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SILVER CUP

Mineral Deposits

By H. C. Gunning

CHAPTER III

ECONOMIC GEOLOGY

INTRODUCTION

The metalliferous deposits of Lardeau map-area have received considerable attention since the early nineties, but at no time has the district been an important producer. The most important properties—among which may be mentioned the Silver Cup, Nettie L, Triune, and claims on Great Northern mountain—were worked primarily for their content of lead and silver. The deposits also contained appreciable gold values and important quantities of sphalerite. As the major operations were carried on during the first decade of the present century at a time when the concentration of such complex ore was a serious problem, many of the values were lost. By far the greatest proportion of the ore shipped was hand sorted to produce a silver-lead product. Large quantities of ore containing considerable zinc blende, and also important amounts of lead, silver, and gold, were left unmixed or were accumulated on the mine dumps because of the penalty that was imposed for zinc by the smelters. One or two expensive, unsatisfactory attempts were made at concentration. It is safe to say, that, if some of the better properties had been discovered thirty years later, with modern mining and metallurgical methods, worthwhile mines would have resulted.

Large amounts of money have been expended on the development of gold-quartz veins in the Lardeau. Some of the properties apparently received fair treatment at the hands of their owners. Many, however, were sadly mismanaged and poorly developed. Over-optimism played too great a part in the history of the camp. The gold quartz veins, although containing, occasionally, rich pockets, are generally of such low tenor that their profitable operation today would be a matter requiring the utmost skill in mining, metallurgy, and organization.

In the following pages, the result of field work during the summers of 1926 and 1927, the ore deposits are treated in a twofold manner. First, the different genetic types are described and discussed in some detail. Practically no detailed descriptions of individual properties are included in this section. It is hoped, however, that the characteristics of the different types will be of value to the prospector and the mining engineer. There are included several paragraphs relating to the distribution, origin, age, etc., of the ore deposits as a whole. Non-metallic ore deposits are described in a separate section. Secondly, grouped according to types, many of the mining properties are described in detail. Scientific theories and speculations are omitted, as far as possible, from this section. It is intended primarily for those who are directly interested in individual properties.

No attempt has been made to visit or report on all of the multitude of claims that have received development in Lardeau map-area. Most of the claims of any merit were visited and their descriptions will be found in this report. It is to be expected that some of the claims that were not examined, due to their location or lack of information regarding them, are of greater merit than some of those described. Mining properties which were not visited by the writer have been mentioned or briefly described from information available in the literature.

HISTORY OF MINING

It is probable that Lardeau district was first prospected in 1865. In that year four boats journeyed up Columbia river from Fort Caldwell to Goldstream river and French creek and it is reported that some members of this expedition examined the territory at the head of the Northeast arm of Upper Arrow lake for placer gold. Apparently their efforts were not rewarded and the subsequent rich finds on French and McCulloch creeks, 100 miles north, tended to turn all eyes in that direction.

The report of the Gold Commissioner at Farwell, for 1888, contains the following statement.

"The Lardo country has not been actively prospected during the past season, but I have seen some $4 free milling gold quartz, brought by trustworthy miners from the surface of a prospect located there." It is apparently the first official recognition of the mineral possibilities of the Lardeau. By 1889 ten locations had been made on the Northeast arm of Upper Arrow lake. Several claims, including the Fish Creek mines, had been worked on the upper reaches of Incomappleux river, really outside Lardeau map-area.

The Gold Commissioner's report for 1890 contains this interesting item.

"On the 4th of August a party consisting of Peter Walker, Lochrie McDonald, Tom Downes, and Charles Holden, purchased an outfit at Revelstoke and started in a small boat down the river. They proceeded to the head of Upper Arrow lake and went up the East arm, where the boat was left, and a trail cut to Trout lake. They returned on the 20th of November, and reported having prospected a creek which pursues a southerly course and flows into the lake at its head (presumably Lardeau river). Holes were sunk in a bench at the side of the canyon, about 2 miles above, and coarse gold found on the bedrock, but not in sufficient quantities to prove remunerative. Below the canyon the water prevented their attempts to bottom the channel. The prospects obtained indicated that a heavy run of gold exists somewhere in the vicinity. It is their intention to return early in the spring and resume operations."

And also this:

"On the 29th of September J. W. Haskins recorded at the Revelstoke office five mineral claims discovered by him in the Lardeau country. They are situated about 6 miles east of Trout lake, and, judging by the assays, indicate the existence of a rich mineral belt in that direction..... The veins average from 2½ to 3 feet wide and are about 18 miles from the head of navigation on the East arm..... He also explored Fish creek and the mountain ranges bordering on that stream, without finding anything worthy of attention."

In the spring of 1890 a smelter was erected at Revelstoke to treat ores from Illecillewaet Valley and Kootenay Lake mining camps. It did not operate that season and no record of subsequent operation can be found.

In 1891 several claims were staked on Incomappleux river about the falls and further prospecting was done east of Trout lake. During 1892, seventy-one mineral claims were recorded in Lardeau district and some interest was taken in gold occurrences on Duncan River drainage area. In 1893 about 27 miles of trail was built in the northern Lardeau and the district was steadily progressing. In the annual report of the B.C. Minister of Mines for that year, Mr. James M. Kellie, M.P.P. for West Kootenay, gives a rather comprehensive report on the Lardeau. He states that one hundred and eighty-five mineral claims had been located and that preparations were being made for building a wagon road from Arrow lake to Trout lake. Among the claims that had received most attention at that time were the Great Northern, the Wagner, Silver Cup, Abbot, Black Prince, and the Abrahamson group—claims that are still of importance in the Lardeau. Claims had also been staked on Lexington mountain. The following pertinent statements were made by W. P. Harvey of the Assay Office at Golden, B.C., on a report dated March, 1893.

"I treated from the Lardeau eleven samples..... These specimens showed remarkable contrast to any other argentiferous lead ores of West Kootenay, in the gold contained. The Silver Cup was decidedly the leader in value of assay, which ran to 251 ounces in silver and $40 in gold to the short ton. The future treatment of these ores will require much consideration and careful analysis."

Judging by subsequent operations it is a pity that the last sentence was not firmly impressed on the mind of every mine operator in the Lardeau. In 1894 activity in the district increased. Half a dozen claims had been staked on Sable creek and the Lexington group was receiving attention. The Wagner, Abbot, Silver Cup, Black Prince, Great Northern, and many others were worked. Some twenty-two placer claims had been located on Lardeau river, but many were abandoned the following summer. In 1895 the True Fissure was bonded to Boston capitalists and the Silver Cup was Crown granted and actively worked. The first recorded shipment, of 60 tons, was made from the latter in 1895 and is reported to have netted $175 per ton.

The history of the Lardeau from that time on really revolves about three camps—Camborne, Ferguson, and Poplar Creek. During the early years the silver-lead ores of the Incomappleux drainage area had attracted most attention. Claims on Sable creek and Lexington mountain and the Beatrice at the head of the east fork of Mohawk creek, had been responsible for most of the interest shown in the region. In July, 1899, however, good gold values were obtained in an assay of quartz from the Eva claim and a gold rush ensued. In the succeeding eight years many gold claims were staked and developed. Four or five stamp mills were erected and the town of Camborne grew rapidly. The operations proved unprofitable, partly due to the low tenor of the ores, and partly due to poor management, so that by 1908 much money had been lost and the camp had become practically dormant. A long period of quiescence followed. In 1927 the operations in Incomappleux district were restricted to the Multiplex Mining, Milling, and Power Company's Spider claim, the development of the Teddy Glacier property, which is a recently discovered prospect, and to random developments and examinations on several other properties.

Ferguson grew steadily from 1893 and the Silver Cup and Nettie L mines were largely responsible for its prosperity. In 1903 a silver mill

was erected at Fivemile to treat the ores from these two mines. It was operated for three or four years, but proved to be unsuited to the ores. It is reported that most of the grey copper, which carried a large percentage of the silver values, found its way in the sluices to Lardeau river. The Silver Cup, however, continued shipments of high-grade ore until 1915, since which time it has lain idle except for occasional work by leasers. It is credited with having produced about 9,600 tons of shipping ore and several thousand tons of mill feed. The Nettie L has a total estimated production of about 2,500 tons. The claims on Great Northern mountain—True Fissure, Broadview, Great Northern, and St. Elmo—have been extensively worked at one time or another since the early days and several small shipments made. The True Fissure has for several years past been actively developed by G. F. Parks of Cincinnati, Ohio. The rest of the properties are idle. Interest has recently been revived in the Silver Cup and adjoining claims and it is hoped that they will receive some attention. Numerous other claims in the district, including the Badshot, Black Prince, and Triune, have produced some high-grade ore, but are now lying idle. Mining of gold quartz veins on Silvercup mountain proved unprofitable and many properties there are now deserted. The old silver mill has been destroyed by fire.

Poplar creek attracted attention from 1898 on and many claims were staked for their gold or lead-silver values. In 1903 some spectacular specimens of free gold were found on the Lucky Jack and a gold rush followed. Litigation and the irregular, pockety nature of the gold values led to a cessation of activities after the town of Poplar had sprung up. Today the town is but a shadow of its former self and the district is attracting little attention.

TYPES OF MINERAL DEPOSITS

On a basis of occurrence and origin the metalliferous deposits of Lardeau map-area may be divided into several distinct groups. In this report the following groups are recognized: contact metamorphic deposits; high temperature fissure veins; gold-quartz veins; silver-lead-zinc veins; galena-sphalerite replacement deposits in limestone; quartz-tetrahedrite veins; silver-lead veins in limestone; placer gold deposits.

It is in many cases impossible to draw a hard and fast dividing line between the different groups of deposits, but the typical examples of each group possess sufficiently distinct characteristics to warrant the subdivision. It is hoped that an understanding of these characteristics, which are given below in the sections devoted to descriptions of the various groups, will be of value to the prospector or mining engineer who may be developing a property in the district.

In the past the gold-quartz veins and silver-lead-zinc veins have been of greatest importance. Today the silver-lead-zinc veins and the galena-sphalerite replacement deposits in limestone are attracting most attention and it is believed they will continue to do so for years to come.

CONTACT-METAMORPHIC DEPOSITS

There is a small, ill-defined group of properties that, from their nature and close association with intrusive igneous rocks, may be classed as contact metamorphic deposits. The examples are relatively unimportant

Where small quartz veins intersect the larger ones, values are often concentrated and some fine pockets of rich ore have been found. On the Burnière property values are said to be better where there is chromium mica in the quartz.

None of the gold-quartz veins has as yet been worked with any great profit. The veins near Camborne were extensively developed during the first decade of the present century, but the average values, of $5 or $6 per ton or less, proved too low to be commercially profitable at that time. At present they are attracting very little attention.

The mineral association and wall-rock alteration of these deposits agree closely with many of the veins described by Lindgren[1] as "mesothermal" deposits. He defines them more closely as "metalliferous deposits formed at intermediate temperatures by ascending thermal waters and in genetic connexion with intrusive rocks."

SILVER-LEAD-ZINC VEINS

Many of the veins in the Lardeau are valuable for their content of gold, silver, lead, and zinc. As stated previously, these deposits in many cases closely resemble the gold-quartz veins and apparently all gradations between the two types may be expected. Where typically developed, however, as, for instance, at the Silver Cup, Nettie L, True Fissure, or Beatrice mines, they are fissure deposits in which replacement of the country rock by vein material has at times played an important part. The deposits generally follow shear zones or series of fissures that cut black or grey slate and schists and occasionally quartzites at low angles to the bedding. Less commonly they occur in greenstone dykes. The dips are generally greater than 45 degrees. Occasionally the veins cut steeply across the strike of the sediments. The gangue minerals are white quartz, varying considerably in coarseness of grain and occasionally cavernous, ankerite or a related lime-magnesium-iron carbonate, some siderite and calcite, and frequent more or less altered inclusions of wall-rock. The ferruginous carbonates are, on the whole, much more abundant than they are in the gold-quartz veins. The wall-rock alteration is most commonly due to silicification and sericitization, but, in the graphitic schists, the veins seem to have effected very little alteration. Where some of the veins cut greenstone dykes the latter, as in the case of the gold-quartz veins, have been extensively carbonated, and green chromium mica is commonly present. Minute stringers and disseminations of sulphides may be found in much of the carbonate rock.

The ore minerals are pyrite, sphalerite, galena, argentiferous tetrahedrite, and small amounts of chalcopyrite generally associated with the sphalerite. Gold values, varying from a small fraction to half an ounce a ton, are most commonly found in the pyrite. Occasionally the gold is associated with galena and sphalerite. In some cases much higher gold values than the above obtain. Silver occurs largely in the tetrahedrite, but also in the galena. It is always present in the lead-zinc ore. Many of the hand-sorted shipments from the older mines, such as the Silver Cup, Nettie L, St. Elmo, and Triune, contained between 100 and 300 ounces per ton. Other properties, such as the True Fissure or the Teddy Glacier, contain from 10 to 20 or more ounces per ton of ore. The silver

[1]Lindgren, W.: "Mineral Deposits, 1928", chap. XXVII (particularly p. 615 et seq.).

values depend not only on the amount of grey copper in the ores, but on the richness of that mineral, for it contains different quantities of the metal in different parts of the district. Ruby silver is reported to have been found in the upper workings of the Silver Cup mine. Arsenopyrite was identified in small amount in one or two properties.

The veins have been formed largely by filling of open spaces along fissures and shear zones. In the former case the veins are generally well defined and continuous over considerable distances. In the shear zone type, the gangue and ore minerals tend to take the form of narrow, lenticular masses, arranged in parallel fashion along the strike of the zone, and varying greatly in dimensions. In this type replacement of the wall-rock has often been quite extensive. Occasionally there is a pronounced banding of ore and gangue minerals. On the whole, ore-shoots occur irregularly in the veins. At the intersections of crosscutting fissures with main veins, bodies of ore are frequently encountered. The sulphides may form a very small part or practically all of the vein. Where fissure veins cut across beds of limestone, the latter are frequently replaced along the bedding by the sulphides. The texture of the sulphides varies from coarse to fine grained and some of the intergrowths of galena and sphalerite are exceedingly intimate. The galena in many cases shows evidence of having been sheared, all gradations from coarse cubes, through gneissic to steel galena, having been observed. The quartz, also, is frequently fractured and crushed. Although this indicates post-mineral movement no large faults have yet been found cutting the deposits.

In the early days the properties were worked primarily for their lead and silver content. Consequently, large quantities of sphalerite with minor amounts of galena, and grey copper, have been accumulated on some of the old dumps.

The characteristics of the silver-lead-zinc veins place them clearly as belonging to Lindgren's "mesothermal" silver-lead veins.[1] Many of the features of Lindgren's "Wood River Type[2]"—tetrahedrite-galena-siderite veins—correspond closely with those of the Lardeau deposits.

GALENA-SPHALERITE REPLACEMENT DEPOSITS IN LIMESTONE

Replacement deposits of galena and sphalerite in limestone are quite common in the Lardeau. In the past this type of deposit has received but little attention. Consequently, none of the properties has been extensively developed and it is somewhat hazardous to venture a definite opinion on their importance. However, the lead-zinc replacements in limestone constitute the most interesting and by no means the least promising potential mineral resources of the district. Similar deposits in the Slocan, as for example, the Whitewater Deep, Lucky Jim, and Kootenay Florence, have been attracting considerable attention of late and the indications are that this type of deposit may prove economically more important at depth than fissure deposits in that district.

Replacement deposits in the Lardeau are formed in bands of grey to white crystalline limestone, particularly in several beds that lie within a belt, some 3 or 4 miles wide, to the west of the so-called lime dyke. Such deposits are known to exist at intervals, in different beds of limestone,

[1]Lindgren, W.: "Mineral Deposits, 1928", p. 640 et seq.
[2]Op cit., p. 642.

in the zone are black and grey schists and slates and quartzites, generally impure, belonging to the Lardeau group, and occasional dykes of greenstone. One great difference does exist within the belt and that is the amount of silver in the grey copper and the relative abundance of that mineral. The silver values at the Triune, Silver Cup, and adjoining properties are high, running up to several hundred ounces per ton of sorted ore. They are also good at the Nettie L and the Multiplex and at the Beatrice. On Great Northern mountain, however, the grey copper seems to be much lower in silver value, with the single exception of a rich ore-shoot developed on the St. Elmo claim.

To the east of the above-mentioned zone is a wide belt of sedimentary rocks belonging to the Lardeau group. There are slates, schists, crystalline limestones, and quartzites, with irregular areas of chlorite schist and greenstone, particularly on the western side. The belt is bounded on the east by the prominent Badshot formation—a broad band of crystalline limestone—which forms the highest peaks in the district. In the sediments are numerous prospects and showings of mineralization which once more exhibit a pronounced tendency to preserve their similarities along the strike of the rocks. Several of the smaller bands of limestone are in part replaced, most commonly near their contacts, by pyrite, sphalerite, and galena. An excellent example is the bed of marble in which are the Surprise, Mollie Mac, and Hidden Treasure deposits. The Alma group, near the head of Pool creek, is probably on the northwesterly continuation of the same bed. The mineralization on all these properties is very similar. At the head of Ferguson creek the Big Five and the Elsmere show replacement bodies in a similar but larger bed of crystalline limestone lying a little farther east. On Duncan lake, at the south end of the district, similar replacement bodies have been found on the east shore in about the same stratigraphic horizon. Every bed of limestone west of the Badshot formation merits careful prospecting for similar deposits.

Immediately west of the Badshot formation is a belt, about half a mile wide, of carbonaceous sediments in which exists a somewhat less distinct type of deposit. The Wagner, part of the Abbot, the Jewell, Mohican, and the Black Warrior at the head of McDonald creek, are in it. They are all fissure veins valuable for their content of lead, zinc, silver, gold, or copper. Similar deposits might be expected at any place in the belt.

Within the Badshot formation several small fissure deposits have been worked for lead and silver, but the ruggedness of the ground makes prospecting extremely difficult.

East of the Badshot formation there are numerous properties in the prospect stage, but, on the whole, they are practically unknown to the writer. Some of them are described elsewhere in this report.

RELATION OF ORE DEPOSITS TO COUNTRY ROCKS

The broad, irregular belts of greenstone and chlorite schist have evidently been distinctly unfavourable to the formation of mineral deposits. Where veins do occur within these rocks they are in most cases extremely irregular and of low grade or very erratically mineralized. In several cases veins have been observed to end abruptly where they encounter

On the surface there are several small exposures of sulphides in quartz. The old shaft could not be examined.

The property is of potential value in that it should contain any southeasterly continuation of the Silver Cup ore-bodies.

Silver Cup Mine

The Silver Cup mine is on the north end of Silvercup mountain, at an elevation of 5,500 to 6,900 feet. It is the largest and one of the oldest mining properties in Lardeau map-area. It is owned by the Ferguson Mines, Limited, the English stockholders being represented in British Columbia by Mr. James Anderson of Kaslo. The mine is developed by some 2½ miles of underground workings on twelve different levels. At the present time, April 1928, the property is lying idle and the workings are in a dangerous condition. Below the seventh level, which is the lowest adit level, the mine is flooded. A good trail connects the property with the Ferguson wagon road. At one time an aerial tramway transported the ore from the mine to the company's concentrator at Fivemile, but the concentrator has been burned and the tram is in a state of disrepair. Some of the buildings at the mine could be repaired. The mine workings are on the Silver Cup and Sunshine claims.

The mine was a continuous shipper from 1895 to 1915 and 20 tons were mined by leasers in 1921. The total output of shipping ore is 9,600 tons of an approximate average value of: gold $6, silver 150 ounces, lead 30 per cent, and small amounts of zinc and copper. In 1904 and 1905, several thousand tons of milling ore were trammed to the concentrator at Fivemile. Due to the smelter penalty for zinc that existed at the time of operation, much ore, containing considerable zinc, was accumulated on the dumps at the mine. Statements made by the management and quoted by the provincial mineralogist in 1913 indicate that this ore, of which there are several thousand tons, would assay about:

Gold	$3.50 to $8.00	Silver	30 to 50 ozs.
Lead	3·5% to 4%	Zinc	5 to 20%
Copper	1·0% to 1·5%		

About 1,400 feet southwest from the Silver Cup upper workings is a large band of grey to white, massive quartzite. Between it and the mine is a thick series of fine, bedded, black to grey sediments that vary from carbonaceous to argillaceous quartzite. The average strike is north 40 degrees to 50 degrees west and the dip is steep to the northeast. On the Free Coinage claim, immediately southeast of the Silver Cup, these sediments contain numerous gash veins of quartz and are cut by one or two small, greatly altered, rusty-weathering, grey dykes. To the northeast, across the strike, lies a large greenstone dyke now consisting essentially of dark green chlorite and remnants of quartz and feldspar. The dyke is a short distance above or east of the Silver Cup leads. It is several hundred feet wide and is nearly conformable with the sediments, cutting across them at low angles in some places. On the Free Coinage and Silver Cup claims, about 100 to 150 feet southwest of the dyke, is a band, up to 40 feet wide, of so-called "spotted phyllite". It is a black carbonaceous phyllite containing irregularly distributed crystals or knots of iron carbonate. The carbonate weathers to a dark brown iron oxide

and gives the rock its peculiar spotted appearance. Where it is unweathered the carbonate is black. The spotted phyllite continues northwest from the Free Coinage past No. 4 adit of the Silver Cup, near the portal, and is again exposed just northeast of the portal of the No. 7 tunnel on the Sunshine claim. Its width where exposed is variable. All the commercial ore so far discovered lies northeast of it.

On the Silver Cup and Sunshine claims, west of the large greenstone dyke, are numerous smaller dykes. They follow the bedding of the sediments, but in one or two places cut across it. They are extremely irregular in width. These smaller dykes and parts of the large dyke have been extensively carbonated in many places until they somewhat resemble crystalline grey dolomite. In some places green chromium mica, approaching mariposite in composition, has been developed in the carbonates and the rock assumes a striking, green-speckled, grey appearance. This rock weathers brown due to the iron in the carbonates and some disseminated pyrite. It evidently is the "yellow weathering diabase schist" mentioned by R. W. Brock[1]. The best place to study this rock is in an open-cut 200 feet southeast of and above the portal of No. 7 adit, at an elevation of 6,300 feet, on the Sunshine claim. At this point a series of fissures striking north 60 degrees east and dipping steeply southeast, cuts across the greenstone which along its strike has been altered, for from 10 to 25 feet from the fissures, to a mass of grey carbonate containing numerous flakes of apple green mica, which gives a strong test for chromium. The main fissure zone is well mineralized with sulphides and the adjoining carbonate rock contains numerous stringers and specks of the same minerals. There is no doubt that ascending solutions, connected with the mineralization, have produced the carbonatization. Geological mapping clearly indicates that the original intrusives were lens-like and roughly followed the strike of the sediments, and that the carbonatization has been very irregular. The greenstone is so much altered, even where not carbonated, that its original composition could not be determined; thin sections of it contain remnants of orthoclase, some albite, and quartz in a mass of chlorite with other accessory minerals, indicating that the rock probably is of intermediate composition, perhaps approaching granodiorite or quartz monzonite.

From the open-cut mentioned above greenstone extends several hundred feet northeast and is bounded on the northeast by black schists. Just southwest of the open-cut a small cut exposes black and grey sediments and farther southwest is more greenstone with numerous lens-like bodies of carbonaceous schist. The largest of the latter is about 100 feet wide and, on its southwest side, has been converted to a typical spotted phyllite. The greenstone has been extensively carbonated.

Two definite "leads" have contributed most largely to the output of the Silver Cup mine. The main or Silver Cup lead is about 100 feet west of the large greenstone dyke, in black slates and schists. It is a shear or fracture zone conforming with or cutting the bedding of the sediments at a small angle, and mineralized with white quartz, frequently vuggy, a small amount of carbonates, and sulphides. Many fragments of country rock are included in the quartz. The wall-rock is partly altered to sericite. The sulphides are pyrite, sphalerite, galena, argentiferous

[1]Geol. Surv., Canada, Sum. Rept. 1903, pt. A, p. 66.

tetrahedrite, and a small amount of chalcopyrite which is generally associated with sphalerite. Ruby silver is said to have been found in the upper workings.

About 50 feet west of the Silver Cup lead is the Blind lead which did not outcrop on the surface although it has been stoped to the grass roots. It is approximately parallel to the Silver Cup lead, approaching or withdrawing from it at intervals, and the mineralization is similar. Numerous stringers of quartz, some of them well mineralized, occupy cross fissures between the two leads. Quartz veins also intersect the Silver Cup and Blind leads on their hanging-wall and foot-wall sides respectively. The junctions of these crosscutting veins with the main leads have been found to be favourable places for concentrations of ore.

In the south end of No. 4 level, over 300 feet below the surface, the two main leads approach within 25 feet of one another and the intervening material is largely quartz, sparingly mineralized with sulphides. At the extreme southern face of this adit level, mashed schists are mineralized, across about 2 feet, with quartz and pyrite. This showing is apparently near the edge of Free Coinage ground, so has not been investigated, but it is about the most favourable prospecting ground in the upper levels of the mine.

The ore throughout the upper parts of the mine evidently occurred in lenticular shoots arranged in parallel fashion along the two main ore zones and, judging by the mine maps, these shoots extended down the dip with a very steep rake to the northwest. R. W. Brock says[1] the shoots occur where cross fissures meet the lead, especially those from the foot-wall of the Blind lead and the hanging-wall of the Silver Cup. The greatest stope length is over 250 feet and the thickness of the shoots varied from a few inches to 5 or 10 feet. Brock also states that tetrahedrite was taken out in blocks as large as 18 inches in diameter and that some of the best tetrahedrite was found at the bottom of the winze in the lowest workings—600 feet below the highest. Assays indicate that the pyrite is the chief gold carrier.

The open-cut above the portal of No. 7 adit has been mentioned. Ore on the continuation of this lead has been stoped from below and varied in width, it is said, up to about 7 feet. The ore-body is peculiar in that it follows a northeasterly course and dips to the southeast—cutting the formation at a large angle. It is further interesting in that it lies in greenstone which has been extensively carbonated near the vein. Similar mineralization occurs at the south end of No. 7 adit near the shaft to the lower workings. The greenstone, where carbonated, can apparently be as favourable a host for mineralizing solutions as the more extensively ore-bearing sediments.

Towser

The Towser mineral claim is on the east side of Cup creek at an elevation of 5,500 feet. It lies immediately northwest of the Sunshine mineral claim. C. T. Porter and associates of Spokane own the property. The development consists of 500 feet of drifting and crosscutting on one adit level, a raise therefrom that reaches the surface, and some surface stripping.

[1]Op. cit., p. 67 A.

It is reported that five carloads of ore were shipped from stopes from the raise. In the annual reports of the B.C. Minister of Mines operations in 1917 and 1918 are noted and it is stated that 25 tons of ore were shipped to Trail in 1917.

The vein on the property is in black schists which strike north 45 degrees west and dip, on the average, 55 degrees northeast. West of the vein, in the crosscut from the surface, are dark to light grey, more or less schisted sediments and intercalations of carbonated greenstone. The vein has been drifted on for about 175 feet and has well-defined walls dipping steeply northeast and striking north 17 degrees west. The width of the vein averages 4 or 5 feet, but it varies considerably. The mineralization consists of pyrite, sphalerite, galena, and some grey copper and chalcopyrite in a gangue of quartz, carbonates, and inclusions of country rock. The quartz is white and generally coarsely crystalline. Fine crystals occur in some of the larger vugs which may be 2 or 3 feet across. The sulphides occur in bunches and streaks in the ledge matter, the greatest thickness observed being less than 1 foot. The raise, in which the best ore is said to have been found, was not examined. To the northeast of the vein, in a crosscut, quartz and small quantities of sulphides have been introduced into the slates in irregular manner for 20 feet. At the southerly end of the drift, a fault, trending north 50 degrees west and dipping steeply northeast, was followed for 100 feet. Much quartz, up to 5 feet wide, occurs along it, but only small, irregular bunches of sulphides. In the crosscut from the surface, 70 feet west of the main lead, a fissure mineralized with some quartz was drifted on for a short way in a southeasterly direction. It may represent the northerly continuation of the one in the southerly end of the drift. The most southerly extension of the main lead shows only quartz and a sprinkling of pyrite.

On the surface, at the top of the raise, about 50 feet vertically above the portal, a smooth fault wall strikes north 15 degrees west and dips 70 degrees east, cutting black schists. Below it is 12 feet of quartz with rock inclusions, numerous stringers of pyrite, and a little galena. Eight feet below, and parallel to the wall there is a 1-foot band of massive galena and pyrite. The whole vein is well banded and is cut by small, irregular quartz stringers.

Yuill

The Yuill claim, owned by C. T. Porter and associates of Spokane, is on the bed of Cup creek, at an elevation of 4,700 feet. The Towser is southeast of it. Mr. George Yuill, the original owner, exposed the vein by ground-sluicing up to 35 feet of blue glacial wash. Practically no further work has been done on the showing.

A smooth fault wall, with about 8 inches of gouge, appears in the creek bottom. It strikes north 35 degrees west and dips 70 degrees northeast. Below it is from 6 inches to 2 feet of quartz with 4 inches or less of sulphides, principally galena and pyrite. It is stated that samples of this assayed as much as 1,800 ounces of silver per ton. Below the vein, which cuts black schists striking north 45 degrees west, is a band of grey, knotty, calcareous schist, and west of this are carbonaceous schists, grey calcareous schists, and a bed of black, spotted phyllite. Northeast of the lead is about 35 feet of black schists cut by numerous small quartz veins and beyond this a band of green spotted, carbonated greenstone.

galena and sphalerite. At the Silver Cup mine pyrite crystallized first and was followed by sphalerite, tetrahedrite, and galena, with the latter two perhaps in part contemporaneous (Plate IV). Quartz crystallized largely before the sulphides, but continued to form until towards the end of mineralization. Galena was found to have clearly replaced the sphalerite on the Bannockburn claim and the same thing was noticed at the True Fissure mine (Plate VII A). At the Wagner, chalcopyrite, grey copper, and galena are closely associated in age, the galena probably continuing to form after the other two minerals, and all three are later than sphalerite which in turn followed pyrite. Good evidence of the same succession was obtained in ores from the Multiplex mine, where chalcopyrite is generally absent. Arsenopyrite in small amount probably followed pyrite in time of crystallization. At the Beatrice mine sphalerite, which was later than pyrite, is replaced by galena which is intimately associated with grey copper. At the Teddy Glacier property the succession was pyrite, sphalerite, and galena. Tetrahedrite and chalcopyrite were intimately associated with both sphalerite and galena. Polished surfaces of the ores from the Surprise group on Surprise creek indicate that magnetite was the first mineral to form during mineralization, that it was partly replaced by ankerite, and that the latter was replaced by sphalerite and galena. Galena replaced sphalerite and pyrite crystallized later than magnetite and earlier than sphalerite. Pyrite crystallized first in the Big Five ores and was accompanied or succeeded by sphalerite. Tetrahedrite followed sphalerite and was succeeded by boulangerite and bournonite, bournonite being the latest mineral to form. Examination of hand specimens and polished surfaces of ore from the Surprise group on Glacier creek shows that the quartz of the veins was fractured and crushed before the sulphides were deposited. Also, that the general sequence of crystallization was sphalerite (earliest), tetrahedrite, and galena. The relation of pyrite and chalcopyrite to the other sulphides was not established. In one specimen chalcopyrite in one place definitely cuts grey copper and in another place the order is reversed. This perhaps might be expected as the two minerals are believed to be practically contemporaneous in most of the Lardeau deposits. In the same specimen grey copper and chalcopyrite occur as fine veinlets in galena. This is the only instance in which either of these two sulphides have been found cutting galena and the reversal may be due to rearrangement of the sulphides under local conditions of pressure and chemical reaction.

In addition to the ore minerals mentioned above, certain others can be placed more or less definitely in the sequence of crystallization. Pyrrhotite, when it occurs, is an early mineral. It generally succeeds pyrite and precedes sphalerite and galena. The evidence, however, points to pyrrhotite and dark brown sphalerite as being very closely related in time of crystallization. This seems to be particularly true in the case of replacement bodies in limestone when both minerals are present. Complex sulpho salts such as boulangerite and bournonite which are mentioned above, and perhaps complex silver minerals, are present in a few examples. The evidence is hardly sufficient to place these minerals in a general sequence of crystallization, but where they have been found they appear to be as late or later than the galena.

alteration is not superficial, for a short adit, driven in the rock, shows no change in the rocks.

At the Silver Cup mine, a short distance above the portal of No. 7 adit, a fissure, or fissure zone, strikes north 60 degrees east, dips steeply to the southeast, and cuts across a belt of massive to schistose greenstone which strikes northwest. The fissure contains a considerable body of sulphides which has been partly mined. The alteration of the greenstone has been intense. From 10 to 25 feet away from the ore zone, along the strike of the greenstone, the rock has been converted to a rather fine-grained mass of light grey carbonates containing many flakes of green chromium mica. Away from the vein the alteration gradually becomes less intense and the normal greenstone appears. It is apparent that the greenstone has been altered by solutions that travelled along the mineralized fracture zone. The altered rock is finer grained than, but otherwise quite similar to, the typical carbonate rock of the "Coon dyke."

At the head of Cup creek, about one mile southwest from the Silver Cup upper workings, near the southwest corner post of the U and I mineral claim, there is an old shaft on a quartz vein which contains bunches of galena, sphalerite, pyrite, and chalcopyrite. The vein strikes north 30 degrees east and cuts green chlorite schists. Within a foot or so of the vein the schists have been altered to a fine-grained, grey, green-spotted, carbonate rock very similar to the finer grained phases of the Silver Cup and "Coon dyke" occurrences. The altered rock weathers rusty brown. The rock has been formed by the same solutions that are responsible for the quartz vein.

Very much the same thing may be seen at the Hercules tunnel on Ottawa creek, where the altered rock, bordering a narrow vein, is very fine grained and grey, containing only a few specks of the green mica.

At the Multiplex mine, near Camborne, the ore occurs along irregular fissures in a banded, green-spotted, grey carbonate rock which strikes northwest. This rock, both to the southwest and northeast, passes gradationally through a partly carbonated zone, into massive or schistose, dark green, chloritic rock. The greatest width of the carbonate rock exposed underground is about 50 feet, but the dimensions of the carbonated zone are extremely irregular. Where it might be expected in No. 5 adit, chlorite schist, partly carbonated in two zones, was found. No ore has been discovered in the uncarbonated chlorite schist, although the strike of the veins is approximately north and south, cutting across the strike of the schist and carbonated zone at sharp angles. Near the veins, which contain quartz, pyrite, sphalerite, galena, and grey copper, the carbonatization has generally been most intense and there has been a concentration of green chromium mica.

At many other places in the district these rusty-weathering carbonate rocks have been observed as: in the Golden Bullock mine near Poplar; on or near the Triune, I.X.L., and Morning Star claims on Silvercup mountain; at the Eva and adjoining properties on Pool creek; and in a broad zone extending therefrom northwest to and beyond the Teddy Glacier property, passing near the Burnière and Lead Star groups on

7. On a small bench at 6,700 feet elevation south of Silver Chief draw, galena is sparsely disseminated through about 10 feet of rusty phyllitic limestone at the faulted northeast contact of the middle band of Lade Peak limestone. This mineralization was not seen to continue to the southeast.

Silver Cup

The Silver Cup, Sunshine, Free Coinage, and adjoining Crown-granted mineral claims are owned by H. E. Jacques and J. E. La Fleur, of Vancouver. The Towser Crown-granted mineral claim is owned by W. D. Morse, of Chelan, Washington, and the estate of the late T. Porter Cutler. The Silver Cup orebodies were discovered about 1890 and mined almost continuously from 1895 to 1914, producing nearly two-thirds of the metal shipped from the Ferguson area to date. Near them, and in similar geological settings, are smaller mineral occurrences on the Sunshine, Towser, and Free Coinage claims. The narrow strip of country that includes these four properties is here termed the Silver Cup mine area.

This area runs obliquely up the slope east of Cup Creek, from near the creek to the ridge separating the basins of Cup and Triune Creeks. The slope is generally moderate, and outcrops are scattered. Small timber grows thickly on the lower part, but thins out on the upper part as timberline is approached.

The mine area may be reached from Eightmile on the Tenmile road via a bridge over Lardeau Creek and a road up to the camp on the Towser claim. In 1956 the lower part of this road was deeply gullied and impassable for wheeled vehicles. The camp is at 5,200 feet elevation on the east side of Cup Creek. The Towser workings are just east of it, and the Sunshine, Silver Cup, and Free Coinage are successively up the slope to the southeast. A jeep-road switchbacks up to No. 7 adit, the main haulage level of the Silver Cup, at 6,312 feet elevation. A trail continues on up to the other workings.

From northwest to southeast the mine workings include: a shallow shaft and short adit on the Towser; four adit levels, nine internal levels, and connecting shafts and raises on the Sunshine and Silver Cup; and an adit on the Free Coinage. The adit levels are shown in whole or in part on Figure 11. No. 7 traverses both the Sunshine and Silver Cup ore structures and is connected with No. 4 level by a raise. From No. 7 an internal shaft descends five more levels to a point 1,200 feet below the outcrop of the Silver Cup orebody. No. 8 is not connected with any other workings.

The Silver Cup was developed and mined steadily from 1893 to 1913, after which it was leased intermittently until 1921. The ore above No. 7 level has been largely mined out. High-grade ore was sorted and carried by aerial tram to Ninemile on the Tenmile road, whence it was shipped by wagon, lake steamer, and railway to the smelter. In 1904–05 an unsuccessful attempt was made to mill some of the lower-grade ore at Fivemile. In 1937 a small flotation mill was built at the Towser camp, and some of the lower-grade ore on the dumps was milled in 1937 and 1941. In 1952 The Granby Consolidated Mining Smelting and Power Company Limited (since March, 1959, The Granby Mining Company Limited), under terms of an agreement with Yellowknife Bear Mines Limited which had optioned the Silver Cup and Sunshine from Ferguson Mines Limited, rehabilitated No. 7 level, unwatered the shaft briefly to No. 10 level, and diamond drilled ten holes from No. 7 level. The option was dropped.

The other properties have had briefer histories. The Sunshine orebody was developed intermittently from 1897 to 1909 in conjunction with mining on the Silver Cup. The Towser shaft and adit were sunk and driven in 1897–1901, and some ore was mined in 1917–18. The Free Coinage adit was driven between 1897 and 1900.

The Silver Cup mine area was geologically mapped by H. P. Trettin, senior assistant in 1956, and the following account is based largely on his work. The raise from No. 7 to No. 4 was in a hazardous condition, and the shaft from No. 7 was flooded. Nos. 3 and 4 adits were reopened, but one-quarter of the total drift length was inaccessible. The Towser adit was partly flooded, and examined only briefly. The Free Coinage was likewise examined only briefly. Plans of workings were made available by Ferguson Mines Limited.

The geology of the mine area is outlined on Figure 11. The mineral deposits are almost all in a thin basal member of the Triune formation and lie close to one of several crests of the Silvercup anticline. The following sequence of members was mapped in the mine area:—

Triune formation—

6c—Grey siliceous slate	1,000 feet
6b—Black phyllite	200 to 400 feet
6a—Grey siliceous slate	0 to 150 feet

Index formation—

5—Green phyllitic lapilli tuff	50 feet
5—Green phyllitic tuff	50 feet
5—Interbedded black and green phyllites	100+feet

The Index formation is not subdivided on Figure 11. The sedimentary rocks are strongly cleaved, and cleavage surfaces in the siliceous rocks are generally smeared with carbon. The contact between Triune phyllite and basal slate appears to be gradational. The phyllites and tuffs are extensively replaced by siderite and green chromian mica, the degree of alteration increasing from northwest to southeast. The siliceous slates are nowhere noticeably altered. There is little apparent relation between alteration and mineralization, although the one vein in tuff, the Sunshine cross-vein, is flanked by several feet of carbonate rock in a part of the mine area where the tuff is generally little altered. On the wall of the Triune basin, both phyllites and tuffs have been converted to massive siderite rock, and only shadows of lapilli on certain weathered surfaces give any clue to the original rock.

The Index and Triune rocks are involved in several tight crests of the northwest-plunging Silvercup anticline. Two crests in Index rocks, separated by a wedge of basal Triune, are indicated by the trace of contacts on Figure 11. Axial planes and contacts appear to be parallel to the cleavage, which dips mostly between 60 and 75 degrees northeast. The Silver Cup mine and the Free Coinage workings are about 200 feet southwest of the southwesterly crest, in the thin basal member of the Triune formation. The Towser showing is in basal Triune on the southwest flank of the second crest. Southeast of the Towser the basal Triune pinches out up-plunge in the syncline between the two anticlinal crests. The Silver Cup band of the basal Triune thins to the southeast due to squeezing and pinches out on the Triune basin slope. At the Silver Cup mine the foliation is warped, and the Index-Triune contact is thrown into a shallow roll plunging steeply northwest (*see* Fig. 11a). This warping does not appear to be related to the principal folding, but suggests compression parallel to the axial planes.

No large strike faults have been identified in the mine area, although several occur to the northeast. A few small strike faults are present in different parts of the mines, and the orebodies lie in zones of shearing and crumpling. Many small cross-faults were seen; one of them, near No. 7 portal, is mineralized.

The Silver Cup mine has developed four orebodies, known as the Silver Cup, Blind, Sunshine, and Sunshine cross-lead. The Silver Cup and Sunshine orebodies lie in a shear zone that either follows bedding or traverses it at a very slight angle to the right. It dips northeast at an average angle of 65 degrees. Between the ore-

bodies it is rather indistinct. Along the orebodies it widens, and the rock on either side is considerably crumpled. The Blind orebody lies in a similar shear zone about 50 feet in the footwall of the first. The Silver Cup and Blind orebodies are side by side, and the Sunshine orebody is 1,200 feet northwest of them. The Sunshine cross-orebody is just northwest of the Sunshine orebody, restricted to tuff in the hanging-wall of the slate, and is essentially a fissure vein striking north and dipping about 70 degrees east. The Silver Cup and Blind orebodies have contributed an overwhelming part of the ore.

The Silver Cup and Blind orebodies are short, narrow, and deep, raking steeply northwest. The exact dimensions are not known. The stoped length of both above No. 7 level is about 250 feet (*see* Fig. 11b). Ore does not seem to have occurred uniformly over this length, but rather to have been concentrated in a number of parallel ore-shoots which raked steeply northwest. The shoots ranged in thickness from a few inches to 5 or 10 feet. The probable depth of the orebodies is suggested by indirect evidence. The Silver Cup orebody was found in outcrop, but is reported to have been very narrow there. The Blind orebody did not outcrop, though it has in part been stoped to surface and was found in crosscutting to the other body. A composite level plan shows equal drifting on the two bodies on No. 9 level, comparable with that on levels above No. 7, but only a short drift on the Blind orebody on No. 10 and none on it on Nos. 11 and 12 levels. It seems probable, therefore, that the Blind orebody may be said to terminate above No. 10 level. Drifts on the Silver Cup orebody are shorter on Nos. 11 and 12 than on other levels, but some stoping was done on No. 12. The Silver Cup orebody therefore appears to have been at least 1,200 feet deep, possibly with a barren section at No. 11 level, and the Blind orebody about 1,000 feet deep.

The occurrence of two short, deep orebodies side by side, at least one lying in a shear zone more extensive than itself, suggests some structural control. The only anomalous feature found around the outcrop of the orebodies is a gentle roll in the hangingwall contact of the siliceous slate and an irregular warping of foliation in the slate (*see* Fig. 11a). The roll plunges steeply northwest, more or less parallel to the orebodies and oreshoots. Underground exposures of the contact are not sufficient to outline the roll or indicate the plunge accurately. The few exposures of the footwall contact of the siliceous slate do not indicate whether it is straight or warped beside the orebodies. In detail the orebodies are slightly sinuous, and they are not strictly parallel to each other nor to the warped foliation in the slate. The orebodies occur in a section of the slates where they are warped, but are not related to the warping in any simple, obvious way. For a few feet into both walls of both orebodies, the slate is strongly crumpled, but the majority of the crumples are not obviously related to known structural directions.

Many cross-fissure veinlets of quartz, some well mineralized, occur on both sides of both orebodies. Level plans, from No. 6 to No. 10 levels, show workings either between or outside the drifts on the Silver Cup and Blind orebodies and trending about 20 degrees to the right of them. It is not clear whether these workings followed cross-fissure veins or branches of the main structures.

The orebodies consist of rock fragments, quartz, pyrite, sphalerite, galena, less tetrahedrite, and minor chalcopyrite and carbonates. Ruby silver is said to have been found in the upper workings. Quartz and carbonates are much less abundant than in most veins in the central mineral belt.

The Sunshine orebody is reported to have comprised two oreshoots, 10 and 25 feet long, extending from surface to No. 7 level, a distance of about 200 feet. Little of this mineralization can now be seen.

The Sunshine cross-orebody is unique in the Silver Cup mine area in striking north and being confined to the tuff. It is exposed in an open-cut above No. 7 portal and in No. 7 adit about 250 feet from the portal, dipping about 50 degrees east. A few tons of ore were mined from it by lessees.

The Towser shaft and drift follow a drusy mineralized quartz-carbonate vein that strikes north 17 degrees west and dips about 70 degrees east, cutting across the beds at a small angle to the right. The vein is in the basal siliceous slate of the Triune formation, close to its contact with the Triune phyllite. The vein has been exposed over a length of 175 feet and a depth of 50 feet; it varies greatly in width, averaging perhaps 5 feet. It contains bunches and streaks of pyrite, sphalerite, and galena, with which are associated some tetrahedrite and chalcopyrite. Minor amounts of sulphides occur with quartz in both the footwall and hangingwall of the vein.

The Free Coinage adit followed quartz-bearing fissures, mainly in Triune black phyllite. A crosscut to the northeast crossed the Triune basal slate and entered tuff. A tight fissure was found in the slate and might be an extension of the Silver Cup or Blind shear zone, but no sulphides were found in it. The fissures in the phyllite are accentuations of the schistosity and are in part occupied by narrow quartz veins. A few small bunches of sulphides are scattered along them. The workings also expose northwest-dipping tension fractures, commonly occupied by quartz seams one-tenth of an inch thick, and irregular pockets of quartz in crumpled rock. Neither the fracture veinlets nor the pockets contain appreciable sulphides.

[References: Brock, 1903, p. 67; Emmens, 1914, pp. 43–44; Gunning, 1929, pp. 61–66; *Minister of Mines, B.C.*, Ann. Repts., 1893–1914, 1917, 1918, 1920, 1921, 1924, 1926–28, 1936, 1937, 1941, 1951, 1952.]

Triune

The Triune mine includes four adits in the southeast wall of the Triune basin. It was owned in 1960 by Richrock Mines Ltd., of Vancouver. It is reached by 3 miles of jeep-road from Tenmile. The lowest, or No. 4 adit is at 7,200 feet elevation, and the highest is at 7,550 feet. The orebody is exposed 100 feet higher on the bluff face, and a raise, with sublevels, was driven to it from No. 3 through Nos. 2 and 1 levels. The remains of an old cabin is anchored to the bluff at No. 4 portal. In the present mapping, only No. 4 and the outer 200 feet of No. 2 adit were accessible. The orebody was discovered in 1900 and developed and mined in the periods 1900–05 and 1916–18. Several tons of sorted ore was sacked and left at No. 2 adit.

The general geology is similar to that at the Silver Cup mine. The host to the ore is a narrow band of siliceous dark-grey slate that dips steeply northeast and is on strike with the band that is host to Silver Cup ore. This band is only 15 to 20 feet wide at the mine but thickens considerably up toward Triune Peak. It is flanked to the northeast by relatively massive greenstone, which resembles the tuff in the Silver Cup mine area, and green and grey Index phyllites. Both the greenstone and the phyllites are partly carbonatized. The slate is flanked to the southwest by greyish-green biotitic phyllite, and this in turn by carbonatized black phyllite. This black phyllite extends up onto Triune Peak and appears to line up with the Triune black phyllite southwest of the Silver Cup mine, although it is covered across the head of the Triune basin. The biotitic phyllite is about 50 feet wide near No. 4 portal, but narrows up the bluff face and pinches out near the ore outcrop.

The orebody is indicated by published descriptions to lie in a shear zone in the siliceous slate. Its dimensions are not given, and it was not seen in the present mapping. The outer 200 feet of No. 2 adit exposes an irregular network of small quartz veins, with associated pyrite and carbonate, in strongly cleaved siliceous slate. No definite shear is apparent here. No. 4 adit, 675 feet long, crosscuts the