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# Geology of Camp McKinney

and of the

# Cariboo-Amelia Mine

## Similkameen District

*by*

M. S. HEDLEY

1940


THE GOVERNMENT OF
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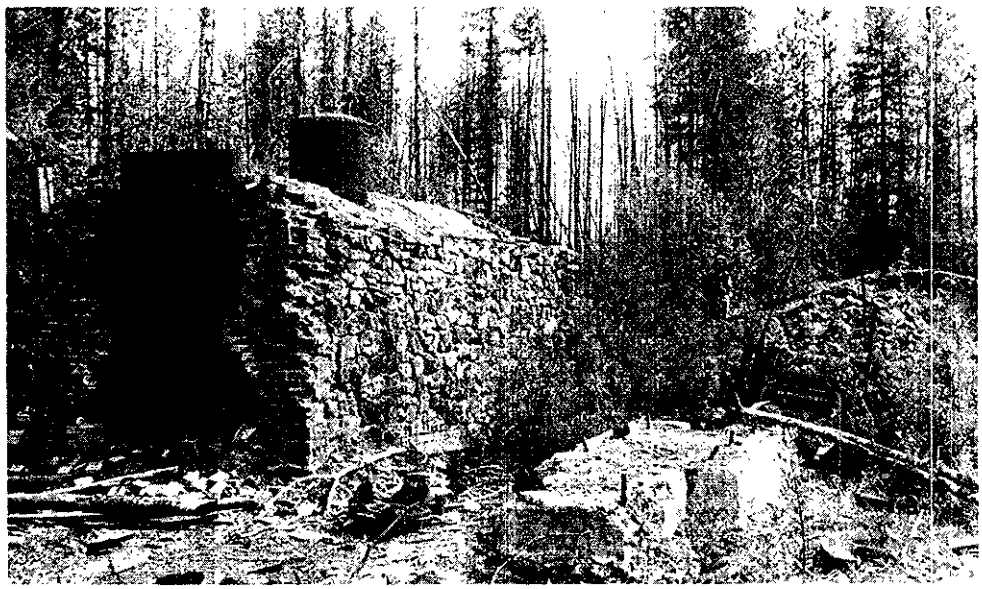
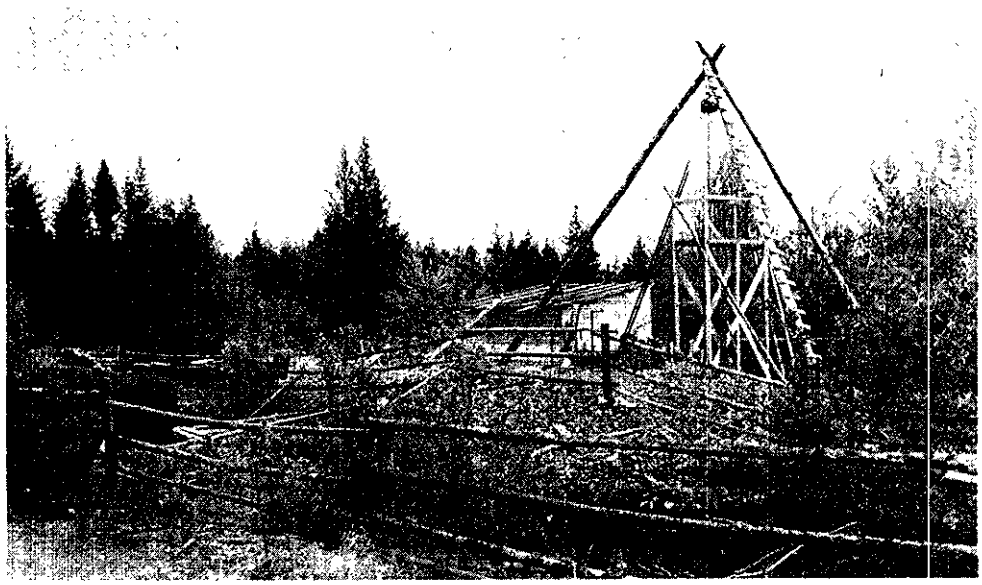
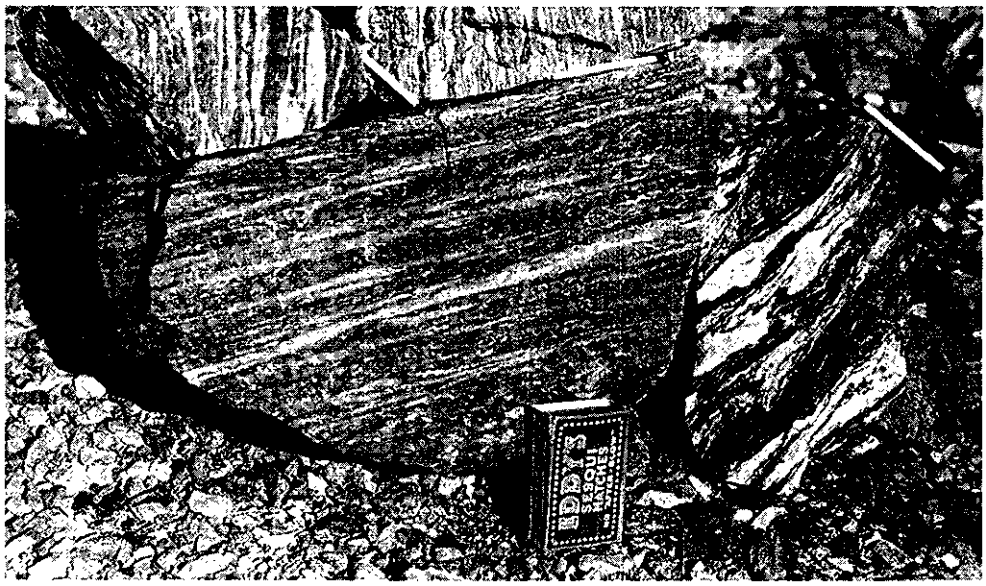


Minnie-ha-ha boiler and hoist foundation, shaft in right background.



Cariboo-Amelia shaft with pumping plant. Stope in foreground and former hoisting plant on left.



Calcareous greenstone from Cariboo-Amelia.

Banded argillaceous quartzite. Area represented about
2 1/2 by 4 feet.

CONTENTS.

# GEOLOGY OF CAMP McKINNEY AND OF THE

# CARIBOO-AMELIA MINE

## INTRODUCTION.

Camp McKinney is in the Greenwood Mining Division on Rock Creek drainage, about 9 miles north of the International Boundary and 6 miles north of Bridesville on the trans-provincial highway. A branch-road leaves the highway 3 miles east of Bridesville and passes through the camp westerly to Oliver. The camp is 6 1/2 miles from this road-junction and 22 miles distant from Oliver. Rock Creek, on the Canadian Pacific Railway (Kettle Valley Branch) is 16 miles south-east of Camp McKinney.

The camp is at an elevation of 4,400 feet on the lower south-eastern slopes of Baldy Mountain that attains a summit elevation of 7,558 feet. The local topography is one of low relief, and rises only through the Edward VII claim in a long ridge to higher summits. Elsewhere low ridges and mounds, and long slopes are characteristic. The area mapped is rocky in part and slightly higher than ground to the south-west, south and east. Mounds and ridges of glacial drift are abundant in the district and some are present within the area; the region has been heavily glaciated and only the area immediately about Camp McKinney has escaped the prevailing general coverage by glacial debris.

The main transmission-line of the West Kootenay Power and Light Company Limited passes through the camp and represents the source of power for any mining operations. Rice Creek, a tributary of McKinney Creek, flows through the camp and its rather small flow may be augmented at no great cost by diverting the waters of Upper Jolly Creek into it. The once heavily-wooded country has been badly burned over, but sufficient green timber is available for mining purposes.

Camp McKinney was, at the close of the last century, an important center of gold production. Discovered in 1887, milling commenced in 1894 and continued for ten years until 1903, when the camp was abandoned. Today, little evidence remains of the former community. It is one of the few old gold camps in which there has not been a revival of activity with the increase, in recent years, in the price of gold.

Attempts at revival have been made during the past 35

years, the last of which was by Pioneer Gold Mines of B. C. Limited, in 1939. Six months were spent in an examination of the Cariboo-Amelia mine that included dewatering, surveying, sampling and diamond-drilling. The work was followed with interest by many, as many stories of the richness of the mine, the abundance of free gold and of the reasons why it was abandoned have long been current. The results of the examination were not considered sufficiently encouraging to press active development, and the option was relinquished.

The following report is based on approximately two months' field work in 1939. Surface geology was mapped with the aid of a plane-table and a thorough geological examination was made of the Cariboo-Amelia workings with compilation on surveys by Pioneer. Examination of the mine was made possible only by Pioneer and the writer wishes to express his deep appreciation of the courtesy and friendly cooperation extended him by that company through Dr. H. T. James, Managing Director, and E. H. Lovitt who was in charge at the camp.

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## SUMMARY AND CONCLUSIONS.

The Cariboo-Amelia mine was the sole important gold producer in Camp McKinney. Production amounted to 69,581 ounces of gold and 5,359 ounces of silver from 123,457 tons milled, the bulk of which came from the central and eastern sections of the mine. The average recovered value was in excess of: Gold, 0.56 oz. per ton. The mill went into production in 1894 and before abandonment in 1903 all readily-available ore was mined out.

The geology of the camp comprises a finely-banded sedimentary series of many rock-types of which the commonest are quartzite and greenstone. The greenstone, so-called because the name is descriptive, is, at least largely of sedimentary origin, and includes a peculiar, finely-banded rock which contains a variable and locally high percentage of carbonate. This rock, probably representing a calcareous tuff, is in this

report termed calcareous greenstone and is a characteristic and important member of the series. A large body of granodiorite which occupies the basin of McKinney Creek is intrusive into the bedded series.

In the western part of the area the rocks are folded into an irregular, overturned syncline. The prevailing strike in other parts of the mapped area is north-westerly and the dip is steep north-eastward; minor plication is common and one pronounced structural flexure exists east of the Cariboo workings. Faulting has been intense.

The Cariboo vein is a persistent, rather narrow, quartz-filled fissure, mineralized with pyrite, sphalerite, galena and chalcopyrite, of which pyrite is by far the most abundant. The vein crosscuts all rock-types, commonly at a large angle; the strike is westerly and the dip vertical to steep southward. Little is known of other veins in the camp.

The geology is complex in the Cariboo-Amelia mine. Faults are numerous and many displacements measure from tens to hundreds of feet. Offsets of the vertical vein are no measure of the actual amount of displacement on the fault-planes. A flat to eastward-dipping system represents a thrust of the hanging-wall north and west, in one case of some 400 feet. A major eastward-dipping fault is later and has produced an opposite displacement of comparable magnitude. It has been found impossible to solve completely the various fault problems or even to trace individual sedimentary bands through the mine. It is impossible to work out satisfactorily the distribution of ore-shoots. Of the factors influencing deposition, the character of the wall-rock appears to have been the most important, and it is a significant fact that the most productive stopes are in greenstones. An eastward rake of the workings is due to the eastward dip of the structure, and also to the eastward dip of prominent faults, but no clue is given as to possible favourable horizons in the vein, about which there remains considerable uncertainty.

The vein has been traced underground for a length of 2,000 feet. It extends as far west as the Emma and probably the Maple Leaf, a total length of about 3,000 feet; correlations farther afield, with the Eureka and Waterloo, are too uncertain to be considered. The vein crosses a heterogeneous rock series, parts of which are favourable and parts unfavourable, within the mined section and also to the east and west. Exploration has extended to a depth of 530 feet, but, if certain faulting is correctly interpreted, the effective depth of development on the vein is only about 350 feet below the surface horizon.

Diamond-drilling by Pioneer Gold Mines of B. C. Limited at the eastern end of No. 4 and No. 5 levels, in the direction indicated by fault movement, failed to locate the eastern continuation of the vein. Drilling from the surface on the Amelia and Wiarton claims located quartz of reported high-grade in one short section only. Diamond-drilling was done by Bralco on the west in 1934.

A structural flexure exists on the surface east of the mined section. In this flexure, bedding strikes easterly and is hence parallel in strike with the vein. In the eastern face of No. 2 level the vein rolls into a bedded shear-zone and is weak, and it is possible that a weak section of the vein lies for some distance to the east. Faulting, however, complicates the picture and the location and effect of this flexure at the various levels cannot be predicted.

If the same conditions of mineralization are to be expected, namely, rich ore-shoots in favourable belts of rock, then there appears to be promise for exploration towards the east and west where, on the surface, favourable rock is seen to exist. Faulting makes the accurate projection of rock-types a difficult if not impossible task, and projection of only the most general sort can be attempted.

The western section of the mine is indicated to be low in grade. Exploration to the west seems a relatively simple matter but promise of immediate reward is slight. Better opportunities are indicated to lie towards the east. Exploration of the central section at greater depth is not feasible owing to the presence of an unfavourable rock horizon that dips eastward beneath that section, and the downward continuation of the eastern section is complicated by major problems.

The condition of the mine workings make for expensive exploration from the existing faces. The small size and poor condition of the shaft, lack of trackage, the need for local timbering and general reconditioning, all point to a necessary, high initial expenditure preparatory to extension of existing workings.

The vein is known to be about 3,000 feet long and has been developed to a measured depth of 530 feet, which represents an effective depth below the surface horizon of only about 350 feet. The greater part of 70,000 ounces of gold came from the central and eastern sections, and it would be extraordinary if these were the only profitable sections, and that the vein should play out, both at the explored depth and at the eastern limit of the workings. Projection of the most general sort shows favourable ground to exist to the east

and west, but exploration through present workings is costly and quick return is not to be expected. Development to the west is straightforward but the riddle of the easterly continuation of the vein has not been solved.

## GEOLOGY.

### General Geology

The south-eastern slopes of Baldy Mountain are thickly overlain by glacial deposits and it is only near Camp McKinney, over an area that is largely covered by Fig. 2 that rock-exposures are at all numerous. Even in this relatively rocky area there is much glacial material and overburden. Geological study is consequently handicapped and many problems of lithology and structure must remain obscure.

The rocks in the area under consideration are members of the dominantly sedimentary Anarchist series, intruded on the west and south-west by granodiorite correlated by Cockfield (1935, p. 12) with the Osoyoos batholith. Numerous dykes, of differing character and age, cut both the granodiorite and the older rocks.

The older rocks are, in large part at least, of sedimentary origin. They include quartzites, impure quartzites, greenstones, amphibolitic rocks, limestone and many intermediate and intergrading types. All are interstratified and most of them are clearly and finely-banded. Alteration of these rocks has been extensive but there is, properly speaking, but little schist developed, and no hornfels or metamorphic rock formed under conditions of extreme heat and pressure.

The quartzites are light-coloured grey rocks of fine grain. They are strongly recrystallized and are finely-banded, the banding evidently representing original, closely-spaced bedding planes. These bands are composed of biotite and of dark argillaceous matter, and are very thin in the purer quartzites. Biotite is present also in small amounts throughout the rocks generally, and tends to be oriented parallel with the banding but not well enough or in sufficient quantity to produce a mica-schist. Impure quartzites are grey, striped rocks characterized by alternating bands composed essentially of quartz and of dark, argillaceous material. Such rocks are referred to as argillaceous quartzites, and are of common occurrence.

Quartzites are intergradational with all other banded rocks in the area, even locally with limestone. Rocks mapped as quartzites to avoid confusion include argillite, quartz-

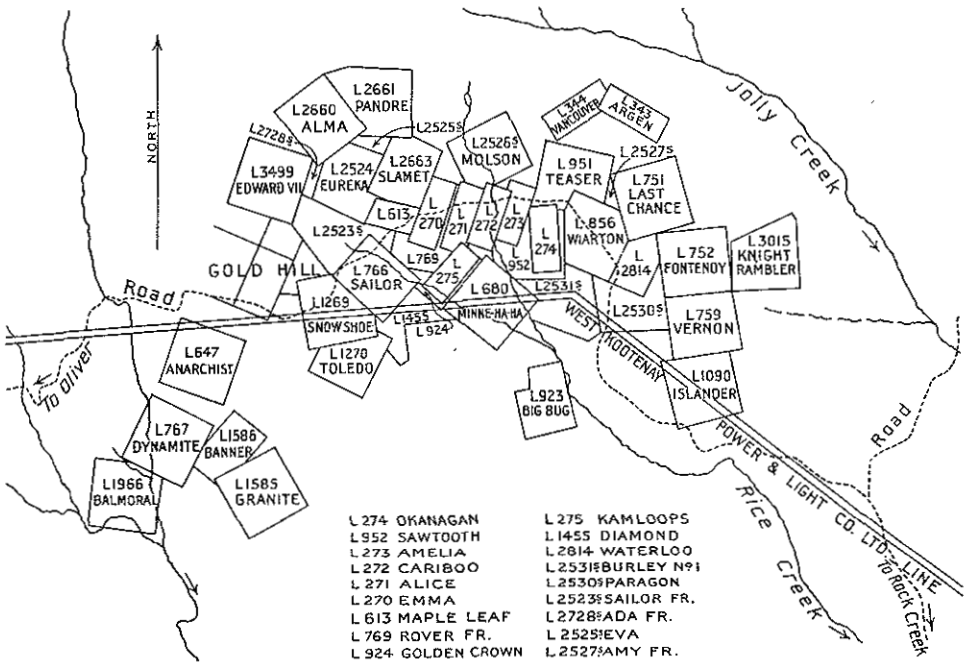


Fig. 1. Key map of Camp McKinney showing principal surveyed claims.

biotite rocks, and a variety of hard and soft, finely-granular rocks, all banded and including a very few schistose types. These represent originally silty sediments.

Quartzites and argillaceous quartzites are most abundant on the west and south-west, where there is a considerable thickness free from irregularly-spaced bands of different rock-types. Elsewhere interbanding of greenstones and calcareous rocks is common.

In the western part of the area, particularly on the Wiarton, rocks so grouped contain little pure quartzite but are difficult to classify. Besides argillaceous quartzites they include soft-grey quartzose rocks, and a variety of sediments, formerly silty to calcareous, now metamorphosed to micaceous and locally amphibolitic rocks.

Greenstone is common throughout the greater part of the area. The name implies a green hornblendic to chloritic rock of andesitic composition and, as commonly used, refers to an extrusive rock. In the Camp McKinney area there is no rock

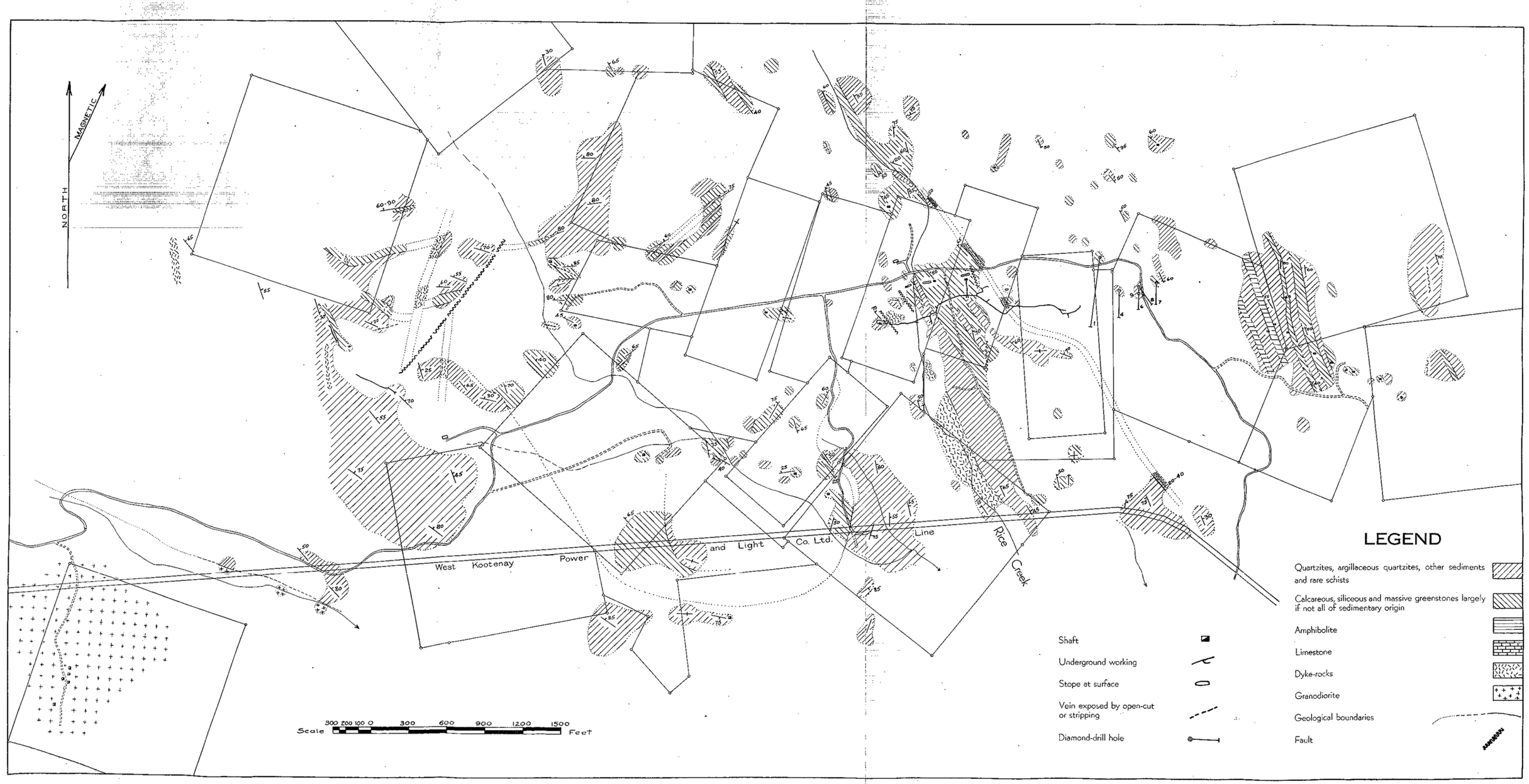


Fig. 2. Surface geology of Camp McKinney showing surface workings and No. 4 level of Cariboo-Amelia Mine.

that can be clearly proved to be lava, although locally there is massive green rock that might represent lava and certainly contains the mineralogical constituents of an andesite. The greater part by far of the rocks here termed greenstones are banded rocks interbedded and intergradational with other members of a sedimentary series. Characteristically they contain a moderate to high percentage of carbonate as original, finely-banded material. When the carbonate is clearly visible the rocks are termed calcareous greenstones.

Massive greenstone is found in the Cariboo workings where it has the appearance of normal andesite. Microscopic examination verifies this, but nowhere has it been possible, either underground or in rare surface outcrops, to demonstrate whether this rock is extrusive, intrusive or even tuffaceous. The remainder of the greenstone, constituting by far the larger part, seems clearly to be a sedimentary rock.

Calcareous greenstone is, by inference rather than by direct proof, a tuffaceous sediment and this name is given it, even though possibly misleading, because of the difficulty of separating the obviously sedimentary material from that more massive greenstone which might have a (somewhat) different origin. The typical rock is green in colour and finely-banded, with as many as 10 or more bands to the inch. The bands are of light-coloured to white calcite and dark chloritic material. A typical thin-section under the microscope shows the dark bands to consist of feldspar (oligoclase) and a considerable amount of chlorite, iron oxide and vague, dusty material; the lighter-coloured material is calcite containing rare, scattered grains of feldspar. There is little or no quartz present. The bands are clean-cut and there is very little gradation between them. Such an assemblage and distribution of minerals seems to indicate a tuffaceous origin; further, it indicates original alternating deposition of lime and of finely-granular andesitic material.

This clearly sedimentary calcareous greenstone grades from material containing 75 per cent. or more of calcite to banded green rock containing little or no calcite. The same greenstone, whether calcareous or not, is locally interbedded with quartzites and argillaceous quartzites, in bands as little as a foot in thickness; some contains a siliceous rather than a calcareous banding and may be termed siliceous greenstone.

The greenstones in the central and western parts of the area are hornblendic rocks and any chlorite present seems to have been derived from hornblende. In the eastern part, on the Waterloo and Last Chance claims, greenstone bands con-

tain no calcite, are composed largely of shreddy amphibole of secondary origin, and may represent in part at least metamorphosed impure calcareous sediments. This point is not clear and they are grouped under the same heading, more particularly because physically they appear to be very similar.

Rocks rich in amphibole occur on the Wiarton claim and are mapped as separate units. These are striped rocks containing an appreciable amount of fibrous amphibole and represent calcareous silty sediments, now altered wholly or in part to amphibolite.

Although there is much carbonate in this part of the series, some of which is now altered, there is very little limestone. Narrow bands of limestone alternating with quartzite, argillite and greenstone in a dominantly greenstone section, occur at the north-western corner of the Cariboo claim, and limestone and argillite are seen to the north of the Amelia claim, but none of this limestone is prominent. The only prominent band, 20 to 30 feet thick, passes through the Amelia claim, and is mapped separately.

The area is intruded on the south-west by a large body of granodiorite, correlated by Cockfield (1935, p. 12) with the Osoyoos batholith. It is a fresh-appearing, grey, granitic rock the contact of which with the sedimentary series is only seen in two small outcrops. The body is approximately 2 miles wide and several times that length in a north-westerly direction.

Dyke-rocks are numerous and may be divided into three general groups. The members of one group cut the granodiorite but seem closely related to it; they include feldspar-porphyries, granodiorite and diorite, and occur in the western part of the area in bodies as much as 30 feet or more wide. Members of the second group are commonly strongly altered so that precise determinations are difficult. They are of rather fine grain, not prominently porphyrytic and are largely dioritic in composition. They occur throughout the area and many are encountered in the Cariboo workings; one large body occupies the bed of Rice Creek and is as much as 200 feet wide. Dykes of the third group include diorites, some of which are hornblende-porphyries. They cut the quartz veins and resemble some of the Tertiary lavas and are probably Tertiary in age.

Metamorphism

The banded rocks, with rare exceptions, are not schistose.

Earlier reports refer to them as gneisses, which is a misnomer, as the original character is in most cases plainly evident, and the texture is not gneissic. Quartzite so highly altered as to merit the term gneiss is seen only within a short distance of the granodiorite contact. Metamorphism is marked, but is of the regional and hydrothermal type, embodying recrystallization and silicification; sericitization is marked on vein-walls but is restricted to the immediate vicinity of veins. All rocks have been strongly recrystallized, but with the exception of the amphibolites no new rocks have been formed.

Contact metamorphism by the granodiorite is of restricted extent as already noted. Another effect of the granodiorite is to be seen in that large area of greenstone near the southern part of the Sailor, where many tiny stringers of aplite cut the rocks. Many of the dykes of group 2 have irregular boundaries and, particularly in the case of the large dyke in Rice Creek, tend to grade into the surrounding rocks. Hydrothermal alteration is believed to have been widespread, either accompanying or following regional metamorphism, and of this alteration silicification is the most important and prominent.

Silicification has been intense and widespread in the south-western corner of the Slamet claim. It is believed that here the greater part of that large single area mapped as quartzite is a product of silicification. The evidence lies in the fact that this body is almost entirely composed of quartz which, although granular and faintly and finely-banded, is different from the quartz of any known quartzite. At the southern end the quartzite appears to crosscut the bedding of a band of greenstone and on the western margin a greenstone band is seen to become progressively more siliceous, narrower, and to die out. Microscopic examination of this latter greenstone shows intense replacement by quartz.

A second major area of silicification is found in the structural flexure on the Okanagan claim. Here the rock appears originally to have been quartzite in large part, but clearly banded with argillaceous material. On the flexure this rock is now composed almost entirely of quartz and the bedding is almost completely obliterated.

Irregular masses of quartz occur near the north-western post of the Cariboo claim, northerly from the main shaft and southerly from the Cariboo dump. These masses may, in a sense, be considered as vein-quartz, but the lack of form and continuity and the merging with surrounding rock strongly indicates some replacement. Similar quartz masses or quartzose zones are seen in other localities. It is not known what relation there may be, if any, between silicification and vein-formation.

## Structure

The sedimentary series represents a great thickness of finely-bedded rocks. Although a division has been made into two main rock-types, this is only arbitrary, and is made for clarity of description. The material as originally deposited consisted of intercalated sands, silts, shales, marls and presumably tuffaceous (andesitic) material, in varying degrees of purity and in many cases intergradational. The prominent feature of this assemblage is the fineness of the bedding which in some cases is of microscopic thickness.

As previously stated, some of the massive greenstone may represent igneous rock, but all appears to be bedded. The abnormal rock-type termed calcareous greenstone is a distinct and characteristic member of the series.

Lack of distinctive horizons, heavy cover, and much faulting make measurements of thickness impossible and study of the structure extremely difficult.

The general strike of the sediments is north-westerly and the dip north-eastward, but there is both major and minor contortion. There is an irregular synclinal fold that passes through the Sailor and Maple Leaf claims. This is an overturned syncline with a steep north-westward plunge and a steep north-eastward dip. Study of Fig. 2 shows the presence of this structure and its great irregularity, but faulting, some proved and some a necessary postulation, makes complete analysis impossible.

The sediments in the eastern part of the area maintain the regional attitude with only minor deviations. The most prominent minor folds are a flexure passing through the Okanagan claim and another north of the Cariboo, on the northerly side of Rice Creek. Elsewhere there are a few, apparently unimportant, changes in strike and dip but in many places the thinly-banded rocks are seen to be crenulated, plicated and locally brecciated.

Faulting has been widespread and intimately affects the progress of mining. The complicated system of faults, including low-angle thrusts of large movement, that occur in the Cariboo workings, will be discussed in detail in a later section. It should be noted that these faults have little noticeable effect on the surface distribution of rock-types in the vicinity of the Cariboo, a fact that is of great importance when attempting to correlate individual horizons and to project horizons at depth.

Apart from those faults traced from underground only one fault is demonstrated on the surface, namely that to the east of Edward VII claim. Other important faults undoubtedly exist, but there is no direct proof of their occurrence or exact position. Two prominent gullys south of the Cariboo dump and extending southerly towards the power-line probably indicate faults. Several northerly-trending gullies on the Wiarton, Waterloo and Fontenoy claims also probably indicate faults.

Economic Geology

Mineralization is confined to quartz veins in which the most abundant mineral is pyrite. Lesser amounts of sphalerite, galena, chalcopyrite and rarely tetrahedrite and pyrrhotite are also present. Native gold is reported to have been prominent in some veins, notably the Cariboo and Waterloo. The most prominent veins strike easterly and cut the bedded series commonly at large angles. Other, less important veins strike at different angles and some follow the bedding. All but the latter dip steeply.

The veins are quartz-filled fissures with, commonly, free walls. They range in width from 1 inch to 10 or more feet, and variations in form, attitude and metal content occur along both strike and dip. Some small stringers are frozen in quartzite and of these some have the appearance of having been formed during metamorphism of the rocks; the quartz having been derived from the rock body itself. This point is not clear, however, and such stringers may be true veins or may be related to processes of silicification, as contrasted with fissure-filling. It is not known, moreover, what relation there may be, if any, between fissure-filling and the prominent regional silicification noted in a previous section.

The quartz veins bear different relations to the walls depending on the character of the wall-rock. They are for the most part free, as already noted, but in the more quartzose rocks the veins tend to merge with the walls and to penetrate them with small and irregular offshoots. In calcareous greenstones of the Cariboo workings the vein occupies a clean-cut fissure. The vein tends to be somewhat more irregular in finely-banded argillaceous quartzites and grey silty sediments, and, in quartzites, tends to grade into shattered walls. In the same workings a band of soft biotite-bearing sediments fails to maintain the vein structure.

Quartz veins cut all principal rock-types, including granodiorite. Rare dioritic Tertiary dykes are post-mineral. Wall rocks, except in the siliceous sediments, are strongly

altered. This has been a process of sericitization, accompanied by the formation of small amounts of calcite and quartz. In the siliceous rocks alteration has been by silicification which failed to replace the darker argillaceous material in the walls of the vein.

## HISTORY.

Gold was mined as early as 1860 from the placers on Rock Creek and its tributaries but the first discovery of lode-gold was made with the staking of the Victoria claim on upper Jolly Creek in 1884. The Cariboo vein was discovered three years later and immediately attracted considerable interest. In spite of the fact that access was only by trail for several years thereafter, a considerable amount of work was done on this and other showings in Camp McKinney.

The history of the camp is largely that of the Cariboo-Amelia, the only successful mine, but several other properties received attention. Prior to 1894, when the Cariboo mill was installed, shafts were sunk on the Eureka, Alice, Emma, Maple Leaf, Fontenoy, Anarchist and other claims. Later when the Cariboo commenced paying dividends, the Minnie-ha-ha, Sailor and Waterloo were developed in an attempt to establish another producer in the camp.

The Sailor and Minnie-ha-ha properties were consolidated in 1900 and a 5-stamp mill was in operation for three weeks in March of that year, after which date the property closed and the shafts filled with water. A 5-stamp mill was erected on the Waterloo in 1899; it ran for a month only in that year, spasmodically in 1900 and closed down for good after a revival of interest in 1902. The Fontenoy shaft was deepened in 1899 and a shaft was sunk on the Kamloops during the same year.

The Cariboo and Amelia claims were incorporated at an early date and were developed from the time of discovery. An adit was driven and two shallow shafts, and, later the main shaft was sunk. In 1894 the Cariboo Mining and Milling Company of Spokane erected a 10-stamp mill which was in operation by May the first, producing both bullion and concentrates. During the next few years the annual production was in excess of $100,000 per year, the recovered value per ton rising from about $11 in the original workings to $17 or $18 at depths to 175 feet. Gold was valued at $20 an ounce.

In 1898 the company's name was changed to Cariboo-McKinney Mining and Milling Company Limited of Toronto, when in addition to the Cariboo and Amelia the company owned the Alice,

Emma, Maple Leaf and Sawtooth, and held a controlling interest in the Okanagan. The milling capacity was increased to 20 stamps late in the same year.

The following year, 1899, the grade of ore was somewhat reduced owing, according to the old reports, to the inclusion of much rock from development work. The cost of development was heavy and diamond-drilling was resorted to. Dividends reached a total of $459,337 by the end of 1900, and only $50,000 additional was paid in succeeding years (in 1902). Operations were suspended at the close of 1903.

A few years after the Cariboo-McKinney Company closed down other interests dewatered the shaft to the No. 4 level, but when it was discovered that the old stopes were largely exhausted the mine was allowed to fill again.

A revival of interest took place in 1917 and 1918 when the West Kootenay Power and Light Company's transmission line was built. The Consolidated Mining and Smelting Company of Canada Limited optioned twenty-nine claims in the camp and carried out some surface exploration. At about the same time two men worked over part of the tailings dump and shipped nine tons of concentrates.

The Waterloo and Fontenoy shafts were dewatered in 1929 by Charles F. Law of Vancouver, but no work was done. In 1932 and succeeding years the Gold Hill group north-westerly from the Cariboo holdings was developed by Camp McKinney Gold Hill Mining Company Limited under the direction of John Carmichael. A forest fire swept the entire area in the same year, destroyed all that remained of Camp McKinney and burned the collars of the shafts.

Bralco Development and Investment Company of Vancouver optioned the Cariboo holdings and a number of other claims in 1934; the claims were re-surveyed and some little surface work was done. Five diamond drill-holes were put down to explore the western extension of the Cariboo vein, but the option was dropped.

In 1939 Pioneer Gold Mines of B. C. Limited optioned the Cariboo-McKinney, Sailor, Wiarton and other holdings and dewatered the Cariboo mine. Work started on April 25th and progressed until October, when the option was relinquished. The Cariboo workings besides being dewatered, were surveyed, sampled and thoroughly examined. Some diamond-drilling was done underground and several holes were put down from the surface. At the close of 1939 the Cariboo mine was filling with

water for the third time in fifty years.

Late in 1939, after Pioneer relinquished their option other interests obtained a lease on the Wiarton and sank a shaft down a vertical diamond-drill hole put in by Pioneer. Results of this work are not known.

The total production from the Cariboo property amounted to 69,581 ounces of gold and 6,359 ounces of silver from 123,457 tons. Some details of mining and milling as gathered from the old reports may be of interest, because practically all available ore was extracted before the mine was abandoned and the following general figures help to tell the story of the open stopes.

Ten stamps were in operation at a capacity of about 7,000 tons a year from May 1894 to October 1898, when the mill was increased to 20 stamps and the capacity to between 15,000 and 16,000 tons a year. Concentrates were shipped throughout the operating period in the ratio of 1 ton to every 25 or 30 tons of ore milled. The greater part of the recovery was in bullion of a fineness of 635 gold and 340 silver (1897 figure) and about 13 or 14 per cent. of the total was recovered in the concentrates. Figures are incomplete but the percentage value in the concentrates seems to have ranged between 7 and 20; the smaller figure is for 1895 and the larger for 1902, which may account for the unsubstantiated reports that the percentage of free gold decreased with depth. The data are actually too meagre to make any such generalizations. Value of the concentrates seems to have ranged between $40 and $80 per ton; in 1897 a typical assay was 35 per cent. iron, 9 per cent. silica, and less than 10 per cent. zinc.

There are no figures on the tailings losses other than that, in 1902, 12.8 per cent of the gross value was so lost, amounting to $1.27 on $9.96 mill-heads.

There is current a belief that the tailings carry several dollars per ton at present prices, and several attempts have been made to reconcentrate the old dumps, but these attempts were short-lived. Two liberal cuts through the main body of the tailings pile, taken by the writer, assayed each: Gold, 0.08 oz. per ton. The grinding was coarse, and certainly a better recovery is to be expected by modern methods of milling.

The recovered value of all ore milled was in excess of 0.56 oz. in gold per ton, with an additional almost negligible amount of silver. The highest grade of ore was obtained

prior to 1900, attaining in one year a recovered value of about 1.0 oz. in gold per ton. In later years both low-grade material and development-rock were put through the mill, and there is no reason to suppose that the stopes on No. 5 and No. 6 levels were not as rich as many closer to the surface.

Mining costs (in 1897) were $4 and milling costs $2 per ton. Freight and treatment on concentrates amounted to $19 per ton. In the same year freighting charges from Penticton were $30 to $35 per ton. Firewood for the boiler plant cost $1.75 per cord.

The method of mining can only be guessed at but, judging from the number of stulls present, full shrinkage-stoping was not employed. Although all stopes were cleaned and some filled there is evidence of platforms and "catwalks" to indicate that many stopes were open or partly open during the progress of mining. All stulls were set solidly in deep hitches, indicating great labour and no small cost. Ore was hoisted one car at a time and trammed 400 feet to a surface bin and an additional 400 feet to the mill.

Stopes were extended right to the main shaft, so that in those sections that follow the vein there is virtually no shaft left. The general condition of the mine when dewatered was good. All timber below the adit-level was sound, although all nails were gone, making ladders and chutes unsafe. There was very little dangerous ground in the stopes; the vein-walls are smooth and are not sheeted or slabby. There was a cave on No. 4 level east of the shaft some 100 feet long owing to sloughing of ground beneath a large flat fault above the back of the tunnel. Caving from the surface above No. 3 level west resulted in the accumulation of some rock and surface sand and gravel on No. 4 level west that nearly filled the tunnel in some places.

## DESCRIPTION OF PROPERTIES.

ANARCHIST. This crown-granted claim, last owned by James B. Rowley of New Westminster, lies to the southwest of Camp McKinney proper on a hillside that slopes at a low angle to the south. It is wholly within granodiorite.

One of the earliest claims in the district to receive development, the Anarchist never produced and has long lain idle. In the early spring of 1939, Mining Corporation of Canada dewatered the two deeper shafts and thoroughly sampled all showings. Results were not sufficiently interesting to warrant de-

velopment, and the shafts had again filled by the time of the writer's examination.

There are two vertical quartz veins from 40 inches to 10 feet wide. These are nearly parallel, are about 50 feet apart, and strike on an average north 20 degrees east. The quartz is almost barren and is characterized by prominent partings of sericite locally very closely-spaced and parallel to the walls. Sparse mineralization includes pyrite and rarely any chalcopyrite, galena and tetrahedrite.

A shaft sunk on the eastern vein, elevation of 4,285 feet, is perhaps 30 feet deep. The vein as seen at the collar is 4 1/2 feet wide and consists of well-banded quartz. Two pits and some stripping lie 70 and 120 feet to the south where two faults have offset the southern block a few feet to the east.

A shaft about 30 feet deep on the western vein, is 320 feet southerly from the upper shaft and is at an elevation of 4,235 feet. The banded quartz is about 6 feet wide. This vein is exposed by an open-cut 75 feet southerly and approximately 200 feet northerly and attains a maximum width of about 8 feet. It is faulted in a manner similar to the other vein. Old reports refer also to flat faulting.

GOLD HILL. This group of eight claims, the outline of which is not fully shown on the map, lies south of the Edward VII. It is owned by Camp McKinney Gold Hill Mining Company Limited, 703 Dominion Building, Vancouver, B. C. Work commenced on this property in 1932 and included sinking a shaft, driving an adit, and re-examination of old showings. No work was being done in 1939. A 60-foot shaft, reported to be on Gold Hill No. 4 claim, was not seen by the writer.

A frame-building is at the end of a short branch-road and a blacksmith-shop is at the adit portal. The adit is on the Little Billy claim a short distance north of the cabin. The rocks are chiefly quartzites but include narrow bands of greenstone; a number of dykes cut these rocks.

The adit, elevation 4,540 feet, is driven in an average direction of north 64 degrees west for 340 feet. It commences as a drift on a quartz vein, strike north 48 degrees west, dip 70 degrees north-eastward, which is followed for 60 feet. This vein is 40 to 48 inches wide, is essentially parallel to the quartzites, and consists of dense white to bluish chalcedonic quartz; very scanty mineralization includes pyrite and pyrrhotite. Twenty feet in from the portal the vein narrows

to 12 inches and at 60 feet fades out into silicified rock; several small north-south faults offset the inner segments to the north.

The adit then trends north 75 degrees west for 150 feet, encountering some sheared ground and short sections of quartz up to 10 inches in width. The innermost 130 feet follows a slip that strikes north 58 degrees west and dips 70 degrees north-eastward; there is a discontinuous and narrow quartz stringer in the foot-wall of this slip. The rocks include argillaceous and impure quartzite and some banded greenstone; sheared ground is encountered throughout the adit.

A series of pits and open-cuts, elevation 4,645 feet explore a 200-foot length of vein 175 feet south-westerly from the Edward VII; the vein strikes north 75 degrees east and dips 75 degrees southward. The best quartz is seen in an 8-foot pit, where the vein is 20 to 36 inches wide on the foot-wall of a shear-zone 3 1/2 to 4 1/2 feet wide. In the other showings, some of which are caved, the vein is as narrow as 9 inches. In the 8-foot pit the quartz contains trains and masses of pyrite which are shattered and veined with quartz. A sample chipped across 28 inches on the eastern end of the pit assayed: Gold, trace; silver, trace. A sample of selected material from the dump assayed: Gold, trace; silver, trace.

An old shaft, perhaps 20 feet deep, is 380 feet south-westerly from the above pit. It is in greenstone, and there is a little quartz on the dump. An adit, 175 feet north-westerly from this shaft is driven 132 feet in an average direction of north 27 degrees west. The adit seems merely exploratory, starting on the foot-wall of a greenstone-quartzite contact that strikes about north 40 degrees west and dips steeply north-eastward. No vein is disclosed.

EUREKA AND SAILOR FRACTION.

On the Eureka claim 250 feet westerly from the Maple Leaf is an old shaft, elevation 4,572 feet, the collar of which is caved. This shaft was apparently sunk in 1889. The Annual Reports, Minister of Mines, British Columbia, state that the depth of the shaft is 159 feet and a drift 112 feet in length exists at the 80-foot level. The vein is as much as 9 feet wide, with only local values, and flat faults are encountered that displace the lower segment of the vein to the south.

The dump is largely quartz that is for the most part barren; there is one pile of quartz well mineralized with pyrite

and a little chalcopyrite. The evidence points to a large vein with only local sulphide. A sample of the best mineralized quartz assayed: Gold, 0.26 oz. per ton; silver, 0.8 oz. per ton.

A series of strippings, open-cuts and one 20-foot shaft extends from near the main shaft for 200 feet in a direction south 68 degrees east, beyond which point the vein is traced an additional 50 feet south 45 degrees east. In the north-western section of these workings the vein is from 4 to 6 feet wide and in the south-eastern, it is from 1 to 3 feet wide. The vein is in greenstone and contains little mineralization.

This vein may or may not be the same as that on the Maple Leaf, which may or may not represent the westerly continuation of the Cariboo vein.

On the Sailor Fraction, just north of the Sailor corner-post is an old shaft perhaps 50 feet deep, now inaccessible. It is timbered to the surface and surrounded by a dump. The dump consists of finely-banded and contorted argillaceous quartzite, much of which contains graphitic partings and some contains irregular, glassy, injected quartz. A mass of quartz 5 by 7 feet, trend east, is just to the west of the shaft and may represent the vein but there is nothing on the dump to suggest that a vein or any minerals except sparse pyrite were encountered. Open-cuts for 300 feet to the east are in drift only.

Westerly from this shaft, on the small creek, is some old and some recent stripping and open-cutting about 70 feet in length on a vein which strikes south 70 degrees east and is apparently nearly vertical. The quartz is about 5 feet wide, although poorly exposed; it varies in appearance, from white and coarsely-crystalline to bluish and dense. Mineralization is largely restricted to the eastern end, and consists of pyrite and sparse chalcopyrite; some massive pyrite has come from a pit 20 feet from the eastern end and a sample of this from the dump assayed: Gold, 0.06 oz. per ton; silver, 0.4 oz. per ton. The vein has not been located to the west under a cover of glacial drift.

SAILOR AND MINNIE-HA-HA.

Considerable work was done on these claims which were amalgamated in 1900 as the Sailor Consolidated Gold Mining and Milling Company, of Toronto (c/o the Trusts and Guarantee Company Limited, Toronto). A 5-stamp mill on the Minnie-ha-ha ran for three weeks in March 1900 and the property closed down later in the same year.

The Minnie-ha-ha shaft, elevation 4,325 feet, is reported to be 200 feet deep, with 600 feet of drifting at the 100-foot, 150-foot and 200-foot levels. The collar has been burned and all that can now be seen is 6 to 8 feet of rock above water and debris. The rock is greenstone, cut by minute quartz-feldspar veinlets; under the microscope it is seen to contain considerable calcite which occurs principally in large grains and appears to be in part at least secondary. The strongly bleached vein-walls have been altered with a breaking down of original constituents and formation of sericite and calcite and perhaps some secondary quartz; there is a little pyrite in this wall-rock.

The vein strikes north 80 degrees west and dips 80 degrees northward in the short distance exposed. It consists of 6 to 12 inches of quartz on the east side of the shaft and of a narrow shear-zone on the west side; there are a few quartz stringers in the foot-wall. A little pyrite and small amounts of galena are seen; there is no ore on the dump so that little can be learned of the nature of the mineralization. A shallow open-cut 30 feet to the east discloses similar quartz.

The Sailor shaft, elevation 4,385 feet, is reported to be 175 feet deep with levels at 75, 100 and 150 feet; at the 100-foot level, 200 feet of drifting is reported to have been done on a vein about 4 feet wide, and at the 150-foot level 140 feet of drifting follows a "much broken" vein.

The shaft is in flat ground with no outcrops close by and is caved so that nothing but a depression in the dump is seen. The rock on the dump is all greenstone with the exception of a little quartzite. It is reported that the vein as exposed consisted of 5 to 6 feet of rather barren quartz and that a discontinuous pocket, relation unknown, near the shaft-house contained good values in gold. This appears to be borne out by the fact that on the dump a pile of well-mineralized quartz (about 3 tons) seems to have come from near the surface, and the remainder of the quartz is almost barren. Some is glassy, much is frozen to greenstone and some contains chloritic partings. Sulphides include pyrite (some of which is shattered, and veined with quartz), fairly prominent galena, and small amounts of sphalerite and rarely chalcopyrite.

Small open-cuts some 100 to 150 feet easterly show a little narrow quartz and quartzose material only.

KAMLOOPS. This claim, owned by James L. Grant, Rolla, B. C., lies between the Sailor and Minnie-ha-ha but was developed separately by the McKinney-Kamloops

Company, of Montreal, and closed down in 1900. A shaft is reported to be 100 feet deep and from it 75 feet of drifting was done.

The collar of the shaft is visible and is in banded greenstone which dips flatly northward. No vein was seen. A 20-foot shaft 80 feet to the south-west is in quartzite and encounters very little quartz.

WIARTON. This claim is owned by Camp McKinney Development Company, c/o D. S. Wallbridge, Yorkshire Building, Vancouver, B. C. The only workings are near the Waterloo-Last Chance corner-post. Here, west of a prominent north-south gully that may represent a fault, the rocks consist of impure quartzites and interbanded amphibolite. Three old shafts were apparently sunk on the formation since they show no evidence of a definite vein and are too far north for the continuation of the Waterloo vein. The westernmost shaft is perhaps 40 feet deep.

A shaft was sunk in the north-westerly part of the claim in 1939 (see below).

On the Last Chance, immediately east of the same gully, is a 15-foot pit on a zone of alteration and pyritization with a little quartz and calcite. The strike is north and the dip 70 degrees east.

WATERLOO CONSOLIDATED FRACTION. This claim was operated by the Waterloo Consolidated Mining and Milling Company Limited of Spokane and has been closed since 1903; it is owned by Ignatius B. Healey, Salt Lake City, Utah. A 5-stamp mill was put into operation in 1899 but was only worked spasmodically. The main shaft is reported to be 260 feet deep, from which there is a considerable amount of drifting. The old reports indicate that there was some promise of success during the development of this property and that coarse free gold was encountered in "blue quartz," but nothing definite can now be learned.

The main shaft, elevation 4,290 feet, is caved and the vein cannot be seen. All rock on the dump is greenstone with the exception of a few fragments of argillaceous material; no quartz is to be seen. Fifty-five feet westerly from the main shaft there is a small pit in greenstone; the pit exposes an 8- to 12-inch rib of bluish, vitreous quartz. A 15-foot shaft farther to the west is also in greenstone and is off the vein, which is apparently faulted. Another shaft, elevation 4,340 feet, is on a ridge 340 feet, westerly from the main shaft

on an offset continuation of the vein. Stripping and open-cutting in greenstone near this shaft exposes a total length of 100 feet on the vein, strike south 80 degrees east, dip 85 degrees northward. The quartz is 20 to 30 inches wide and is bluish, vitreous and largely barren.

FONTENOY. This claim, owned by Fontenoy Gold Mining Company, c/o Lawson & Davis, Victoria, B. C., is developed by one incline shaft, elevation 4,245 feet, and one small caved shaft 220 feet to the north-west. No geological information can be gathered except by an inspection of the collar of the shaft and of the material on the dump.

The shaft is sunk on a shear-zone essentially parallel with the formation in this locality, strike north 35 degrees west, dip 45 degrees north-eastward. The shear-zone contains as much as 40 inches of vein quartz on the north-west wall and a few inches on the south-east wall. The rock on the dump is argillaceous quartzite and argillite in which graphitic slickensides are common; much of the rock has the appearance of being sheared. There is some alteration and pyritization of the walls and the vein-mineralization includes pyrite and small amounts of galena and sphalerite. The amount of quartz on the dump is small.

OTHER VEINS. Such was the activity during the development of Camp McKinney that pits and shafts were put down wherever there was any evidence whatever of a quartz vein. In fact, work was done in some cases on siliceous rock that was in reality part of the formation and not a later vein-filling. There is no need for more than passing mention of these workings since the veins disclosed are small and irregular fissures.

On the Molson claim just northerly from the Cariboo is a shaft perhaps 50 feet deep. In it is seen a vein a few inches wide, strike north 75 degrees east, dip 80 degrees southward in a sheeted zone the full width of the shaft. Some open-cutting nearby is on irregular masses of quartz.

On the eastern border of Edward VII is a vein seen on the surface to be 3 to 24 inches wide with frozen walls; it strikes north 60 degrees west and dips 75 degrees south-westward. Work done on this vein consists of a small shaft and adit, both of which are caved.

Westerly from the Last Chance a shaft was sunk on a small vertical quartz vein that strikes north-westerly.

On the Minnie-ha-ha, south-easterly from the main shaft are two small shafts, one on a quartzose zone and one on a quartz stringer, which strikes north 65 degrees east, and dips 75 degrees northward.

North-easterly from the Anarchist, where the West Kootenay Power Co. pole-line crosses the road is a vein 4 to 8 inches wide, strike north 50 degrees west, dip 70 degrees north-eastward.

CARIBOO-AMELIA. This property, owned by The Cariboo McKinney Mining and Milling Company, c/o The Trusts and Guarantee Company Limited, Toronto, consists of seven Crown-granted claims, the Cariboo, Amelia, Okanagan, Sawtooth, Alice, Emma and Maple Leaf. A stamp-mill was in operation from 1894 until 1903, during which time 123,457 tons of ore was milled. Recovery totalled 69,581 ounces of gold and 6,359 ounces of silver. Dividends amounted to $509,337.52 by the end of 1902 and the total paid to shareholders reached $565,588 at the close of operations. The general history of the property has been given elsewhere, together with that of Camp McKinney as a whole.

Production has come entirely from one vein which is traced underground for a length of 1,800 feet and to a vertical depth of 530 feet. On the surface the vein is, with local exceptions, covered with a considerable thickness of overburden, and little attempt has been made to trace it continuously. A vein exposed on the Emma claim is almost certainly the western continuation of the Cariboo vein, and it is probable that it continues farther west, through the Maple Leaf. No correlation with the Waterloo vein to the east can be made across the gap of 2,000 feet. If the veins on the Maple Leaf and the Cariboo are the same, the length represented is about 3,000 feet.

The vein crosses the formation at a large angle and most of the rock-types of the camp are cut by it. Between Rice Creek and the band of limestone on the east the rocks are dominantly banded, calcareous greenstones with a few intercalated bands of quartzite. East of the limestone are scanty outcrops of quartzites, with a minor but prominent amount of greenstone. In the bed of Rice Creek and in the foundation of the old mill is a dioritic dyke as much as 200 feet wide; the outlines of this dyke are vague, owing to faulting, and owing also to the irregular nature of intrusion that has resulted in the incorporation of sedimentary material in the body of the dyke. Westerly from the dyke, nearly to the Emma line, there is believed to be a considerable amount of soft biotite-bearing

sediments. Farther to the west the rocks appear to be dominantly greenstones, although, because the series includes bands of quartzite and strikes nearly parallel with the vein, it is not known just what rock-types may be encountered in this largely drift-covered area.

The rock series, at least within the area of the mine workings, is disrupted by faults, along many of which the displacement has been considerable. This fact is not apparent from a study of the outcrops, and the lack of surface evidence of existing faults makes it hard to predict the character of ground in any of the yet unexplored sections of the vein. Those faults shown in Fig. 2 are drawn because they are known to exist, not because their position is detected by examination of the surface geology.

The Vein

The Cariboo vein is a quartz-filled fissure with clearly-defined walls, that ranges from a mere stringer to a width of 10 feet or more. The dip is vertical or steep southward, in places as low as 70 degrees southward or, as in the western section of the mine, locally overturned but on the average approximately vertical throughout the explored depth. The effective horizontal displacement along the vein-fissure has been about 30 feet, and the north side has moved westerly.

It is difficult to obtain an idea of the average width because much of the vein is mined, but early reports state that the vein was 3 to 4 feet wide in the upper workings. In the western section it ranges from 5 to 8 feet and is locally as much as 15 feet wide; in the central and eastern sections the width ranges between 2 and 5 feet although some stopes indicate greater local widths.

The vein has with local exceptions, free walls. It consists of white quartz which, particularly in the richer sections contains narrow bands of sulphide or shadowy, dark-coloured material. Blue quartz, referred to in old reports as containing free gold, is not abundant. As seen at the eastern end of No. 2 level this is bluish, dense quartz, chalcedonic in appearance; no free gold was observed, but mineralization in this section is locally heavy.

Mineralization consists largely of pyrite, in addition sphalerite is fairly prominent and there is less galena and small amounts of chalcopyrite. An idea of the sulphide content may be gained from the fact that during operation, in early days on richer sections of the vein the sulphides con-

stituted 3 to 3 1/2 per cent of the mill-heads; in 1901 the concentrating ratio was 39:1 when, supposedly, a considerable amount of low-grade material from the western section was milled.

Results of sampling by Pioneer Gold Mines of B. C. Limited indicate that higher values are in general to be expected from (a) well-banded sections of the vein, and (b) quartz containing prominent amounts of sphalerite and galena. Three polished sections were studied; gold was seen in only one of these, associated with galena and sphalerite which, with chalcopyrite, are later than, and vein the pyrite. It is not known whether the gold is always associated with these last-formed sulphides throughout the mine.

The walls of the vein have been altered, locally so strongly that it is not always possible to be sure of the original character of the rock. The alteration varies in degree with the character of the rock; it is least marked in argillite and quartzites and is most marked in greenstone and dyke-material. In hand-specimens the alteration has produced a bleached, earthy material in which the original texture is in part or wholly obliterated. Under the microscope alteration is seen to have resulted in sericitization with the development of a considerable amount of calcite and a small amount of quartz. In advanced stages of alteration the product is schistose.

The vein is most clean-cut and well-defined between walls of calcareous greenstone and the large dyke on the western end of No. 3 level. In these rocks the walls are smooth and free and the vein is uniform. In broad zones of quartzite the vein is more irregular, tends to be frozen, and offshoots extend for short distances into the shattered walls. In the mixed quartzites and softer sediments, as on No. 2 level east, the vein tends to be smaller and erratic. Width and uniformity of the quartz vary directly with the competency of the wall-rock to sustain a clean-cut fissure. Westerly from the shaft the vein disappears in a belt of soft, biotite-bearing and schistose sediments, that have been incapable of sustaining the fissure.

On No. 3 level near the shaft-station the vein is split and consists of a weak foot-wall band up to 16 inches wide, 12 feet north of the main band. A short distance easterly from the shaft the main body of the vein is split and irregular. In caved ground at the top of the raise to surface from No. 3 level west, a band of quartz 8 to 20 inches wide is 6 feet in the foot-wall of the vein. No other splitting of the vein is apparent.

Replacement is seen in No. 2 level stope at the base of the air-shaft. Here the vein intersects the prominent band of limestone and penetrates it irregularly over a stope width of 25 feet. This stope is 80 feet long in a north-westerly direction at an angle to the elsewhere normal vein.

Surface Workings

On the Maple Leaf an old, 15-foot shaft is sunk on a quartz vein that strikes south 70 degrees east and dips 80 degrees southward; the vein is 4 to 4 1/2 feet wide on the west wall, and is 20 to 30 inches wide on the east wall, plus a little additional quartz on the hangingwall of the 4 1/2-foot zone. The walls are sheeted and partly schistose close to the vein, and are hydrothermally altered; the rock is apparently greenstone, but does not outcrop near the shaft.

The quartz contains pyrite which occurs as trains, bands and masses aligned parallel with the walls of the vein; a considerable amount of well-mineralized vein-matter on the dump shows the pyrite, when most massive, to be fractured and veined with quartz. A sample of selected better material from the dump assayed: Gold, 0.14 oz. per ton; silver 0.4 oz. per ton. A grab-sample of fines from the dump assayed: Gold, trace; silver, 0.6 oz. per ton. This is a well-defined vein that has not been traced in either direction from the shaft.

The Emma shaft is perhaps 30 feet deep, and was filled with water at the time of examination. Rock on the dump is strongly altered and appears to have been greenstone. A considerable part of the quartz on the dump is barren, but some is well-mineralized with pyrite and very small amounts of galena and chalcopyrite. New stripping easterly from the shaft discloses rather irregular quartz about 2 feet wide containing sulphide which has been largely leached.

The raise from No. 3 level to surface coincides with the position of an old shaft, and another shallow shaft lies a short distance to the west. The rocks here include soft argillaceous and biotite-bearing sediments, some quartzite, and dyke-rock. The vein cannot be clearly seen at this point, but appears to be irregular and branching, with a prominent footwall-strand.

The original discovery of the Cariboo vein, on the west bank of Rice Creek, consists of a strong outcrop of quartz 45 to 50 inches wide and about 70 feet long, which has not been mined. The vein is exposed at the "Whim" and "Doyle" shafts and at the latter shaft is 40 to 50 inches wide at the surface.

The vein has not been positively traced by surface workings easterly from the main shaft. About the top of the raise from No. 2 level (air-shaft) a number of old open-cuts are nearly all caved. One of these is in a mass of quartz several feet across, the boundaries of which are not seen, and nearby is a narrow width of quartz containing a considerable amount of galena. Neither of these showings appear to be directly related to the vein.

Underground Workings

The workings are about 2,000 feet long on the strike of the vein, extending 910 feet easterly from the shaft and 1,080 feet westerly. Total length of working, exclusive of sub-levels, aggregates about 8,700 feet. Fifty-eight per cent of all workings consists of drifts on vein-matter and of this 83 per cent (48 per cent. of the total) was in stoping ground.

The mine is developed by a vertical shaft 360 feet deep. Below the lowest level a winze extends an additional 200 feet. Levels, with distance below the collar of the Main shaft (elevation 4,400 feet) include: Tunnel, 70 feet; No. 1, 130 feet; No. 2, 165 feet; No. 3, 250 feet, and No. 4, 350 feet. No. 5 level is 103 feet below No. 4 level and No. 6 level is 187 feet below No. 4. No. 6 level is 530 feet lower in elevation than the collar of the main shaft.

Earliest access to the mine was by Doyle and Whim shafts and by an adit (Tunnel level). The adit portal, on the easterly side of Rice Creek, is now covered by a waste dump, the shafts are largely stoped out, and Tunnel level is unsafe in those parts remaining westerly from the shaft; No. 1 level is also stoped out. This upper western section of the mine was consequently not examined, and data were obtained from an old map.

The general condition of the mine on dewatering in 1939 was good. A section of No. 4 level easterly from the shaft beneath a flat fault was completely caved for nearly 100 feet and had to be re-driven, and sections on No. 4 level west had to be shovelled out owing to an accumulation of surface debris from a cave at the top of the raise to the surface. A cave on the western end of No. 5 level was not cleaned out. Elsewhere, the only trouble was encountered in the shaft, which was blocked by debris at the Tunnel and No. 2 levels.

At the time of examination and with the exception of the Tunnel level, which is above water-line and in bad condition, all timber was protected by water and was sound. Nails were

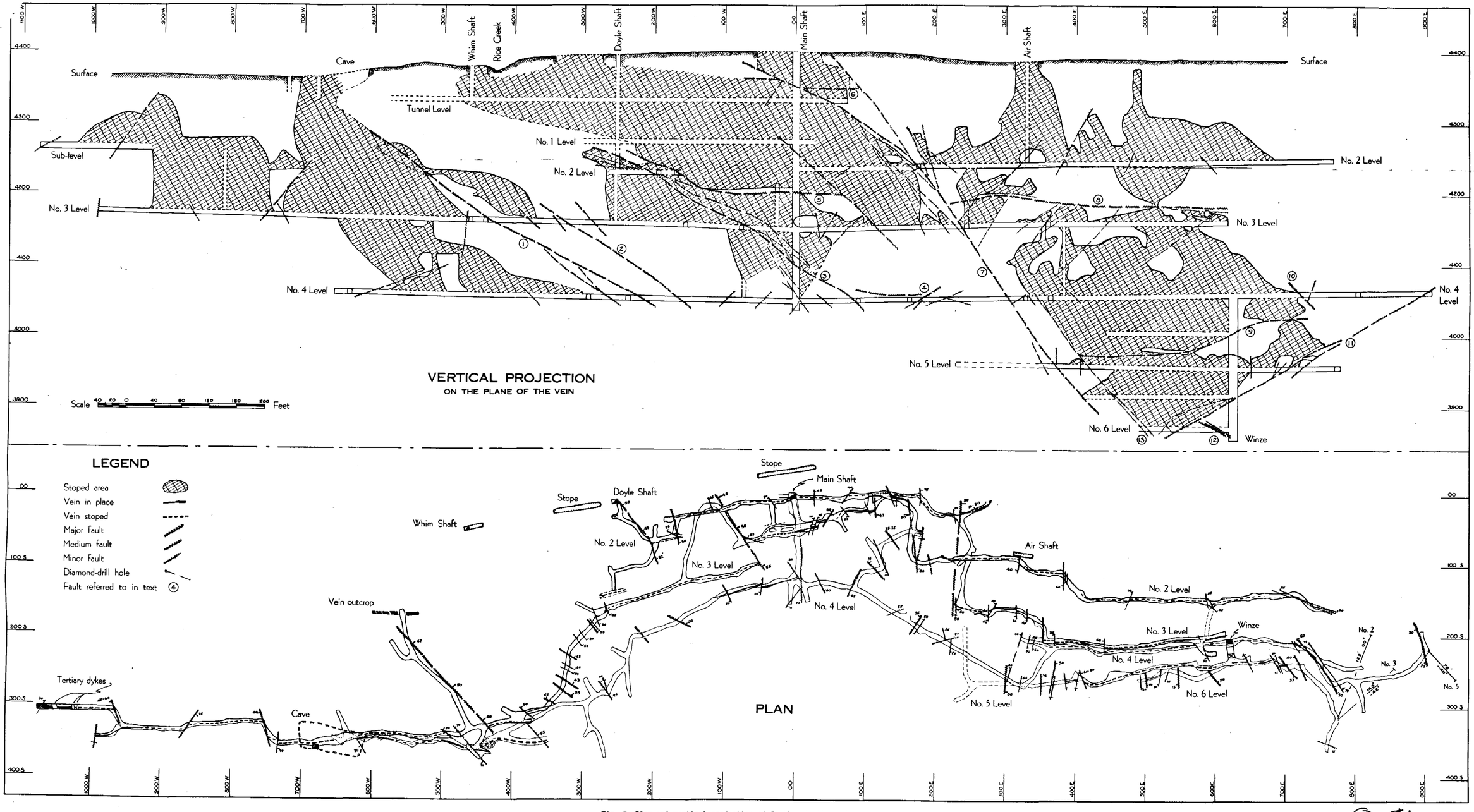


Fig. 3. Plan and vertical projection of Cariboo-Amelia workings (after surveys by Pioneer Gold Mines of B. C. Limited).

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of course leached and ladders and chutes were unsafe. Stulls were set solidly in deep hitches and were sufficiently abundant. The vein-walls were sound and not sheeted or slabby, and loose masses of rock were seen in only two or three places in the stopes. Drifts through sheared or faulted ground were lightly timbered, which allowed the section of No. 4 level east to cave, and bad ground was seen in the sheared section on No. 3 level west. One pocket of methane was encountered trapped in the eastern end of No. 3 level immediately after dewatering, but otherwise the air was good, and there was a good natural circulation throughout the body of the mine.

A cave prevented examination of a western section of No. 5 level, some 200 feet in length according to an old plan; this is indicated in broken lines in Fig. 3. Although the mine was completely dewatered the writer did not examine No. 6 level, which was again flooded at the time of his last visit. Data on this level are furnished through the courtesy of Pioneer Gold mines of B. C. Limited.

The mine is considered to the best advantage in three sections, the subdivision being a natural one of rock-types and faulting. The western section is westerly from a belt of soft, biotite-bearing sediments in which faulting is localized and through which the vein has not been followed. The central section includes the shaft and all original, near-surface workings. The eastern section lies easterly from the major eastward-dipping fault (7).

On No. 3 level the rocks to the west of the incompetent belt are largely indeterminable for a distance of 200 feet; they are all strongly altered and apparently include some dyke-rock and many interbedded types. Farther westerly is a 220-foot belt of quartzite and argillaceous quartzite, and the westernmost 240 feet of No. 3 level is in a large dyke. On No. 4 level, the complex sedimentary belt is 60 feet wide, and the remainder of the drift, for 240 feet to the face, is in argillaceous quartzite.

The vein in the complex of sediments is somewhat irregular and tends to be small on No. 3 level but is wide on No. 4 level. In the quartzites it is wider and sends off-shoots into the walls. In the dyke, above No. 3 level, is the most clean-cut stope in the mine; the vein has smooth, straight walls and is 5 to 10 and more feet in width. Values in this whole section, particularly in the west end, are believed to be low. Quartz in the westernmost stope is massive and poorly mineralized. Three small Tertiary dykes limit the stope but the vein is still seen in the face of No. 3 level and in the face

of the sub-level above. The vein is not seen in the face of No. 4 level, and the reason for its absence is not clear.

Faults in the western section are not numerous and each faulted segment of the vein has been traced.

The central section is one of considerable complexity. From it, particularly above No. 3 level, much high-grade material has been mined over a continuous stope length of about 500 feet. Faulting is complex but all important segments of the vein have been explored.

The rocks are dominantly greenstones, including both massive and banded calcareous types; argillaceous quartzites and quartzites are interbanded with these. The vein is strong down to No. 3 level but on No. 4 level it is weak and only a few inches wide; the stope below No. 3 level is filled. On No. 3 level west the vein narrows and ends against the incompetent belt and on No. 2 level west passes into a broken zone between a complex of flatly-dipping faults.

The shaft is collared 35 feet southerly from a surface stope, encounters the faulted vein at 50 feet depth, follows it for 140 feet and continues downward in solid rock past a second major offset in the vein; stopes have been carried right to the shaft. The vein is offset by flat and eastward-dipping faults, and the major segments are further broken by minor faults. The combination of faulting results in different offsets on different levels; some faults are offset and there is some "take-up" between others. The eastward-dipping fault (7), a branch of which penetrates the central section, is one of the most important in the mine.

The eastern section is bounded on the west by the major plane of fault (7). Above No. 2 level faulting is not serious, the vein is irregularly stoped, and a raise extends to the surface. There is a flat fault of major importance between No. 2 and No. 3 levels, and another irregular flat fault occurs above No. 5 level. The workings bottom in a wedge between an eastward-dipping and a westward-dipping fault, (13) and (11).

Above No. 2 level east the rather narrow vein is in interbanded argillaceous quartzite and greenstone westerly from the air-shaft and in argillaceous quartzites and assorted grey sediments on the east. At the extreme eastern end the vein rolls into a shear-zone parallel with the formation.

No. 3 level is driven in greenstones, for the most part calcareous, and the face is in black argillite and argillaceous

quartzite. Some ground is stoped above the level, up to fault (8). Below No. 3 level the rock is calcareous greenstone, and in it the vein is largely stoped out, down to the apex on No. 6 level. This large, continuous stope is as much as 360 feet in length and is offset appreciably only by fault (9).

Rock in the easternmost sections of No. 4 and No. 5 levels, as well as that encountered in diamond-drilling, is largely calcareous greenstone but includes some argillaceous quartzite and dyke rocks.

Faulting

Faults are numerous in the Cariboo-Amelia, and displacements, large and small, have greatly impeded the course of mining and development. Solution of the problems presented by faulting is not always easy, and it must be admitted that the early operators, although in some cases they turned the wrong way, succeeded well in the difficult task of development and accounted for most of the faulted vein-segments in the developed sections of the mine.

Although some fault displacements do not seem great as judged by lateral offsets of the vein, the vein is essentially vertical and the amount of offset produced on it is a measurement of the horizontal component of movement only, and not of the total displacement in the plane of the fault. This is illustrated by the fault at the base of the air-shaft above No. 2 level east; the vein is offset only 12 feet, but in the stope above is a 30-foot band of limestone that is not seen on the level, and a displacement to have so shifted the limestone must be about 40 feet or more. The flat fault (8), between No. 2 and No. 3 levels produces a vein offset of about 60 feet, but the actual displacement in the plane of the fault has been 400 feet or more.

All the faults should be considered, in a sense, as thrusts, since a horizontal component of movement is indicated in each case, and no movement seems to have consisted simply of a relative sliding of the hanging-wall either up or down the dip. The thrusting has in most cases consisted of a relative movement of the uppermost fault-blocks to the north and west, but there are exceptions to this rule.

It is commonly possible in a study of fault problems to group the individual faults into sets, referring to relative age, attitude and character of displacement; it may then be possible to demonstrate, co-ordinate or relate, sets of a particular age.

Such an analysis is not easily made in the Cariboo-Amelia. A natural division is into eastward-dipping, westward-dipping and flat faults. Westward-dipping faults commonly offset the western segment of the vein to the north, flat faults offset the lower segment to the south, and eastward-dipping faults commonly, and with one major exception, offset the eastern segment to the north; members of the steeper systems vary widely in strike and dip.

Familiarity with what is known of individual faults is necessary before further discussion can be profitable, more particularly as general discussion must involve a certain amount of theoretical consideration. A brief description of the major individual faults follows; reference being made to those numbered on the vertical projection (Fig. 3). The projection, of necessity, must foreshorten, and further reference should be made to the plan for attitudes at observed points.

(1) This eastward-dipping fault with a north-westerly strike forms part of a complex system with (2). It offsets the vein 35 feet to the north and the evidence is that the hanging-wall has moved relatively upward and to the north.

(2) This series of eastward-dipping faults is localized in the belt of soft biotite-bearing sediments. On No. 3 level it comprises a number of fault-planes, some of which appear to be of major size, in sheared, talcose ground. Correlation on No. 4 level is difficult, but some planes appear to have joined together, and the ground is less sheared. The total offset of the vein across this zone is about 120 feet on No. 3 level and the offset on No. 4 level is a combination of (1) and (2), with the intermediate block not accounted for.

(3) This complex, eastward-dipping fault offsets the vein 35 feet to the north on No. 3 level and 50 feet on No. 2 level. Below No. 3 level, although the stope is filled, projection of observable faults indicates a branching downward, with smaller individual offsets. At No. 2 level the fault merges with (5) and also seems to fray out into a number of flat planes with individual offsets on the vein of a few feet each. The hangingwall-segment has moved up and to the north in each case.

(4) Is a complex series of faults on No. 4 level, including two or more rolling and flatly-dipping fault-planes and one strong fault-plane that dips 35 degrees westward. One rolling flat fault follows above the back of the main

crosscut and may be related to (3). The strong, westward-dipping fault indicates a relative displacement of the hanging-wall northward and upward, but the actual relationship of this and other planes is not clear. No vein was seen in this section.

(5) This flat fault is nearly horizontal for a considerable distance, but rolls upward on the west to parallel (3), with which it is closely associated. On the east it passes into an eastward-dipping fault that carries the same 30-foot offset on No. 3 level and produces practically no offset on No. 2 level. (5) is part of a system of flat and eastward-dipping planes on which the displacement consists of a thrusting of the hanging-wall to the west and north, with compensating breaks at the sharper rolls.

(6) Is a horizontal fault above Tunnel level that offsets the vein about 40 feet, the upper segment of vein being represented in the surface stope northerly from the shaft. It is cut by the western, foot wall branch of major fault (7) and presumably by eastern branches also. It may be the equivalent of that flat fault that tops the stope westerly from the shaft, but the stope is inaccessible and the offset produced by the latter fault is not known. A crosscut driven northerly at this point is now caved.

(7) This is a major fault of great importance. The interpretation placed upon it has a direct bearing on the tracing and correlation of ore-shoots. It is abnormal in that it cuts flat faults and offsets the eastern segment of the vein to the south, whereas the rule (as in (1), (2) and (3)) is that eastward-dipping faults offset the eastern segment to the north. Whether this implies completely the reverse movement, i.e. hanging-wall relatively down and to the south, or whether it is also a "thrust" with merely a reversal of the horizontal component, is not known positively. Examination of the fault plane itself at accessible points throws no light on this problem.

A footwall-branch of this fault passes through the shaft, producing a 15-foot vein-offset on Tunnel level; other, steeper branches are not seen above No. 2 level. Total offset on No. 2 level is about 80 feet in two or more steps; the offset is not known on No. 4 level and is complicated by fault (8) on No. 3 level. On No. 5 level, crosscutting and diamond-drilling was done to the west of fault (7) but it is not known whether the vein-structure was located.

The eastern, or hanging-wall block has moved relatively

south and it is believed to have also moved downward. Evidence for this last statement is that flat faults (5) and (8) appear to be the same and that (5) is offset about 30 feet by the footwall-branch of fault (7). If the movement were the reverse of this a major flat fault should traverse the mine to the west of (7) within the explored section unless displacement is very large, much larger than the 300-odd feet indicated by a down drop. Offsets produced on both flat fault and vertical vein bear the same ratio on the footwall-branch as they do on the main branch.

It is not known whether other smaller, eastward-dipping faults that offset the vein to the right also represent "normal" displacements (i.e. hanging-wall relatively downward).

(8) This is a flat fault of major displacement. The hanging-wall has moved relatively to the west 400 or more feet and also to the north to offset the vein about 60 feet. The fault-plane is nearly horizontal where seen in the backs of stopes above No. 3 level, and appears to dip northward on the west.

This fault has thrust all the quartzitic and argillaceous sediments in No. 2 level to the west above the calcareous greenstones of No. 3 and No. 4 levels. It is probably related to that flat, curving fault seen in a branch crosscut at the northern end of fault (7) on No. 3 level.

(9) Is an undulating flat fault with a low dip westward. The footwall-segment has been offset about 15 feet to the south, but nothing else is known concerning it.

(10) Is an eastward-dipping fault that marks the eastern limit of stoping on No. 4 level. Although the vein is not positively identified to the east of this fault, the offset of the eastern segment is clearly to the south, as marked by sympathetic breaks and by quartz in the fault-zone. Examination of the fault-zone indicates the same displacement and also that the hanging-wall moved relatively upward. Nothing else is known of this fault.

(11) This fault dips at a low angle westward and marks the eastern limit of the mine. Study of the fault-plane indicates that the hanging-wall moved relatively downward and to the north. On No. 5 level the horizontal component of movement is checked on a hangingwall-branch on which the lower segment of the vein is offset some 15 feet to the south; it should be noted that such a movement is indicated on the hangingwall-plane alone. The indicated total downward movement of the

hanging-wall must be large to account for the distribution of rock-types on either side of this fault.

(12) Is reported to be a strong-appearing fault with a dip of 20 degrees eastward. Nothing else is known concerning this fault.

(13) Is related to (7) and is not particularly important. The western segment of the vein is offset by it a few feet to the north on No. 5 level. It appears to be a branch or relative of (7) that weakens and loses its identity on the dip above No. 4 level.

Westward-dipping faults, with few exceptions, offset the eastern segments of vein to the south a few inches to about 20 feet. The vertical component is not known positively, but probably the hanging-wall moved downward in most cases. Some of these faults are larger than the vein-offset would at first indicate, since that one at the base of the air-shaft above No. 2 level has shifted the limestone band at least 40 feet, about four times the length of the vein-offset. These faults are cut by eastward-dipping faults and appear to be the earliest formed.

Other faults, not enumerated, strike and dip at various angles and are seemingly unimportant. Any fault that offsets the vein no more than a few feet is not a very serious impediment to exploration, although, when closely-spaced, mining may be considerably hampered. The displacements on these, as on all faults, may be considerably greater than the vein-offsets and this fact has made it impossible to trace with certainty any given bedded horizon through the mine.

A summary of fault conditions may be given as follows:

(1) A series of westward-dipping faults that offset the footwall-block to the south a few inches to some 20 feet. The vertical component may be several times as large, but of unknown relative movement; probably the hanging-wall moved relatively downward.

(2) A later series of major thrusts (including eastward-dipping faults and flat faults), some of which are closely related and may together form, as in the central section of the mine, a complex system. The hangingwall-blocks of these faults have moved to the north and west. The effective displacement in one case is at least 400 feet.

(3) A later, eastward-dipping fault in which the hang-

ingwall-block has moved relatively down and to the south, with a total displacement in excess of 300 feet. Other faults of similar nature but smaller in size may exist.

(4) A westward-dipping nearly flat fault, (11), of unknown relationship but not apparently a member of the general westward-dipping system. The indicated displacement is large, with the hanging-wall moving down and to the north.

There is no evidence, that faulting has been in any way responsible for, or genetically related to, the occurrence of ore-shoots. The vein is cut cleanly and is dragged locally towards but not into the fault-planes. One exception to this statement exists in fault (10), of apparent abnormal displacement, in the plane of which there is a mass of uncrushed quartz about 10 inches wide and 8 feet long; this quartz seems to indicate formation later than the fault but at the same time it is of a somewhat different appearance than the nearby vein.

Banding of the vein indicates movement within the vein-fissure that has resulted in re-opening and successive periods or waves of mineralization. The banding, wherever observed, is parallel to the vein-walls; it is not more intense, nor is the vein wider or more strongly mineralized, in proximity to faults. In other words the faults appear to be entirely post-mineral and their effect on the vein has been merely to offset it.

Ore-Shoots

Early reports state that the ore-shoots raked to the east. This is true in that the main eastern ore-body is lower than that of the central section. It is true also that eastward-dipping faults make stope boundaries. An eastward rake to the workings is obvious. Consideration of the reconstructed vein, difficult and incomplete as this picture is, indicates an eastward rake owing to rock-structure.

The best ore seems clearly to have been mined between walls of greenstone or largely greenstone. The reason for this may be in part chemical but certainly the physical character of these rocks was of great importance in the formation of a vein-fissure, with clean-cut walls, that was active during the formation of the vein. The rock most capable of maintaining such a fissure was the greenstone, and in it was localized not necessarily the highest values but certainly the best mineable ore. The most unfavourable rock was the belt of biotite-bearing sediments between the central and western sections of the mine. Other localizing factors are not known, and if there

are minor shoots within the major ore-bodies, evidence of these is now lost or obscure.

Reconstruction of the faulted vein is not possible except in the case of faults (7) and (8). From what has been said in a previous section regarding displacements, the horizon of the vein immediately beneath fault (8) corresponds with that at the surface between the Doyle shaft and the main shaft. In other words, rocks at the latter horizon do not dip from the surface down through the central section but down through the eastern section; the exact location is unknown. It follows that, speaking generally and ignoring many other faults, the central and eastern sections were once contiguous parts of one large ore-body as determined by the favourable greenstone series, and originally lay at comparable levels. The downward continuation of the quartz on No. 2 level lies to the east of the present workings.

Diamond-Drilling

Pioneer Gold Mines of B. C. Ltd. drilled eleven holes on the eastern extension of the vein, eight from the surface and three underground. The positions of these are shown on the surface plan and on the mine plan. (Figs. 2 and 3).

Holes Nos. 2 and 3 were drilled 50 feet from the eastern face of No. 5 level. No. 5 was drilled 30 feet from the eastern face of No. 4 level. Each of these holes encountered calcareous greenstone and Nos. 2 and 3 included some argillaceous quartzite and dyke-rock. No vein was encountered.

The following table gives the data on the surface holes.

| HOLE NO. | DIRECTION | DIP | LENGTH |
|---|---|---|---|
| 1 | South 7 degrees West | 48 degrees 45 minutes | 846 feet |
| 4 | South | 48 degrees 15 minutes | 323 feet |
| 6 | South | 41 degrees | 240 feet |
| 7 | South | 42 degrees | 228 feet |
| 8 | South 37 degrees East | 42 degrees | 230 feet |
| 9 | | Vertical | 46 feet |
| 10 | South | 60 degrees | 50 feet |
| 11 | North | 70 degrees | 50 feet |

Hole No. 1 passed through banded greenstones almost exclusively, cutting one 50-foot length and several minor lengths of argillaceous quartzite and a few small dykes. The banded

greenstone is in part siliceous but most of it is calcareous. Two 5-foot bands of limestone separated by 10 feet of greenstone were encountered at 330 feet, but the limestone band on the surface was not encountered.

The other surface holes demonstrate the presence of interbanded quartzites and greenstones of various types, as is indicated by the scanty outcrops in that section (see Fig. 2).

Hole No. 6 encountered a narrow width of quartz which is reported to have contained high values. During the course of further drilling this quartz was struck only in No. 9 hole, drilled vertically to intersect it close to the point of intersection by No. 6 hole. A shaft was later sunk by other interests on No. 9 hole to explore this quartz, but the results of this work are not known.

No. 1 hole and those drilled underground disclose the presence of a considerable amount of greenstone not far to the east of the present workings. Little light is thrown on the structure by these holes except that No. 1 hole for some distance at the halfway point, intersects the bedding approximately at right angles. The failure to locate the limestone band by this hole indicates that the band has been faulted a great distance towards the east or else that the drill-hole passed between two adjacent faulted segments.

The failure to pick up the easterly continuation of the Cariboo vein by diamond-drilling indicates the following possibilities (1), that the vein does not persist, (2) that the holes passed between faulted segments of the vein, or (3) that it is faulted beyond the limits of the holes. The answer is not known. The vein-fissure, containing no quartz, could be cut by a diamond-drill and no evidence of this fact show in the core.

Five holes were drilled by Bralco in 1934 on the western extension of the vein. One of two long holes put down from the surface to explore the western section at depth had to be abandoned. Three relatively shallow holes were put down from the surface to cut the vein westerly from existing workings. The results of this drilling are not known.

Vein Continuations

There is little ore remaining in the mine. Wide quartz on the western end was left by the early operators when it was cheap and easy to mine, and it is safe to say that the average grade of this section is low. Stopes above No. 2 level east

were abandoned at different elevations, and there may be sections left that would repay the cost of extraction. The stopes below No. 3 level in the eastern section appear to have been high in grade; a few pillars and corners remain in these stopes.

The total available tonnage is not great, and its removal would in many cases need elaborate preparation, particularly for pillar removal in the open stopes at lower levels. If the mine is to operate again extensions must be found.

The vein is strong, though poorly mineralized, in the face of the sub-level above No. 3 level. No. 3 level west stops where the vein is cut by a vertical fault; the offset is clearly to the north, but no attempt has been made to locate the next segment. The western face of No. 4 level shows no vein in soft, banded sediments; a rather flat, westward-dipping fault offsets the vein about 15 feet to the north in the stope above, but a crosscut to locate the vein on the level was unsuccessful. The bottom of the stope above this fault is not seen and it is not clear why the vein should not persist downwards a relatively short distance; there is evidently some complicating factor.

The western accessible limit of No. 5 level is in soft, schistose grey rock, microscopic examination of which suggest a dyke. An old mine plan indicates that the drift was continued westerly from fault (7), that diamond-drilling was done and that a crosscut was driven northerly, possibly to intersect one hole, but no drifting was done. These workings are inaccessible.

No. 2 level is bounded on the western end by the fault system (3) and (5). Quartz is found beneath the main plane of this system but is much broken up in short sections by flat footwall-branches.

On the eastern end No. 2 level stops in a bedded shear-zone in argillaceous sediments, into which the vein passes. The bedding in the eastern part of No. 2 level strikes more easterly than elsewhere and the vein tends to follow bedded slips in one or two other sections.

The eastern face of No. 3 level is in black argillite in which there is a narrow quartzose fissure that probably represents the vein-structure; this is beneath fault (8). Exploratory work was apparently done on the assumption that the vein was offset, but it is more likely that the vein continues in the face where, in incompetent rocks, it is a weak and narrow structure.

On No. 4 level stoping ground is limited by eastward-dipping fault (10), the hanging-wall of which is indicated to have moved to the south. No vein is seen in the workings beyond, that extend easterly as far as fault (11), but there is a faint break followed by the short northern drift; this break may possibly represent the vein, with a short offset produced by (10), but if so it is difficult to account for the sudden weakness of the vein-structure. A complicating factor is introduced by the westward-dipping fault that intersects (10) just beneath the level. Displacement on fault (11) is indicated to be such that the hanging-wall moved downward and to the north.

On No. 5 level the vein is in a short sub-level, offset to the south about 15 feet, below a hangingwall-branch of fault (11). It has not been located beyond the footwall-branch of this fault although the crosscut appears to have been driven far enough. Diamond-drilling below this fault proved the existence of a favourable formation but failed to locate the vein.

No. 6 level is bounded by faults (11) and (13). The general position of the vein on the west is indicated from the upper workings; on the east the same problems arise as on No. 5 level. Strength and grade of the vein appear to have persisted to the horizon of No. 6 level.

The downward continuation of the western section of the mine is not in doubt. Ground has been stoped from No. 4 level to surface beneath the unfavourable belt of rock that rakes to the east (north-eastward dip). The downward continuation of the central and eastern sections presents a few problems.

The only vein-quartz seen in the central section on No. 4 level is narrow and weak. On the western end it is abandoned as it passes into incompetent rocks and on the eastern-end, it disappears past what seems to be a minor fault. The stope above is filled, but a raise put up on this narrow band appears to have encountered minable ground a short distance above the level. There is dyke-rock of irregular distribution at the shaft station on No. 4 level and also at the intersection of the drift with the crosscut from the shaft; the vein-quartz in this rock is weak and accompanied by little alteration.

The weakness of vein-quartz on No. 4 level might in some way be related to the presence of the dykes, but it is more likely related to the presence, a short distance below, of the unfavourable horizon of biotite-bearing rocks in which the vein-fissure fails to persist and which may be considered to

have acted as a seal or dam to rising mineralizing solutions.

A considerable length of vein is unaccounted for in the central section on No. 4 level, but it must be badly broken by large faults. The unfavourable horizon rakes eastward beneath this section and is bound to limit the immediate depth. As a consequence, exploration on this part of No. 4 level, and close beneath it, holds little promise of finding important ore.

The downward continuation of the eastern section of the mine must be deferred until the easterly continuation of the vein is proven at the lower levels in this direction.