentaries of the Hazelton series, in which there are numerous intrusions of granodiorite. One shear-zone, the maximum width of which is $2\frac{1}{2}$ feet, and which is mineralized almost entirely with chalcopryrite, occurs wholly within granodiorite. These lie at elevations of between 4,820 and 5,420 feet and are further described in the 1930 Annual Report, in which also will be found a general description of this region. A new discovery was made by the owners in 1931 which exhibits promise, and further investigation of it and the surrounding region is undoubtedly justified.

The new discovery consists of a quartz vein between 3 and 4 feet in width, striking S. 85° W. (mag.) and dipping at between 45° and 60° to the north-west. It is situated at the extreme headwaters of Douglas creek, on the south side of the valley of the latter at elevation 4,840 feet. Very little work had been done at the time of inspection on September 20th, on which date, exposures, all lying within a horizontal range of about 75 feet, consisted of a shallow open-cut in the vein-outcrop, a pit in shallow surface debris, which just exposed the vein, and a third exposure by natural agencies.

Where exposed by the open-cut, the vein is seen to be between 3 and 4 feet in width and is well mineralized with galena, zinc-blende, pyrite, and a small amount of chalcopryrite. A sample taken across a width of 3 feet at this point assayed: Gold, 0.6 oz. to the ton; silver, 3 oz. to the ton; lead, 3 per cent. A sample of the more leady portions only, assayed: Gold, 0.10 oz. to the ton; silver, 13 oz. to the ton; lead, 16.7 per cent.

This vein exhibits little or no surface oxidation and occurs in sedimentaries of the Hazelton series, which are locally disturbed and intensely silicified owing to an intrusion of granodiorite which outcrops within a few feet of the vein at this point. After preliminary surface prospecting this vein could, if necessary, be developed to advantage by adit-tunnel in the Douglas Creek valley-slope. While this and other showings on this property lie above timber-line, a good camp-site during the initial prospecting and development stage is to be found in timber at elevation 4,020 feet at the head of the North fork of Lorne creek.

Manson Section.

Germansen Development Syndicate, Ltd.

This company was incorporated during the year for the purpose of prospecting and developing its holdings. The authorized capital is \$50,000, in shares of \$1 par value. The president is W. F. Paquette, Prince George; the secretary-treasurer is W. B. Bowler, Prince George; and the registered office of the company is c/o E. J. Avison, Quesnel. The company holds options on twenty-two claims on the Germansen river and four claims on Manson creek. This property consists of the *Black Hawk* group, situated on Blackjack mountain, flanking Blackjack gulch, Manson river; the *Mother Lode* group, situated on Germansen river, about 9 miles above the mouth of the river and distant about 8 miles from the *Black Hawk* group; and the *P.E.M.* group, situated on Germansen river, about 4 miles above the mouth of the river.

On the *Black Hawk* the type of mineralization so far disclosed is essentially silver-lead-zinc, and a description of it is herein given not because it falls in the lode-gold class, as judged by present exposures, but rather that the quartz veins on the property might reasonably be expected to contain gold, and also for convenience in completing a description of this company's property within the same report. On the *P.E.M.* and *Mother Lode* groups the type of mineralization is essentially gold-silver-copper.

This group is situated on Blackjack mountain, south-west of Blackjack gulch, and is in part, at any rate, a restaking of older locations on which are a few old workings and a cabin. The mode of mineral occurrence exhibited is that of eight quartz veins, in main well mineralized, all more or less parallel, occurring within a belt of country not exceeding 500 feet in width. The minerals observed were pyrrhotite, pyrite, galena, and zinc-blende. The veins vary in width from 18 inches to 5 feet, the largest being apparently the most heavily mineralized. Sampling disclosed good silver values per unit of base metal, but no noteworthy gold values were found. A sample of pyrrhotite from one of the veins showed quite high silver values, assaying: Gold, 0.02 oz. to the ton; silver, 68 oz. to the ton. Assay of this sample for nickel showed negative results. The strike of these veins

varies from N. 5° W. (mag.) to N. 15° E. (mag.). All save two dip easterly. The largest vein and one next adjoining dip westerly.

The workings consist of one short tunnel on one of the smaller veins, 20 feet in length, and a few open-cuts.

The country-rock is a schisted volcanic, and the bedding-planes strike N. 78° E. (mag.) and dip north-west at about 60°.

A sample from the largest vein across 5 feet assayed: Gold, trace; silver, 21 oz. to the ton; lead, 0.5 per cent.; zinc, 2.8 per cent. A sample of sulphides, only, from this vein assayed: Gold, 0.02 oz. to the ton; silver, 61 oz. to the ton; lead, 8.7 per cent.; zinc, 5.3 per cent. A sample from the dump resulting from open-cuts on another vein of maximum width 3½ feet assayed: Gold, trace; silver, 2 oz. to the ton.

P.E.M.

This group comprises a number of mineral claims situated on both sides of the Germansen river at a point about 4 miles above the mouth of the latter.

In this region the peridotitic country-rock is sheared and serpentinized locally, and three intensely altered and silicified zones, each about 12 feet in width and about 500 feet apart, cut through this group, striking in a north-west and south-east direction, and can be seen for hundreds of feet on both sides of the river. Within these altered zones are developed quartz veins, which show a mineralization of chalcopyrite, grey copper, and malachite, with promising values in gold, but there has so far not been indicated any noteworthy continuity of the veins. It seems likely that these altered zones are the outward manifestation of underlying acid igneous tongues. One such is exposed on the *Mother Lode* a few miles higher up the river. Alteration has been so intense in these zones as to produce at one point a deposit of calcareous tufa.

It is the quartz veins in these altered zones that have engaged the attention of the operators. On the east side of the river, at about 100 feet vertically above the river, one of the altered zones mentioned shows a quartz vein 2 feet in width, mineralized with grey copper, chalcopyrite, and malachite. A sample across 2 feet assayed: Gold, 0.8 oz. to the ton; silver, 1.6 oz. to the ton; copper, 0.2 per cent. Exposure is by open-cut. This vein strikes N. 70° W. (mag.) and dips steeply north-east. A sample of a small pile of ore lying by the open-cut assayed: Gold, 0.32 oz. to the ton; silver, 15.2 oz. to the ton; copper, 0.4 per cent. About 40 feet vertically below the open-cut, a crosscut tunnel, 62 feet in length, run on a bearing N. 10° E. (mag.), passes through a quartz vein 5.5 feet in width, which may be the downward continuation of the vein exposed by the open-cut mentioned, but this shows but little mineral and a sample across the full width of the vein disclosed upon assay traces only of gold, silver, and copper.

On the opposite side of the river, at a slightly higher elevation, in the same altered zone, a tunnel has been run a distance of 21 feet in the zone, bending to the right at the face and passing apparently out of the zone. Silicification and alteration of the country-rock is intense in the zone, and a green mineral apparently chlorite is much in evidence, together with a little malachite. A sample from the tunnel across a width of 2 feet at the most promising-looking place disclosed a trace only of copper, and no gold, silver, or nickel values.

On the east side of the river, and 575 feet vertically above the latter, a tunnel 15 feet in length preceded by 20 feet of open-cut is run on a bearing N. 35° E. (mag.), crosscutting one of the altered zones previously referred to. This exposure shows a certain amount of quartz with a little chalcopyrite. A sample of a small pile of mineral lying by this working assayed: Gold, 0.30 oz. to the ton; silver, 0.1 oz. to the ton; copper, trace.

Distant from the above working about 3,000 feet in a north-west direction, and 135 feet vertically below, an altered zone 11 feet in width shows a width of 5 feet of quartz and brecciated country-rock, but little mineral is in evidence.

On this group, in quartz-schist country-rock, occurs an acidic sill, probably quartz feldspar, which is pyritized. The width is about 20 feet, and in it occurs a ramification of quartz veins of various widths and of irregular strike and dip. The largest of these gash-veins is 5 feet wide at the widest point. The veins are slightly mineralized with grey copper and malachite. Exposure is mainly by natural agencies and very little work has been done on any of the veins. A sample of selected mineral from these veins assayed: Gold, 0.44 oz. to the ton; silver, 47 oz. to the ton; copper, 1 per cent. A sample of the igneous tongue itself assayed: Gold, trace; silver, 1.5 oz. to the ton. This igneous tongue is very similar to those which outcrop at various points in the Barkerville district and is probably of the same composition.

On the adjoining claim, the *Flagstaff*, owned by W. B. Steele, of Manson Creek, small quartz veins are exposed at several different points. One of these, 15 inches in width, showed grey copper and malachite, and a sample of selected mineral from it assayed: Gold, 0.10 oz. to the ton; silver, 18 oz. to the ton; copper, 1 per cent.

This group is owned by O. J. Crites, of Manson Creek, and is situated on Germansen river. On the left bank of the river, just below the junction of *Plug Hat* creek, there is exposed a large quartz vein from 10 to 12 feet in width, which appears to mainly follow the planes of schistosity of the enclosing schists, although the latter are cut by numerous smaller spurs of the vein.

The vein is sparsely mineralized with pyrite, chalcopyrite, and copper-stain. The foot-wall is a carbonaceous schist and an adit just above water-level follows the vein for a distance of 120 feet. For the first 45 feet the bearing is S. 67° W. (mag.) and for the remaining distance the bearing is S. 25° W. (mag.). The tunnel exposes the foot-wall rock for almost the entire distance, but it is doubtful if the full vein-width is exposed. At the face of the tunnel the vein appears to be mainly in the back. A sample of selected portions of mineral assayed: Gold, trace; silver, 0.6 oz. to the ton; copper, 1 per cent.

CARIBOO MINING DIVISION.

Cariboo Gold Quartz Mining Co., Ltd.

The results obtained at this property during the year, and to date, are important, inasmuch as they affect not only this property, but it is a reasonable assumption that certain features disclosed will quite likely prove characteristic of the Barkerville area generally. It is evident that views previously held concerning the vein systems in this area must be modified in important respects. Work accomplished has comprised completion of camp buildings, and power plant and air-compressor, described in the 1930 Annual Report, at or near the portal of the main crosscut tunnel; the advancement of the latter; and the following-up of certain of the veins met with.

The portal of the main crosscut tunnel is situated about 100 feet vertically above Jack of Clubs lake and is about 375 feet vertically below the upper workings. The size of the tunnel is 6 by 9 feet and on October 6th the face of this tunnel was 510 feet distant from the portal.

At 275 feet from the portal, at a depth of approximately 75 feet vertically below the surface, the tunnel passed obliquely through a well-mineralized "cross" vein. On the north wall of the tunnel the greatest width of continuous mineralized quartz is 4½ feet. On the south wall the greatest width of continuous mineralized quartz is 5 feet, but if a small stringer of quartz outside this is included the width is 6½ feet. The maximum width of mineralized quartz exposed in the back of the tunnel is 2 feet.

This vein has been followed south-west of the main tunnel for a distance of 60 feet by a drift, which, except for the first few feet of its length, is run wholly in the east wall of the vein. The existence of the latter was proved during the length of this drift by drilling holes from the machine at right angles to the bearing of the drift to a depth of 5 or 6 feet, and it is stated that quartz and sulphides showed in these holes to approximately the depth drilled.

North-east of the main tunnel this vein has been followed by a drift, which intercepts its north-eastward continuation at a point approximately 40 feet from the main tunnel. The average vein-width in the region of the described workings may be from 3½ to 5 feet. It is a reasonable conjecture that the mineralized length of vein in this region is about 100 feet, but the average width applying to this length is indeterminable from the present exposures.

A very heavy sulphide mineralization, mainly pyrite, characterizes this vein, and the vein-walls are heavily pyritized. Some galena shows in the vein at one point. Free gold was observed, and where it is not visible to the naked eye wide variation in assays of samples suggests its presence in finely divided form also.

It is stated that specimens of mineral containing tellurium were found in the vein at the point of penetration by the main tunnel. That may be so. It is unlikely that the Resident Engineer has seen all the different kinds of high-grade mineral, as it is quite natural that most choice specimens should be removed when first encountered. Samples analysed by the Bureau of Mines have failed to disclose the presence of tellurium, proving to be either chiviatite, or a

mixture of galena and bismuth sulphide, or bismuthinite. These minerals are, at any rate, the concomitants of high gold values locally.

As to the values in this vein, from the foregoing description it will be apparent that exposures are not such as to permit of the arrival at either the average width or the average values. At or near the point of penetration by the main crosscut tunnel, the following samples were taken:—

Character of Sample.	Gold.	Silver.
	Oz. to Ton.	Oz. to Ton.
Composite sample made up of one cut across 4½ feet on north wall of main crosscut, and of two cuts across 2¾ feet and 5 feet respectively on the south wall of main crosscut.....	0.73	.....
Chip sample taken across 15 feet diagonally across the vein at the commencement of the south-west drift.....	1.06	0.50
Sample taken by manager, with mull, at the same point as last-mentioned sample.....	0.40	0.56
The arithmetic mean of these assays is.....	0.73	0.53

The main tunnel at 450 feet from the portal penetrated another vein well mineralized, the width of which was 3 feet in the north wall of the tunnel, but which narrowed to a few inches in the south wall of the tunnel. It is stated that when first cut this vein showed high-grade mineral. It well merits being followed in a northerly direction. Just prior to cutting this vein some other small veins a few inches in width were penetrated.

At 475 feet from the portal the tunnel passed through a strong-looking vein, heavily mineralized with pyrite, 18 inches in width. This vein is slightly faulted, shows much slickensiding, strikes S. 60° W. (mag.), and has steep, almost vertical dip. Widening of the tunnel at this point exposes it over a length of about 30 feet. A sample taken in the south wall across 18 inches assayed: Gold, 0.26 oz. to the ton; silver, 0.14 oz. to the ton. A sample from this point of sulphides only, assayed: Gold, 1.2 oz. to the ton; silver, 0.6 oz. to the ton. It is understood that another promising vein was penetrated by this tunnel subsequent to the last visit of the Resident Engineer.

Important features of development to date are:—

(1.) The existence of free gold below the zone of oxidation. This feature is apparent to the naked eye at several points in different veins in upper and lower workings, and where it is not so apparent the existence of finely divided free gold is indicated by variation in assays of samples taken from the same point. It is to be noted that where this feature has been observed sulphide mineralization is particularly heavy both in the vein and adjoining wall-rock.

(2.) In point of size, apart from other features of importance, "cross" veins are considerably larger than anticipated.

(3.) The number of "blind" veins (that is, veins met with underground, but of which there is no evidence on the surface) encountered is likely to be appreciable.

The geology of the Barkerville area is described in great detail by the late W. L. Uglow in Memoir 149 of the Geological Survey of Canada. It may be stated, in brief, that the rocks of the Barkerville area are intruded by acid dykes and sills of the quartz-feldspar type. The latter, although not numerous at any one point, occur over a wide area. They are presumed to be tongues from an invisible and deep-seated batholith, which at no point has been unroofed by erosion. The general geologic features described being found at all points of the Barkerville area, it is reasonable to anticipate that the features disclosed by underground development at this property, and above enumerated, will be found to prevail not only at other points of this property, but throughout the Barkerville area generally. These features indicate, moreover, that the views generally held as to the vein systems in that area must be modified in the light of recent developments.

Tonnage Possibilities and Values indicated.—It is evident that this company is steadily increasing the number of objectives which may be considered of major importance. In addition to those enumerated in the 1930 Annual Report, namely:—

- (1.) The large "cross" vein encountered in the upper workings;
- (2.) The promising exposures of quartz showing on the surface about 1,100 feet south of the cabin on the *Rainbow* group, and further described in the 1929 Annual Report;
- (3.) The investigation of the area immediately below the *Rainbow* group,—
there is now added:—
- (4.) Veins disclosed in the lower crosscut tunnel.

Of (2) and (3) above nothing new has transpired, and nothing definite can be said concerning them beyond the fact that justification for their full investigation is greatly strengthened by the additional knowledge as to mineralization and possibilities gained by development to date.

As to (1) above, it is a reasonable conjecture that the mineralized length of this vein is not less than 150 feet. But it is only exposed at intervals in this distance by workings, and in the region where it approaches a width of 10 feet it is followed by a foot-wall drift from which holes were drilled into the vein in the course of running the drift to prove its existence. It is therefore manifest that the average width of this vein cannot be determined by actual measurement, owing to lack of exposures. For the same reason, its average assay value cannot at present be determined. Free gold shows at several different points of this vein, and also other minerals. One sample taken by the Resident Engineer across 9 feet assayed: Gold, 0.30 oz. to the ton; silver, 0.06 oz. to the ton. Another sample taken from what is probably another part of the same vein across 1.5 feet assayed: Gold, 0.62 oz. to the ton; silver, 0.20 oz. to the ton. Exposures are quite inadequate to enable an accurate average value to be assigned to a definite width extending over a definite length. From the presence of free gold, it is, moreover, evident that an accurate idea of average values can only be obtained by sampling at frequent intervals. At the horizon of exposure this vein shows marked strength and indicates potential tonnage.

As to the vein exposed in the lower tunnel at 275 feet from the portal, it is a reasonable assumption that the mineralized length of this to date is about 100 feet. Its width probably lies between 3½ and 5 feet. In the case of this vein also exposures are inadequate to assign any definite value or width as applying to the mineralized length stated. The average of all samples in the vicinity of the main crosscut tunnel is: Gold, 0.73 oz. to the ton; silver, 0.53 oz. to the ton. While this assay cannot be taken as the average value of the mineralized length of this vein, there is no justification for assuming that the true average value will be sensibly higher than this. It is also possible that the veins exposed in the lower crosscut tunnel at 450 feet and 475 feet respectively will prove productive.

Summary and Conclusions.—(1.) While there is no tonnage actually blocked out at this property to date, potential ore tonnage is decidedly indicated. Owing to lack of exposures it is impossible in the present stage of development to assign any average value or width applying to a definite length, but high average values are not indicated by underground ore-exposures to date.

(2.) In view of the fact that the outcrops of veins on the *Rainbow* group were markedly rich, being in fact rocked for their gold contents, and as, moreover, bismuthinite was found close to the surface in this region, it is quite possible that higher average values will be found at depth in this region than at other points.

(3.) It seems quite possible, even likely, that certain important features of development to date will be found to recur at other points of this property, and at other properties in the Barkerville area.

(4.) As to the question of the existence of tellurium in the ore, several specimens analysed by the Bureau of Mines have failed to disclose the presence of tellurium. The minerals identified being chivalite and bismuthinite. It is possible that a mineral containing tellurium occurs in the ore in addition to those mentioned. But, inasmuch as it has been proved that the ore contains certain minerals which are the concomitants of high local gold values, the establishment of the identity of all such minerals appears to be a matter of scientific rather than of commercial interest.

(5.) Generally speaking, this property undoubtedly exhibits the earmarks of promise, and the grounds which justified development originally are becoming stronger as development proceeds.

It is suggested that a complete survey of this property should be made and a map prepared therefrom showing all important exposures and workings.

Myrtle. This group is situated on Barkerville mountain, near Barkerville, and is owned by E. E. Armstrong, of Barkerville. By intelligent and painstaking prospecting the owner this year made what promises to be a discovery of importance in the south-eastern portion of this group. Surface pits at intervals disclose two veins, known as Nos. 1 and 2, which strike north-west and south-east, parallel to the planes of schistosity of the enclosing country-rock, and which are crossed by smaller veins striking north and south at frequent intervals. These veins are approximately 300 feet apart and evidently continue for a considerable distance; free gold occurs in them, being readily disclosed by panning.

A sample taken from the *Martha* claim from the oxidized outcrop of No. 1 vein assayed: Gold, 1.64 oz. to the ton; silver, 1.56 oz. to the ton. A seam of galena at this point 3 inches in width was found to assay: Gold, 0.42 oz. to the ton; silver, 213 oz. to the ton; lead, 67.4 per cent. A sample taken from the *Morning Star* claim, which immediately adjoins this group on the south-east (and is owned by F. J. Tregillus, of Barkerville), from a vein which appears to be the continuation of No. 1 vein across a width of 3 feet assayed: Gold, 2.20 oz. to the ton; silver, 0.84 oz. to the ton. Other showings in the north-western portion of the *Myrtle* group are described in the 1924 and 1925 Annual Reports.

Aurum. This group is situated on Island mountain, distant about 5 miles from Barkerville, in the north-western portion of belt No. 1. It is owned by C. J. Seymour Baker, of Barkerville, and includes the property formerly owned by the Island Mountain Mining Company, which company erected a stamp-mill on the property at the outlet end of Jack of Clubs lake in 1890. Only a small tonnage was, for various reasons, treated in this mill, which finally passed into the hands of the Government. Whatever additional reasons brought about the suspension of operations at that time, certain it is that the milling difficulties experienced by every operator of that generation in this area must have proved an insurmountable obstacle to successful treatment. Attention was originally directed to this property apparently by the fact that a material amount of gold was recovered by the earliest prospectors by rocking the vein-outcrops.

No actual mining operations have been carried out at this property for many years, but for some years past, since the present owner acquired the property, he has employed a small force of men each year in clearing out the old workings, retimbering tunnels, and rendering these accessible, and in repairing the old trails and wagon-roads which lead to the various workings.

As the result of these efforts, not only have all old workings been opened to inspection, but the existence of two large veins, and tunnels therein, hitherto unknown has been disclosed.

The two last-mentioned veins outcrop strongly on the steep mountain-side about 500 feet vertically above Jack of Clubs lake. Here they are about 150 feet apart, are from 5 to 6 feet in width, strike N. 70° E. (mag.), and dip steeply south-easterly. They can be developed to great advantage by adit-drift, and the main Quesnel-Barkerville road passes along the base of the mountain immediately below. On the more westerly of these veins a tunnel was formerly run about 275 feet, at a point 80 feet above Jack of Clubs lake, and the portal of this tunnel was formerly connected with the mill by a surface tramway, the grade of which now forms a good trail. These veins are fairly well mineralized with arsenopyrite.

At considerable distance east of these veins are others, of which the "John's Ledge" has received most attention. On this two adits are run, known as "Lower John's" and "Upper John's" tunnels. The lower of these is 600 feet vertically above Jack of Clubs lake; the upper tunnel is about 40 feet above the lower. In the "Upper John's" tunnel the last portion of the tunnel follows what is apparently a "cross" vein, which is well mineralized, mainly with arsenical iron pyrites. A sample across 3 feet at about the best-looking point assayed: Gold, 0.30 oz. to the ton; silver, 0.50 oz. to the ton. The position of this property in belt No. 1 makes it worth detailed examination and systematic sampling.

Proserpine. This group, owned by C. J. Seymour Baker, of Barkerville, is situated on Barkerville mountain, the claims extending down to and across Williams creek. Work was carried out this year by the owner in further prospecting the large quartz vein, discovered last year on the *Pani* and *Pani South* claims on the left bank of Williams creek, in immediate proximity to the latter. This vein strikes north-west and south-east. Open-cuts and trenches on the left bank of the creek show alternate bands of quartz and country-rock over a total width of about 60 feet. In places the quartz shows a considerable

amount of mineral, chiefly galena, pyrite, and zinc-blende. A sample of selected portions assayed: Gold, trace; silver, 20 oz. to the ton; lead, 20.3 per cent.; zinc, 1.3 per cent.

The remaining workings on this property are on Proserpine mountain, and no mining has been carried on in connection with these for some years past. A description of them will be found in the 1914 Annual Report, and also in Memoir 149 of the Geological Survey of Canada.

The following references are given to reports containing descriptions of other meritorious properties in belt No. 1 in the Barkerville area:—

Kitchener. Owned by F. J. Tregillus and T. A. Blair, of Barkerville, and *Independence*, owned by E. E. Armstrong, of Barkerville. Both these groups, situated on

Proserpine mountain, were taken under option by a subsidiary of the Mining Corporation of Canada in 1919. After erection of camp buildings and a certain amount of development-work this corporation relinquished its options in 1920, since when but little work of importance has been done. Descriptions of these properties will be found in the Annual Reports for the years 1917 to 1922 and in the 1925 Annual Report. In the Annual Report for 1922, on page 119, John D. Galloway, the Provincial Mineralogist, then Resident Engineer, comments on the withdrawal of the Mining Corporation of Canada, thus: "These properties received an undeserved 'black eye' when the Bryce Syndicate in 1920, after carrying out certain development-work, failed to take up the options on the claims. It has always been believed by the writer that a number of these veins may be found to contain shoots of ore which would pay to work." On page 148 in the 1925 Annual Report somewhat similar views are expressed.

Black Jack. This group, owned by F. J. Tregillus and T. A. Blair, is situated close to Barkerville, on Williams creek. Its early history is described fully on pages 193 and 194 of Memoir 149 of the Geological Survey. An account of the *Westport* claim of this group will be found in the Annual Reports for 1926 and 1930.

Hudson. This group, owned by estate of the late I. E. Moore and F. M. Wells, of Barkerville, is situated on Cunningham creek and is distant about 21 miles from Barkerville. A car can now be driven to the *Trehouse* hydraulic mine, from which a good pack-trail 9 miles in length leads to this property. Attention has been frequently drawn to this property, which exhibits much promise, in the Annual Reports. The most recent account is that appearing in the 1929 Annual Report.

Perkins. This group, owned by Clarence Fuller and associates, of Quesnel, is situated on Burns mountain, north-east of Stanley, in belt No. 2, at an elevation of approximately 5,000 feet. It is reached by a good trail about 1½ miles in length from the Stanley-Houseman Creek road, the total distance from Stanley being about 2¼ miles. Very little expense would be required to enable a light motor-truck to be taken to the property.

The free gold originally showing in the oxidized outcrops of the veins on this group attracted attention in the very early days, and a stamp-mill was erected on the property in the late seventies. Owing largely, apparently, to the metallurgical difficulties with which the operators were confronted, when the oxidized surface ores gave place to sulphides at very shallow depth, operations were discontinued in the nineties. Subsequently no material amount of work was done until the present year, when Clarence Fuller and associates cleaned out the old crosscut tunnel and resumed prospecting. More recently an option on the property was acquired by J. H. Johnson, of Prince George, by whom very encouraging results are reported subsequent to the date of inspection by the Resident Engineer.

On the gently sloping mountain surface, at 5,060 feet elevation, four typical cross-veins of the "B" type of W. L. Uglow's nomenclature, varying in width up to 15 inches, striking N. 20° W. (mag.) and dipping steeply south-westerly, occur within a belt of country about 65 feet in width. The vein-filling is quartz and siderite, with a considerable amount of pyrite and a lesser amount of galena. These veins are well exposed by surface-strippings and shallow underhand stopes at various points within a distance along their strike of about 480 feet, although the continuity of any individual vein has not been proved for this distance. On two of these veins, shafts, now caved, were sunk in the early days, and at the extreme north end of the surface exposures a crosscut tunnel several hundred feet in length was run at elevation 5,000 feet, on a bearing N. 80° E. (mag.). This tunnel was cleaned out by Clarence Fuller and associates and an inspection of it was made. At about 24 feet from the face of the tunnel, a branch tunnel now caved is said to connect with one of the shafts mentioned above. At 12 feet from

the face a vein 11 inches in width is cut by the tunnel. This vein is well mineralized with pyrite. A sample taken across the full width assayed: Gold, 0.28 oz. to the ton; silver, 0.3 oz. to the ton. A sample of sulphides only, assayed: Gold, 3.2 oz. to the ton; silver, 0.6 oz. to the ton. The evidence obtained points to the likelihood that good gold values are likely to persist in the sulphides at depth. There can be no question that the oxidized outcrops of these veins originally showed attractive values in free gold.

Distant about 400 feet in a north-easterly direction from the above-described group of veins, at elevation 5,115 feet, is another vein cutting the formation, but striking N. 20° E. (mag.). This was originally opened up by a short crosscut tunnel about 20 feet below the outcrop and drifted on for a considerable distance, but the drift has now caved. A hole in the cave near the face of the drift shows a quartz vein slightly faulted, about 10 inches in width, well mineralized with pyrite and galena. A sample taken across the width of 10 inches assayed: Gold, trace; silver, 1 oz. to the ton. About 200 feet east of the above working, at a slightly lower elevation, open-cuts expose an apparently paralld quartz vein 6½ feet in width, but further work is required at this point to better expose this last-mentioned vein.

Further investigation of this property seems fully warranted. By way of preliminary, it is suggested that much additional information may be gained by further surface prospecting, which is greatly facilitated by the topography of the mountain-top and the absence of heavy drift-cover. There appear to be two intersecting vein systems on this property and it would seem advisable to first determine the approximate point of intersection. Open-cutting in the vicinity of the point of intersection is clearly advisable. Further surface work should be done to better expose the large quartz vein mentioned, and some trenching at right angles to the strikes of the veins would also seem well worth while, as it is quite possible that additional veins may be found.

An account of this property will also be found in "Placer and Vein Gold Deposits of Barkerville, Cariboo District, British Columbia," Memoir 149 of the Geological Survey of Canada, by W. A. Johnston and W. L. Uglow. Refer to pages 183, 184, 185, and 209.

QUESNEL MINING DIVISION.

Properties on Yanks Peak, Keithley.

Owing to the depth of snow on Yanks peak at the time of the visit of the Resident Engineer in October, properties on Yanks peak could not be examined. An account of the more important properties will be found in the 1929 Annual Report, since when it is believed that no great amount of development has taken place, other than that given below and compiled from information supplied by the respective owners. The most important properties are the *Yanks Peak*, *Midas*, and *Jane* groups, which merit detailed investigation. These are all situated in the south-eastern extremity of belt No. 2.

Yanks Peak.—This group is owned by H. Talbot and J. Larson, of Keithley. It is understood that the small mill in process of construction at the time of inspection in 1929 has now been completed.

Midas.—This group is owned by O. J. Pickering, J. Glover, and associates, of Keithley. They state that the crosscut tunnel has been advanced a total distance of 550 feet from the portal, and that to date a vein 3 feet 8 inches in width showing \$4 to the ton in gold values has been encountered. The surface showings on this property are good. The results of surface sampling by an examining engineer are given in the 1930 Annual Report. These, in addition to those given in the 1929 Annual Report, indicate that investigation is justified.

Jane.—This group is owned by R. Reinhold, of Keithley, who reports having opened up a new vein on the property, which, as judged by the sampling of examining engineers, exhibits considerable promise.

CENTRAL MINERAL SURVEY DISTRICT (No. 3).

REPORT BY H. G. NICHOLS, RESIDENT MINING ENGINEER (HEADQUARTERS, KAMLOOPS).

INTRODUCTION AND GEOLOGICAL DISCUSSION.

The mining of lode gold in the Central District has been confined almost exclusively to quartz veins of the gold-silver type of mineralization, and in this respect forms an exception to the past record of this particular phase of the industry in the Province generally. This characteristic is related to geological factors, and these in turn are identified with certain topographical features of the district, which are here briefly reviewed. A large part of the total area, occupying the greater proportion of the territory covered by the Clinton, Ashcroft, Kamloops, Nicola, and Vernon Divisions, is represented by plateau-like conditions, and this belt lies between a mountainous country associated with ancient crystalline rocks on the eastern border of the district, and the Coast Range mountains on the west.

The belt of Interior plateau is approximately 100 miles wide and reaches in north-westerly and south-easterly directions beyond the boundaries of the district. With exceptions to be noted later, it is a gently undulating country, embossed with recent volcanic accumulations and intersected by deep river-valleys; the western border of this belt is serrated by mountain-spurs, flanking the peaks of the Coast range, of which an important section is included in the district. On the east again there are distinct characteristics represented by the mountainous country forming the western flank of the Gold range (Columbia system), which passes north-westerly through the Cariboo and south-easterly into the well-mineralized Lardeau country. There are thus three main belts, each with its characteristic features affecting mineralization.

The plateau area is for the greater part underlain by volcanic and sedimentary rocks, of which vast accumulations were deposited previous to the period of upheaval and intrusion that resulted in the formation of the Coast range. These were greatly crushed, fractured, and contorted by the same movement, but without the features of high relief that elsewhere resulted in the deep exposure, by erosion, of the underlying intrusive rocks. Throughout this area erosion has succeeded in doing little more than expose the original surface of minor batholithic intrusions which are found as more or less isolated stocks, and it is significant that mineralization of one kind or another, and of varying degrees, occurs in all these areas.

The fact that, owing to the low relief, the heart of these intrusive masses has not been penetrated by erosion has an important bearing upon the discovery in the plateau area of lode-gold deposits of economic extent; such fissuring in the intrusive rocks as is revealed is of superficial character, and may very well be more erratic and less persistent than that identified with more stable conditions of consolidation. A further factor affecting economic concentration is the crushed and contorted character of the overlying rocks, by reason of which mineralization has been dissipated, rather than collected in veins and ore-shoots of commercial value. The wide extent of this mineralization, however, is a feature of striking encouragement to development at greater depth.

More positive evidence of the favourable structural conditions affecting vein formation likely to be encountered at deeper horizons is to be found in the fact that the great majority of our valuable gold-mines are on the flanks of the Coast range of mountains, where erosion has played a more important part. It is to be noted that production has been almost exclusively from the Bridge River area, where gold-silver quartz veins are developed in the heart of an intrusive mass that has been deeply incised by erosion. It by no means follows, however, that production in the future is to be limited to this class of vein, and the foregoing remarks are intended as an introduction to the consideration of factors having a bearing upon future discoveries.

A considerable portion of the Coast Range belt is included within the district, but this has not been prospected to anything like the same extent as it has been in the coastal region, where access by the many fiords has assisted greatly in the search for mineral-deposits. The approach from the east is in many regions highly inaccessible and prospecting has not reached much beyond outlying spurs of the range. There is still a great deal to be done in this direction, and it is entirely possible that deposits of a different character will be discovered in the more remote mountain regions, having relation to the exposed cores of batholithic rock. In such areas it is

reasonable to look for those high-temperature deposits largely associated with copper minerals, but in which the gold content is to be regarded of more than associated value. Such deposits are represented by the Rossland ores.

The difficulties attending development of ore-bodies in the plateau area have already been hinted at, and are largely responsible for the meagre production in the past. The widespread mineralization, however, embraces several different types of gold ore which call for individual attention. One type, of which evidence has already been obtained in several localities throughout the district, is gold ore associated with arsenopyrite; several prospects, which will be alluded to in more detail, have been discovered in areas not far removed from intrusive rocks. Sulphide ore-bodies of the lead-zinc-silver type are also found carrying a valuable gold content, and in a few cases, where structural conditions are favourable in more massive and less contorted rocks, there is promise of a valuable ore-supply to be developed. Further possibilities are in relation to deeper development of bedded deposits in the crystalline rocks occupying the eastern belt. The near-surface mineralization in this belt is chiefly of the lead-zinc-silver type, but there are some indications of a possibility of a change of this type to that of copper-gold with depth. These indications are found near intrusions of batholithic rock. It is of significance that several streams draining areas composed exclusively of these rocks have been found to carry alluvial gold. Lastly, indications of gold are found in conglomerate formations. A considerable amount of importance was placed upon the possibility of such gold content by Dawson, more particularly by reason of the close association of areas of this formation with placer-gold occurrences. Up to the present time no economic content has been discovered in these conglomerates, but it is entirely possible that horizons may be discovered in which an economic content has been introduced by cementation.

SUMMARY OF LODGE-GOLD OCCURRENCES.

Every Division of the district is represented in the known areas of lode-gold mineralization. In the Yale Division, which is wholly identified with batholithic conditions related to the Western range of mountains, there are gold-quartz veins with low silver content closely identified with intrusions of granitic rock and developed for the greater part in a slate formation. There are also copper-gold replacement deposits in brecciated quartzite.

In the Nicola Division, which lies entirely in the plateau area, there are siliceous lead-zinc-silver veins with notable gold content occurring in greenstone; and also copper-sulphide deposits from which gold recoveries have been obtained in zones of secondary enrichment. Both of these types are related to near-by intrusive masses.

In the Vernon Division—in the upper half of which the eastern belt of crystalline rocks is represented, the lower half lying in the plateau belt—there are mineralized stockworks bordering minor intrusions of diorite in which gold is found associated with lead and silver sulphides; several small gold-quartz veins have also been discovered in broken formations, and there are areas deserving of more development where intersecting veins and bodies of quartz of considerable size are found to carry low gold values. Gold is also found as telluride associated with kidneys of pyrrhotite in massive quartz-outcrops.

The Kamloops Mining Division, of which the south-western portion covers typical plateau country, the north-western section being occupied in large part by the western fringe of the eastern belt of crystalline rocks and embracing many areas of more recent intrusive, covers a wide variety of types; on the south, gold values are found in sheared granite associated with a low-grade copper mineralization and in quartz veins occupying irregular fissures in isolated stocks of granite. On the east, in the Shuswap area, similar occurrences of gold in quartz veins have been found, and more towards the centre of the Division veins carrying magnetite with a gold content in telluride form have been developed; in the same area gold is found associated with arsenopyrite in an altered limestone formation near an intrusive contact. To the north, extensive bodies of quartz in massive and vein-like form are found in the eastern belt of crystalline rocks which are here developed to a great thickness, there being no sign of intrusive rocks in the vicinity; these quartz-bodies carry free gold irregularly distributed.

In the Clinton Mining Division, which, with the exception of a small corner at its southern extremity, covers typical Interior Plateau country, prospecting is seriously hampered by the topographical conditions. In the southern extremity, taking in a section of the east flank of the Coast range, interesting discoveries of gold have been made as a surface eluvial deposit, and

gold is also associated with copper in wide zones of shearing in the batholithic rock. Gold values are also reported to have been discovered in copper-bearing quartz veins around an isolated stock of intrusive in the north-eastern corner of the Division, and a low gold content is found in a conglomerate formation of considerable extent bordering the Cariboo road.

In the Ashcroft Division, where the border-line between the Coast Range conditions and the Interior plateau is represented roughly by the valley of the Fraser river, lenticular bodies of quartz, occupying shears in granite with some spots of high gold enrichment, are found in the western section, while, on the east, gold-quartz veins are found in volcanic formations which in some cases have no immediate relation to granitic rocks.

The Lillooet Division, which reaches farther up into the Coast range than any other section of the district, provides practically the entire gold production of the Central District at the present time; this is derived from quartz veins occupying well-defined fissures in the cores of batholithic rocks. Several other interesting occurrences are found along the flanks of the range, including surficial gold-bearing deposits derived from veins of arsenopyrite with high gold content, and bodies of gold-bearing quartz in zones of fracturing and as irregular and isolated deposits in shattered formations near intrusive contacts. Notable gold values are also found in sulphide replacement bodies occupying shears in roof-pendants; the gold is associated with lead and zinc minerals in massive pyrrhotite.

DESCRIPTION OF PROPERTIES.

(Arranged alphabetically under Mining Divisions.)

KAMLOOPS DIVISION.

Allies. This property, owned by O. S. Batchelor, of Kamloops, and associates, is situated at a distance of $5\frac{1}{2}$ miles west by north of Pass lake, at an elevation of about 3,700 feet. A series of open-cuts, starting near the creek-bed of Middle fork, a tributary of Tranquille creek, and reaching up the ridge of the hill for a distance of about 400 feet, exposes more or less similar conditions of mineralization. The principal attraction is in connection with some decomposed heavily iron-stained material from which free gold may be panned. This is found alongside broken seams of quartz with a heavy pyrite content and also carrying copper. The notable feature is that in every one of these occurrences, excavations, as far as they have gone, have shown the decomposed material as well as the quartz to merge into seams and layers of blue clay, and in several cases that were examined the quartz, although appearing in vein-like formation, was found to peter out as disintegrated fragments and to be lost in the decomposed clayey material. In the lowest workings, near the creek, two or three similar occurrences of quartz and rusty material, mixed with the clay, are found, and there is also a belt of hard rock classified as a silicified porphyry passing through the mineralized zone. The workings on the hill lie in an approximate east-west direction and the porphyry has an apparent strike of about N. 30° E. Although some indications have been found on the eastern side of this intrusive, most of the showings lie to the west, and it is believed that these will be found to be more or less parallel with the intrusion.

Occurrences of a feldspar porphyry higher up the hill and lying to the north of most of the workings, near a short prospecting-tunnel, indicate that the intrusion is not a regular dyke, but will be found probably shot through the whole formation, and this is held to be the explanation of the occurrence. The clay is very evidently an end product of decomposition of the olivine-basalt, which is the country-rock, kidneys of the unaltered basalt being found within masses of the clay, and the probable explanation of the occurrence is that an olivine-basalt formation, in which gold-bearing quartz veins occurred in a more or less definite zone, has been intruded, extremely shattered, and decomposed.

The occurrence of large boulders in the broken-up surface material makes prospecting difficult and the gentle slope of the hill does not offer much chance for tunnelling. It is, however, recommended that a crosscut tunnel should be started close to the bed of the creek on the eastern side of the porphyry dyke and be driven in a general westerly direction through the dyke and below the open-cut workings, where it is hoped that the boulder conditions of the surface will be got away from and there will be a chance to sample the several quartz occurrences with a view to driving in on any one of them that shows promise of persistence. A picked sample of the decomposed material assayed: Gold, 2.86 oz. to the ton; silver, 5.40 oz. to the ton.

Big Slide. This property is situated at the mouth of Kelly creek, which flows into the Fraser river at Pavilion, some 20 miles above Lillooet. A description of this property appears in the Annual Report for 1928, page 214. Development-work has been in progress during 1931 and it is understood that plans have been made for more active operation.

Blue Ice. Situated in the Clearwater area at an elevation of about 8,000 feet, this group covers gold-quartz occurrences at the head of the North fork of Hobson creek, in zones of fracturing in a formation consisting of "metamorphosed quartzose sediments, including massive quartzite, quartz-pebble conglomerate, and quartz sericite-schist, with interbeds of limestone and argillite." The zones have been prospected by surface cuts; the mineralization is erratic, consisting of pyrite, siderite, galena, and chalcopyrite, and the gold content, as determined by sampling, is low, although higher values are reported to have been found. One sample taken across a width of 4 feet of quartz assayed: Gold, 0.40 oz. to the ton; silver, 4 oz. to the ton; lead, 0.2 per cent. The property, which is held by Eastern interests, represented by J. Errington, of Toronto, is described at some length in the Annual Report for 1929, page 219.

Gold Hill. This property is situated near Chu Chua, on the North Thompson river; and is owned by G. Fennell and H. Skonig, of Chu Chua. Mineralized zones, identified with shears in a greenstone formation, have been found to carry free gold in quartz stringers, associated with galena. Some quite coarse gold has been found. One zone can be traced for over 1,500 feet, with a maximum width of about 20 feet. The property is described by W. L. Uglow in the Summary Report, G.S.C., 1921, Part A, page 99, and in the Annual Report for 1928, page 211.

Homestake. This property is situated on Jamieson creek, in the North Thompson River valley. Massive bodies and veins of quartz occur in shears and fractures in granite. Some high values in gold have been obtained, but there has been little development and the mineralization as exposed in surface showings is erratic. The property is described in some detail in the Annual Report for 1930, page 189. The owners are T. Bulman, O. Redpath, and associates, of Kamloops.

Lakeview. A considerable degree of interest was aroused by the discovery in 1930 on this group of high gold values associated with arsenopyrite in a massive body of pyrrhotite and magnetite in a limestone formation about 14 miles west of Mount Olie, on the North Thompson river. The property, which was located by P. Johnson and F. Lambert, of Mount Olie, was bonded almost immediately by the Premier Gold Mining Company. The original discovery consisted of a body of massive sulphide about 6 feet wide, exposed to a depth of 6 feet in an open-cut crosscutting what appeared to be a well-defined zone of mineralization about 30 feet wide. Samples showed a high content in gold and a 3-inch seam of clean arsenopyrite yielded on assay 12 oz. gold to the ton.

Work by the Premier Company from July to the end of February, 1931, consisted of open-cut workings to the north and west of the original cut in order to determine the extent of the pyrrhotite, and of tunnel-workings 18 feet below the surface. The open-cuts were not deep enough to give conclusive results, but it appears that towards the north the pyrrhotite gives place to magnetite, and towards the west, and higher up the hill, there is an altered limestone where it would not be found on the original theory of the direction of the mineralization.

Some work was also done in the original open-cut which showed the arsenopyrite to be confined to one streak rather than as being disseminated through the pyrrhotite, and it is possible that this one high-grade streak may have salted all the samples from the cut. In the underground workings a tunnel was driven slightly to the north of the pyrrhotite-body in the open-cut which should have intersected the continuation of the arsenopyrite seam, but no arsenopyrite was found. Four branch tunnels were driven exploring the ground under the open-cut and around it, but with the exception of occasional blocks of pyrrhotite no definite mineralized seam was found. An important feature, however, is the occurrence of a porphyritic rock which was cut through obliquely by the tunnel to the point about where the arsenopyrite should have been encountered, and is also found in two of the branch tunnels, showing its contact to lie irregularly. Small grains of arsenopyrite have been identified in this porphyritic rock and a new theory of the whole occurrence is indicated.

It does not seem that there is any definite zone of fracturing in the limestone as was at first supposed, but, on the other hand, it appears as though the limestone had been intruded by

a porphyritic stock which has shattered and fractured it in several directions and is responsible for the deposition of gold-bearing arsenopyrite. This would account for the failure to pick up the arsenopyrite in the tunnel-workings, as the porphyry rock comes right up against the mineral at only a few feet below the open-cut. It points to the necessity for close investigation of this intrusive and to the possibility of the existence of other bodies of high-grade ore associated with its contact.

Under these circumstances the hesitation of the Premier Company to carry on development of a prospect which was originally supposed to be a plain-sailing proposition is hardly to be wondered at. At the same time the property warrants further investigation.

This is a prospect situated near Grindrod, in the Shuswap area, on which a
Sugar Loaf. fairly well-defined quartz vein occurs in a zone of crushing in quartzite. A short tunnel exposes a width of 7 feet; there is sparse mineralization with traces of gold, but no ore-shoot has been exposed in the limited workings. The owner is E. Smyth, of Grindrod.

On this group, situated in the Clearwater area, a number of lenses and massive
Summit. bodies of quartz occur in a sheared quartzite and sericite-schist formation. Gold values of variable amount are associated with a pyrite content. In a tunnel exposing a width of 25 feet on one lens, average samples have shown a value of around \$3 a ton, and selected samples of the clean pyrite taken from different points have yielded a gold content of from 1 to 2 oz. to the ton. The property, which is owned by Angus Horne and associates, of Blue River, is described in the Annual Report for 1927, page 192, and in subsequent reports.

This group is situated in the same area as the foregoing, but at a lower altitude, and is owned by A. Anderson and associates. There are a number of
War Colt. exposures of quartz indicating intersecting veins. An interesting feature is that at the lowest point of exposure there is a body of sulphide with a copper content of about 7 per cent., carrying low gold values. Values of about \$1 to the ton in gold are reported to have been obtained from the quartz veins, but these have not been confirmed. The property is described in the Annual Report for 1927, page 194.

This property is situated near Chu Chua, on the North Thompson river. The
Windpass. mineral occurrence consists of a quartz vein in pyroxenite which was found at the surface to carry free gold in association with magnetite, chalcopyrite, and pyrite. Exceptionally high assays were obtained from the lodestone variety of magnetite occurring at the surface; the gold also occurs in telluride associated with bismuth. The vein, which has a general east-west strike, and a northerly dip of approximately 45°, has been quite extensively developed to a depth of 300 feet and a considerable tonnage of ore has been blocked out. The values were, however, found to be erratic and the property has been idle since the year 1925. The owners are A. B. Trites, of Vancouver, and associates. Detailed descriptions of this mine are published in the Annual Report for 1925 and previous years.

ASHCROFT MINING DIVISION.

Ashcroft. Situated upon the eastern flank of a mountain range rising to a height of over 6,000 feet between the Thompson and Fraser rivers, at a distance of about 20 miles below Ashcroft, this property, comprising fifteen claims, covers occurrences of quartz veins in volcanic and sedimentary formations near the contact of a granitic rock. The particular rocks traversed by the veins appear to be volcanic agglomerates and dark-coloured argillites, which have been subjected to great disturbance and are much shattered. On the lower slope of the mountain, at a height of about 700 feet above the river-valley, two major series of zones of shearing are developed and in these zones bodies of quartz are found. In one series of these zones having a general north-northwest direction, the quartz is in the form of regular veins that may be traced for considerable distances. Attention was attracted, apparently, to this property, in the first place, by the deposits of placer gold alongside the highway and railway-tracks of the Canadian National Railway on the banks of the river. This placer-ground occurs at the bottom of a ravine which extends up the mountain-side and intersects the formation in which the quartz veins occur. Float carrying gold values was found at several points on this slope of the mountain and the fragments are similar in appearance to the vein-quartz. There are said to be three such veins, but one only was examined

owing to snow conditions at the time of inspection. This vein has been exposed by open-cutting in three places and the silicified zone of shearing may be traced through two claim-lengths. Where the quartz has been exposed in a ravine, which appears to be identified with the shearing of the rocks, it has the appearance of a well-defined fissure-vein; the principal showing consists of an outcrop from 6 to 7 feet wide. The quartz is slightly shattered and carries limonite; there are inclusions of sheared country-rock, and the walls, which are well defined, also show signs of shearing. At a distance of about 60 feet south of this showing, the vein is again exposed in a shallow cut, but this working has not been carried down far enough to expose its width; it appears to be from 6 to 8 feet wide. At a distance of about 550 feet north of the main showing and apparently on the same line of strike the vein is again exposed in an open-cut on the side of a ravine, having here a width of about 2 feet, but with many stringers passing into the walls; the dip in all cases is from 50° to 60° to the west. At a further distance of about 600 feet to the north, the same zone is exposed on a small ridge where quartz and country-rock alternate over a width of about 12 feet. Parallel veins are said to occur at distances of about 1,000 feet east and west of this central occurrence. Some exposures of quartz on the westerly occurrence were noted, but although the same general direction of shearing appears to be indicated, there was not the same evidence of continuity. It is claimed by the owners, H. Blair, of Vancouver, and associates, that gold values are to be found in all these exposures and that high assays have been obtained in certain cases. In view of the ideal conditions this property would represent a paying proposition with even moderate average values, and if further developments result in proof of such values it will be decidedly attractive; meanwhile it is to be stated that samples taken from the exposed faces showed only traces of gold.

This group of seven claims is situated at a distance of about 12 miles up the valley of Steyn creek, which flows into the Fraser river from the west, at about 5 miles north of Lytton. The location is at an elevation of between 6,500 and 7,000 feet, covering a precipitous ridge, below which is a small glacial lake which is the source of a small creek, locally known as Last Chance creek, which flows into Steyn creek from the south. The elevation of this lake is approximately 6,600 feet.

The mineral occurrence is represented by prominent lenticular bodies of quartz outcropping across the face of the craggy rock bluff in a general north-east and south-west direction. These bodies of quartz, which are not continuous, appear to occupy a zone of fracturing in the predominating coarse biotite granite which underlies the whole of this area.

The several lenses range up to about 150 feet in length, with an apparent width of from 6 to 12 feet, including bands of altered granite. They have a flat dip towards the south-east, and while apparently occupying the same zone of fracturing the outcrops peter out rapidly. Two of these outcrops were inspected and the occurrence appears to conform to the description of similar bodies of quartz elsewhere, described by Dawson, as follows:—

"The granite is considerably decomposed and in the vicinity of the veins is highly siliceous. The veins themselves are composed of quartz, sometimes holding fragments of granite and showing pyrites, with a little galena, blende, and tetrahedrite. It is probable that the date of origin of the veins is contemporaneous, or nearly so, with that of the intrusion of the granite-mass, and that its silicification and decomposition happened concurrently with the segregation of the vein-quartz, which often forms irregular stringers characterizing certain zones of the rock."

At another difficultly accessible point which, in the time at disposal, was not inspected closely, it is stated that high gold values are obtained, and it is not improbable that such occurrences might be found in deposits of this description, although the general character does not afford promise of either tonnage or average values calculated to make the operation of this property a paying proposition. It is stated that the quartz outcrops on the other side of the ridge, but that the lenses finger out into small stringers.

The several claims of this group are held by Indians, the original discovery having been made three or four years ago. It is understood that an option agreement was entered into last year with W. D. Munro, of Hope.

This claim represents a relocation of an old property upon which a tunnel was driven in pre-war days to prospect occurrences of quartz on Gladwin creek, close to the public highway, at a distance of about 14 miles below Spences Bridge, on the Thompson river. On a precipitous hillside extensive bodies of a white glassy quartz occur in an altered volcanic formation close to a granitic contact and intersected by a series of quartz-felsite dykes. The old tunnel was driven for a distance of about 275 feet to

intersect one of these bodies of quartz, from which it is reported that assays of about \$4 a ton in gold had been obtained. This tunnel has been extended by the present owners, W. S. Clark and Freeman Armstrong, of Spences Bridge, encountering a badly fractured formation in which there are wide zones characterized by secondary quartz and considerable pyrite. The rock appears to be a siliceous tuff or quartzite and is also extensively impregnated with pyrite; no gold values were found in this material.

Operations of more than usual interest are being carried on by D. B. Sterrett upon a property situated around Vidette lake, about 43 miles north of Savona, at the head of Deadman creek, at an elevation of about 3,000 feet above sea-level. There is here an area of Nicola greenstones that is intersected, on both sides of the narrow chasm occupied by Vidette lake, by a series of gold-bearing quartz veins. These veins are narrow and appear to belong to two distinct series, one of which has an apparently north-south strike with a dip to the east, the other lying in a north-westerly direction with a dip to the north-east. The principal vein of the first-named series outcrops at both sides of the lake and has been exposed in a number of open-cut workings.

To the north the ground appears to be considerably disturbed and the persistence of this vein is open to question; on the south side, however, fairly uniform continuity is indicated and tunnel-workings are in progress with the object of proving the occurrence in depth. A vein of the latter series is exposed in open-cut workings along the side of the hill on the north side of the lake and is being developed by incline shaft-workings. The width of this vein varies from a few inches up to about 18 inches, so far as developed at the time of examination, the average width being about 6 inches. Subsequent development has resulted in opening up a vein 18 inches wide at a depth of 65 feet, from which assays of \$30 to the ton are stated to have been obtained. Systematic sampling has been carried on in all the workings and it is calculated that an average value of around \$25 a ton is assured for the limited tonnage so far developed. On the assumption that an amount of from 500 to 1,000 tons of such ore was proven with the possibility of considerable increase as operations proceeded, Mr. Sterrett decided to install a treatment plant and a considerable amount of work has been accomplished in this direction.

A road of about 5 miles from the end of the existing road to the property has been constructed with assistance from the Department of Mines, and machinery has been taken in and erected. This undertaking represents a creditable attempt to develop an attractive small property out of returns from operations.

CLINTON MINING DIVISION.

Buzzer. This group, owned by E. J. Taylor, of Vancouver, is situated in the Tascko Valley (Whitewater) area. It covers zones of alteration in a granitic rock in which gold values associated with copper minerals are found over considerable widths. The property is referred to in the Annual Report for 1928, page 213.

Flanking the Cariboo road and intersected by the valley of Maiden creek, **Maiden Creek.** a tributary of the Bonaparte river, about midway between Ashcroft and Clinton, there is a belt of sandstone and conglomerate formation from which it is reported that samples have been obtained yielding low gold values.

The sandstone conglomerate formation in this area lies in a belt described by Dawson as being approximately $2\frac{1}{2}$ miles wide and having a total thickness of not less than 500 feet. The beds have a strike of approximately east-west magnetic, with a dip of from 10° to 15° to the north. The formation is exposed in several places along the valley of Maiden creek, where hillsides are for the greater part covered with overburden.

There is some question about the age of this formation. Dawson* is inclined to refer the formation to the Tertiary, but admits the possibility of it representing an outlier of the Cretaceous, which he has indicated as the possible source of much of the placer gold in the Fraser river. It is to be noted, however, that the gold-bearing possibilities of this sandstone conglomerate are not restricted to forms of Cretaceous age and Dawson reports gold content from Tertiary conglomerate. In this connection the following extract from his report,* page 314, is of interest:—

"It thus appears that, in three localities of the occurrence of the peculiar cherty conglomerates of the Lower Tertiary, traces of gold have been found. In three other Tertiary con-

* Kamloops Map Sheet, page 66, G. M. Dawson, G.S.C.

glomerate specimens, and in the two only specimens of Cretaceous conglomerates examined, no gold has been found. It may, I think, be assumed that wherever traces of gold can be detected in a hand specimen of conglomerate, it is worth while to further examine the deposit, to investigate particularly its lower layer upon the old bed-rock if this can be reached, to test in succession each of the superposed beds which shows points of difference, and to seek for any layers in which notable quantities of pyrites, magnetite, or other heavy minerals have accumulated. Magnetite is perhaps the most constant associate of gold in placer deposits of all kinds, and a ready mode of ascertaining its presence in conglomerates is found in pulverizing these and applying the magnet to the powder."

In the precipitous bluff which is covered by the *Beatrice* claim alternating beds of sandstone and pebble conglomerate are exposed covering a vertical range of approximately 200 feet. Samples taken from various horizons failed to yield more than traces of gold, but the range of possibilities could only be covered by systematic prospecting. It is interesting to note that alluvial gold is reported to have been recovered from the bed of Maiden creek.

Situated in the Taseko Valley (Whitewater) area, this group covers occurrences similar to those of the *Buzzer* group. Surface sampling of a zone

Mother Lode. 70 feet wide afforded encouraging results in regard to gold content, and this property was bonded by the Consolidated Mining and Smelting Company of Canada, a certain amount of underground development being carried out in the season of 1928. The results of this work were inconclusive, but owing to lack of sufficient encouragement in the work accomplished and to difficulties of transportation, etc., the work was suspended. The property is referred to in the Annual Report for 1928, page 213.

Spokane. This property is located in the same general area as the *Mother Lode*, having been under option to the Consolidated Company at the same time as that property. It is stated that considerably higher gold values were obtained from the mineralized zone on this group than from the other occurrences. Work was confined to trenching. This property is also referred to in the Annual Report for 1928.

Timothy Mountain. Complex ores, in which the principal minerals are chalcopyrite, bornite, pyrite, galena, and sphalerite, in quartz gangue, occurring in sheared quartz diorite, on the summit of this mountain in the north-east corner of the Clinton Mining Division, are stated to carry notable gold values. These veins and the reports of assays obtained are described in Memoir 118 of the Geological Survey of Canada, page 97.

Windfall. High recoveries in gold have been obtained from a small vein occurring in volcanic tuff formation and overlying the granite-contact in the Taseko area. The gold is found in disintegrated material at the surface, amenable to panning, but a considerable amount of underground work failed to locate the vein at any depth. This property as well as the *Buzzer*, *Mohawk*, and *Spokane* groups are described in the Summary Report, 1928, Part A, G.S.C., page 89 *et seq.*

LILLOOET MINING DIVISION.

Alpha. A mineralized zone in which gold and silver values are associated with pyrrhotite, galena, sphalerite, and stibnite occurs in a shear in the Bridge River series, and the *Alpha* claim, covering the occurrence, was located by W. Davidson, of Bridge River, at a distance of about 1 mile below the junction of Gun creek with the Bridge river. Samples showing a gold content up to 0.5 oz. to the ton have been taken, but these values are spotty, and the average content, over widths ranging between 2 and 4 feet, is low—namely, from a trace to \$2 in gold and a few ounces in silver to the ton. The property was bonded by the Consolidated Mining and Smelting Company of Canada and a tunnel has been driven on the shear for a distance of over 400 feet. The property is described in the Annual Report for 1930, page 202.

Anderson Lake Mining and Milling Co. This company owns a group of claims situated on McGillivray creek, which discharges into Anderson lake from the west. At an elevation of about 3,500 feet, large bodies of quartz occur over a considerable distance up the steep hillside on the north side of the creek. Much tunnelling and stoping-work was carried out about twenty-five years ago on a vein reaching a width of 21 feet. A 10-stamp mill was erected, driven by water-power under a head of 320 feet. Treatment of 6,000 tons of ore is reported to have yielded about \$4,000. The production was mostly from occurrences of rich streaks found generally on the walls of the ore-body. The property

has been optioned to C. Noel and associates and work during the past two years has been devoted to extending a lower tunnel between 200 and 300 feet below the ore-shoot previously worked. About 100 lb. of exceptionally rich specimens of ore were obtained from these workings, but the general average of the vein is low grade.

The occurrence appears to be a heavy deposition of quartz along a zone of shearing and dislocation in a formation consisting of intercalated beds of volcanic (tuffaceous) rock and a sedimentary (black argillite), with some bands of limestone. The character of the deposit is influenced largely by the amount of argillite included in the shear-zone; several bands of more or less altered sedimentary rock are included in the vein-like structure and high values appear to be associated to a great extent with these inclusions.

The extent of dislocation is also related to the interbedding of the two formations, and at the face of the lower production-tunnel, where operations were suspended by the old-time owners, a complete swing of the shearing is found, and the quartz appears to die out almost entirely within a distance of about 20 feet.

Twenty feet back from the face where the tunnel is swung round towards the west in badly broken country, quartz is found over a width of about 18 feet, and at a short distance farther back in the tunnel a raise was put up to surface, from which stopes were carried on massive quartz averaging about 20 feet wide.

This ore-body has a pronounced dip towards the east, whereas the ore-body exposed at the portal of the lower tunnel (in which present operations are being conducted) shows a steep dip towards the west.

It is also noted that the position of outcrops on the hillside below, notably at the old mill-site (some 500 feet below), which lie towards the east of the general line of strike, does not correspond with this westerly dip, and it is believed that further development will show that the dislocation is a more important factor than the shearing in determining the trend of the quartz-deposition. It is stated that outcrops on the surface extend for a considerable distance up the hill towards the north and beyond the point on which the quartz was found to peter out in the lower production-tunnel.

It is stated that low gold values have been obtained on sampling from large widths of quartz, and in view of the occasional high values the property deserves big-scale development. Facilities for this development are excellent, calling for a minimum of dead-work.

This property, which is generally known as the *Eldorado*, consists of a group of five claims situated in the *Eldorado* basin of the Bridge River area and is owned by Grant White, of Bridge River. The southern slope of *Eldorado* mountain is covered with a much-decomposed material from which assays in gold are obtained over an area extending laterally for about 1,000 feet and to a height of about 600 feet above the basin. This gold-bearing material is characterized by a reddish colour due to the oxidation of veins of arsenopyrite having directions varying between north-west and south-east and east and west, with varying dips. The character of this decomposed material is not determined. According to McCann's report, the whole of this area is occupied by sedimentary rocks of the *Eldorado* series, but the summit of the mountain is undoubtedly composed of granodiorite, although argillites occur around the base of the mountain and form the adjoining ridge on the west side of the main fork of the creek. The first impression gained is that the whole of this decomposed material is to be classed as a very much altered granite. At one point near the summit of the mountain, however, at an elevation of about 7,400 feet, the general structure is that of bedded sedimentaries, but the presence of crystalline structure points to the possibility of even these rocks being sheeted sills of granodiorite. The direction of these beds or planes is east-west (mag.), with a dip of 55° to the north, and on the precipitous north side of this eastern part of the mountain a well-defined zone of fracturing cuts across these planes almost at right angles, with a dip of about 60° to the south-east. The direction of this zone is approximately north-east and south-west (true) and it lies up with the whole of the mineralized area on the southern slope; that is to say, allowing for the dip, this zone would be exposed at surface over practically the whole of the area in which the mineralization is found.

The gold is undoubtedly related to the decomposition of veins of arsenopyrite in this zone and weathering has produced a surficial deposit extending to a depth of several feet from which gold may be panned almost anywhere. Gold can also be panned on the gravelly soil of the basin between the two forks of the creek running around the southern and western flanks of

the mountain. Particular attention has been paid to veins in this zone varying from a few inches up to 3 feet and over, in all of which arsenopyrite is a particular feature.

Two tunnels have been driven—one on a vein lying almost horizontally for a distance of about 45 feet, and the other on a nearly vertical vein which splits up in a distance of about 30 feet. Below these tunnels a wide vein with a flat dip towards the east is exposed in an open-cut where there is a considerable width of oxidized material and a vein of solid arsenopyrite about 12 inches wide. This latter is said to carry about \$40 in gold to the ton and an average of about \$12 is claimed for all the veins. Some encouraging assays have been obtained from samples taken.

The occurrence has been described as a blanket proposition owing probably to the fact that a number of costeaning-ditches have cut down through the surficial deposit to depths of about 6 feet; there is little doubt, however, that the mineralization is definitely related to the zone of fissuring and this may go to considerable depth. Arsenopyrite is to be seen staining the strata on all the surrounding mountains; in these occurrences the seams are all more or less localized, but on this southern slope of the mountain the mineralizing solutions appear to have percolated throughout the whole mass of the decomposed material.

This property is not without distinct promise. At the present time it is reached by a trail about 18 miles long from Tyaughton, the actual distance from Bridge River valley being about 12 miles. The elevation of the basin is about 6,000 feet.

A considerable production of gold was obtained several years ago from a **Golden Cache.** superficial deposit occurring in very broken formation and at a high altitude, some 8 miles up the valley of Cayoosh creek. Subsequent attempts to trace the ore-body underground were not successful.

This group is situated in the Tenquille basin of the Pemberton area, at an elevation of about 6,300 feet. The ore occurrence consists of a well-defined **Gold King.** shear-zone in roof-pendant rocks, in which a body of massive pyrrhotite has been exposed over a distance of about 500 feet by open-cutting and may be traced for a considerably greater distance over the surface. This body of mineral is approximately 11 feet wide, and in certain workings penetrating to about 26 feet below the surface evidence has been noted of an increasing amount of lead and zinc mineralization, samples from which yielded encouraging values in gold. The property is one which might be cheaply and easily developed by diamond-drilling and offers attraction on the score of the strength of the mineral occurrence and the possibility of gold values being found at some little depth. This property is owned by C. Barbour, of Pemberton, and has been referred to in Annual Reports of recent years.

Bridge River Area.

All the following properties are situated in this area and, as notable developments have been made in some of them, resulting in a considerable degree of importance to the industry of the Province, it may be well to insert a brief description of the general geological features of the ore occurrence. These developments in the Bridge River area are confined to the Cadwallader Creek section, where the greatest exposure of the gold-bearing formation is found. This area lies on the eastern flank of the Coast mountains and the topographical feature of chief importance is the deep erosion by which the ancient sedimentary and volcanic rocks have been exposed to great depth as well as stocks of plutonic rocks by which they have been intruded. The gold-bearing formation of this area is an augite diorite which is believed to represent a basic forerunner or differentiation product of the main batholithic intrusion. It is thus of a particular character and of a geologic age distinct from that of other granitic rocks in the district which do not present the same features of mineralization.

The mineralization is represented by free-milling gold-quartz veins occupying well-defined fissures in the augite diorite. These fissures also pass into and through the intruded schists and greenstones, but tend to fray out in these formations, and the economic value has been, up to the present time, definitely confined to the augite diorite. There are several tongues and stocks of this intrusive in the area, but the most important is the elongated and roughly crescent-shaped stock which is exposed on the east side of Cadwallader creek. Towards the north-west and south-east this tongue of augite diorite narrows preceptibly, the major dimensions being confined to a length of approximately $2\frac{1}{2}$ miles. The greatest width is approximately 1,000 feet.

Within the limits of observation permitted by the surface and underground workings, the contact between the augite diorite and the schists of the Bridge River series, the greenstones

of the Cadwallader Creek series, and a belt of serpentine which also occurs is irregular and roof-pendants of the intruded rocks are found in unexpected places.

The fissuring, which is so definitely related to the augite diorite, has been described previously as belonging to two systems, one parallel to the general direction of the diorite tongue and one transverse to it. Some recent observations, to be attributed largely to facilities afforded by development underground, point to the probability that all the fissuring is, to a predominating extent, marginal to the contact of the intrusive. However this may be, it can be said that the greatest development of veins of economic importance has been near the periphery of the augite-diorite stock. These veins have well-defined walls; they pinch and swell, reaching sometimes a width of over 10 feet and in the sections of economic development maintain an average width of about $3\frac{1}{2}$ feet. They are also locally faulted, but the disturbance is of no serious importance in regard to development, but owing to the disturbance of the walls where it occurs has been found to be some detriment to stoping operations. The higher-grade ore is identified largely with a ribbon-structure due to a sheeting of the quartz veins by subsequent movement. This sheeting action is more pronounced in certain other stocks of the augite diorite where the effect has been to produce silicified zones rather than well-defined quartz veins.

In the particular section under discussion and in which the greatest interest centres at the present time, the veins are composed of a milky-white quartz in which native gold occurs in fine particles and also distributed in association with pyrite, arsenopyrite, chalcopyrite, and as telluride. The greater part of this gold is free. As indicated above, rich shoots are found and in these places the gold is easily recognized with the naked eye, average values, applicable to considerable tonnage, ranging over \$50 to the ton. The general tenor of the veins, as developed, shows no diminution in depth and upon geological grounds the continuation in depth of the veins is to be expected within the limits of the augite diorite.

This property represents one of the attractive possibilities of the Bridge River area. The vein system, which has been extensively prospected near surface, has not yet been developed sufficiently at depth, although the large amount of tunnelling already carried out has thrown valuable light upon the structural conditions. The one vein, upon which most development has been done, possesses, in general, the same characteristics as the *Pioneer* vein, in that it occurs as a fissure in the same augite-diorite stock and the mineralization is practically identical. There are other veins upon the property, however, which, as so far developed, are found to exist in the overlying formation, and the ultimate prospects of the property will depend upon more intensive development of these veins at greater depth, where the possibility is indicated of continuance into the intrusive rock and of conditions of mineralization similar to those so far established for this area.

The property was acquired during the early part of the year by Bralorne Gold Mines, Limited, and an active campaign of development and mill-construction has been embarked upon. The development up to the present time has been mainly devoted to proof of ore on the *King* vein, although some further work has been done on the *Shaft* vein, where some high-grade ore was discovered at one point. The result of this work has been to outline a possibility of a tonnage to justify milling operations to protect the investment, and it is understood that a further programme of intensive development is to be carried out.

This property is the principal producer in the district and by reason of the results of more recent work constitutes the outstanding example of successful development in the Province. The *Pioneer* vein, occurring as a persistent fissure in the augite-diorite stock exposed on the east side of Cadwallader creek, preserves an average width of $3\frac{1}{2}$ feet to a depth as developed of over 1,000 feet, and the value as developed in the lower levels is slightly higher than that in the upper horizons of the mine. The vein often reaches a width of 8 feet and over, a ribbon-structure being characteristic of the richer portions from which assays of \$50 to the ton and over are consistently obtained. The actual recovered value in recent operations is around \$19 a ton in gold. Descriptions of this mine will be found in past Annual Reports.

The property was originally located in the year 1897, and following the suspension of the initial operations, in which partial development was carried down to a depth of about 230 feet below the surface by means of a vertical shaft, very little was accomplished until the year 1923, when an effort was made by David Sloan (for the original owners) to interest New York capital in it. The shaft was unwatered at that time to permit of an examination, but the proposition

was declined by the examining engineer. In July of the following year arrangements were completed between David Sloan and the owners, whereby a policy of development was commenced and financed entirely, with the exception of a small initial outlay, by returns derived from ore extracted from the old stopes. By the exercise of strict economy the same policy of development was carried on successfully during the two succeeding years, and by the end of 1926 the mine was partially developed to a depth of 500 feet and with a favourable outlook with regard to lateral extension. During the ensuing three years the property was acquired by Pioneer Gold Mines of B.C., Limited, with a capitalization of \$2,400,000. A new vertical shaft was put down and development carried on with establishment of ore reserves sufficient to warrant the erection of a new cyanide-treatment plant. This plant was operated for more than a year upon a mixture of ore from the mine and tailing from the previous operations, in which the latter predominated, and it was not until the year 1930 that the mill was run entirely on ore directly supplied from the mine-workings.

At the beginning of the year 1930 the situation was as described in the 1929 Annual Report, with available ore reserves above the 500-foot level practically exhausted, with the shaft down to the 1,000-foot level, and with drifting commenced on the lower levels. By the end of the year four levels had been driven, as follows:—

On the 625-foot level: East drift, 300 feet; west drift, 850 feet; total, 1,150 feet.

On the 750-foot level: East drift, 603 feet; west drift, 1,030 feet; total, 1,633 feet.

On the 875-foot level: East drift, 654 feet; west drift, 704 feet; total, 1,358 feet.

On the 1,000-foot level: East drift, 520 feet; west drift, 450 feet; total, 970 feet.

The production for the year 1930 was \$285,461, of which approximately \$62,000 was from ore stoped and the remainder from rock and ore extracted in development. The average value of all heads to the mill was calculated as from \$14 to \$15 to the ton.

The conditions of faulting which have been encountered throughout the mine-workings are not serious, the vein being always picked up again after passing through a disturbed section in the course of a few feet, and their chief disadvantage lies in the fact that the ore cannot be broken down as cleanly where they occur. Faulted conditions appear to be less prevalent on the lower levels than they are above, and the walls of the vein-fissure are strongly defined.

During the past year the stage has been reached at which the mine for the first time in its history is freed from the immediate demands of development and the 100-ton mill has been kept running on stoped ore alone. The result has been to show what this mine can do and the results have been most satisfactory. The production in bullion for the year 1931 was slightly over \$600,000 and the grade of ore produced from stopes from the eighth level has been well over \$20 a ton. At the same time intensive development has been carried on; the vein has been proved to extend for a distance of over 1,800 feet and both in point of width and general structure appears to be stronger at 1,000 feet than in the levels above.

A new shaft has been carried to a depth of about 200 feet below the 1,000-foot level, the ultimate object being to sink to a depth of 3,000 feet, and to open up five new levels by the time that the new mill, now under construction, is completed. This additional equipment is calculated to provide the total capacity of 300 tons a day and it is anticipated confidently that the output of this mine will increase steadily.

A hydro-electric equipment, capable of developing 750 horse-power, has also been installed, deriving power from the South fork of Bridge river, at a distance of $3\frac{1}{2}$ miles from the mine, by which the water-shortage difficulty for power will be overcome permanently. One hundred and twenty-five men, on an average, are employed at this property.

P.E. Mines. The Pioneer Extension Company holds groups of claims in the valley of Cadwallader creek above the *Pioneer*, where tongues of the same augite-diorite stock occur. Active prospecting is being carried out on quartz veins occurring in this area, from which encouraging values have been obtained.

Wayside. This property is situated on the north side of the Bridge River valley at a distance of about 5 miles from the Cadwallader Creek mines. A gold-bearing quartz vein is found in a zone of sheeting in a stock of diorite having more or less the same characteristics as the main mass. Some high values in gold have been obtained from this vein, but these are not consistent and the quartz appears to occur more as irregular inclusions in a sheeted zone rather than as a fissure-vein. This property is described in the Annual Report for 1927, page 216.

Why Not (Bridge River Consolidated). Quartz veins are exposed over a distance of about 600 feet on the side of a precipitous bluff at the northern extremity of the augite-diorite stock in the Cadwallader Creek area, and some high assays in gold have been obtained from surface workings. The *Why Not* and *Forty Thieves* groups, covering these exposures, are under option to Bridge River Consolidated Mines, Limited, and development-work is in progress.

NICOLA MINING DIVISION.

Planet and Donohoe. The series of veins occurring in the Nicola greenstone formation in the neighbourhood of Stump lake carry an appreciable gold content in association with the lead-zinc-silver type of mineralization which is their characteristic. These veins have been found to be fairly persistent and, although pinching and swelling within wide limits, preserve an average stoping-width of about 2 feet. Various attempts to mine individual members of this series of veins have not met with continued success, but sustained production may be anticipated from co-ordinated development under technical guidance. More recent operations in this field are described in the Annual Report for 1929, page 243.

Aberdeen. This property, situated west of Guichon creek, has been worked intermittently with the production of some high-grade copper ore, and from certain sections of the mine shipments were made of a chalcocite ore with gold content.

YALE MINING DIVISION.

A.M. A prospect relying in large measure upon gold values is that covered by the *A.M.* and *August* groups, situated near Cedar flats, on the Hope-Princeton road. This property has been bonded by the Consolidated Mining and Smelting Company of Canada and prospecting-work has been in progress during 1931. The mineral occurrence is represented by copper impregnation with associated gold values in a brecciated quartzite which covers a wide area on the slope of a high mountain flanking the Skagit River valley.

Work has been confined to open-cuts and shallow tunnelling and has not penetrated below the zone of oxidation; the rocks are greatly leached. The open-cut workings extend for a distance of about 900 feet along a zone of mineralization at least 250 feet wide which appears to have a general north-and-south direction, conforming to rather steeply dipping bedding-planes and certain well-defined but narrow seams of mineral. The economic importance of the property appears to be in connection with replacement in the brecciated quartzite. One tunnel, which has been driven for a distance of 60 feet in the solid rock, and along which systematic sampling was carried out, indicates an average content of 1.8 per cent. copper and about 75 cents in gold to the ton. The occurrence is at no great distance from an exposure of granitic rock. It is understood that the development of this property at greater depth will be resumed next year.

Aurum. Exceptionally high gold values in flaky form and associated with arsenopyrite have been found along shears in the serpentine-belt of the Coquihalla area. Gold-quartz veins are also found in the surrounding slate formation. More recently attention has been concentrated upon the latter form of deposit and work upon this group has been confined to prospecting one of such occurrences on the *Idaho* claim.

A crosscut tunnel has been driven for a distance of 115 feet at a vertical distance of about 130 feet below a quartz-outcrop, from which values in gold have been obtained. No particular body of quartz has been cut in this tunnel, but there is a wide silicified zone in the slates, including many small stringers of quartz. It is stated that an average value of from \$4 to \$5 to the ton is obtained over a considerable width of this zone.

A considerable amount of open-cut work has been carried out with a view to proving the continuity of this *Idaho* zone. The open-cuts extend for a distance of about 450 feet downhill and bands of silicified rock are found in all of them with disintegrated iron-stained slate. Small amounts of quartz occur and in one cut there is a width of about 3 feet of broken quartz.

The ground, in general, exposed in these cuts is more or less similar to that crosscut in the tunnel and to all appearances there is no definite vein; however, some high assays are reported to have been obtained and an average value of about \$1.60 to the ton in gold is claimed. In the second cut below the tunnel values of \$9 and \$22 to the ton are reported to have been obtained across several feet. In the cut below, a value of \$17 to the ton was obtained across 15 feet, and in the lowest cut but one an assay is recorded of \$95 to the ton across 5 feet. Gold

is found on panning in all these cuts and panning has been used as the guide in following the presumed zone. The impression is conveyed that the greater part of these values, if not all, may be due to the disintegrated surface material, of which a goodly proportion was included with all samples.

This property represents another gold-quartz prospect in the slates near the **Emancipation** serpentine-contact in the same area. In past years high-grade gold ore in limited amount was extracted from an ore-shoot near the surface, and latterly a tunnel has been driven from workings, which wander out into the serpentine, in order to get below this rich shoot. This tunnel has picked up the Dyke vein in which this ore-shoot occurred, and has been continued along its intersection with the flat crossing vein which was responsible for the higher values in the old workings. The tunnel is driven on the flat vein passing obliquely through and over it, leaving the Dyke vein exposed on its under-side. Free gold is found, associated with the two veins, for a distance of about 140 feet. It is noticeable that the "flat vein" nowhere passes through the Dyke vein, but, on the other hand, appears to lose itself in a system of fissuring and faulting, and the suggestion is created of this "flat vein" representing an individual streak of mineralization in a wider zone of fracturing. This condition affords greater promise in regard to the possibility of enriched shoots in the "Boulder" vein, a wider vein paralleling the Dyke vein on its foot-wall side. In this connection the marked change in the character of the Boulder vein in the far end of the workings where it passes away from the "flat vein" fissuring, and also the appearance of the Dyke vein in the same direction, make it appear probable that both these veins represent depositions of quartz in the slates that are related primarily to the "flat vein" fissuring system. The developments give strong encouragement to the idea of exploration from the lower "Barn" tunnel some 160 feet below, from which workings could be extended in the general direction of the downward continuation of an ore-shoot on the "flat vein" fissuring, which would investigate possibilities related to the Boulder vein and would also prove definitely to what depth the Dyke vein extends, or whether it is cut off at the serpentine-contact. The same possibility of being cut off applies to the Boulder vein, which is also dipping towards the serpentine; but with the possibility of the mineralization being primarily related to the "flat vein" system, which has an opposite dip, the chances for the extension in depth are greatly enhanced. From this point of view also, it is distinctly possible that the extremely flat dip of this vein may prove to be only a phase of the surface conditions of the ground lying between the two veins; in other words, the length of the ore-shoot that has been developed appears to open up a possibility of developing a mine on an ore-body dipping away from the serpentine-contact.

Assay plans show average values for the 140 feet of \$29 to the ton over a stopping-width of 3 feet. (The Dyke vein itself appears to vary between 6 and 14 inches.) It is noted also that, although the tunnel continues in quartz of the "flat vein" type, no regular walls can be followed; this also bears out the idea of a system of fissuring.

At one point just below the winze-workings the Dyke vein itself, where it is cut by one of the fault-fissures, shows remarkably high values with a considerable amount of visible gold. It is estimated that there might be an amount of about 1,000 tons of ore available above the new tunnel-workings and it has been decided to treat this ore on the ground. For this purpose the old mill has been reconditioned, and although operations were retarded by an undue amount of experimentation, some shipments of concentrate have been made. The property is controlled by Dawson Gold Mines, Limited, of Vancouver.

VERNON MINING DIVISION.

Jumbo. This is a gold-quartz prospect alongside the high road about 2 miles north of Vernon. Free gold in noticeable amount is found in small pockets in a broken vein, showing some pyrite mineralization in a contact area of argillite and a much-altered igneous rock; the whole formation being much disturbed. The property is owned by H. J. Blurton, of Vernon, who has done a considerable amount of prospecting-work, without, however, succeeding, so far, in proving continuity of the occurrence.

Skookum. Situated at a distance of $3\frac{1}{2}$ miles from Okanagan lake up the valley of Deep creek, this group is located at an elevation of about 3,700 feet. A large body of gold- and silver-bearing quartz is exposed in two open-cuts on a narrow ridge. The open-cuts are supposed to follow along the hanging-wall and foot-wall respectively

of a body of quartz 18 feet wide, each open-cut being about 25 feet in length. The quartz occurs in a tongue of argillite included in a formation which is held to be a very highly altered fragmental volcanic. The whole formation is considerably broken and mineralized as a result of intrusion by a granitic rock which is exposed at several points in the area. The quartz in the open-cuts is shattered, and it is believed that the whole occurrence represents a deposition of quartz along a zone of shattering in the argillites and that it is not by way of being an individual vein or even a main lead. It is probably an offshoot from a main vein which may be found existing under more favourable structural conditions, and it is notable that several outcrops of quartz of considerable width point to the existence of such a vein lying more or less parallel with the remarkably persistent vein on the *Pay Roll* group on the other side of Deep creek. Low gold values are stated to be found in all these outcrops; the area is one deserving of more thorough prospecting. The *Skookum* group is owned by H. J. Blurton, of Vernon.

This group, consisting of seven claims, situated on Monashee mountain, is owned by St. Paul Mines, Limited, a private company with headquarters in New Westminster. There are two more or less distinct vein systems on this property; one of these on the summit of the mountain was developed some years ago from shaft-workings and is characterized by the occurrence of free gold with silver values in quartz associated with lead and antimony sulphides; in the other, on the slope of the mountain, a network of quartz veins bordering a diorite-contact carry some gold values associated with pyrite and arsenopyrite and occasional high silver values in antimonial sulphides. A full description of the geology and workings is given in the Summary Report, Part A, 1930, G.S.C., page 116.

White Elephant. This property covers an occurrence of massive quartz in a granite area, in which gold-bismuth-telluride minerals were found associated with kidneys or lenses of pyrrhotite. The group is situated at an elevation of about 2,500 feet on the west side of Okanagan lake, some 5 miles from Ewings Landing. A rich shoot of ore from which some spectacular specimens were obtained was found in open-cut workings, and underground development-work has been carried out which is stated to have established a low average gold content over considerable width of the quartz. A small pilot-mill was erected for the purpose of making an iron concentrate for shipment from the gold-bearing pyrrhotite, but this attempt was abandoned in favour of operations to be conducted on a larger scale on the quartz-body itself.

LIKELY PROSPECTING AREAS.

(1.) The area lying west of the Fraser river in the Yale and Ashcroft Divisions and reaching north to Cayoosh creek. Gold-quartz veins in granitic rocks and sulphide replacements in limestone and sediments near intrusive contacts should be looked for. The area is difficult of access, but may be reached by way of the valleys of Nahatlatch river or from Cayoosh creek.

(2.) The heart of the Coast range lying west of the Lillooet river and around the headwaters of Bridge river and south of Chilko lake. A trail has been built for a considerable distance up the main fork of Bridge river. Gold-quartz veins in granitic rocks and massive bodies of copper ore and impregnations in volcanic rocks should be prospected for gold values.

(3.) The area lying to the west of Okanagan lake and along the divide between the Vernon Division and those of Nicola and Kamloops. There are several uncharted dykes and stocks of intrusive; quartz veins should be looked for. This is a likely gold area. Pack-horse transportation is fairly easy; one section may be reached by trail up Deep creek, flowing into the North arm of Okanagan lake.

(4.) The Adams River and Canoe River watersheds on the eastern border of the Kamloops Division. Pyritized quartz veins in schist should be prospected for gold, especially in the northern half. This area has hardly been prospected at all. Intrusive contacts may be looked for and followed in the southern portion.

(5.) The area on the west of the North Thompson river, south of Mahood lake, where there are several exposures of intrusive rocks and where occurrences of gold associated with arsenopyrite are to be looked for.

Broadly speaking, the prospects of lode-gold mining in the Central District may be classified as follows:—

First: In relation to the existence of high-temperature ore-bodies of contact, or replacement, type in the remoter areas of the Coast range lying to the west where prospecting has been retarded by conditions of relative inaccessibility.

Second: In relation to fissure-veins and shear-zones developed in the exposed flanks of the Coast range.

Third: In relation to similar occurrences in and around the isolated exposures of batholithic rocks in the interior and in fissure-veins developed in rocks of favourable texture such as are represented by highly altered diabase in certain areas.

Fourth: In relation to more extensive prospecting and deeper development in the eastern belt of crystalline rocks.

In conclusion, it may be said that the district presents varied attractions for the intensive search for lode-gold resources that is forecast for the coming season.

SOUTHERN MINERAL SURVEY DISTRICT (No. 4).

REPORT BY P. B. FREELAND, RESIDENT MINING ENGINEER (HEADQUARTERS, GRAND FORKS).

GRAND FORKS MINING DIVISION.

PAULSON SECTION.

This geologically interesting area has been prospected spasmodically by a few men for a number of years. Within a radius of 8 miles of Paulson, situated upon the Canadian Pacific Railway between Grand Forks and Nelson, there are many series of quartz fissure-veins occurring generally in the syenite on the east side and in the greenstone on the west. Most of these veins contain gold in variable quantities. This gold is in some cases free and in others is associated with galena, sphalerite, and chalcopyrite. To the south-east siliceous replaced limestone contains gold in pyrite and pyrrhotite. On the east side the quartz veins vary from a few inches to 6 feet in width, and, judging by intermittent outcrops, the zone persists for about 2 miles in length. At the south end the *Berlin* and *Alice L.* claims are located, and in 1918 142 tons averaging 3 oz. in gold and 15 oz. in silver to the ton was shipped. Shipments made from the *Cascade-Bonanza*, located to the north, were:—472 tons, containing: Gold, 338 oz.; silver, 1,127 oz.; copper, 288 lb.

Many years ago some ore was mined and rawhided from the *Molly Gibson* mine, on the west side, to Coryell. This gold ore occurs in pyrite and pyrrhotite in lenticular-formed bodies in siliceous lime. The property is at present being prospected by J. Singer, of Rossland, under lease from the Molly Gibson (Burnt Basin) Mining Company, of Rossland, and shipments of ore are expected. On the *Motherlode*, on the west side, gold in its free state, also associated with pyrite, has been found in narrow quartz veins in the greenstone.

According to the owners of the *Motherlode*, free gold was discernible in one of the dykes adjoining the property. Small quantities of platinum were also recovered and were evidently associated and genetically connected with a basic gabbroidal dyke-rock which outcrops near the workings. On both sides of Paulson there are many comparatively young alkali-syenite dykes of Tertiary age, all cutting the older formations and probably related to the main mass of syenite which outcrops over an extensive area, chiefly to the east. On the west the geology is more complicated and the rocks have been subjected to several different periods of igneous intrusion and consequent metamorphism. The older series, including limestone, argillites, and greenstone, are the most attractive rocks in which to prospect.

Transportation facilities are excellent, and, besides the railway, a narrow but passable road leads from Christina lake up McRae creek to Paulson, a distance of approximately 15 miles, and thence 4 miles into the mineralized area on the east side. A 6-foot trail 4 miles long has also been built from the Christina Lake-Paulson road to the *Molly Gibson*, with other trails leading from it. A small but comfortable hotel and store are located at Paulson. The Trail smelter is situated 55.4 miles by railway from Paulson.

LIGHTNING PEAK SECTION.

This area includes the headwaters of the Granby river, Rendell creek, and smaller streams flowing into Inonoaklin creek and sections along the boundaries of the Grand Forks, Greenwood, and Arrow Lake Mining Divisions.

During 1930, C. E. Cairnes, of the Geological Survey of Canada, spent a short time surveying this area, and although in his general statement reference is made to the silver-lead-zinc deposits found in the highly altered volcanic and sedimentary rocks, which have been developed to a greater extent, particular attention may be drawn to his account of the "North and South" quartz fissure-veins, which are worthy of the prospector's attention. Part of his "Economic Geology" follows:—

"Interest in Lightning Peak camp has been sustained by small shipments of high-grade silver ore carrying, in some cases, important percentages of lead and values in gold and zinc. Attractive mineralization amounts are too small to be profitably mined, yet their presence has encouraged prospecting in the hope of finding better values and more substantial deposits.

"A belt of highly altered volcanic and sedimentary rocks, a mile or more wide and extending for several miles in a general east-and-west direction, is flanked by wide areas of batholithic intrusives and is soaked with granitic material and penetrated by many acid dykes of probably related origin. The older rocks are everywhere more or less severely altered, and as direct indication of mineral possibilities, outcrops commonly carry liberal impregnations of iron sulphide regardless of whether vein-matter is present or not. The porphyritic granite member of the batholith is correlated with the Nelson granite, which in Slocan district is host-rock to many valuable ore-deposits and is regarded as chiefly responsible for the extensive mineralization occurring elsewhere in that district. In Lightning Peak district this granite also contains significant mineral-deposits.

"Mineralization at Lightning Peak camp occurs mostly within the belt of pre-batholithic rocks, but a couple of prospects of possible commercial value have been located in the Nelson granite over a mile to the north of this belt. Within the belt, mineralization sufficiently attractive to warrant further exploratory work has been discovered at a dozen or more localities situated at intervals over a distance of about 4 miles from east to west across the area. Still others of less prospective value have been located at intermediate points, and doubtless other discoveries would have been made were it not that prospecting is in most places handicapped by an overburden of glacial drift, stream-wash, and soil.

"The other type of vein is represented by numerous quartz veins striking nearly north and south. These vary from a few inches to several feet in width and have been traced for distances up to 1,000 feet or more. In many cases they follow along one or other wall, preferably the foot-wall of narrow dykes of quartz porphyry, or may even occur in such dykes. These veins carry a sparse dissemination of pyrite. More locally and for distances of a few yards, mineralization may be much more pronounced, and in such cases it generally includes other sulphides, among which galena, sphalerite, chalcopryite, and grey copper or other high-grade silver minerals may be recognized. Commonly, too, these veins carry low values in gold amounting to a few dollars a ton. In places, selected samples are reported to have assayed \$30 or more in gold and up to 200 or 250 oz. in silver. The gold values are thought to be associated with pyrite and chalcopryite. No free gold has been observed. Quite a little surface or near-surface work has been done on a number of these quartz veins, but no production is recorded. On the A.U. claim of the *Waterloo* group a shaft has been sunk on such a vein for 35 feet, in which it increases from less than a foot to nearly 2 feet in width and shows, in general, progressive increase in mineralization, including towards the bottom and along either wall, bands or long, narrow lenses up to several inches wide composed of nearly solid sulphides.

"The relation between the north-south system of quartz veins and the east-west-trending mineralized shear-zones is uncertain. Though much the same suite of ore-minerals is present in both, the proportions are quite different. Pyrite, rather coarsely crystallized in general, is the characteristic and, commonly, the only visible mineral present in the quartz veins, whereas it is a very minor constituent of the other set, where, too, it mostly occurs in finely crystalline form. For the reason that gold probably accompanies the pyrite, gold values are a significant feature of the quartz veins and of negligible importance in the east-west veins. High-grade silver minerals are present in both vein systems, but are more abundant in the east-west veins, which include conspicuous amounts of ruby and native silver, whereas the north-south veins are more apt to contain grey copper. The inference is either that the two vein systems were formed at different times or under different conditions.

"The curious persistence with which so many of the north-south quartz veins follow along a wall or angle across dykes of quartz porphyry suggests either a structural or genetic relation-

ship between the two. That the relation is probably structural is indicated by the facts: That some veins occur quite independently of dykes; that some veins cut across the dykes; that the dykes themselves are rarely mineralized to any appreciable extent; and that dykes in places are faulted and mineralized vein-quartz occurs along such fault-planes.

"No intersections of north-south and east-west veins were observed. The 'Shaft' vein on the A.U. claim of the *Waterloo* group is, however, cut off, to the north of the shaft, by a strong east-west shear-zone, suggesting that this shear-zone as a whole is later than the north-south vein. This shear-zone is not mineralized, and even if it had been it might be uncertain whether mineralization had not occurred in both veins at about the same time and that displacement of the 'Shaft' vein was due to post-mineral movement along the east-west shear-zone. The matter appears to be worth investigation, as there is a possibility that if the two series of veins were formed at or about the same time, some concentration of values might be found at their intersections. A place where the condition should be readily explored is at the intersection of the 'Big' vein on the *Silver Spot* claim of the *Waterloo* group with a smaller north-south quartz vein."

Since Cairnes's survey was made the inclined shaft upon the A.U. claim was deepened to 70 feet and a drift driven 72 feet in a southerly direction, with a crosscut 40 feet long near the end and across the dyke. The vein faults to the west and the values in gold increased in depth from a few dollars to \$70 to the ton (recorded by the management). A sample of sorted ore taken from the bottom of the shaft and along the drift whilst the mine was being examined in September assayed: Gold, 1 oz. to the ton; silver, 24.5 oz. to the ton; lead, 10.5 per cent.; zinc, 8 per cent. This compares with a 10-inch sample taken 14 feet down the shaft in 1930, which assayed: Gold, 0.36 oz. to the ton; silver, 16.6 oz. to the ton; lead, 8.2 per cent.; zinc, trace.

The vein pinches and swells with a maximum width in the shaft of about 24 inches and an average of about 8 inches. Minerals found in this quartz vein are pyrite, galena, sphalerite, and chalcopyrite. In the drift from the shaft the vein is narrow, badly broken and warped, due to faulting and the intrusion of a narrow porphyry dyke. The junction of two veins, which was the original shaft objective, was not reached before the attempt was abandoned.

These north and south fissure-veins vary from a few inches to 4 feet in width and can be traced several hundred feet in length. On the surface the mineralization occurs in segregations and fractures sometimes widely separated and in many instances buried under deep drift. The increase in gold values in the A.U. shaft, however, is sufficiently attractive to warrant some deep prospecting, especially where there appears to be a chance of the veins joining.

Transportation was improved during 1930 and trucks and cars drove the 18 miles into camp with the assistance of planks to cover several of the deeper mud-holes.

SECTIONS BETWEEN LIGHTNING PEAK AND FRANKLIN CAMP.

About 40 miles of country lies between the Lightning Peak and Franklin Camp mineralized areas. Very little intensive prospecting has been done in this belt, and although the outcrops show a preponderance of granite, syenite, and many porphyritic phases of each, there still remains a sufficiently large distribution of sedimentaries, greenstone (highly altered sediments), and volcanic rocks to warrant further exploration, especially since transportation from the north and south has been so vastly improved. Porphyritic types of granite found at Lightning peak, and correlated by Cairnes with the Nelson granite, which was responsible for many valuable Slocan ore-deposits, also occur in this section and must not be overlooked. Thirty years ago prospectors were searching chiefly for iron gossan or large mineralized bodies containing copper. To-day, with the demand for gold, quartz-fissures, especially in the granite and greenstone, should receive more attention. Barren quartz should not be disregarded, but traced by surface cuts in case ore occurs in shoots or faulted zones, and outcrops only in certain localities in the vein. An old trail, recently cut out, traverses the high ridges from Franklin camp north.

FRANKLIN CAMP.

This camp has received much newspaper publicity during 1930 on account of some spectacular gold-quartz finds, both in the *Union* and on the *Homestake*, situated about 3,000 feet to the west of the *Union*. These discoveries were made in both instances in or near old workings and point to the ever-increasing need for more prospecting and development in many of our geologically favourable areas where there has been a concentration of mineral. A distinct handicap to mine-development is the fact that many owners of Crown-granted mineral claims have allowed

their workings to fall into disrepair, with the result that possible purchasers cannot examine or sample the ore. Demand for minerals and metals is ever changing, and with constantly improved transportation facilities and metallurgical methods, no mineral-showings, however meagre, should be disregarded by the owner, providing geological conditions are promising. The discovery of high-grade gold ore on the *Homestake* was the result of a hole drilled and shot in the side of an old inclined shaft. These workings have been idle for thirty years. C. W. Drysdale, of the Geological Survey of Canada, reported upon the Franklin Camp area in his Memoir No. 56. Excerpts from his "Economic Geology" were printed in the Annual Report for 1928. More recent developments have increased the possibility of finding gold ore in certain types of rocks, and since the output from the *Union* was chiefly silver in past years, the following suggestions may be of value to those intending to prospect for gold, both in the map-area and beyond it.

The *Union* mine is described quite thoroughly in past Annual Reports. During 1931, 56,666 tons of ore was milled. One car-load—54.6 tons—of high-grade ore from the new ore-body shipped to the smelter returned 41.05 oz. gold to the ton, 18.65 oz. silver to the ton, and 8.55 per cent. lead.

The rocks responsible for the *Union* and *Homestake* ore-bodies are still in doubt. Drysdale suggests the granodiorite as being the host-rock and correlates this mineralization with the Jurassic crustal and igneous disturbances, and this theory is very probably right. Absolute proof of the relation of the granodiorite to the copper-deposits on the *Glouster* has been noted. The only igneous rocks found so far in the *Union* workings are a narrow dacite porphyry and one pulaskite (alkali-syenite) dyke. Both these dykes cut through the ore-body and are therefore more recent. A very small outcrop of what appears to be monzonite in place was found close to the boarding-house and at least 100 feet below the lowest ore-body in the *Union*. This rock is comagmatically related to the augite syenite and more recent than the granodiorite. If the granodiorite is responsible for the gold ores found in the camp, it is possible that certain leads or fissures may be found at depth in the monzonite which overlies the diorite. If, on the other hand, the monzonite was the parent rock, as it is in other parts of the district, notably on Wallace mountain, Beaverdell, and the types of ore-bodies both there and in Franklin camp stimulate this supposition, then a search along the monzonite, greenstone, cherty-quartzite contacts may be recommended. The monzonite has been allotted to the Tertiary period and, as such, has not received the attention it should, in spite of the fact that several geologists who have examined the Boundary country have called attention to it. The relation of the monzonite, syenite, and pulaskite porphyry (locally known as "birds-eye") has been established. Practically all the ore-bodies of any note in the Boundary are associated with these types of rocks and their responsibility for ore-deposition has by no means been disproven.

On Drysdale's geological map it will be especially noted that the Franklin group of rocks (i.e., greenstones, cherty-quartzite, and altered tuff in which the gold ore occurs) are overlain by the Kettle River formation (i.e., conglomerate, arkosic grit, and acidic tuff, also trachyte-flows, etc.), so that there are extensive tracts of ground on the east and west strike of the ore that show no outcrop.

Some difficulty may be found in differentiating the greenstone of the Franklin group and the acidic tuff of the Kettle River group of rocks, both being very similar to the unaccustomed eye. The greenstone close to the mineral-zone generally has a slightly porphyritic and fragmentary structure made up of chert, ragged and often elongated inclusions of white limestone, and segregations of dark-grey, dense, and highly altered sediments, probably argillites, in a siliceous chloritized ground-mass. The acidic tuff as described by Drysdale is a light-grey rock with a decidedly clayey odour when breathed upon, due probably to the alteration of the feldspathic constituents. The rock breaks with uneven conchoidal fracture and varies in texture from fine granular to dense.

Attention may be drawn, at this time, to the shonkinite-pyroxenite and augite-syenite rocks which invade this section on the north-west. On the contacts of the syenite on the *Maple Leaf* platinum has been found associated with chalcopyrite and bornite. The same mineral was discovered in the copper-sulphide magmatic segregations on the *Buffalo* and *Averill* group.

To the south and west of the area mapped by Drysdale there is a continuation of similar types of rocks, which in place have yielded attractive values in gold. The greenstone-outcrops

are less frequent, being buried more often than not under flows and acidic volcanic tuffs. Comparatively large but isolated areas of this group occur on both sides of the Granby river, for many miles to the south, especially on the *Morrell* and *Robert Simpson* claims on the west side.

Owing to the lean appearance of most of the gold-bearing quartz in this camp, a considerable amount of assaying is essential. Transportation consists of a narrow motor-road 45 miles long from Grand Forks following the Granby river, and the Canadian Pacific Railway train running once a week between Grand Forks and Lynch Creek, a distance of 18 miles.

GREENWOOD MINING DIVISION.

BOUNDARY CREEK MINING DISTRICT.

The name of the Boundary Creek Mining District is used here because certain sections described below can be more easily followed by referring to R. W. Brock's geological map, 1905, under this title. This map covers a rectangle 14 by 17 miles, commencing at the International boundary south of Grand Forks and follows a line 14 miles due north and 17 miles due west. First of all, it is as well to point out that very large areas on this map were not intensively surveyed, and with comparatively few exceptions the work done encompassed the existing operating mine sections, most of which were copper. In the opinion of many, this belt, long overlooked, is one of the most interesting and well-mineralized tracts in the Province. Its having fallen into disrepute is owing to the fact that, in the past, several operating copper companies mined out their holdings and were unable at that time to discover any ore-deposits consistent with the treatment used in their metallurgical plants.

The greenstones, similar to those in which gold has been discovered in Franklin camp, are widespread and seldom well prospected by the old-time miners, who were searching for large bodies of copper or pyrrhotite—pyrite-cappings similar to those found at Phoenix and Rossland.

The serpentine rocks are plentiful in this belt and small tonnages of gold generally associated with arsenopyrite have been extracted from such mines as the *E.P.U.*, *Winnipeg*, *Athelstan*, No. 7, and *City of Paris*, etc. (see table). The ore-bodies or quartz fissure-veins in this very old and highly metamorphosed rock are often difficult to follow owing to intense shearing and faulting, and some knowledge of their structural behaviour is essential to the prospector.

In the *Stemwinder* and *Brooklyn* at Phoenix the pyrite-chalcopryite ores contain, in certain sections of the mine, gold values up to and over 1 oz. in gold to the ton. As there are several hundred tons of this type of ore already developed, according to reports, a closer examination of the mines appears to be warranted. Robt. Forshaw, of Greenwood, is the owner, and development-work will be done this winter (1931-32) under his management.

On the east side of Greenwood there are several parallel systems of narrow gold-bearing quartz veins that have not been developed extensively, from which small tonnages have been shipped. These include the *Last Chance*, *Prince Henry*, *Helen*, *Bay*, etc. At the *Ruby*, a short distance north-east of Boundary Falls, stringers of spectacular gold quartz were found in the past. On the *Great Hopes*, in the Deadwood basin, west of Greenwood, lenses and fissure-veins containing gold-bearing arsenopyrite have been explored to a small extent.

At Jewel lake (Long lake), the *Jewel*, reported upon in the 1930 Annual Report, has produced gold ore. The *Gold Drop* mine, now being worked in the same locality, has also been a producer of gold and some very spectacular pockets containing free gold and tellurides (probably sylvanite) are found there. On Hardy mountain, near Grand Forks, the *Yankee Boy* and *Girl* claims have produced small tonnages of gold quartz.

An examination of Brock's map will bring to light the fact that there has been a wide distribution of mineralization containing gold. In most instances the veins are quartz-fissures occurring in the greenstone, schists, or other cover-rocks which predominate over the area. Most of the workings are shallow and the deepest level reached was 320 feet on the *Jewel*. According to reliable reports on this mine, the fissure-vein was found to be more persistent and in greater average widths and value in the granite than in the schistose rocks. The mineral solutions when entering the cover-rocks evidently followed numerous fractures, with the result that the veins in these formations, although having a persistent strike, are often split, and enfold large fragments of country-rock. Where folding has taken place there is generally some enrichment of the ore.

Possibly other similar types of surface showings will develop accordingly when depth is reached. It can be truthfully stated that there has been no deep prospecting done in this area.

on quartz veins where there is a persistency of strike and width. Intensive geological study followed by diamond-drilling seems to offer the best means of proving whether or not some gold-mines occur under this very highly mineralized section of the country.

The whole section is very well provided with roads and trails, and the Canadian Pacific Railway and a high-power electric line pass through its centre, affording better mining facilities than any other part of the Province.

The following table shows officially recorded shipments from a number of properties in this area, up to the end of 1930:—

Mine.	Tons.	Gold.	Silver.	Copper.	Lead.
		Oz.	Oz.	Lb.	Lb.
Jewel.....	36,856	14,503	66,911	.....	.....
Gold Drop.....	13	24	141	.....	61
Providence.....	5,750	3,225	746,951	.....	187,689
Strathmore.....	218	154	17,089	.....	9,118
Yankee Girl and Grand Forks Mining Syndicate.....	42	99	68	277	.....
Prince Henry.....	21	13	1,272	.....	1,676
E.P.U.....	536	1,324	6,961	.....	12,119
Helen.....	37	5	170	.....	258
Elkhorn.....	131	145	9,470	.....	13,586
Elkhorn Fraction.....	48	8	7,385	.....	4,607
Gold Pick.....	3	2	138	.....	211
Winnipeg (Wellington).....	57,492	10,782	34,835	149,430	.....
Athelstan.....	36,614	5,781	6,757	15,965	.....
No. 7.....	7,453	1,405	59,482	.....	89,000
City of Paris*.....	2,000	.....	.....	.....	.....
Brooklyn.....	246,754	17,107	86,442	6,075,662	.....
Stemwinder.....	36,129	3,445	14,333	1,073,265	.....
Last Chance.....	735	147	97,109	.....	.....
Bay.....	83	249	114	.....	.....
Great Hopes.....	83	26	5	.....	.....
Little Bertha.....	157	181	1,151	.....	.....
Mountain Rose.....	11,629	6	178	48,514	.....
Jack Pot (see Athelstan).....	.....	.....	.....	.....	.....
Skylark.....	1,666	651	157,190	.....	49,794
Rambler.....	88	2	17,254	.....	10,933
North Star.....	2	.....	200	.....	.....
Roderick Dhu†.....	2	.....	.....	.....	.....
Ethiopia.....	11	3	691	.....	.....
Senator.....	5,467	311	716	22,488	.....
Golden Eagle.....	963	204	1,953	30,919	.....
Gold Bug.....	42	22	647	.....	.....
Defiance.....	4	6	1,545	.....	269
Humming Bird.....	1,092	916	1,825	.....	561
Combination.....	12	21	1,940	.....	1,591
Seattle.....	327	29	142	.....	6,818
Union.....	40,421	11,943	472,472	.....	40,803

* Contents not recorded.

† Contents unknown.

CAMP MCKINNEY SECTION.

Increased interest is expected in this gold camp in the spring of 1932 owing to the clearance of practically all the dense underbrush and small timber by forest fires, which will enable the prospectors to examine rock-outcrops that have been hidden since long before the camp was first developed in 1884.

The geology of the mineralized section, in which the gold-bearing quartz veins occur, varies but little. The formations are composed of highly metamorphosed rocks, chiefly mica and chlorite schists and gneissic varieties of the granodiorite batholith which invades the area to the north and west. The schist resembles the Shuswap series seen elsewhere in the district and can be provisionally classified under that heading. Numerous pulaskite and rhomb-porphry dykes of more recent age have been intruded into the schists. To the east and along the banks

of the creeks highly metamorphosed and serpentinized greenstone and tilted beds of quartzite occur. To the north the country-rocks are entirely buried under immense glacial moraines. Along the north-west slope of Baldy mountain intrusions of dunite in a serpentinized condition containing chromite have been found.

The quartz where mineralized is a dense milky-white colour which gradually turns into a bluish-grey when in contact with mineral. These veins as a rule strike across, and do not conform to, the bedding of the schist. Vein-widths varying from a fracture to 10 feet, and persisting to a known depth of about 400 feet, contain chiefly pyrite with lesser amounts of galena, sphalerite, and free gold (on surface), and extend about 4 miles in length in an easterly and westerly direction in parallel lines.

The camp lies at an elevation of about 4,500 feet and slopes gradually down to 3,500 feet to the south-east and up to Baldy mountain (elevation 7,558 feet) to the north-west, so that in the vicinity of the old workings shaft-sinking had to be resorted to. The camp is well provided with old narrow roads over which a car can be driven and the West Kootenay power-line traverses the centre of the mineral region. One main thoroughfare affords an outlet either via Oliver to Penticton to the west or Rock Creek to the east; all three places providing railway transportation.

Costs in 1897 were about as follows: Mining, \$4 a ton; milling, \$2 a ton; smelting, \$3.50 a ton; freight on concentrates to Penticton, \$10 a ton; freight to smelters, \$5.50 a ton; supplies to camp, \$35 a ton; cordwood, delivered, \$1.75 a cord. Now, with cheap power, easy transportation, and improved mining and metallurgical methods, a different aspect is thrown upon the future possibilities in the camp.

CARMI-BEAVERDELL-KETTLE RIVER SECTION.

L. Reinecke's Geological Memoir No. 79 covers the greater part of this section, and although his report deals mainly with the silver-producing mines, there are a few gold prospects in similar types of rocks on the outer edge of and beyond the map-area. To briefly sum up Reinecke's conclusions, it may be stated that there are three important groups of rocks which are placed in order according to their relative sequence; the oldest being the Wallace group, consisting of metamorphosed igneous rocks, largely lavas and tuffs; next the Westkettle batholith, made up of quartz diorite and dykes, which were followed by the Beaverdell quartz-monzonite batholith. Mineralization, consisting of pyrite, pyrrhotite, arsenopyrite, with lesser amounts of galena and sphalerite, occurs in stock or lens form in the oldest rocks and is genetically connected with the invasion of the quartz diorite. The silver sulphides, galena-sphalerite ore found in shear-zones in the quartz diorite, are connected with the quartz-monzonite intrusion.

Some gold has been mined in the lower horizons of the quartz-diorite shear-zones, such as at the *Carmi* and *Butcher Boy*, and also on the *Mogul*, which lies $1\frac{1}{2}$ miles north-west of Triple lakes. On the *Silver Dollar*, *Bernato*, *Hackla*, *Yorkshire Lass*, and other claims in the Triple Lake area, gold associated with pyrite, pyrrhotite, and arsenopyrite occurs in stocks, lenses, and fissures in the tuffs. These lenses, sometimes 25 feet in diameter on the surface, diminish considerably within the depth of 30 feet to what may be a "fissure-feeder" containing more quartz and comparatively low values in gold. If comparisons may be used, the occurrence of values and vein permanency found in the *Butcher Boy* and *Carmi* workings below the more or less dissipated vein-outcrop may offer a solution of the type of ore-deposit found in the tuffs near Triple lakes and promote sufficient faith to continue development to the contact of the quartz diorite where a possible continuance of the ore may be found. In the *Mogul* workings in the diorite, gold is associated with minerals similar to those found in the tuffs, and although the ore is formed against favourable faults and slips in the workings, nevertheless there is no doubt that a fissure once occurred there. A recent intrusion of augite syenite-porphry probably disturbed the vein system, and when deeper levels, away from the dyke influence, are explored, there appears to be a possibility of finding a more permanent fissure. If, as Reinecke suggests, the gold-quartz veins are the lower horizon of the shear-zones, then similar conditions may also be looked for on those claims near Triple lakes.

Shipments of ore have been made from the *Carmi* and *Butcher Boy* veins. The Beaverdell map-area is a most interesting one geologically and there is a large territory only partly explored, in the centre, north, and north-west, that offers attractions to the prospector.

OSOYOOS MINING DIVISION.

OSOYOOS LAKE SECTION.

• This section contains Fairview, one of the oldest known mining camps (1888) in the district, from which some very spectacular gold ore was mined.

Some geological information was gathered by H. S. Bostock, of the Geological Survey of Canada, during the reconnaissance mapping of the surrounding district, but no detailed examinations of properties or microscopic rock studies were made. The names are tentative and may be revised. What he states in part is as follows:—

“It is apparent from the reconnaissance that the mineral-deposits throughout the area are of the same general type—namely, quartz veins in which free gold, pyrite, and other sulphides occur.

“The formations of the area include a considerable variety of rock types. They are, however, separable in four main divisions for description here. These divisions are the quartzite-schist series, the Fairview granite stock, the Oliver granite stock, and the metamorphic complex.

“The quartzite-schist series consists of the oldest rocks of the area and includes a great variety of metamorphosed sedimentary and volcanic rocks, including thinly bedded quartzites, quartz mica, amphibolitic and chloritic schists, minor amounts of crystalline limestone and talc schists. The formation covers a considerable area extending to the south. In the vicinity of Fairview these rocks strike N. 60° W. and dip 50° N. approximately. They are thought to be of Permo-Carboniferous age or older. This series forms the crust into which the Fairview and Oliver granites and numerous smaller bodies of intrusive igneous rocks which comprise a large part of the metamorphic complex have intruded.

“The metamorphic complex is the term used to refer to the rocks which lie in the vicinity of the head of Myers creek, on the north side of the Oliver granite stock adjacent to it. It is composed of bands and detached areas of rocks similar to those of the quartzite-schist series and a great number of small intrusive igneous bodies which have invaded the series here. In them are a wide range of types from hornblende-rich gabbros and diorites to granodiorites which seem to have originated in a succession of intrusions, the more basic and dark types first.

“The Fairview granite stock is a body of approximately equi-dimensional plan and about 2 miles in diameter. Its central point lies 1 mile west of Fairview. It is completely surrounded by the rocks of the quartzite-schist series, etc.”

Dr. Bostock continues to discuss the Oliver granite, which passes within 300 yards of the Fairview granite-contact and in contrast is most strikingly fresh. In comparison the Fairview granite appears to be the older of the two. Regarding the vein system, he goes on to say:—

“The majority of the veins which were noted occur in the quartzite-schist series within a mile of the south contact of the Oliver granite and there is a marked concentration of these in the strip of these older rocks which occurs between the Fairview and Oliver granites north and north-west of Fairview. Those veins at the head of Myers creek lie approximately a mile north of the main contact and those of the *Susie* group lie near the middle of the Oliver granite. The most remote are those on the north side of Tinhorn creek, which are nearly 2 miles south of the granite. Some of the larger veins are remarkably persistent. These occur in the quartzite-schist series and tend to follow the bedding-planes closely, thus dipping towards the Oliver granite and paralleling the contact on the south side. A number of cross-veins with north-easterly strikes were also noted in the quartzites and schists, but these are smaller and less persistent. The age of the veins based on the occurrence of those of the *Susie* group in the Oliver granite is considered as younger than this granite, and from this and the general distribution they are, in the lack of other evidence, considered as owing the origin of their constituent materials to the same granite.”

Most of the claims on this vein system are Crown-granted and many of them have lapsed for non-payment of taxes and may be leased for \$25 from the Provincial Government. After the richer parts of the veins containing free gold on and near the surface were mined, shafts were sunk to variable depths, the deepest being about 600 feet, and in one known instance the vein 10 feet wide, and values of about \$12 in gold and silver to the ton persisted. On the surface the veins, varying from 2 to 20 feet in width, have been traced for several thousand feet and in many of the outcrops and surface workings only low values in gold and silver were obtained. If it were possible for one company to option the entire group, there appears to be a good chance

of finding a large low-grade tonnage of ore that might be profitably mined and milled. It seems as well to advise the owners of claims in this camp that owing to the fact that much of the ore in these large veins will only average about \$4 in gold and silver to the ton, a proportionally large expenditure will be required before their worth is proven. The ore-minerals are pyrite with smaller galena and sphalerite contents in a gangue of quartz.

A motor-road passes through the centre of the camp and the railway terminal at Oliver is about $2\frac{1}{2}$ miles distant. Two miles to the north, the West Kootenay Electric Company's line crosses the vein system and will provide cheap operating power. Reports upon this camp were made during active mining operations in the Annual Reports, 1897 and 1898, by the Provincial Mineralogist.

The *Dividend-Lake View* property is located on Kruger mountain, Osoyoos lake. These claims, which were being worked in 1913, were reported upon by the Assistant Provincial Mineralogist in the Annual Report for that year. According to this report, sixteen cars of gold ore were shipped in 1912 and 1913, containing values from \$17.14 to \$31.73 to the ton. At the present time Dave Loney and associates, of Oroville, Wash., have an option on the group and offer easy terms to any one who will develop the property.

About 4 miles due south of Twin lakes and north-westerly of Fairview lie the old *Oro Fino* and *Independence* group. It lies within the geological area described by Bostock. Numerous strong quartz veins containing segregations and streaks of high-grade gold ore have been found from time to time in the schist, with intervening low-grade material. More work is justified to develop the veins at depth and prove whether or not a large tonnage of average-grade ore can be found that will pay for the cost of milling operations.

The whole belt lying between the Okanagan and Similkameen rivers contains many series of gold-bearing quartz veins, both in the schist and granite rocks, that are worthy of more intensive prospecting.

A large variety of mineralization occurs on both sides of Keremeos creek at Olalla, 4 miles north of the village of Keremeos. Gold quartz has been found on the *Roadside* and in 1899 values up to \$10 to the ton were reported. On the east side, the valley is skirted by basaltic rocks showing remarkably fine columnar structure, encircling remnants of sedimentary rocks, including quartzite, limestone, and siliceous argillites, also dense highly altered and brecciated volcanics. On the west side, in the immediate vicinity of the valley are similar sediments intruded by stocks and dykes of gabbro, diorite, and numerous undetermined porphyry dykes. Most of the ore occurs in or on the contact of the sediments.

Between Olalla and Hedley, where the famous *Nickel Plate* mine is located and where the gold-bearing arsenopyrite has been mined for many years, there are many geologically interesting localities having the same mineralization in brecciated volcanic rocks and quartzites, etc. Included amongst these may be mentioned the *Nelson* group in Apex basin, the *Golden Zone*, *Yuniman* group, and the west slope of Independence mountain.

Before visiting this area, access to which is afforded by a narrow road from Le Leivre's ranch to the *Nickel Plate* mine, it will be advisable to read both Camsell's Memoir No. 2, 1910, G.S.C., and Bostock's report published in the Summary Report, 1929, Part A, G.S.C., from which much valuable information can be obtained. The reports deal mainly with the Hedley Company's mine and details of the rocks responsible for ore-deposition, a knowledge of which is essential.

In spite of the fact that the minable ore-bodies occur in the *Nickel Plate* series of limestone in conjunction with the gabbro-diorite dykes in the *Nickel Plate* mine, and, up to the present, no other large bodies containing sufficient gold values have been found, there is similar high-grade arsenopyrite carrying several ounces of gold to the ton to be found elsewhere, such as on the *Metropolitan* group, the *Whirlwind* group on the south-west side of Hedley creek at Hedley, and also on the *Boston* group to the north and in certain localities near Sterling creek. Up to the present no large bodies have been found, but there appears to be no reason why there should not be other mines in the district, considering the fact that there is an abundance of limestone, and some high-grade ore has already been discovered. Dan McKinnon and associates, Herb Neil, of Hedley, and others have been prospecting the area for many years, and their efforts have resulted in proving the above facts, but owing to the extreme hardness of the metamorphosed limestone, and the idea that if there were any good prospects in the vicinity the Hedley Gold Mining Company would have secured them, development-work has been slow and financial aid very difficult to obtain.

SIMILKAMEEN MINING DIVISION.

This Division is noted for its production of copper, coal, placer gold, and platinum. Up to the present there has been only a small output from lode-gold deposits. In spite of this, there are attractive areas that require more prospecting and development. It is a well-known fact that placer gold, in many instances rough-edged, denoting the fact that it has not travelled far, is found for many miles up the Similkameen and Tulameen rivers and their tributaries. This does not necessarily mean that there is lode gold in the immediate vicinity of these rivers, because the glaciers are known to have played an important part in placer-distribution and the gold may have been brought many miles from its original source during the ice-movement.

Gold quartz has been found on Jack Crowley's old claim on the Similkameen (Roche) river just above its confluence with the Pasayten. The schistose and argillaceous rocks which abound there contain these quartz-fissures and are the most likely ones to prospect. This also applies to the same type of rocks found along the banks of Whipsaw creek, where gold has been discovered with arsenopyrite on the *Virginia*, and also associated with pyrite in the limestone-beds about 14 miles up the creek from Lamont Creek bridge. On the Tulameen river, about 6 miles above Tulameen village, a spectacular discovery of free gold in narrow stringers of quartz in argillite was made by Wm. Britten a few years ago. It seems probable that much of the placer gold came from this source and a closer examination of these old highly metamorphic slates in this region might bring very satisfactory results.

On Granite creek, about half a mile below its junction with the North fork on the east side, some likely gold-bearing quartz veins are found, also just below and above what is known as the "Basin." Some development was done upon these veins in the early days and free gold as well as gold contained in pyrite and galena was uncovered. This creek was particularly noted for its placer gold.

In Charles Camsell's Memoir No. 26, G.S.C., part of the Tulameen-Granite Creek area is described, and the Tulameen group, which is the oldest formation, includes andesite, breccia, limestone, and argillite. These rocks, in which many of the most attractive gold-quartz veins have been discovered, cover a very large part of map No. 46A, accompanying the memoir, and it is in them that the source of the placer gold may be found. This group, tentatively assigned by Camsell to the Triassic period and correlated with Dawson's Nicola series, is overlain in certain areas by basaltic and andesitic volcanics and other rocks, especially in the neighbourhood of Granite creek and Riddell mountain and to the north-east. Veins found in the Tulameen series, striking into the cover-rocks which are presumed to be comparatively shallow, but which may cut them off at the surface contact, may be sought at depth under the latter.

EASTERN MINERAL SURVEY DISTRICT (No. 5).

REPORT BY B. T. O'GRADY, RESIDENT MINING ENGINEER, AND A. M. RICHMOND,
ASSISTANT ENGINEER (HEADQUARTERS, NELSON).

(Reports marked * are by A. M. Richmond.)

INTRODUCTION.

Towards the end of 1931 much interest developed in gold-mining possibilities. Several new activities were initiated on a small scale during the fall and winter months, some of which promise to expand substantially during 1932. Present lode-gold mining activities in the district are largely concentrated in the Nelson Mining Division and near Rossland, in the Trail Creek Division, where leasers are busy on several high-grade properties on the slopes of O.K. mountain. During the period under review the largest production, approximately \$200,000 in value, was derived from the *Reno* mine and ten others contributed smaller amounts in bullion, concentrates, and crude ore shipped to the Trail smelter. Of these the *Second Relief* mine provided \$4,581 in value. The district gold production of the past was largely derived from the auriferous copper ores of the Rossland camp, supplemented by the gold production made from the Ymir and Sheep Creek camps, and the Nelson area, and to a smaller extent the Lardeau.

The approximate total gold production from 1895 to 1930, inclusive, is shown under Mining Divisions in the following table:—

Mining Division.	Gold.	Remarks.
	Oz.	
Fort Steele.....	2,224	Chiefly miscellaneous sulphide ores.
Golden and Windermere.....	70	
Ainsworth.....	1,720	Chiefly gold associated with dry silver ores.
Slocan and Slocan City.....	4,831	
Nelson.....	404,644	From gold-quartz and auriferous silver-lead-zinc ores.
Arrow Lake and Revelstoke.....		Small production, not segregated.
Lardeau.....	15,981	From gold-quartz and complex sulphide ores.
Trail Creek.....	2,870,227	Almost entirely from auriferous copper ores. This figure includes the 1894 production.

The district gold production gradually decreased in proportion to the reduction in the scope of the Rossland operations and slumped severely when production in that area was discontinued. The mines and mineral properties adjacent to Rossland are now largely owned by the Consolidated Mining and Smelting Company, which carried out considerable exploratory work, including diamond-drilling, during the latter stages of mining before production ceased. While no information is available regarding the results of this exploration, it is not to be supposed that all possibilities for future production of gold are exhausted in the area controlled.

Apart from the Rossland camp, it must be said, in justice to the district, that many of the gold properties have hardly had a fair trial. Overoptimism and lack of engineering and mining knowledge often played too important a part in the developments. Under good management gold production should have been maintained at a consistently fair level instead of the erratic fluctuations which have occurred since gold-mining was initiated in the Lardeau (including the old Trout Lake Division) and Nelson Mining Divisions.

Several new activities have quite recently been initiated, as it is realized that conditions are now ideal for gold-mining, with the bonus equivalent to the discount on Canadian funds at New York, reduced cost of labour and supplies. In addition, low smelting charges are being obtained on crude ore containing a high percentage of silica shipped to the Trail smelter. It is considered that much ore, considered too low grade to mill in the old plants which made poor recoveries, can now be shipped at a profit where transportation is good. In view of the new conditions numerous partially developed properties merit investigation, and in the course of mining lower-grade ores which were left it is only to be expected that new discoveries will be made.

For convenience the potentialities of the various gold areas (exclusive of the Trail Creek Division, dealt with separately) are briefly analysed in the order of their importance as indicated by past production.

SUMMARY AND CONCLUSIONS.

Gold occurrences, in which the gold is usually associated with more or less sulphides, are very widely distributed in District No. 5, but for many years exploration has been largely directed to silver-lead-zinc properties. This particularly applies to the recent mining boom, during which period a very large aggregate amount of development was done in the Slocan and Ainsworth Divisions and at other points in the district. It is significant that out of some 150 mining activities (exclusive of operations by the Consolidated Mining and Smelting Company) initiated or carried on during that period only some twelve were gold properties. Of these, deep crosscutting operations were not completed at the *Yankee Girl* and *Granite-Poorman*; the *Good-enough* was tried out very inconclusively, the lower tunnel not having penetrated the ore-zone; work at the *Howard* was discontinued owing to the fall in prices of the metals with which the gold values are associated; and lack of adequate financing has been responsible for the intermittent character of the work done at others. The only property to have been properly provided for in this respect is the *Reno*, which has been brought into regular production. There were very many other minor gold activities, but the above brief summary of conditions applies to mines where crews of men were employed.

It is safe to assume that if a larger proportion of the capital expended of recent years in this district had been applied to gold-mining a very different condition in regard to employment and production would now exist. The opportunities can be broadly segregated into:—

- (1.) Probabilities and possibilities in semi-developed mines.
- (2.) Slightly prospected and unprospected areas.

PROBABILITIES AND POSSIBILITIES IN SEMI-DEVELOPED MINES.

Under the first heading numerous properties, such as specified in the body of this report, have made some production (in some cases quite important) from a zone extending from a few hundred to 1,200 feet below their vein apices. In some cases it has been shown that extensions of the ore-bodies previously mined can be expected laterally and at depth; in others it is a matter of finding new ore-bodies in favourable geological zones or of solving the fault problems which were responsible for discontinuation of exploration. The lack of a systematic development policy under skilled technical direction, accompanied by too hasty production, whereby the available capital was largely absorbed by premature milling plants, has often been responsible for past failures. The inconclusive nature of much of the mining done is striking. In some cases the complexity of the ores, such as at the *Wisconsin* and *J. and L.*, discouraged deeper exploration, but the progressive development of metallurgical technique encourages the expectation that such ores will become amenable to economical treatment. In the instances just specified, however, further development is first necessary to determine the general character of the mineralization below the zone of oxidation, since the unaltered sulphides should present less difficulty for separation by selective flotation. In addition to the properties to which attention has been drawn, there are prospects worthy of attention on which attractive showings of limited extent have been exposed, but insufficient work has been done to indicate the character and continuity of these deposits. It is not intended to convey an impression that a large number of attractive prospects are available such as would appeal to engineers representing large mining companies, but it is believed that there are definite opportunities for properly organized and technically directed development and exploration companies which would undertake the essential preliminary work necessary to test prospects or sufficiently improve their showings to the extent necessary before the operating companies can be interested. An obstacle in the past has often been the lack of realization by property-owners of the "relative probabilities" in mining, with the resultant exaggerated sale value placed on their holdings. Some education in this respect seems desirable, so that owners may come to appreciate the perspective of the examining engineer. False impressions of values have in the past been created by stock propositions where the actual productive possibilities of the mine figured less than the psychological factors which might favourably affect the value of shares. This phase seems to be about over and possibilities for future activity on a substantial scale depend on the owner's ability to interest the representatives of the companies who make mining a business. To do this, price and terms, especially in the older camps, must be sufficiently attractive to offset the hazardous factor always present in the initial stages of mining.

SLIGHTLY PROSPECTED AND UNPROSPECTED AREAS.

There have been few new discoveries during the last twenty-five or thirty years and the prospects and productive mines of to-day were discovered by the old-time prospectors, who thoroughly covered the high exposed ground in most sections. To supplement the available number of prospects likely to attract capital for their development, we must look to properly organized scientific exploration if sufficient new deposits are to be found whereby the present comparatively limited gold-mining industry in this district is to be expanded. After the early boom years, when the prospector found a ready market for his discovery, the active army of his brethren moved on to other fields, leaving only a few old-timers awaiting a recurrence of the boom conditions. Discouraged by lack of interest in mining, which existed for long periods following the exciting times of the old days, the faithful minority chiefly confined attention to the old claims, doing desultory work without adding much, in most cases, to the apparent value of the showings formerly opened up. The exceptions to the thorough prospecting done in the early days include the formerly brushy and densely wooded areas which have since been cleared by forest fires, and the more inaccessible sections.

Although the old prospector did his job pretty thoroughly under the old conditions, the same cannot always be said of those responsible for subsequent exploration. An example of this is

the prospecting opportunity still remaining in the Sheep Creek camp, where this prospecting will be partly confined to ground covered by Crown-granted claims. In this connection the accompanying illustration by J. F. Walker is reproduced by courtesy of the Geological Survey of Canada. On this sketch the important quartzite-bands, favourable for the discovery of ore-bodies where the easterly-westerly fissures cross them, are distinguished. The most westerly quartzite, which at the north end of the map contains the *Reno* vein and at the southerly end the *Queen* vein (they are about 3 miles apart), remains practically unprospected in the area opposite the *Nugget* and *Motherlode* vein-fractures. These last two veins have been explored in the next quartzite-band going easterly. Similarly, the easterly quartzite-bands have not been prospected opposite the *Reno* and *Queen* veins. An interesting possibility is thus afforded for systematic prospecting along definite lines. For detailed information regarding the favourable localities for finding ore-shoots in the Sheep Creek gold camp the reader is referred to "Mineral Developments in the Salmo Map-area," by J. F. Walker, Summary Report of the Geological Survey of Canada, 1929, Part A. In a letter to the writer accompanying the map reproduced the author says: "The easterly band of quartzite coloured purple should really be green to correspond with the *Reno* quartzite, being the east side of the anticline, but I still have some detail to work up before I can definitely say whether part or all of it should be of the same colour as the *Reno* quartzite-belt. It is the physical character of the rock which counts and that is indicated." The colours applied to the several quartzites in the original referred to are replaced by distinguishing hachuring in the printed reproduction.

As mentioned before, virgin prospecting areas are probably very limited in extent, but there are several only slightly prospected areas worthy of careful attention. Using the old West Kootenay Sheet (No. 792) of the Geological Survey of Canada as a map reference (the geology is being progressively revised), the following localities are of interest:—

The contact marginal zone between the granitic rocks of the Nelson batholith and the metamorphosed sedimentaries of late pre-Cambrian age, being the northerly extension of the rocks as mapped by J. F. Walker in the Summary Report of the Geological Survey of Canada, 1929, Part A. At the northern end of this region, near the headwaters of Midge creek, are situated the *Wisconsin* gold veins and at the south end is the Sheep Creek gold camp. In the intervening area, some 5 miles in length, which is not known to have been prospected to any appreciable extent, the only other finds were at the *Howard* and adjacent claims on the South fork of Porcupine creek. Northerly from the *Howard* much of the formerly densely wooded country has been burned over and access has been improved by the Cultus-Canyon Creek trail.

The area of rocks of the Rossland volcanic group, referred to the Triassic, surrounding Erie creek (North fork of Salmo river), seems to deserve more careful attention. Forest fires have denuded much of the former dense growth and geological conditions are similar to those at Rossland, where the auriferous iron and copper sulphide ores occurred almost exclusively in the massive members of the eruptive series and most of the important ore-bodies were situated either on or close to the line of contact between the gabbros and surrounding porphyrites and diabases. Similar ores have been found on Granite creek, an upper tributary of Erie creek, but the very limited amount of surface work done gives little idea of the extent of the ore-bodies.

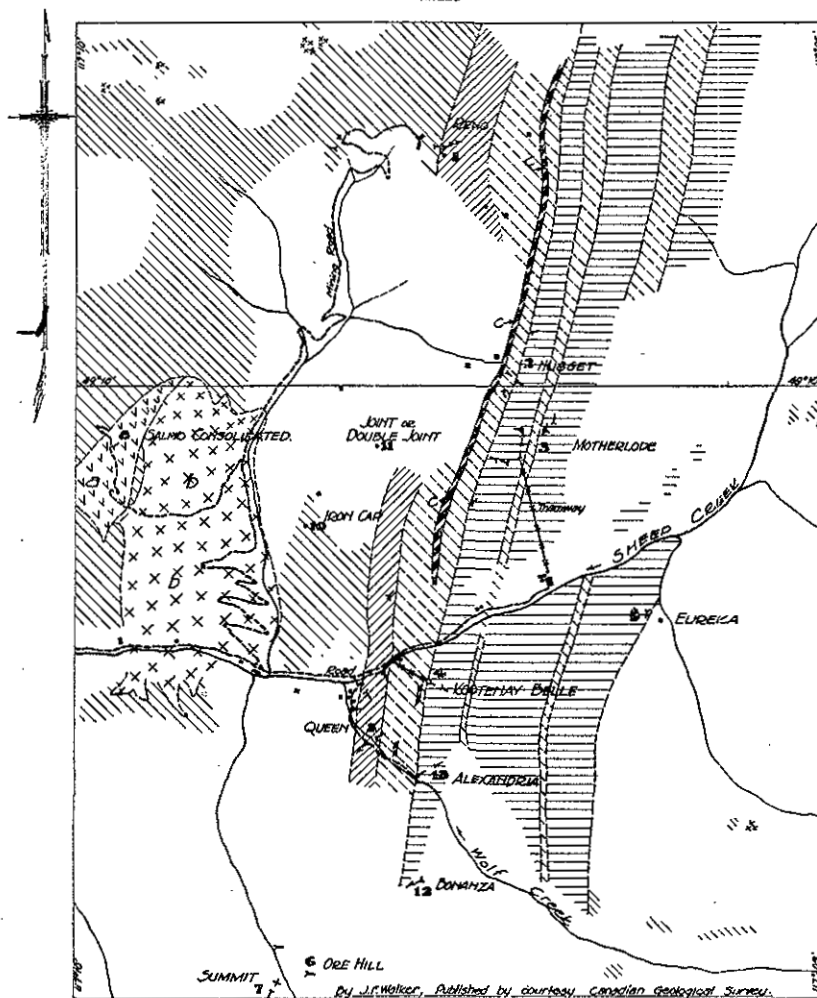
On and around Toad mountain, south of Nelson, hundreds of claims were staked on discoveries made in the old days. The majority of these claims were Crown-granted and quite a few have reverted to the Crown for taxes, being now available for acquisition by lease or purchase. A class of gold lead in this section includes pyritized belts, often a hundred feet or more in width, traversing the schistose eruptives, being simply more or less mineralized portions of the schistose country-rock, carrying occasional ribs and stringers of quartz. They are very low grade, but owing to the practically unlimited amount of material might possibly in some instances be profitably worked. Some partial testing of such zones has been made, but no comprehensive investigation of these belts has ever been carried out. In the Summary Report of the Geological Survey of Canada for 1896, R. G. McConnell quotes a Mr. Francis, representing an English company, as having obtained an average of \$3 in gold to the ton over a wide zone of mineralized schist on the *Starlight* claim. In the Summary Reports on the Operations of the Geological Survey of Canada for the years 1888 and 1889, G. M. Dawson on page 9A says:—

"At the east end of Toad mountain a whole belt of rusty schistose rocks, containing more or less quartz and much iron pyrites, has been discovered. The superficial portions of this belt have been completely oxidized and afford free-milling gold. This property has been acquired

SKETCH SHOWING GEOLOGY OF THE SHEEP CREEK GOLD CAMP.

Nelson Mining Division.

MILES



LEGEND

- | | | | |
|--|---|--|---|
| | Mostly white quartzites.
(Purple coloring in original map.) | | Younger granite rocks.
(Red coloring in original map.) |
| | Argillites, quartzites, schist
and some limestone.
(Orange coloring in original map.) | | Aplite porphyry dyke.
(Red coloring in original map.) |
| | Grey and white quartzites.
(Green coloring in original map.) | | |
| | Chiefly dark grey argillite, some
dark grey quartzite and limestone
bands near contact with next above.
(Yellow coloring in original map.) | | |
| | Older granite rocks.
(Red coloring in original map.) | | |

With Report by D.T.O'Grady,
Resident Mining Engineer,
Nelson, B.C., 1932.
D.C. Bureau of Mines.

A.M.R.

by an English company, known as the Cottonwood Company, and a Huntingdon mill has been erected for the purpose of treating, in the first place, the decomposed surface material, of which there is, in the aggregate, a great quantity in sight. The results of trials so far carried out have not been made public. Should it prove, however, that the deeper pyritous portion of the deposit contains sufficient gold to pay for concentration, roasting, and chlorination, the quantity of the ore appears to be almost unlimited." The property referred to includes the *Golden King* and *Golden Wreath* Crown-granted claims adjoining Cottonwood lake, in connection with which R. R. Hedley, of Vancouver, recently made some further investigations. This property lies about $1\frac{1}{2}$ miles south-easterly from the *Deadwood* claim of the Hillside Mining Company, of Nelson, where a similar (and possibly the same) belt of pyritized silicified rock has been slightly investigated. The *Starlight* belt mentioned by McConnell lies some distance easterly and farther up the mountain. Systematic exploration of both zones might disclose concentrations of gold values at certain points.

In the Lardeau Division prospecting of the rock-outcrops, chiefly at high elevations, was pretty thoroughly done by the old-timers. The *Teddy Glacier* gold-silver-lead veins were discovered within the last few years, due to the retreating of the glacier which formerly covered the showings. The same series of rocks continues across the valley of Dog creek, which is an upper tributary of the Akolkolex river (Isaac creek). They have been classified as slates and schists, quartzites and grits, chlorite-schists and crystalline limestones, the whole series being classified as the Lardeau series of late pre-Cambrian age. The ground in the vicinity of the headwaters of Dog creek and to the north-west is considered to merit prospecting. This area contains the north-westerly extension of the "Central Mineral Belt," in which the major deposits of the Lardeau Division are all located. North-westerly from the *Teddy Glacier* this region has been essentially unprospected owing to its inaccessibility, and this situation is not much improved, although it can be approached by following the North fork of Sable creek from the *Teddy Glacier* trail (see Map 235A, Geological Survey of Canada, "Lardeau Area").

In the Big Bend district, north of Revelstoke, the belt of rocks containing auriferous arsenopyrite ores similar to the *J. and L.* deposits, described later, merits further prospecting, float-ore having been found adjacent to Carnes creek southerly from the *J. and L.* and over the divide. Discoveries would, however, be affected by the success attained in solving the treatment of the *J. and L.* complex ores which at present is the main issue.

In the East Kootenay there is a wide distribution of quartz veins, chiefly in the argillaceous rocks of the Creston formation, for which low gold values are claimed in certain localities such as Perry creek. In the area northerly from Kitchener to White Grouse mountain, G. A. M. Young, of Creston, who has in recent years been actively prospecting, reports that there is a widespread development of quartz veins in the Aldridge formation and that "some of the leads are from 50 to 100 feet wide and miles in length. Most of them are barren, but some of the large ones carry low values in gold, or gold-copper." The amount of prospecting for gold ores in this section, which seems worthy of attention, has been very limited and past activities have been largely confined to the hematite-deposits on Goat mountain and one silver-lead proposition on Goat creek, along which a good trail extends for 10 miles (see Map 147A, Geological Survey of Canada, "Cranbrook District").

A gold-prospecting possibility worthy of attention is the Toby conglomerate (late pre-Cambrian), which is known to extend from a point some 5 miles westerly from Golden southerly through the heart of the Purcell range to a point on Akokli (Goat) creek 5 miles easterly from Kootenay lake. Its exact position is shown on the maps accompanying the following publications of the Geological Survey of Canada, containing reports by J. F. Walker: Memoir 148, "Windermere Map-area"; Summary Report, 1928, Part A, "Kootenay Lake District"; Summary Report, 1925, Part A, "Reconnaissance in the Purcell Range West of Brisco." It is just possible that at some points this conglomerate may be mineralized sufficiently to be worked. A sample chipped by the writer from a large boulder of conglomerate, believed to have been derived from the Toby formation, on the edge of the St. Mary river, about 1 mile westerly from the Cranbrook-Kimberley highway crossing, assayed \$1.40 in gold to the ton and 0.48 per cent. copper. West of Golden, specimens of conglomerate are reported to have contained appreciable gold values. Areas of the Toby conglomerate are readily accessible at numerous points throughout the area mentioned. No attempt can be made here to enumerate the numerous other areas of gold occurrences in District No. 5, but their wide distribution, in some measure, warrants the assumption that if prospecting had been continued on the active scale of former years, accom-

panied by more systematic exploration of the known, partially developed deposits, gold-mining would take a much more important place in the metal production of the district.

NELSON MINING DIVISION.

Publications of the Geological Survey of Canada covering portions of this Division include: Summary Report, 1911, pages 139-157, Nelson Map-area; Summary Report, 1929, Part A, Mineral Developments in the Salmo Map-area; Memoir 94, Ymir Mining Camp. The history of mining development and production is to be found in the Annual Reports of the Minister of Mines from the year 1895. A very consistent annual production, averaging 21,000 oz., was maintained from the year 1899, when milling plants got well started, to 1914, when a noticeable falling-off occurred. It is evident that a severe set-back to gold-mining was caused by the uncertain economic conditions, high cost of labour and supplies during the war years. An appreciable improvement occurred in 1926 and 1927, followed by lowered production in 1928 and 1929 owing to the development campaign at the *Yankee Girl*. As a result of the stock crash this development was not completed and the expected substantial production failed to materialize. In 1930 the *Reno* mine production began to be noticeable, and in 1931 this mine's production approximated \$200,000. Judging from the new activities which materialized during the winter months, and suspended operations planning to resume, gold production will resume its former importance in the Nelson Division.

DEPOSITS IN ROSSLAND VOLCANICS, NELSON BATHOLITH.

The gold-ore deposits in the vicinity of Nelson occur either in the granitic rocks of the Nelson batholith or in the schists of the Rossland volcanic group. In the granitic rocks the veins occupy well-defined fissures and the ore is essentially gold or gold-copper with a quartz gangue. In some cases ore-bodies are found in distinct fissure-veins cutting the strike or dip of the schists. Another type of deposit consists of elongated lenses of quartz occurring along lines of shearing coinciding with the attitude of the enclosing schists. In most cases gold values are associated with iron and copper and (or) iron, lead, and zinc sulphides. Native gold was found chiefly in the oxidized portions of the veins associated with limonite, the predominating metallic mineral being pyrite. Free gold also occurs in some cases either in the quartz or in the solid sulphides. Quartz predominates extensively as a gangue-mineral, occasional accessory constituents of the ores including calcite, siderite, scheelite, epidote, and garnet.

Space does not permit of mentioning the very numerous partially developed mines and raw prospects, located south, west, and south-west of Nelson, many of which are still in the same condition as when described in old Annual Reports. A few interesting deposits typical of the district occurrences will be briefly reviewed.

These contiguous properties, situated on the east slope of Morning mountain, south of Nelson, are briefly described in the Summary Report for 1911, G.S.C., pages 148-150, which covers the past period of chief activity. The *Venus* was further developed until 1915, when work was discontinued owing to financial conditions due to the war. From 1912 to 1915 a small tonnage of ore was treated at the *Athabasca* mill and the poor recoveries made were evidently a contributory factor necessitating the shut-down. The *Venus* workings are now being reconditioned by H. D. Dawson, G. Allen, and E. K. Allison, all of Nelson, with a view to shipping a fairly substantial tonnage of ore left in the workings, of fair grade according to assays, which could not formerly be profitably treated at the *Athabasca* mill. Considerable information regarding past mining and milling operations of the *Athabasca* and *Venus* is contained in the Annual Reports from 1896 to 1904, inclusive.

A comprehensive description of the *Athabasca* vein, the only one of the several known veins having been worked, is contained in the Journal of the Canadian Mining Institute, Vol. V., 1902, by E. Nelson Fell. His observations on this type of deposit, listed below, are of considerable interest since they may have an important bearing on numerous slightly explored prospects in the vicinity:—

- "(1.) The vein occurs cutting both granite and schist.
- "(2.) There is a remarkable concentration of values along the contact, especially on the schist side.
- "(3.) The values in the granite do not average as well as in the schist; the vein being inclined to be more uneven, both in size and contents.
- "(4.) The vein in the granite is found in a more normal condition and is better adapted for mining.

"(5.) In the schist the vein is flat and very much disturbed by faults and folds, and finally enters upon an area of ground which is so shattered that all traces of the vein are lost. It is probable that it will be recovered here at some deeper point, approach being made from the granite.

"(6.) Extreme caution must be exercised in undertaking the opening-up of a vein in shattered ground of this kind. Theories of parallel ore-bodies and numerous veins may be rudely dispelled by events, and the plan of work must be held continually subject to modification. Only the most shadowy estimates can at any time be made of ore in sight, and the plan of operations can only be outlined in a vague way. To open up a mine of this description is an entirely different proposition to that of opening up a regular ore-body. It would appear, however, that the vein, where it is now being worked in the granite, has at last reached a condition of permanency, and it is likely that it will retain this character as further depth is attained.

"I have attempted to outline the doubts and difficulties connected with opening up an ore-body of this character. This is a class of mining, however, which opens up attractive possibilities and cannot be neglected. This vein yielded in thirty months \$350,000 from 11,500 tons of ore. It is an open question whether the system of limited-liability company organization is adapted to a mining proposition of this kind. For conducting large operations on lines which can be definitely and permanently foreseen and laid out, the present system is no doubt to be preferred. But I believe that a system of assessable stock would be found to be more economical and, speaking generally, more suitable for working a property of the kind under discussion."

Subsequent events showed that this type of deposit would not stand much overhead, and there still remains a good possibility that careful investigation will lead to profitable production from such properties, not necessarily on a large scale.

California. This property, being developed with a small crew by the Hillside Mining Company (F. T. Harbour, of Nelson, president), is situated westerly from the *Athabasca*. The veins have chiefly been explored in the schists near the granite-contact. The property is described in the Annual Report for 1930. In view of the experience gained at the *Athabasca*, veins which extend from the schist into the granite should be prospected in the untested formation, and particularly at the contact where important concentrations of values are likely to occur. In the schists the fissure-vein ore has been found to be lensey.

Perrier. At this mine, situated 4 miles south of Nelson, renewed activity was recently inaugurated by F. J. S. Sur and associates, of Calgary (British America Exploration Syndicate). Drifting and stoping is proceeding on two levels in an ore-shoot north of the shaft and crude ore is being shipped to the Trail smelter at the rate of 150 tons a week. The ore, containing a large percentage of silica, is smelted at a flat rate of \$2 a ton. Cost of freight and truck-haul combined amount to \$1.85 a ton. Under these conditions, and the bonus equivalent to the discount on Canadian funds at New York, \$12 ore (gold and silver values) nets a nice profit according to the management, and milling in the small mill has been discontinued after a short run. The vein is now quite narrow north of the shaft and very flat in the stoped area. The ore breaks clean from the walls, however. On the south side of the shaft recent work has opened up higher-grade ore over a good width, but this is not yet explored to any appreciable extent.

The main fissure-vein cuts across the foliation of the chlorite-schists and has been traced for a considerable distance on the surface by open-cuts, tunnels, and an inclined shaft. Recent work has been confined to the last-mentioned working, which is down a little over 210 feet, with three levels driven on the vein to the north. Concentrations of better values occur in flat rolls in the vein, which structural factor was overlooked in previous exploration.

A new small Ingersoll-Rand hoist and a 35-40-horse-power Diesel-type portable engine were added to the former equipment. The *Perrier*, where fifteen men are now employed, is a very interesting operation which has possibilities for expansion.

Catherine. Situated easterly from the *Perrier* and in a granitic tongue extending from the adjoining batholithic mass, the *Catherine* fissure-vein has been superficially explored at intervals during the last few years and small shipments of crude ore have been made, together with small lots sent to the *Perrier* mill for treatment. During the past year W. Jarvis, of Nelson, and associates, worked the claim for a period under lease from the owner, M. Egan, of Nelson. The principal values are in gold, which is associated with iron sulphides and argentiferous galena, the better gold values being in the oxidized material near

the surface. The strike of the vein, which follows a zone of strong fissuring, is north-westerly (down the hill) towards a schist area. Further prospecting in this direction would seem desirable to test the vein in the marginal zone of contact.

St. Anthony.—Work was started in December at this gold prospect, adjoining and below the *Catherine*, by W. Jarvis and partner, employed by the owner, A. Mesker, of Nelson. The property has not yet been visited.

At this prospect, north-east of the *Perrier*, work was done by R. Rainey, **Golden Gem.** T. MacDonald, and W. Jarvis, all of Nelson, for a short period late in the fall.

Some tunnelling was done on a small quartz vein cutting the schists, but the gold values proved disappointing and work was discontinued with a view to testing the vein later at other points along its outcrop.

At this group, on the summit east of Apex Siding, open-cutting was continued during the summer by S. Terzian, of Nelson, to test the outcrop of a fissure-vein in granite. The values are low considering the narrow widths of the pay-streak.

Blue Bird.

Euphrates.

At this property, adjoining the Great Northern Railway at Golden Age Siding, there are three or more veins traversing altered eruptives of the Rossland volcanic group. They all strike with the formation and, with one exception, dip with the stratification. Most of the work has been done on the *Eu-Tee* vein cutting the foliation of the rocks (see Annual Report for 1929). This contained high-grade ore over narrow widths in the zone of oxidation which was not very deep. The other veins, very slightly prospected, are considered to have better possibilities for developing tonnage, since the surface showings are, in places, of good mining width. Considerable development-work has been accomplished under the direction of R. M. Betts, mining engineer, of Eugene, Ore., representing Portland capitalists who acquired an option on the controlling interest in the Euphrates Mining Company, Limited. Under the new management, which took over control in May, an aerial tramway and a 116-133-b.h.p. heavy-duty oil-engine have been installed and several thousand feet of air-pipe, rails, ore-cars, and general camp equipment have been provided, and a crew of some thirty-eight men employed during the season. A surface tram, 1,000 feet in length, has also been constructed from the portal of the lower *Eu-Tee* tunnel to the lower *Minto* showing. The crosscut from the inner end of the lower *Eu-Tee* tunnel has been extended to 335 feet. In this new working a wide zone containing stringers of ore, corresponding to the expected position of the *Lost Cabin* vein at this horizon, was cut at 150 feet from the main tunnel. Other underground work done included a tunnel, 60 feet long, driven on the lower *Minto* showing. The *Eu-Tee* tunnel, from which two small car-loads of ore were shipped to Trail, was advanced a short distance. The old board of directors has resigned and officials representing the new interests have been appointed. Work has been temporarily discontinued pending consideration of future plans.

K. and S.

On Hall creek, south of Nelson, Frank Kennedy, of Ainsworth, and associates, staked the *K. and S.* group on ground formerly known as the *Gold King* property. The old shaft-workings were unwatered and the vein sampled with a view to further exploration. The quartz vein strikes across the creek paralleling the *Fern* vein system farther east.

Rainbow and H.B.—These claims, farther up Hall creek, have been actively prospected by C. Peterson and H. Erickson, of Hall. The vein belongs to the same north-south-striking system which includes the *K. and S.* and *Fern* veins.

Fern.

The *Fern* and the last two properties mentioned are all in the Rossland volcanic group and their veins are quartz-filled fissures. The *Fern*, shut down for some years, was fairly extensively developed and some very high-grade ore was produced. Its equipment formerly included a small mill. The property was fully described in Geological Survey of Canada Memoir 94. Toward the close of operations the vein was lost through faulting. Under the heading of "Future Work," C. W. Drysdale stated: "The territory west of the lamprophyre dyke-fault deserves further exploration, with the aim of finding the continuation of the main *Fern* vein and granite-porphyry dyke" (which the ore-body paralleled). "Assuming that the fault is a normal one by which the ground east of the fault-plane has been dropped vertically with respect to that west of the plane, the vein should lie to the north-west or on the hanging-wall side. A horizontal movement or heave, however, may have accompanied vertical displacement, and in that case the above deduction might not

hold true. The finding of striations on the fault-plane would aid in the solution of this fault problem. The country-rock on both foot-wall and hanging-wall sides should also be carefully prospected for parallel veins and the presence of further productive acute-angled intersections between different vein or veins and porphyry dykes."

Since this was published in 1917 desultory efforts to locate the vein beyond the fault mentioned have been unsuccessful, which was to be expected since the work was chiefly done within the lamprophyre dyke itself. The problem is apparently a difficult one, but, if it has not already been attempted, the vein might be picked up beyond the fault by prospecting the surface in the general area indicated.

At the head of Hall creek, H. E. Dill, of Nelson, put in part of the season prospecting the gold-quartz and other veins described in the 1930 Annual Report. The formation here is also composed of schistose rocks of the Rossland volcanic group.

Reah. Situated at the head of Barrett creek, 4 or 5 miles south-westerly from the **Porto Rico.** *Fern* and in the same general formation, this property, shut down for many years, was described at great length in Geological Survey of Canada Memoir 94. The following figures represent the total production made between 1897 and 1905, when the old 10-stamp mill was in operation: Tons, 5,561; gold, 5,699 oz.; silver, 1,316 oz.; copper, 709 lb. Of this, all the ore was milled with the exception of 41 tons shipped as sorted ore in 1897.

The vein, of the true fissure type, averaged 3 feet in width, the mineralization consisting of free gold and pyrite in a quartz gangue. The largest ore-shoot had a stope-length of 450 feet on the No. 3 tunnel-level. Space does not permit of further details, but that this at present inactive property merits close investigation is indicated by C. W. Drysdale under "Future Work" on page 136 of the above-mentioned publication, as follows:—

"Since the apex of the vein is well exposed on the divide and has the same structural relations there, as below in the mine, with the same persistent lamprophyre dyke as hanging-wall, it would seem advisable to explore the vein more extensively and systematically, both laterally and in depth. The vein to the south-west could readily be explored for ore-shoots by continuing the adit-tunnels beyond the schistose zone, which, in No. 3 tunnel, deflected the working to the foot-wall. No. 2 tunnel also left the main vein and dyke and is in the foot-wall country. The dyke ought to prove a good indicator of the position of the vein. Should the vein leave it, however, and the values in the vein cease, other dyke intersections with the same or parallel veins should be sought after. Before doing this underground development-work in search for lateral extensions of ore, the vein and dykes should be carefully traced on the surface and, if possible, the width of the schistose zone measured. Neither the vein nor dyke have as yet been proved to extend to the north-east into the augite-porphyrite sill. Although the augite porphyrite of the lower workings is not the ore-bearing country-rock of the *Porto Rico* mine, yet it is the country-rock to high-grade ore from prospects below the mine near the wagon-road, as well as from the *Fern* mine. In the case of the *Fern* mine, however, the ore-shoots are found in contact with a granite-porphyrity dyke. Dyke intersections, both lamprophyres and porphyries, with veins, particularly where at acute angles, should be carefully prospected for. As several lamprophyre dykes have already been disclosed in the mine-workings and found to strike at acute angles to the main vein-fissure, the chances are fair for finding not only extensions of old ore-shoots, but also new shoots on the *Porto Rico* and adjoining properties."

The showing, referred to by Drysdale, on the summit south-easterly and beyond where the vein was lost in the *Porto Rico* workings is about 3 feet wide and assays from \$2 to \$8 in gold to the ton. The No. 3 tunnel would only have to be driven some 200 feet to test the vein below this showing. Further work is advisable to test the downward continuation of the vein below the No. 3 tunnel by sinking to determine its probable position preparatory to crosscutting on the No. 4 level. What is thought to be the *Porto Rico* vein shows on the *Spotted Horse*, a claim lying north-east of the *Porto Rico* group and adjoining it, and now included in the same group. This showing, about 3,000 feet north-easterly from the present workings, merits careful prospecting, as it parallels a dyke similar to that accompanying the *Porto Rico* vein, with the same general strike.

On the *Spotted Horse* there is, in addition, an east-west-striking zone of shearing and silicification mineralized with disseminated iron sulphides on which a short tunnel has been driven and from which 17½ tons shipped to the Trail smelter in 1902 averaged \$21.06 to the ton. No other attempt seems to have been made to explore this lead or to determine the width and

continuity of the mineralization. This could be ascertained to a useful extent by ground-sluicing or trenching across the strike.

This property, on Erie creek and owned by the Relief-Arlington Mines, Limited, has been adequately described in the Annual Reports for the last few years. Due to various circumstances, including change of control, operation by this company of mine and mill has only been intermittent, but arrangements have now been made for continuity of policy and work is expected to be resumed early in the spring. The vein, cutting altered eruptive schistose rocks of the Rossland volcanic group, has a similar north-easterly strike to the *Porto Rico* vein, previously mentioned, and is also formed along a dyke, which in this case has been considered to be of dioritic type. Past production figures are not at hand, but the mine is understood to have produced around 50,000 tons of \$15 ore in which the values were chiefly in gold. The metallurgical difficulties which prevented satisfactory recoveries being made in past milling operations are being overcome. If, as anticipated, the vein maintains its values over a good stoping-width at depth and one or two of the similar parallel veins, slightly exposed on the surface, prove up like the *Second Relief* vein, a very satisfactory operation can be expected. The vein, exploited for a length of 1,500 feet (to the *Ida D.* claim, in which the company owns a half-interest) and a depth of 400 feet below its apex, has every indication of permanence at depth, and on the No. 4 level shows good stoping-widths in places. During 1931 the new No. 5 level was advanced to 680 feet and is approaching the ground below the ore-zone exploited in the upper tunnels. The mill, operated for six weeks during the summer, when sufficient water was available for power, produced \$4,581 from bullion and concentrates.

Arlington. This property is situated near Erie and is also controlled by the Relief-Arlington Mines, Limited, but no activity has yet been undertaken in connection with it. Between 1903 and 1913 about 10,000 tons of sorted ore of an average gross value of between \$50 and \$60 a ton was shipped. Large dumps of low-grade material then accumulated, which is now considered to be of potential value, but no comprehensive sampling operations are known to have been undertaken. The mine, not inspected by the writer, is believed to have been pretty well exploited in past years. The extreme ends of the workings are inaccessible, however, and it is not known what conditions terminated exploration north and south. The accessible part of the old workings was recently examined by J. F. Walker, of the Geological Survey of Canada. Apparently the ore-bearing part of the vein was confined to a very shallow synclinal roll in the west-dipping argillaceous rocks. The vein follows a granitic sill, sometimes above and sometimes below the sill. It strikes roughly north and dips low to the west.

Keystone. A short distance from the *Arlington* this property lies in the same general formation. New activity, which has since been discontinued, materialized during the fall when A. E. Bostrom, of Spokane, and associates commenced construction on a small concentrating-mill intended to treat the dumps derived from past mining operations. From the main adit crosscut, 390 feet long, the vein has been drifted on 70 feet south-westerly and over 270 feet north-easterly, with some stoping from the latter working, which is plugged with waste at its inner extremity. A raise put up to the vein 30 feet south of where the crosscut reached it follows the vein for 100 feet. For the first 50 feet the vein averages 8 inches, then widening in a flat roll to about 3 feet. About 64 feet vertically above the crosscut, a level was run north-easterly for 350 feet and considerable stoping done above it. The vein looks poor at the north-easterly end, and at the south-westerly end, under the old shaft, caving prevents inspection. The writer is indebted to J. F. Walker for the measurements quoted and other information. It is considered that a little more work might be done to advantage by carefully surveying a projected continuation of the vein around the nose of the hill westerly to try and pick up an outcrop, or trench for the vein. If found with any values the vein could then be drifted on.

Clubine-Comstock Gold Mines. On Boulder creek, north of Salmo, exploration on a small scale has been undertaken by this recently incorporated company under the direction of L. R. Clubine, of Salmo. The deposits are in an area of schistose rocks of the Rossland volcanic group, about half a mile north-westerly from the contact of the granite area extending along the Salmon river from Hidden creek to Salmo. The country-rock in the vicinity of the workings is apparently chiefly greenstone.

The lower (or No. 2) tunnel is about 370 feet in length. It follows a line of shearing and silicification along the lower contact of a dyke which, according to J. F. Walker, proved under the microscope to be an augite-biotite-syenite. The shear-zone strikes about N. 20° W. and its average dip is 35° to the north-east. At 300 feet in from the portal there is an easterly bend in the working and then the tunnel continues along its original bearing for another 70 feet. The bend marks the location of a fault which causes a small displacement. Mineralization consists of iron sulphides disseminated through siliceous bands and streaks occurring in small elongated lenses in the vein. At 90 feet in from the portal there is a small stope up some 30 feet above the level. A sample taken across 18 inches on the foot-wall side of the vein in the stope assayed: Gold, 0.41 oz. to the ton; silver, 1.1 oz. to the ton. Across the creek a short distance from the No. 2 tunnel portal a sample taken across an exposure of quartz, containing pyrite and visible free gold, 6 feet wide, assayed: Gold, 2.44 oz. to the ton; silver, 1.2 oz. to the ton. At the time of examination early in the summer this showing had not been opened up to any appreciable extent.

The dyke can be traced several hundred feet northerly up the hill by outcrops and a shallow cut. An upper tunnel, 488 feet horizontally and 176 feet vertically above the No. 2, and in a westerly direction from it, exposes a small fracture containing a narrow seam of galena. This is not considered to have any relation to the lower tunnel vein. Showings in several open-cuts farther up the hill were not seen, but good values are claimed over widths approximating 1 foot. Work has recently been done here and a car-load of sorted ore shipped to Trail towards the end of 1931. A start was previously made to drive a crosscut under the 6-foot showing sampled across the creek from the No. 2 tunnel, but this was discontinued for further surface work. The property is connected by half a mile of trail to a branch road, 1½ miles in length, with the Nelson-Salmo highway.

Alma N. This prospect, situated at the head of Eagle creek, south-westerly from Nelson, has been worked intermittently during the summer season by G. Matthews, of Salmo. A brief description of the superficial showings, which occur in a vein following a granite-schist contact-zone, is contained in the Annual Report for 1930. Insufficient work has been done to gauge the character and continuity of the deposits, which seem to merit more superficial exploration with a view to interesting the necessary capital for deeper development if warranted by the results of preliminary work.

Eureka. North-westerly from the *Alma N.*, this property is situated in a granite area containing remnants of calcareous sediments. The ore contained values in gold, silver, and copper. The property, described in the Annual Report for 1915, was subsequently developed intermittently until 1920, as stated in the intervening Annual Reports.

Granite-Poorman. This mine, situated in the main granite-mass north of the *Eureka*, has been frequently described in publications of this Department, notably in the 1915 Annual Report, and in Geological Survey of Canada Summary Report for 1911. Inactive since 1929, when driving of the long low-level crosscut tunnel was discontinued by the Granite-Poorman Gold Mines, Limited, this mine is credited with a past production of over \$1,000,000 in gold, being the largest local example of deposits in quartz fissure-veins in granite. The deepest workings on the ore-bodies, opened between 1915 and 1918, are on the *Poorman* and *Hardscrabble* veins in connected shaft-workings, full of water when visited several years ago. The values encountered at the deeper horizon by the Kootenay Gold Exploration Company in 1917 and 1918 are not known, and the future of the mine depends on the persistence of commercial values to depth on these and the other three less deeply explored veins on the property. The testing of the ore-bodies at the depth of the low-level crosscut, which was discontinued when in about 1,000 feet out of the 4,000 feet contemplated, would have provided valuable information bearing upon what might be expected at the numerous other gold-quartz fissure-veins of similar type in the Nelson batholith.

West of the *Granite-Poorman* property the *Royal Canadian* vein is also in **Royal Canadian and Nevada.** granite and has a similar strike and dip. The ore remaining in the workings is very low grade. The *Nevada* vein, south and farther up the hill, striking nearly at right angles, has only been very superficially prospected by a crosscut containing short drifts, connecting with a shallow shaft. G. Birtsch, of Nelson, recently commenced work here under lease. The vein adjoins a contact between granodiorite and schist and

it varies in width from 8 inches to 3 feet. A shipment was made in 1911 from an underhand stope in the east drift which averaged \$20 in gold to the ton. These *Nevada* workings were not in very good condition when the property was examined in 1928, but there was no apparent reason for the lack of testing at further depth, except possibly that the grade of the ore would not stand shipment at the time the last work was done.

Situated on Whitewater creek, a tributary of Rover creek south-west of Nelson, these adjoining claims were actively prospected during the summer and fall by T. P. Moran, G. Birtsch, and W. Cuning, all of Nelson. High-grade gold-quartz float has been found along a definite line for a considerable distance adjacent to the creek, and the superficial exploration by the above-mentioned prospectors has been done with a view to locating the vein in place. The old *Whitewater* workings, consisting of two short tunnels, considerable stripping and open-cutting, develop a fissure-vein in granite striking N. 40° E. and dipping at 60° to the south-east. Sampling of this vein showed the values to be spotty and the best assays were obtained from decomposed ledge-matter. The unleached quartz containing pyrite did not give good assays. The granite area, apparently quite limited in extent, is surrounded by schistose rocks of the Rossland volcanic group. The *Whitewater* vein in the granite should be tested farther along its strike to where it enters the schist area. The very interesting high-grade float, consisting of quartz containing occasional native gold with iron sulphides, and occasionally galena and sphalerite, is found at frequent intervals up the creek from the *Whitewater* claim through the *Columbia*, *Stillwater*, and *Snow Water* claims. In some of it the mineralization includes an unidentified mineral with which exceptionally high gold values are associated. The rocks of the adjoining area are pretty well covered except near the creek, where granite is exposed at numerous points. The following samples were taken:—

Description.	Width.	Gold.	Silver.	Lead.	Zinc.
	Inches.	Oz. to Ton.	Oz. to Ton.	Per Cent.	Per Cent.
Whitewater—					
Outcrop.....	4	0.39	0.9	.....	.....
Outcrop.....	66	0.54	0.7	.....	.....
Grab from quartz-dump in bin at head of old mill, 35 to 40 tons.....	.....	0.90	0.9	.....	.....
60 feet in upper tunnel.....	50	0.29	1.0	.....	.....
10 feet in upper tunnel, heavily oxidized.....	32	4.08	3.6	.....	.....
Upper tunnel in face.....	30	0.05	0.8	.....	.....
Stillwater, float-ore, composite sample of large loose slab of quartz.....	.....	0.37	3.6	.....	.....
Snow Water—					
Boulders in ground-sluice; specimen float-ore.....	.....	7.06	37.6	.....	.....
Large loose silicified schistose rock.....	.....	0.15	1.7	0.15	0.3
Miscellaneous specimens of float-ore.....	.....	3.76	16.3	.....	.....

The trend of the float indicates that it originates from a vein probably crossing the creek at an acute angle, and from the nature of some of the gangue it evidently is derived in part, at least, from a vein in the schistose rocks.

At this mine, now reached by the Cultus-Canyon Creek route from Kootenay lake, work has been discontinued for the winter. For several years exploration of a quartz-filled fissure-vein in granodiorite has been carried out by B. N. Sharp, of Spokane, on behalf of J. B. Gerrard, of New York. Extended references to the property are contained in the Annual Reports for 1915 and 1929. In the zone of oxidation, not very deep in this case, the gold values were good, but it remains to be demonstrated if commercial values persist to depth.

In the same general formation, and a few miles distant from the *Bayonne*, the *Spokane* gold-silver-lead prospect is described in the 1915, 1917, and 1927 Annual Reports. The owners, the Laib Bros., of Kuskonook, have accomplished a considerable amount of well-planned exploration throughout a long period of years and a substantial tonnage of oxidized gold-silver-lead ore has been developed in a vein having a width of 2½ to 3 feet. Shipments of sorted ore from these workings, aggregating some

150 tons, were made between 1915 and 1918, the ore being packed over the divide to the Sheep Creek road. The following information was extracted from the smelter returns:—

Net Weight.	Gold.	Silver.	Lead.	Net Weight.	Gold.	Silver.	Lead.
Lb.	Oz. to Ton.	Oz. to Ton.	Per Cent.	Lb.	Oz. to Ton.	Oz. to Ton.	Per Cent.
21,450	0.12	48.5	71.2	82,040	0.72	15.5	15.7
58,235	0.56	31.5	44.5	48,769	0.74	13.0	12.4
7,437	0.50	31.2	47.1	41,434	0.16	32.5	57.8

The property needs deeper development to assure the additional ore reserves necessary to warrant installation of milling plant, which is essential to handle the output of the mine to best advantage.

DEPOSITS IN PEND D'OREILLE SCHISTS AND ADJOINING GRANITIC INTRUSIVE ROCKS
(Ymir Camp).

Goodenough. Described in the Annual Reports from 1926 to 1930, inclusive, this property, on Ymir (Wild Horse) creek, is owned by H. Jackson, A. McDonald, of Ymir, and associates. Negotiations were recently proceeding for a deal. Briefly recapitulating previously published information, the ore consists of auriferous pyrite associated with zinc-blende and argentiferous galena, the principal values being in gold. The formation is composed of Pend d'Oreille schists intruded by tongues from the Nelson batholith. Cutting diagonally across these rocks, the fissure-veins strike north-east by east, with steep dips to the north-west. The original superficial workings on the summit indicated two distinct veins about 90 feet apart, which converged towards the south-west. From the two upper tunnels the total amount of ore (largely selectively mined) shipped between 1926 and 1930 was about 1,360 tons, which contained 3,993 oz. gold, 30,283 oz. silver, and 431,091 lb. of lead. The gold content of this ore averages 0.856 oz. to the ton. When the last shipments were made in 1930 the combined silver and lead content of the ore just about paid for the cost of freight and treatment. The shipments were made as smelting-ore, payment being made for gold, silver, and lead only. The ore has obtained a favourable smelting rate on account of its high silica content. Hauling charges to the railway are from \$1.25 to \$1.50 a ton and freight rates about \$2.40 a ton. The No. 1 and No. 2 tunnels develop an ore-zone about 600 feet long at depths of 220 and 374 feet respectively, measured on the dip of the veins, below their apices. In these workings the character of the deposits has been somewhat irregular owing to the lenticular shape of the ore-bodies and offsetting by numerous small faults and dykes. Material below shipping-grade has been left in these tunnels. The strength of the mineralization in No. 2 tunnel is promising for the downward continuation of the ore below that level. The ore-zone is wide and contained numerous small lenses of good ore. The last work done under company management was the driving of a lower (No. 3) tunnel for a length of about 550 feet to gain an additional depth of 220 feet on the dip of the veins, or rather shear-zone, which best describes the channel of mineralization in the underground workings. A survey showed that the No. 3 tunnel was driven too far to the north and the owners changed its direction to cut the veins in the shortest distance. This tunnel, now in about 700 feet from the portal, has not yet cut the objective and is roughly estimated to be about 300 feet away, in a direct line, from the most westerly ore-shoot mined in the No. 2 tunnel above. This work has been temporarily discontinued.

At the same elevation and some 300 to 400 feet southerly from the portal of No. 3 level, a new surface showing of gold-bearing sulphide ore was found by the owners in 1930. At the point of discovery this was about 10 feet wide, consisting of mixed iron, lead, and zinc sulphides, the lead content being apparently above the average. The gold values here are understood to be about \$10 to the ton. Since the writer's last inspection a tunnel (No. 4) was driven by hand some 80 feet north-easterly along the apparent direction of the vein from this surface showing. It is reported that there is ore on the southern side of this tunnel, which would be on the foot-wall side of the vein, and that a hole drilled into this side of the tunnel near the face showed several feet of strong sulphide ore. It seems probable that these newly found showings are in reality along the trend of the same vein-zone as developed in the Nos. 1 and 2 tunnels,

suggesting that the inner end of the No. 3 tunnel will have to be driven some little distance farther south to intercept the lead in its position as now indicated at this horizon.

Discussing the possibilities of the *Goodenough* deposits, there are no conditions that would suggest the weakening or impoverishment of the veins for a considerable distance laterally or in depth. The convergence of the two widely separated veins in the upper tunnels indicate a juncture close to the level of the No. 3 tunnel, which would not have to be driven far to prove the ore-zone at this new horizon, 220 feet on the dip of the veins below the No. 2 level. It is to be expected that below the point of juncture larger ore-widths will be found and possibly more regular conditions of deposition. At the easterly end of the workings the veins should pass out of *Goodenough* ground at a depth of approximately 350 feet into the *Mugwump* claim of the adjoining *Ymir* mine property, and it is evident that this claim is necessary to complete the potentially valuable holdings. There is not yet much evidence on which to estimate the possibility of developing sufficient milling-ore to warrant a plant to treat it, but the strong probability of at least developing a substantial quantity of ore, such as has previously been shipped, is a strong incentive for continuing exploration on the No. 3 tunnel-level. The surface showing of good sulphide ore found south of the portal at this level adds fresh interest, in that the length of the zone in which ore-shoots might be found is very considerably extended.

Ymir. This mine was formerly a large producer, the active period of operations having been between 1896 and 1908. Production made between 1899 and 1908 totalled 304,494 tons, which contained 80,540 oz. gold, 304,342 oz. silver, and 7,647,223 lb. of lead. Discoveries and production made at the adjoining *Goodenough* during the last few years have revived interest in the old *Ymir* property, the possibilities of which are not believed to be by any means exhausted.

A very comprehensive report on the property is contained in Memoir 94, Geological Survey of Canada. The following notes by R. W. Brock, then Director of the Geological Survey (made since operations ceased), from the Summary Report of the Survey for 1908, indicates interesting possibilities for further exploratory work at the *Ymir* mine: "From Nelson a trip was made to *Ymir*, where the *Ymir* mine was visited. This, with its extensive equipment, including an 80-stamp mill, was formerly a large producer, but at present work is confined to development. The main workings are on a large lens-shaped ore-shoot about 500 feet long and 30 feet wide, which was continuous downward for 500 feet. There gangue began to become prominent, but rich pockets continued for several hundred feet, the gangue, however, gradually increasing. At 1,000 feet in depth the ore was confined to streaks. At the east end of this ore-shoot it seems to gradually peter out, but the west end may be cut off by a fault, although I understand that what is thought to be the same fissure has been traced on the surface for several thousand feet without finding another body of ore. The second level has been drifted on for 250 feet west of the dyke and then a crosscut 800 feet long has been made into the hill. At this point broken ground is encountered and a drift run along it with a raise on a bunch of ore.

"On the surface above the outcrop of the producing vein a large amount of rich float has been found, which must have originated in a second vein; but extensive prospecting has failed to discover this lead. The float would appear to indicate a point of origin near the edge of the main ore-shoot block, about in line with the ore at present being worked at the end of the long crosscut in the second level.

"Although a good deal of prospecting has been done on the property, it has been chiefly to test the ore-shoot at depth, and a considerable amount of very promising territory still awaits exploration. The ground west of the ore-shoot, beyond the probable fault, has been tested only by the drift on the second level and the long crosscut. No crosscut in the opposite direction has yet been made and no crosscuts have been run from the main shoot to test for parallel ore-bodies. The rich float up the hill, and the frequency with which parallel veins and ore-shoots occur in Southern British Columbia, renders such exploratory work a promising venture. This ground should be tested, for the *Ymir* mine has been one of the prominent dividend-payers of the West Kootenay District."

The large *Ymir* quartz-lens, continuous to the 1,000-foot level, frequently contained a long narrow band of argillite, analogous to the wider parting between the *Goodenough* hanging- and foot-wall veins, through the centre of the vein. Beyond the lens the vein pinches to a mere crack at the face of the 1,000-foot level. Throughout the mine the vein is much larger and more regular than the *Goodenough* vein, but the character is otherwise the same. The minor faulting

system is similar in both mines. At the west end of the *Ymir* workings the vein has been cut by a fault striking north-north-east and dipping steeply westward. The throw is not definite in direction or amount, but appears to conform to that of the other northerly-striking faults, which caused displacements to the south, only of greater extent. A possibility has been suggested that the *Goodenough* veins represent the faulted westerly continuation of the *Ymir* vein, which appears plausible, but is not supported on any definite evidence as yet.

Analysing the *Ymir* and *Goodenough* deposits, they have other points in common. The *Ymir* vein strikes N. 70° E. and dips 70° to the north-west, and the *Goodenough* vein has an approximately similar strike and dip. Both cut the bedding of the argillites, but in the case of the *Ymir* no granitic tongues were encountered in the ore-zone. The walls of the *Ymir* vein are fairly good and continuous and are generally accompanied by a small gouge as in the *Goodenough*. The vein-filling is comparatively massive white, somewhat vitreous, quartz containing a somewhat smaller proportion of sulphides than the *Goodenough* veins.

In addition to the possibilities for further exploration suggested by R. W. Brock, not known to have been implemented to any degree in the small amount of subsequent exploration, there is thought to be a probability that below the 1,000-foot level there may be a recurrence of conditions favourable to ore-deposition where the vein should cut a series of harder argillaceous rocks similar to the country-rock of the ore-body. The east end of the *Ymir* vein on the 1,000-foot level also terminates in faulted ground, and no further effort has been made to pick up its continuation here, probably because the property beyond, now consolidated with the holdings of the *Ymir* Gold Mines, Limited, was then owned by another company.

Ymir-Wilcox. At this property, situated about 2 miles north-easterly from the *Ymir* mine, work was discontinued by F. A. Hebbard, of Vallejo, California, after the concentrates derived from milling in 1930 were shipped. The ore is said to have been bunched, requiring close sorting before milling. The property is described at length in Geological Survey of Canada Memoir 94. The main country-rock to the veins is granite, though roof-pendants of altered sedimentaries are present in the vicinity.

Yankee Girl. At this mine near *Ymir*, to which extended references have been made in recent Annual Reports, renewed activity has been initiated by E. P. Crawford, mining engineer, of Vancouver, and a car-load of ore has recently been shipped to the Trail smelter. The ambitious deep-development programme of the *Yankee Girl* Consolidated Mines, Limited—a Stobie-Forlong enterprise—from *Ymir* Creek side was discontinued following the stock-market collapse, and the original mine on Oscar (Bear) creek reverted to the Texas-Yankee Girl Mines, Limited (N.P.L.), of Fort Worth, Texas, and Nelson, B.C. The ore just shipped was in the bin, having previously been extracted from development. Mining and stoping of ore will proceed shortly, but the present small beginning is expected to expand substantially.

Dundee. This property, adjoining the *Yankee Girl* to the south, has been shut down for many years. Shaft-workings and a long tunnel, below and not connected with the shaft, develop a parallel vein to the *Yankee Girl* lead, also cutting diagonally across the Pend d'Oreille schists. According to Drysdale in Memoir 94, the geology of the deposit is as follows:—

"The *Dundee* vein is a strong fault-fissure with well-defined walls traceable for several thousand feet. A gouge, a few inches to over 1 foot thick, marks the hanging-wall. The fissure, which is filled by quartz and altered, mineralized wall-rock, strikes north-east and south-west, with a north-westward dip of 60° to 70°. It is parallel to the *Yankee Girl* vein. The vein varies from 5 to 20 feet in width and cuts diagonally across the trend of the Pend d'Oreille schists. Toward the north-east, where the ore-shoot occurs, the vein encounters a fine-grained granitic tongue injected from the main mass of Nelson granite and gneiss to the east. The ore-shoot occurs in the granite at its acute-angled intersection with the fault-fissure. The ore is galena, iron pyrite, and some zinc-blende, carrying gold and silver values; the gangue is quartz. Some of the ore first opened up ran as high as \$100 per ton. As a general average, however, the ore would run about \$25 per ton in gold and silver. Much pyritic milling-ore is present, averaging \$6 or \$7 per ton. Both foot and hanging walls carry pay-streaks aggregating 30 inches in width, with disseminated ore between. The ore-shoot in part represents granite replaced by silica containing sulphides. Galena, as is so characteristic of *Ymir* ores, is accompanied by good gold

values and in places good silver values; zinc-blende is accompanied by both gold and silver values, especially when associated with galena."

Some ore, containing values in gold of from 1.095 to 2.858 oz. to the ton, with silver from 7.65 to 18.4 oz. to the ton, and from 4.3 to 19.9 per cent. lead, was shipped in car-load lots to the old Hall smelter at Nelson in 1897 and 1898. In addition, a small tonnage was put through the old concentrator, subsequently destroyed by fire. The ore shipped, amounting to some 300 tons, and the ore milled was extracted from the shaft-workings. The tunnel, aggregating close to 3,000 feet of crosscutting and drifting, enters the ore-zone towards the extreme inner end, where a little stoping was done over a short length. Exploration was therefore discontinued at a very interesting stage, as the inner 1,000 feet of drifting in the long tunnel is now entering the zone of acute-angled intersection of the vein with granitic outliers from the batholith, which condition governed, to a considerable extent, the locus of ore-deposition in the *Yankee Girl*. The *Dundee* vein dips steeply towards the adjacent boundary of the *Yankee Girl* property, but it is not known accurately where the vein would be likely to leave *Dundee* ground. In any case the *Dundee* property would appear to be of potential value as an adjunct to the adjoining more extensively developed mine.

Under "Present Status and Future of District," Drysdale says: "Without doubt many undiscovered veins and ore-shoots are still hidden under the thick cover of wash and drift in certain promising belts. Much of this territory, however, is held by Crown grant and there is little encouragement to the prospector. Veins parallel to those of the main producers of the past should be sought after and many of the abandoned barren veins should be tested further for the occurrence of ore-shoots at geologically favourable localities. The successful exploitation of the ores in the district would be aided by an amalgamation of interests which would result in systematic prospecting and the development of the ore reserves."

Old-Timer. Under the classification of veins parallel to those of the main producers of the past can be included the *Old-Timer* prospect, owned by A. Burgess, of Ymir, on the North fork of Ymir creek and the *Summit* group in the same vicinity. These were described in the Annual Report for 1928 and the advisability of testing these veins in favourable geological zones is emphasized. Granitic tongues outcrop at several points between the two prospects. The *Old-Timer* work was done where the vein enters the main granite-mass and the *Summit* vein is barren where it has been explored by a tunnel in the schist west of the favourable zone of granitic intrusives.

Blackcock. An option on this property, situated south-westerly from the *Ymir-Wilcox*, has been secured by Calgary interests and substantial mining activity is expected in the spring. This prospect, unworked for many years, is situated in the contact marginal area and the easterly-westerly-striking vein belongs to the same system which includes the *Ymir*, *Goodenough*, *Yankee Girl*, *Dundee*, and other veins. Much information about this property is contained in the Annual Report for 1928.

SHEEP CREEK GOLD CAMP.

The geology of this area has been undergoing revision by J. F. Walker, of the Geological Survey of Canada, who has been engaged at intervals since 1928 in preparation of a new map of the Salmo area. In Geological Survey of Canada Summary Report, 1929, Part A, under "Mineral Developments in the Salmo Map-area," he says:—

"The mineral-deposits are of two distinct types and are found in well-defined belts. Zinc and zinc-lead replacements in limestone are found along the westerly anticline and gold fissure-veins are found along the central quartzite anticline. Some gold-deposits lie to the east of this anticline and to the west between it and the zinc-belt are some sulphide deposits carrying gold. The junction of Wolf with Sheep creek may be considered to be the heart of the gold camp and is distant 10 miles by motor-road from Salmo.

"The gold-deposits occur as fissure-veins, cutting quartzites and schists. The sediments strike north to 15° east of north and dip from 50° east to vertical and steeply west. The fissures strike 60° east of north to east and the dips are generally high to the south to vertical.

"Displacement on the fissures varies from a few feet to about 200 feet and in all cases observed the south wall has moved west in relation to the north wall. The fissures are in part filled with quartz and crushed country-rock and vary from almost nothing to some 20 feet in

width, the average being generally less than stoping-width. Pyrite and a little galena and sphalerite occur sparingly in the quartz. Kidneys of tungsten minerals have been reported from the *Kootenay Belle* vein. In the upper part of the vein the pyrite has ordinarily been oxidized and the gold set free. With the exception of the *Queen* vein, the primary ore has been found of too low grade to mine, which may be accounted for in part in that the average vein is narrower than stoping-width and dilution enters into the problem. The result is that most of the mine-workings have been confined to the oxidized zones, which vary in depth from a few feet to as much as 500 feet.

"The ore-shoots appear to be confined to the quartzites and harder argillaceous rocks, the fissures being tight, with little vein-matter where they cut the schists. The ore-shoots tend to rake with the dip of the sediments, but are very irregular and the rake is not always evident."

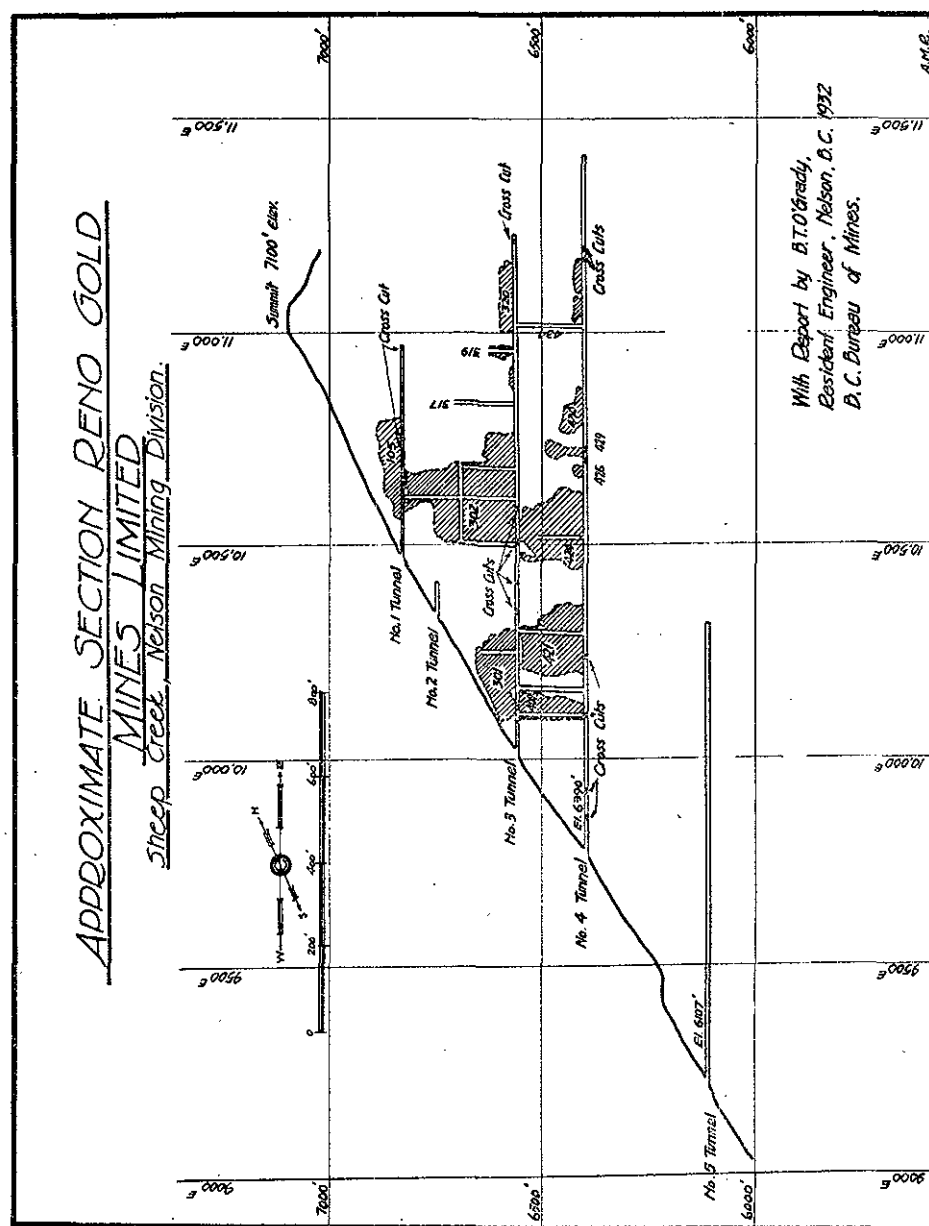
There follows a description of the following gold properties: *Queen*, *Kootenay Belle*, *Nugget-Motherlode*, *Reno*, *Salmo-Consolidated*, and *Howard* (gold-silver-lead-zinc). The only one to have been developed since then is the *Reno*, mentioned hereafter. The past output of the leading producers of the camp was approximately as follows:—

Period.	Mine.	Tons.	Gold.	Silver.	Lead.
			Oz.	Oz.	Lb.
1900-1902.....	Yellowstone.....	17,115	4,249	2,736	.....
1902-1928.....	Queen.....	118,225	57,397	19,894	.....
1904-1928.....	Kootenay Belle.....	5,687	6,693	2,885	.....
1906-1915.....	Motherlode.....	61,336	37,153	15,025	10,429
1907-1922.....	Nugget.....	36,665	21,409	4,836	.....

The only actively producing property at the time of writing is the *Reno*, which is credited with an approximate production of \$400,000 in value from August, 1929, when milling commenced, to the end of 1931. This property, on Fawn creek, has proved an exception to the general experience in regard to continuity of good values in the primary ores below the zone of oxidation, and the character of the ore-body on No. 4 level gives every expectation of some permanence at depth. Extended references to the *Reno* are contained in the Annual Reports from and including 1927. Work done during 1931 includes the opening-up of a length of 400 feet of ore, averaging 2 feet in width and about \$40 in gold to the ton, at the inner end of No. 4 level. This ore contains galena, zinc-blende, pyrite, pyrrhotite, and chalcopryite, the sulphides in places forming a considerable proportion of the vein-filling. Diamond-drilling has been done at various points in the mine. The new No. 5 level had been driven about 1,000 feet towards the end of the year and the vein was cut and is being drifted on to open up the downward continuation of the zone of ore-shoots on No. 4 level. New equipment provided includes an additional Diesel engine and compressor to cope with the extended programme of development undertaken.

The following notes have been supplied by the management: During 1931 development-work done amounts to a total footage of 2,487 feet, including drifts, crosscuts, and raises. Diamond-drilling totalled 2,455 feet. Forty-five tons a day is now being milled, as against 32 tons a day for the first seven months of the year. The ratio of oxidized ore to sulphide ore going to the mill is 1.4 to 1. Formerly the mill-feed was practically all oxidized ore. Certain changes have been made in the flow-sheet to take care of the sulphides, and further additional changes are being made.

There was milled during 1931 11,944 tons, averaging \$18.871 a ton in gold. This includes development ore, where dilution reduced the grade. The stope ore is now averaging \$23.274 in gold to the ton. Average mill recovery for the year was 92.42 per cent. The sulphides reduced the average recovery, but recent changes in the flow-sheet are improving the percentage. Recovery for the year amounted to \$201,570.10, to which must be added \$13,938.93 premium, making a total of \$215,509.03. The ore is ground to 52.64 per cent. through 200-mesh. Recovery is made as follows: Amalgamation, 40 per cent.; cyanidation, 53 per cent.; concentrates, 7 per cent. A programme of intensive development to increase ore reserves has been initiated. There are fifty-seven men now employed and the operation is of considerable benefit to the surrounding district.



Vancouver. At this gold prospect, adjoining the *Queen*, new activity has been initiated by J. Gallo and W. Applegate, of Calgary, and a start was made in December with a crew of six men. High-grade gold quartz is being mined for shipment from a shoot, 30 feet long and 18 inches wide, in the No. 2 tunnel. Stopping is also proceeding on another shoot on the same level, in which the ore is 4 feet wide. The estimated backs are 100 feet and the following assays of ore being broken were supplied by the management:—

Width, 36 inches: Gold, 1.14 oz. to the ton; silver, 0.4 oz. to the ton.

Width, 6 inches: Gold, 44.52 oz. to the ton; silver, 6.8 oz. to the ton.

Width, 18 inches: Gold, 8.86 oz. to the ton; silver, 1.9 oz. to the ton.

Very high gold assays are obtainable in places and a good grade of ore should be maintained in the shipments. The *Vancouver* vein has the same strike as the other veins of the camp and cuts similar rocks (*see* Annual Report for 1926).

This property on Sheep creek is being purchased by Wisconsin interests. The **Nugget-Motherlode.** Nugget Mines, Limited, with registered office at Nelson, was recently incorporated in connection with this undertaking. The deal includes the *Motherlode* mill-site, fifteen mineral claims, the mill, and all mining and milling equipment. No mining operations have yet been initiated at the time of writing, but exploration will presumably be started before long. The last work done was during the period 1920 to 1922, when H. Lakes, of Nelson, was superintendent, and A. Lakes, now of Vancouver, was consulting engineer.

Howard. At this property, situated on Active (the South fork of Porcupine) creek, resumed activity is expected to be undertaken during the coming season. Exploratory operations were suspended in 1930 pending an improvement in metal-market conditions. Although the gold values predominate in the ore, the silver, lead, and zinc are important factors in considering profitable production. A very substantial body of ore has been partially explored. During the latter stages work was started to explore for the faulted southerly continuation of this ore-body, but this work was not concluded at the time the mine was shut down. Constructive suggestions by J. F. Walker regarding the faulting problem are contained in Geological Survey of Canada Summary Report, Part A, 1929. Exploration along the lines suggested, if successful, would convert the existing small mine north of the fault into a substantial operation. The property is owned by the Howard Mines, Limited, largely controlled by J. F. Duthie, of Seattle.

Wisconsin. This prospect, described in the Annual Report for 1929, is considered to have major possibilities for the development of large tonnage. The deposits are situated in a contact area of metamorphosed sedimentaries and granitic intrusions, the stratified rocks being apparently the northerly extension of the rocks of the Sheep Creek gold camp as described by J. F. Walker in the area to the south. The ore, which in the shallow zone explored is of complex character, contains consistently good gold values, associated with arsenopyrite, and subsidiary values in silver, with small percentages of copper, lead, zinc, and antimony. The outcrop of the main vein has been developed at short intervals by a series of open-cuts for a total length of over 650 feet, and 145 feet of drifting has been done from a short crosscut tapping the vein at a depth of about 50 feet below the surface. The vein is from 20 to 30 feet wide and the ore up to 18 feet wide where crosscut in the drift. Some results of separate samplings are given for comparison in the appended table:—

Description.	Width.	Gold.	Silver.	Remarks.
		Oz. to Ton.	Oz. to Ton.	
Cut No. 10.....	3.0	0.42	3.20	At north-east end of outcrop workings.
Same.....	3.0	1.54	6.82	Ditto.
Cuts 9 and 8.....	.....	.....	.....	These are in granite to south-east of vein and were not sampled.
Cut 7.....	6.0	0.08	1.40	Full width of vein not exposed.
Same.....	6.0	0.17	1.25	Ditto.
Cut No. 6.....	10.5	0.19	1.17	"
Same.....	10.5	0.07	1.65	"
Cut No. 5.....	6.0	0.64	7.10	"
Same.....	5.0	0.98	3.40	"
Same place.....	5.0	2.04	7.46	"
Cut No. 4.....	8.0	0.34	2.60	"
Same.....	8.0	0.53	2.63	"
Cut No. 3, hanging-wall section.....	4.0	0.20	0.86	11 feet in two sections.
Same place, foot-wall section.....	7.0	0.86	3.00	Ditto.
Same place, hanging-wall section.....	2.5	0.18	3.20	9.5 feet in two sections.
Same place, foot-wall section.....	7.0	0.36	6.50	Ditto.
Cut No. 2.....	5.0	0.52	5.10	Full width of vein not exposed.
Same place.....	5.0	1.22	9.38	Ditto.
Cut No. 1.....	.....	0.12	1.08	Width not specified. At south end of workings.

SAMPLINGS—Continued.

Description.	Width.	Gold.	Silver.	Remarks.
		Oz. to Ton.	Oz. to Ton.	
Diagonal crosscut through vein in No. 1 tunnel-drift	11.0	0.38	2.60	One section from foot-wall to hanging-wall.
Ditto.....	7.0	0.61	6.50	Ditto.
"	9.6	0.06	0.70	"
"	7.8	0.02	0.40	"
"	6.7	0.08	1.90	"
"	7.3	0.10	1.50	"
"	5.5	0.49	2.60	Same section from foot-wall to hanging-wall.
"	6.2	0.56	4.60	Ditto.
"	6.0	0.39	4.60	"
"	6.0	0.07	2.30	"
No. 1 tunnel-drift (145-foot length sampled)	9.3+	0.35	3.40	Excluding low-grade samples on hanging-wall and foot-wall.
Cuts Nos. 2 to 5, length 100 feet.....	7.2+	0.52	3.60	
No. 1 tunnel across full width of ore at winze and both sides of second crosscut, length 60 feet.....	17.8	0.43	3.90	

In the case of one sampling operation a comparison was made of the relative values of the sulphide and oxidized parts of the ore-body with results as follows: Strong sulphide, 0.32 oz. gold to the ton, 3 oz. silver to the ton; mixed oxide and sulphide, 0.32 oz. gold to the ton, 3 oz. silver to the ton; strong oxide, 0.12 oz. gold to the ton, 3.1 oz. silver to the ton.

A composite average of seven samples, mostly sulphide, assayed: Gold, 0.48 oz. to the ton; silver, 4.1 oz. to the ton; lead, 0.6 per cent.; zinc, 0.65 per cent.; copper, 1.42 per cent.; arsenic, 13.25 per cent. The calculated average values from the separate assays of the same samples was: Gold, 0.52 oz. to the ton; silver, 4.9 oz. to the ton.

An analysis of a composite sample from the No. 1 tunnel gave: Silica, 26.8 per cent.; lime, 0.6 per cent.; alumina, 10.7 per cent.; iron, 26.5 per cent.; sulphur, 14.5 per cent.; arsenic, 11.1 per cent.

An analysis of a composite sample across the "pay-ore" in the No. 1 tunnel crosscut gave: Silica, 27 per cent.; alumina, 5 per cent.; magnesia, 0.4 per cent.; iron, 27 per cent.; lime, 0.8 per cent.; sulphur, 8.8 per cent.; arsenic, 10.2 per cent.; copper, 0.26 per cent.; zinc, 0.5 per cent.; antimony, 3.50 per cent.

South of the No. 1 tunnel, the No. 2 is a crosscut in which the vein, not drifted on, is very wide but low grade. The best values are on the foot-wall side, where 3.5 feet assayed: Gold, 0.30 oz. to the ton; silver, 3.4 oz. to the ton. A cut across the full width of mineralization in three sections, commencing at the foot-wall side, gave:—

Width, 9 feet: Gold, 0.21 oz. to the ton; silver, 2.8 oz. to the ton.

Width, 9 feet: Gold, 0.07 oz. to the ton; silver, 0.8 oz. to the ton.

Width, 9 feet: Gold, 0.11 oz. to the ton; silver, 3.2 oz. to the ton.

Summarizing conditions, the property, 14 miles by trail from the Canadian Pacific Railway at Midge creek, has a very attractive showing of fair-grade ore, of which some 7,500 tons are sufficiently developed between the No. 1 tunnel and the surface to be classed as "probable ore." In the old winze, sunk 60 feet from the No. 1 working, water prevented an inspection below about 10 feet, in which distance the vein is going down strong. No information is recorded regarding results at the bottom of the winze, from which, according to report, a short drift was run. From observations of the present vein-exposures the property is considered to have a reasonable chance of developing into a large mine. The important factors to consider are the extent of the ore-body, the values in the unaltered sulphides, and their amenability to economical treatment. Diamond-drilling in this case seems to be the most advantageous means of preliminary testing.

MISCELLANEOUS DEPOSITS AND ACTIVITIES.

These include the following: At the *Gold Queen*, adjoining the new highway south of Gray creek, on the east side of Kootenay lake, discoveries have been made of quartz stringers, containing substantial gold values associated with pyrite and chalcopyrite, in metamorphosed

calcareous rocks belonging to the Hamill series of late pre-Cambrian age. A large excavation was made at the base of the bluffs by the roadside and a test shipment of 1 ton shipped to Trail. A sample of selected ore assayed: Gold, 2.15 oz. to the ton; silver, 12.1 oz. to the ton; copper, 6.96 per cent. The vein cuts the strike of the formation at an acute angle and subsidiary stringers of mineralization extend into the country-rock.

Near Ginols Landing, W. Frampton, of Trail, and associates have constructed a long chute connecting the tunnel-workings of the *Valparaiso* quartz vein with the bench above the Gray Creek-Kuskonook highway, and some construction is proceeding at the lower terminal. The *Valparaiso* is part of the holdings of the Sanca Mines, Limited, and recently the Canada Smelters, Limited (N.P.L.), was formed by interests associated with the former company. According to a news item which appeared in the June 6th, 1931, issue of the *Western Examiner*, Calgary, the new company is a subsidiary of the Sanca Mines, Limited, and the ostensible purpose of the "smelting" venture is to treat gold ore from the latter company's claims, and custom ores of the immediate district, in a Mace furnace. No appreciable tonnage of commercial ore, such as would be necessary to justify initiation of any kind of smelting, however limited in scope, is known to exist in the area at the present time. The *Valparaiso* quartz veins are large and strong, but where exposed in the granite the values are considered too low to be profitably worked. (For assays see Annual Report for 1927 under "Associated Mining and Milling Company.") If these veins, however, could be traced northerly into the area of metamorphosed sediments, of late pre-Cambrian age, near Akokli (Goat) creek, it is possible some change in the character of the mineralization might occur and better and more regular values be found.

In concluding this review of lode-gold deposits in the Nelson Division, it seems highly probable that a substantial expansion in gold production can be expected, judging from the new activities being initiated and the renewed interest being shown in long-dormant partially explored properties, the potentialities of which, in many instances, have not been fully realized.

LARDEAU MINING DIVISION (INCLUDING THE OLD TROUT LAKE MINING DIVISION):

Most of the gold-bearing deposits in this area are reached from Camborne, Ferguson, Trout Lake, Poplar, and Gerrard. Much information concerning the geology of individual gold prospects and their history is contained in the Annual Reports of this Department, notably by N. W. Emmens in the 1914 Report, and in Geological Survey of Canada Memoir 161, "Lardeau Map-area," where the general geology is described by J. F. Walker and M. F. Bancroft, and mineral-deposits are discussed by H. C. Gunning. This publication summarizes much valuable information concerning the deposits and offers constructive suggestions for future exploration. From the section devoted to "Types of Mineral Deposits," the following notes from Gunning's report have been abstracted:—

Many of the quartz veins of the Lardeau have been worked for their gold content and a well-defined belt of this type of deposit extends in a north-westerly direction along the strike of the formation, from Cascade creek, near Poplar, on the south, to Stephney creek, tributary of Sable creek, a few miles north of Camborne. In the Camborne area the veins were extensively developed about 1900 to 1910 and the \$5 to \$6 gold values developed were too low to be commercial at that time. The country-rocks of this area, which are argillaceous and carbonaceous sediments varying from slates to graphitic schists, and with quartzitic varieties of the same, are associated with greenstone dykes and bands of chloritic schists roughly intercalated with the sediments. The ore-deposition is quite similar in type throughout the area, the predominating type being the quartz-filled fissures, which are well developed along shear-zones or series of fissure-zones in the country-rocks. The veins are continuous and well defined over considerable distances, usually have a greater dip than 45°, and, cutting the rocks at small angles to their strike, are mineralized with small amounts of calcium-magnesium-iron carbonates, the gold values usually being found either in the free state or associated with the pyrite mineralization in the quartz vein-filling. Near Poplar some gold is found associated with arsenopyrite. Many of the deposits contain sulphides of lead and zinc in association with gold values and there is generally gradual gradation from the quartz-pyrite-gold type of deposit to the quartz-lead-zinc-pyrite-gold type of deposit. The gold values vary from a few cents a ton to \$10 a ton and more, many instances of considerably higher values having been recorded in the past.

The quartz veins are generally associated with the greenstone dykes, which, in the main, are altered to a grey carbonate rock, principally a calcium-iron-magnesium-carbonate rock, in

the area of the vein. In places many small quartz stringers lead off from the main vein into the country-rock, causing alteration and silicification of the wall-rocks, and it is found that the gold values are very often better at the intersection of the branch veins with the parent quartz vein. This point was stressed by R. W. Brock, who points out the importance of the intersections of these smaller veins with the larger ones as the loci of ore-deposition and favourable points for increased values.

In the Camborne area some of the quartz veins replace and alter the country-rock, the mineralization occurring as irregular lenses and due partly to replacement processes as well as to the filling of fissures. Much alteration of the country-rock has taken place in the vicinity of the veins, the grey carbonates being well developed. These altered rocks weather a rusty brown, a characteristic feature in their identification.

The distribution of values in the veins is quite erratic, but the average assays are low, as will be seen in the following descriptions of the properties. The *Burnière* is somewhat different from the other leads. In this quartz vein green chromium mica, approaching mariposite in composition, has been quite abundantly developed along seams and fractures in the quartz. Gold values are better where this mineral is abundant than elsewhere in the vein and consequently the mica has come to be recognized as a guide to good values.

Eva. This property, near Camborne, owned by the Imperial Development Syndicate, of Nelson, was worked from 1899 to 1908 and the 10-stamp mill was in operation for thirty-three working months between 1903 and 1907. During this period, according to information attributed to A. H. Gracey, formerly manager of the property, there was treated a total of 30,595 tons, from which was recovered \$147,553.92, an average of \$4.86 a ton. The average tailing loss during this period was 83 cents a ton, so that the gross value of the ore milled amounted to \$5.69 a ton, showing an extraction of 85.3 per cent. of the valuable metals in the ore. Work was apparently discontinued because of the low grade of the ore. Much information is contained in the Annual Report for 1914, including a recapitulation of a report by R. W. Brock published in Geological Survey Summary Report for 1903.

The above-mentioned report, by Emmens, includes a cross-section diagram of the old workings which aggregate 5,570 lineal feet, including 3,130 feet of drifts, 2,000 feet of crosscuts, 375 feet of raises, and 75 feet of shaft, in addition to which there are two glory-holes and many open-cuts. These workings are not all accessible at the present time, but it is not supposed that any considerable tonnage of quartz was left which could be extracted at a profit. It is noticeable, however, that in several cases exploration was discontinued when the lower levels were entering favourable ore-zones in which better values might be expected from the results of stoping done above. In order to make a comprehensive examination before future development plans could be considered, some of the lower workings should be reopened and a lot of sampling done.

The adjoining *Cholla* group, under the same ownership, is also described by N. W. Emmens in the Annual Report for 1914. On this property, very slightly developed, there are several quartz veins giving good gold assays in places. The adjacent *Oyster-Criterion* group is also described by R. W. Brock in Geological Survey Summary Report for 1903 and by Emmens in the Annual Report for 1914, since when no appreciable amount of mining has occurred. The following extract is from the latter publication:—

"No. 1 level cuts the vein at a depth of 100 feet below its outcrop, and approximately 1,000 feet of drifting has been done here upon what proved to be a practically continuous ore-shoot averaging in width approximately 5 feet. Between this level and the surface some 14,000 tons of ore were extracted, yielding bullion to the value of \$52,469.42, or within a fraction of \$3.75 per ton."

Goldfinch. At this property, on Menhinick creek, C. Menhinick, of Victoria, spent the season in reconditioning the old workings preliminary to investigation. It is described under "*Camborne Group*" by R. W. Brock in Geological Survey of Canada Summary Report for 1903, and by N. W. Emmens under "*Goldfinch*" in the Annual Report for 1914, together with the adjoining *Independence* group. The reports on both properties should be read in conjunction. Concluding his report on the *Goldfinch*, Emmens says:—

"From what can be seen, there is no verification of the existence of a commercial ore-body in this portion of the ground, but the face of the lower adit is very close to the line of the

Independence, and if it was continued until it cut the 'big vein' in that property might uncover an ore-body of considerable value."

Information concerning the following gold prospects in the vicinity of Camborne is included in Geological Survey of Canada Memoir 161 and in the Annual Report for 1914: *Lucky Jack*, *Red Horse*, *Burnière*, and *Silver Dollar*. Regarding the *Burnière*, H. C. Gunning, in the Geological publication mentioned, says:—

"The *Burnière*, near the headwaters of Scott creek, in beautiful grassy uplands, is an interesting property. Messrs. Cory and Stanley Menhinick, of Camborne, are the owners. A vein of white quartz, up to 5 feet wide, strikes about N. 55° W., cutting a greenstone dyke. The dyke has been altered to grey, rusty weathering carbonate rock and contains considerable green chromium mica. The quartz is much fractured and along many of the fractures the same mica, which approaches mariposite in composition, has been developed. Free gold is visible in places in the vein and very small, irregularly distributed quantities of galena, chalcopryite, and grey copper. The gold is in many cases somewhat concentrated in fractured areas where the green chromium mica is abundant, and accordingly that mineral has come to be recognized as an indicator of gold values. Faults cut across the vein, and one section, about 40 feet long, has been offset 15 feet or more to the north-east. The vein is well exposed on the surface and has been traced for about 400 feet. Two short adits have been driven to encounter it at shallow depths."

Describing the history of the area, Gunning says: "The history of the gold camp is a sad one. Much money has been spent and little obtained in return. The *Eva* had all the appearances of developing into a steady producer, but \$5 or \$6 ore proved too low grade to be profitable. In justice to the district it must be said that many of the properties have hardly had a fair trial. Overoptimism and lack of engineering and mining knowledge seem to have played too important a part in the developments. Under skilled management a different story would have been written."

Among other properties described in this publication is the *Teddy Glacier*, where the ore contains appreciable gold values associated with pyrite, argentiferous galena, and sphalerite. This property is also described fully in the 1925 and other Annual Reports.

Since Memoir 161, "Lardeau Map-area," was published in 1929 only a small amount of shallow tunnelling has been done below the showings under the general direction of A. S. McCulloch, of Vancouver, and C. E. Bush, of Detroit.

Other silver-lead-zinc deposits containing appreciable gold values in the vicinity of Camborne include the *Beatrice* at the head of the East fork of Mohawk creek. Concluding his description of this property in Memoir 161, Gunning says:—

"The *Beatrice* is on the same belt of sediments as the *Silver Cup*, *Nettie L.*, and *True Fissure* mines and the mineralization is similar to that found on them. Much work has been done on the property. Silver values are excellent and the mineralization is sufficiently strong to justify a careful examination of the workings with a view to ascertaining the possibilities of the property."

In the area tributary to Ferguson and Trout lake past gold production has chiefly been from silver-lead-zinc deposits, of which the *Silver Cup* has been the largest example. Between 1895 and 1915 some 9,600 tons of sorted ore was shipped, of an approximate average value of: Gold, 0.3 oz. to the ton; silver, 150 oz. to the ton; lead, 30 per cent.; with small amounts of zinc and copper. In 1904 and 1905 about 10,000 tons of milling-ore was trammed to the reduction-works of the Ferguson Mines, Limited, at 5-Mile. This plant, long since destroyed by fire, combining concentration, chloridization, and amalgamation, was not a success, the tailing losses being very high. The mine was developed on twelve levels by some 2½ miles of underground workings. Below No. 7 level, the lowest adit working, the mine is flooded. Much information concerning the *Silver Cup* is contained in the Annual Reports for 1903, 1904, 1914, and in Geological Survey Memoir 161. In the last mentioned, under the heading of "Vertical Extent of the Ore Deposits," Gunning says:—

"In a district where little deep mining has been done the evidence bearing on the vertical extent of the ore-deposits is necessarily meagre. The fact that ore-deposits occur throughout the Lardeau from the tops of the mountains to the bottoms of the valleys does not indicate that individual ore-bodies should persist through similar vertical ranges."

"The *Silver Cup* mine is the chief property on which deep exploration has been done. The veins on that property have been developed to a depth of about 1,200 feet below the outcrops. Unfortunately the lower 500 feet of the mine is now flooded. It is reported, however, that commercial ore was encountered in the lower levels. It is known that good ore continued to 700 feet below the outcrops, and from the plans of the mine-workings one may safely conclude that it persisted to greater depths. At the surface on the *Silver Cup* and adjoining claims the veins nearly parallel the strike of the formation, cutting across it at very small angles, and occur in a zone of fracturing and shearing. This zone strikes north-west down the hillside, from an elevation of 7,000 feet at the *Free Coinage* to 4,700 feet at the *Yuill* claim in the bottom of Cup creek. Between the two elevations, veins in the zone have been developed on the *Silver Cup*, *Sunshine*, and *Towser* claims. Although it cannot be said that all the showings from the *Free Coinage* to the *Yuill* are on the same lead, they are certainly in the same zone of mineralization. Although the deposits so far developed at the lower elevations—on the *Towser* and *Yuill* claims—are not as extensive as those encountered in the upper workings of the *Silver Cup* mine, yet they are by no means unimportant, and, what is more important, the type of mineralization is practically identical. The silver values at the *Yuill* and *Towser* are apparently equally as good as those at the higher elevations. The horizontal distance between the upper and lower showings is about 4,500 feet. The above facts naturally do not indicate that there is continuous mineralization in the *Silver Cup* zone between the limits observed. They do support the expectation that ore-bodies similar to those already developed may occur between the limits observed. The type of mineral-deposit to which the *Silver Cup* belongs is such that the ore-bodies may be expected to be quite erratic in size and distribution in the mineralized zone."

On subsequent pages the *Free Coinage*, *Towser*, and *Yuill* claims, adjacent to the *Silver Cup*, and containing similar but less developed deposits are described. In concluding his discussion on the *Free Coinage*, Gunning says: "The property is of potential value in that it should contain any south-easterly continuation of the *Silver Cup* ore-bodies." In considering possible future production of gold, associated with high silver values, the area containing these properties cannot be overlooked. It must be remembered that the *Silver Cup* reduction-works at 5-Mile was installed before the oil-flotation process had been successfully introduced as an economical method for the separation and recovery of metals, and the failure of the unsuitable plant no doubt discouraged further exploration. The *Nettie L.* and *Ajax*, formerly operated in conjunction with the *Silver Cup*, also contained gold values associated with silver-lead-zinc veins. It is reported that on the *Ajax* some of the quartz, mineralized with dark-brown sphalerite, pyrite, and galena, assayed \$100 a ton in gold. The *Nettie L.* needs exploration to find new ore-bodies and in this connection the geological discussion by Gunning in Memoir 161 is of value. The *Ajax* workings are not in condition permitting detailed examination. Former descriptions of the *Nettie L.* and *Ajax* are contained in Geological Survey of Canada Report for 1903 and in the Annual Reports for 1903 and 1914. When these properties and the *Silver Cup* were operated the smelter penalty on zinc no doubt contributed to the discontinuation of exploration on deposits such as those mentioned above and much zincky material containing appreciable gold and silver values was discarded on the dumps.

Prospects tributary to Trout lake and Ferguson, the ores of which are interesting for their gold values, include the *Cromwell* and the *I.X.L.*, both on the North fork of Brown creek; the *Triune* on Triune creek; the *U & I*, *Okanagan*, *Foggy Day*, *Alpine*, all reached from Trout Lake; the *Ophir Lode* on Gainer creek; the *Magnet* and *Maybe*, *Mobbs*, *Fidelity*, *Golden Crown*, and *Bonanza*, the last five being reached from Gerrard. These have all been described in past Annual Reports and in G.S.C. Memoir 161. From this last-mentioned publication the following notes on the *I.X.L.* have been made: The *I.X.L.* is on the north side of the North fork of Brown creek, on the second draw east of the *Cromwell* cabin, at an elevation between 6,000 and 7,000 feet. Mr. Hanson and associates, of Trout Lake, own the property.

A narrow but quite persistent quartz vein in calc-schist has been developed by three adit-levels at this property. In the upper level galena, pyrite, sphalerite mineralization is developed over a width of 6 inches and more, with an apparent concentration of values where the flat-dipping main vein is met by steeper-dipping quartz-filled cross-veins which closely parallel the strike of the schists. Similar conditions exist on the 65-foot long intermediate level, 70 feet below, and a shoot of ore 18 inches wide and 30 feet long is exposed. At the lowest adit-level, 130 feet down the hill, the vein follows along a shear-zone in the grey talc-schists and the

inner 60 feet of the 190-foot tunnel is mineralized with galena, pyrite, zinc-blende, grey copper, and some chalcopyrite, the ore-shoot showing an average width of 18 inches for this 60-foot length. Samples taken by Emmens from the lower tunnel across a 12- to 18-inch face assayed 1.46 oz. gold and 12 oz. silver.

H. C. Gunning sums up his report with the statement that "as a small property the I.X.L. shows considerable promise and certainly deserves more development-work."

Gold prospects in the Poplar Creek section are described in numerous past Annual Reports, notably in those for 1903 and 1914, in Geological Survey of Canada Summary Reports for 1903 and 1907, and in Memoir 161. For many years there has been only minor intermittent activity in this camp, and in 1931 work was confined to prospecting carried on with a few men by W. Applegate and associates, of Calgary, at the *Snowstorm* and adjacent gold-quartz claims situated on the divide between Poplar and Cascade creeks.

In 1903 the finding of spectacular gold quartz, notably at the *Lucky Jack*, led to considerable staking and exploration of a superficial character.

A description of the *Lucky Jack* by H. C. Gunning in Memoir 161, G.S.C., is as follows:—

"On the *Lucky Jack* property carbonaceous schists and dykes of greenstone are cut by quartz veins. The igneous rock is generally fine-grained and massive and most of the veins in it follow joints and are more persistent than in the sediments. Pyrite is widely disseminated through the rocks. Shearing has produced schists from parts of the intrusives.

"In the upper adit a 2-foot vein follows a joint in the greenstone and is mineralized with pyrite and arsenopyrite.

"One of the numerous open-cuts shows a quartz vein, in places 3 feet wide, in the greenstone. It has been followed down to where it enters the underlying carbonaceous schists. In the latter it pinches to 4 inches and is very irregular. Pyrite and arsenopyrite are present; gold may be obtained by panning the schists.

"A short adit at the foot of the hill exposes a small, oxidized quartz stringer in the greenstone. Free gold occurs in some of the iron oxide in the quartz. A sample of the quartz stringer assayed 4.22 oz. of gold per ton.

"The quartz veins are numerous and contain values at irregular intervals. The smaller veins seem to be somewhat higher grade than the larger. There is not sufficient mineralized quartz developed to warrant mining operations. A sample of altered greenstone immediately adjoining the auriferous vein of the short adit at the foot of the hill was taken. The rock contained some fine quartz stringers and a little disseminated pyrite. The assay returned no gold values. A second sample of the massive greenstone containing a little pyrite, from near the upper adit, also proved to carry no values.

"The gold evidently occurs in irregular pockets in some of the quartz veins, either associated with pyrite and arsenopyrite or as the native metal. Brock remarks that 'even with the eye a large quantity of free gold can be seen in the arsenopyrite.' Oxidation and leaching of the sulphide leaves free gold. The junctions of quartz veins are favourable places for good values. The mineralization has not extended into the country-rock to any perceptible degree. The panning of free gold from oxidized schists in the vicinity has led to much optimistic talk. As far as could be ascertained, the gold in the schists has been set free by oxidation and leaching of the sulphides containing it. The colours are exceedingly fine, many being barely visible to the naked eye; such may be obtained by panning material that would assay only a very few cents per ton."

In Geological Survey of Canada Summary Report for 1907, page 85, R. W. Brock says: "The arsenopyrite-bearing country-rock, which in places at least is auriferous, has not yet been systematically prospected, so there is still a possibility that somewhere it may be found to be of pay grade." No attempt has since been made to investigate the possibility suggested, exploration having been confined to quartz veins in which gold values, below the occasional rich outcrops, were not found to persist or were found to be too spotty. In some cases the quartz occurred in typical gash-veins, terminating abruptly at shallow depth.

In concluding these notes on the Lardeau Division, one is impressed with the lack of system and co-ordinated effort in past exploration. There seems to be little doubt that, in many instances, properties were exploited for the personal benefit of individuals with consequent premature discontinuation of development.

SLOCAN AND SLOCAN CITY MINING DIVISIONS.

The geology of the Slocan camp is summarized by C. E. Cairnes in the Summary Report of the Geological Survey of Canada, 1925, Part A. Gold values are associated in some cases with the "dry" silver ores of the Slocan, this term being generally applied to quartz veins or veins in which the predominating gangue is quartz. The chief values in ores of this type are usually in silver, with subordinate lead and zinc and sometimes gold. In such deposits the mineralization commonly includes pyrite and grey copper associated with galena, and may contain native silver, argentite, ruby silver, chalcopyrite, and pyrrhotite in various combinations.

In the Slocan Mining Division properties containing ores in which gold values are an important constituent include the following: *Molly Hughes*, on Slocan Lake, where fissure-veins cut granitic rocks (refer to Annual Reports, 1904, 1922 to 1929, inclusive, Geological Survey of Canada Summary Report, 1925, Part A); *Mowitch*, near New Denver, quartz vein cutting rocks of Slocan series (Annual Reports, 1904 and 1920); *Capella*, near New Denver, quartz vein in granite (Annual Report for 1904); *Monitor*, at Three Forks, fissure cutting rocks of Slocan series (Annual Reports, 1904, 1926, 1929, and Summary Report, G.S.C., 1925, Part A). The *L.H.* property at the head of 8-Mile creek is the only straight gold property in the Slocan Division. It is described by M. F. Bancroft in Geological Survey of Canada Summary Report, 1917, Part B, from which the following excerpts are taken:—

"The roof remnant on the headwaters of 8-Mile creek embraces a complex of igneous rocks surrounded by granite. It extends 3 miles north-east and south-west and has a maximum width of 1 mile. The *L.H.* is located on the north-west margin of this elliptical-shaped area.

"The sulphides are in a zone, varying from 20 to 40 feet in width, which follows the master-jointing. This zone strikes 80° (mag.) and dips 55° north-east. An abundance of quartz stringers prevails in the ore-bodies and furnishes guides to the same. The ore-bodies developed by the *L.H.* workings vary from 8 to 30 feet in length and the boundaries are not well defined. The pitch of the ore-shoots appears to be the north-east. Surface indications point to other smaller zones paralleling the main one in which the underground development-work has been done.

"The ore consists of pyrrhotite, pyrite, arsenopyrite, and quartz and the gangue is country-rock. It is reported that quartz stringers carrying visible native gold have been found on a near-by property, cutting this set of rocks. Small stringers of native arsenic and calcite occur in the ore-body near the mouth of tunnel No. 1. The native arsenic is tin-white on fresh fracture and tarnishes to a dull grey. The gold values obtained in the different ore-bodies are not uniform."

Mineralization at depth in a contact-metamorphic deposit is difficult to judge. The ore-bodies form and are localized where temperature and pressure conditions are favourable for a concentration of the minerals. The *L.H.* is a low-grade gold-deposit that will require the outlay of considerable capital to handle the ore in quantity. If workable ore-bodies are found on the level of No. 3 tunnel a fairly large tonnage might be assumed. A mill-site has been chosen below the property on one of the branches of Vevey (8-Mile) creek. Also refer to comprehensive description in Report of the Minister of Mines for 1915.

Bayonne.* During the past year A. Jarvis, of Silverton, did considerable prospecting and exploration work at some of the small quartz-filled fissures which occur in the granitic rocks to the south of Silverton. The first part of the season he spent at the *Bayonne*, situated about 1 mile west down the mountain-slope from the *L.H.* property, where a 6-inch quartz-filled fissure in granite carrying values in gold and silver was explored along a length of 150 feet by open-cuts and a short crosscut adit. The values of several samples taken showed only small values in gold and work was discontinued in this section, to be carried on at the *Little Daisy* group of claims, situated about a mile farther south and at an elevation of 3,700 feet above sea-level.

Little Daisy.* At the *Little Daisy* group of four claims, owned by A. Jarvis and H. Alwin, of Silverton, the narrow quartz fissure-vein in the coarse feldspathic granite country-rock has been traced along the surface for several hundred feet and by underground drifting for about 200 feet. At places in the vein, notably near the portal of the tunnel, the quartz is banded and well mineralized across 3 to 6 inches width with pyrite carrying gold values. A shipment of 3 tons of sorted ore from a small stope mined in the portal section of the vein returned the owners about \$67 a ton net. Samples taken in the stope and across the vein

at various places along its surface exposure indicate values averaging about \$15 a ton in gold. The vein is persistent, uniform in width, strike, and dip, and suitable for leasing activities.

In the Slocan City Mining Division the "dry" ores are chiefly confined to the very large area of granitic rocks (Nelson granite) extending southerly and south-easterly from Silverton and including Springer creek, where mining of recent years has been limited to small-scale leasing and individual activities. Farther south, on Lemon creek, numerous gold-quartz veins have been worked in the past, and in one case, at the *Chapleau* and *Kilo*, with a small stamp-mill.

This group, consisting of six claims, situated at 5,300 feet elevation on the **Gold Stream.*** small tributary of Chapleau creek of the same name, is owned by George Stoll, George Soucey, and associates. The workings are about half a mile to the north-east of the *Kilo* and consist of several open-cuts on either side of the small stream-bed. A length of 65 feet along the surface of a narrow quartz vein in the granite rock of the area has been opened up by the owners during the past year and some attractive values in gold have been obtained. When the property was visited early in 1931 the vein as exposed was from 6 to 16 inches wide and had been stripped in two places for short lengths. Four samples were taken and the results were as follows:—

Sample Description.	Gold.	Silver.
	Oz. to Ton.	Oz. to Ton.
Several channel samples across 12 inches of oxidized quartz vein in the west open-cut	0.36	0.24
Sample across 16 inches of quartz vein in the west open-cut on portion of vein containing less oxide than sample above.....	0.10	0.50
Sample across several sections of a 6-inch quartz vein exposed in the east open-cut to the east of the creek-bed.....	0.70	0.70
Grab sample of quartz from a low-grade quartz vein to the south of the open-cuts	0.03	0.40

Dry gold-silver ore properties on Springer creek, from which some past production has been made, include the *Howard Fraction*, *Meteor*, both described in the Annual Reports for 1904 and 1919; *Dayton*, and *Evening Star*. With the exception of prospecting done by claim-owners, the only activity which occurred on this creek during 1931 was at the *Meteor*, where C. Lunstrom and W. Boisvert, both of Slocan City, started leasing in the fall. Past production figures from this property are not at hand, but it is roughly estimated that 1,200 tons of sorted ore has been shipped of a gross value of \$100,000. The average assays of such material would be about: Silver, 100 oz. to the ton; gold, 0.8 oz. to the ton. The ore was extracted from small stopes in four ore-shoots on five adit-levels and two intermediate levels, partially developing the vein, which is much broken by faults, for 380 feet below its apex. The property is considered to have good leasing possibilities, but would not stand much overhead in company operation.

At the *Elk*, a similar but less explored prospect in the vicinity, P. Bruin and R. Bruin, of Slocan City, have carried on intermittent exploratory work. From the *Evening Star*, owned by the Hugh Sutherland Estate, of Winnipeg, some car-loads of high-grade silver-gold ore were shipped many years ago from workings off a 100-foot, 70°, incline shaft. This is not safely accessible now without a rope. Below the shaft a tunnel comprising some 450 feet of work includes some drifting towards the shaft, which was discontinued before reaching the objective. At the inner end of the tunnel-drift the vein is 10 inches wide in the roof, but narrows down to a few inches at the floor-level. The gangue is quartz mineralized with streaks of pyrite and some lightly disseminated silver sulphides. The prevailing country-rock, as at the *Meteor*, is a coarsely feldspathic granite. At the top of the shaft the vein consists of three bands of quartz, being, from foot-wall to hanging-wall, 8, 6, and 6 inches wide respectively, with partings of granite 20 and 34 inches wide. The centre band is apparently the high-grade pay-streak, the mineralization being similar in appearance to the face of the drift below, from which a sample representing selected material assayed: Gold, 0.97 oz. to the ton; silver, 355.4 oz. to the ton. A small quantity of similar ore can be found around the portal of the lower tunnel. The property was visited in connection with a proposed leasing activity which did not materialize, the lease being refused.

There are numerous other prospects in the same general formation on Enterprise (10-Mile) creek, the northerly forks of Lemon creek, and at the head of Lemon creek, in which the quartz

veins contain auriferous pyrite and silver sulphides. In most cases the exploration done has been very limited and shallow. Descriptions of the *Kilo* and *Chapleau* gold-quartz veins on Lemon creek are contained in the Annual Report for 1904. A small tonnage from both properties was treated at the *Chapleau* mill, but the activity seems to have been short-lived and there has been no mention of these properties since 1905. The adjacent district contains numerous auriferous quartz veins, mostly small, on which only a small amount of shallow work has been done. From a general survey of the camp containing the silver-gold and gold ores, the impression was formed that the district should prove to be one of small, high-grade properties, calling for careful and skilful individual work, both in the mining and following-up of the ore-bodies, a class of mining particularly adapted to the "leasing" system of working, since by this system the success of the undertaking is dependent on constant personal attention of the miner to follow up the least indications, which might be overlooked by one not always actually in contact with the work. If the district is to be successfully developed, this should be achieved by a large number of small producers rather than by company management on a large scale. It is possible, however, that exceptions will occur and larger deposits found which might warrant separate milling plants.

AINSWORTH MINING DIVISION.

Gold production in this Division has been unimportant as compared with the large aggregate production of silver, lead, and zinc. Gold-bearing veins occur in several widely separated localities, including the granite country drained by Keen (South fork of Kaslo) creek and Woodbury creek; the Kaslo volcanic area north-east of the Kaslo-Nakusp branch of the Canadian Pacific Railway; and in the vicinity of Hall creek, a tributary of the upper Duncan river, where the formation consists of metamorphosed sediments belonging to the Hamill series of late pre-Cambrian age. Commencing at this northern extremity of the Division, the only gold prospect to have been developed to any appreciable extent is the *Red Elephant*, owned by H. McKay and J. W. Power, of Kaslo. Development consists of a 70-foot shaft and an adit-tunnel over 200 feet long, in addition to open-cuts. The property is described by H. C. Gunning in Memoir 161, Geological Survey of Canada, from which the following excerpts are taken:—

"The property lies a short distance east of the so-called Lime dyke. The underlying rocks are a series of dull grey, argillaceous and black carbonaceous schists with interbedded limestones. The sediments are greatly contorted and are sheared in places, but on the average strike about N. 20° W. and dip steeply west.

"The main zone of mineralization trends a little east of north, but is very irregular. Numerous quartz stringers are present and much of the rock is more or less silicified. Some silver-grey schists are exposed near the face and have probably been developed from impure limestone by shearing and alteration. A few copper-stains were observed.

"The ore has formed by replacement, along a zone trending east of north, of the schists by silica and pyrite, with minor amounts of chalcopyrite. The mineralization in part follows the strike of the sediments, particularly where the schists have been sheared against the more massive limestone-bands. Subsequent oxidation has almost completely decomposed the pyrite, leaving a honeycombed siliceous mass that carries much limonite and values in free gold. The depth to which oxidation extends is an important question, as it is not known whether gold will occur free in the unoxidized portions of the deposit."

On Cascade creek, south of Poplar, gold values, associated with iron, lead, and zinc sulphides, are found in numerous quartz veins. Most of these have only been slightly explored on the surface, the only one to have been developed underground to any extent being the *White Eagle*, described in the Annual Reports for 1928, 1929, and 1930. The best gold values here are associated with heavy sulphide ore with a substantial lead and zinc content. Work has been discontinued by the Keene Mountain Gold and Silver Mines, Limited, of Calgary, pending better metal prices. In the adjoining area, known as "Silver Park," numerous shallow diggings of former years expose quartz veins, some of which give fair gold assays associated with lightly disseminated iron, lead, and zinc sulphides. This section, containing widespread mineralization of this character, deserves systematic investigation. It is in the same general formation, the Lardeau series (subdivision of the Windermere formation of late pre-Cambrian age), as the previously described deposits of the Lardeau Mining Division and adjacent to intrusive granitic stocks of the Kuskanax batholith. North-west of Kaslo the greenstones of the Kaslo volcanics are the country-rock of some gold-quartz veins, including the *Phoenix*, on which some exploration was

carried out a few years ago by the Consolidated Mining and Smelting Company, the option subsequently having been relinquished. On Keen creek (South fork of Kaslo creek) gold values are in some cases contained in quartz veins, carrying silver, lead, and zinc as their more important constituents, as at the *Bismark*, in rocks of the Slocan series. In 1928 some exploration was carried on at this property, which was described in the Annual Report for 1904, by the Consolidated Mining and Smelting Company, which subsequently dropped its option. At the *Silver Bear*, where Frank Helme, of Kaslo, and partner have been continuing exploration at the south end of the property, gold values are reported to have been encountered recently. This is primarily a silver property, lead and zinc being present in minor amounts. The formation is composed of rocks of the Slocan series, which, not far to the west, give way to a large area of granitic rocks which contain the auriferous quartz veins of the *Joker*, about which little is known, the old workings being badly caved.

WOODBURY CREEK AREA.*

The Slocan is generally considered purely as a silver-lead-zinc camp, and such it rightly is, but at one or two of the properties in the upper section of the Woodbury Creek area gold occurs along with the sulphide ores in sufficient quantity to be worth mentioning in this bulletin on lode-gold deposits. Particular reference is made to a small group of small properties which have been staked and explored to a limited extent in the granitic batholith area to the south of its contact with the argillaceous shales, slates, and quartzites of the Slocan sedimentary series. Here quartz veins carrying galena, tetrahedrite in small amount, zinc sulphide, and pyrite, etc., are found to contain gold values which vary between 10 to 50 cents and up as high as \$30 and more to the ton over widths of as much as 5 feet. As yet the lengths of vein exposed by exploration are short, but the occurrence of such good gold values in conjunction with silver-lead-zinc values is worthy of further investigation and indicate an area in which further development may prove up small properties of merit.

Scranton Consolidated Mining Co.*

The *Scranton*, *Pontiac* (includes the *Tecumseh*), and *Sunrise* groups, comprising in all thirteen claims and covering an area of 450 to 500 acres on Pontiac creek, are controlled by the Scranton Consolidated Mining Company, of Portland, Oregon. The various owners of the three groups of claims, including Hon. J. D. Chaplin, C. F. Caldwell, T. Doyle, and J. Henry (deceased), have, through the efforts of C. F. Caldwell and C. J. Bailer, given the company an option to purchase the various properties. The Scranton Consolidated Company is incorporated for 650,000 shares of \$1 par value stock, divided into 500,000 shares of "A," voting stock, and 150,000 shares of "B," non-voting stock. The company is selling the class "B" stock and giving a bonus of one share of "A" stock with each share of "B" stock sold. C. O. Boyer is president, F. Olson is treasurer, and Wm. Shenker is secretary and attorney, and these three gentlemen, who are all residents of Portland, constitute the board of directors.

The claims are reached from Ainsworth by taking the main Nelson-Kaslo road north for 3 miles to the start of the main Woodbury Creek trail; thence 8 miles west to the junction of Woodbury and Pontiac creeks, from which point a 2-mile trail leads south up Pontiac creek to the Scranton camp of the company. The topography, in common with the Slocan, is rugged and mountainous, the elevations varying from 5,900 feet to as much as 8,600 feet above sea-level. The mountain-sides up to 6,800 feet elevation are covered with a good supply of mining-timber and a moderately severe climate provides sufficient snow to ensure an adequate supply of water for mining purposes.

The holdings of the company are located along a system of north-easterly and south-westerly striking fissure-veins in the granite rocks of the Nelson batholith in an area which is particularly free of dykes. The total lateral extent of the holdings amounts to approximately 11,900 feet, and while much of the vein system is very narrow, 2 to 6 inches, and still a greater proportion of it is covered with soil and detritus, exploration and mining in past years at three widely separated points along the vein system has shown the presence of narrow and comparatively small lenses of gold-silver-lead mineralization. At the present time exploration-work is being confined (during the early months of 1931) to promising showings near the centre of the holdings.

At the north-eastern end of the property past work at the *Pontiac*, where there is some evidence in the old caved workings to show that the vein system, here well defined, and possibly

mineralized for a length of 350 to 400 feet, was stoped to a depth of 190 feet before mining was discontinued. At the south-eastern end of the vein system on *Sunrise* ground mineralized sections of the vein aggregating about 350 feet in length have been stoped over narrow widths and to a depth of 200 feet. However, the most promising showing is that which has recently been exposed by open-cutting near the *Scranton* camp and about midway between the *Pontiac* and *Sunrise* sections of the property. Several open-cuts, a shallow winze, and a short crosscut tunnel have opened up a length of 150 feet of well-mineralized vein which varies from a few inches to as much as 6½ feet in width. One section of the vein, 65 feet long and averaging 4.68 feet wide, is well mineralized with pyrite, galena, and zinc-blende, with which are contained gold and silver values. The results of assays on five channel sample cuts in this section were found to average: Gold, 0.72 oz. to the ton; silver, 8.1 oz. to the ton; lead, 7.4 per cent.; zinc, 1.4 per cent. The gold content in the five samples varied from \$2.80 to \$28.40 a ton, with the above-stated average of \$14.20 a ton. These substantial gold values are encouraging and warrant the further exploration of the ground by systematic surface-trenching with a view to proving additional length to the vein to the south-east and possibly finding similar concentrations of mineralization to those already prospected. The ground to the south-west offers attractive country in which to prospect for paralleling fissures to those found in the main zone of fracturing. Recent reports from the property indicate that work has been discontinued recently, though it is anticipated that exploration will be actively resumed in the 1932 season.

In these notes on the Ainsworth Mining Division it is interesting to note that 1,070 oz. of gold have been recovered from about 150,000 tons of ore mined from the *Whitewater* property on Kaslo creek. Extended references to this zinc-lead-silver producer are given in past Annual Reports.

REVELSTOKE MINING DIVISION.

Most of the gold-bearing veins in this Division are situated in the Big Bend district, bounded on the north, east, and west by the Columbia river and on the south by the main line of the Canadian Pacific Railway. Valuable information concerning this section is contained in the Summary Report, G.S.C., 1928, Part A, under "Geology and Mineral Deposits of Big Bend Map-area," by H. C. Gunning. Included are the gold-quartz veins of the *Ole Bull*, *Orphan Boy*, and other prospects in the Groundhog basin, the *Roseberry* on the North fork of Carnes creek, and the complex auriferous sulphide deposits of the *J. and L.* and *A. and E.*, both situated on forks of Carnes creek.

J. and L. The *J. and L.*, owned by the J. and L. Mining Company, of Regina, is an exceptionally interesting property. The ore contains consistent gold values associated with pyrite, arsenopyrite, sphalerite, galena, with minor amounts of chalcopyrite and grey copper. An analysis of a lot sent for testing to the Mines Branch, Department of Mines, Ottawa, was as follows: Gold, 0.52 oz. to the ton; silver, 3.50 oz. to the ton; zinc, 4.57 per cent.; arsenic, 11.90 per cent.; copper, 0.15 per cent.; lead, 6 per cent.; iron, 21.8 per cent.; antimony, 0.22 per cent.; insoluble, 16.38 per cent. A very comprehensive summary of conditions, including the results of extensive testing of the ore, is contained in the above-mentioned publication. The conclusions derived from the mill tests was that the flotation of the sulphides was not satisfactory, poor recoveries and poor separations being made in each test. The slightly oxidized condition of the ore interfered with the flotation. It is considered possible that better results might be obtained with unoxidized material and that the future of the property lies in the development of a sufficient tonnage of ore to warrant the erection of a mill capable of recovering all the values present. Assays are given in the writer's description in the Annual Report for 1922.

W. E. Narkaus, a mining engineer of Seattle, who subsequently examined the property, took twenty samples from the various showings. The lowest assay for gold and silver combined was \$4.15 and the highest \$27.10 to the ton. The average of the twenty samples was \$12.04 in gold and silver to the ton and 12.7 per cent. As_2O_3 . Larger ore-widths were subsequently opened up by the late E. McBean, then owner of the property.

A. and E. At this group of claims, owned by A. Kitson, of Revelstoke, and the McBean Estate, underground exploration has been carried on to a small extent since the report in the Summary Report, 1928, Part A, G.S.C., and from which the following is quoted: "Very little work has as yet been done on the property. The ores resemble closely those of the *J. and L.* group, but contain less arsenic and would probably average a little

higher in lead. The continuity of the surface showings is certainly sufficient to encourage further development."

On the Jordan river, T. A. Lloyd, of Revelstoke, has been actively prospecting gold-quartz veins on his *Frisbie* group, which has not yet been visited.

EAST KOOTENAY.

Past gold production in the East Kootenay was largely derived from placer-mining; gold-mining has not yet been developed to any extent. In the Golden Mining Division the *Bobbie Burns*, *Alpha*, and *International* gold prospects, at the head of Bobbie Burns creek (Middle fork of the Spillimacheen river), have been superficially explored, but their remoteness from transportation appears to have been a factor which contributed to the lack of conclusive results attained. References to these properties are contained in Annual Reports for the following years: *Alpha*, 1922, 1929; *Bobbie Burns*, 1898, 1923; *International*, 1896, 1898. Except the first mentioned, which was further explored in 1922 and 1923 by the Alpha Mines Syndicate, Limited, of London, England, the situation is much the same as when described in the old reports. From this area north-westerly to the Canadian Pacific Railway, numerous quartz claims were staked in the late nineties, as shown on a useful prospector's map compiled by F. C. Lang, of Golden, and published in 1897. For many years, however, there has been no activity in connection with these. This area west of the Columbia river is largely underlain by rocks of the upper Purcell and Windermere series of late pre-Cambrian age, as mapped farther south by J. F. Walker, of the Geological Survey of Canada, and published in Memoir 148. In this area gold-deposits of economic value have not yet been found.

In the Fort Steele Mining Division gold prospects are chiefly concentrated in the Perry Creek area. Much information concerning the numerous quartz veins in this section is contained in past Annual Reports, notably those for 1898 and 1915, and in Geological Survey of Canada, Memoir 76. The *Homestake*, which has received the most development, was being investigated last fall by E. W. Watson, of Calgary, and associates, who, following extensive sampling operations, are reported to have acquired an option on the property from the Cranbrook Gold Mining Company. A series of parallel quartz veins, very persistent in length, and in some cases very wide, strike parallel with the enclosing argillaceous quartzites and schists of the Creston formation. In the vicinity of the *Homestake* the strike of these rocks is north-easterly and south-westerly. The deposits have been described as true fissure-veins, the associated minerals being free gold, pyrite, and quartz. For many years, following certain inconclusive mill tests described in the Annual Report for 1898, differences of opinion existed as to the average gold content of the veins, but this point in regard to the *Homestake* deposits should now be conclusively demonstrated and results obtained in this case should have an important bearing on the numerous similar veins of the camp.

On Hellroaring creek minor gold values are associated with silver-lead-zinc mineralization in the argillaceous quartzites of the Creston formation, such as at the *Boy Scout* (see Annual Report for 1930) and the *Mascot* and *Eclipse* (Memoir 76, G.S.C.). In the latter publication S. J. Schofield describes the copper-gold deposits and states on page 140: "The copper-gold deposits of the Cranbrook area are widespread and at present somewhat neglected, since they are overshadowed so greatly in importance by the deposits of silver-lead. Nevertheless, from their extent and character, a moderate amount of success is possible in these deposits if carefully worked." A detailed description of these copper-gold properties is given. The situation in regard to this class of activity has not changed appreciably since the above report was published in 1915. The Fort Steele Division also contains numerous prospects, the ores of which carry gold as a minor constituent of the mineralization, which have not been sufficiently developed to prove the character or continuity of the deposits.

ARROW LAKE MINING DIVISION.*

The area to the north-east of Burton City, in the Arrow Lake Mining Division, has been the scene of a limited amount of prospecting and development on gold-bearing quartz veins which here cut remnants of a sedimentary series closely allied to the slates, argillaceous limestones, and shales of the Slocan series to the east. The properties are as yet prospects and include: The *Promestora*, described in the Annual Report for 1896 by W. A. Carlyle, and situated on the south-west side of Mineral creek, where substantial gold values were obtained from a 3- to 4-foot

quartz-fissure in siliceous limestone and slaty country-rock; the *Ora Granda*, owned by J. C. Anderson and situated immediately to the east and north of the *Promestora*, which covers the easterly extension of the *Promestora* vein; the *Caribou Ace* group of seven claims on the west side of Caribou creek, owned by A. A. Burton, of Burton City, and under option to D. J. Cleveland and associates, of Vancouver, where several quartz veins containing gold values are being prospected; the *Silver Queen* group of nine claims, owned by W. H. Stones and J. Gayford, of Burton City, and situated on the divide between Canyon and Snow creeks, where massive quartz veins are found cutting the quartzitic, argillaceous country-rocks; and the *Lily-Flossie* group of two claims on the north side of MacDonald creek, where quartz veins in slate and shale sedimentaries are found to contain gold-silver values. This last property is owned by Clark Marshall, of Burton City. The Annual Reports of the Department for the past few years contain adequate references to the above-mentioned groups, which are all being prospected either by their owners or small syndicate groups.

Another area in the Arrow Lake Mining Division that is deserving of some attention by the prospector is that section which lies to the north-west of Edgewood, along both sides of the Vernon-Edgewood highway. Until a few years ago, when this road was completed, the section between the *Monashee*, in the Vernon Mining Division of No. 3 Mineral Survey District, and the lower portion of Fire valley was comparatively inaccessible and as such largely overlooked. Favourable deposition of mineralization has taken place in quartz veins in the granite-granodiorite country-rock, as is evidenced by the *Meadowview* and *Waterloo* (Greenwood Mining Division) gold-quartz occurrences of this general area, and further discoveries are to be expected as more serious attention is given to prospecting near the contacts of the granitic rocks with the old highly altered and metamorphosed volcanic rocks. For a description of the *Meadowview* property the reader is referred to the 1927 and 1929 Annual Reports.

TRAIL CREEK MINING DIVISION.*

ROSSLAND SECTION.

The city of Rossland has long been associated with the mining of lode gold in British Columbia, and as a matter of historical record it is interesting to note that over 42 per cent. of the total lode-gold production of the Province to the end of 1930 came from forty-two properties in the vicinity of this famous mining community. The total lode-gold production for the Rossland camp to the end of 1930 was \$59,296,035, and 98 per cent. of this total came from the four or five main producers—namely, *Centre Star*, *Le Roi*, *Le Roi No. 2*, *War Eagle*, etc. These properties, latterly controlled by the Consolidated Mining and Smelting Company of Canada, Ltd., are now closed and much of the machinery and equipment salvaged.

Discovered in 1890 by Messrs. Bourgeois and Morris, the camp was brought into production about 1894 and for the next six or eight years experienced all the ups and downs of a new and booming mining camp. From about 1899, when the production of gold amounted to 102,976 oz., until 1916, with a production of 129,790 oz. of lode gold, a yearly average production of about 128,500 oz. of gold was maintained. In addition to the gold production during these years, a substantial silver and copper production as auxiliary metals was also recorded. The average value of the ore mined to the end of 1930 was about \$13.10 a ton from a total of over 6,000,000 tons of ore.

Following 1916 the production dropped off rapidly to about one-third of its previous average until 1922, when but 8,256 oz. of gold were produced from the Rossland mines. A short revival of interest in the camp occurred in 1923 following the consolidation of the main holdings in the area by the Consolidated Mining and Smelting Company. This continued until 1928 with varying measures of success, at which time the company decided to shut down the *Centre Star*, *Le Roi*, and contingent properties under its control after extensive diamond-drilling and underground exploration programmes had been carried out. Since 1928 the principal mining activity in the Rossland camp has occurred at the small properties on O.K. mountain, where a small bonnage of high-grade gold ore has been won from narrow quartz veins in serpentine country-rock.

In Memoir 77 of the Geological Survey of Canada, C. W. Drysdale has described in detail the geology and ore-deposits of the Rossland camp and some notes are later taken therefrom to indicate the types of mineral-deposits that have produced the bulk of the gold from the lode mines of the area. It is true that the camp is generally considered to have been largely depleted

of its metallic reserves, but interest is well maintained in deposits of the O.K. Mountain section and should be productive of at least a small tonnage of high-grade ore. Especial attention in prospecting and developing in this area (O.K. mountain) should be given to the sections of the narrow quartz veins which are flatter in dip than is normal for the area, and which are adjacent to the fault-planes which cut across the strike of the banded and massive quartz veins, as it is at these sections that the high-grade concentrations of gold are apparently found.

Regarding the mineralization at Rossland, C. W. Drysdale in his memoir points out that over 90 per cent. of the gold was won from typical high temperature-pressure deposits essentially of the replacement type. Sheeted fissure-zones, or shear-zones, in the augite-porphyrite country-rock were the more receptive zones for the deposition of mineralization, and values were deposited either in irregular, lenticular, or tabular shoots, with well-defined walls and of uniform width and values; or as shoots of ore having one definite wall and one frozen wall in which the limiting factor in the width mined was dependent on the lowest grade of ore which could be mined at a profit. The wall was a commercial rather than a geologic one. In these two typical types of deposit were also found zones where localized cross-fracturing had opened ground and permitted the deposition of small and relatively unimportant ore-bodies. Two other types of mineralization were noted by Drysdale—those of the impregnation type, irregular in shape and occurrence found in the country-rocks underlain by the sediments of the Mount Roberts formation, or as impregnations around small pegmatitic stocks and aplitic syenite dykes, and those types of deposits mentioned above as being common to the O.K. Mountain section—namely, small quartz veins in serpentine. At the present time most of the prospecting and underground work in the camp is being devoted to this latter type of deposit, where the mineralization is chiefly pyrite, pyrrhotite, some copper and lead sulphides and free gold. Gold is also associated with the pyrite. Descriptions of some of the more prominent operations on O.K. mountain are given here as representative of several individual prospecting and syndicate mining ventures.

I.X.L.* This property, situated about $2\frac{1}{2}$ miles south-west of Rossland, on the west bank of Little Sheep creek, gained considerable notice from 1921 to 1925, when shipments of exceptionally high-grade free-gold ore were made to the smelter at Kellogg, Idaho. About \$290,000 worth of gold was recovered from 410 tons of ore shipped during this period, and all mined from a narrow short section of quartz vein in a faulted section of the serpentine country-rock. The ground was staked in 1891, but mining and development to the end of 1917 had only produced \$35,000 worth of gold, and it was not until 1921 that a small syndicate of eight experienced engineers and miners from the Rossland mines secured a lease on the property and succeeded in developing the shoot of ore which netted them such handsome returns.

The quartz-fissure strikes east and west, dipping to the south at 38° . The country-rock is serpentine and the vein, which is 14 to 16 inches wide, is mineralized where it is cross-fractured and faulted, the ore following along the fault-zone in the nature of a chimney. The best ore was mined from the No. 3 level, some 170 feet below the upper workings, where a length of 50 feet of quartz was found to be faulted at the eastern end and heavily mineralized with free gold and associated pyrite, galena, and siderite. The gold was in sufficient quantity to be visible and the vein was characteristically banded. The foot-wall was marked by a filling of gouge, while the hanging was a frozen wall. Following the mining of the high-grade ore down to a depth of 50 feet below the No. 3 level, the vein encountered badly faulted crushed and broken ground and disappeared. Since that time leasers have expended a large sum of money in trying to find other sections of the vein that carry sufficient gold values to be of commercial interest, always in the hope that the returns will be similar to those experienced by previous operators. So far the results have been disappointing, but the work is being continued and a new tunnel has been driven near the *Midnight* boundary-line in the hopes of reaching a section of a quartz vein now being worked by the miners on the latter property.

Midnight.* At this property, which adjoins the I.X.L. to the east, Martin Daly and Nick Leface have accomplished considerable underground stope and development tunnelling in their exploration of the serpentine ground to the east of the I.X.L. underground workings. In one small stope a flat-dipping segment of a quartz vein which lies close to a vertically dipping fault has been productive of a small tonnage of high-grade gold ore. More recently the work has been concentrated in driving a crosscut tunnel and development drift to intersect the downward extension of a quartz vein exposed in the upper workings

of the mine. The vein of quartz, which is from 3 to 5 feet in width, has been drifted on for a considerable distance and some very high-grade specimens of ore recovered. The operators have been decidedly encouraged and report encountering excellent gold values. Since 1927 a total of 140 tons of sorted ore carrying 460 oz. in gold and 159 oz. in silver has been shipped to the Trail smelter.

O.K.* This property, situated to the north of the *I.X.L.* ground, has been explored by drifting and crosscutting from near the face of the lower level tunnel by John Hendrickson, Tom Nimsick, and associates, of Rossland. The present crosscutting is an attempt to pick up the downward extension of a vein of quartz exposed in a shallow winze on the upper level of the *O.K.* workings. It is reported that the vein contains small quantities of high-grade gold ore, comparable to values found in the old workings on this upper level and which are now caved.

Snowdrop.* At this property, which is situated a short distance above and to the north of the *O.K.* and *I.X.L.* claims, Harry Lafevre, of Rossland, with two men are leasing on the upper levels. A small tonnage of gold-bearing quartz vein lying alongside a faulted area has been stoped. Here the vein is in the serpentine country-rock, and in common with the other properties in this type of ground it would appear that the gold values are concentrated at flattened portions of the narrow banded quartz veins in close proximity to fault-planes. This is in evidence at several of these small properties and further exploration along these lines would be of interest.

At the *Golden Drip*, which adjoins the *I.X.L.* to the south, J. C. Penny and associates, of Rossland, did a limited amount of prospecting and development before taking the *Rubenstein* under lease from the owner. Other prospects in the area around Rossland which are being actively explored by leasers or other prospector-owners include: The *Camden*, above the *O.K.*, where John Lindberg has spent some time in exploring along the contact of the serpentine and the Mount Roberts sediments; the *Golden Butterfly*, to the south of the *Golden Drip*, where John Kristenson and Hans Linger, both of Rossland, are leasing and exploring claims in the granite; and the *Lord Roberts* group, situated a few miles north of Rossland in the Mount Roberts formation, where John Senkowski is prospecting.

Caribou.* The *Caribou* group of four claims is situated on the west side of Little Sheep creek and a short distance north of the Rossland-Grand Forks highway. It is owned by J. Tomich, of Rossland. The old workings are near the northern end of the property and consist of a 150-foot crosscut driven in a westerly direction through slates and argillaceous sediments of the Mount Roberts formation to intersect a narrow vein of quartz and crushed country-rock. About 35 feet of drifting along the north-south-striking and vertically dipping vein has opened up a small tonnage of low-grade gold-silver ore. Several open-cuts on the surface along the outcrop of the vein have been excavated, but in all cases the samples taken across the full width of the ledge-matter were low grade and disappointing.

The southern end of the property at 4,175 feet elevation has been developed to a limited extent by five shallow open-cuts and a 26-foot winze. The winze develops a 12- to 16-inch vein of quartz along the hanging-wall side, in which low-grade gold values were obtained in sample 1 (see table). One hundred feet to the south a 20-foot open-cut across argillaceous sediments exposes an 18-inch vein of quartz well mineralized with pyrite and pyrrhotite carrying small values in gold and silver. An 18-inch channel sample assayed as per sample 2, while a selected sample of the dump from this open-cut assayed as shown in sample 3. The vein is cut by a 4-foot quartz-diorite dyke striking across the vein at right angles, the vein where exposed striking S. 72° W. Four adjacent open-cuts have not succeeded in finding an extension of the vein, being in all cases off the projected line of the vein strike.

Sample No.	Gold.	Silver.	Description.
	Oz.	Oz.	
No. 1.....	0.04	0.80	Across 16 inches 20 feet down winze from collar.
No. 2.....	0.13	3.10	Across 18 inches in 20-foot open-cut near centre.
No. 3.....	0.88	4.20	Selected dump material from 20-foot open-cut south of winze.

SHEEP CREEK SECTION.

Reference has been made from time to time in the Annual Reports of the occurrence of gold values in quartz fissure-veins which traverse, mainly, the syenitic country-rocks near the head of Sheep creek (note this area is to the north-west of Rossland and not south-east of Salmo). In one or two instances the mineralization, which consists principally of gold, some pyrite, and occasionally copper and lead sulphides, is found in fissures in the granitic tongues of the Nelson batholith which are found here, or close to the contact of the country-rocks with limestone remnants of uncertain age.

The area, best reached by road east and south from Paulson, a flag-station on the Kettle Valley Railway, contains the *Alice L.-Berlin*, *Cascade-Bonanza*, *Enterprise*, *Albion*, *Inland-Empire*, and other groups of properties. The district was discovered shortly after Rossland became famous and shipments of gold ore were made from the *Cascade-Bonanza* group as early as 1902, since which time small shipments of ore at widely spaced intervals of time have been made from other properties in the camp. The total production from the camp has been small, amounting to 4,200 tons of ore, from which 1,061 oz. of gold and 6,052 oz. of silver were recovered. Only 60 oz. of gold and 1,853 oz. of silver were recovered from the 3,520 tons mined at the *Inland-Empire*.

The only activity in the past few years at the gold prospects has been that of the prospector-owners, who have opened up some showings of promise and from which assays containing fair gold values have been obtained. The area is worthy of more intensive prospecting and investigation than it has hitherto received, and a brief description of some of the gold properties, with notes as to their present condition, is included here as a summary of notes made when the area was visited in 1930 and embodying information contained in past Annual Reports over a period of twenty-nine years.

This group of claims, owned by Messrs. Griswold and Allan, of Cascade, is **Alice L.-Berlin.*** situated at an elevation of 5,500 feet on the eastern slope of Grenville mountain and approximately 4.5 miles by wagon-road from Paulson. Production from the group, mined in 1917-19 by the Inland Mining Company, has amounted to 208 tons of ore, from which were recovered 663 oz. of gold, 3,072 oz. of silver, and 1,247 lb. of copper.

Development and exploration over a period of years has opened up a quartz vein in the syenite country-rock for a length of several hundred feet. A main adit-level several hundred feet long follows the vein and serves as an entry to the shaft (down 110 feet) and three intermediate levels, 40, 60, and 100 feet below the shaft-collar. The vein, which strikes N. 25° W., dips vertically, and is from 6 inches to 2½ feet wide, is cut by numerous lateral and horizontal faults, and the mineralization, consisting of chalcopyrite, pyrite, some galena and gold values, is concentrated below a main fault-fracture which strikes across the vein near the shaft-collar. Below this fault, which dips to the north at about 60°, stoping operations on the 40- and 60-foot levels to the west of the fault succeeded in winning the ore mentioned above. When visited in 1930 the stoped ground below the main adit-level was flooded and could not be examined, but according to Resident Engineer P. B. Freeland, who made an examination of the underground workings in 1923, it is considered probable that profitable exploration-work to the north-east side of the shaft on the 40- and 60-foot levels and to the east of the face on the 100-foot level could be readily accomplished. The property is idle at present and would require unwatering and some retimbering before these ore possibilities could be investigated, but the attractiveness of finding further shoots of \$60 gold ore is worthy of consideration.

This group of eight claims is situated a short distance to the south of the **Albion.*** *Alice L.-Berlin* group and is owned by J. Kloman. On the *Albion* claim of the group the development consists of a 40-foot shaft to a 300-foot long adit-level (now caved at the portal) and several open-cuts on a north-south-striking quartz vein in syenite. This vein is thought to be a southerly extension of the *Alice L.-Berlin* vein. In the shaft the vein is 6 feet wide at the collar, but pinches out to a thin streak of gouge at the tunnel-level. Values in the pyrite are mainly gold and are stated to run up to \$10 in gold to the ton. Fifty feet to the north of the shaft-collar a wide open-cut has exposed a series of quartz stringers, aggregating 8 feet in width, in the syenite, and samples taken across a 2-foot section of the best part assayed: Gold, 0.46 oz. to the ton; silver, 4.5 oz. to the ton.

A 12-foot shaft on a wide quartz vein on the *Albion Fraction* claim of the group, and a short distance to the east of the workings mentioned above, was sampled across a width of 7 feet 6 inches and assayed: Gold, 0.17 oz. to the ton; silver, 1.4 oz. to the ton.

**Cascade-
Bonanza.***

This group, which covers the outcrop of a quartz vein close to the contact of the limestone sediments and the syenite and syenite porphyry near the head of Iron creek, a small easterly-flowing tributary of Sheep creek, is about 6 miles south-east of Paulson by road. The *Cascade*, on the north side of the creek and a short distance above it, has been developed by an adit-tunnel 450 feet long, from which a narrow stope, started about 125 feet in from the portal, has been mined to connect with a 35-foot shaft collared 100 feet above the tunnel-level. It was from this small stope that 396 tons of ore containing 293 oz. of gold and 683 oz. of silver was mined about 1902. The quartz vein strikes roughly north and south in common with the other veins of the district and is from 2½ to 3½ feet wide, and mineralized with pyrite, some lead and zinc sulphides, and small amounts of gold. A number of samples taken in 1930 by a reputable engineer gave values as high as \$40 a ton in gold from unmined narrow sections of the stope-back, while other samples taken across narrow widths of the vein only returned \$3 to \$5 values in gold to the ton.

The *Bonanza* group is situated south of the *Cascade*, on the south side of Iron creek, and an adit-tunnel at 5,000 feet elevation develops a narrow quartz vein from which a shipment of 76 tons of ore containing 45 oz. gold, 444 oz. silver, and 288 lb. of copper was made in 1902. The winze stope from which this ore was mined was full of water and could not be examined, but evidence in ore on the dump shows it to contain pyrite, lead, and zinc sulphides and copper mineralization.

WESTERN MINERAL SURVEY DISTRICT (No. 6).

REPORT BY G. A. CLOTHIER, RESIDENT MINING ENGINEER (HEADQUARTERS, WORKMEN'S
COMPENSATION BUILDING, VANCOUVER).

This district is naturally divided into two great, parallel, distinctive geological belts, the granitic Coast range of the mainland and the Vancouver range comprising Vancouver island, separated by the great depression occupied by Georgia and Johnstone straits.

The granodiorite Coast range, which also underlies the whole of Vancouver island, is, as the source of all metallic minerals, the dominant formation. It averages about 100 miles in width extending from tide-water east, and includes, with the exception of Texada, Lasqueti, and a portion of Quadra islands, all the Coast islands.

Practically all the metallic minerals found within the Coast range are contained in the masses or belts of pre-existing formations now included in the granodiorite. Immense masses of these rocks were lifted up on the surface of or enveloped in the intruding granite, underwent intense alteration from heat, pressure, rock-movements, etc., and became the host-rocks for minerals emanating from the granite. The predominating commercial mineral contained in these belts is chalcopyrite, carrying small gold values, associated with pyrite, pyrrhotite, and magnetite. This is exemplified in this district in the *Britannia* mine, one of the largest copper-producers in Canada, and many copper prospects on the main west coast. The size of these areas is illustrated in the *Britannia* belt, which is about 2 miles wide at the beach and extends south-easterly for over 15 miles.

Certain of these belts contain gold-bearing pyritized quartz veins which may develop into profitable gold-mines. One such zone extends across the north ends of Sonora and Thurlow islands, appears again in the *Alexandria* and *Doratha Morton* properties on the west side of Phillips arm, and extends north through to Loughborough inlet. More thorough and systematic prospecting will doubtless prove many of these belts to contain very promising possibilities in both gold and copper.

Vancouver island is composed of the Vancouver series of rocks consisting of volcanics, andesite, basalts, tuffs, and intrusive porphyrites; sedimentaries, mainly crystalline limestone; and schistose derivatives of both. All are underlain by the granites of the Coast range. These

formations have been intruded by masses of the granites, and later dykes, altogether creating very favourable conditions for the deposition of ore-bodies originating in the underlying granodiorite.

The type metallic minerals of Vancouver island are copper, gold, silver, lead, and zinc. The copper-deposits are closely associated with the granite intrusions and are found chiefly in the altered volcanic or sedimentary rocks at or near the intrusive rock. The lead-zinc deposits occur mainly as replacements in the limestone on or near the granitic masses or associated with intrusions within the limestone-body. The ore-deposits are irregular, but may be classed in three main types—contact deposits, replaced shear-zones in which are sometimes pyritized gold-bearing quartz veins, and quartz veins traversing the diorite and granodiorite intrusions.

PROSPECTING AND PROSPECTING AREAS.

Prospecting was more active in 1931 for the reason that so many men have been out of work that a number of them, both with and without prospecting experience, have taken to the hills to try their luck. It is a surprising fact that only a relatively small portion of this district has been looked at in any way, and a much lesser portion has been really prospected. A study of the map marking the mineral-claim locations shows that the majority of the claims are situated at the beach or within a mile or two of it, except, of course, those located contiguous to the railways. The same applies to Vancouver island. A great many of these claims were located and staked by trappers and hand-loggers who stumbled on the outcrops by accident. The largest mine in the district, and now one of the outstanding Canadian copper-producers, the *Britannia*, was discovered by a hunter, later located by a trapper, and developed in its early stages by fur-dealers.

The geological map, Vancouver Sheet, No. 196A, issued by the Geological Survey of Canada, shows how numerous the included belts in the granodiorite are along the main coast-line from Vancouver north, and, judging by the cross-section of the range along the Pacific Great Eastern Railway, these belts are proportionately numerous from the heads of the inlets to the summit of the range. Few of these, even along the coast-line, have been thoroughly prospected and there is therefore ample field for individual prospectors and plenty of opportunity for organized prospecting by the larger companies. The immense interior of Vancouver island offers a practically virgin prospecting country from Alberni north. H. C. Gunning, of the Geological Survey of Canada, who has been in the section from Buttle lake north for the past three years, expresses a very favourable opinion of that area for prospecting.

The advantages of favourable geological conditions, easy and inexpensive accessibility, cheap transportation to smelters, good operating conditions, and favourable year-round weather are features to be considered.

Vancouver Island.—The area around the heads of Leech and San Juan rivers is being prospected to some extent. The placer gold taken from Leech river in the early days came from the small gold-bearing quartz veins in the Leech River slates. These veins where found have so far proven too low grade to be important as gold-producers in themselves.

The Loss and Sombrio rivers, on the west coast, south of Port San Juan, have piled up great banks of gold-bearing gravels at the beach and extending some distance up the rivers. These creeks rise in the range south of the San Juan river and traverse the Leech River formation. More or less placer-gold indications have been found in the creeks at the head of the San Juan, in the vicinity of Todd mountain. I therefore judge that the area justifies some careful prospecting. There is a trail up the West fork of Leech river, meeting the Koksilah River trail at the head of Jordan river, but my information is that the trail up the Koksilah river from the wagon-road which leaves the main highway at Cobble Hill is the preferred route. This trail crosses to the north side of the Koksilah river at the big bridge and follows the old Frenchman's trail to where it crosses back to the south side, again continuing on through to Todd mountain.

Placer gold in China creek, gold-bearing quartz veins at the head of China and Franklin creeks, and good gold values at the head of Cottonwood creek, about half-way down Cowichan lake, would indicate gold possibilities along the main range north of Cowichan lake, at the headwaters of Nitinat river, and Shaw and McKay creeks.

This area is accessible by way of Nitinat lake from the west coast; the Canadian National Railway grade from the head of Cowichan lake; by trail from Alberni canal, at Island Copper Company's camp to the Canadian National Railway grade east of Francis lake; and by a new

trail cut out this year from the bend in the Canadian National Railway grade, about 5 miles from Cowichan lake, to the bend in the grade just east of Francis lake. This trail crosses the Nitinat river (by cable) just below the grade and is about 7 or 8 miles through to the Little Nitinat. The *Southern Cross* cabin is on the divide between Parker and Worthless (Cultus) creeks. A short distance above the cabin another trail branches north to Tuck lake. There is also an old timber-cruiser's trail from Kissinger, about $1\frac{1}{2}$ miles from Cowichan lake and rail-end of the Canadian National Railway, to the Nitinat river, which it follows up the east side to the head and crosses over to the head of China creek, but I do not know its condition.

The Kennedy (Elk) River section from the head of Kennedy lake to the summit of the range at the source of Elk river warrants some careful prospecting. The formation is essentially andesite and limestone, in which are large intrusive dykes and bodies of a greyish diorite which no doubt is the source of the gold. The veins are as a rule small and composed of pyritized quartz showing small amounts of chalcopyrite and zinc-blende in places. The gold is probably mainly associated with the pyrite, though free gold shows in the quartz in places. Small plants were put on two properties many years ago, notably the *Rose Marie*, described later, but operations were not very successful.

The gold-showings at the head of Bedwell river in from the head of Bedwell sound, on the You group, suggest that the gold-bearing belt may extend along the west slope of the range, from Elk river across the heads of Clayoquot river and Tofino creek to the headwaters of Ursus creek.

Dolmage* says that these gold-bearing veins constitute a type of mineral-deposit which is different from any previously described in connection with the west coast of Vancouver island, and although they have not yet proved to be of commercial importance, they do in places carry good gold values and may, with further prospecting and developing, turn out to be valuable. Dolmage also concludes that, from his examination of the Wreck Bay formation and the intervening topography, it seems almost certain that the gold content of these gravels originated in the quartz veins of the district.

To give access to this section a good foot-trail has been completed up the Kennedy river from Kennedy lake and over the divide to the Taylor River trail down to Sproat lake. Also the Taylor River trail has this year been extended up the river to above the forks, so that prospectors may cross the low range to the headwaters of Ursus creek, Tofino creek, etc., on the coast slope. There are trappers' cabins up the Taylor River trail, but none on the Elk River side except at the *Rose Marie*. Small boats can be lined from tide-water up the short rapids, at the outlet of Kennedy lake, to the lake itself without difficulty. The area may thus be reached either from the head of Sproat lake or by way of Kennedy lake from the west coast.

The Buttle Lake section has sufficient mineral-showings and geological features to strongly recommend it as a very favourable one for extensive, systematic prospecting. What prospecting has been done and development-work accomplished has been due to the energy and perseverance of Jim Cross during the twenty years or more that he has "stayed with" that section.

From my observations of the range on the east side of the lake, and in the vicinity of Mount Albert Edward, 7 or 8 miles east of the lake at the head of Ralph creek, I judge that the massive, unbroken, unfavourable volcanics extend eastward until overlain by the coal formation of shales, sandstones, etc., which extend inland from 6 to 12 miles from the east coast. That area of volcanics would present little encouragement for prospecting.

The west side of the south end of the lake, however, is quite different. About $1\frac{1}{2}$ miles west of the lake at Myra creek a large body of granodiorite has been thrust up through the overlying Vancouver volcanics, resulting in intense shearing action and alteration of the andesites across a width of several hundred feet, in which are mineral replacements indicating important ore possibilities.

The volcanics have been converted into light-coloured chlorite and sericitic schists, the schistosity striking north-westerly and dipping almost vertically. Pyrite is disseminated through the schists, giving them a yellow to red appearance on the surface. Zinc-blende, chalcopyrite, and galena occur in different combinations, in lenses and small veins either with the schistosity or crossing it, in places making up to 10 feet in width of heavy sulphide content. The ores are not high grade, gold varying up to \$15 a ton, silver to 6 oz. a ton, copper to 2.5 per cent., lead to 2.5 per cent., and zinc to 35 per cent., but indications are that great tonnages of milling-ore can be developed, suggesting large operations at some future time. H. C. Gunning

* Summary Report, 1920, Part A, G.S.C.

made a reconnaissance of that area in 1931 and considered it as having many possibilities for the prospector.

Buttle lake, about 20 miles long, is reached from Campbell River by auto to Sutherland's camp on Upper Campbell lake, from there by boat to the head of the lake, then by good horse-trail 9 miles to the head of Buttle lake, where there are cabins. Saddle and pack horses are kept by the Sutherland's and outboard-motor boats on Buttle lake.

The Nimpkish section, notwithstanding the fact that the properties in the vicinity of the lake did not meet the expectations of the Consolidated Mining and Smelting Company in its extensive exploration-work, has a large unexplored area containing favourable conditions and possibilities for copper- and gold-ore deposits. Had the surface showings of the *Kinman* claims been less extraordinary the results of the surface work and diamond-drilling would probably not have been considered so discouraging. No doubt the replacement ore-bodies, in the limestone, such as are exposed on the surface recur to the depth of the limestone-bed, and had one of these bodies been encountered in the exploratory work there might have been a different story.

H. C. Gunning,* who has covered several hundred square miles in the two years of his geological-survey work in this area, says: "The mineral-deposits of this area are related to intrusions which vary in composition from granite to gabbro. . . . Most of the ore-bodies were formed within rocks of the Vancouver group, particularly limestone, but it is evident that important mineralizations may extend into the Coast Range intrusives (granodiorites), although these rocks are not, on the whole, considered to be favourable hosts. Replacement has been the most important process in the formation of the ore-deposits and particularly in the case of copper-magnetite and lead-zinc mineralization." He also emphasizes the fact that copper ores may be concentrated in places in belts or zones of garnetite, epidote, or magnetite, and may be absent in other portions of the same belt; therefore all such belts should be considered as favourable formation for containing copper-gold ore-bodies and should be prospected accordingly. He is of the opinion that there are many localities along the Nimpkish river, between the Nimpkish river and the north coast of the island along Johnstone strait, and on both sides of the main range of the island south to Buttle lake, in which there are excellent chances in prospecting.

As assistance to the geological-survey work and anticipating the ore possibilities in that area, on recommendation of the Resident Engineer, the Department of Mines this year repaired the old logging-road for 7 miles up the Nimpkish river from the south end of the lake, and continued it as a good foot-trail for a further 6 or 7 miles along the east side of the river, thus giving access to that extent of prospecting country. It is hoped that prospecting of this section will ultimately warrant the extension of this trail to the headwaters of the Nimpkish, across the divide, and down Gold river to the west coast. It is also proposed to build a prospector's trail from the mouth of the Tsitika river, which flows into Johnstone strait at Robson bight opposite Cracroft island, to the copper prospects up the river to its head, eventually to connect with the Nimpkish River trail.

There are gold and copper prospects on the Adams river, also flowing into Johnstone strait, that are reached by road from Sayward to the forks of the Salmon and White rivers; thence by trail up the White river, crossing over to the showings at the head of Adams river. (See *Lucky Jim*.)

On the Zeballos river, flowing in at the head of Zeballos arm, off Esperanza inlet, on the west coast, small high-grade gold-bearing veins have been found. I am informed that there is a promising area up in the main range at the headwaters of the river.

There is a good trail from the head of Zeballos arm to the camp of the Marks Gold and Copper Mines camp at the forks, and a blazed trail extends up the river for some distance beyond the camp. The extension of the geological survey from the Nimpkish river west to the summit and including the Zeballos River drainage area would give a splendid cross-section of the island from coast to coast.

The Nahwitti Lake section has showings of lead and zinc ores in limestone. There is a big country north and west of this, to the coasts, of volcanics and limestones intruded by large bodies of granodiorite, providing good prospecting conditions. The area is at present reached from Port Hardy, on the north-east coast, by a foot-trail up the Glenlion and Tsulquate rivers to Kains lake, a distance of 12 miles; then by boat to the head of the lake, 3 miles, where there is a comfortable cabin, and from there by foot-trail 6 miles to the *H.P.H.* group.

* Summary Report, 1929, Part A, G.S.C.

On the mainland, as previously stated, the mineralization occurs in connection with the included belts or roof-pendants or roof-remnants occurring in the Coast range. Mineralization has been restricted almost entirely to these inclusions of altered stratified rocks, but in some cases there has been some mineralization along the contact-borders within the granodiorite itself.

Many of the ore-deposits occur along contacts between the granite and stratified rocks replacing the latter and associated with such minerals as epidote, garnetite, etc. Limestone is particularly susceptible to such replacement. Also the deposits may be situated some distance from the immediate contact, along lines of fissures, shear-zones, or bedding-planes, where mineral-bearing solutions from the underlying and surrounding granodiorite have found easy passage.

The shearing and fissuring are the results of rock-movements in the main granite-mass or adjustments taking place later as the granodiorite cooled. It therefore follows that prospecting in these belts should be along the main contact with the granite or where there has been some shearing or fissuring. Many of these belts are solid, practically unaltered, masses of volcanics and sedimentaries and consequently do not offer favourable prospecting areas.

In the Shoal Bay area there are several parallel belts up to 2 and 3 miles wide containing zones of intense shearing in which quartz veins are numerous. These are quartz replacements of the sheared material and vary from small lenses to veins several hundred feet long. As a rule they are irregularly mineralized with gold-bearing pyrite, with which can sometimes be seen metallic gold. J. A. Bancroft* says: "These quartz veins and their mineral contents originated during the period when the interior portions of the batholith of granite were cooling." Camsell states that "the lateral contacts are mineralized mainly by copper ores, but on the roof-contacts—that is, where the batholith plunges under a roof of stratified rocks—the mineralization is often by the more precious metals."

The gold-bearing belts extend along the north ends of Sonora and Thurlow islands, extend across to the mainland north of Frederick and Phillips arms, and north-westerly to Loughborough inlet, making this a promising gold-prospecting area.

The whole mainland coast, cross-sectioned by many inlets up to a width of 40 miles, contains many such belts and presents a favourable permanent prospecting-field.

The Pacific Great Eastern Railway area continues this cross-section into the interior a further 30 miles in this district. Camsell, in the 1917 Summary Report, Part B, G.S.C., says that the conditions traversed by the railway are most favourable for the occurrence of metallic deposits of copper, lead, zinc, gold, and silver, and the whole interior of the Coast mountains becomes an excellent field for prospecting. He concludes with the remark that prospectors should pay more attention to the Coast mountains than they have done. Any part of the coast is easily reached and trails will be built back into the hills as warranted by prospecting.

There are fair chances for gold-prospecting on Fire mountain, reached by trail from the upper end of Harrison lake. The country east of Harrison lake and north of the lake up the Lillooet river also offers some encouragement.

On Pierce mountain and farther east, south of the Chilliwack river, the geological map of the International Boundary survey shows a large body of diorite lying west of a great mass of granodiorite, and intruding the Chilliwack series of argillites, sandstones, quartzites, etc. The fact that gold indications have been found at this contact in places on Pierce mountain, and that the *Boundary Red Mountain* mine in the same belt south of the boundary-line has been a producer of gold bullion for several years, should be sufficient inducement for the close prospecting of the border of the diorite-body.

There is a horse-trail from Vedders Crossing to Chilliwack lake, from which trails branch up Slesse creek to the *Boundary Red Mountain* property, and a little farther on another branches to the *Mountain Goat* group on the summit of Pierce mountain.

Information regarding prospecting areas, how to get there, maps, sketches of trails, etc., may be had by addressing the Resident Engineer's office, Workmen's Compensation Building, Vancouver.

DEVELOPMENT.

Many inquiries have been received during the year for prospects on which it is worth spending money for development-work. Though the gold standard seems to be out of vogue to a great extent at present, it apparently has not had any disturbing effect on gold-mining, and much

* Memoir 23, page 136, G.S.C.

interest is being taken in this class of mining, both placer and lode. Development has therefore been confined mainly to prospects that show possibilities of workable gold values.

Development has been about on a par with last year in this district. The owners, in many cases, do more than the amount of work required for annual assessment purposes. Practically all the copper, lead, and zinc properties have been kept in good standing. Further work was done on the properties at the head of Cottonwood creek, up from Cowichan lake—the *El Capitan*, *Paint Pot*, *Cottonwood*, and *Silver Leaf*.

The *Ormond*, on Flores island, on the west coast of Vancouver island, had a small crew working the most of the summer. The Marks Gold and Copper Company's property on the Zeballos river was also developed in a small way. The *Alexandria*, on Phillips arm, on the mainland coast, has been operating the greater part of the year. The Pacific Copper Company bonded the Thurlow Gold Mines property and did considerable underground work. Some further work was also done on the *Sonora* and *Douglas Pine* properties. The *Geller* group back of Granite bay and the *Inca* group at Heriot bay, both on Quadra island, were further explored in 1931. Jim Cross extended the work on the claims at Buttle lake. Exploratory work by way of sinking is under way in a couple of places on Texada island. Several properties on the Pacific Great Eastern Railway, the *Brandywine*, *Blue Jack*, and *McVicar*, were worked this season. A little work has been done on the Pitt Lake properties, and also on Pierce mountain up the Chilliwack river. Altogether development-work has not been at a standstill, by any means, throughout the district.

ESQUIMALT & NANAIMO RAILWAY.

The Esquimalt & Nanaimo land grant, covering about a third of Vancouver island, is outlined on all Government maps. For the information of the prospector unfamiliar with the regulations pertaining to minerals in the grant, the following is given:—

All base metals, copper, lead, and zinc, within the area belong to the railway company, leaving only the precious metals, gold and silver, belonging to the Government. The area is, however, open for prospecting and mineral claims may be staked under the regulations of the "Mineral Act," but they are also subject to the regulations outlined by the railway company. The locator of mineral claims on unsold areas may, for \$1 paid to the railway company, procure an option for one year to purchase the surface rights and timber at \$5 an acre, which would be \$260 for a full claim of 52 acres; also the timber may be purchased at \$1.50 a thousand in excess of 8,000 feet an acre; this timber to be used for mining purposes and not to be moved from the claims.

The railway company places the following royalties on the base metals mined: On lead, $\frac{1}{10}$ cent a pound of lead; that is, on a 10-per-cent. lead ore the company would collect 20 cents a ton. On zinc the royalty is $\frac{1}{20}$ cent a pound of zinc up to 40 per cent. and $\frac{1}{10}$ cent a pound above that; a 40-per-cent. zinc ore would therefore have to pay 40 cents a ton and a 50-per-cent. ore 60 cents a ton. On copper ores the royalty is $\frac{1}{10}$ cent a pound up to 2 per cent., or 4 cents a ton; on an ore assaying from 2 to 5 per cent. the royalty is on a sliding scale, a 5-per-cent. ore paying 10 cents a ton; over 5 per cent. the royalty is $\frac{3}{10}$ cent a pound, making the charge against a 10-per-cent. ore—about what a prospector would sort out to ship—46 cents a ton.

A copy of the regulations may be procured from the Land Agent, Esquimalt & Nanaimo Railway, Victoria.

REFERENCES.

The reader is referred to the 1928 Annual Report, page 358, for a list of reports, etc., pertaining to this district, and to the 1927 Annual Report, page 333, for an index of all mineral claims and mining companies reported in the Annual Reports from 1917 to 1926.

VICTORIA MINING DIVISION.

SOOKE AND JORDAN RIVER SECTIONS.

As stated under "Prospecting Areas," these sections have produced some placer gold from the Leech River area and have placer possibilities in the large gravel-banks at the mouth of the Sombrio river, but the gold-bearing quartz veins which have no doubt been the source of the placer gold have, so far as discovered, been too low grade to be of any commercial importance as lode-gold producers. It would, however, seem a reasonable surmise that there are possibilities in such areas where geological formations and conditions are favourable.

COWICHAN LAKE SECTION.

The particular area at the head of Cottonwood creek, on the divide between Cowichan lake and the Chemainus river, is reached by auto or Canadian National Railway to Youbou, where a large sawmill is situated. Any mineral discoveries made along the main range at the head of Cottonwood creek and north at the headwaters of China and Franklin creeks, which empty into Alberni canal, contain good gold values. It is therefore suggested that along this main mountain range of Vancouver island would be a worthy prospecting-field, and probably especially at its intersection with one of the main cross-ranges extending from the west coast above Nitinat lake, crossing the main range at the headwaters of the Nitinat, Franklin, China, and Cameron rivers, and extending along the north side of Nanaimo river toward the east coast.

This group of four un-Crown-granted mineral claims, the *El Capitan* and **El Capitan.** *El Capitan* Nos. 2, 3, and 4, is owned by a Duncan syndicate under the management of E. F. Miller, of Duncan. They are situated at the head of Cottonwood creek, which empties into Cowichan lake about midway up its north side, and on the summit of the main range of the island between Cowichan lake and the headwaters of the south branch of the Nanaimo river on the east side. The mineral-showings are on the apex of the mountain at 4,300 feet elevation.

The property is reached from Youbou Station on the Canadian National Railway at Cowichan lake, by following the railway for a mile to Cottonwood creek; thence up the creek for 6 miles by an old logging-road to the foot of the hill, and from there by a good foot-trail to the cabin at 3,850 feet elevation. Last year, with financial assistance from the Department of Mines, the old logging-road from the Canadian National Railway was improved into a fair truck-road by taking up the old railway-ties and filling in the holes for about 5 miles. The ties were used for covering the bridges. A little more work in removing the balance of the ties and grading in a few places will make this a first-class truck-road. In the event of the property becoming a producer, an aerial tram from the mine to the head of the road and trucks to the Canadian National Railway would provide cheap transportation.

The general rock formation is andesite of the Vancouver volcanics. The work consists of two tunnels, the upper about 100 feet below the apex of the mountain and another 50 feet vertically lower, both on the east side of the hill, where the outcrops are more prominent than on the west or lake side. On the surface the croppings show two veins about 10 feet apart; the north one is only a small seam and consequently the work has been done on the south or larger one. The south vein is about 20 inches wide on the surface and consists of heavily oxidized material carrying some gold values. It strikes about east-west (mag.) and dips slightly to the south. The upper tunnel was driven 50 feet following the vein, which shows the same intense oxidation all the way. At about half-way in it opens to a width of 6 feet, due to the junction of a small vein from the south side. Small ribs of sulphides of iron and copper were encountered in the oxides which assayed up to \$39 a ton in gold. This is encouraging for the reason that good values may be expected when sufficient depth has been attained to get below the oxidized horizon. Beyond the wide place the vein narrows and at the face has split up into two small veins of low-grade oxides.

The lower tunnel was started in a heavy slide, through which it was driven 20 feet; then about 40 feet diagonally across the small north vein and intervening rock to the south vein, on which it was continued about 50 feet and is now about half-way in under the upper tunnel. The vein, where cut, shows about 4 inches of sulphides on the foot-wall; then 3 to 4 feet of oxidized material; then about 6 inches of partially oxidized chalcopryrite ore on the hanging-wall. The foot-wall seam assays \$54 in gold to the ton and 3.5 oz. silver to the ton, and a sample of the hanging-wall seam assayed \$82 to the ton in gold, 1.3 oz. silver to the ton, and copper 13 per cent. There are more sulphides in the oxidized material in the lower tunnel. A sample from a couple of tons of sorted ore on the dump assayed over \$100 in gold to the ton. A crosscut of about 12 feet at the face shows the vein to have split into three oxidized small veins. An independent sampling of the crosscut gave 10 inches of oxides on the hanging-wall assaying \$9 in gold to the ton; then 6 feet 6 inches of slightly mineralized rock assaying \$2 in gold to the ton; then 17 inches of oxides assaying \$45 to the ton; then 4 feet of rock, and finally a small seam of oxides on the foot-wall portion assaying about \$3 in gold to the ton. The 8-foot portion of the hanging-wall would constitute a fair grade of milling-ore.

The consistently high gold values in the sulphides are, I think, a sufficient encouragement to justify further development of the property.

This claim and probably two more adjoining claims are owned by J. E. Fletcher, of Duncan, and associates. They are situated adjoining the *El Paint Pot*. *Capitan* on the south and are reached from the *El Capitan* cabin. The mineral-showing is a 2-foot vein replacing a shear in the andesitic country-rock, consisting of sulphides of iron and copper. A sample across the vein assayed \$2.80 in gold to the ton, 1.5 oz. silver to the ton, and 6.1 per cent. copper. The vein can be seen in the perpendicular cliffs above for a considerable distance. A short tunnel driven on the ore in 1931 is reported as showing about the same as on the surface.

ALBERNI MINING DIVISION.

This Division occupies a part of the central western half of the island and is the drainage area of Barkley sound, Alberni canal, and Sproat and Central lakes. All parts of it can be reached from Alberni or Port Alberni.

ALBERNI CANAL SECTION.

This group of four Crown-granted mineral claims, *W.W.W. Nos. 1, 2, 3, and 4*, is owned by A. James, Vancouver. They are situated about 12 miles up the Franklin river on the east side of Alberni canal. There is a trail, starting near the mouth of Franklin river, to the property. I understand that the trail is badly overgrown and hard to follow in places, and the bridges are badly dilapidated, but in the event of the reopening of the property it could be again put in commission at a comparatively small cost.

The general formation is evidently Vancouver volcanics, and Clapp says that the deposits are probably chiefly impregnations and partially replaced shear-zones. Excerpts from the Annual Report of 1921 are: "The ore is deposited in fissures which have clean-cut walls, but vary considerably in width from a few inches up to 14 inches. The vein is made up almost entirely of quartz, mineralized with iron pyrite and some free gold. There are apparently two fissures striking S. 10° W. (mag.) and dipping 45° E. There are two tunnels, the upper one 72 feet and the lower one 117 feet long. The upper tunnel follows the fissure all the way; the ore-shoot is about 30 feet long and 12 inches wide. The values at the face are encouraging and the vein has indications of widening. In the lower tunnel the fissure shows for its full length and the ore-shoot about 40 feet, which has been stoped to a small seam in the back."

Several examinations of the property have been made this season and the general opinion seems to be that, although there is little commercial ore in sight, there are possibilities of the recurrence of similar lenses as exposed in the tunnels and which might make a small profitable property.

There are three claims in this group—the *Regina*, *Regina No. 1*, and *Regina No. 2*—now owned by E. Maralia, of Port Alberni. They are situated about 9 miles from Port Alberni on the logging-railway of the Alberni Pacific Lumber Company. There is a good trail from the railway at 1,000 feet elevation to the old cabin at 2,100 feet elevation.

The mineralization consists of a mixture of pyrite, sphalerite, and chalcopyrite in a siliceous gangue replacing a shearing in the volcanic country-rock. The vein strikes north-south and dips 30° E. into the hill. It has been opened up a little by a wide open-cut along the face of the hill and a short incline shaft sunk on the vein. The shaft does not show much mineralization for the reason that it has been sunk at a point where the vein is offset or faulted, and consequently more or less broken. Beyond this the vein is shown to be well mineralized and about 2 feet in width.

Judging by the mineralization, I think it worth while to obtain some depth on this vein and then do some drifting on it. The gold and copper contents are encouraging and would make a nice-grade concentrate if sufficient tonnage could be developed to justify a small mill. About 20 tons of ore piled on the dump, which may possibly have been roughly hand-sorted, assayed \$3.60 in gold to the ton, 5 oz. silver to the ton, and 5 per cent. copper. If the chalcopyrite carries the gold, a good-grade copper concentrate could be made. An arrangement with the lumber company would provide cheap transportation to tide-water.

Although the side-hill at the croppings is fairly steep, the flat dip of the vein (about 30°) would necessitate sinking on the vein for preliminary work rather than crosscutting to obtain depth, unless, of course, the surface water would make sinking prohibitive. The shaft on the vein would furnish continuous information. Altogether it is an attractive little prospect.

SPROAT AND GREAT CENTRAL LAKES SECTION.

This group is comprised of the three claims, *Morning*, *Morning No. 1*, and *Morning Apex*, owned by Andrew Smith, of Alberni, and W. P. Beavan, of Victoria.

Last year the claims were under option to a syndicate headed by Gordon Campbell, Port Alberni, and P. L. Anderton, Courtenay, with the development-work under the supervision of R. N. Dickinson, of Comox. I have no information as to the present holding. The claims are situated on the north-east side of Taylor river, about 3½ miles from the head of Sproat lake, and reached by a branch from the main Sproat Lake-Kennedy Lake trail.

One long tunnel has been driven and an extensive amount of surface work done in stripping and open-cutting, all showing a number of parallel veins of quartz, filling fissures in a basaltic country-rock. The general strike of the veins is N. 60° E. (mag.) and dip about 85° W. The mineralization consists mainly of pyrite and pyrrhotite, with some galena, sphalerite, and chalcopyrite in places, carrying appreciable gold and silver values. The veins vary in width from 1 to 6 feet and carry up to \$18 in gold to the ton in the heavy pyrite. The average is estimated at \$6 to \$7 a ton.

The old work consisted of the tunnel and some open-cutting on the lower claims. The tunnel, at 500 feet elevation, was driven 345 feet, the first 100 feet following a slip to the vein and the balance a drift on the vein. The vein is here shown to be from 1 to 5 feet wide, heavily oxidized, and carrying low average gold values. At 100 feet above the tunnel an open-cut in the same vein shows 5 feet of vein, with a heavier sulphide content assaying \$2.40 in gold to the ton. At 875 feet elevation another cut shows a vein-width of 2 feet assaying \$4 in gold to the ton. About 200 feet west of the tunnel another vein similar in every way has been opened up by an open-cut and short tunnel. Good gold values are reported in the heavy sulphides in this vein.

A sample of average ore was sent to Ottawa for testing purposes, which assayed: Gold, 0.34 oz. to the ton; silver, 1.06 oz. to the ton; copper, 1.22 per cent. It was found that the gold was contained in both the pyrite and chalcopyrite, which eliminated selective flotation, but straight flotation gave a recovery of 98.7 per cent. of the copper and 89.7 per cent. of the gold. A very small percentage of the gold is free-milling.

The later work by the syndicate consisted of a few cuts between 650 and 800 feet elevation and three open-cuts on the higher ground of the *Apex* at about 3,000 feet elevation. This work proved the existence of more veins of similar widths and values and showed the necessity of extensive exploration and development-work to demonstrate whether a sufficient tonnage of this grade of ore can be developed to make the property a profitable undertaking. I think that present indications justify going ahead.

CLAYOQUOT MINING DIVISION.

This Division occupies the central hundred miles of the west coast of Vancouver island and is accessible by coast-lying boats from Victoria or Port Alberni. There is a road from Ucluelet, at the north entrance to Barkley sound, through to Tofino in Clayoquot sound, by way of Long beach, but the trip over it is generally an experience.

KENNEDY LAKE AND RIVER SECTION.

There are several old properties in this section that may have gold possibilities, a few of which will be described briefly to give the reader an idea of the showings and conditions. (See also under "Prospecting Areas.")

This group consists of the *Jo Jo* and *Jo Jo No. 1*, owned by W. S. Dixon and the late Wm. Spittal. The claims are situated on the east side of Kennedy river, about 3½ miles from the head of Kennedy lake, a short distance off the main Kennedy Lake-Sproat Lake trail. The general formation is a greyish dioritic rock with belts of limestone. Within the volcanic rock are quartz-filled fissures, mineralized with pyrite and pyrrhotite, some galena, zinc-blende, and chalcopyrite, as a rule carrying gold values.

Several open-cuts have exposed such a vein on this property about 2 feet wide, striking N. 40° E. (mag.) and dipping slightly to the west. It is well defined, well mineralized, and can be traced on the surface for several hundred feet. A sample, however, taken at the deepest open-cut gave a small percentage of copper, but low gold values. Further prospecting might give better results.

There were four claims in this group, owned a few years ago by A. Watson, **Rose Marie.** of Port Alberni, and associates, but I do not know its present standing. It is on the east side of Kennedy river, about 3 miles up from Kennedy lake. The vein is typical of the quartz-vein type of deposits of this section; that is, quartz-filled fissures mineralized with pyrite, pyrrhotite, and some galena, zinc-blende, and chalcopyrite, as a rule carrying gold values. The croppings are at 1,000 feet elevation and a considerable tonnage was mined from the surface. Later a tunnel was driven 350 feet on the vein about 400 feet below the outcrops. The surface ore presumably paid, as there was a 4-stamp mill, tables, compressor, etc., plant on the property in 1899 which was operated for a couple of seasons. Evidently the ore obtained in the driving of the tunnel was too low grade to treat and the property was abandoned. No further work has ever been done on it.

This claim was situated about 2 miles up from Kennedy lake on the east side of Kennedy river. It contained the same type of quartz vein as described under the *Jo Jo* and *Rose Marie* groups. It was described by Forbes in the 1913 Annual Report as follows: "The principal development-work consists of a tunnel 340 feet long situated about 1,000 feet from the river; this tunnel has been driven on a small ledge from 6 to 12 inches wide with diabase walls. At 117 feet in the tunnel a winze has been sunk on the ledge, in which it is said that better values and a wider ledge were found. A small shipment has been made from this winze which yielded a return of over \$100 a ton. Mineralization consisted of pyrite, arsenopyrite, in a gangue of quartz, and calcite. A sample taken near the winze assayed 1.4 oz. gold to the ton."

The property was worked during 1914 and 1915 by W. W. Gibson, the inventor of the Gibson mill, who must have treated a considerable tonnage judging from the stoped portion of the vein, and is reported to have recovered about \$9 a ton. There are several other claims in this section showing similar veins in which are patches of gold-bearing sulphides. Both the *Rose Marie* and *Leora* furnished some considerable tonnage of milling-grade ore and I therefore think that the belt offers some inducement for gold-prospecting.

This group, consisting of the *Ex*, *Ten*, *You*, and *Eight* claims, is owned by **You.** J. B. Woodworth, of Vancouver. It is situated about 13 miles up Bedwell river, in from the head of Bedwell sound, at an elevation of about 3,000 feet. At one time a good road extended for 9 miles in from tide-water, from the end of which this property and the *Ptarmigan* were reached by trail. The bridges on the road are badly dilapidated, and two of the largest, one over the Bedwell river, have gone out entirely. There have been no operations in the valley since 1914.

The *You* vein is of quartz in a shearing of the Vancouver volcanics, very similar to the Elk River shears and quartz-vein replacements. It is, between well-defined walls, about 3 feet wide, the gold-bearing quartz vein occupying up to a foot in width of this. The quartz is mineralized with pyrite, galena, zinc-blende, and copper sulphides, carrying gold and silver values and in places visible free gold.

The vein has been traced down a narrow gulch for several hundred feet by a series of open-cuts. A tunnel has been driven about 80 feet on the vein, which gives considerable backs as the vein rises abruptly. Samples from the tunnel show high-grade gold values throughout; a general sample from the dump assayed: Gold, 2.92 oz. to the ton; silver, 2.6 oz. to the ton; copper, 0.5 per cent.

Little work has been done on the property since 1922, but I am informed by Mr. Woodworth that he fully intends reopening the property in the spring of 1932 if it is at all accessible under present transportation conditions. The above is taken from the 1921 Annual Report by Wm. Brewer, Resident Engineer at that time.

ESPERANZA INLET SECTION.

This section is reached by the Canadian Pacific Railway coast boats to Nootka, or Hecate cannery, and from either of these places by launch to the head of Zeballos arm.

Tagore. This claim is owned by H. Malmberg and C. Nordstrom, of Quatsino, and is situated about 2 miles up the Zeballos river from the head of Zeballos arm. It is on the trail up the river to the Marks Gold and Copper Mines, Limited, camp. Several other claims were staked and taken over by A. B. Trites, of Vancouver, in the fall of 1929. I understand that a small shipment of very high-grade ore was taken out and some surface prospecting done without very satisfactory results. Malmberg was working on a small stringer of quartz up to 3 or 4 inches wide which, where mineralized with galena, zinc-blende, and chalcopryrite, carried as high as \$700 to \$800 in gold to the ton.

Marks Gold and Copper Mines, Ltd. This company, incorporated in 1928 with a capitalization of 3,000,000 shares at \$1 par, acquired the *Ehatset* group from T. J. Marks. The group comprised thirteen claims, *Ehatset Nos. 1 to 13*, situated at the forks of the Zeballos river, about 6 miles up from the head of Zeballos arm. There is a good foot-trail from the beach to the camp. The showings are mainly copper, occurring in a sheared belt about 200 feet wide, bordered on one side by a wide body of limestone. Within the shearing are, in places, small quartz veins varying from knife-blade seams up to an inch or two in width. Where these quartz stringers are mineralized with zinc-blende they carry very high gold values. They are not numerous enough to be of any commercial value, but are mentioned to show that high gold values are found in the Zeballos basin and may be indications that should not be overlooked.

QUATSINO MINING DIVISION.

Alice Lake. There are seven claims in this group—*Alice Lake, Lucky Strike, Cedar, Hornet, Iron Knob, Galena, and Paystreak*—owned by Wm. Clancy and W. D. Kinsey, of Quatsino. The ore-showings are being developed by the owners under the direction of Mr. Clancy on the property. It is situated about half a mile from the Jeune Landing—Alice Lake road of the Coast Copper Company, and about 4 miles from Jeune Landing, a port of call of the Canadian Pacific Railway west coast boats. There is a foot-trail from the road to the workings at about 1,000 feet elevation.

The general rock formation is a belt of crystalline limestone from 3 to 4 miles wide, extending across the South arm of Quatsino sound, south to the *Old Sport* group on Elk lake. Within the limestone are many intrusions striking and dipping in all directions. On this property the mineralization consists of galena, zinc-blende, and pyrite, carrying good values in gold and some silver besides the lead and zinc contents. A considerable amount of work has been done by way of stripping, open-cutting, and a crosscut tunnel and the present drift-tunnel, all of which demonstrates that the intrusions have had little or no influence on mineralization.

The drift-tunnel has been driven nearly 100 feet, following an ore-shoot about 18 inches wide, assaying from \$10 to \$20 in gold to the ton, 7 oz. silver to the ton, and up to 12 per cent. lead and 14 per cent. zinc. This exploration-work is being carried out by Mr. Clancy along the lines of a property in Mexico, very interestingly described by Basil Prescott in the *Engineering and Mining Journal* early in 1926. The occurrence is described as a pipe or chimney of ore forced up from the molten magma through the limestone, maintaining a fairly uniform cross-section and only diverted by some more resisting stratum in the limestone. Development-work consists, therefore, in following the ore. Since transportation presents no difficulties, the owners feel that, with normal metal prices, they can hand-sort to a profitable grade of shipping-ore.

NANAIMO MINING DIVISION.

This Division, occupying the eastern half of Vancouver island and all the west mainland coast from Jervis inlet north to Seymour inlet, has probably the most diversified production of the Mining Divisions of the Province.

NIMPKISH LAKE SECTION.

This area was brought into prominence a couple of years ago on the discovery by E. L. Kinman, of Vancouver, of exceptionally promising outcroppings of copper, lead, and zinc ores up Lime creek, about 4 miles from the south end of Nimpkish lake on the east side. The *Kinman* groups, consisting of over fifty claims, were staked, as well as several other groups in that vicinity. Extensive surface work along a wide contact-belt between granodiorite and limestone

had exposed large bodies, up to 30 feet wide, of chalcopyrite, as well as remarkable showings of zinc-blende and galena.

An option was taken by the Consolidated Mining and Smelting Company, Limited, and further extensive surface work done which gave every encouragement. Subsequent diamond-drilling, however, failed to prove the downward extension of these ore-bodies to the satisfaction of the company and the option was finally abandoned. While the principal metallic mineral is copper, the fact that one of the diamond-drill holes crossed from 2 to 3 feet of \$50 gold ore is cited as indicative of the gold possibilities in the contact deposits in this section.

Smith. This group, about a mile east from near the south end of Nimpkish lake, also had a considerable amount of work done while under option to the Consolidated Mining and Smelting Company, with disappointing results. However, later work done by the partners, A. Smith (since drowned) and G. K. Storey, of Englewood, discovered some promising showings of galena and zinc-blende, from which a gold assay of over \$100 a ton was obtained. This example, with the *Kinman* sample, and similar occurrences in the Coast copper ore-bodies, shows that these are probably small enriched pockets which are liable to occur anywhere.

Lucky Jim. This property, consisting of three claims—*Lucky Jim*, *Lucky John*, and *Margorie*—was owned by Jas. and Walter McKay, of Vancouver, one of whom was killed at the mine a couple of years ago. The group is located on Adams river and reached by trail from Sayward, on Johnstone strait, at the mouth of the Salmon river. I have not seen the property, but from W. Brewer's report in the 1918 Annual Report I find that the ore occurrence is given as of the contact-metamorphic type on a granodiorite-limestone contact. The mineralization consists of pyrite, pyrrhotite, and chalcopyrite carrying gold values up to \$18 a ton.

The Consolidated Mining and Smelting Company took a bond on the property in 1927, improved the trail so that a diamond-drill could be taken over it, and did considerable drilling. The results, however, did not meet the company's requirements and the bond was closed. As far as I can learn, there has been little done on the property since.

Silver Leaf. There are three Crown-granted claims in this group—*Silver Leaf*, *Mountain Ash*, and *Hemlock Fraction*—situated at the head of the south branch of Jump creek, the main south tributary of the Nanaimo river. They are on the east slope of the main mountain range of the island between the Nanaimo River basin on the east and Cowichan lake on the west. The best route to the camp and showings is by way of the *El Capitan* trail up Cottonwood creek from Cowichan lake to a low summit at 3,625 feet elevation, and down to the cabin at 2,300 feet a couple of miles from the *El Capitan* cabin on the west slope. The property is owned by T. Service, the original locator, E. F. Miller, of Duncan, and others, constituting the Silver Leaf Syndicate.

The general rock formation is andesite of the Vancouver volcanics, in which there are on these claims four parallel shearings striking S. 60° W. (mag.) and dipping from 75° to 80° E., each containing lenses of quartz and sulphides, replacing the sheared rock.

On the south zone, about 400 feet above the camp, a tunnel has been driven 70 feet, with a crosscut into the hanging-wall about 10 feet back from the face. This work is under a surface outcrop of good chalcopyrite ore exposed for about 70 feet on the surface, with a width of about 30 inches. The tunnel starts in a body of good ore, 2 feet wide, composed of quartz and calcite well mineralized with pyrrhotite, arsenopyrite, and chalcopyrite, assaying \$10 in gold to the ton, 1.5 oz. silver to the ton, and 9 per cent. copper. At 50 feet in the tunnel a lens of solid sulphides, pyrrhotite, and chalcopyrite, on the hanging-wall, up to 16 inches wide and about 20 feet long, has been exposed, assaying \$15 in gold to the ton and 9 per cent. copper. A piece of the purer chalcopyrite assayed \$1.20 in gold to the ton and 17.5 per cent. copper. A winze 25 feet back from the face of the tunnel was sunk 6 feet, showing the downward continuation of this ore-shoot, 2 feet wide. The vein shows a width of 3 feet in the face, but only sparsely mineralized. The tunnel should certainly be continued.

About 50 feet north of the collar of the tunnel, another parallel vein has been exposed by a few shots. This has proved to be about 2 feet wide of chalcopyrite and oxides, across which a sample gave \$13 in gold to the ton, 2.2 oz. silver, and 16 per cent. copper. This fully warrants further development. About 500 feet farther up the hill at 2,800 feet elevation, and presumably on this same vein, an open-cut shows a vein-width of 5 feet, of which 18 inches on the hanging-

wall is clean chalcopyrite, and another stripping some 200 feet above shows the same width, but it has not been shot into.

About 200 feet north of the tunnel, another shear about 10 feet wide has been discovered, showing 2 feet of oxidized material on the foot-wall side, in which are lumps of arsenopyrite, a sample of a few pieces assaying \$28 in gold to the ton. The balance of this zone is a fine-grained, dark-coloured argillaceous rock, throughout which are sparsely mineralized veinlets of calcite. This zone was later exposed up the hill and I am informed looks encouraging. There is another shear-zone on the *Mountain Ash* claim with mineral indications on the surface, but no work whatever has been done.

Although insufficient work has been done on these different ore-showings to prove their extent, except perhaps on the 70-foot tunnel, where the lenses proved short, the grade of the ore where found gives the property promising possibilities, and might, without any great amount of development, be brought to the producing stage. I understand that the date of location entitles the owners to all metals, although it is situated within the railway belt.

The serious handicap in connection with the property is transportation. Situated on the east slope of the main range, the natural outlet is down the Nanaimo river to tide-water, a distance of 13 miles down Jump creek to the wagon-road on the north side of the Nanaimo river and a further 12 to 14 miles to tide-water. The alternative route would be to go over the low divide of the range at 3,625 feet, and about 1,500 feet higher than the lowest ore-showings, and down to the Canadian National Railway at Cowichan lake. From the tunnel-level to the summit would be less than a mile in a direct line for a tramway and from the summit to the Canadian National Railway between 6 and 7 miles.

NORTH-WEST COAST AND ISLANDS.

This company was incorporated in Ontario in 1927 with a capitalization of **Alexandria Gold** 5,000,000 shares of \$1 each. It is a holding company with its head office in **Mines, Ltd.** Toronto, Ont. Included in its holdings was a controlling interest in the (formerly **Alex- Alexandria Mining Company, Limited**, which owned the *Alexandria* group, **andria Mining Co., Ltd.**) arm. The group consists of the seven Crown-granted claims—*Alexandria, Waterloo, Highland Laddie, Emperor Frac., Duke, and Jubilee*. The *Alexandria Mining Company, Limited*, was incorporated in 1928 by Chas. Dickie, of Duncan, and associates. Its capitalization was 3,000,000 shares of 50 cents a share, with the head office in Vancouver. This company carried on the development of the *Alexandria* property for several years until acquired recently by the holding company on a share-for-share basis.

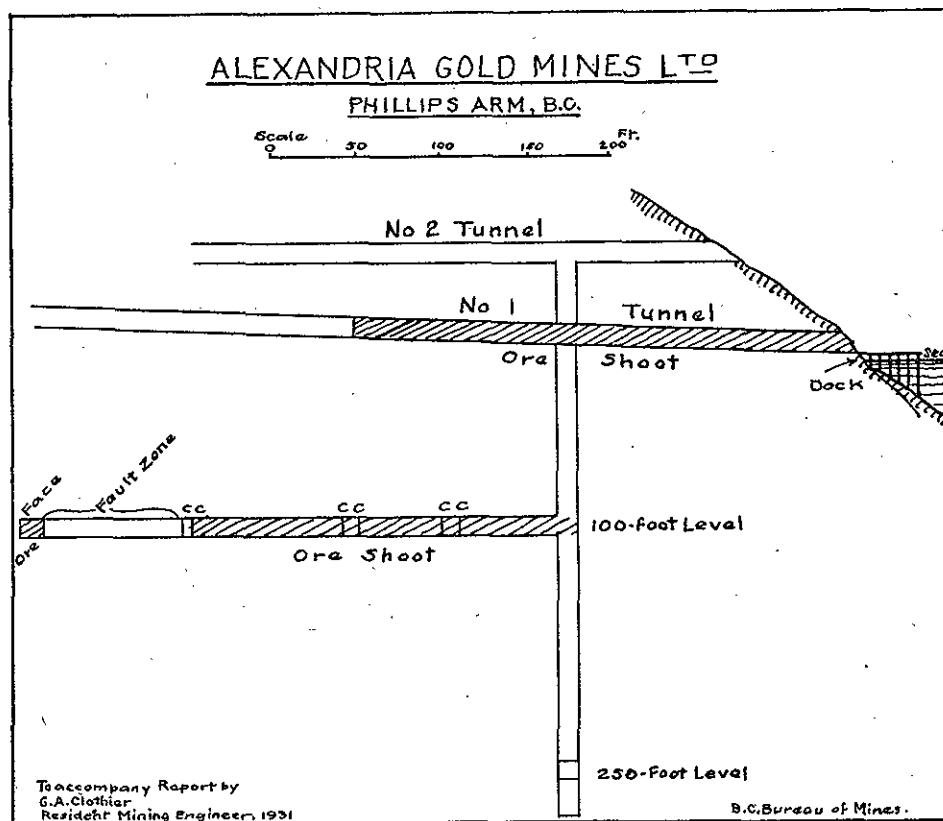
The property is reached by Union S.S. coast-plying boats to Shoal bay (Thurlow Post-office), on the north end of Thurlow island, directly across the channel from the mine. A dock has been constructed at the mine, at which the Coast boats call when business warrants. The camp, plant, and working-tunnel are ideally located on the beach. The camp consists of office, mess-house, and bunk-house, furnishing accommodation for thirty men. In 1929 a heavier power plant was put in, comprising a 600-cubic-foot compressor, driven by a 125-horse-power Crossley engine, giving sufficient power for drilling, drill-sharpeners, pumping, and hoisting for several hundred feet of depth.

The general rock formation is a belt, possibly a mile wide, of altered sedimentaries and volcanics contained in the Coast Range granodiorite. Within this belt and on or near the granodiorite on the south-west side, a zone of shearing has been replaced in places by a quartz vein conforming with the strike of the schistosity; i.e., north-westerly. Such quartz veins, lenses, and masses are believed to be a later phase of the cooling granodiorite. The mineralization consists of pyrite, in places containing a little chalcopyrite, carrying gold and small silver values. As the gold is practically all contained in the iron sulphides the ore is very amenable to concentration.

The earlier work on the property consisted of four tunnels. The No. 1 or beach tunnel is just above extreme high tide, and was driven 530 feet following the quartz vein all the way. The ore-shoot extends from the collar of the tunnel for about 300 feet. Six crosscuts were driven—two at 85 feet from the portal, two at 385 feet, and two at the face. At 185 feet a raise was first put up to the No. 2 tunnel, a distance of 50 feet, and a winze sunk a short distance, a total of about 950 feet of work. The No. 2 tunnel, at 55 feet elevation, was driven about 275

feet; the No. 3 tunnel, at 300 feet elevation, about 75 feet; and the No. 4, at 426 feet elevation, about 50 feet. Later, in 1928, another tunnel, No. 5, was started about 400 feet north of No. 1 tunnel, driven 125 feet to the vein and some drifting done on the vein. All this work, where on the vein, showed it to be badly broken up and consequently the mineralization and values were very irregular. Surface work, extending several hundred feet above the upper tunnel, proved the vein continuous for that distance.

As the ore-shoot in the No. 1 tunnel showed a continuous length of 300 feet, with an average width of 5 feet, of which a thorough sampling gave average values of nearly \$9 to the ton in gold and silver, it was decided to sink on this ore-body at a point under the raise, or 185 feet from the collar of the tunnel. The old winze was enlarged, hoist and pump installed, and a 2-compartment shaft sunk 270 feet. A short distance down a heavy flow of surface water was encountered and the work was somewhat retarded until a heavy-duty pump was installed. At



the 100-foot level a station was cut and a drift driven west on the vein for 325 feet. Three crosscuts were driven: No. 1, 60 feet west of the shaft, showed 9 feet of vein; No. 2, at 130 feet, 8 feet of vein; and No. 3, at the fault, 235 feet from the shaft, showed the vein to be 13 feet wide, an average width of about 10 feet. The drift is in ore all the way to the fault or cross-shear zone, from which point the formation is broken for a distance of 65 to 70 feet, when quartz stringers came in, which in a short distance consolidated into a 2-foot quartz vein assaying, I am informed, \$16 in gold to the ton. The values are said to be improving and the vein widening in the short distance driven in this section of the vein before work was suspended. It is decidedly encouraging to find the vein and values continuing beyond the fault-zone, proving the existence of ore a couple of hundred feet farther into the hill than in the No. 1 tunnel above.

T. S. Davey, the company's consulting engineer, gives the average values on the 100-foot level, from the shaft to the fault a length of 235 feet, as \$10.40 in gold to the ton, and estimates

the average width at between 7 and 8 feet, indicating an improvement in depth, of average values and vein-width which may also be considered as very favourable features.

It is now proposed to crosscut to the vein at the 250-foot level in the shaft and drift on it both ways from the shaft. At this depth the shaft will be about 500 feet from the salt water if the slope of the hill continues uniformly under water. Should the vein show improvement on the 250-foot level as indicated on the 100-foot level, or if it even maintains its size and values as proven on the 100-foot, the *Alexandria* will make an important gold-producer. The outlook is promising.

This group is situated up the hill from Fanny bay on Phillips arm at an **Doratha Morton.** elevation of about 2,500 feet. There is a good trail from the beach to the workings. The property is owned by the Morton Woolsey Consolidated Mines, Limited, which has a share capitalization of 3,000,000 shares of \$1 a share.

The *Doratha Morton* is an old property, dating back to 1898 and 1899, when a cyanide plant was installed and operated for about a year. About 10,000 tons of ore was treated, yielding 4,434 oz. of gold and 10,000 oz. of silver, representing a recovery of 92.9 per cent. of the gold and 71 per cent. of the silver.

Three tunnels were driven. The No. 1 tunnel at 2,265 feet elevation consists of a crosscut of 144 feet to the vein and drifts both ways on the vein totalling over 500 feet. Practically all the ore mined was stoped above this tunnel to the surface, the ore-body extending only a few feet below the tunnel-level. No. 3 tunnel was started about 200 feet below this and was intended as a main working-tunnel, and consisted of a crosscut of 650 feet to the vein, which was drifted on 40 feet west and 50 feet east.

In 1925 the Glasord Mining Corporation, Limited, was organized and took over the property, camps were re-established, considerable surface prospecting done, and the east drift in the No. 3 tunnel advanced beyond the fault, encountering fair indications of ore. Another crosscut tunnel was started about 400 feet east of the No. 1 tunnel, at 2,140 feet elevation, with the object of exploring the vein east of the fault. Work, however, was suspended and nothing has been done since. There would appear to be possibilities in that section.

This group of twelve claims is situated west of and adjoining the *Doratha* **Julie-Enid.** *Morton* group and was also included in the holdings of the Glasord Company. Some work was done in 1925 on these claims by way of a crosscut tunnel of 60 feet and a shaft sunk on the *Julie* claim. This work exposed similar vein and mineralization to the *Doratha Morton* and *Alexandria*, though it is supposedly another parallel vein. Very attractive gold values were found in places and the property probably deserves further exploration.

This group, consisting of the three Crown-granted claims—*Blue Bells*, *Gold* **Blue Bells.** *Bug*, and *Dashwood*—is situated on the west side of Frederick arm off Cordero channel. The property is in the name of G. W. Hutchings, of Vancouver. There was a good trail from the beach to the showings, a distance of about 1½ miles, but it is pretty well grown over now. The last work done on the property was in 1920 by the Ladysmith Smelting Corporation, Limited.

The showings consist of a quartz vein in a metamorphosed sedimentary country-rock very similar to the *Alexandria*. The vein is pyritized in part, with a little chalcopryite, but in the main is barren-looking quartz. A series of open-cuts exposed in the vein on a N. 60°-70° W. (mag.) strike for several hundred feet up the hill from the big outcrop. Here, at the junction of the main vein and a N. 20° W. (mag.) vein, is an immense body of quartz over 50 feet wide intruded by small basic dykes. In places where the sulphides are best developed there are substantial gold values, and free gold has been found in the quartz. Two tunnels, the upper one at 1,750 feet elevation and about 100 feet under the big cropping and the lower one at 1,600 feet elevation, have been driven and several hundred feet of underground work done, exposing an extensive body of barren-looking quartz. It has been thoroughly sampled, but apparently has been considered too low grade to offer much encouragement for further development.

Nimrod Mining and Development Co., Ltd.—This is an old company that owned seven Crown-granted claims on the extension toward the beach of the *Blue Bells* vein. Some surface work was done toward tracing the vein down to the beach, but at present the claims have reverted to the Crown for unpaid taxes.

Thurlow Gold Mines, Ltd. This company was incorporated in 1928 with a capitalization of 2,000,000 shares at 25 cents each. The company acquired the *Hope* group of three claims—*Hope*, *Hope No. 1*, and *Hope No. 2*—situated on the north-east side of Thurlow island, cut out a road of about a mile from the beach to the showings, put up a good camp, and installed a small compressor and mining equipment.

The mineral showing at 300 feet elevation is a quartz vein from 1 to 5 feet wide, lying within the granodiorite or along the contact of the granodiorite and a wide belt of altered sedimentaries, and is probably the same belt as that in which the *Alexandria* quartz vein occurs. The quartz is mineralized with pyrite principally, but occasionally showing a little chalcopyrite, the sulphides carrying the gold up to \$50 a ton in places. A tunnel had been driven on the vein about 70 feet, showing some encouraging values. This was extended to 100 feet to a cross-fault which cut off the vein. Some little work was done in trying to find the extension of the vein beyond the fault, but without results.

Very little was done until 1931, when the Pacific Copper Mines, Limited, took over the property. The old shaft, about 200 feet east of the mouth of the tunnel, was cleaned out, enlarged, timbered, and sunk to a depth of 68 feet. A crosscut of 12 feet from the bottom of the shaft picked up the vein and a drift was run on the vein toward the tunnel. The first 65 feet of the drift from the shaft showed a well-defined vein with irregular values and low average. At 65 feet a cross-shearing or faulted zone consisting of broken and disturbed formation was entered, which has continued to the present face, 130 feet from the shaft at my last examination. Since then it has been extended to within about 50 feet of being under the collar of the tunnel. There is a fault at the mouth of the tunnel which appears on the surface to dip toward the shaft at about 70°. This foot-wall slip of the fault has just been reached in the shaft-drift and some crosscutting to the right should pick up the vein. The ore-shoot in the adit-tunnel gave encouraging average gold values, and it is unfortunate that finances did not hold out until this ore-body was found on the shaft-tunnel level.

White Pine. There are three Crown-granted claims in this group—*White Pine*, *Electric*, and *Union*—owned by Seymour Campbell, of Thurlow, and associates. The claims are reached by an old logging-road and trail from Shoal Bay. It is one of the old properties of this section on which work was done several years ago.

The work consisted of a shaft at 750 feet elevation, probably 75 feet deep, judging by the size of the dump, and a crosscut tunnel 165 feet long, at an elevation of 650 feet, at a little distance south of the shaft. The crosscut cuts the vein at 90 feet in the tunnel, showing it to be 3 to 4 feet wide, striking N. 70° E. and dipping 65° S. There is a fault between the shaft and the tunnel which offsets the vein about 40 feet toward the collar of the tunnel. A crosscut from the tunnel, about 40 feet north of the vein, to the fault would pick up the portion of the vein, on which the shaft was sunk, at a depth of 100 feet.

No drifting has been done on the vein either from the shaft or crosscut tunnel. Samples from the shaft dump assay \$2 to \$4 a ton. The vein shows small outcrops in a number of places in a few hundred feet north of the shaft. The vein and formation are identical with that of the Thurlow Gold Mines. No work has been done in recent years pending results obtained on the Thurlow Gold Mines property.

Douglas Pine. There are nine claims in this group—the *Douglas Pine* group of three Crown-granted claims, *Douglas Pine*, *Gold Exchange*, and *Cone Fraction*, to which have been added, by staking, the *Rand* group of six claims. They are situated on the north-east corner of Thurlow island just up the hill by a good foot-trail from Shoal bay.

The property was bonded by A. C. Gerhardt, of Vancouver, in 1929 and a crosscut tunnel started with the objective of intersecting several small gold-bearing quartz veins exposed on the surface. The tunnel was driven about 70 feet, cutting two small veins carrying \$8 and \$6 in gold to the ton respectively. Beyond a little surface work nothing further has been done.

Sonora Gold Mines, Ltd. This company was incorporated in 1929 with a capitalization of 2,500,000 shares at 25 cents a share, with its registered office at 804 Dominion Building, Vancouver. The holdings comprise twenty-one claims situated on the north-west side of Sonora island. They cover a width of over 1,000 feet of altered sedimentaries and volcanics. One belt is 500 feet wide; then about 200 feet of granodiorite; then another belt of several hundred feet wide to the main granodiorite-mass. Within these belts and along the borders of the granodiorite are lenses of quartz sparingly mineralized with

pyrite. The pyrite carries high gold values, up to \$200 a ton having been obtained. Such assays, however, mean nothing so far as ore is concerned, for no place has yet been found where sufficient ore is indicated to be worth while.

These quartz "veins" are mainly along or near the contact of the included belts and granodiorite, occurring both in the altered rocks and in the granodiorite, in places extending from one formation to the other. So far as I observed, the gold values were found only in the veins occurring in the granodiorite and only in the pyritized spots in the quartz. The conclusion may therefore be drawn that prospecting should be emphasized along the granite borders. The quartz-lenses are characteristically short and of no great width.

This year such a quartz vein was uncovered in the granodiorite about 100 feet from the contact and a couple of hundred feet up from the beach. The seam is about 25 feet long, from 1 to 4 inches wide, and in one spot shows a little pyrite, probably 100 lb., assaying over \$100 in gold to the ton. There are several such lenses up the hill; the highest exposed is at a shaft at 900 feet elevation. This was sunk many years ago to 60 feet depth on a quartz vein about 6 feet wide in the granodiorite a few feet from the contact. The dump shows only a few pieces of pyrite, the remainder being white quartz. Stripping beyond the shaft exposes the extension of the vein for about 75 feet, which also shows only odd patches of sulphides.

Altogether the work shows a wide distribution of mineral and values, but unfortunately not enough in any one place to indicate any commercial possibilities. The only thing that can be done is to continue surface prospecting along the contact-borders in the hope of finding an ore-showing worth developing.

This group of three Crown-granted claims—*Lucky Jim*, *Saxon*, and *Rising Sun*—is situated along the main Granite Bay–Open Bay road, about 3 miles from Granite bay on Quadra island. In 1910 the property was under operation by the Great Granite Development Syndicate, of Vancouver. At that time the shaft was down 110 feet, stated to be in good ore all the way. A shipment of 184 tons taken from 25 feet down assayed \$22 in gold to the ton, 3.5 oz. silver to the ton, and 8 per cent. copper. A level was started at 100 feet and drifts run 25 feet east and 15 feet west, showing good ore. Boilers, a compressor plant, pump, etc., were installed.

The property apparently was closed down in 1911 and lay idle until 1927, when some further surface work was done under the supervision of R. Crowe-Swords, of Vancouver, without results. The power plant, camps, etc., were wiped out by forest fire in 1925.

This is another old group about a mile beyond the *Lucky Jim*, just off the main road from Granite bay. This and several other claims in that section are now held by T. Noble, of Quathiaski Cove. Gold values in several small quartz stringers would suggest possibilities.

TEXADA ISLAND SECTION.

Mining has been carried on in this section since 1898, when the *Marble Bay*, *Cornell*, and *Copper Queen* mines were staked. Of these, the *Marble Bay* became the most important producer and was developed to the seventeenth level. The deepest ore mined was from the sixteenth level. The copper ores, chalcopyrite and bornite, were the main minerals, but some shipments of ore carried from \$10 to \$15 a ton in gold. There were also a number of properties containing gold-bearing quartz veins occurring in the intrusive porphyrites, which is the predominating formation of the northern-central and western portions of the island. The great majority of these gold-deposits were found to be very irregular, pockety, and confined to the surface. The only gold properties on which any appreciable depth was obtained were the *Marjorie* and *Gem* (*Nutcracker*).

This group contained five claims situated about 1½ miles west of Vananda, on Texada island. The claims were located in 1903 on the discovery of quartz-croppings carrying free gold. It is claimed that \$6,500 in gold was taken from a hole 7 feet long and 6 feet deep on the surface. There are a number of well-defined quartz veins on the property in a width of 210 feet, occurring in shears in the porphyritic country-rock. They strike east-west and dip almost vertically and vary from a few inches to 4 feet wide. The mineralization consists of pyrite, chalcopyrite, some zinc-blende, galena, and magnetite, carrying gold values up to \$100 a ton and small values in silver. There has been a lot of surface work done in trenching along these veins and a shaft sunk about 70 feet on one

of the most promising-looking veins. The vein was drifted on the 60-foot level of the shaft for 80 feet to a fault.

In 1926 the Chickamin Mines, Limited, was incorporated with a capitalization of 2,000,000 shares at 25 cents each and acquired the property. The principal work done was a crosscut 250 feet long from the bottom of the shaft with the objective of intersecting the several veins showing on the surface. This work apparently was not very encouraging, as work was discontinued and the mine allowed to fill with water. Several of the trenches along the veins are over 100 feet long; one on the shaft vein for 98 feet westerly from the shaft shows it to be from 1 to 4 feet wide. Much of the ore taken from the shaft-drift and the surface work was treated in a Gibson mill, apparently without profitable results. From this one must conclude that, although there are many small pockets of high-grade gold ore, the values are not sufficiently distributed to constitute a workable milling-grade ore.

This group of five Crown-granted claims—*Gem, Gerald D., Harold D., Dandy Gem (B.C. Gold Fr., and Crackerjack*—is the original *Nutcracker* group, and in 1924 was *Mines, Ltd.* acquired by the B.C. Gold Mines, Limited. This company was incorporated in that year with a capitalization of 1,000,000 shares at \$1 each, and the property acquired from John McConville, who had it under bond from the original owners, Messrs. Logan and Danaher, of Vancouver. The claims are situated near the east end of Kirk lake and can be reached by auto from Vananda.

It is an old property, dating back to its discovery by Hugh Kirk in 1895. A shaft was sunk in 1896 to a depth of 18 feet, from which \$2,000 worth of gold was recovered. From then it lay idle until 1923, when bonded by John McConville, who sunk the shaft to a depth of 50 feet and drifted both ways from it. Later surface-trenching on the vein east of the shaft disclosed some spectacular ore and the east drift in the shaft was extended, encountering a fault; the vein was picked up beyond this in the drift, showing very encouraging ore. To proceed with the development and equipment of the property the B.C. Gold Mines, Limited, was organized.

A new shaft was started 125 feet easterly from the old one and equipment installed, consisting of a Petter semi-Diesel engine, machine-drills, compressor, pump, and hoist, driven by a Fairbanks-Morse gasoline engine; a Denver quartz mill and crusher, driven by a fuel-oil engine, two amalgamating-plates, etc. The shaft was sunk to 150 feet depth and drifts run both ways on the vein from the 50-foot and 100-foot levels. The mill was operated, and treated probably a couple of hundred tons. A careful sample of the tailing-dump assayed 0.70 oz. in gold to the ton. Owing to unsatisfactory results of operations the property was closed down about the first of December, 1926.

In 1928 the Texada Gulf Mining Company, Limited, was organized with a capitalization of 3,000,000 shares at 50 cents a share and procured the property from the B.C. Gold Mines, Limited. The main shaft and underground workings were unwatered and some \$20,000 expended in further exploratory work with the expectation of developing a tonnage of milling-grade ore, but without success. The property is now held by the original owners, Mr. Logan, of Vancouver, and associates, who did some further surface work this season in exploration of the cross-veins west of the main shaft.

This Crown-granted claim is situated north-west of and adjoining the old **Lorindale.** *Gem or Nutcracker* group and is now owned by Mrs. E. S. Cook, of Nanaimo.

Considerable work was done on the claim as early as 1897 by way of a 70-foot tunnel and a shaft 46 feet deep at the mouth of the tunnel on one of the veins and a hole 19 feet deep on another vein. Fine specimens of free gold were obtained from one of the veins on the surface, but apparently the results at any depth obtained were not encouraging. Nothing has been done on the property since.

LASQUETI ISLAND SECTION.

This company was incorporated in 1920 as a private company with a capitalization of \$250,000, with its head office in the Birks Building, Vancouver. **Lasqueti Mining Co., Ltd.** The company acquired the *Venus* group of four Crown-granted claims—*Mars,*

(*Venus Group*). *Venus, Venus Fr., and Hill 60*—and the *Leo* claim, held by assessment. The rock formation consists of basalt, intruded by a wide belt of diorite. There are three veins on the property—the west vein in the diorite, the centre vein on or near the

basalt-diorite contact, and the east vein in the basalt. The veins are quartz mineralized with pyrite and chalcopyrite, the main values being copper, but carrying up to \$15 in gold to the ton.

The company confined its work to the centre or contact vein, tracing it by surface cuts the length of two claims, the south end being mostly in the diorite. A 100-foot tunnel was driven from the beach at the head of Banes cove, opening up a nice shoot of chalcopyrite ore, from which some 300 tons were mined and shipped, netting about \$25 a ton, containing from \$6 to \$15 in gold to the ton. A shaft was started in this ore-body and sunk to 100 feet depth, the ore extending only a short distance down. A drift was run from the bottom of the shaft, but no ore was found.

In 1928 the Lasco Development Company, Limited, was organized with a capitalization of 200,000 shares at \$1 each and took over the *Venus* group for further development-work. The main tunnel was extended a further 140 feet, but as no ore in shipping quantity was found, work was closed. Nothing more was done until this spring, when a lease was let to private interests, who mined and shipped 50 tons from the south end of the vein.

Juneau. This is a group of three Crown-granted claims—*Juneau, Ohm, and Morore*—owned by Khurtzhals Bros., of False Bay, and situated west of and adjoining the *Venus* group. The vein conditions and mineralization are the same as the *Venus* showings. A great deal of surface work in stripping, open-cutting, and sinking has been done by the owners. Ore has been found on all the claims, but not enough work has been done to show the extent of the ore-showings nor the relation of the different showings to each other. A copper content up to 19 per cent. and gold values up to \$14 a ton have been obtained in different places, and I think the property worth a close study to determine whether or not the surface indications are sufficient to justify a small mill for the treatment of the ore.

St. Joseph. This group of three claims adjoins the *Venus* group on the east and I understand is part of the holdings of the Lasqueti Mining Company, Limited. Old reports say that ore was shipped about 1910 from workings at the beach that carried good gold values, up to \$80 a ton. Nothing has since been done on it. *Hill 60* vein on the *Venus* ground is believed to be the extension of the *St. Joseph* vein.

Tatlayoko Lake Gold Mining Co., Ltd. This company was incorporated several years ago and acquired the Morris property, 6 miles south of Tatlayoko lake. There are six Crown-granted claims in the holdings—*Copper Dyke, Copper Dyke Extension, Spokane, Isaac, Tyee, and Tatlico*. The elevation of the workings is 5,500 feet. Tatlayoko lake is drained by the Homathko river into the head of Bute inlet. The claims are inaccessible from the coast, but may be reached from Williams lake by automobile to the head of Tatlayoko lake.

W. M. Brewer, former Resident Engineer, made an examination of the property in 1921. Previous reports were made by the Provincial Mineralogist in 1910 and J. D. Galloway in 1916, to which the reader is referred for details of geology, sampling, etc. The following notes are from the previous reports: The general formation consists of argillites, quartzites, and conglomerates, intruded and intensely altered by a network of granitoid dykes and stocks. The main vein occurs in a fracture-zone in the altered sedimentaries, a granite dyke in places forming the foot-wall. The gangue or vein-filling is composed of crushed wall-rock containing some quartz and calcite stringers mineralized with pyrite, arsenopyrite, and stibnite. The vein varies up to 4 feet wide, with an average of 18 inches. The values are mainly in gold, samples from the surface assaying up to \$50 to the ton. Underground sampling shows gold values up to \$15 a ton, but averaging much lower. Two tunnels have been driven; the upper one on the main vein is in 370 feet with a couple of raises from it. The lower one has been driven 250 feet on another smaller vein about 8 inches wide. The work shows the veins to be persistent and the values consistent, but probably too low for an operation in that location.

VANCOUVER MINING DIVISION.

This Division includes the drainage areas of Jervis inlet, Howe sound, and Burrard inlet, and extends up the Pacific Great Eastern Railway to Alta lake, at the summit of the Coast range.

This group was formerly called and reported on as the *Golden King* group.
Golden Coin. It is now grouped as the *Golden Coin* and consists of the eight claims—*Golden Coin, Robbie Burns, Grandview, Derby, Devonian, Fonk, Petro, and High-*

lander—owned by the Pykett Estate; C. Anderson, of Cheekye; R. J. Carson, of Squamish, and others.

The claims are situated 10 miles up Ashlu creek, which empties into the Squamish river 22 miles above the town of Squamish on tide-water, the terminus of the Pacific Great Eastern Railway. There is a fair auto-road from Squamish to the point where the river is crossed at the old bridge, once known as Upper Squamish. From the river across the Ashlu flats, a distance of about 3 miles, there is a poor trail, overgrown in places, washed out in places, and blocked by sloughs during the high water in the rivers. After the foot of the hill is reached there is a good foot-trail to the summit at 1,500 feet elevation about 3 miles, and through to the cabin, another 3 or 4 miles, at about 1,300 feet elevation. It is advisable to make arrangements beforehand with C. Anderson, one of the owners at Cheekye, to act as guide and provide a boat to cross the Squamish river.

The predominating rock formation of the area is granodiorite here intruded by a broad belt of diabase, striking about north-south (mag.) and lying on the granite at a dip of about 45° W. On the granite-d diabase contact is a pyritized quartz vein up to 5 feet and averaging about 3 feet wide, carrying gold values associated with the pyrite. On the south side of Ashlu creek, crossed by a well-built foot-bridge, a tunnel has been driven at an elevation of 1,180 feet. It is 300 feet long, the first 170 feet following the foot-wall of the vein, gradually bearing away from it until at that point the vein is wholly above the tunnel, requiring a short raise to cut it. A few feet farther along another vein, or a faulted section of the main vein, appears in the bottom of the tunnel and is drifted on for 75 feet until it also disappears in the back of the tunnel and is likewise tapped with a short raise. A few feet farther a third vein, or fault-section, comes in the bottom and is followed to the face, a distance of 55 feet, showing a width of 2 feet of banded quartz and country-rock, 8 inches of which assayed \$2.40 in gold to the ton. Whether the three veins drifted on are parallel veins or faulted sections of the same vein has not been determined.

The vein is again exposed on the north side of Ashlu creek, 200 to 300 feet north from the mouth of the tunnel, along the west bank of a small tributary creek for 250 feet. There is therefore from 500 to 600 feet of vein exposed altogether, on the surface and in the tunnel. The pyritization is shown to be very irregular and spotty throughout, and as the gold values are only found with the pyrite they are consequently very erratic. Samples of the sulphides assay up to \$100 in gold to the ton, but they are too scarce to constitute other than low-grade average ores. Promising assays were obtained at only about three places in the tunnel, at the raises and about 25 feet back from the face. The tunnel is mainly on the foot-wall of the vein and it might therefore be worth while to crosscut the vein at intervals to be sure that no values on the hanging-wall are being overlooked.

This group of eight claims—*Brandywine, Brew, Exchange, Annie, Eureka, Pioneer, Cyprus, and Wild Rose*—is owned by Wm. Barclay, of McGuire, and partners. The claims are situated about 2 miles up the Brandywine river from the falls at the Pacific Great Eastern Railway. There is a good trail from Barclay's cabin at Brandywine Falls to the cabin on the claims at 1,750 feet elevation, or 150 feet above the railway.

The mineral-bearing formation is a light-coloured feldspathic rock forming a wide belt contained in the Coast Range granodiorite. Within this belt are zones where there has been intense shearing, in which are found quartz lenses or "veins" mineralized with pyrite, galena, and zinc-blende, carrying gold and silver values.

The "veins" are as a rule too limited in size to be important, but their gold content indicates that the area is well worth prospecting. This summer a 6-inch vein was found on the hanging-wall of a light-grey dyke, from which samples of the sulphides, pyrite, galena, and zinc-blende assayed up to \$150 in gold to the ton. Fine gold was panned from the overburden just below the vein. Such values are worth prospecting for.

This is a group of eight claims lying east of and adjoining the *Brandywine* group and owned by A. E. Snow, of Vancouver. The same conditions and mineralization are found as on the *Brandywine*. Considerable work has been done in crosscutting the formation, disclosing several small lenses of mineralized quartz carrying substantial gold values. No ore-body of importance has been developed, but surface indications warrant a lot of prospecting.

NEW WESTMINSTER MINING DIVISION.

**Harrison Gold
Mining and
Development
Co., Ltd.**

This company was incorporated in 1929 with a capitalization of 1,000,000 shares at 50 cents each, with its head office at 590 Richards Street, Vancouver. The company's holdings consist of the *Providence* group of two Crown-granted claims, *Providence* and *Silver Bell*, and others held by assessment, situated on the west side of Harrison lake, about 28 miles up from Harrison Hot Springs. It is an old property developed in 1898, when a couple of hundred tons of ore was shipped to Tacoma, assaying about \$34 to the ton in gold and silver values.

Judging by the amount of work done, some encouragement must have been obtained in the development-work. One tunnel was driven 575 feet on a pyritized vein-filling and a shaft sunk at the mouth of the tunnel a short distance from the beach. No work had been done in the tunnel to indicate that anything with possibilities had been found. Farther along the beach two more tunnels were driven, each about 60 feet, on parallel veins a short distance apart. These veins are of banded, bluish quartz mineralized sparingly in places with pyrite carrying gold values. A shaft said to be 100 feet deep was sunk on the south of these veins. The dump shows vein-matter but no ore in any quantity. The property probably justifies some surface prospecting up the hill where the high-grade float is reported found.

This group consists of the nine claims, *Mountain Goat Nos. 1 to 9*, inclusive, owned by Ed. Allison, who has a ranch about 11 miles up the Chilliwack river from Vedders Crossing, and associates. The group was bonded in the fall of 1931 to Vancouver interests, who, I am informed, are carrying out some surface-prospecting work. The claims are situated on Pierce mountain, which is on the south side of the Chilliwack river, east of Sleese creek. They are reached by a horse-trail branching from the main trail through to Chilliwack lake, a short distance east of Sleese creek, at a small cabin on the south side of the trail. At that point the elevation is 1,000 feet, at the old lean-to cabin on the claims is 4,800 feet elevation, and the showings are at 5,800 feet elevation.

The general rock formation is the Chilliwack series, of argillite, sandstone, quartzite, and interbedded conglomerates, intruded on the east by a wide stock of diorite. The mineral-showings occur in the altered sedimentaries along or near their contact with the diorite, and can be traced for a thousand feet or more, striking N. 20° E. (mag.) and dipping 80° W. The mineralization is pyrrhotite in a quartz gangue up to 8 to 10 inches wide, carrying in places bonanza gold values.

On the adjoining claims below, a 300-foot tunnel was driven following the contact-seam, encountering small bunches and lenses of quartz which, when carrying pyrrhotite, carries good gold values. The lenses are so small and infrequent that they are unimportant from an ore-producing standpoint. Going up the hill from the tunnel, other small lenses of mineralized quartz are found on the *Mountain Goat* ground assaying high in gold. At the top of the ridge where the country drops off abruptly to the creek-basin, a shaft was sunk 80 feet on the "vein," and a little farther along a pit about 6 feet deep also exposed the vein. The old timbers in the shaft would not permit of an examination of it, but very little ore was noted on the dump. In the 6-foot hole the vein was split into two 4-inch to 6-inch seams about 18 inches apart, samples from which gave varying assays up to \$70 in gold to the ton.

It will be seen from the length of the vein exposed in the tunnel and along the surface that the mineralization and consequently the values are very irregular. The only suggestion I could make was that prospecting be continued along the contact-zone in the hope of finding a sufficient concentration of mineralization to indicate a possible tonnage, and develop it. The high gold values, up to several hundred dollars to the ton, are very enticing. The borders of this mass of diorite, both in the diorite itself and formations in contact with it, should be carefully prospected for another Boundary Red Mountain mine.

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