

CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
MEMOIR 223
(Revised Edition)

**MINERAL RESOURCES, HAZELTON AND
SMITHERS AREAS, CASSIAR AND COAST
DISTRICTS, BRITISH COLUMBIA**

BY
E. D. Kindle



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EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1954.

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Bulkley Gate and Canyon, looking north over Bulkley River, 3 miles northeast of New Hazelton (86157). (Pages 5, 13.)

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PREFACE

Since the original memoir was issued, in 1940, there has been a considerable revival of mining interest in the Hazelton and Smithers districts of British Columbia. In this period the Silver Standard mine has been reopened and has been steadily producing silver, lead, zinc, and cadmium; the Red Rose and Rocher Déboulé mines near Skeena Crossing have produced tungsten and copper respectively; and several mines on Hudson Bay Mountain have been producing silver, lead, and zinc.

The author spent the field season of 1951 re-examining properties that had been active since his previous studies in 1939, and also visited new discoveries reported. As a result this revised edition is not only more up to date, but is more comprehensive than the earlier one and, combining as it does a general and geological description of the area with a description of all or nearly all mines and prospects, should prove of value to all connected with mining and prospecting in the area.

GEORGE HANSON,
Director, Geological Survey of Canada

OTTAWA, February 2, 1954

Mineral Resources, Hazelton and Smithers Areas, Cassiar and Coast Districts, British Columbia

CHAPTER I

INTRODUCTION

GENERAL STATEMENT

This report deals with mineral deposits examined by the writer during the 1937, 1938, and 1939 field seasons in the vicinity of Hazelton and Smithers, supplemented and brought up to date by further examinations.

New Hazelton, the most northerly town served by the Prince Rupert line of the Canadian National Railways, is 177 miles by rail northeast of Prince Rupert. Hazelton is situated 3 miles northwest of New Hazelton, and is distant, by railway or highway, 48 miles northwest of Smithers. The latter has a population of about 1,000 persons. It is the shopping centre of a farming community, and all articles of commerce may be purchased there. Railway repair shops are located at Smithers, and in 1938 a substation of the Dominion Experimental Farm was established 5 miles to the south. Hazelton, though much smaller than Smithers, is an active trading and mining centre, and both are served by a good road, which runs east to connect with the Cariboo-Vancouver highway at Prince George and extends southwest from Hazelton to reach Terrace and Prince Rupert. Hazelton is off of the main air routes, but its small, serviceable landing field is frequently used. There is a Government owned landing strip at Smithers.

SUMMARY OF MINING ACTIVITIES

The district is noted for the variety of its mineral deposits, which contain gold, silver, lead, zinc, copper, antimony, cadmium, bismuth, cobalt, uranium, tungsten, molybdenum, and coal. Gold-copper ore was first discovered in 1899 on Telkwa River. In 1901, coal leases were staked there and in the vicinity of Kispiox, north of Hazelton. Silver-lead-zinc ore was discovered on Hudson Bay Mountain in 1905, and in 1908 similar ore containing antimony was found on Nine Mile Mountain at Hazelton. During the next few years many mineral bearing veins were discovered and staked on Nine Mile and Glen Mountains northeast of Hazelton, in the Rocher Déboulé Mountains south of Hazelton, and on Hudson Bay Mountain. Between 1910 and 1930, development work was carried out from time to time on seventy-five groups of claims in these areas. Small shipments of high-grade silver-lead ore were made from fifteen different properties, and four producing mines were operated, namely, the Silver Cup, Silver Standard, and Rocher Déboulé mines at Hazelton, and the Duthie mine near Smithers.

Development work was carried on intermittently at the Silver Cup mine from 1914 to 1928, during which period 375 tons of hand-sorted silver-lead-zinc ore were shipped. A flotation-type mill of 50-ton capacity was built and operated during 1929, treating 5,710 tons of ore to produce 571 tons of concentrates. Between 1913 and 1917, the Silver Standard mine shipped about 3,000 tons of selected silver-lead-zinc ore, and its mill, of 50 tons daily capacity, treated about 9,000 tons of ore from 1919 until 1922. In 1923, this mine achieved a record of 14,500 tons of ore mined and milled, producing concentrates with a gross value of \$500,000. The Rocher Déboulé mine, operated from 1914 until October 1918, mined 39,833 tons of ore, containing 4,214 ounces of gold, 62,865 ounces of silver, and 5,746,306 pounds of copper and having a gross value of about \$1,000,000. Underground work at the Duthie mine commenced in 1922, and during the next 5 years several shipments of hand-sorted silver-lead-zinc ore were made. In 1927, a flotation mill of 50-ton capacity was completed, and was operated until suspension of mining early in 1930. The mine produced ore having a gross value of more than \$1,000,000.

There was very little mining activity between 1930 and 1940. S. F. Campbell and associates shipped a carload of silver-lead-zinc ore from Glacier Gulch in 1937 and during 1938 made several shipments of high-grade gold ore from the Glacier Gulch Gold group. Canadian Cadillac Gold Mines Limited commenced underground and surface work at the Silver Standard mine in 1938 and shipped some high-grade ore in 1939. Smithers Mines Limited operated the Duthie mine on a small scale during 1940 and 1941. Ore shipped amounted to 456 tons and yielded 101 ounces of gold and 72,699 ounces of silver as well as lead and zinc. Duthie Mines (1946) Limited carried out further exploration at the Duthie mine during the years 1946 and 1947. This property was acquired by Sil-Van Consolidated Mining and Milling Company Limited in 1950 along with the Canary, Hummingbird, Mamie, Victory, Coronado, and Homestake groups on the southern slope of Hudson Bay Mountain. The Canary, Hummingbird, and Mamie claims were under active development throughout 1951 and 1952. Substantial orebodies were blocked out, and a new mill of 150 tons daily capacity was built at the site of the former Duthie mill. Glacier Gulch Mining Company Limited carried out exploration of a silver-lead-zinc vein on the south side of Glacier Gulch during 1950 and 1951.

The Silver Standard mine at Hazelton was reopened in 1947 by Silver Standard Mines Limited, and to the end of 1950 milled 42,163 tons of ore containing 3,420 ounces of gold, 1,321,935 pounds of silver, 2,405,418 pounds of lead, 5,395,968 pounds of zinc, and 64,945 pounds of cadmium. Developed and indicated ore reserves sufficient for 5 years were reported in the autumn of 1952. A net profit of \$791,395 was earned by the company in the year ended March 31, 1952, compared with \$777,898 in the preceding year. This profit was won from the milling of 20,319 tons of ore averaging \$97.06 a ton as compared with 21,041 tons milled the previous year averaging \$90.36 a ton. In the year 1951-52, each ton of ore yielded a net profit of \$38.94.

The Red Rose tungsten mine south of Hazelton was developed from the raw prospect stage by The Consolidated Mining and Smelting Company of Canada Limited in 1942, and before the mine was closed down,

in 1943, some 1,194,000 pounds of tungsten concentrates were recovered. The mine was leased by Western Tungsten Copper Mines Limited in 1951 and production resumed in 1952. During the first 6 months of that year, the mine produced 190,608 pounds, dry weight, of tungsten concentrate having a gross value of \$390,569. In July, with the mill operating continuously, 75,304 pounds of scheelite concentrates were produced, with a gross value of \$142,591.

Western Tungsten Copper Mines Limited reopened the Rocher Déboulé copper mine in 1950. A mill of 100 tons daily capacity was completed early in 1952, and nine carloads of copper concentrates are reported to have been shipped to Tacoma smelter between early May and the end of July.

Many raw prospects are presently under investigation by mining companies in the Hazelton and Smithers areas and elsewhere in the belt of country adjacent to the Prince Rupert line of the Canadian National Railways. Cronin Babine mine, 20 miles northeast of Smithers in the Driftwood Creek area, is a recent new producer. A milling plant of 50 tons daily capacity commenced operations there in the autumn of 1952, producing silver-lead and zinc concentrates.

PREVIOUS WORK AND ACKNOWLEDGMENTS

All mining properties described in this report have been examined from time to time by officers of the British Columbia Department of Mines. Their descriptions are in the Annual Reports of the Minister of Mines for British Columbia, references to which are listed under the title of each mining property. W. W. Leach, R. G. McConnell, and G. S. Malloch carried out the first geological work for the Geological Survey of Canada in this district between 1908 and 1912. J. J. O'Neill examined the properties around Hazelton in 1917. George Hanson mapped the Zymoetz River area between Hudson Bay Mountain on the east and Skeena River on the west in 1925, and during the same season R. H. B. Jones examined the geology and some of the mineral deposits on Hudson Bay Mountain. In 1936, F. A. Kerr examined mineral properties along the railway between Prince Rupert and Prince George and a few others at Hazelton and Smithers, and E. J. Lees mapped a large part of Smithers map-area. J. E. Armstrong and G. Gray mapped the south part of the west half of Hazelton map-area in 1938. A. H. Lang reported in 1929 on the geology of the Owen Lake mining camp, and during the 1938 and 1939 field seasons mapped the geology of the Houston area east of Smithers. About 175 square miles in the northwest corner of Houston map-area, known as the Driftwood Creek area, had been mapped by George Hanson in 1924.

In the neighbourhood of Hazelton the average magnetic declination is close to 29 degrees, and near Smithers it is 28°30' east of true north; these figures have been used in correcting for true north throughout this report. The assays given in the descriptions of mining properties, unless otherwise specified, are of samples collected by the writer and assayed by the Ore Testing Laboratories, Department of Mines and Technical Surveys, Ottawa.

The following student assistants from the University of British Columbia rendered efficient aid with the field work: J. W. Hoadley and W. R. Bacon (1937 season); W. J. G. Clarke, H. W. Little, and R. B. Toombs (1938 season); and A. H. Booth, E. W. Johnson, and H. L. Hamersley (1939 season).

PHYSICAL FEATURES

Hazelton and Smithers areas are characterized by isolated groups of rugged mountains that rise to elevations exceeding 8,000 feet, and are separated by prominent valleys whose floors range from 1,000 to 3,000 feet in elevation. Small glaciers occupy cirques on the north and east sides of the highest peaks, and the streams springing from them are deeply encised. Alpine glaciation has produced many knife-edge ridges and serrated peaks above elevations of 6,000 feet, but the slopes into the main valleys below 5,000 feet have undergone little change since they were smoothed by continental glaciation, except where the mountain streams have cut deep gorges. The wide valley occupied by Bulkley and Kispiox Rivers is a particularly prominent topographic feature. It ranges from 2 to 10 miles in width, and extends in a northwest direction for 100 miles across Smithers and Hazelton map-areas. It merges with the Nass River Valley on the northwest. Rocher Déboulé, Hudson Bay, and other unnamed mountains lying west of this valley constitute the Bulkley Range of the Hazelton Mountains. The latter pass into the Coast Mountains on the west. The mountains lying east of Bulkley River and between Skeena and Babine Rivers north of Hazelton form the Babine Range of the Skeena Mountains. This range passes into the Nechako Plateau on approaching Babine Lake.

Rocher Déboulé Mountains, south of Hazelton, are 20 miles long from north to south and 14 miles wide (*See Plate II A*). Several of the peaks surpass 8,000 feet in altitude, and one peak is 8,200 feet high. There are numerous small glaciers on the east sides of the higher peaks. These mountains are bordered on the north and east by Bulkley River Valley, on the northwest by Skeena River, and by the valley of Kitseguecla River, a north-flowing tributary of the Skeena, on the west and southwest. The elevation at South Hazelton station is 985 feet, so that the maximum relief exceeds 7,000 feet. The west slope of these mountains is drained by Kitseguecla River and Juniper Creek (*See Plate II B*) and their tributaries. The north and east slopes are drained by Station (Mission), Mudflat, Porphyry, Straw, Chink, Corya, and John Brown Creeks, all of which flow into Bulkley River. Sheedy Creek, which also runs easterly to the Bulkley, drains a valley 1 mile wide that separates Hudson Bay Mountain on the south from Rocher Déboulé Mountains.

Hudson Bay Mountain (*See Plate IV*) is 12 miles broad from east to west and extends for 15 miles in a northwest direction. The main peak, 12 miles northwest of Smithers, rises to 8,600 feet, and several of the nearby peaks exceed 8,000 feet (*See Plate V A*). The elevation at Smithers is 1,627 feet and the maximum relief is over 7,000 feet when measured from the level of Bulkley River. On the east side of the highest peak a glacier $1\frac{1}{2}$ miles long has cut a deep valley called Glacier Gulch. Another glacier, also $1\frac{1}{2}$ miles long, runs down to the northeast from the

main peak into the valley of Toboggan Creek. Toboggan, Glacier Gulch, Simpson, and numerous smaller creeks head on the east slope of Hudson Bay Mountain and drain easterly into Bulkley River. Silvern, Henderson, and other creeks on the west and southwest slopes of the mountain empty into Aldrich, Dennis, and McDonell Lakes, which lie on a valley floor ranging from 2,600 to 2,800 feet in elevation. These lakes form the headwaters of Zymoetz River, which drains southwest to join Skeena River at Copper City. Silvern and Toboggan Creeks have cut deep valleys, which nearly encircle the highest group of peaks. The headwaters of Silvern and Toboggan Creeks are separated between Silver and Schufer Lakes by a pass whose elevation is 5,100 feet.

Nine Mile Mountain, 5 miles northeast of Hazelton, has a lateral extent from east to west of 12 miles and from north to south, 8 miles. It is bounded on the north by the deeply cut valley of Shegunia River, which enters the Skeena near Kispiox. Bulkley River Valley lies to the south and Suskwa River Valley is on the southeast. This mountain has a subdued profile with the highest point, at elevation 5,745 feet, gently rounded. Precipitous slopes are confined to the north side of the mountain, where glacial cirques, now free of ice, form a series of steep-walled basins. Glen Mountain, lying between Nine Mile Mountain and Skeena River, and Four Mile Mountain, between Nine Mile Mountain and Bulkley River, are also gently rounded. They are small mountains having maximum altitudes of about 2,200 feet. The mountains lying north of Shegunia River are higher than Nine Mile Mountain and foster many small glaciers.

Skeena River is a wide, swift, turbid stream scarcely navigable for boats, although river steamers did ascend as far as Hazelton prior to completion of the railway to South Hazelton late in 1912. The river flows in a southerly direction across the west half of Hazelton map-area to its junction with Bulkley River (*See Plate II A*), then swings southwest for 12 miles as far as Skeena Crossing, and then westerly on its trip to the sea. Bulkley River flows northwest for 35 miles from Smithers and then west for 8 miles to where it joins the Skeena. Hazelton is on the north side of Bulkley River where it empties into Skeena River. Kispiox River runs southeast to join the Skeena 6 miles north of Hazelton, and Babine River flows into the Skeena from the east 30 miles north of Hazelton. All these rivers are swift and numerous rapids and steep-walled rock canyons render them unfit for canoes.

Where spared by fire the valleys and mountain slopes up to elevations of 4,500 feet are well forested with trees of one or more of the following kinds: hemlock, spruce, cedar, balsam, poplar, and jack pine. Many cedar poles are shipped each year from South Hazelton and New Hazelton, but cedar trees are scarce near Smithers. The average rainfall in Bulkley Valley at Smithers is a little under 20 inches a year, but it is considerably more at Hazelton.

About 3 miles east of New Hazelton, where the Canadian National Railway skirts the Bulkley River Canyon, two diorite sills, each about 10 feet thick and about the same distance apart, strike northeast across Bulkley River and form what is known as Bulkley Gate. These sills have resisted the erosive force of the fast running river better than the enclosing sedimentary rocks and project from the 150-foot high canyon walls for as much as 50 feet on both sides of the river (*See Plate I*).

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- Map 278A: Prince Rupert Sheet; issued by Geol. Surv., Canada, 1933.
- Map 671A: Houston, geological map; issued by Geol. Surv., Canada, 1942.
- Map 44-23: Smithers, British Columbia, preliminary geological map; issued by Geol. Surv., Canada, 1944.
- Map 44-24: Hazelton, British Columbia, preliminary geological map; issued by Geol. Surv., Canada, 1944. Revised edition 1953.
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CHAPTER II

GENERAL GEOLOGY

SUMMARY STATEMENT

A thick series of Mesozoic sedimentary and volcanic rocks known as the Hazelton group form the bulk of the mountains and uplands in the Hazelton and Smithers areas. These rocks are invaded by numerous granodiorite stocks that may be related to the batholithic rocks of the Coast Mountains that lie some 25 to 35 miles westerly. Small areas of Upper Cretaceous or Paleocene beds occur along Bulkley River Valley, and at Moricetown these are overlain by thin andesite and dacite flows. Lode deposits occur in both the granitic intrusions and older rocks.

HAZELTON GROUP

Mesozoic rocks of the Hazelton group occupy about 90 per cent of the Hazelton and Smithers areas. The group consists of an apparently conformable succession of interbedded sedimentary and volcanic rocks ranging in age from pre-Middle Jurassic to Lower Cretaceous, and includes coal-bearing members hitherto mapped as the Skeena formation or series of Lower Cretaceous age. On Hudson Bay Mountain, a fivefold division of the Hazelton group has been made, namely: a Middle Jurassic or older volcanic division; a Middle Jurassic marine sedimentary division; a Middle or Upper Jurassic volcanic division; an Upper Jurassic and Lower Cretaceous marine and continental sedimentary division; and a Lower Cretaceous or Younger volcanic division (Armstrong, 1944). On Rocher Déboulé Mountain the first two of these divisions are either missing or have not been recognized, but the three younger divisions are well developed and have a combined thickness of possibly 16,500 feet (Armstrong and Kindle, 1953).

MIDDLE JURASSIC OR OLDER VOLCANIC DIVISION

The oldest rocks on Hudson Bay Mountain are best exposed near the head of Toboggan Creek, on the Silver Creek mining property, and on the slopes east of the Silver Lakes. They consist of andesitic and rhyolite flows, tuffs, and breccias, and some crystalline limestone. On the Silver Creek claims, dark grey, green, and purple andesites and light-coloured rhyolitic flows with interbedded tuffs are separated from overlying green and red tuffs by a band of fossiliferous crystalline limestone. The limestone forms a lenticular body about 1,500 feet long and 65 feet thick at its widest point. Poorly preserved specimens of the mollusc *Pecten* and the brachiopod *Terebratula* collected from it by Hanson (1924, p. 25) were determinable only as probably Jurassic. The beds strike easterly and are overturned to dip from vertically to 50 degrees north. The limestone is overlain on the south by green calcareous tuffs about 300 feet thick and these grade upwards into about 1,000 feet of purple and red tuffs, with

TABLE OF FORMATIONS

Age	Formation and approximate thickness in feet	Lithology
Quaternary (Pleistocene and Recent)	200	Silt, sand, gravel, marl, boulder clay, stratified clay, glacial drift, talus
<i>Unconformity</i>		
Tertiary	Moricetown flows 200	Andesite, dacite
<i>Unconformity</i>		
Upper Cretaceous or Paleocene	200	Conglomerate, sandstone, shale, volcanic breccia, coal
<i>Great unconformity</i>		
Cretaceous ?		Felsite, trap, porphyritic diorite
	Bulkley intrusions	Granodiorite, diorite, granite
Lower Cretaceous or later	Volcanic division 3,000	Andesitic, dacitic, rhyolitic, and basaltic lavas, tuffs, and breccias; minor sandstone and shale
Upper Jurassic and Lower Cretaceous	Sedimentary division 5,000	Sandstone, shale, argillite, slate, quartzite, conglomerate, greywacke, tuff, arkose, hornfels, coal
Middle or Upper Jurassic	Volcanic division 4,000	Andesitic, dacitic, rhyolitic, and basaltic lavas, tuffs, and breccias
Early Middle Jurassic	Sedimentary division 500	Argillite, quartzite, limestone
Early Middle Jurassic or earlier	Volcanic division 4,000	Andesitic, dacitic, rhyolitic, and basaltic lavas, tuffs, and breccias; minor limestone

some red volcanic breccia. The red tuffs are conformably overlain, east of Lower Silver Lake, by argillite, quartzite, and limestone of early Middle Jurassic age; consequently, the rocks of this volcanic division are of early Middle Jurassic age or older.

A thrust fault traceable for 3 miles along the west face of Hudson Bay Mountain near an elevation of 6,500 feet, separates strata of this lower volcanic division from younger volcanic rocks that outcrop farther east and southeast. A branch of this fault extends northerly a short way east of the Silver Creek property and west of Schufer Lake. Movement along the main thrust fault was from the southeast to the northwest, and the underlying rocks below it are dragged and overturned to the northwest. The strata are intersected by a great many other lesser faults, only a few of which have been mapped.

MIDDLE JURASSIC SEDIMENTARY DIVISION

Rocks of the Middle Jurassic sedimentary division are best exposed just east of Lower Silver Lake on the west slope of Hudson Bay Mountain, where they occupy a strongly asymmetric syncline from which the upper beds have been eroded. The remainder, comprising about 500 feet of strata, rest conformably on bedded red tuffs of the underlying volcanic division.

The rocks of this division consist of thin-bedded argillites, quartzites, argillaceous quartzites, and limestone, with minor slate and chert bands, the latter becoming more numerous in the upper part of the section. The beds are highly fossiliferous. Hanson (1925, p. 105) collected specimens of twenty-one fossil species in talus of these rocks at Lower Silver Lake, and these were identified by F. H. McLearn of the Geological Survey as of Bajocian (early Middle Jurassic) age.

Two other small areas of these sedimentary rocks are exposed on the north slope of Hudson Bay Mountain south of Sheedy Creek, but they have not yet been found on Rocher Déboulé Mountains or elsewhere in the Hazelton area.

MIDDLE OR UPPER JURASSIC VOLCANIC DIVISION

Andesitic, dacitic, rhyolitic, and basaltic lavas, tuffs, and breccias that underlie the southern slope of Hudson Bay Mountain are of Middle or Upper Jurassic age as they are overlain on the east slope of the mountain by sedimentary rocks containing fossils of Upper Jurassic or Lower Cretaceous age. Similar relationships date the volcanic rocks at the head of John Brown Creek, and those along Harold Price Creek in the Hazelton area, as of Middle or Upper Jurassic age. The lavas of this division are generally porphyritic and many show flow structure. They are medium grained, contain both plagioclase and orthoclase phenocrysts, and vary in colour from pale yellow to purple, green, grey, and brown. The green hue has resulted from a development of chlorite and the reddish colours appear to be due to the presence of small amounts of finely disseminated hematite. This series is at least 4,000 feet thick, but has not yet been studied in detail. A good section of these rocks is exposed just south of the head of the south fork of Juniper (Brian Boru) Creek.

UPPER JURASSIC AND LOWER CRETACEOUS SEDIMENTARY DIVISION

The country north, east, and west of Hazelton is underlain by a series of sedimentary rocks, about 5,000 feet thick, including tuffaceous sandstone, greywacke, arkose, argillite, conglomerate, and shale. Carbonaceous shales and thin coal seams occur at wide intervals throughout the succession. Near intrusive stocks the strata are altered to slate, quartzite, and hornfels. A hard, grey, even-grained rock is the most abundant type. It is formed of small fragments that range from andesitic to rhyolitic in composition, with some broken feldspar crystals and occasional subangular quartz grains. Some of these tuffaceous strata lack any discernible bedding structure for thicknesses of 50 feet or more, but in most places they are interbedded with normal sandstones and shales.

Members of this division also outcrop on the east slope of Hudson Bay Mountain at Glacier Gulch and along Toboggan Creek. At Glacier Gulch they are seen to rest directly upon rocks of the Middle or Upper Jurassic volcanic division. The basal beds on both sides of the gulch are dominantly black, carbonaceous sandstones and black slates, and these beds contain about twenty thin coal seams within a stratigraphic range of 600 feet. Rusty weathering quartzites and argillites predominate above the coal-bearing zone¹. Only 1,500 feet of the division is represented here, the rest having been eroded away.

Both upper and lower contacts of this sedimentary division are exposed in the Rocher Déboulé Mountains near the head of Brian Boru Creek. Sandstones, dark greywacke, and black shales are particularly abundant in the lower 1,000 feet. A central zone, about 2,500 feet thick, is composed of the more massive beds of greyish hue, mainly argillites, tuffaceous sandstones, greywacke, and arkose. The upper 2,000 feet of the section contains numerous bands of dark shale, black greywacke, and dark, tuffaceous sandstones. These are impregnated with pyrite, and are altered to hornfels near the granodiorite stock that forms the core of the mountain. Oxidation of pyrite has imparted a reddish hue to all weathered rock surfaces in this zone. The uppermost beds are overlain by volcanic breccia and andesitic lavas of the overlying volcanic division.

In the mountains about Hazelton the beds of this sedimentary division are everywhere folded into broad, open anticlines and synclines with the limbs of the folds dipping at angles of less than 45 degrees. On Glenn and Nine Mile Mountains the larger folds trend northeasterly and the southeast limbs of the anticlinal folds have the steeper dips. More closely folded and faulted basal sedimentary members are seen in the valley bottoms. Most of the ore deposits near Hazelton occur in these sedimentary rocks and in the granodiorite stocks that cut them.

Fossil plants collected from some argillaceous beds close to the coal seams at Glacier Gulch coal mine were identified by W. A. Bell of the Geological Survey as:

- Dictyophyllum* sp.
- Gleichenites nordenskiöldi* (Heer)
- Coniopteris* sp.
- Cladophlebis strictinervis*? (Fontaine)
- Cladophlebis virginienensis*? Fontaine
- Pterophyllum* (*Anomozamites*) *montanensis* (Fontaine) Knowlton
- Pagiophyllum* sp.

¹ See description of the Lake Kathlyn coal mine, p. 134.

According to Dr. Bell the age of this florule is most probably Lower Cretaceous and possibly of about the same age as that of the lower flora of the Blairmore group in Alberta.

Fossil fauna and flora of Upper Jurassic or Lower Cretaceous age were collected by Armstrong (Armstrong and Kindle, 1953) from many places in the Hazelton district. The flora were generally divisible into collections correlated provisionally with either the Kootenay or Lower Blairmore of Alberta, of Lower Cretaceous age. The marine shell collections, on the other hand, were generally identifiable as of either Upper Jurassic or Lower Cretaceous age. Coal-bearing beds of Lower Cretaceous age were formerly referred to the Skeena series or formation, but as coal is now known to occur at intervals throughout the entire 5,000 feet or so of this sedimentary division, the name Skeena can no longer be applied.

LOWER CRETACEOUS OR YOUNGER VOLCANIC DIVISION

The thick division of sedimentary rocks described above is overlain, with apparent conformity, on Rocher Déboulé Mountain by some 3,000 feet of volcanic rocks. These are andesitic, dacitic, rhyolitic, and basaltic lavas, tuffs, and breccias, with minor, intercalated sandstone and shale beds. Much of the east slope of Rocher Déboulé Mountain is formed of these rocks, and the volcanic rocks on the west slope may be of like age, although northerly trending major faults there have made it difficult to assign these rocks to their proper stratigraphic position. Volcanic rocks of this division also occur on Hudson Bay Mountain on the north side of Toboggan Creek where they overlie shales and argillites of Upper Jurassic or Lower Cretaceous age. Because of their stratigraphic position at the top of the Hazelton group, they must be of Lower Cretaceous or later age.

BULKLEY INTRUSIONS

Granodiorite, and dioritic stocks intrude the volcanic and sedimentary rocks of the Hazelton group in both the Hazelton area and on Hudson Bay Mountain in the Smithers area. These intrusions were first noted by Leach (1909) who named them the "Bulkley eruptives". As they cut sedimentary beds containing Lower Cretaceous fossils and some 3,000 feet of volcanic rocks that overlie the fossiliferous sedimentary strata, they are of late Lower Cretaceous or later age. On the other hand, they antedate a prolonged period of erosion in late Cretaceous time, as witnessed by the deposition of Paleocene beds in the valley bottoms. These granitic intrusions are of special significance in that most of the mineral deposits of the region either occur in them or near them in the invaded rocks of the Hazelton group.

The mineral deposits on Rocher Déboulé, Four Mile, and Nine Mile Mountains occur in or near granodiorite stocks of identical appearance, composed of grey, coarsely crystalline rock consisting of about 10 per cent quartz, 10 per cent orthoclase, 10 per cent biotite, 10 per cent hornblende, and 60 per cent andesine feldspar. The Nine Mile stock is about 4 miles long and $\frac{1}{2}$ mile wide; the Four Mile boss is 1 mile in diameter; and the Rocher Déboulé stock is 6 miles wide at the north end of the mountain and extends 10 miles south, narrowing gradually.

At the Silver Standard mine on Glen Mountain there are two small stocks of granodiorite-porphyry composed of about 20 per cent quartz, 15 per cent altered biotite, 60 per cent oligoclase feldspar, and a little orthoclase. This rock is grey-white on fresh surfaces but weathers rusty as a result of oxidation of its contained pyrite. A small stock seen on the roadside $\frac{1}{2}$ mile south of the mine contains abundant quartz phenocrysts. Numerous small stocks and dykes of grey diorite-porphyry intrude Hazelton sedimentary rocks along Skeena River near its junction with the Kispiox.

The volcanic rocks on Hudson Bay Mountain are intruded by several small granodiorite stocks, and larger igneous bodies may lie concealed at no great depth. A stock 3,000 feet long and 500 feet wide on the Silver Creek group of claims lies close to the mineral deposits. Another stock, about 1,000 feet in diameter, forms the peak of Mount Evelyn and contains one small vein. A much larger stock outcrops on the east shoulder of this mountain and is not far from small veins in the intruded volcanic rocks. Other small stocks were seen on the valley slope north of Toboggan Creek. Boulders of porphyritic granodiorite lying near the foot of the glacier in Glacier Gulch suggest the presence of an intrusive stock concealed beneath the ice. Another granodiorite stock, roughly 2 miles across, lies at the southeast tip of Hudson Bay Mountain, and small dioritic and granitic stocks invade the volcanic rocks near the head of Simpson Creek.

DYKES

The igneous stocks, their apophyses, and older rocks are cut by small dykes of diorite (*See Plate I*), diorite-porphyry, felsite, trap, alaskite, aplite, quartz diorite, and augite diorite. Some of these dykes antedate the economic vein deposits in the district, but others followed the formation of the veins. None of the dykes contain ore, nor do they appear to have any particular economic significance except that mineralization is usually lacking or weaker where diorite dykes older than the veins occur along the walls of the vein fissures. Molybdenite occurs in one place in fractures in a trap dyke at the foot of the glacier in Glacier Gulch.

UPPER CRETACEOUS OR PALEOCENE

Sedimentary rocks containing a fossil flora identified by W. A. Bell of the Geological Survey as of Upper Cretaceous or Paleocene age outcrop along the banks of Bulkley River near Moricetown and near Seaton. They are soft sandstones and shales that for the most part were probably deposited in their present position, and they exhibit initial dips ranging from 15 to 30 degrees. The strata include a few thin coal seams, and the sandstones hold many fossil plant stems and branches. About a mile north of the Moricetown bridge the beds consist of alternating bands of shale, volcanic breccia, and sandstone, there being two bands of the breccia, each 12 feet thick, separated by 2 feet of fossiliferous shale. The formation there is probably less than 200 feet thick.

As these sedimentary rocks were deposited in Bulkley Valley in Upper Cretaceous or Paleocene time, the valley must have been eroded to its present depth in pre-Tertiary time.

TERTIARY LAVAS

The Upper Cretaceous or Paleocene sedimentary rocks are overlain at Moricetown by fine-grained andesitic lavas that extend 1,200 feet north from the bridge over the Bulkley. The lavas range from light grey to brownish red, and near the north end of their outcrop area they contain numerous quartz, calcite, and chalcedony amygdules 1 inch to 2 inches long. A well-developed unconformity separates the lavas from the underlying sedimentary rocks, and in several places they appear to fill earlier channels incised by Bulkley River in the sedimentary beds. Although less than 100 feet of lavas is now exposed along the river, a like amount has probably been removed by erosion and glaciation.

PLEISTOCENE AND RECENT DEPOSITS

Bulkley and Skeena River Valleys were filled during Pleistocene time by broad, deep rivers of glacial ice. Evidence of this is seen in the mantle of boulder clay that occupies these valleys, thinning on the ridges and deepening in the depressions. The boulder clay is generally concealed by a layer of fertile clay or sandy clay soil ranging from a few inches to several feet in thickness. The boulder clay consists of finely ground rock flour, which forms a heavy sticky clay cement around a variety of angular and scratched pebbles, cobbles, and boulders. Five miles southeast of Smithers the boulder clay passes downwards into laminated and varved, glacial-lake clays, which contain a few scattered angular pebbles and boulders evidently dropped to their present position from floating ice in a glacial lake before the advancing ice-front.

The pulverized rock that forms the chief constituent of the boulder clay becomes a heavy, tough, sticky clay when wet. It is almost impervious to the passage of water, and wells dug in it have rarely furnished an adequate supply of ground water for domestic consumption. In some places, however, the boulder clay contains gravel seams that may range in thickness from a few inches to several feet, and extend for several hundred feet along strike; these seams commonly lie nearly horizontally, but may be inclined as much as 30 degrees. Where the gravel seams occur near the surface they are a source of a fair water supply to wells in them. A well on the farm of C. J. Killer, 6 miles southeast of Smithers, was drilled to a depth of 355 feet, passing through 205 feet of boulder clay before entering bedrock, but encountered no water. Likewise, a 60-foot shaft, with a 42-foot bore-hole from the bottom, sunk on the Experimental Farm 5 miles southeast of Smithers, failed to find water in the glacial till or boulder clay that underlies the property. In some instances water was encountered near the sides of the main valley by drilling or digging to the contact of the boulder clay with bedrock, as on the farm of J. C. K. Sealy, 4 miles east of Smithers, where bedrock and a good flow of water were encountered at a depth of 64 feet.

The boulder clay is partly and irregularly eroded along Bulkley and Skeena Rivers or is largely concealed by Recent river deposits of stratified silts, sands, and gravels. In many places these fluvial sand and gravel deposits form level benches extending for more than half a mile back from the river (*See Plate II A*). There is a natural abundance of water in these permeable, river-worked gravels and wells put down almost anywhere in them will find water at the contact of the sand and gravel with the underlying, impermeable boulder clay.

CHAPTER III ECONOMIC GEOLOGY

HAZELTON AREA

VEIN DEPOSITS

General Statement

Mineral deposits in the Hazelton area contain various amounts of the following metals: gold, silver, lead, zinc, cadmium, copper, molybdenum, tungsten, antimony, bismuth, cobalt, nickel, uranium, and tin. The deposits occur in veins along faults and shear zones in volcanic and sedimentary rocks of the Hazelton group and in intrusive diorite and granodiorite stocks or in related dyke rocks. The veins are equally distributed in the rocks of these types but in the volcanic and sedimentary rocks commonly occur near intrusions.

Principal Types of Vein Deposits

The vein deposits of the Hazelton district are divisible into the following five principal types:

(1) *Silver-lead-zinc Veins.* The sulphide-bearing quartz veins of the Silver Standard mine are the best all-round example of this type of vein. The chief metallic minerals in the ore shoots are galena, tetrahedrite, and sphalerite. Both tetrahedrite- and galena-rich sectors of the vein may carry much silver, and cadmium occurs with the sphalerite. Many of these veins contain some arsenopyrite, pyrite, and chalcopyrite, and an increase in the arsenopyrite content is marked by a decrease in the silver and an increase in the gold content.

(2) *Silver-lead-zinc-antimony-bismuth Veins.* The sulphide-bearing quartz veins at the Silver Cup and Mohawk mines and on the Lead King, Sunrise, and Barber Bill groups of claims are examples. The metallic minerals of these veins include jamesonite, galena, sphalerite, and tetrahedrite and, where bismuth is present, cosalite, a sulphide of lead and bismuth. Cosalite is most abundant in some of the veins on the Sunrise property, where it constitutes as much as 10 per cent of the vein matter.

(3) *Copper Veins.* Copper occurs as chalcopyrite in quartz and hornblende veins at the Rocher Déboulé mine and on the Highland Boy and Great Ohio properties. The veins at the Rocher Déboulé mine also carry small amounts of cobaltite, glaucodot, complex cobalt-nickel sulpharsenides, scheelite, and uraninite. The average gold content of these veins is less than 0.1 ounce a ton and the silver content is generally a few ounces a ton.

(4) *Gold-cobalt-uranium Veins.* Hornblende veins on the Victoria property contain arsenopyrite, molybdenite, cobalt-nickel sulpharsenides, a little uraninite, and appreciable gold. The gold occurs in shoots associated with the cobalt minerals. The veins also contain small shoots of uranium ore, but the over-all average uranium content is only 0.096 per cent uranium oxide. A minimum of 0.15 per cent uranium oxide (U_3O_8) is required to constitute ore.

(5) *Tungsten Veins.* A quartz vein-lode containing scheelite is mined for its tungsten content at the Red Rose mine. Scheelite-bearing veins on the Blue Lake and Black Prince properties are very similar but they also contain some molybdenite. Uraninite and cassiterite occur in small amounts in some parts of the tungsten veins, and small amounts of ferberite or wolframite occur throughout them.

Structure of Vein-bearing Fissures

In general, the veins in the Hazelton area show marked strength and continuity. The main veins on the Rocher Déboulé and Highland Boy groups exceed 3,500 feet in length and range from a few inches to 8 feet in width. There are eleven veins on the Silver Standard property that range from 100 to 1,500 feet in length and vary from 4 inches to 10 feet in width. The Silver Cup vein is 500 feet long and, where stoped, ranged from 6 inches to 5 feet in width. On the Lead King and Sunrise there are numerous veins ranging from 100 to 500 feet in length and from 3 inches to 4 feet in width.

Most of the veins on Rocher Déboulé Mountain strike from northeast to east and dip at steep angles to the northwest and north. The veins on the Red Rose and Black Prince groups strike northwest and dip 50 to 75 degrees southwest.

On Glen Mountain, the veins on the Silver Standard property strike northeast and dip from 50 to 70 degrees southeast. They are arranged *en échelon* from 100 to 400 feet apart and intersect a broad, northerly trending anticlinal fold. In the vicinity of the Nos. 1 and 2 veins, on the west limb of the anticline, the strata dip 30 to 35 degrees west, whereas east of the main shaft they dip 5 to 10 degrees east.

The veins on the American Boy property in the sedimentary rocks on the west slope of Nine Mile Mountain strike north and dip 45 to 60 degrees east. They occur on the west limb of a gently folded anticline that also strikes north, the beds in the vicinity of the workings dipping 15 degrees west. The Silver Cup vein is another that occurs on an anticline in gently folded sedimentary rocks. It strikes north 30 degrees east and dips 50 to 80 degrees southeast. It crosses the axial plane of an anticlinal fold dipping 10 to 30 degrees to the northwest and southeast.

On the Sunrise and Lead King properties there are two sets of intersecting veins in the granodiorite stock along the north side of Nine Mile Mountain. One set strikes northeast and dips from 10 to 50 degrees southeast, the other set strikes east and dips 10 to 40 degrees south into the mountain. Many of the veins occur in parallel or *en échelon* groups. In a few instances a vein may branch to join one of another set. Such veins occur in a disturbed zone some 700 feet wide and possibly 2,500 feet long that extends from the Lead King group west across the Sunrise property. The zone parallels the north contact of the granodiorite and intruded sedimentary rocks, but lies from 300 to 500 feet within the granodiorite. Both sets of veins are believed to have formed simultaneously from tensional stresses set as the granodiorite cooled.

Throughout the area, the various faults and shear zones along which the veins formed represent differential movement ranging from a few inches to 50 feet or more. The latest movements along the larger vein fissures

were generally in a horizontal direction, as recorded by slickensides and striations on the vein walls. In some cases, as in the Rocher Déboulé and Silver Standard mines, vein formation was interrupted by renewed movement along the fault fissures, and the ore deposits are offset for a few feet by post-mineral faults.

A major fault that trends northerly across Rocher Déboulé Mountains passes along the upper valley of Brian Boru Creek, crosses Juniper Creek, and from there extends across the northwest shoulder of the mountains a quarter mile west of the Rocher Déboulé mine. For convenience in writing this fault is named the Brian Boru fault. There is probably a vertical displacement, east side up, of more than 1,000 feet along this fault. Its continuation north of the Rocher Déboulé mountains is concealed by drift, but it probably extends up the east side of Skeena River Valley east of Hazelton. Most of the vein fissures in the Rocher Déboulé Mountains are thought to have formed at the same time as the Brian Boru fault and others of the same system. Vein fissures at the Silver Standard mine and those of the National Exploration property half a mile southwest of the Silver Standard lie near the projected line of strike of the Brian Boru fault, and may be related subsidiary faults. If so, all ground adjacent to the Brian Boru fault would appear to be worth careful prospecting.

A small lake on the southeast side of the Golden Wonder property is bordered on its northwest and southeast sides by steep-walled cliffs that extend for hundreds of feet along straight but slightly divergent courses. It is believed that these cliff walls mark lines of faulting. Minor faults that strike east across the ridge on the west side of the lake are mineralized with a little gold, copper, and silver.

Mineral Zoning

Mineral zoning is evident in the chalcopyrite-hornblende ore of the Rocher Déboulé mine. The veins lie on the west side of the Rocher Déboulé granodiorite stock, strike west, and extend westerly into adjoining sedimentary strata. Two drifts along No. 2 vein follow the fissuring for about 125 feet in the sedimentary beds and for 2,000 feet into the granodiorite. In both drifts more cobalt bloom (erythrite) occurs west of the Rocher Dyke (See Figure 6) than east of it and still more to the west toward the contact of granodiorite and sedimentary rocks. The ore shoot, however, extends for less than 100 feet into the sedimentary strata. Scheelite occurs at intervals along No. 2 vein for 650 feet east of the margin of the granodiorite but, like the cobalt minerals, it is more abundant near the contact. The gangue minerals are largely hornblende and quartz, but near the sedimentary rocks hornblende decreases and there is a corresponding increase in the amount of vein quartz. There is a great increase in the amount of magnetite present in the chalcopyrite-hornblende-quartz mineral association of No. 4 vein in an easterly direction from the portal of the 100 level. This feature is seen only in the surface exposures as the drift on the 100 level is driven westerly towards the sedimentary rocks. Along the 1,200 level drift on this vein, roughly 1,200 feet vertically below the surface, sulphides are lacking and the vein is composed largely of quartz, hornblende, plagioclase, and apatite with minor amounts of uraninite. There is a progressive change from the margin of the stock inward and downward.

Near the contact the ore is dominantly chalcopyrite and cobalt-nickel sulpharsenides with minor scheelite and gold; farther away the ore changes to chalcopyrite, hornblende, and magnetite with less gold but more uraninite. The change is probably the result of the lower temperatures that prevailed near the margin of the stock when the ore was being deposited. Small silver-lead-zinc veins that cut the chalcopyrite hornblende ore of No. 2 vein are second generation veins of younger age that were deposited from much cooler solutions.

Vein Genesis

There appears to be a direct genetic relationship between the mineral deposits and the granodiorite stocks within or near which the deposits occur. The veins associated with individual stocks contain distinctive mineral deposits. Thus, the small granodiorite-porphyry stocks of Glen Mountain lie near veins that contain gold, silver, lead, zinc, and cadmium. Veins in the granodiorite stocks of Nine Mile and Four Mile Mountains contain silver, lead, zinc, antimony, and bismuth; those in the granodiorite stock of Rocher Déboulé Mountain are characteristically copper bearing, with variable amounts of gold, cobalt, tungsten, molybdenum, uranium, tin, silver, lead, and zinc. In each case, the veins appear to owe their origin to mineralizing solutions given off by the enclosing or nearby intrusions. A period of faulting followed the consolidation of the crystalline rocks, and channels were opened both within the stocks and the intruded sedimentary and volcanic rocks. The mineral-laden solutions probably rose from deep within the stocks along these fissures and, as cooling progressed, the mineral content of the supersaturated solutions was precipitated to form the vein deposits.

COAL DEPOSITS

Coal seams and carbonaceous shales occur along Skeena River at the mouth of Kitsequecla River; along Skeena and Kispiox Rivers for some 10 miles above the junction of the two streams; and along Bulkley River in the vicinity of Seaton. They are also found 8 miles west and 1 mile south of Hazelton on the south side of Cedar Creek, a small tributary of the Skeena. The coal seams and carbonaceous shale beds are interbedded with grey and yellow sandstones, greywackes, shales, and conglomerate. The beds are closely folded and badly faulted, and the coal seams are squeezed and crushed. North of Kispiox village, the strata are cut by numerous igneous dykes and sills. All coal seams seen in the vicinity of Kitsequecla River were less than 6 inches thick, and in any case are too highly sheared and contained too much ash to be of economic interest. Similarly, any coal seams observed along Cedar Creek were too narrow and dirty to be of value.

The Seaton and Kispiox fields contain a few coal seams up to 5 feet in width, but the larger of these are commonly split by shale bands and are squeezed, dirty, and discontinuous along strike. Various analyses have shown that these coals contain from 10 to 20 per cent volatile matter, 40 to 69 per cent fixed carbon, and 18 to 30 per cent ash. None of the seams explored to date is workable as, aside from their high ash content, they are enclosed in strata too highly deformed and faulted to permit of the coal being mined for more than a short distance. So far these bituminous coals have been used only in the forges of local blacksmiths.

OIL POSSIBILITIES

No oil-bearing rocks or oil-shales are known in the Hazelton area, and no seepages of petroleum or natural gas have been reported. Several settlers in Kispiox Valley have observed an iridescent film of oily appearance on the surface of the water in their wells, but this is accredited to iron compounds that produce an iridescent scum somewhat resembling that formed by oil.

PROSPECTING POSSIBILITIES

Vein deposits in the Hazelton area occur in the volcanic and sedimentary rocks of the Hazelton group or in the Bulkley intrusions and associated dykes, so that all these rocks constitute favourable prospecting ground. In three different places veins of economic importance were discovered on anticlinal folds in the sedimentary rocks, suggesting that such structures should be carefully prospected. The course of the major northerly trending faults in the Rocher Déboulé Mountains is also recommended for close prospecting, keeping in mind that although evidence of mineralization may be lacking along the major faults themselves, deposits may occur along smaller related branch fissures. Large areas of relatively unexplored ground lie in the mountains north of Hazelton.

SMITHERS AREA (HUDSON BAY MOUNTAIN)

VEIN DEPOSITS

General Statement

Fifty known vein deposits on Hudson Bay Mountain contain one or more of the following metals: gold, silver, lead, zinc, copper, bismuth, and molybdenum. The mineral deposits occur in four main localities: at the head of Toboggan Creek; at Glacier Gulch; on the southwest slope of the mountain; and near Simpson Creek.

The veins are largely confined to the volcanic flows and tuffs of the Hazelton group except one deposit replacing limestone and a few small veins in stocks of granodiorite. The vein on the Victory property is largely in volcanic rocks, but at its southwest end extends into overlying sedimentary beds. On the Rio Grande property, sedimentary rocks are mineralized along their contact with the overlying volcanic rocks.

Principal Types of Vein Deposits

From a viewpoint of mineral associations the following six types of vein matter are represented on Hudson Bay Mountain.

- (1) Galena, sphalerite, tetrahedrite, and ruby silver in a gangue of quartz and carbonate; the Henderson and Ashman vein deposits at Duthie mine are of this type, but pass into type 3.
- (2) Galena, sphalerite, tetrahedrite, and arsenopyrite in a gangue of quartz and carbonate; the veins on the Victory and Coronado properties are of this type, but grade into type 3.
- (3) Arsenopyrite, sphalerite, and gold, with some quartz or carbonate gangue. The Mamie and Matuss veins are good examples, and the veins on the Victory, Coronado, and Henderson groups contain much of this type of ore.

- (4) Sphalerite-pyrrhotite-pyrite veins; large lenses of ore of this type occur on the Silver Creek group.
- (5) Gold-tetradymite vein-lodes; highly altered tuff containing gold, tetradymite, and some bismuthinite; gold ore of the Glacier Gulch Gold group is the only example.
- (6) Molybdenite veinlets in a trap dyke; an occurrence is below the ice-front on the south side of Glacier Gulch.

In addition to the minerals listed, the ores of the first four types all contain small amounts of chalcopyrite.

Mineralization has almost everywhere been accompanied by alteration and bleaching of the wall-rocks on Hudson Bay Mountain. The changes are a result of hydrothermal alteration involving sericitization, propylitization, and silicification and are represented chiefly by the formation of much fine sericite, with introduction of carbonate and quartz.

Structure of Vein-bearing Fissures

Most of the large veins and vein-lodes occupy fault fissures, sheeted zones, brecciated zones, or shear zones, and not uncommonly a single vein may pass along strike from one such structure to another. In the case of sheeted zones, where several parallel fractures may occur within a width of as many feet, the individual fissures contain sulphide veins that rarely exceed 6 inches in width, and the intervening rock is replaced to varying degrees by sulphide stringers to form substantial vein-lodes. The veins on the Victory, Coronado, Mamie, and Henderson groups all lie parallel and form a system across a belt 2 miles wide along the southwest slope of the mountain. They strike northeast and have steep dips. The veins range from a few inches to 10 feet in width and are remarkably persistent. The largest vein-lode, the Henderson, has been traced for 3,500 feet in a northeast direction through a vertical range of 900 feet, with mining operations largely confined to its southwest part. The Victory vein exceeds 1,600 feet in length and has an exposed vertical range of more than 600 feet. Elsewhere the veins are shorter.

All of the vein fissures on the southwest slope of the mountain lie a short distance east of the major, northerly trending fault that extends north along Silver Creek, and may be subsidiary fractures that formed at a time of renewed movement along the fault. The massive volcanic formations of Hudson Bay Mountain underwent considerable deformation during the initial period of mountain building, as illustrated by the overturned syncline and thrust fault east of Lower Silver Lake. The vein fissures probably developed later, possibly when a considerable load of overlying rocks had been removed by erosion. With a lessening of the load, adjustments to renewed pressures may have been by fracturing and faulting rather than by folding. The complete structural picture of the mountain will not be known until its geology is mapped in more detail.

Mineral Zoning

Zoning is a prominent feature on the southwest slope of Hudson Bay Mountain. In the Duthie mine, the galena-sphalerite-tetrahedrite-ruby silver ore changed along the strike of the vein, giving place to arsenopyrite-

sphalerite-gold ore towards the northeast nearer the core of the mountain. In like manner, the silver-lead-zinc ore on the Victory and Coronado properties changed to higher temperature arsenopyrite-sphalerite-gold ore, as on the Mamie vein, although still including some silver-lead minerals. The change in mineralization is thought to be directly connected with relative distances from the central granitic core of the mountain and to distances from the base of the thick, overlying sedimentary rocks of Upper Jurassic and Lower Cretaceous age that once covered the entire mountain. Vein minerals of the lower temperature type were deposited most abundantly in fractures in the volcanic rocks in the relatively cooler zone near these overlying sedimentary rocks. A fractured trap dyke near the foot of the glacier in Glacier Gulch contains abundant small veinlets of molybdenite, and illustrates the highest temperature type of mineral deposit on the mountain. Also, the gold-tetradymite mineral occurrence in altered tuff on the south side of Glacier Gulch, roughly 1,000 feet east of the molybdenite showing, is believed to have been deposited from high-temperature solutions. All the mineral deposits are considered to be genetically related to the granitic stock that is known to form the core of the mountain.

The deposits at the head of Toboggan Creek illustrate a zonal arrangement in relation to the granodiorite stock that outcrops on the south side of the pass between Silver Lake and Schufer Lake. The Silver Creek sphalerite-pyrrhotite-pyrite ores that occur a few hundred feet south of this stock are characteristic of vein minerals deposited at fairly high temperatures. Galena occurs in some places in the vein farthest from the intrusive rock, but is associated with arsenopyrite or pyrrhotite. A small pocket of silver-lead ore mined some years ago from this vein may represent the root of a lower temperature type of vein deposit. About 4,000 feet south of the stock and 1,500 feet higher, veins of the low-temperature type, consisting of galena, sphalerite, and freibergite, with some chalcopyrite, occur on the Silver Lake claims.

COAL DEPOSITS

On Hudson Bay Mountain, coal deposits occur in sedimentary rocks of Upper Jurassic or Lower Cretaceous age. At Glacier Gulch more than 1,500 feet of these sedimentary rocks have escaped erosion, and coal seams occur at irregular intervals throughout the lower 600 feet of the formation. At the Lake Kathlyn coal mine on the southeast side of the gulch, about twenty of these seams have been prospected. Most of them range from 6 to 12 inches in width, but two of the seams are up to 4 feet wide, and two others show widths of 18 and 24 inches respectively. The two larger seams are 200 feet apart, the lower one 150 feet above the contact of the sedimentary and underlying volcanic rocks. In this vicinity the sedimentary strata strike northwest and dip about 50 degrees northeast. Faulting has occurred along the contact of the sedimentary and volcanic rocks, and many of the coal seams have been sheared or squeezed and in some cases pulverized by fault movement.

Analyses made on samples from the Lake Kathlyn mine indicate that the coal is variable in quality. It contains roughly 14 per cent moisture, from 9 to 28 per cent ash, 3 to 7 per cent volatile matter, and from 50 to 70 per cent fixed carbon. This coal contains more moisture than normal anthracite and has a graphitic colour, features that have led to its classification as super-anthracite¹. According to the new method of classifying coal by rank² and grade, the Glacier Gulch coals fall largely into the anthracite group, but some are of semi-anthracite and some of meta-anthracite rank.

¹ Prospecting in Canada; Geol. Surv., Canada, Ec. Geol. Ser. No. 7, p. 109 (1935).

² National Research Council, Report No. 814, 1939.

CHAPTER IV
DESCRIPTIONS OF MINERAL DEPOSITS
MINERAL DEPOSITS OF THE HAZELTON AREA
 (See Figure 1)

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American Boy Group (19)¹

(American Standard Mines, Limited)

References: Ann Repts., Minister of Mines, B.C.: 1910, p. 87; 1911, p. 79; 1912, p. 112; 1913, p. 106; 1914, pp. 197-199; 1915, p. 76; 1916, p. 89; 1917, p. 104; 1918, p. 117; 1923, p. 107; 1927, p. 131. Geol. Surv., Canada: Sum. Rept. 1912, p. 104; Mem. 110, 1919, p. 33.

The American Boy mining property is on the southwest slope of Nine Mile Mountain, 6 miles northeast of Hazelton. The Nine Mile Mountain motor road passes along the base of the mountain at an elevation of 1,575 feet, one-half mile west of the mine workings, which lie between elevations of 2,500 and 2,900 feet. The camp and workings are reached from the road by a steep switchback road built for fourwheel drive vehicles. The original eight Crown-granted claims were staked by D. A. Harris in 1910. Between 1910 and 1915, Harris Mines, Limited, carried on intermittent development work, and between 1912 and 1914 it is stated that 100 tons of high-grade silver-lead ore, worth about \$7,000, were shipped. In 1915, a shipment of 15 tons sent to the Trail smelter assayed: gold, 0.04 ounce a ton; silver, 98 ounces a ton; lead, 30 per cent; zinc, 14 per cent. In 1918, 240 tons of lower grade ore was hauled from the dumps to the Silver Standard mill for treatment. Harris Mines, Limited, did a little further work late in 1927 when a crosscut was extended from the bottom of the main shaft to pick up the vein. Operations were suspended in December 1927 when a flow of water was encountered. The Viking Mining Company of Vancouver did some work during the spring months of 1937. The property was acquired by American Standard Mines, Limited, in 1950, and a vigorous exploration program was begun under the direction of L. B. Gatenby, mine manager, and J. T. Mandy, consulting geologist. The veins were tested by surface stripping, diamond drilling, and underground work, but no substantial orebodies were found. In the autumn of 1951 a new, high-grade ore shoot about 50 feet long was discovered 1,400 feet southeast of the No. 5 vein. Pioneer Gold Mines of B.C. Limited became interested in the property in 1952, and carried out further surface stripping of the veins.

The claims are underlain by well-bedded sedimentary rocks striking north and dipping about 15 degrees west (*See Figure 2*). A grey, clastic, bedded rock, which has the appearance of an impure sandstone, is most common. Thin section examination shows that this rock is a calcareous tuff composed of volcanic ash, crystallites, devitrified glass grains, and magnetite shreds, with a strong development of calcite. They are interbedded with fine-grained argillites. Several poorly preserved fossil shells were seen in tuffaceous sandstones along the trail to the camp at an elevation of 2,450 feet, and some shells are reported to have been found in the mine workings.

Six quartz veins occur along fault fissures crossing both tuffs and argillites. Four of these veins strike roughly north and dip from 40 to 70 degrees east. The fifth and most southwesterly vein strikes northeast and dips 80 degrees southeast. The veins range from 4 inches to 4 feet in width, and consist of quartz with occasional carbonate stringers, and with both banded seams and irregular patches and bunches of sulphides scattered irregularly through them. The ore minerals in order of abundance are,

¹The number in parentheses appears on the accompanying index map (*Figure 1*) at the approximate location of the property.

galena, zinc blende, arsenopyrite, tetrahedrite, and pyrite. Both galena and tetrahedrite carry a high silver content and the arsenopyrite carries considerable gold.

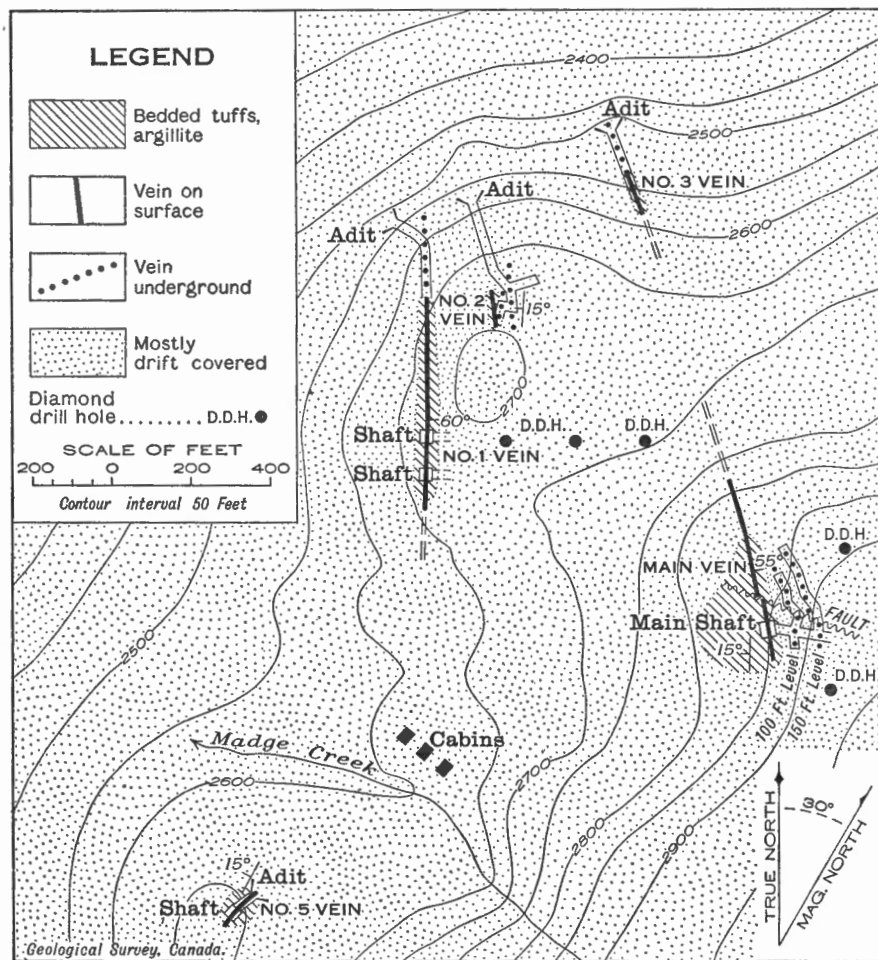


Figure 2. Plan of part of American Boy group.

No. 1 vein is the most westerly, No. 2 vein lies 180 feet east of No. 1 vein, and No. 3 vein lies 400 feet east of No. 2 vein. The main or No. 4 vein is 800 feet east of the No. 1 vein and 900 feet south of the No. 3 vein. As Nos. 3 and 4 veins are on the same strike they may be the same vein. If so, the total length would exceed 1,300 feet. No. 5 vein is 1,200 feet southwest of No. 1 vein. No. 6 vein lies 1,400 feet southeast of No. 5 vein.

No. 1 vein has been traced along the surface by stripping and by open-cuts for over 300 feet. Two inclined shafts 100 feet apart were sunk on the vein about 1912. Between these shafts, the vein ranges from 3 to 4 feet in width and carries from 3 to 5 per cent of sulphides, chiefly galena,

sphalerite, and tetrahedrite, with a little chalcopyrite. Towards its north end the vein narrows to 2 feet and is very sparsely mineralized. According to the 1914 report of the Minister of Mines, British Columbia, the south shaft is 100 feet deep on a 60-degree incline, with drifts at 27 and 50 feet. The following quotations are from the 1914 report.

"The drift on the 27-foot level has been run in to the north 12 feet; a sample taken across 20 inches at the face of the drift assayed: gold, 0.04 ounce; silver, 47.4 ounces; lead, 11.0 per cent.

"On the 50-foot level the drift extends 6 feet to the south: a sample was taken at the face here across a width of 22 inches which assayed: gold, 0.02 ounce; silver, 15 ounces."

A representative sample of broken ore collected by the writer from a small ore dump at the south shaft assayed: gold, 0.015 ounce a ton; silver, 8.82 ounces a ton; lead, 2.39 per cent; zinc, 0.26 per cent; copper, 0.18 per cent; arsenic, nil. A sample of somewhat similar broken ore, collected from the dump at the north shaft, assayed: gold, 0.02 ounce a ton; silver, 81.93 ounces a ton; lead, 6.90 per cent; zinc, 5.49 per cent; copper, 0.68 per cent; arsenic, 0.34 per cent.

About 350 feet of drifting was done along No. 1 vein from an adit driven on the north slope of the mountain during the winter of 1951. The vein persists throughout the adit, but the quartz is only sparsely mineralized.

No. 2 vein is followed for about 100 feet along its strike by rock cuts and stripping. Where exposed, the vein ranges from 16 inches to 4 feet in width and carries about 1 per cent of sulphides, but some high-grade ore was removed from the main open-cut years ago. At elevation 2,550 feet, 125 feet vertically below the vein outcrop, an adit was run south 250 feet to intersect the vein and the vein was drifted along for 45 feet. At the end of the drift a crosscut runs 20 feet west to a branch vein, which is drifted along for 26 feet. Both veins range from 4 to 12 inches in width where exposed in the workings, and both are very sparsely mineralized. An 8-inch channel sample taken across the branch vein 15 feet from the face assayed: gold, a trace; silver, 0.23 ounce a ton. A crosscut extends an additional 80 feet east from the drift on the main vein, but cuts no other veins.

No. 3 vein is exposed in trenches about 400 feet east of the portal of the adit to the No. 2 vein. It has been followed for about 200 feet up the mountainside, but the vein is mostly concealed due to caving in of the trenches. At elevation 2,500 feet an adit was driven south along the vein for 280 feet during the winter of 1951. A strong vein fissure is exposed along the full length of the adit, but the vein is narrow and its sulphide content has been leached out in places.

The wall-rock along the vein is altered and rusty and may contain some gold. A sample of massive arsenopyrite veined by galena stringers taken from an ore pile at a pit 150 feet up the slope from the adit, assayed: gold, 1.435 ounces a ton; silver, 10.81 ounces a ton; lead, 13.46 per cent; arsenic, 35.70 per cent.

The main vein (No. 4) is followed along its strike by surface cuts and by the underground workings for 300 feet. At elevation 2,850 feet the vein is developed by an inclined shaft with levels at 100 and 160 feet down the slope. Below the second level the mine is water filled, but there is said to be a short drift from the bottom of the shaft. On the

100-foot level a drift follows the vein 45 feet south from the shaft and 132 feet north from the shaft. In the south drift the vein ranges from 4 to 10 inches in width. It consists of banded quartz with carbonate seams and contains about 2 per cent of arsenopyrite, galena, sphalerite, and tetrahedrite. A 6-inch channel sample taken across the vein on the face of the south drift assayed: gold, 0.1 ounce a ton; silver, 17.28 ounces a ton; lead, 2.35 per cent; zinc, nil; arsenic, 0.08 per cent. At the shaft the vein has a width of 10 inches and 30 feet north of the shaft at a cross fault it has widened to 3 feet. The fault strikes north 70 degrees west and dips steeply. The northerly continuation of the vein is moved 25 feet to the west along the fault. A raise is driven up for 50 feet along the vein at a point 60 feet north of the shaft and considerable ore was stoped out between the raise and the cross fault. On the north side of the raise the vein ranges from 8 to 20 inches in width, and in places carries up to 50 per cent of sulphide. An altered aplite dyke lies on the foot-wall side of the stope, but there is probably no direct relation between the ore shoot and the dyke as larger ore shoots occur elsewhere in the mine where both wall-rocks are tuffaceous sediments. A similar altered aplite dyke about 15 feet wide lies on the west side of the vein at the collar of the shaft. This dyke was intruded prior to the formation of the fault fissure along which the vein occurs, as it is cut off sharply at the vein. Numerous horizontal fault striæ along the vein indicate that movement was horizontal. About 15 feet north of the raise, on the 100-foot level, there is a minor fault that strikes north 30 degrees west and dips 15 degrees southwest, and there the northerly continuation of the vein is offset a few feet to the east. Twenty feet north of the raise, a stope from the 160-foot level breaks through the floor of the drift. A 9-inch channel sample taken across the vein from the roof of the stope, 5 feet below the floor of the 100-foot level, assayed: gold, 0.023 ounce a ton; silver, 12.02 ounces a ton; lead, 2.35 per cent; zinc, 4.98 per cent; arsenic, 3.65 per cent. A 7-inch channel sample taken across the vein at the face of the north drift, 133 feet north of the shaft, assayed: gold, 0.09 ounce a ton; silver, 19.57 ounces a ton; lead, 11.68 per cent; zinc, 0.66 per cent; arsenic, 9.90 per cent.

On the 160-foot level, the vein is developed by a drift that runs 242 feet north from the shaft. A 24-inch channel sample taken across the vein 10 feet north of the shaft, where the quartz carries about 2 per cent of sulphide, assayed: gold, a trace; silver, 0.10 ounce a ton; lead, 0.70 per cent; zinc, 1.2 per cent. Forty feet north of the shaft the vein is offset 25 feet to the west along the cross fault mentioned on the level above. There is a raise and small stope on the vein 100 feet north of the shaft, where the vein widens to 2 feet. A 20-inch channel sample taken across the vein 6 feet south of this raise assayed: gold, 0.02 ounce a ton; silver, 19.64 ounces a ton; lead, 13.41 per cent; zinc, 1.63 per cent. There is another raise 145 feet north of the shaft and there a stope about 30 feet wide extends through almost to the 100-foot level. Forty feet north of this raise the vein narrows to 12 inches and splits into two parts. The east branch pinches to 3 inches, and in a few feet passes into the east wall of the drift. The main branch ranges from 4 to 6 inches in width for 45 feet to the face of the drift and contains from 1 to 2 per cent of sulphides. A 6-inch channel sample taken across

the vein at the face of the drift assayed: gold 0.06 ounce a ton; silver, 0.21 ounce a ton. A 12-inch channel sample taken across the vein 8 feet south of the junction of the two arms of the vein assayed: gold, 0.04 ounce a ton; silver, 0.085 ounce a ton; lead, nil; zinc, nil; arsenic, 2.86 per cent.

The No. 5 or "Mullan" vein is developed by a vertical shaft 25 feet deep and a rock cut and adit 65 feet in length, which connect with the shaft. The vein has an average width of 14 inches and contains irregular ore shoots. In the shaft the vein quartz appears relatively barren. A 14-inch channel sample taken across the vein at the bottom of the shaft assayed: gold, 0.01 ounce a ton; silver, 5.38 ounces a ton. Samples of ore piled near the portal of the adit carry from 5 to 10 per cent of sulphide. The quartz gangue is cut by rusty carbonate stringers and carries galena, sphalerite, tetrahedrite, and a little chalcopyrite. A representative sample of the ore dump assayed: gold, 0.01 ounce a ton; silver, 27.89 ounces a ton; lead, 2.91 per cent; zinc, 5.64 per cent; copper, 0.62 per cent.

The vein discovered in the autumn of 1951 about 1,400 feet south-east of No. 5 vein was not seen by the writer. According to press reports (October 1951) it is a mineralized zone 50 feet long ranging from 2 to 4 feet in width. An average of four assays of samples collected from the best mineralized part of this zone across an average width of 3.2 feet gave: gold, 0.04 ounce a ton; silver, 102.36 ounces a ton; lead, 16.11 per cent; zinc, 20.7 per cent; and copper, 0.4 per cent.

Babine Group (20)

The Babine claims are on the north side of Four Mile Mountain, 3 miles north of New Hazelton. An old trail leads north to the prospect from the north end of the road to the Mohawk mine. The claims have been neglected since about 1912.

At elevation 2,000 feet a 15-inch quartz vein occurs along a fault fissure in grey, coarsely crystalline granodiorite. The vein is exposed at the surface in a small open-cut 35 feet above the portal of an adit that is driven southwest to the vein. The entrance to the adit is now blocked by a cave in. On the rock dump at the portal of the adit, there is about 10 tons of ore consisting of banded sphalerite and galena in a quartz gangue with a little chalcopyrite. The vein strikes south 50 degrees west and dips 65 degrees southwest.

A 15-inch channel sample taken across the vein in the open-cut assayed: gold, a trace; silver, 2.27 ounces a ton; lead, 2.65 per cent; zinc, nil. A representative sample collected from the 10-ton stock of hand-sorted ore assayed: gold, a trace; silver, 7.69 ounces a ton; lead, 11.02 per cent; zinc, 5.94 per cent; antimony, 0.25 per cent; copper, 0.84 per cent.

Roughly 500 feet farther east, a second adit has been driven south to explore another quartz vein in the granodiorite. The portal of this adit is also blocked by a cave in and all vein exposures are concealed by slumping in the open-cuts. Some of the grey granodiorite on the rock dump is sheared and altered, and is impregnated with fine seams of pyrrhotite. A representative sample of this rock comprised of thirty

chips picked at random from the dump assayed: gold, a trace; silver, nil. A sample of ore representative of a small amount scattered on the dump assayed: gold, 0.06 ounce a ton; silver, 2.25 ounces a ton; lead, 3.42 per cent; zinc, 9.00 per cent; antimony, 1.14 per cent.

Barber Bill Group (5)

(Crown Silver Lead Mines Limited)

References: Ann. Repts., Minister of Mines, B.C.: 1910, p. 87; 1917, p. 107; 1928, p. 155.

The Barber Bill claims are on the east side of Silver Cup Basin on the north side of Nine Mile Mountain. Silver Cup Basin is reached by way of the Nine Mile Mountain road, which reaches the lower end of the basin, at an elevation of 3,400 feet, by a series of switchbacks. From the road, a good trail about 1 mile long leads up to the lower workings, which are situated in the timber. W. S. Harris and associates carried out a little development work on this property in 1928. C. H. Schwerdt restaked eighteen claims of the group in 1948, and optioned the prospect to Crown Silver Lead Mines Limited, a subsidiary of Transcontinental Resources Limited. Surface work was carried out during the 1951 season by C. D. McCord, for the company, on both the Barber Bill and Lead King groups of claims.

At an elevation of 4,100 feet, a vein is exposed by stripping and by open-cuts for about 375 feet along the steep east slope of the basin. It is enclosed in fine-grained, bedded greywacke just north of the northwest end of the granodiorite stock that intrudes the sedimentary rocks on this side of the mountain. The vein strikes north, dips from 18 to 30 degrees east into the mountain, and ranges in width from 4 inches to 4 feet. It lies along a fault that closely follows the bedding of the greywacke. The vein is essentially a replacement of the greywacke along both sides of the fissure by very finely crystalline jamesonite, sphalerite, galena, and arsenopyrite. A little vein quartz and fine pyrite are associated with these sulphides along the original fissure.

Midway along its strike the vein is explored by a 45-foot adit, with a shallow winze, at the face. In the adit the vein has an average width of 2 feet, widening to 4 feet for a short distance where it is joined by a divergent fracture. A 24-inch channel sample taken across the vein near the winze assayed: gold, 0.045 ounce a ton; silver, 14.89 ounces a ton; lead, 5.67 per cent; zinc, 12.50 per cent; antimony, 2.22 per cent; arsenic, 8.15 per cent; and cadmium, 0.1 per cent.

In a trench 125 feet north of the adit, the vein is 1 foot wide and consists mostly of altered greywacke replaced by jamesonite. An 11-inch channel sample taken there across the vein assayed: gold, 0.03 ounce a ton; silver, 9.91 ounces a ton; lead, 5.88 per cent; zinc, nil; antimony, 1.91 per cent.

In an open-cut 150 feet south of the adit, the vein fissure carries little ore and the wall-rocks are sparsely mineralized. The granodiorite stock lies between 50 and 75 feet south of this cut, but the actual contact is talus covered.

A published report (January 1952) by Crown Silver Lead Mines Limited, states that ten samples collected from a section of the vein 70 feet long commencing at the portal of the adit gave the following average assay across an average width of 2.02 feet: silver, 23.76 ounces a ton; lead, 6.90 per cent; and zinc, 8.26 per cent. Eighteen samples collected from a second vein 1,600 feet farther south, at an elevation of 4,750 feet, gave the following uncut averages over a length of 250 feet and width of 1.84 feet: silver, 8.32 ounces a ton; lead, 3.02 per cent; and zinc, 5.37 per cent.

Black Prince Property (31)

References: Ann. Repts., Minister of Mines, B.C.: 1913, p. 107; 1914, p. 205; 1916, p. 117; 1918, p. 113; B.C. Dept. Mines, Bull. No. 10, pp. 67-70, 1943. Geol. Surv., Canada: Mem. 110, p. 25; Sum. Rept. 1924, pt. A, p. 45.

The Black Prince property is on Rocher Déboulé Mountain 6 miles south of New Hazelton. A branch road 1 mile in length leaves the highway about 6 miles southeast of New Hazelton and extends southwest to the foot of the mountain, from where a pack-horse trail 5 miles long follows up the north side of Mudflat Creek Valley to the prospect. The cabin is on a flat bench at an elevation of 4,150 feet between two small cirque-lakes, and the workings lie a short distance to the south on a steep shoulder of the mountain. The property consists of eight claims that are currently (1951) recorded as the Eriksen group. Mrs. B. Sargent of New Hazelton is the owner.

A shear zone containing tungsten and molybdenum minerals occurs in the granodiorite about 1,500 feet southwest of the contact of the Rocher Déboulé granodiorite stock with sedimentary rocks of the Hazelton group. The shear zone strikes north 30 degrees west and dips from 50 to 70 degrees southwest. It ranges in width from 1 foot to 8 feet, and contains from one to four parallel quartz veins from 2 to 18 inches wide. The quartz veins and the sheared and altered granodiorite are mineralized with various amounts of scheelite, pyrite, chalcopyrite, molybdenite, wolframite, and ferberite.

The vein-lode extends up steep rock bluffs between elevations of 4,650 and 5,000 feet. Below 4,650 feet it is largely covered by talus, but a narrow quartz vein exposed by stripping between altitudes of 4,500 and 4,550 feet may represent one of the downward diverging fault planes of the shear zone. Above 5,000 feet, the vein-lode follows along fairly level ground for 500 feet. It is exposed for the first 100 feet along the level bench by open-cuts, but is covered by drift for the next 400 feet. The drift area ends against steep, unscalable granodiorite bluffs where the vein-lode cannot be examined above an elevation of 5,100 feet. The indicated over-all length of the veined zone is 900 to 1,000 feet, and it has a vertical range of more than 600 feet.

In the lowest rock cut, at an elevation of 4,700 feet, the vein-lode ranges from 1 foot to 3 feet in width. It is rust stained, and across a width of 6 inches along the hanging-wall side is impregnated with pyrite and a little molybdenite and scheelite.

An adit is driven 35 feet along the sheared zone at an elevation of 4,900 feet. This work was done by Frank Meryth for the Privateer Mining Company in 1944. A 12-inch channel sample, collected by the writer across

the vein-lode at the face of the adit, assayed: tungsten trioxide, 0.38 per cent; molybdenum, 0.14 per cent; gold, 0.02 ounce a ton; tin, none. It was impossible for the writer to determine the amount of scheelite exposed by the adit with the ultra-violet lamp as the walls were too caked with dust at the time of his visit.

In a large open-cut at elevation 4,950 feet the vein-lode is about 6 feet wide. From east to west it consists of: 6 inches of sheared granodiorite replaced by quartz that carries from 1 to 2 per cent scheelite; 4 feet of altered granodiorite; 12 inches of sheared granodiorite replaced by honey-comb quartz and containing pyrite, scheelite, and ferberite; a 20-inch, porphyritic diorite dyke that pinches out at the top of the cut; and a 4-inch vein containing a little pyrite and chalcopyrite. Sericite crystals up to an inch long occur locally along the hanging-wall of the 4-inch vein. Several scheelite crystals an inch in diameter and a nodule of intergrown wolframite and scheelite 2 inches in diameter were found in the cellular quartz near the floor level of the open-cut when the property was visited by the writer in 1938.

In an open-cut 12 feet long at the top of the rock bluffs, at elevation 5,000 feet, 12 to 18 inches of sugary, leached vein quartz contains a little molybdenite, chalcopyrite, pyrite, scheelite, and ferberite. The scheelite is largely concentrated along a band 4 inches wide along the foot-wall at the south end of the cut. A 12-inch channel sample taken across the vein at the south end of the cut assayed: tungsten trioxide, 0.38 per cent; molybdenum, 0.11 per cent; tin, none; gold, 0.005 ounce a ton.

Two parallel quartz veins about 6 feet apart mark the course of the shear zone some 500 feet farther south where the zone extends over unscalable rock bluffs. The hanging-wall vein ranges from 12 to 16 inches in width where the vein was examined, at elevation 5,100 feet, whereas the quartz vein on the foot-wall side is only a few inches wide. Both quartz veins contain scheelite, some pyrite, and a little molybdenite, and in the wider vein the scheelite is concentrated along or near the foot-wall. The scheelite is white and occurs in grains up to an inch long. A 14-inch channel sample taken across the larger quartz vein assayed: tungsten trioxide, 0.34 per cent; molybdenum, 0.21 per cent; gold, 0.035 ounce a ton.

A block of vein quartz 10 inches thick, which had fallen down from higher up the slope, contained about 3 per cent scheelite.

The No. 2 vein outcrops between elevations of 4,300 and 4,400 feet about 1,500 feet south of the cabin camp. At an elevation of 4,300 feet, an adit was driven south along this vein for 110 feet about 40 years ago, but no work has been done since. The vein strikes north 30 degrees west and dips 65 degrees southwest. It is a quartz vein, and though narrow, ranging from 2 to 10 inches in the adit, is very persistent. It is a quartz-filled fissure along a fault line in the granodiorite. The quartz carries chalcopyrite, pyrite, and scheelite in appreciable amount as well as some cassiterite and uraninite. The chalcopyrite is most plentiful where the vein is widest, but scheelite comprises 2 to 3 per cent of the vein matter throughout the length of the adit. Only a section of the vein 12 feet long, beginning 10 feet from the portal, contains sufficient uraninite to affect the Geiger counter. A sample taken across 3 inches of the vein 18 feet from the portal assayed: tungsten trioxide, 2.37 per cent; tin, 0.8 per cent;

gold, 0.03 ounce a ton; U_3O_8 equivalent, 0.039 per cent. A sample collected in the adit 88 feet from the portal, where the vein is 4 inches wide, assayed: tungsten trioxide 1.10 per cent; tin, 1.3 per cent; gold, 0.155 ounce a ton; U_3O_8 equivalent, 0.005 per cent.

According to the Annual Report of the Minister of Mines for British Columbia, 1916 (Galloway), there is an open-cut 10 feet above the adit on a vein 4 feet wide slightly mineralized throughout, with 10 inches of well-mineralized vein matter on the foot-wall. A sample collected by Galloway across the 10-inch zone assayed: gold, 0.14 ounce a ton; silver, 2 ounces a ton; copper, 11.2 per cent. Galloway was not sure whether the adit and open-cut were made on the same or on separate veins, and this has still to be determined.

Blue Lake Group (30)

The Blue Lake group of ten claims is on the east slope of Rocher Déboulé Mountain about 7 miles south of New Hazelton station. The property is reached by way of a mile-long branch road that leaves the highway 5 miles southeast of New Hazelton and by a pack-horse trail 5 miles long that follows along the north side of Mudflat Creek to the Black Prince camp, at elevation 4,150 feet. The claims are owned by Louis A. Parent of New Hazelton and O. L. Skogland of Zeballos.

Two veins little more than 100 feet apart are exposed in steep granodiorite bluffs between elevations of 5,450 and 5,600 feet at the head of a high mountain valley a mile southwest of the Black Prince workings at the head of Mudflat Creek. The more easterly, or No. 1, vein strikes north 75 degrees west and dips 65 degrees northeast. At the foot of the steep rock face the vein consists largely of white milky vein quartz from 4 to 10 inches wide, and the quartz contains up to 10 per cent tetrahedrite and a little chalcopyrite. The No. 2 vein is exposed for 150 feet up the steep rock bluffs and at intervals for about 500 feet south from the top of the bluffs on ground that slopes gently southeast. This vein strikes from north 15 to 35 degrees west and dips at about 70 degrees to the southwest. Along the steep face of the bluff the vein ranges in width from 1 foot to 3 feet, and consists largely of sheared granodiorite and vein quartz that carries small amounts of molybdenite. The precipitous nature of the ground prevented examination for scheelite with the ultra-violet lamp along this part of the vein, and some may occur there. On the gently sloping ground about 50 feet south of the top of the rock bluffs, a shallow trench at an elevation of 5,600 feet discloses a vein 5 feet wide. The vein quartz in this trench carries a little scheelite, molybdenite, and chalcopyrite. Farther south the vein is well exposed for 100 feet at an elevation of 5,525 feet. There, it ranges in width from 6 to 14 inches, and is composed largely of quartz that in most places carries from 0.25 to 2.0 per cent scheelite, roughly equal amounts of molybdenite, and a little chalcopyrite. The scheelite occurs as white crystals, most of which are less than $\frac{1}{2}$ inch in diameter. Much of the scheelite is concentrated along one or more dark bands in the vein quartz. The dark bands are about an inch wide, and are the loci of fracturing by fault movement parallel with the strike and dip of the vein. Some open cavities

occur along the dark bands, and these are lined with small euhedral quartz and scheelite crystals. The dark colour appears to be due to the presence of many minute chloritized hornblende crystals.

A typical specimen of the vein material from near the south end of the 100-foot exposure of the vein assayed: molybdenum, 0.85 per cent; tungsten trioxide, 1.00 per cent; gold, a trace. A radioactive test on this sample disclosed a U_3O_8 equivalent content of 0.004 per cent.

Approximately 300 feet south of the 100-foot vein exposure, bedrock is again exposed for a few feet and there the vein was seen to be only 2 inches wide and to consist solely of hornblende gangue with a sprinkling of white scheelite crystals along a central fracture.

The No. 2 vein is everywhere enclosed in the Rocher Déboulé granodiorite stock, but lies 6 feet southwest of a 25-foot dyke of feldspar porphyry for a distance of more than 100 feet, where the rocks are well exposed at an elevation of 5,525 feet. A 2-inch quartz stringer on the southwest wall of the dyke appears to be barren of other minerals.

The No. 3 vein lies about 2,000 feet northwest of the No. 2 vein, at an elevation of 5,800 feet. It strikes north 15 degrees west and dips 75 degrees southwest into the mountain. It is exposed in a rock trench at the top of steep granodiorite bluffs and outcrops northwesterly along very precipitous ground at the top of the bluffs. In the rock trench, the vein consists of about 1 foot of vein quartz and 1 foot of sheared granodiorite, with the vein quartz sandwiched between the sheared granodiorite and a trap dyke 18 to 24 inches wide. The vein quartz is somewhat honeycombed, and contains an abundance of scheelite, and a little molybdenite and chalcopyrite. The sheared granodiorite on the hanging-wall contains small amounts of scheelite, and in one place a little scheelite was seen across a width of 2 inches in the altered rock on the foot-wall side of the trap dyke. A typical hand specimen of the vein quartz from the hanging-wall, assayed: gold, 0.08 ounce a ton; tungsten trioxide, 11.31 per cent; molybdenum, 0.06 per cent. A radioactive test made on the hand specimen prior to grinding gave 0.004 per cent U_3O_8 equivalent.

Small pockets of dark-coloured altered hornblende and chlorite occur in this vein, and in some places a little scheelite is associated with these dark minerals. A little ferberite may be present. A hand specimen of this dark material assayed: tungsten trioxide, 0.46 per cent; molybdenum, 0.21 per cent; manganese, none; iron, 19.48 per cent. A radioactive test of the specimen gave only 0.002 per cent U_3O_8 equivalent.

Freshly broken samples of vein quartz from the hanging-wall contain white scheelite crystals up to 1 inch or more in length, but on weathered surfaces some of the scheelite crystals display a yellow to yellowish green hue owing to their partial alteration to the hydrated tungstic oxides, tungstite and meymacite.

According to information received from O. L. Skogland, another tungsten-bearing vein was found late in the summer of 1951. He states that it lies 200 feet above the No. 3 vein and that it also strikes northwest and dips southwest. Skogland collected a sample across 15 inches that assayed 5.5 per cent tungsten trioxide. A molybdenum-bearing vein is said to occur another 100 feet higher on the mountain.

Another vein is exposed on precipitous ground about 300 feet below the No. 3 vein. Skogland reports that it is 5 to 10 feet wide, is exposed for 75 feet, and strikes northwest and dips northeast at about 60 degrees. He describes it as composed mostly of a mixture of fine-textured, milky white quartz with some inclusions of brecciated wall-rock (granodiorite), the quartz containing small specks and streaks of grey copper (tetrahedrite). A representative sample collected by Skogland from the vein outcrop assayed: gold, 0.02 ounce a ton; silver, 55.4 ounces a ton.

Brian Boru Group (41)

References: Ann. Repts., Minister of Mines, B.C.: 1914, p. 191; 1926, p. 127. Geol. Surv., Canada, Mem. 110, 1919, p. 19.

The Brian Boru group is 7 miles southeast of Skeena Crossing at the head of Brian Boru Creek, north-flowing tributary of Juniper Creek. The claims are reached by following the Skeena Crossing-Rocher Déboulé mine road for 5 miles to where a pack-trail, 4 miles long, follows Brian Boru Creek to a cabin on the south fork of the creek at elevation 4,000 feet. The workings are on the southwest side of a spur that separates the south and east forks of the creek, half a mile southeast of the cabin. The claims are owned by J. Creagh.

At elevation 5,175 feet a 15-foot adit is driven northeast along an aplite sill, 3 feet in width, that intrudes interbedded sandstones and argillites. The sediments and sill strike north and dip 35 degrees east. The sediments are rust stained at their contacts with the sill, but contain only small amounts of disseminated pyrite.

A sulphide vein outcrops 200 feet farther east at elevation 5,280 feet. The vein is 60 feet long and ranges from 3 to 12 inches in width. It consists largely of solid black sphalerite with some pyrite. The vein strikes northeast and dips 45 degrees northwest. It lies in bedded greywacke, which strikes north 30 degrees west and dips 15 degrees northeast. An 8-inch channel sample taken across a particularly rich section of the vein in a small open-cut assayed: gold, 0.015 ounce a ton; silver, 1.36 ounces a ton; zinc, 41.95 per cent.

Another sphalerite vein of similar appearance occurs 150 feet farther east and 60 feet farther up the slope. This vein, prospected by one open-cut, is 35 feet long and is from 3 to 12 inches wide. It strikes north 80 degrees east and dips 50 degrees north. At the open-cut near the centre of the vein, the rock on the north side is slightly sheared over a width of 6 feet and is traversed by small seams of pyrite.

In an open-cut 200 feet farther east, at elevation 5,440 feet, there is a sheared zone 6 feet wide that contains numerous stringers of black sphalerite, one of which attains a width of 4 inches. The shearing is very weak and the sulphide stringers pinch out a short distance on either side of the open-cut. A similar sheared zone containing scattered sphalerite stringers over a width of 10 feet, occurs 50 feet below and 75 feet farther along the slope. These sphalerite stringers pinch out 10 feet on either side of an open-cut that exposes the greatest width of mineralization.

Roughly 800 feet farther east along the southeast side of the spur, a relatively strong vein occurs in volcanic rocks. This vein has been traced by four open-cuts for 300 feet up the steep slope between elevations of 5,475

and 5,700 feet. The vein strikes northeast and dips 65 degrees northwest. It consists largely of black sphalerite with a little galena, pyrrhotite, and chalcopyrite. In general the vein is from 3 to 12 inches wide, but in several places the fissure is tight, with no vein filling. A 6-inch channel sample taken across the vein in the second open-cut, at elevation 5,575 feet, assayed: gold, a trace; silver, 6.43 ounces a ton; lead, 1.84 per cent; zinc, 11.27 per cent.

On the valley floor, at elevation 5,200 feet, below the last-described workings, a number of small veins have been prospected by open-cuts. The veins lie along small fissures of varying strike and dip in volcanic rocks. They are composed largely of sphalerite with considerable pyrrhotite and some pyrite. Most of them are less than 50 feet in length.

Brunswick Group (39)

(Skeena Silver Mines, Limited)

References: Ann. Repts., Minister of Mines, B.C.: 1914, p. 191; 1925, p. 134; 1926, p. 126.

The Brunswick group, consisting of the Kaslo and Brunswick claims, is on Rocher Déboulé Mountain 10 miles northeast of Skeena Crossing railway station. The claims are on the north side of the valley at the head of Balsam Creek, and adjoin the Red Rose property on the south-east. They are accessible by way of the road to the Red Rose camp. Joe Miller of South Hazelton held these claims from 1912 until his death in 1940. The property was restaked by Skeena Silver Mines, Limited, in 1951 and other claims were added to the group. Some diamond drilling and surface work were done along the vein in 1952.

The claims are underlain mainly by poorly bedded sedimentary rocks, largely argillites, hornfels, and greywacke, all somewhat altered by proximity to the large granodiorite stock that forms the core of Rocher Déboulé Mountain less than a mile to the east. Near the vein on the Brunswick claim, the strata strike northeast and dip 45 degrees southeast. The beds are intruded by a small diorite stock that extends for several hundred feet along the creek at an elevation of 4,725 feet.

A quartz vein occurs in a fault fissure on the east bank of the stream on the Brunswick claim. It is prospected by two adits, the lower at elevation 4,450 feet and the upper at elevation 4,540 feet, 200 feet farther up the 29-degree slope. The lower adit is 155 feet long, and the upper one, caved at the portal when examined in 1951, is said to be 90 feet long. In the lower adit the vein ranges from 1 foot to 3 feet in width and contains from 1 to 4 per cent sphalerite, galena, and tetrahedrite. The vein strikes north 60 degrees east and dips 55 degrees northwest. A representative sample of the mineralized vein quartz collected from a large heap on the dump assayed: gold, 0.005 ounce a ton; silver, 7.72 ounces a ton; lead, 0.76 per cent; zinc, 0.78 per cent. At the portal of the upper adit is a pile of vein quartz measuring 20 by 15 by 3 feet, containing an average of 10 per cent sphalerite, galena, tetrahedrite, chalcopyrite, and pyrite. There are also thirty bags of selected ore that contains about 75 per cent of these sulphides. A representative sample collected from several of these bags assayed: gold, 0.03 ounce a ton; silver, 110.89 ounces a ton; copper, 1.91 per cent; lead, 17.27 per cent; zinc, 28.40 per cent.

Farther up the hill, on the Kaslo claim, a quartz vein 18 inches wide is exposed in an open-cut 20 feet long with a 15-foot face. An average sample collected in 1914 from the dump of this cut is reported to have assayed: gold, 0.02 ounce a ton; silver, 18 ounces a ton; lead, 8 per cent; zinc, 4.6 per cent.

Cap or Comeau Group (27)

References: Ann. Repts., Minister of Mines, B.C.: 1914, p. 200; 1916, p. 90; 1917, p. 107; 1929, p. 155. Geol. Surv., Canada, Mem. 110, 1919, p. 23.

The Belton and Cap claims, owned by Denis Comeau, are on the northwest slope of Rocher Déboulé Mountain 4 miles south of New Hazelton. A good trail leads up to the property from Comeau's ranch at the foot of the mountain.

A little development work was done on a mineralized, sheared zone on this property each year from 1914 until 1918. During 1917 a 29-ton shipment of ore was made to Ladysmith smelter, an average sample of which assayed: gold, 0.03 ounce a ton; silver, 10 ounces a ton; copper, 8 per cent. Some further work was done in 1929.

A brecciated and sheared zone crosses fine-grained tuffs. The sheared rock is partly replaced by siderite and a little quartz and is impregnated with considerable pyrite and a little chalcopyrite. It has been traced by open-cuts and natural exposures for a distance of 350 feet between elevations of 2,165 and 2,225 feet. The zone strikes north 70 degrees east and dips from 70 to 80 degrees northwest. It ranges from 6 inches to 4 feet in width.

Near its northeast end a crosscut adit has been driven 76 feet southeast to the zone and a drift extends along the zone. At a distance of 27 feet southwest of the crosscut, a raise from the drift connects with No. 1 shaft. The distance from the top of the raise to the floor of the adit is 35 feet. An ore shoot 30 inches wide, which was encountered in the raise, furnished the ore shipped in 1917. According to the 1916 report of the Minister of Mines, B.C., an average sample taken across 30 inches in the raise at that time assayed: gold, a trace; silver, 3.2 ounces a ton; copper, 3.7 per cent.

On the surface the zone narrows northeast of the shaft. A 6-inch channel sample collected by the writer across the full width of the zone in an open-cut 25 feet northeast of the No. 2 shaft assayed: gold, 0.01 ounce a ton; copper, 2.05 per cent.

No. 2 shaft, 10 feet in depth, is 200 feet southwest of the No. 1 shaft. A heap of low-grade ore piled alongside the shaft consists of tuff replaced by siderite, quartz, calcite, and pyrite with a little chalcopyrite. Ten feet southwest of the shaft there is a 12-foot open-cut in which the sheared zone is 40 inches wide. A 40-inch channel sample taken across the zone in this cut assayed: gold, a trace; silver, 1.39 ounces a ton; copper, 0.05 per cent.

At elevation 1,975 feet, 440 feet southwest of No. 2 shaft, an adit is driven 206 feet in a northeast direction. The adit cuts a number of small mineralized fractures, none of which continues over 25 or 30 feet. Although the adit is on the line of strike of the main zone as projected

from No. 2 shaft, it has evidently failed to intersect it. At No. 2 shaft the zone dips 70 degrees northwest, and as the adit is 190 feet below No. 2 shaft the zone should lie about 75 feet farther northwest at the adit level. This being so, a crosscut driven northwest from the face of the adit should intersect the sheared zone.

Comet Group (22)

References: Ann. Repts., Minister of Mines, B.C.: 1920, p. 87; 1928, p. 158; 1929, p. 159.

This group of three claims is on the south side of Four Mile Mountain $5\frac{1}{2}$ miles east of Hazelton. The claims are reached by a road, 3 miles long, that joins the Hazelton highway at Two Mile Creek. The property was first prospected by Tommy Stevenson and Jim Dyer about 1920 and work was carried on periodically for several years. In 1929 small-scale operations were conducted by Bulkley Mines, Limited, but no work has been done since.

Massive, coarsely crystalline, grey granodiorite is exposed in the main workings (See Figure 3). The granodiorite is traversed by numerous intersecting fault planes and shear zones that strike chiefly from northwest to northeast and dip from 15 to 60 degrees. Quartz veins occur along some of the fault fissures and sheared zones and contain various amounts of jamesonite, sphalerite, galena, and pyrite. Jamesonite is the most abundant mineral present. Assays show that the jamesonite and galena are silver bearing. Some of the veins contain much siderite gangue, and those veins in and close to a body of quartzite and greywacke consist almost entirely of siderite holding jamesonite and sphalerite.

The main crosscut adit, at elevation 1,200 feet, is driven 147 feet north. For most of this distance fault fissures of small displacement containing quartz vein lenses from 1 inch to 3 inches in width are followed. At 65 feet from the portal a drift runs 88 feet northeast along a quartz vein that dips from 15 to 30 degrees southeast. This vein ranges from 6 to 9 inches in width, consists principally of quartz gangue with a little siderite, and carries about 10 per cent jamesonite and 5 per cent pyrite. A 6-inch channel sample taken across the vein at the face of the drift assayed: gold, 0.015 ounce a ton; silver, 1.46 ounces a ton; lead, 5.36 per cent; antimony, 2.41 per cent. A 9-inch channel sample taken across this vein 60 feet southwest from the face of the drift assayed: gold, 0.01 ounce a ton; silver, 0.34 ounce a ton; lead, 0.51 per cent; antimony, 0.32 per cent. Forty feet from the portal of the main adit a branch crosscut and drift runs 70 feet northeast and follows another vein for about 35 feet. This vein strikes north 80 degrees east and dips 25 degrees south. It ranges from 4 to 9 inches in width and consists of quartz gangue carrying considerable jamesonite and pyrite with a little galena and sphalerite. At the face of the drift, the vein is cut off by a strong post-mineral fault striking north 70 degrees east and dipping 60 degrees southeast.

About 30 feet above the main adit a 15-foot shaft is sunk on a vein that strikes north and dips 70 degrees east. In a cut 25 feet north of the shaft this vein is much richer at its intersection with a 3-inch cross vein that strikes north 55 degrees east and dips 55 degrees southeast. The ore

gangue is largely siderite with a little quartz and the siderite is impregnated with finely crystalline jamesonite and with irregular masses of solid sphalerite. There is somewhat over 5 tons of ore piled near the shaft, a representative sample of which assayed: gold, a trace; silver, 78.69 ounces a ton; lead, 7.97 per cent; zinc, 12.95 per cent; antimony, 3.53 per cent; bismuth, nil; tin, 0.07 per cent; arsenic, a trace.

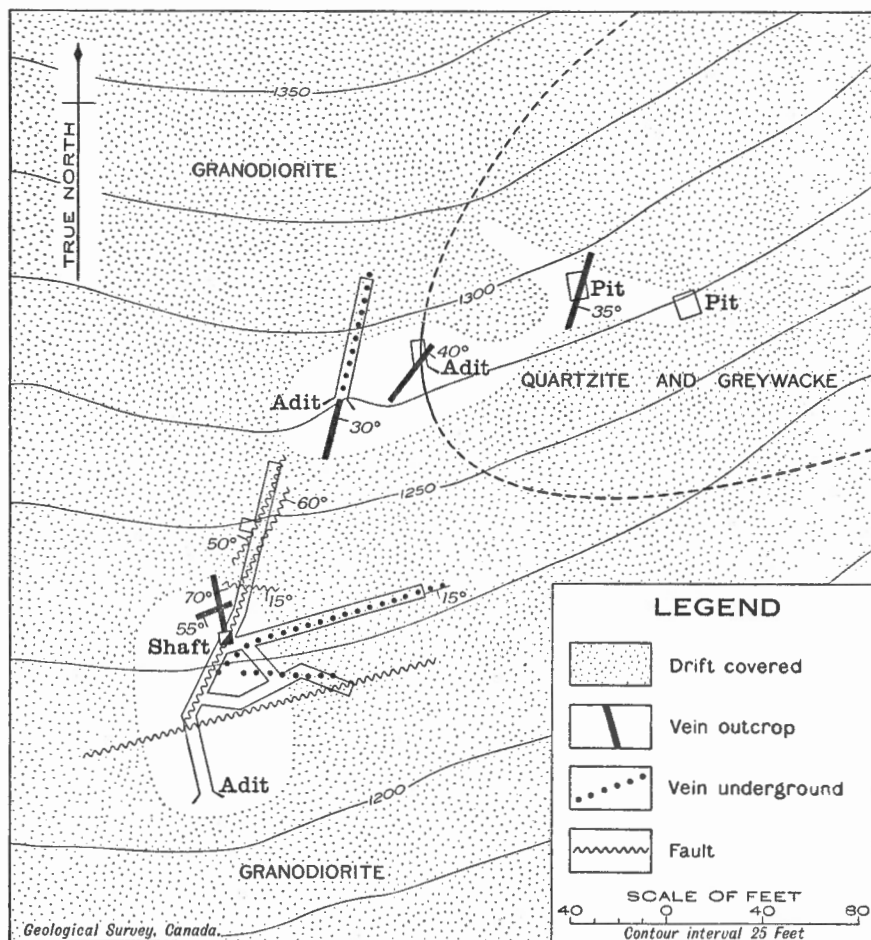


Figure 3. Plan of part of Comet group.

No. 2 adit, at elevation 1,275 feet is 52 feet in length. It follows north along a quartz vein that strikes north 20 degrees east and dips from 30 to 50 degrees southeast. The vein ranges from 4 to 10 inches in width and is well mineralized with jamesonite and sphalerite, with a little galena and pyrite. Near the portal the jamesonite is spotted with stibiconite, a characteristic yellow oxidation product. At the portal a parallel fault fracture, which lies 4 feet above the vein, contains no vein matter. A

10-inch channel sample taken across the vein in the adit 11 feet from the portal assayed: gold, 0.01 ounce a ton; silver, 8.68 ounces a ton; lead, 1.22 per cent; zinc, 2.29 per cent; antimony, 0.47 per cent; bismuth, nil. Four feet from the face of the adit, a 4-inch channel sample taken across the vein assayed: gold, a trace; silver, 0.22 ounce a ton; lead, 0.36 per cent; antimony, 0.13 per cent; arsenic, 0.25 per cent.

A 10-foot adit 35 feet northeast of No. 2 adit is on the contact of the granodiorite with a body of sedimentary rocks extending to the east. The sediments are largely concealed by a light drift cover of sand and gravel. In the 10-foot adit a siderite vein passes from the granodiorite into impure quartzite. The vein ranges from 4 to 10 inches in width where exposed for 20 feet in the granodiorite, but pinches to 1 inch in a few feet on entering the quartzite. The vein is dark due to fine replacement of the carbonate by jamesonite. Sphalerite of resinous appearance is present in large, plum-like masses, and its colour blends with the rust from the oxidation of the siderite. A 6-inch channel sample taken across the vein at the portal of the adit assayed: gold, 0.005 ounce a ton; silver, 16.01 ounces a ton; lead, 7.82 per cent; zinc, 2.34 per cent; antimony, 3.68 per cent.

Seventy feet farther northeast a very similar carbonate vein ranging from 2 to 8 inches in width is exposed in an open-cut in greywacke. The vein strikes north and dips 35 degrees east. It is exposed for 60 feet along the slope. A 6-inch channel sample taken across the vein in the cut assayed: gold, nil; silver, 1.32 ounces a ton; lead, 5.67 per cent; zinc, a trace; antimony, 2.51 per cent; bismuth, nil; arsenic, nil.

Daley West Group (24)

References: Ann. Rept., Minister of Mines, B.C., 1916, p. 116. Geol. Surv., Canada, Mem. 110, 1919, p. 25.

The Daley West property is on the east side of Mission Creek, 2 miles south of New Hazelton. A wagon road was constructed to the property in 1916 and the Spokane Rocher Déboulé Mining and Copper Company explored the vein by driving two adits.

The claims are near the northern end of the porphyritic granodiorite boss that forms the core of Rocher Déboulé Mountain. The granodiorite is a coarsely crystalline grey rock with conspicuous phenocrysts of brown biotite and light-coloured plagioclase (zoned, ranging andesine to oligoclase) in a groundmass of quartz and orthoclase. A quartz fissure vein occurs in the granodiorite between elevations of 2,000 and 2,400 feet, following a strong fault plane. The wall-rocks are altered and silicified and bear sulphides over widths up to 1 foot. Both vein and wall-rock carry up to 50 per cent of pyrite and arsenopyrite with a little chalcopyrite, but the average sulphide content of the vein as a whole does not exceed 5 per cent.

The main adit, at elevation 2,175 feet, is driven 235 feet southerly along the vein. In the adit the quartz vein strikes south 30 degrees west and dips 65 degrees northwest. The vein has an average width of 6 inches, and with the additional mineralized wall-rock in many places approaches 3 feet in width. An 18-inch channel sample taken across the vein 45 feet

from the portal of the adit assayed: gold, 0.06 ounce a ton; silver, 0.27 ounce a ton; copper, 0.05 per cent. A 7-inch channel sample taken 12 feet from the face of the adit, where the deposit is largely silicified and pyritized altered granodiorite, assayed: gold, 0.025 ounce a ton; silver, 0.38 ounce a ton; copper, 0.63 per cent. A 15-inch channel sample taken across the vein in the face of the adit assayed: gold, 0.04 ounce a ton; silver, 1.37 ounces a ton; copper, 1.92 per cent; tungsten, none; uranium, none.

The lower adit, 125 feet vertically below the main adit, is now caved about the portal and could not be examined. It is described by O'Neill (1919) as follows.

"The lower tunnel is 155 feet long and follows two small stringers which are 2 to 3 feet apart and separated by partly decomposed granite; farther in the tunnel the stringers join and then separate as before. Each of the stringers carries an inch or two of chalcopyrite."

The vein is exposed at intervals above the main adit by four open-cuts on a 40-degree slope, the top cut being at elevation 2,300 feet. Above the topmost cut the vein is concealed by talus.

Erie Group (Mohawk Mine) (21)

References: Ann. Repts., Minister of Mines, B.C.: 1909, p. 84; 1910, p. 87; 1911, p. 102; 1914, p. 200; 1920, p. 87; 1925, p. 133; 1927, p. 132; 1928, p. 156; 1929, p. 158. Geol. Surv., Canada, Sum. Repts.: 1909, p. 66; 1912, p. 103.

The Erie group of four Crown-granted claims is on the west side of Four Mile Mountain, about 5 miles by motor road east from Hazelton. The original owner, E. L. Kinman of Vancouver, carried out small-scale development operations between 1909 and 1914, and commenced the driving of the main crosscut adit at elevation 2,000 feet (*See* Figure 4, in pocket). This adit was continued in 1920 from the 200-foot mark to nearly 500 feet. Some drifting was done on the main vein by W. S. Harris in 1925 and by E. G. Brown in 1927. The property was optioned to Federal Mining and Smelting Company for a short time in 1928. Mohawk Mining Company, Limited, continued underground development work in 1928 and shipped 69 tons of hand-sorted and hand-jigged silver-lead-zinc ore. An additional 30 tons of ore was shipped in 1929. Operations were suspended in the autumn of 1929 after completing 745 feet of crosscutting and 940 feet of drifting in the main adit, with a 175-foot air raise to the surface at a point 885 feet from the portal.

The veins occur along faults in intensely altered and recrystallized tuff and sandstone beds, which are intruded by coarsely crystalline, grey granodiorite. Many of the veins lie in faults along the contact of the altered sediments and the intrusive granodiorite or in the altered sediments close to the granodiorite, and narrow after a few feet on entering the intrusive. The granodiorite is part of the boss-shaped body 1 mile in diameter that forms Four Mile Mountain. The main workings are in the tip of a tongue-like body of the altered sedimentary rocks that extends eastward into the granodiorite. The shape of this body is open to question, but judging from the surface outcrops and the underground exposures it is approximately 500 feet across from north to south in the vicinity of the workings and its

outline is indented by abundant apophyses of the granodiorite. The sediments are also cut by a few small dykes of biotite aplite, which are exposed in the main adit. Three veins striking northeast and dipping from 30 to 65 degrees southeast are prospected by the workings in the tongue-like body of altered tuff and sandstone. A fourth vein, also striking northeast and dipping about 60 degrees southeast, is prospected by a shaft and trenches in an isolated body of altered tuff about 800 feet northeast of the main vein exposure. The veins range from 4 inches to 4 feet in width and from 100 to 450 feet in length. They are composed of a gangue of banded quartz and siderite, for the most part very sparsely mineralized, but there are a number of small, rich ore shoots of erratic distribution. The ore minerals in order of abundance are, jamesonite, sphalerite, pyrite, galena, and tetrahedrite. Assays show a high silver content and appreciable amounts of antimony in the high-grade shoots, in addition to lead and zinc.

The main vein is exposed by trenches and open-cuts for 210 feet along the surface at elevation 2,080 feet. To the southwest the vein terminates at a cross fault that strikes north 80 degrees east and dips 30 degrees southeast. The fault is at the east end of a 140-foot rock trench 12 feet deep in the altered sediments. Thirty feet north of the fault, a shaft inclined at 65 degrees is sunk 38 feet on the vein. From the bottom of the shaft a drift follows the vein northeast for 130 feet. The vein ranges in width from 12 inches at the shaft to 4 feet at the north face of the drift. The quartz gangue carries from 2 to 10 per cent of jamesonite, sphalerite, galena, and tetrahedrite. The vein is stoped out above this level for 40 feet along the vein, beginning 65 feet north of the shaft. Along the surface the vein ranges from 1 foot to 3 feet in width and carries disseminated sulphides with occasional narrow seams of high sulphide content within the wider vein. In a rock cut 45 feet north of the shaft the vein consists of 16 inches of vein quartz with a 4-inch seam near its centre, rich in sulphides. A sample from the 4-inch seam assayed: gold, 0.01 ounce a ton; silver, 38.6 ounces a ton; lead, 7.24 per cent; zinc, 15.04 per cent; antimony, 0.25 per cent; arsenic, 0.14 per cent. In a pit 30 feet farther northeast the vein carries about 3 per cent of sulphides throughout its width of 30 inches, and there is in addition a central 3-inch sulphide seam. In the most northerly pit, 130 feet north of the 38-foot shaft, the vein consists of about 50 per cent quartz and 50 per cent brecciated, altered, tuffaceous wall-rock, containing about 5 per cent of sulphides. A 30-inch channel sample taken across the vein in this pit assayed: gold, 0.01 ounce a ton; silver, 1.73 ounces a ton; lead, 0.41 per cent; zinc, 0.56 per cent; antimony, 0.25 per cent; arsenic, 2.37 per cent.

In the long crosscut adit driven at elevation 2,000 feet, the main vein is intersected at 450 feet from the portal and a drift runs northeast following the vein for 260 feet. At the crosscut intersection the vein is sparsely mineralized. Sixty feet northeast along the drift the vein widens to 4 feet of quartz, 18 inches of which carries about 2 per cent of sulphide, with a central 3-inch seam containing better than 50 per cent of sulphide. An 18-inch channel sample taken across the mineralized part of the vein assayed: gold, a trace; silver, 0.24 ounce a ton; lead, 0.05 per cent; zinc, a trace; antimony, a trace. Forty feet farther northeast, the vein has narrowed to 5 inches of quartz carrying about 50 per cent of grey sulphides, chiefly jamesonite. A 5-inch channel sample taken across the vein at this place

assayed: gold, 0.01 ounce a ton; silver, 18.33 ounces a ton; lead, 4.44 per cent; zinc, 9.23 per cent; antimony, 2.13 per cent; arsenic, nil. Another 40 feet northeast the vein has widened to 2 feet of quartz and carries only a sparse mineralization, chiefly sphalerite. One hundred and ninety feet northeast of the crosscut, there is an ore shoot 12 inches wide and 25 feet long containing about 50 per cent of jamesonite and sphalerite. A 12-inch channel sample taken here across the vein assayed: gold, 0.015 ounce a ton; silver, 14.67 ounces a ton; lead, 6.90 per cent; zinc, 9.75 per cent; antimony, 1.39 per cent; arsenic, 0.42 per cent. Near the end of the drift, the vein splits into three parts, two of which die away on entering a tongue of granodiorite, and the third, 6 inches in width, continues northeast into the wall, along the faulted contact between granodiorite and altered tuff.

No. 2 vein lies 100 feet east of the No. 1 vein, and is reached by a crosscut from the north end of the drift on No. 1 vein. The vein is followed by drifting for 138 feet southwest and 300 feet northeast from the 100-foot crosscut. In the south drift, the vein maintains an average width of 1 foot, but is sparsely mineralized. Fifty feet south of the crosscut some of the best-looking material carries about 5 per cent of jamesonite and sphalerite. An 11-inch channel sample taken across the vein at this point assayed: gold, a trace; silver, 2.14 ounces a ton; lead, 5.35 per cent; zinc, 0.25 per cent; antimony, 0.98 per cent; arsenic, 0.12 per cent. Eighty feet northeast of the crosscut, a raise is driven up 175 feet to the surface. At the foot of the raise and continuing for 75 feet to the northeast, the vein ranges from 3 to 12 inches in width and the quartz gangue is well mineralized with jamesonite. A typical 4-inch channel sample taken across the vein at the foot of the raise, consisting of about 60 per cent sulphide and 40 per cent quartz, assayed: gold, a trace; silver, 14.67 ounces a ton; lead, 6.90 per cent; zinc, 9.75 per cent; antimony, 4.01 per cent; arsenic, 0.05 per cent. For 100 feet at its northeast end, the vein is very sparsely mineralized and in a number of places the fault fissure contains no vein filling whatsoever. Two hundred feet north of the raise, the vein splits and one branch, consisting of 12 inches of sheared tuff veined with quartz and siderite, passes into the north wall of the drift. The east branch is drifted along, but ends suddenly where the drift enters a body of granodiorite.

The drift continues 60 feet northeast from the end of No. 2 vein through granodiorite, then follows No. 3 vein for 120 feet along the fault contact between granodiorite on the northwest and altered tuff on the southeast to where the vein ends abruptly against a strong cross fault and sheared zone that strikes north and dips 75 degrees east. The vein has an average width of 6 inches and is generally only sparsely mineralized, but in several places carries from 3 to 5 per cent of jamesonite and pyrite.

In places along the back of the drifts sphalerite had been altered to the hydrous zinc carbonate, hydrozincite. It occurs in sphalerite-rich parts of the vein as thin, yellowish white streaks that show up as bright white streaks in ultra-violet light. A few stalactites of this mineral 1 inch long were seen. Hydrozincite does not have as bright a fluorescence as scheelite, and no scheelite was noted in these workings.

No. 4 vein lies approximately 800 feet northeast of the main vein at elevation 2,225 feet. It is enclosed in a small body of fine-grained, recrystallized, tuffaceous rock. The vein is 100 feet long and ranges from 4 feet in width at its southwest end to 4 inches in width at its northeast end.

It is developed by a 50-foot shaft that follows the vein down on an incline of 65 degrees. Twenty feet south of the shaft the vein ends abruptly against a cross fault that brings in a V-shaped wedge of the main body of granodiorite along the strike of the vein. The quartz gangue is well mineralized in the wide part of the vein south of the shaft and for 40 feet north of the shaft, and carries up to 30 per cent of jamesonite, sphalerite, galena, and tetrahedrite. An 18-inch channel sample taken across the vein 12 feet northeast of the shaft assayed: gold, 0.01 ounce a ton; silver, 4.19 ounces a ton; lead, 8.38 per cent; zinc, 1.73 per cent; antimony, 3.84 per cent; bismuth, nil; arsenic, 0.87 per cent.

A few tons of hand-sorted ore are piled on the rock dump at the main adit. A hand specimen of this ore, consisting of banded, finely crystalline jamesonite and sphalerite with fine stringers of argentite replacing the jamesonite, assayed: gold, 0.015 ounce a ton; silver, 116.06 ounces a ton; lead, 22.33 per cent; zinc, 7.98 per cent; arsenic, 0.61 per cent; antimony, 11.54 per cent; bismuth, nil; cobalt, 0.21 per cent. Another sample, composed of 50 per cent grey quartz replaced by jamesonite and with a few nodules of sphalerite, assayed: gold, 0.01 ounce a ton; silver, 49.26 ounces a ton; lead, 11.45 per cent; zinc, 3.40 per cent; arsenic, 0.06 per cent; antimony, 6.45 per cent; bismuth, nil; cobalt, 0.21 per cent.

Fortune Hill Claim (1)

Reference: Ann. Rept., Minister of Mines, B.C., 1933, p. 97.

The Fortune Hill claim, owned by Lars Hagan of Hazelton, is on the west bank of Skeena River about 4 miles above the mouth of Kispiox River. The prospect workings are on the east side of a hill that drops steeply for about 500 feet to the river. The property is reached by a trail from Love's farm.

About 200 feet above the river a mineralized replacement zone is exposed by four open-cuts for 275 feet along the side of the hill. This zone ranges from 2 to 5 feet in width and follows the bedding of the enclosing sediments, which strike north and dip 30 degrees west into the hill. The wall-rocks are indurated sandstone composed of subangular grains of quartz and chert cemented by siderite with a little extremely fine argillaceous material. The replacement zone follows a bed in the sandstone that is unusually rich in siderite. The siderite is replaced by disseminated pyrite with minor amounts of pyrrhotite, arsenopyrite, chalcopyrite, and sphalerite. The replacement process was accompanied by the introduction of silica and the quartz and chert grains in the mineralized zone are largely recrystallized.

A 3-foot chip sample taken across the mineral zone in the north pit assayed: gold, 0.01 ounce a ton; silver, 0.15 ounce a ton; lead, none; zinc, 0.16 per cent; copper, 0.09 per cent. In a pit 80 feet farther south, a 24-inch channel sample taken across the vein assayed: gold, 0.005 ounce a ton; silver, 0.32 ounce a ton; lead, none; zinc, 0.90 per cent; copper, 0.15 per cent.

Golden Wonder Group (26)

References: Ann. Repts., Minister of Mines, B.C.: 1917, p. 107; 1918, p. 113. Geol. Surv., Canada, Mem. 110, 1919, p. 24.

The Golden Wonder group is at the foot of Rocher Déboulé Mountain, 4 miles south of New Hazelton and about $\frac{1}{2}$ mile east of the highway. The road to Comeau's ranch passes close to the workings.

Several narrow zones containing copper were discovered on this property by Harris and Comeau about 1914. Later the claims were secured by M. W. Sutherland, who in 1917 and 1918 put down a 100-foot shaft on the best looking vein. The property was acquired by the National Exploration Company, Limited, in 1951.

Two parallel zones lying 115 feet apart have been traced by open-cuts for 200 feet across a low ridge on the southwest side of a small lake. The ridge is composed of poorly bedded tuffs with some interbedded argillite. The strata strike south and dip 75 degrees west. The ridge trends in a direction somewhat east of north, and the zones strike north 85 degrees east and dip northerly at from 65 to 75 degrees. The fissured zones range from 1 foot to 3 feet in width and contain narrow sulphide lenses consisting largely of pyrrhotite with small amounts of pyrite, arsenopyrite, and chalcopyrite. At the surface the sulphide lenses are short, and most of them are less than 3 inches wide. A 100-foot shaft was sunk on the more northerly of the two zones; at the collar the zone carried very little sulphide, but during sinking operations some massive sulphide lenses were encountered containing considerable chalcopyrite. Some of the ore from the shaft is piled in two nearby heaps of about 20 tons. A representative sample from the smaller of the two piles assayed: gold, 0.20 ounce a ton; silver, 7.25 ounces a ton; copper, 6.50 per cent; nickel, none. A representative sample of the larger ore pile assayed: gold, 0.46 ounce a ton; silver, 7.63 ounces a ton; copper, 4.69 per cent. Both samples were tested for radioactivity, but were found to carry less than 0.01 per cent U_3O_8 equivalent. Another sample collected from 8 bags of ore near the shaft assayed: gold, 0.10 ounce a ton; silver, 5.48 ounces a ton; copper, 2.97 per cent; tin, 0.15 per cent.

This zone is exposed several hundred feet farther west on the side of the road, where it has been trenched for 50 feet and prospected by a shaft 30 feet deep. The shaft is sunk on two fissures from 2 to 3 feet apart. One fissure ranges from 3 to 6 inches in width and is filled mainly by sheared rock sparsely mineralized. The other fissure carries a 3-inch sulphide vein at the surface, which increases in width to form a pyrrhotite lens 2 feet wide at the water level 10 feet down the shaft. A representative sample taken from a small heap of pyrrhotite lying at the collar of the shaft assayed: gold, 0.04 ounce a ton; silver, 0.16 ounce a ton; copper, 0.30 per cent; nickel, none.

At the north end of the low ridge, 1,000 feet northeast of the 100-foot shaft, a narrow dyke of altered porphyritic diorite has been followed for about 200 feet by several open-cuts. In this vicinity the tuffs strike north and dip 40 degrees east. The dyke crosses the nose of the ridge, striking north 70 degrees west and dipping 75 degrees northeast, and ranges from 8 inches to 4 feet in width. Short quartz lenses from 1 inch to 10 inches in width lie along both walls. In places, too, the dyke is fractured parallel

with its strike, and is traversed by small quartz stringers. The quartz carries a little pyrite and chalcopyrite. A representative sample of the mineralized quartz taken from the east open-cut assayed: gold, none; silver, 0.12 ounce a ton; copper, 0.79 per cent. A sample collected in the highest cut about 150 feet farther northwest, assayed: gold, 0.01 per cent; silver, 0.72 ounce a ton; copper, 1.16 per cent. Radioactive tests on both samples showed a U_3O_8 equivalent of less than 0.001 per cent.

Great Ohio Group (36)

References: Ann. Repts., Minister of Mines, B.C.: 1911, p. 80; 1912, p. 114; 1913, p. 107; 1914, p. 188; 1915, p. 77; 1916, p. 113. Geol. Surv., Canada, Mem. 110, p. 18.

This group staked by Sargent and Munroe in 1910 consists of seven claims, the Pilot, Great Ohio, Scotch Hill, Henrietta, Maple Leaf, Kitseguecla, and Princess. The property is near the head of Juniper Creek on the south side of the valley opposite the Rocher Déboulé mine. The camp, at elevation 3,950 feet, is $9\frac{1}{2}$ miles by road northeast from Skeena Crossing. The claims were prospected between 1913 and 1916 by Messrs. Jennings and Trimble, who drove a long adit. National Exploration Company Limited restaked the property in 1951.

The property is astride the west contact of the granodiorite stock that forms the core of Rocher Déboulé Mountain. In the granodiorite, near its contact with sandstones and argillaceous sediments, a strong shear zone has been followed up the precipitous mountain slope for about 800 feet. There are several small open-cuts on it and narrow quartz lenses are exposed that carry small amounts of chalcopyrite, pyrite, galena, and sphalerite.

An adit, at elevation 4,500 feet, explores two subsidiary shear zones in the granodiorite, in addition to the one mentioned. One of these is followed for 355 feet from the portal on an average bearing of north 50 degrees east, and from the end of the drift a crosscut runs 190 feet southeast to the second shear zone and an additional 70 feet southeast to the main shear zone. The second shear zone is drifted along for 128 feet, and the main shear zone for 400 feet to the northeast. In each drift the sheared zone strikes north 50 to 55 degrees east and dips from 65 to 70 degrees northwest.

The most westerly shear zone, the one followed for 355 feet, ranges from 1 foot to 4 feet in width. There is much gouge and rust along the middle of the zone, but no vein quartz or concentration of sulphides were seen. An 18-inch hornblende lamprophyre dyke follows along the zone and has been sheared and brecciated where it crosses from the foot-wall to the hanging-wall side of the fissure.

The second shear, as seen in the 128-foot drift, ranges from 8 inches in width at the crosscut to 2 inches in width at the face of the drift. It consists of sheared granodiorite replaced by various amounts of vein quartz, hornblende, and chalcopyrite. A 5-inch channel sample taken across a typical part of the vein 60 feet from the crosscut assayed: gold, 0.005 ounce a ton; copper, 0.62 per cent.

The main shear zone in the 400-foot drift has an average width of 20 inches. It consists chiefly of sheared and brecciated granodiorite with much rusty gouge. In several places there is much hornblende associated with small quartz stringers that carry a little pyrite and chalcopyrite. A 12-inch lamprophyre dyke that closely follows the fissured zone is much altered and impregnated with pyrite. A 26-inch channel sample taken across the sheared zone on the southwest face of the drift at the crosscut assayed: gold, 0.01 ounce a ton; copper, 0.12 per cent. A 12-inch sample taken across the lamprophyre dyke on the foot-wall side of the vein, adjacent to the part of the zone represented by the 26-inch sample, assayed: gold, none; copper, 0.18 per cent. An 18-inch channel sample taken across the vein at the northeast face of the drift assayed: gold, none; copper, 0.12 per cent.

Hecla Group (25)

The Hecla group, owned by George Tallman of New Hazelton, is at the head of Station Creek on the north slope of Rocher Déboulé Mountain, 3 miles south of New Hazelton. It is reached by a good trail that follows the east side of the creek.

An altered aplite dyke 9 feet wide intrudes the granodiorite on the steep slope at the head of Station Creek. In an open-cut at elevation 3,900 feet the dyke strikes south up the slope and dips 75 degrees west. The dyke is cut by small quartz stringers over a width of 4 feet on the hanging-wall side, and the silicified rock is impregnated with a little pyrite and chalcopyrite. A representative sample of the mineralized rock assayed: gold, a trace; silver, 1.06 ounces a ton; copper, 0.22 per cent. At elevation 4,000 feet the 9-foot dyke is approached by a pegmatitic dyke about 6 feet wide. The pegmatitic dyke is prospected by an adit that extends 20 feet south as a crosscut with a 30-foot drift. The pegmatitic dyke is about flat-lying. It is bleached and somewhat altered, and is impregnated with a little disseminated pyrite and chalcopyrite. A representative sample of the mineralized rock collected from the face of the west drift assayed: gold, a trace; silver, 0.53 ounce a ton; copper, 0.39 per cent.

At an elevation of 3,000 feet on the Ingenico claim, a 2-inch vein of pyrite and arsenopyrite is exposed for a short distance in a small creek 100 feet east of Station Creek. An open-cut on a shear zone at elevation 3,600 feet exposes five or six fissures across a width of 20 inches in granodiorite but little or no evidence of mineralization.

Higgins Group (14)

Reference: Ann. Rept., Minister of Mines, B.C., 1917, p. 106.

This property is situated in a cirque on the north slope of Netalzul Mountain between elevations of 4,500 and 6,000 feet. It is reached by a pack-trail, $2\frac{1}{2}$ miles in length, that branches south from the Hazelton-Babine trail at a point 30 miles east of Hazelton.

A granodiorite stock intrudes the sediments on Netalzul Mountain. The contact crosses the property and the mineral showings occur within 500 yards or less of this contact both in the granodiorite and the sedimentary rocks. The latter, which are argillite, quartzite, and hornfels, strike north 40 degrees east and dip 35 degrees northwest.

The showings consist of a sulphide vein 4 inches wide and several quartz veins 2 to 7 feet wide. At elevation 4,500 feet the sulphide vein is exposed for 20 feet in an open-cut. It occurs along a small fault in the sedimentary rocks less than 50 yards from the granodiorite stock. The vein strikes north 60 degrees east and dips 60 degrees southeast. It consists of sphalerite, galena, and tetrahedrite, sphalerite being the most abundant mineral.

Well within the granodiorite, at an elevation of 5,500 feet, a quartz vein 4 feet wide has been exposed by a 9-foot pit and surface stripping. The vein strikes north 75 degrees east and dips 60 degrees southeast. It has been traced for 100 feet along its strike. The ore is buncy and consists of sphalerite, galena, tetrahedrite, pyrite, and chalcopyrite. The sulphides constitute less than 5 per cent of the vein material. A sample containing about 25 per cent sulphides assayed: gold, 0.10 ounce a ton; silver, 56.14 ounces a ton. A sample containing no sulphides assayed 0.01 ounce a ton in gold.

Two hundred yards down the slope at an elevation of 5,400 feet another quartz vein, varying in width from 2 to 7 feet, is exposed. It occurs in the granodiorite as a filling along joint planes that strike north 20 degrees east and dip 60 degrees southeast. At various points along its strike it is offset from a few inches up to 5 feet along a second set of joint planes that strike north 60 degrees west and dip 70 degrees northeast. This vein could be traced for at least 2,000 feet. It is very sparsely mineralized with galena, sphalerite, tetrahedrite, pyrite, and scheelite.

Elsewhere on the property quartz stringers, $\frac{1}{2}$ to 1 inch wide and mineralized with pyrite, occur along the joint planes in the granodiorite.

Highland Boy Group (29)

References: Ann. Repts., Minister of Mines, B.C.: 1912, p. 114; 1913, p. 107; 1914, p. 189; 1916, p. 109; 1917, p. 102; 1918, p. 113; 1919, p. 101; 1920, p. 87; 1921, p. 97. Geol. Surv., Canada, Mem. 110, 1919, p. 14.

The Highland Boy claims are immediately east of the Rocher Déboulé group, about 11 miles by road northeast from Skeena Crossing. The road follows the valley of Juniper Creek, keeping on the northwest side of the stream. The claims blanket a precipitous mountain ridge whose peaks rise to elevations exceeding 6,500 feet. This property was first prospected by Butte-Rocher Déboulé Copper Company, Limited, in 1912. The Delta Copper Company of Edmonton secured the property in 1917 and carried out some development work. In that year a shipment of 74.92 dry tons of ore was made to Ladysmith smelter, and yielded 10,494 pounds of copper, 4 ounces of gold, and 35 ounces of silver. In 1919 and 1920 a little further work was done, and in 1921 Lynch Brothers of Spokane are reported to have done some diamond drilling. Western Tungsten Copper Mines Limited acquired the property in 1951.

A number of fissure zones occur on this property in the coarsely crystalline, grey granodiorite that forms the core of Rocher Déboulé Mountain. The two principal zones strike in an easterly direction and dip from 45 to 80 degrees north. One of these zones is an easterly continuation of the main upper zone on the Rocher Déboulé group. From the most easterly adit, at elevation 5,160 feet on the latter

property, this zone extends east across the Timber Line, Iowa, and Coral Queen claims to the Highland Boy claim of the Highland Boy group. The length of this fissure approaches 1 mile across the two properties, but no work has been done on it east of the old adit on the Timber Line claim. Its outcrop is largely concealed by talus. The main fissured zone of the Highland Boy group lies about 700 feet farther north. It has been followed for 3,500 feet in an easterly direction across the Delta Fraction, Balmoral, Zig Zag Fraction, and Golden Fleece claims. At its east and west ends, the outcrops are above an elevation of 5,700 feet. Midway along its strike, between elevations of 6,400 and 6,500 feet, the zone is almost inaccessible where it crosses sharp, jagged peaks.

Both zones occur along faults of marked displacement. The gangue minerals are chiefly hornblende, actinolite, chlorite, and quartz, with a little carbonate. Where faulting has caused much brecciation of the wall-rock the granodiorite fragments have been altered and replaced by the gangue and by metallic minerals. The widths of the ore shoots are determined by the amount of brecciation or shearing of the wall-rocks along the fault fissures. The metallic minerals are principally chalcopyrite, pyrite, and magnetite, and the ore carries small amounts of gold, silver, and scheelite.

At elevation 5,700 feet an adit has been driven north 45 degrees west along a fissured zone that dips 80 degrees north. The adit is now caved at the portal and the vein is concealed by talus. At elevation 5,875 feet, about 310 feet up the slope, a second adit has been driven north 45 degrees west. The portal of this adit is also blocked by a cavein and the zone is hidden by talus. The main adit, at elevation 6,050 feet, about 350 feet farther up the slope has been driven 300 feet along the zone, with a 17-foot crosscut to the northeast and a 9-foot crosscut to the southwest from the end of the drift. In the adit the zone has an average strike of north 54 degrees west and dips 70 degrees north. At the portal a width of 4 feet of the granodiorite is traversed by ten parallel fractures with a sparse dissemination of chalcopyrite throughout, but the middle 18 inches is well mineralized, carrying up to 10 per cent of pyrite and chalcopyrite with a little magnetite. Thirty feet within the adit the vein pinches, and no further sulphides were seen until a 5-inch seam of almost solid pyrite, with some chalcopyrite, comes in on the south wall 70 feet from the portal. For the next 15 feet the vein strengthens, and between 87 and 105 feet from the portal the roof is stoped out for 10 to 15 feet up. At 100 feet from the portal a winze is reported by O'Neill (1919) to have been sunk for 30 feet, "In 12 inches of ore throughout this depth; at the bottom of the winze the ore was 12 inches wide at the east side and 26 inches wide at the west side, all of high grade". This winze is now ice filled the year around.

The vein carries a little scheelite on both the east and west sides of the stope. A sample across 6 inches of the vein on the east side of the stope, which there carries a fair amount of scheelite at floor level, assayed: gold, 0.02 ounce a ton; silver, 0.44 ounce a ton; copper, 4.97 per cent; tin, 0.90 per cent; tungsten trioxide, 0.72 per cent; and uranium oxide equivalent, 0.015 per cent.

For 40 feet west of the winze the fissure traverses a lamprophyre dyke, and throughout this rock there is no vein filling. For the next 150 feet west, from the dyke to the crosscut, the fissured zone ranges from 3 inches to 2 feet in width and carries ore minerals for most of that distance. There is a stope from 114 to 131 feet from the portal. At the face of the drift, 300 feet from the portal, the zone is cut off by a cross fault that strikes northeast and dips 55 degrees northwest. The continuation west of the fault lies to the southwest.

The walls of the drift were heavily ice coated when examined by the writer, but nevertheless the presence of scheelite west of the winze was noted in two places.

Above the adit the fissured zone is followed by several large open-cuts, to an elevation of 6,400 feet where it crosses the precipitous peak and cannot be followed. In one rock cut at elevation 6,340 feet, 500 feet west of the portal of the adit, the zone is 2 feet wide. It is much oxidized and leached at the surface, but much massive chalcopyrite shows in the bottom of the cut. The chalcopyrite is banded by seams of coarsely crystalline black magnetite and contains pyritohedral pyrite crystals up to 1 inch in diameter. Twenty feet west of this cut, a branch fissure joins the main vein. The branch fissure carries up to 24 inches of solid sulphides, chiefly chalcopyrite, for a distance of 30 feet from the main vein. Other exposures were seen in the open-cuts between the cut just described and the portal of the adit. In most of these cuts the sulphides have been oxidized and are mostly leached out by surface waters.

A representative sample of the solid sulphide ore, collected from a small heap of ore stacked at the portal of the main adit, assayed: gold, 0.13 ounce a ton; silver, 0.73 ounce a ton; copper, 15.03 per cent. A 5-inch channel sample taken across the vein in the adit, 70 feet from the portal where the sulphide present is chiefly pyrite, assayed: gold, 0.015 ounce a ton; silver, 0.23 ounce a ton; copper, 2.50 per cent.

Scheelite was seen in crystals up to 1 inch in diameter in several mineral samples on the ore dump.

On the Delta Fraction claim the Highland Boy fissure zone is exposed on the northwest side of the steep mountain ridge between elevations of 5,900 and 6,000 feet. In an open-cut at elevation 5,950 feet the zone is 2 feet wide and it is abundantly mineralized with chalcopyrite. It strikes east and dips 50 degrees north. Between elevations 5,650 and 5,900 feet the smooth, striated foot-wall of the zone, along which the mineralization occurs, rises abruptly from a talus slope under which the deposit is concealed. Some of the gangue still clings to the foot-wall, but most of it has tumbled down the steep talus slide. At elevation 5,600 feet, an adit driven in below the zone extends 372 feet on an average bearing of north 60 degrees east. This adit lies parallel with the zone and 30 to 40 feet south of it. At 243 feet from the portal a crosscut runs 145 feet southeast, and from its end a branch crosscut extends 27 feet northeast. The zone would have been reached from the main adit by driving a crosscut northeast 30 to 40 feet.

There is evidence that a crosscut adit was driven towards the zone at an elevation of 5,856 feet, but this adit is now completely hidden by a talus slide.

Killarney Group (40)

Reference: Ann. Rept., Minister of Mines, B.C., 1926, p. 128.

The Killarney group is on the west side of Brian Boru Basin at the head of the south fork of Brian Boru Creek, 7 miles southeast of Skeena Crossing. It is reached by a pack-trail 4 miles in length, which branches from the Rocher Déboulé mine road 5 miles east of Skeena Crossing and leads south to the camp at elevation 4,000 feet on Brian Boru Creek.

About 500 feet south of the cabin, the bed of Brian Boru Creek is formed of fragments of altered rock heavily replaced by pyrite with a little pyrrhotite, sphalerite, and galena. The immediate banks of the creek are muskeg covered, but several hundred feet farther west the mountain rises steeply and in an open-cut at elevation 4,200 feet there is a heavily pyritized sheared zone 10 feet in width. The mineralized zone appears to strike up the slope, but has not been found there due to drift cover.

At elevation 4,250 feet, about 200 feet south of the open-cut, an adit, now caved at the portal, was driven along an aplite dyke that intrudes tuffaceous rocks. The dyke is largely concealed by the drift, but its width exceeds 10 feet. The aplite is considerably altered, with a strong development of carbonate, and is impregnated with considerable pyrite and a little galena and sphalerite. The ground is heavily drift covered in the vicinity, but 50 feet farther up the slope the mineralized dyke is exposed in an open-cut. A representative sample of the broken, mineralized rock taken from the dump at this cut assayed: gold, a trace; silver, 1.10 ounces a ton; lead, 0.71 per cent; zinc, 2.19 per cent.

Lead King and Leadsil Groups (7)

(Crown Silver Lead Mines Limited)

References: Ann. Repts., Minister of Mines, B.C.: 1910, p. 86; 1911, p. 79; 1912, p. 113; 1914, p. 205; 1918, p. 227; 1923, p. 106. Geol. Surv., Canada, Sum. Rept. 1909, p. 66.

The Lead King and Leadsil groups of mineral claims, owned by Crown Silver Lead Mines Limited, are on the north slope of Nine Mile Mountain about 8 miles in a straight line northeast of New Hazelton station. The claims are bounded on the west by the Sunrise group and on the east by the Silver Pick group. They are reached by way of Nine Mile Mountain road, 13 miles long from South Hazelton station to Silver Cup Basin at elevation 3,400 feet, and an additional 3 miles along a good pack-horse trail to the Lead King cabin in a grassy meadow at elevation 4,075 feet. The cabin is at the foot of a glacial cirque. The veins outcrop on the steep mountain slope between elevations of 4,600 and 5,100 feet on the east side of the cirque (See Figure 5, in pocket).

Although numerous, small, rich veins containing silver, lead, zinc, and antimony occur on this property, there is only one record of ore shipped, namely, 5 tons taken out in 1909. The Hazelton Nine Mile Mining Company, Limited, held the property in 1912, but work was confined to a 40-foot inclined shaft and a 30-foot drift. Little work has been done since that date except for opening up veins along the surface by stripping

and open-cuts. Crown Silver Lead Mines Limited acquired the property in 1950, and the veins were mapped and sampled by C. D. McCord during the summer of 1951.

The veins occur along slickensided fault fissures in the granodiorite stock that intrudes the sediments along the north side of the mountain. They lie in a disturbed zone about 700 feet wide and possibly 2,500 feet long, which extends from the Lead King ground west across the Sunrise property. This zone is parallel with the line of contact of the granodiorite and intruded sediments, and its north border lies about 500 feet south of the contact within the intrusion. There are two distinct sets of vein fissures. One series strikes north and dips from 25 to 45 degrees east, and the other series strikes east and dips from 10 to 35 degrees south into the mountain. The fissures are offset a few feet by normal faults that strike north and dip from 60 to 90 degrees east. The veins commonly range from 100 to 300 feet in length. Their average width is about 1 foot, but they are lenticular and range from 4 inches to 3 feet wide. They are commonly arranged *en échelon*. In some cases parallel veins lie only 6 feet apart and could be mined together. The veins are mostly of quartz heavily mineralized with jamesonite, sphalerite, cosalite, and galena, with some argentite and tetrahedrite. They are, in addition, sheared zones in which the granodiorite is altered and replaced by fine veinlets of quartz, galena, sphalerite, and jamesonite.

At elevation 4,700 feet, about 100 feet east of a ridge marking the east side of a cirque, there is an open-cut and a 43-foot adit. A zone of sheared granodiorite carrying about 10 per cent of sphalerite and galena was stripped at the portal and 5 tons of ore is stockpiled there. No veins were cut in the adit. A representative sample of the ore assayed: gold, nil; silver, 37.97 ounces a ton; lead, 23.86 per cent; zinc, 29.50 per cent; antimony, 0.76 per cent.

About 725 feet farther east at the same elevation, an inclined shaft, now water filled, is sunk for about 40 feet on an 18-inch quartz vein. This vein is exposed at intervals for 200 feet along its strike, and ranges from 6 inches wide at both ends to 20 inches wide near its centre. A parallel vein lies from 10 to 15 feet below the shaft and is exposed at intervals, mostly by natural agencies, for 250 feet along its strike. Both veins strike east and dip 30 degrees south into the mountain. Two other veins outcrop at 50 and 70 feet, respectively, above the inclined shaft, and others are exposed in a small ravine 325 feet east of the shaft. All these veins carry an abundance of jamesonite and sphalerite and some cosalite, galena, and arsenopyrite in a quartz gangue. An 18-inch channel sample taken across the vein in the mouth of the inclined shaft assayed: gold, a trace; silver, 9.15 ounces a ton; lead, 6.47 per cent; zinc, 17.11 per cent; antimony, 2.63 per cent; arsenic, 2.43 per cent.

At 120 feet west of the inclined shaft the veins are cut off by a fault that strikes north and dips 60 degrees east. On the west side of this fault, nine veins outcrop along the precipitous slope between elevations of 4,750 and 5,100 feet. Most of these veins are exposed by natural agencies. One vein, exposed between elevations of 4,940 and 5,075 feet, is cut into three parts by two faults that strike north and dip east. The middle segment is 100 feet long and ranges from 18 to 24 inches in width. There is a 12-foot open-cut at its east end at elevation 5,000 feet. The

west segment is offset only a few feet. It is 40 feet long and ranges from 6 to 12 inches in width. The east segment of the vein is offset about 15 feet to the north. It is 160 feet in length and also ranges from 6 to 12 inches in width. The veins are of quartz well mineralized with jamesonite, sphalerite, and galena, with a little pyrite, cosalite, and arsenopyrite. The sulphides occur disseminated through the quartz and as alternate bands of solid sulphide.

A 24-inch channel sample taken across the vein in the open-cut at elevation 5,000 feet assayed: gold, a trace; silver, 5.24 ounces a ton; lead, 11.01 per cent; zinc, 5.71 per cent; antimony, 2.68 per cent; arsenic, 2.43 per cent. An 18-inch channel sample taken across the same vein, 90 feet west at 50 feet higher elevation, assayed: gold, a trace; silver, 3.51 ounces a ton; lead, 8.00 per cent; zinc, 6.55 per cent; antimony, 2.16 per cent; arsenic, 3.20 per cent. An 8-inch channel sample taken across the east segment of the vein, 130 feet east of the open-cut, assayed: gold, 0.015 ounce a ton; silver, 0.60 ounce a ton; lead, 0.36 per cent; zinc, 0.81 per cent; antimony, none. A 10-inch channel sample taken across a strong vein at elevation 4,800 feet, 180 feet southwest of the inclined shaft, assayed: gold, a trace; silver, 15.23 ounces a ton; lead, 8.18 per cent; zinc, 16.70 per cent.

A mineralized shear zone in the granodiorite occurs on the steep east side of the cirque at elevation 4,940 feet. In a 10- by 20-foot open-cut the sheared and bleached granodiorite is impregnated with small veinlets of quartz, galena, sphalerite, and jamesonite over a width of 8 feet. A representative sample of this ore assayed: gold, nil; silver, 3.74 ounces a ton; lead, 2.82 per cent; zinc, 3.30 per cent. Fifty feet south of the open-cut, the continuation of the shear zone is covered by talus, and 50 feet north it narrows and splits into two parts, which follow north around the nose of the ridge. The eastern branch is exposed for 100 feet and the western for 160 feet. Both range from 6 to 18 inches in width and are heavily mineralized with jamesonite and sphalerite.

A considerable tonnage of silver-lead-zinc ore containing a little antimony and bismuth is indicated from the surface exposures.

Lone Star Claim (32)

The Lone Star claim is on Rocher Déboulé Mountain 6 miles south-east of New Hazelton. The workings are on Pangea Creek, the south fork of Mudflat Creek. The owner, Angus White of New Hazelton, has constructed an excellent branch trail to the claim from the Mudflat Creek trail to the Black Prince group.

At elevation 3,950 feet, a pyrrhotite vein is prospected by an open-cut on the southwest bank of the creek. The vein ranges from 1 inch to 4 inches in width and is less than 25 feet long. An adit driven 145 feet in a southerly direction along the strike of the vein does not disclose any mineralization. At distances of 175 and 475 feet, respectively, farther up the creek, 30-foot and 20-foot adits are driven into the southwest bank of the creek along small fissures, but likewise disclose no mineralization.

The rocks exposed along the banks of Pangea Creek, and on the steep slopes towards the west, are bedded sediments, composed of greywacke, slate, and argillite. They are intruded near the workings by several small

dykes of porphyritic diorite and by a large body of granodiorite 1 mile to the west. Massive, grey, porphyritic andesite flows outcrop a short distance east of Pangea Creek and extend easterly to the Bulkley. Both sediments and volcanic rocks are flat-lying on this claim, and are in fault contact a short distance east of Pangea Creek. This north trending fault is several miles in length. It is exposed on the steep south slope of Porphyry Creek and on the ridge on the north side of Mudflat Creek. The possible occurrence of veins along it has not been investigated, as it is largely drift covered.

MacDonald Group (33)

References: Ann. Repts., Minister of Mines, B.C.: 1926, p. 126; 1930, p. 139.

The Black Pilot, True Blue, and Summit claims, staked by Dan MacDonald in 1926, are between the head of the south fork of Mudflat Creek and the head of Porphyry Creek, 7 miles southeast of New Hazelton. The claims are reached by a poor trail that extends up the south fork of Mudflat Creek from the Lone Star property.

On the divide between the south fork of Mudflat (Pangea) Creek and Porphyry Creek, a pyrite vein was prospected some years ago by a 25-foot adit. The vein occurs along the contact of a lamprophyre dyke with argillites. It is lenticular and less than 25 feet long.

At elevation 5,100 feet on the north side near the head of Porphyry Creek, pyritized argillite beds interstratified with greywacke and shales, which also contain a little finely disseminated pyrite, are prospected by several open-cuts and by a short, inclined shaft. In this vicinity the sediments strike west and dip 10 to 15 degrees north. They are intruded by several dykes of granodiorite, and the granodiorite stock that forms the core of the mountain lies a quarter of a mile to the west. Samples of the pyritized rock assayed only a trace in gold and silver.

On the Katherine claim on the south side of Porphyry Creek, a vein 6 feet wide occupies a shear zone in andesite at elevation 3,900 feet; it contains a few small seams of barite and a little sphalerite.

National Exploration, Group D (15)

National Exploration Company Limited staked a group of claims one-half mile southwest of the Silver Standard mine during the summer of 1950. Some large quartz veins were discovered, and in 1951 these were prospected by diamond drilling under the direction of G. L. Oates and J. T. Mandy.

Arkose, tuffaceous sandstone, and argillites of the Hazelton group form the bedrock in the vicinity of the veins. The strata strike south 20 degrees east and dip 15 to 20 degrees northeast. Three roughly parallel quartz veins, 75 to 100 feet apart, have been traced several hundred feet along their strike by surface stripping and diamond drilling operations. The veins range in width from 1 foot to 21 feet. They strike northwest and dip 65 to 70 degrees southwest. In one place the vein quartz at a small open-cut contains up to 5 per cent of galena, chalcopyrite, pyrite, and sphalerite, but elsewhere the veins are only sparsely mineralized at the surface. Drilling failed to intersect any well-mineralized zones in 1951.

O.K. Group (13)

References: Ann. Repts., Minister of Mines, B.C.: 1921, pp. 91-100; 1929, p. 160.

This group is situated on the north side of Thoen Basin between elevations of 5,500 and 6,500 feet. A pack-trail $3\frac{1}{2}$ miles long leads to the property from Twentynine Mile Creek crossing on the Hazelton-Babine trail. Twentynine Mile Creek is a southerly flowing tributary of Suskwa River approximately 29 miles east of Hazelton. Development work consists of a 40-foot crosscut adit and surface strippings.

The country rock is tuffaceous sandstone and argillite cut by alaskite and porphyritic granodiorite dykes and sills. The stratified rocks strike approximately north 40 degrees east and dip 20 to 30 degrees northwest into the face of the mountain. To the west of the property the sediments are intruded by a stock of granodiorite. A tongue projects from this stock to within 300 yards of the more important veins.

The mineral occurrences consist of small, irregular veins occupying shear zones that for the most part parallel the bedding. The veins are considerably leached, so that the filling now consists largely of iron oxide. The adit cuts through one vein 6 inches wide that is entirely leached and contains no sulphides. Another vein, varying in width from 6 inches to 2 feet, is exposed above the adit, which has not been driven far enough to cut it. This vein contains galena, light and dark brown sphalerite, and tetrahedrite, with some quartz, carbonate, and pyrite. According to the Minister of Mines Report for 1921, a sample of the solid galena assayed: gold, 0.02 ounce a ton; silver, 190 ounces a ton; lead, 70 per cent; and a sample taken across 10 inches of leached-vein filling returned: gold, 0.02 ounce a ton; silver, 80 ounces a ton; lead, 36 per cent. Several other veins 2 to 6 inches wide have been exposed by surface strippings.

Several other veins were discovered about 1920 in Bergsten Basin immediately north of Thoen Basin. The Minister of Mines report for 1929 describes a shear zone 6 feet wide in the centre of Bergsten Basin at elevation 5,060 feet, 1 foot of which carries galena, sphalerite, arsenopyrite, and pyrite. Three thin rhodonite veins occur above this point on the west side of the basin; all are well mineralized with galena and sphalerite but they are only a few inches wide. At elevation 6,300 feet, west of the pass between Thoen and Bergsten Basins, a small granodiorite tongue is mineralized with chalcopyrite. A sample across the best 2 feet of this zone, assayed: gold, 0.30 ounce a ton; silver, 11 ounces a ton; copper, 2.1 per cent.

Pole Star Claim (9)

The Pole Star claim is between the Silver Cup mine and the peak of Nine Mile Mountain, on the south side of Silver Cup Basin. The claim was staked by Joe Miller in 1909, and for a number of years small veins were prospected by open-cuts and by stripping on the gently rising ground between elevations of 5,100 and 5,400 feet above Silver Cup Basin.

The main vein is exposed for about 100 feet along the face of the bluff at the top of the basin. It ranges from 6 to 24 inches in width, strikes north 30 degrees west, and dips 15 degrees southwest. The vein

is well mineralized with galena and sphalerite and contains a little tetrahedrite and arsenopyrite. It is prospected by a 15-foot adit and a trench 60 feet long and 8 feet deep. About 10 tons of ore from these operations has been stockpiled. The enclosing sediments, interbedded greywacke, sandstones, and argillites, strike south 30 degrees west and dip 15 degrees east.

Red Rose Mine (38)

References: Ann. Repts., Minister of Mines, B.C.: 1914, p. 190; 1916, p. 113; 1926, p. 126; 1942, p. 78; 1943, p. 78. Geol. Surv., Canada: Mem. 110, 1919, p. 18; Sum. Rept. 1924, pt. A, p. 44. Can. Inst. Min. and Met., Jubilee Volume, p. 129.

The Red Rose tungsten mine is in the Rocher Déboulé Mountains on the north side of Balsam Creek 8 miles east of Skeena Crossing railway station. A good truck road extends from Skeena Crossing (altitude 650 feet) to the Red Rose mill (altitude 4,100 feet). The mine workings lie near the mountain top between 5,500 and 6,300 feet above sea-level. The mine is serviced by a switchback tractor road about 2 miles long and ore is delivered to the mill by way of a mile long aerial tramway (Plate III A).

Western Tungsten Copper Mines Limited obtained a lease from The Consolidated Mining and Smelting Company of Canada, Limited, on the Red Rose tungsten mine early in 1951. The mine was cleaned out and reconditioned, camps were rebuilt, a new aerial tramline constructed, and a new 150 tons daily capacity mill was built during the year. An initial shipment of 7 tons of tungsten concentrates was made in January 1952.

This property was originally staked by C. Peterson and C. Ek about 1912. In 1914, a syndicate headed by T. J. Vaughan-Rhys secured an option and drove two adit drifts at elevations of 5,450 and 5,690 feet on a sheared zone that contains a little gold, silver, and copper. At elevation 5,150 feet a crosscut adit was driven 430 feet to intercept the downward continuation of the sheared zone, but without success. In 1916 the Skeena Development Company continued the work, driving the drift adit at elevation 5,450 feet to a total distance of 250 feet, and the upper adit a total distance of 160 feet along the sheared zone. Later the owners did a little surface stripping on a large quartz-rich vein, and found that it contained tungsten. The tungsten-bearing quartz vein outcrops immediately above the sheared zone at elevation 6,000 feet, and continues up and along the shoulder of the mountain for 300 feet at elevation 6,300 feet. Thence it extends down beneath a covering of talus into the valley of a small stream (Armagosa Creek) that lies half a mile north of Balsam Creek. In 1940, the wartime demand for tungsten spurred The Consolidated Mining and Smelting Company of Canada to drill this tungsten-bearing vein. Drilling results were none too encouraging, but underground work, started in June 1941, disclosed a substantial tonnage of high-grade scheelite ore. Milling commenced in January 1942 and by the autumn of 1943, some 1,194,000 pounds of tungsten concentrate had been recovered. Mining ceased in November 1943 because of orders from the Metals Controller that no more shipments would be permitted.

The tungsten-bearing vein occurs along a fissured zone within a diorite stock and along the faulted contact of the diorite with intruded sedimentary rocks. The latter consists of hornfels, argillite, quartzite, and grey-wacke. The diorite is a fine-grained grey intrusive that is probably connected at depth with the large granodiorite stock that forms the core of Rocher Déboulé Mountain. The vein strikes north 45 degrees west and dips between 40 and 75 degrees southwest. Within the mine workings it ranges from 6 inches to 12 feet wide and in the wider parts is a vein-lode formed of scheelite, quartz, schistose diorite, and altered sheared grey-wacke. Scheelite occurs as individual crystals and as veinlets and bands both in the quartz and in the sheared diorite. The scheelite is white and can be detected only with the ultra-violet lamp. Small amounts of ferberite, pyrite, magnetite, and chalcopyrite are associated with the scheelite. In some places the gangue includes a little orthoclase, apatite, biotite, and tourmaline. Where the walls of the vein are composed solely of altered sedimentary rocks, pyrrhotite was deposited and there is little or no associated scheelite. A diorite porphyry dyke intrudes the diorite in the vicinity of the old workings on the south slope of the mountain and forms the hanging-wall of the vein in the old upper adit driven at elevation 5,690 feet in 1914. It is not known whether scheelite is present in this adit; the portal is now caved and these old workings were never lamped. The portal of the next lower adit at elevation 5,540 feet is also caved. This adit was entered in 1938 by the writer and was seen to follow a sheared zone along an irregular contact between fine-grained grey diorite and intruded argillite. It consisted of soft, rusty, pulverized rock largely leached of its sulphide content. There is no doubt that the sheared zone explored by this adit is the same one along which the tungsten vein occurs higher up. Vein forming conditions may be more favourable farther north along the trend of the drift at elevation 5,450 feet, where diorite may form the walls of the vein rather than sedimentary strata. Most scheelite in the present mine workings is found where the wall-rocks are diorite.

The following table lists the mine levels and amount of drifting completed in the main underground workings at the Red Rose mine, as of August 15, 1951. The levels are numbered according to their distance below the surface outcrop of the vein.

Level No.	Elevation	Length of drift	Depth from surface
	Feet	Feet	Feet
150	6,236	330	50+
350	6,130	480	156
600	5,920	480	366
800	5,660 (started 1951)	40	626

Most of the scheelite ore above the 150 level was stoped by The Consolidated Mining and Smelting Company in 1943 but some ore was seen by the writer towards the south end of the drift. At the southeast

face the vein was only 6 inches wide but appeared to contain up to 20 per cent of scheelite. A local concentration of magnetite with some pyrite occurs north of a winze on this level. A radioactive test made on a sample of the black fine-grained magnetic showed a 0.009 per cent U_3O_8 equivalent.

On the north end of the 350 level, a stope about 150 feet long and up one round, showed a vein width of from 5 to 8 feet and the vein-lode carried between 5 and 15 per cent of scheelite. The wall-rock is biotite schist that was derived by the shearing and alteration of the grey diorite. Near the southeast face of the drift, the shearing divides. The main vein-lode is 5 feet wide and 4 feet of altered sedimentary strata separates it from an 8-inch vein of quartz and scheelite.

On the 600 level the tungsten vein ranges from 2 to 12 feet wide, and in places carries up to 20 per cent of scheelite across widths of 4 or 5 feet. The scheelite is present in thin bands of irregular shape and size, some of which are up to 3 inches thick. In places small branching veinlets of quartz and scheelite run off along joints in the diorite at right angles to the main vein. At the southeast face of the drift the vein is 24 inches wide and contains only about 1 per cent scheelite. At the northwest face, the vein is enclosed in hornfels and contains an abundance of pyrrhotite, but almost no scheelite.

Drifting on the 800 level had begun only a short time before the writer's visit to the mine and only 40 feet was completed. On this level the vein is confined within hardened sedimentary strata near the intersection of the drift and crosscut, and its scheelite content is very low. The management expected to encounter the diorite and tungsten vein-lode as drifting was continued southeasterly.

A sample representative of a 4-foot vertical section of the old tailings pile was collected in 1951 by the writer, 50 feet below the head of the tailings pile. This sample contained 0.16 per cent tungsten trioxide. Tested for radioactivity, the sample showed a U_3O_8 equivalent content of 0.006 per cent.

Rocher Déboulé Mine (35)

(Western Tungsten Copper Mines Limited)

References: Ann. Repts., Minister of Mines, B.C.: 1911, p. 80; 1912, p. 113; 1913, p. 107; 1914, p. 185; 1915, p. 77; 1916, pp. 106-108; 1917, p. 101; 1918, p. 111; 1928, p. 158; 1929, p. 155; 1930, p. 138; 1950, p. 100; 1951, p. 110. Geol. Surv., Canada: Mem. 110, 1919, pp. 7-14; Mem. 223, 1940, pp. 50-54.

The Rocher Déboulé mine is on Rocher Déboulé Mountain near the head of Juniper Creek (See Plate II B) about 8 miles northeast of Skeena Crossing station. The property was acquired by Western Tungsten Copper Mines Limited in 1950, and the work of reopening the mine commenced. During 1951, the 1,200, 1,000, and 300 levels (See Figure 6) of the mine were cleaned out and necessary retimbering done. New mine buildings, bunkhouses, residences, and a school were erected; a hydro plant of 1,600 h.p. was installed, and construction had begun on a mill with an ore capacity of 100 tons a day. The Delta Copper and Highland Bay groups of claims, which adjoin the Rocher Déboulé ground on the east,

were acquired during the summer of 1951, and the Victoria group, also owned by the company, lies immediately north of the Rocher Déboulé group on the Skeena River slope of the mountain. The Red Rose tungsten mine, being worked by the same company, lies 3 miles southeast of the Rocher Déboulé mine.

The property was originally staked by Munroe and Sargent who transferred it to Rocher Déboulé Copper Company Limited of Salt Lake City, in 1911. During the next 2 years, the Nos. 2 and 4 veins were explored by drift adits and considerable copper ore was blocked out. In 1914, Montana Continental Development Company, of Butte, Montana, secured a 2-year lease on the mine. A small gauge railway $\frac{1}{2}$ mile long was installed to carry the ore from the portal of the 300 level, at elevation 5,150 feet, across the mountain top to an aerial tramway that took the ore down to the railway at Tramville. Ore from the No. 2 vein was carried up an inclined surface tramway that ran from the portal of the lower adit (1,200 level) at elevation 4,167 feet to the ore bunkers at the 300 level. This surface tramway was rebuilt early in 1951. Development work completed by the former operators consists of more than 2 miles of crosscuts and drifts, 2,200 feet of raises, and 330 feet of winzes.

In 1915, from May 17 to December 12, 17,000 tons of ore was shipped to Granby smelter at Anyox, averaging 8 per cent copper and \$1.65 in gold and 50 cents in silver a ton. In 1916, mining was resumed by the Rocher Déboulé Mining Company, and 16,800 tons of ore, containing 1,200 ounces of gold, 16,700 ounces of silver, and 1,619,145 pounds of copper, was shipped. Smaller ore shipments were made the following 2 years, but in October 1918 all mining operations were suspended. From April 1915 until October 1918, the mine produced 39,833 tons of ore containing 4,214 ounces of gold, 62,865 ounces of silver, and 5,746,306 pounds of copper.

In 1929, Aurimont Mines Limited took an option on the property and shipped 72 tons of hand-sorted ore, which assayed: gold, 0.14 ounce a ton; silver, 40 ounces a ton; and copper, 4 per cent. A little further work was done in 1930 by Hazelton Copper Mines Limited under W. S. Harris.

The claims are on the west contact of the granodiorite stock that forms the core of Rocher Déboulé Mountain. The contact of this intrusion with sandstone, argillite, and tuffaceous sediments of the Hazelton group runs northerly across the west boundary of the property. The granodiorite is traversed by four well-defined veins that are intersected by the mine workings through a vertical range of 1,250 feet. The No. 2 vein has been drifted on for 2,100 feet on the lowest or 1,200 level, and the No. 4 vein for 1,100 feet on the 300 level. The latter vein has been traced an additional 1,200 feet easterly along the surface. Only the No. 2 vein has been drifted on westerly into the bedded rocks. The veins range in width from 1 foot to 8 feet; they strike easterly, and dip from 35 to 65 degrees north into the mountain.

A fine-grained, grey, quartz diorite dyke, 50 feet wide, that strikes a little east of north through the mine workings and dips 55 degrees north-west is named by the management the "Rocher dyke". This dyke was intruded prior to fissuring of the vein channels and is offset a few feet where crossed by the veins. Roughly horizontal fault striations seen along

the walls of the drift on the 1,000 level indicate that the latest fault movements at least were in a horizontal direction, and that on this level the dyke exhibits an apparent horizontal displacement of 6 feet. Very little vein gangue has been deposited where the vein fissures cross this dyke, and no ore is known to occur in the mine where the Rocher dyke forms the wall-rock. This is of interest on the 300 level where the drift ends at the east face within the Rocher dyke, as ore may be found east of this dyke if drifting is resumed. An aplite dyke that lies along the foot-wall of the No. 1 vein is sparsely mineralized with pyrite in some places adjacent to the vein. On the 1,200 level, a dyke of porphyritic andesite from 8 to 15 feet wide lies along or close to the hanging-wall of the No. 3 vein and is believed to antedate the period of mineralization.

The veins are fissure fillings that formed along strong fissured or fault zones. The gangue is predominantly quartz, hornblende, actinolite, and altered granodiorite. In No. 4 vein on the 1,200 level it consists of quartz, hornblende, and plagioclase, with some apatite, the last occurring as prismatic, fibrous, pale grey to greenish white crystals up to $\frac{5}{8}$ inch in diameter and 6 inches long. Other gangue minerals include calcite, siderite, chlorite, titanite, tourmaline, and rutile. Chalcopyrite is the most widely distributed ore mineral in the mine. Only high-grade copper ore shoots were removed by the former producers, all ore of milling grade being left in the mine or thrown on the dump. O'Neill (1919) states that in the upper part of the No. 4 vein there were four large bodies of high-grade copper ore of irregular shape at approximately the same elevation, but separated horizontally by 50 to 200 feet of material carrying much less copper and in places none. In addition to chalcopyrite, the copper ore contains variable amounts of magnetite, pyrrhotite, pyrite, scheelite, cobaltite, arsenopyrite, molybdenite, tetrahedrite, smaltite-chloanthite, glaucodot, some complex cobalt-nickel sulpharsenides, and a little uraninite. This association of minerals suggests high-temperature conditions of deposition, and the presence of scheelite and cobaltite in increasing amounts westerly along the No. 2 vein, as the contact of the granodiorite and sedimentary rocks is approached, indicates zoning, and is accompanied by a decrease in the amount of hornblende gangue and an increase in the proportion of vein quartz.

Banded milky quartz veins containing small amounts of galena, sphalerite, tetrahedrite, pyrite, and chalcopyrite traverse the chalcopyrite-hornblende ore, or lie along the hanging- or foot-wall sides of the main veins in some places, particularly along the easterly sectors of No. 2 vein. These veins were formed following renewed movement along the vein fissures, and the lack in them of hornblende, pyrrhotite, and molybdenite suggests that the temperature of deposition of these second-generation veins was much lower than that of the first. The silver-lead veins are generally less than $\frac{1}{2}$ foot wide but may be over 100 feet long.

The following table lists the results of assays made by the Mines Branch, Ottawa, on ore samples collected by the writer from veins at the Rocher Déboulé mine. They are presented to illustrate the diversity of mineral associations in the mine, and are not representative of the over-all ore content of the veins, for which many hundreds of samples would be required.

Sample No.	Vein width	Locality	Au	Ag	Cu	WO ₃	Co	Mo	Sn	Pb	Zn
	Inches		oz/ton	oz/ton	%	%	%	%	%	%	%
<i>Main adit, 1,200 level</i>											
1	30	No. 1 vein, E. side of x-cut	0.015	.....	0.50	.....	.....	.....	.....	.....	.....
2	14	No. 2 vein, 750' W. of x-cut	0.05	14.86	1.06	.....	.....	.....	.....	1.49	.....
3	14	No. 2 vein, 904' W. of x-cut	2.36	.....	0.37	0.38	2.30	.....	.....	.....	.....
<i>No. 2 adit, 1,000 level</i>											
4	36	No. 2 vein, 20' W. of x-cut	0.02	.....	1.20	.....	.....	0.23	.....	2.02	2.36
5	24	No. 2 vein, 250' W. of x-cut	0.07	.....	9.68	.....	.....	.....	0.15	.....	.....
6	18	No. 2 vein, 280' W. of x-cut	0.04	16.33	3.35	.....	.....	.....	.....	8.24	11.44
7	28	No. 2 vein, 400' W. of x-cut	0.10	1.55	5.53	.....	.....	.....	.....	.....	.....
8	18	No. 2 vein, 650' W. of x-cut	0.04	.....	1.30	.....	0.03	.....	.....	.....	.....
9	12	No. 2 vein, 1,240' W. of x-cut	0.26	2.25	11.39	.....	1.01	.....	.....	.....	.....
<i>No. 3 adit, 300 level</i>											
10	18	No. 4 vein, 300' E. of x-cut	0.005	1.96	3.00	.....	.....	.....	.....	.....	.....
11	22	No. 4 vein, 30' W. of x-cut	0.01	.....	1.08	.....	0.10	.....	.....	.....	.....

Scheelite occurs in the west part of the No. 2 vein as coarse white crystals that generally range from 1 inch to 2 inches in diameter. On the 1,200 level, it was noted in places along the vein from 900 to 1,510 feet west of the main crosscut (face of drift is at 1,525 feet). On the 1,000 level, scheelite was seen 550 feet west of the crosscut entry and it occurs at intervals from there west to the face of the drift at 1,315 feet. The scheelite is unevenly distributed, occurring in local concentrations and streaks, where it may constitute up to 3 per cent of the vein matter for short distances. These scheelite-rich shoots range from 5 to 50 feet long and from 6 to 24 inches wide, and they alternate with vein zones where scheelite is rarely seen though the vein contains its normal complement of copper and cobalt sulphides. Some of the scheelite along the walls of the drift is concealed by a 30-year covering of mine dust through which it cannot be detected with the ultra-violet lamp. Nearly everywhere it is associated with vein quartz or with silicified altered granodiorite. The large euhedral crystals are suggestive of pegmatitic origin, one such crystal seen on the south wall of the 1,200 level, 1,100 feet west, measuring 4 inches long and 2 inches wide. Until scraped clear of dust this crystal appeared as a spot only 1 inch in diameter under ultra-violet light, illustrating the need of cleaning the walls of the drift before adequate grading of the vein can be undertaken. In general the scheelite-rich shoots are more plentiful near the contact of the granodiorite with the sedimentary rocks. Scheelite was one of the early formed minerals and fractures in it are traversed by veinlets of chalcopyrite and cobalt sulpharsenides.

A large solitary scheelite crystal was seen in the No. 3 vein on the 1,000 level, and as this is a quartz-rich vein it may contain an increasing amount of scheelite farther west towards the sedimentary contact. Scheelite may likewise be found in No. 1 vein near the contact of the granodiorite with the sedimentary rocks. No scheelite was seen by the writer in the 300-level drift along the No. 4 vein, but it may have occurred in some of the earlier mined ore shoots there, and does occur farther east along the strike of this vein in the workings on the Highland Boy group of claims.

A little pink stain (cobalt bloom) on the walls of the drifts along the No. 2 vein on both the 1,200 and 1,000 levels is indicative of the presence of cobalt in the vein. The cobalt bloom (erythrite) is most abundant west of the Rocher dyke and decreases in amount east of the dyke. Westerly along the 1,000-level drift on No. 2 vein, bloom is first noticed 600 feet west of the crosscut and was seen at intervals along the drift to a distance of 1,300 feet west of the crosscut, or to within 15 feet of the face of the drift. The amount of bloom increases as the contact of the granodiorite with sedimentary rocks is approached. For 70 feet west from the contact, the vein in the sedimentary rocks consists of 6 to 15 inches of vein quartz carrying abundant chalcopyrite and cobaltite, and here the pink bloom is particularly well developed. At the face, the vein consists of only 4 inches of sparsely mineralized fault gouge. A channel sample taken across the 12-inch vein 15 feet west of the contact, assayed: gold, 0.26 ounce a ton; silver, 2.25 ounces a ton; copper, 11.39 per cent; cobalt, 1.01 per cent; and nickel, 0.02 per cent. A channel sample collected across the 14-inch vein on the 1,200 level, 40 feet west of the Rocher dyke, assayed: gold, 2.36 ounces a ton; copper, 0.37 per cent; tungsten trioxide, 0.38 per cent; and cobalt, 2.30 per cent. At the latter locality, there is an inch of solid cobaltite and associated sulphides on the hanging-wall side of the vein. The assay suggests that gold values are highest where cobalt minerals are most plentiful. At this point the vein also contains a $\frac{1}{8}$ -inch seam of uranium oxide-rich material that fluoresces yellow under the ultra-violet lamp in contrast with the blue-white of scheelite.

Glaucodot, the cobalt-iron arsenic sulphide, is more plentiful than cobaltite in the hornblende-chalcopyrite ore of No. 4 vein, but judging from the cobalt bloom showing there, the cobalt minerals constitute only a fraction of 1 per cent of the vein matter.

The cobalt minerals will presumably be recovered along with chalcopyrite in the mill circuit, and if so must be separated from the copper by chemical means. The over-all cobalt content of the No. 2 and 4 veins is thought to be less than 0.5 per cent, but its presence should add to the value of the ore. (Government prices in 1951 for cobalt ranged from \$1.20 a pound in concentrates containing between 7 and 7.99 per cent to \$2 a pound where concentrates contain more than 10 per cent cobalt.)

All of the veins in the Rocher Déboulé mine are mildly radioactive. The Geiger counter used by the writer showed an unusually high count along No. 4 vein where it is intersected by the main crosscut, yet the best sample collected there showed only 0.022 per cent uranium oxide equivalent. Large bulk samples might yield slightly higher assays, but the weight of evidence of the twenty-eight samples listed below shows that the radioactive content of the veins is too low to be of economic importance. Under the microscope, a thin section of the vein gangue from the No. 23 sample shows a few minute black octahedral crystals of uraninite associated with quartz, altered hornblende, and cobaltite.

*Results of Radioactive Tests on Ore Samples from Rocher Déboulé Mine,
Western Tungsten Copper Mines Limited, Skeena Crossing, B.C.*

(Samples collected by E. D. Kindle, 1951)

Sample No.	Locality	Description	Uranium oxide equiv.
1	<i>No. 1 vein—1,200 level</i> E. side of main x-cut.....	30" altered aplite, calcite, and sulphides.....	0.009
2	E. side of main x-cut.....	6" aplite and chalcopyrite.....	0.002
3	<i>No. 2 vein—1,200 level</i> 300' west of main x-cut.....	20" hornblende, chlorite, quartz, and calcite.....	0.006
4	385' west of main x-cut.....	30" quartz, hornblende, and chlorite.	0.003
5	750' west of main x-cut.....	8" chloritized brecciated granodiorite and 6" quartz with sulphides	0.012
6	904' west of main x-cut.....	14" chloritized granodiorite, cobaltite, chalcopyrite, and scheelite...	0.007
7	<i>No. 3 vein—1,200 level</i> 40' west of main x-cut.....	36" quartz and granodiorite.....	0.001
8	<i>No. 4 vein—1,200 level</i> 50' west of x-cut.....	16" quartz and calcite.....	0.001
9	50' east of raise.....	24" hornblende pegmatite.....	0.001
10	<i>No. 2 vein—1,000 level</i> 20' west of x-cut.....	36" hornblende, quartz, and sulphides	0.001
11	250' west of x-cut.....	24" hornblende, quartz, and sulphides	0.012
12	625' west of x-cut.....	24" hornblende and sulphides.....	0.001
13	650' west of x-cut.....	18" hornblende, quartz, and sulphides	0.005
14	1,050' west of x-cut.....	14" altered granodiorite and sulphides	0.005
15	west face of drift.....	4" gouge—pale fluorescence.....	0.003
16	<i>No. 3 vein—1,000 level</i> West drift—5' from face.....	18" quartz and sheared granodiorite.	0.003
17	West drift—55' from x-cut, N. wall.....	hornblende, some cobaltite.....	0.020
18	In x-cut to No. 3, at raise.....	typical granodiorite wall-rock....	0.003
19	<i>No. 4 vein—800 level</i> In x-cut 25' S. of vein.....	5 lbs. granodiorite wall-rock.....	0.003
20	125' west of main x-cut.....	clay gouge of Juniper fault.....	0.002
21	30' west of main x-cut.....	22" hornblende and quartz.....	0.007
22	W. side of main x-cut.....	24" sheared altered granodiorite.....	0.009
23	E. side of main x-cut.....	15" sheared altered granodiorite.....	0.022
24	135' east of main x-cut.....	36" hornblende, quartz, and sulphides	0.001
25	300' east of main x-cut.....	18" hornblende, quartz, and sulphides	None
26	735' east of main x-cut.....	12" hornblende, quartz, and sulphides	0.015
27	<i>Delta east vein</i> In adit—85' from portal.....	6" quartz, chalcopyrite, scheelite....	0.015
28	Ore dump at portal.....	pyrite, chalcopyrite, scheelite....	0.017

The samples listed above were tested by the Radioactive Resources Division of the Geological Survey of Canada.

The primary ore shoots of No. 4 vein have a known vertical range of about 600 feet. Westerly dipping sedimentary rocks lie a short distance west of the outcrop of No. 4 vein and once overlay the present surface outcrop of the vein by only a few hundred feet. It follows that the known ore in No. 4 vein occurs in the outer shell, 1,500 feet thick, of the Rocher Déboulé stock. Following original consolidation, the outer part of the

stock cooled first, and lowering temperatures there are thought to have favourably influenced mineral deposition. The primary ore along No. 2 vein has a proved vertical range of more than 500 feet and this ore also occurs in the granodiorite within 1,500 feet of westerly dipping sedimentary rocks or within 1,500 feet of their projected overhead position. Ore also occurs within 100 feet of the contact where the wall-rocks are argillite, greywacke, and slate. Chances of finding ore at depth should theoretically be best near this sedimentary contact, if temperature was one of the important factors controlling mineral deposition, though of course the formation of channels for circulating mineralizing solutions, through faulting and brecciation of the brittle granodiorite, was the prime necessity for ore deposition. The widest ore shoots in the mine are found where brecciation occurred across widths up to 10 feet, or where the main fault fissure is joined by diverging fissures. Intermittent fault movement contributed to the opening of these channels. It is concluded that chances for finding more ore along No. 1, No. 3, and No. 4 veins should improve on all levels of the mine as the outer or west contact of the granodiorite is approached, and the discovery of ore along No. 4 vein east of the 'Rocher dyke' is in part dependent on whether this sector lies within the 1,500-foot thick outer zone of the stock. As the capping sedimentary rocks have been eroded away here, their former position can only be assumed. Actually No. 4 vein is exposed at intervals for 1,500 feet in an easterly direction from the portal of the 100-level adit. Immediately east of the adit it is concealed by talus, but from a point 600 feet east of the adit a small stream follows along the course of the vein for 500 feet. Only the foot-wall side on the south wall of the stream is visible. In a few places exposed, the vein gangue is of quartz and hornblende mineralized with chalcopyrite and magnetite. The presence of the magnetite suggests a higher temperature condition at the time of vein formation than farther west where magnetite is not seen. A grab sample of the ore collected here at elevation 5,150 feet, 190 feet west of the old Delta inclined tramway, assayed: gold, 0.005 ounce a ton; silver, 0.11 ounce a ton; and copper, 0.77 per cent. The stream may overlies richer sectors of the vein. Ore shoots of good grade that occur farther east between elevations of 5,700 and 6,500 feet (mountain top) are described in the account of the Highland Boy group.

No. 4 vein is at present "lost" on the 300 level west of the Juniper fault (See Figure 6). This fault strikes northwesterly through the mine workings and dips 72 degrees southwest. Its presence is marked by about 2 feet of soft, kaolinized fault gouge. On the 1,000 level, No. 2 vein was found 100 feet farther north on the northeast side of the fault. No. 4 vein is probably offset a corresponding distance.

Rocher Déboulé Mountain Group (34)

Rocher Déboulé Mountain Mines Limited own several claims just west of the Rocher Déboulé mine. During the summer of 1952 a diamond drilling program was under way to find the westerly continuation of the No. 4 vein of the Rocher Déboulé mine.

Silver Bell Claim (4)

Reference: Ann. Rept., Minister of Mines, B.C., 1933, p. 97.

The Silver Bell claim, owned by William Jeffrey and Arthur Johnson of Kispiox, is on the road west of Skeena River, about $\frac{1}{2}$ mile south of the mouth of Kispiox River.

On the west side of the road a dyke of rusty weathering granodiorite intrudes dark argillaceous sediments. The dyke is about 50 feet wide and strikes north 30 degrees east. In a large open-cut, 12 feet wide, on the southeast side of the dyke, there are three parallel faults that strike west and dip 75 degrees south. The fault planes are marked by horizontal slickensiding. A quartz vein ranging from 3 to 6 inches in width occurs along the middle fissure. The quartz carries about 25 per cent of sulphides, chiefly arsenopyrite, with various amounts of pyrite, sphalerite, and galena. A 4-inch channel sample taken across this vein in the face of the cut assayed: gold, 0.095 ounce a ton; silver, 2.88 ounces a ton; lead, 3.78 per cent; zinc, 3.95 per cent. A representative sample taken from a 2-ton stack of hand-sorted ore on the rock dump assayed: gold, 0.09 ounce a ton; silver, 1.77 ounces a ton; lead, 1.99 per cent; zinc, 3.50 per cent.

About 100 feet farther southwest there are two other 6-inch quartz veins 20 inches apart, which also strike west across the granodiorite dyke and dip 75 degrees south. These veins appear barren in the small pit in which they are exposed, but should be stripped and examined farther along their strike.

As there are five parallel fissures crossing the dyke in a distance of 100 feet, an effort should be made to trace them west into the sedimentary rocks in the higher ground where vein-forming conditions may be more favourable.

Silver Cup Group (8)

References: Geol. Surv., Canada: Sum. Repts.: 1909, p. 65; 1910, p. 97; Mem. 110, 1919, p. 34. Ann. Repts., Minister of Mines, B.C.: 1909, p. 84; 1910, p. 86; 1911, p. 105; 1912, p. 113; 1914, pp. 201-204; 1915, p. 76; 1920, p. 84; 1925, p. 134; 1926, p. 126; 1927, p. 130; 1928, p. 152; 1929, p. 156.

The Silver Cup group of four Crown-granted claims, the Silver Cup, Silver Dollar, Duke, and Duchess, is on the north side of Nine Mile Mountain and blankets the west side of a steep-walled cirque known as Silver Cup Basin. The property is the most westerly of those on the north side of the mountain. It is 8 miles north of New Hazelton station or 13 miles by way of the Nine Mile Mountain road to the lower end of Silver Cup Basin at elevation 3,400 feet. The mine workings are on the steep southwest rim of the basin between elevations of 4,600 and 5,000 feet. The mill, now dismantled, is below the basin in the timber at an elevation of 3,000 feet.

The claims were staked in 1909 by Messrs. Harris and Trainer. Silver Cup Mines, Limited, was organized, and in 1910 a 200-foot adit was driven on the main vein at elevation 4,800 feet, a 90-foot adit at elevation 4,700 feet, and a 100-foot adit at elevation 4,575 feet. The latter is now the main adit level. Two other adits were started in the slide rock, but never got far enough to strike the vein and soon caved in. Two short adits were also

driven on the Duchess claim at elevations of 3,750 feet and 4,135 feet, respectively. On the Duke claim to the west, an adit drift 150 feet in length was driven, and other small veins farther up the ridge were prospected by open-cuts and a 20-foot adit. In 1914 the mine was leased by Clothier Brothers who shipped 23 tons of selected ore that year and 70 tons in 1915. Work was recommenced in 1925 by W. S. Harris and a little additional ore shipped. In 1927, Duke Mining Company, Limited, built a 3,200-foot aerial tram from the main mine level and started construction of a 50-ton daily capacity mill employing Macintosh flotation cells. Development work was pushed in 1928 and 256 tons of hand-sorted ore were shipped during the year. The mill was completed and put into operation in May 1929 by the Silver Cup (Hazelton) Mining Company, Limited. Difficulties were encountered in treating the ore, but finally a flow sheet was worked out that recovered a single concentrate containing 92 per cent of the silver, 90 per cent of the lead, and from 40 to 45 per cent of the zinc content of the ore. The capacity of the mill was found to be in excess of the productive power of the mine and it soon became evident that no profit could be earned under the existing conditions. Mining operations ceased in November and the mill shut down on December 7, 1929. Approximately 5,710 tons of ore were treated and 571 tons of concentrates were made.

The Minister of Mines, British Columbia, report for 1929 gives the average grade of concentrates shipped for the months of September and October of that year as: silver, 126.40 ounces a ton; lead, 25.60 per cent; zinc, 16.90 per cent; and for the month of November and part of December as: silver, 152.60 ounces a ton; lead, 27.60 per cent; zinc, 16.00 per cent. As a check on the precious metals and antimony content of the concentrates shipped, the writer collected two samples in 1937 from a small amount of concentrates still remaining in the bins at the mill. These samples gave an average assay as follows: gold, 0.013 ounce a ton; silver, 79.07 ounces a ton; platinum, nil; lead, 21.56 per cent; zinc, 18.21 per cent; arsenic, 5.22 per cent; antimony, 6.16 per cent; sulphur, 19.81 per cent; bismuth, a trace; tin, none; cobalt, 0.06 per cent; copper (not tested).

The Silver Cup quartz vein is exposed on the precipitous rim of the basin between elevations of 4,600 and 5,000 feet. It strikes north 30 degrees east and dips 75 degrees southeast. The vein occurs along a fault marked by horizontal slickensides in bedded sediments.

The quartz gangue carries abundant sphalerite, galena, jamesonite, tetrahedrite, and pyrite. In some places two or more parallel fractures from 1 foot to 3 feet apart have increased the width of the vein, the enclosed, brecciated rock being replaced by a little quartz with sulphides. The sediments are chiefly thick-bedded, impure sandstones, in places tuffaceous, with interbedded, finely laminated argillites. On the west side of the vein the sediments strike northeast and dip from 10 to 15 degrees northwest. A short distance east of the vein the sediments have a similar strike but dip 15 degrees southeast, so that the vein is located on a fault along the crest of an anticlinal fold. The west tip of the granodiorite stock, which intrudes the sediments for 3 miles along the north side of the mountain, approaches to within 1,000 feet of the vein. The intrusion is exposed in the east wall of Silver Cup Basin, but its westerly extension is

covered by talus. Granodiorite dykes, evidently apophyses from the main stock, are exposed in the workings. These dykes were intruded prior to mineralization, as they are faulted along the vein fissure. The vein is believed to have been deposited from mineralizing solutions arising from an underlying body of the granodiorite.

The main adit, at elevation 4,575 feet, is 730 feet long. The vein is intersected 170 feet from the portal and has been drifted along in a southwesterly direction for 425 feet. For the first 130 feet the vein ranges from 4 to 24 inches in width, with an average width of 12 inches. For the next 90 feet the vein has been stoped out, and a little farther along there is a 40-foot length stoped out for 10 feet above the roof level. At 340 feet from the portal the main raise leads up to the next level. The vein width averages 6 inches there, but 75 feet farther south it splits into three diverging parts, the centre branch of which is followed by the drift for 80 feet south to where the vein flattens and disappears at a short cross-cut to the east. The adit ends roughly 100 feet farther south in a dyke-like body of granodiorite.

A 4-inch channel sample taken across the vein 170 feet from the portal of the adit, at the intersection of the main crosscut with the adit drift, assayed: gold, 0.02 ounce a ton; silver, 27.10 ounces a ton; lead, 3.37 per cent; zinc, 3.58 per cent; antimony, 2.13 per cent. An 11-inch channel sample, taken across the vein 60 feet farther northeast, assayed: gold 0.01 ounce a ton; silver, 1.05 ounces a ton; lead, 0.21 per cent; zinc, 0.15 per cent; antimony, nil. A 24-inch channel sample, taken across the vein just north of the main stope or 225 feet from the portal of the adit, assayed: gold, 0.015 ounce a ton; silver, 0.78 ounce a ton; lead, 1.22 per cent; zinc, 3.10 per cent; antimony, 0.92 per cent.

The next higher adit, at elevation 4,700 feet, is 560 feet long and for most of its length follows the vein. Between 50 and 275 feet from the portal the vein is stoped out above this level. Farther south the vein ranges from 3 to 6 inches in width for about 250 feet and then pinches out near the face of the adit. Granodiorite shows in the face and on both walls 65 feet north of the face of the adit. This adit is connected with the main adit and the upper adit by a raise that comes up at a point 310 feet from the portal. A 4-inch channel sample, taken across the vein 15 feet south of the raise, assayed: gold, 0.05 ounce a ton; silver, 47.72 ounces a ton; lead, 10.63 per cent; zinc, 8.64 per cent; antimony, 1.90 per cent. This section of the vein carries abundant sulphides, and there is a parallel 2-inch vein of similar ore 18 inches to the east. The 4-inch seam is typical of the better parts of the main vein south of the raise.

The upper adit, at elevation 4,800 feet, was not examined as the entrance was ice filled.

There is a vein in a 20-foot trench at elevation 5,030 feet, about 1,000 feet south of the portal of the main adit. This may be the Silver Cup vein, but there is a possibility that it is a different vein as it is 200 feet south of the ends of the adit workings. The vein strikes north 30 degrees east and dips 70 degrees east. It ranges from 3 to 8 inches in width and consists of quartz and carbonate gangue with considerable jamesonite and sphalerite. An 8-inch channel sample taken across the vein assayed:

gold, 0.015 ounce a ton; silver, 35.40 ounces a ton; lead, 13.51 per cent; zinc, 1.27 per cent; antimony, 2.80 per cent. Further search should be made to the south for a continuation of this vein.

At elevation 4,130 feet, or 850 feet down the talus slide from the main adit, there is a 46-foot adit on the Duchess claim. It is driven south in flat-lying argillites, which are cut by a 3-foot dyke of granodiorite 20 feet from the portal. The small calcite stringer investigated is unmineralized.

At elevation 3,750 feet, an exploratory adit 45 feet long follows a 12-inch quartz vein for about 20 feet to where the vein is cut off by a fault. The quartz gangue carries up to 30 per cent of galena, sphalerite, and pyrite. A representative sample taken across the vein a few feet from the portal assayed: gold, 0.025 ounce a ton; silver, 9.17 ounces a ton; lead, 1.80 per cent; zinc, 6.50 per cent.

Silver Pick Group (11)

References: Geol. Surv., Canada, Sum. Rept. 1910, p. 98. Ann. Repts., Minister of Mines, B.C.: 1909, p. 84; 1910, p. 87; 1914, p. 205.

These claims are on the north side of Nine Mile Mountain 8 miles due northeast of South Hazelton, or 13 miles by the Nine Mile Mountain road with an additional 4 miles by trail east along the north side of the mountain from Silver Cup Basin. The claims are immediately east of the Lead King and Slocan groups. No work has been done here for many years.

The country rocks are sandstone, argillite, and bedded tuff intruded by the east end of the granodiorite stock that extends for 3 miles along the north side of Nine Mile Mountain. In this vicinity the granodiorite stock is about 800 feet wide.

At the top of a steep ridge at elevation 4,500 feet a shaft inclined at 20 degrees is driven about 50 feet on a small quartz vein in sedimentary rocks. The vein is less than 75 feet long and has an average width of about 8 inches. It strikes north and dips 20 degrees east. The sulphide content of the vein is completely oxidized at the surface, and the resulting cavities are partly filled with a light yellow oxide of lead. A 10-inch channel sample, taken across this vein at the mouth of the shaft, assayed: gold, a trace; lead, 5.07 per cent.

About 800 feet farther east a 12-foot adit is driven on an 18-inch shear zone in the granodiorite. The shear zone is exposed for about 50 feet. It carries a little arsenopyrite, but appears rather barren at the face of the drift. An 8-inch channel sample of the best mineralized rock near the portal assayed: gold, nil; silver, 0.51 ounce a ton. In an open-cut 125 feet farther northeast and 80 feet lower there is a 3-inch shear zone that also carries a little quartz and arsenopyrite. It is in the sedimentary rocks north of the granodiorite.

At elevation 5,100 feet, there is a quartz vein in the sedimentary rocks on the nose of a steep spur about 500 feet south of the granodiorite stock. The vein strikes east and dips 15 degrees south. It is about 50 feet long with an average width of 8 inches. The vein quartz carries a little jamesonite and sphalerite. An 8-inch channel sample taken across the vein midway along its strike assayed: gold, a trace; lead, 1.53 per cent; zinc, 2.84 per cent; arsenic, 3.86 per cent; antimony, 0.64 per cent.

At elevation 4,900 feet, about 1,000 feet farther east, a strong quartz vein is exposed by natural agencies at the base of a precipitous bluff. The vein ranges from 1 foot to 3 feet in width and is probably several hundreds of feet long. It strikes north 20 degrees east and dips 80 degrees southeast. The vein occurs along a fault plane and is characterized by numerous brecciated fragments of tuff and argillite in a finely crystalline quartz matrix. In some places the quartz is sliced by as many as four parallel fault planes, all marked by vertical striæ. The vein is very sparsely mineralized. A parallel vein of very similar appearance lies 50 feet farther west. This one is not as strong, nor is the quartz sliced by later movements, but it maintains an average width of 12 inches where exposed for several hundred feet up the steep rock bluffs. A rough, 20-inch sample taken across the main vein at elevation 4,950 feet assayed: gold, none. A representative sample taken at elevation 4,900 feet, where the vein is 2 feet wide, assayed: gold, none. A rough sample taken from the parallel vein, 50 feet to the west, assayed: gold, none.

At elevation 5,400 feet, two small veins were seen 100 feet from the mountain top at the edge of a bluff that drops precipitously towards the veins described above. The veins are in argillaceous sediments that strike north 30 degrees east and dip 80 degrees southeast. Both are quartz veins that carry an abundance of stibnite with a little sphalerite and galena. They have an average width of about 6 inches and are somewhat over 50 feet in length. A representative sample of picked sulphide assayed: gold, a trace; silver, 4.74 ounces a ton; lead, 2.04 per cent; zinc, 0.76 per cent; arsenic, 7.32 per cent; antimony, 29.4 per cent.

Silver Standard Mine (16)

References: Geol. Surv., Canada: Sum. Rept. 1912, p. 105; Mem. 110, 1919, pp. 27-32. Ann. Repts., Minister of Mines, B.C.: 1911, pp. 81 and 99; 1912, pp. 112 and 116; 1913, p. 105; 1914, p. 194; 1915, p. 76; 1916, pp. 89 and 119; 1917, p. 106; 1918, p. 115; 1919, p. 101; 1920, p. 84; 1921, p. 97; 1922, p. 98; 1923, p. 105; 1924, p. 93; 1947, p. 97; 1948, p. 77; 1949, p. 82; 1950, pp. 87-94; 1951, p. 109.

The Silver Standard mine is on Glen Mountain about 6 miles by good motor road northwest of New Hazelton railway station. The principal veins and mine workings are on the west side of the mountain between elevations of 1,200 and 2,000 feet. The property was first staked in 1910 by Messrs. McBean and Long, from whom it was purchased and developed by Stewart, Welsh, McLeod, and associates of Vancouver. The first shipments of gold-silver-lead-zinc ore were made in 1913, and by June 1917, 2,229 tons of silver-lead ore had been shipped, carrying 746,259 pounds of lead, 516.8 ounces of gold, and 304,411 ounces of silver, with an average of 20.3 per cent of zinc. In 1916 and to the end of May 1917, 393.9 tons of zinc ore were shipped; this averaged 43.16 per cent zinc and 0.24 ounce gold and 60.02 ounces silver a ton, yielding a total of 328,050.5 ounces of silver. In 1918 a 50-ton water concentrator was built, and about 4,000 tons of ore treated in it in both 1919 and 1920. The mine was closed throughout 1921, but reopened for 3 months early in 1922, when an additional 900 tons of ore was mined and milled. This yielded 165 tons of concentrates containing 45 ounces of gold, 20,191 ounces of silver, 21,071 pounds of zinc, and 30,979 pounds of lead. The 1923 Annual Report of

the Minister of Mines, British Columbia, gives the production record of the Silver Standard mine as: 14,500 tons of ore mined and milled to produce 1,100 ounces gold, 626,000 ounces silver, 1,225,000 pounds lead, 1,400,000 pounds zinc, with a gross value in the neighbourhood of \$500,000.

The property was under active development by Canadian Cadillac Gold Mines Limited, of Montreal, during 1938, but operations were suspended early in 1939 owing to lack of funds.

The Silver Standard mine was reopened by Silver Standard Mines Limited in 1947, with R. W. Wilson as managing director and H. B. Gilleland as mine manager (*See Plate III B*). The 1,300 level (*See Figure 7*, in pocket) crosscut was soon extended to No. 4 vein where a valuable orebody was outlined. Milling operations (60 tons a day) began in September 1948, ore being drawn from Nos. 1 and 4 veins. In 1949, the 1,300 level crosscut was extended east to No. 6 vein where a new rich orebody was found. An internal shaft was sunk from the 1,300 level, between Nos. 4 and 6 veins, in 1951, with three lower levels at 150-foot intervals. High-grade ore was being drawn from stopes in the rich No. 6 vein on the 1,150-foot level by the autumn of 1952.

The production of the Silver Standard mine during the 5-year period from 1948 to 1952 is shown in the following table:

Year	Tons milled	Gold Ounces	Silver Ounces	Lead Pounds	Zinc Pounds	Cadmium Pounds
1948.....	3,543	195	46,559	62,805	255,472	2,266
1949.....	17,516	1,267	378,888	603,953	1,739,817	18,209
1950.....	21,104	1,958	897,420	1,741,800	3,439,000	44,470
1951.....	20,858	1,516	889,849	1,845,945	2,977,490	41,997
1952.....	20,893	1,750	907,646	1,638,529	3,351,022	46,980
Totals.....	83,914	6,686	3,120,362	5,893,032	11,762,801	153,922

In the year ending March 31, 1952, Silver Standard Mines Limited earned a net profit of \$791,395, won from the milling of 20,319 tons of ore averaging \$97.06 a ton, and a net profit of \$777,898 was realized the preceding year on ore averaging \$90.36 a ton.

Glen Mountain is composed of gently folded sedimentary rocks of the Hazelton group of Upper Jurassic or Lower Cretaceous age. The sedimentary rocks range from thick-bedded, coarse, grey, impure sandstone and greywacke to finely laminated, grey to green argillite and siltstone. The sandstones contain numerous rounded fragments of lava, and by admixture of material of direct volcanic origin graduate into beds of tuff. Some of the sandstone is highly feldspathic and grades into arkose. On the west slope of the mountain, on the Silver Standard property, the sedimentary beds form a low anticline with the limbs of the fold dipping east and west and the axial plane striking northerly; at the lower mine adit the beds dip up to 35 degrees west, and east of the main shaft they

dip from 5 to 15 degrees east. On the east side of the mountain, the strata are folded to dip more steeply to the west. This broad structure is interrupted by numerous minor folds on the limbs of the main fold. The west limb of the anticline is intruded between elevations of 1,300 and 1,700 feet by two stocks of porphyritic granodiorite, the largest of which has an average diameter of about 500 feet.

A dozen or so strong quartz veins on the property all strike northeast and dip from 50 to 70 degrees southeast (See Figure 7). The veins occur along strong fault fissures in the gently folded sedimentary rocks, and three of them (Nos. 3, 4, and 6 veins) extend south into the intrusive granodiorite. In the mine workings, the veins lie from 100 to 400 feet apart and range from 200 to 2,000 feet in length and from a few inches to 12 feet in width, but widths of from 1 foot to 3 feet are most common. The productive veins occur within a zone 2,000 feet wide from west to east across the mountain, and lie just north of the two small granodiorite stocks. They trend northeasterly across the west limb of the northerly trending anticlinal fold and dip about normal to the enclosing sedimentary strata. The vein fractures are comparatively straight, but No. 4 vein turns more southerly on approaching the nearer intrusive stock. Many smaller fractures diverge from the main vein fractures into the walls; some of these contain quartz veins that narrow to less than an inch wide a few feet from the major fractures, and none is of economic importance. Most of the ore shoots are confined to the straight sections of the veins; where the veins are curved they are generally narrower or tend to split into lower grade stringers, although in places they may be wider than in the straight sections and the ore of higher grade.

Milky white quartz generally forms the most abundant constituent of the veins, and massive white calcite and buff-hued siderite are associated with the quartz in places. The metallic minerals that form the ore shoots include banded, massive, and disseminated galena, sphalerite, pyrite, arsenopyrite, pyrrhotite, tetrahedrite, and chalcopyrite. The ore carries a high silver content and an appreciable gold content. All of the high silver assays are associated with the presence of galena or tetrahedrite, and sphalerite is nearly everywhere associated with these two minerals. The sphalerite contains an appreciable quantity of cadmium, but little silver. The more westerly veins contain abundant arsenopyrite and have a higher than average gold content, which varies with the relative abundance of arsenopyrite.

The productive veins vary greatly in metallic mineral content throughout their length and depth, and parts containing barren quartz may pass into sulphide-rich ore shoots within a few feet. Company assay plans show that some of the stoped ore shoots of higher than average grade were separated by parts of the vein that contain lower than average grade ore. Much of the ore occurs in pockets or as paystreaks that lie parallel with the walls of the veins, along or near either wall or concentrated along fractures midway in the veins. Where the galena, sphalerite, and tetrahedrite occur in small pockets there is a tendency for these minerals to crumble and fall from the face and back of the workings as a result of blasting. Consequently, mill recovery is commonly found to be higher from such stopes than indicated by the assays of samples collected from

the roof and walls. Also, the irregular distribution of the ore minerals in the veins makes it difficult to estimate the grade of a vein by assaying vein cores of diamond drill-holes.

Ore from No. 6 vein, the richest in the mine, generally assays better than 100 ounces of silver a ton. Most of this ore is composed of a very finely crystalline mixture of galena, sphalerite, and tetrahedrite. A large part of this mixed ore is banded, with alternating layers of galena, sphalerite, and tetrahedrite less than 0.01 inch thick. The mixed ore includes some finely crystalline pyrite, pyrrhotite, and chalcopyrite; it ranges from grey to yellow-brown in colour and, where sphalerite is more abundant than galena, has a somewhat stony appearance.

No. 0 Vein. A newly discovered vein that lies 200 feet northwest of the 1,300-level portal is named the No. 0 vein.

No. 1 Vein. This vein outcrops at elevation 1,400 feet and has been traced for 500 feet along the surface by open-cuts. It strikes north 42 degrees east, dips 65 degrees southeast, and ranges in width from 8 inches to 5 feet. Midway along the vein, ore has been removed to a depth of 10 feet by an open-cut 35 feet long. At the north end of the cut, where a raise comes through from the lower adit, the vein is 3 feet wide. At the south end, the vein narrows to 8 inches, and a channel sample taken there across the vein assayed: gold, 0.545 ounce a ton; silver, 6.62 ounces a ton; lead, 0.78 per cent; zinc, 14.48 per cent; arsenic, 3.61 per cent; and antimony, nil. In a second cut 20 feet north of the head of the raise, the vein widens to 5 feet and is well mineralized; a channel sample across it assayed: gold, 0.37 ounce a ton; silver, 16.32 ounces a ton; lead, 0.87 per cent; zinc, 18.87 per cent; arsenic, 7.33 per cent; antimony, nil; and bismuth, nil.

The vein is intersected in the 1,300 level adit at 350 feet from the portal, and has been opened up by drifts that run north and south. A fault zone offsets the vein a few feet about 160 feet northeast of the crosscut. Stopes extend through to the surface between the crosscut and the faulted zone. A channel sample taken across the vein 35 feet north of the crosscut adit, where it is 3 feet wide, assayed: gold, 0.13 ounce a ton; silver, 44.36 ounces a ton; lead, 0.28 per cent; and zinc, 10.82 per cent.

No. 2 Vein. This vein lies 95 feet east of the No. 1 vein and outcrops 35 feet higher on the mountain slope. Its attitude is almost identical with that of the No. 1 vein, but it has been traced for only 250 feet, in which distance it ranges in width from 6 to 12 inches. The quartz gangue carries abundant arsenopyrite and pyrite, with some shoots rich in galena and sphalerite. A channel sample, taken across the vein at the surface midway of its length, where it is 6 inches wide, assayed: gold 1.215 ounces a ton; silver, 60.49 ounces a ton; lead, 5.42 per cent; zinc, 3.61 per cent; arsenic, 3.80 per cent; and antimony, 0.28 per cent.

In the No. 1 adit (elevation 1,300 feet) where the No. 2 vein is intersected 100 feet east of the No. 1 vein, it is 8 inches wide and contains up to 30 per cent galena and sphalerite.

No. 3 Vein. This was the first vein encountered in the No. 2 crosscut adit at 140 feet from the portal. O'Neill (1919) describes the vein as consisting of about 6 inches of mixed ore. In the No. 1 adit this vein is 6 inches wide and contains about 50 per cent of galena and sphalerite where intersected by the crosscut.

No. 4 Vein. This vein is the strongest on the property, having been traced by surface trenching and by underground workings for a distance of 1,200 feet. It varies in strike from north 40 degrees east at its southern extremity to north 58 degrees east at its north end, and the dip ranges from 65 to 80 degrees southeast. At the surface, the vein rises gradually from an elevation of 1,615 feet at an old shaft near its north end to 1,715 feet at its south end, which is enclosed for 200 feet in granodiorite. An average vein width of 2 to 3 feet of quartz is maintained on passing from the sedimentary into the intrusive rock, but the vein carries much less sulphide where granodiorite forms the wall-rock. Near the centre of the small granodiorite stock, the vein widens to 7 feet and contains about 1 per cent galena and 1 per cent pyrite. A chip sample taken across the vein in a rock-cut at this point assayed: gold, 0.015 ounce a ton; silver, 0.17 ounce a ton; and lead, a trace. The vein splits and pinches about 50 feet farther south.

The No. 4 vein is cut on the 1,500 level at 400 feet from the portal, and is drifted on for over 230 feet north and 150 feet south of the crosscut. Much of the vein was stoped out above this drift for 100 feet north and 135 feet south of the crosscut in the 1911-22 period of activity. A channel sample collected across the vein 135 feet south of the crosscut, where it is 12 to 15 inches wide and contains 15 to 20 per cent arsenopyrite, galena, and sphalerite, assayed: gold, 0.40 ounce a ton; silver, 22.10 ounces a ton; lead, 5.25 per cent; and zinc, 39.52 per cent. At 150 feet north of the No. 2 crosscut, in the north drift, 1,500 level, the vein pinches from 3 feet to 1 foot, and maintains this width roughly to the face of the drift. At the face, the vein ranges from 6 to 12 inches in width and consists of white, milky quartz sliced parallel with the vein by small horizontal faults carrying finely banded seams of pyrite and galena. A 7-inch channel sample across the vein at the face, assayed: gold, 0.05 ounce a ton; silver, 14.20 ounces a ton; lead, 0.74 per cent; and zinc, 1.48 per cent.

On the 1,300 level, the No. 4 vein is as much as 12 feet wide near the main crosscut, but this includes a horse of wall-rock. It has been stoped over a length of 400 feet through to the 1,500 level and most of the vein matter in this stope ranged from 3 to 4 feet in width. The vein is less than a foot wide northeast of the main stope, and near the northeast face swings easterly and splits into stringers about an inch wide. It also splits into several stringers southwest of the central stope, the stringers containing arsenopyrite and chalcopyrite.

No. 5 Vein. This vein lies 95 feet east of No. 4 vein, and when seen by the writer was developed by a 32-foot drift north and a 55-foot drift south from the crosscut on the 1,500 level. The vein is 8 inches wide at the crosscut, but at the face of the north drift is only 2 inches wide. In the south drift, a lens of ore 30 feet long and 3 feet wide has been partly stoped, but at the face the vein pinches to a width of 4 inches.

No. 6 Vein. This vein is 193 feet east of No. 5 vein, and is intersected by No. 2 (1,500 level) crosscut adit 685 feet from the portal. It is only 4 inches wide 16 feet northeast of the crosscut but widens gradually farther northeast. Between 30 and 260 feet northeast of the crosscut the vein is 18 inches wide and is well mineralized; for 75 feet farther its width gradually decreases, and the fracture is barren of vein matter in some places. At the face of the south drift, 30 feet southwest of the crosscut, the vein is 3 feet wide but contains mostly pyrite and arsenopyrite in place of silver-lead-zinc sulphides.

On the 1,300 level No. 6 vein is fairly straight and dips gently, in places as little as 35 degrees, to the southeast. It has an average width of 30 inches for about 255 feet northeast and 130 feet southwest of the crosscut and contains abundant sphalerite, galena, and tetrahedrite. Much of the ore drawn from this sector of the vein contained more than 100 ounces of silver a ton. The vein is narrow from 130 to 230 feet southwest of the crosscut and in places is represented only by gouge, but farther southwest, near its contact with a granodiorite body, it widens gradually to as much as 6 feet. The vein fracture curves more westerly and splits on entering the granodiorite. At the southwest face of the drift the larger vein is 18 inches wide and is mineralized with pyrite and arsenopyrite and a very little galena and sphalerite. In the northeast drift the vein narrows, curves easterly, and splits some 75 feet northeast of the straight central section.

Press reports in the autumn of 1952 stated that drifting on No. 6 vein on the new, 1,150 level had opened up 300 feet of continuous ore. Sampling of the first 240 feet showed an average across 3.6 feet of: gold, 0.125 ounce a ton; silver, 63.1 ounces a ton; lead, 8.9 per cent; zinc, 9.6 per cent; and cadmium, 0.134 per cent.

No. 7, or former Main Vein. This vein has been followed along the surface and in the mine workings for 800 feet. In this distance it strikes north 55 degrees east and dips 60 degrees southeast. From the main shaft, at an elevation of 1,730 feet, the vein is followed southwest up the slope by a series of open-cuts for 600 feet, to an elevation of 1,830 feet, and scattered quartz float seen several hundred feet farther south suggests that it continues in that direction. At the shaft, the vein is 2 to 4 feet wide, and the quartz gangue is well mineralized with galena and sphalerite. A large sample of almost solid galena, with a little sphalerite and freibergite, collected on the south side of the collar of the shaft, assayed: gold, 0.04 ounce a ton; silver, 146.95 ounces a ton; lead, 81.60 per cent; zinc, 1.12 per cent; and antimony, 0.57 per cent.

A short crosscut adit driven southeast at a point 150 feet southwest of the collar of the shaft cuts the No. 7 vein at 26 feet from the portal and the hanging-wall vein at 56 feet from the portal. The latter vein branches northeasterly at a small angle from the main vein at a distance of 230 feet south of the shaft at the surface. In a 30-foot drift the main vein is 8 inches wide and carries from 5 to 15 per cent sulphides. The hanging-wall vein is drifted on for 60 feet in this adit; it maintains an 8-inch ore width for 50 feet from its junction with the main vein, and then pinches. A slope 20 feet long is carried through to the surface.

A second short adit is driven southeast to intersect the main vein from a point 375 feet south of the collar of the main shaft. This adit intersects the vein 57 feet from the portal, but there the vein is offset for 20 feet by a fault that strikes north 20 degrees east and dips 75 degrees southeast. A drift follows this fault, which is unmineralized for 150 feet. The main vein is explored south of the fault by a 50-foot drift, which is reached by a short crosscut from the drift on the fault. Here, the vein ranges from 21 to 30 inches in width, and the quartz gangue is banded by fine seams of sulphide, most of which is pyrite and arsenopyrite with some galena. A sample taken across 18 inches of ore from the roof of the drift, 15 feet from the face, assayed: gold, 0.025 ounce a ton; silver, 14.96 ounces a ton; lead, 5.30 per cent; and zinc, nil. A sample collected across 13 inches of vein matter from the roof of the drift, 25 feet from the face, assayed: gold, 0.085 ounce a ton; silver, 0.21 ounce a ton; lead, nil; and zinc, nil.

The No. 7 vein is intersected by the No. 2 crosscut adit 192 feet east of the No. 6 vein or 880 feet from the portal of the adit. On this level the vein was drifted on for 765 feet, in the 1911-22 period, namely 248 feet southwest and 517 feet northeast of the crosscut intersection. This drift reaches the former main shaft 320 feet northeast of the end of the 1,500 level main crosscut. Near the shaft there is a 118-foot drift along the hanging-wall vein that branches northeasterly from No. 7 vein. The main vein is continuously exposed along the 765-foot drift; and ranges from 6 inches to 5 feet in width. For most of this distance the vein consists of white, milky quartz sparsely mineralized with iron, lead, and zinc sulphides. An ore shoot that extended 50 feet southwest and 100 feet northeast of the shaft was developed by two raises to the 150-foot level and considerable stoping was done from both levels. The hanging-wall vein, which joins the No. 7 vein 50 feet south of the shaft on the 1,500 level, provided an ore shoot 80 feet long, varying from $2\frac{1}{2}$ to 4 feet in width. This vein pinches to a width of 4 inches of quartz 100 feet northeast along its strike from the main vein.

According to O'Neill (1918) the No. 7 vein ore shoot was 200 feet long on a level established 150 feet below the collar of the old main shaft, and it varied from 6 inches to 8 feet in width with an average of about 4 feet.

No. 8 Vein. This vein is 400 feet east of the No. 7 vein, and has been traced along the surface for 380 feet between elevations of 1,830 and 1,880 feet. The vein strikes north 55 degrees east and dips 70 degrees southeast. Two shallow shafts are sunk on it about 100 feet apart and ore was removed between the shafts in a trench 75 feet long and 10 feet deep. The vein ranges from 6 to 12 inches in width in the surface cuts and is about 5 per cent sulphides. In an open-cut at the south end of the vein, 130 feet south of the deeper shaft, an 8-inch channel sample taken across the vein assayed: gold, 0.025 ounce a ton; silver, 3.16 ounces a ton; lead, nil; and zinc, nil.

Fifty feet above the last-mentioned cut, and 360 feet farther southwest, there is an exposure of quartz 6 feet in diameter, the strike and dip of which were indeterminable due to drift cover. A representative sample from this outcrop assayed: gold, 0.06 ounce a ton; silver, 0.16 ounce a ton.

On the 250-foot level (No. 2 adit), the No. 8 vein is intersected by a crosscut 400 feet east of the main shaft. A drift follows the vein 96 feet northeast and 75 feet southwest from the crosscut intersection. The vein gangue consists of white, milky quartz containing up to 10 per cent of fine pyrite and arsenopyrite, and ranges from 4 feet in width at the crosscut intersection to 8 inches at both faces of the drift. An 8-inch channel sample taken across the vein in the south face of the drift assayed: gold, 0.025 ounce a ton; silver, 0.11 ounce a ton; and lead, none. A representative sample of the vein quartz from the 4-foot lens at the crosscut, carrying about 20 per cent of fine sulphides, assayed: gold, 0.105 ounce a ton; silver, 0.16 ounce a ton.

A parallel vein ranging from 6 to 12 inches wide was seen in the crosscut 50 feet northwest of the No. 8 vein, but no work has been done on it.

Nos. 9 and 10 Veins. These veins lie 400 and 600 feet, respectively, east of the No. 8 vein at an elevation of about 1,970 feet. They have an average width of 1 foot, and each has been traced for about 100 feet. In both veins the quartz gangue carries up to 5 per cent of pyrite, arsenopyrite, galena, and sphalerite. A representative sample from the north cut on No. 9 vein assayed: gold, 0.03 ounce a ton; silver, 1.73 ounces a ton; lead, 0.31 per cent; and zinc, nil. A representative sample from the main cut on No. 10 vein assayed: gold, 0.02 ounce a ton; silver, 9.07 ounces a ton; lead, 1.02 per cent; and zinc, 0.15 per cent.

Black Prince Vein. The vein known as the Black Prince is at elevation 1,940 feet and is 1,000 feet northeast of the No. 9 vein or 1,700 feet northeast of the shaft on the main vein. It strikes north 55 degrees east and dips 60 degrees southeast. It is explored by one open-cut and by a 50-foot shaft recorded as sunk in 1911. The vein is 18 inches wide at the surface, and carries about 3 per cent of sulphide, mostly pyrite. A rough channel sample taken across the vein 50 feet south of the shaft assayed: gold, 0.04 ounce a ton; silver, 7.46 ounces a ton; lead, 1.07 per cent; and zinc, 1.12 per cent. The report of the Minister of Mines for British Columbia for 1915 states that 15 tons of ore from this shaft was shipped that year.

Other Veins. On the east side of the mountain, 1,100 feet southeast of the Black Prince vein, two short adits were driven in 1911 to explore small veins. The lower adit, at elevation 1,900 feet, was driven 25 feet west along an 18-inch vein that strikes west and dips 55 degrees north. At the face of the adit the vein is cut off along a strong cross fault striking north 52 degrees east and dipping 75 degrees southeast. The vein carries an average of 5 per cent of pyrite and arsenopyrite throughout, and at the portal a pile of hand-sorted ore was seen containing up to 30 per cent of galena, sphalerite, and tetrahedrite. An 18-inch channel sample taken across the vein in the roof of the adit, 10 feet from the face, assayed: gold, 0.01 ounce a ton; silver, 0.21 ounce a ton; lead, nil; and zinc, nil. A grab sample from the $\frac{1}{2}$ -ton pile of hand-sorted ore on the dump assayed: gold, 0.10 ounce a ton; silver, 94.70 ounces a ton; lead, 10.68 per cent; and zinc, 9.70 per cent.

The other adit, 25 feet higher and 90 feet farther south, is driven 97 feet west into the mountain. Fifty feet from the portal it intersects a

sparsely mineralized vein that strikes north and dips 65 degrees east. A 6-inch, flat-lying branch vein is followed in the adit to where it is faulted at the face.

According to the Annual Report for 1950 of the Minister of Mines for British Columbia (page 94), the Silver Standard mill produces a lead concentrate that assays about: gold, 1.0 ounce a ton; silver, 500 ounces a ton; lead, 50 per cent; and zinc, 10 per cent. And the zinc concentrate assays about: gold, 0.10 ounce a ton; silver, 30 ounces a ton; lead, 1.0 per cent; and zinc, 50 per cent, and contains most of the cadmium in the ore. The concentrates are shipped by rail to the Trail smelter.

Silverton Group (2)

Reference: Ann. Rept., Minister of Mines, B.C., 1911, p. 98.

The Silverton group of six claims was staked by Long and McBain on the south slope of Cariboo Mountain in 1911. No work has been done on these claims in recent years.

W. Fleet Robertson, in the reference listed above, describes the strata on this part of Cariboo Mountain as largely altered argillites and sandstones cut by numerous light-coloured acidic dykes. At an elevation of 5,100 feet the strata are well exposed and are intersected by many small, quartz-filled fissures. These quartz veins are lenticular; most of them range from 6 to 10 inches in maximum width and hold some pyrite and galena. A sample of clean ore assayed: gold, 0.70 ounce a ton; silver, 5.7 ounces a ton.

Slocan Group (10)

The Slocan mineral claims, formerly owned by J. A. Miller of South Hazelton, cover the top of Nine Mile Mountain eastward from the peak and extend down the precipitous north slope to form a unit with the Lead King claims. They form part of the group of fifty-two claims now held by Crown Silver Lead Mines Limited. The showings are reached by way of the trail to the Sunrise property, there being an easy gradient from the Sunrise workings to the mountain top. The claims are 8 miles northeast of South Hazelton, but by road and trail the distance is 16 miles.

At elevation 5,500 feet, on the east side of the highest part of the mountain, a sheared zone 2 feet wide has been traced for 150 feet by trenches. The country rocks are sandstones, tuffs, and argillites intruded about 600 feet to the north by the granodiorite stock that outcrops for 3 miles along the north side of the mountain. The sheared rock is sparsely mineralized, but carries at its centre a sulphide vein composed of jamesonite, galena, and pyrite with a little quartz gangue. The vein strikes north 55 degrees west and dips 30 degrees south. It ranges from 3 to 6 inches in width. A 4-inch sample taken across the vein in the face of a 40-foot open-cut assayed: gold, a trace; silver, 5.96 ounces a ton; lead, 12.32 per cent; antimony, 4.95 per cent.

A few hundred feet farther east, at elevation 5,400 feet, a 6-inch quartz vein is followed for 100 feet by a series of rock cuts. The vein carries an abundance of jamesonite, sphalerite, and galena. It strikes

north 30 degrees west and dips 37 degrees southwest. The enclosing sediments, mostly tuffaceous sandstones and argillites, strike south 40 degrees west and dip 80 degrees southeast. A 6-inch channel sample taken across a typical part of the vein midway along its outcrop assayed: gold, a trace; silver, 4.10 ounces a ton; lead, 3.73 per cent; zinc, 1.88 per cent; antimony, 1.65 per cent. About 100 feet south of the vein and at the same elevation, there are a number of narrow, graphitic coal seams. A rough surface sample taken from the largest seam, 12 inches thick, was assayed by the Fuel Testing Laboratories at Ottawa. On a dry basis the sample contained 70.3 per cent ash, 6.9 per cent volatile matter, and 22.8 per cent fixed carbon.

At elevation 5,300 feet, roughly 600 feet farther southeast on the east side of a draw that drains south, an 18-inch quartz carbonate vein is exposed in the sediments by two open-cuts. The vein strikes north 50 degrees east and dips 70 degrees southeast. It carries about 3 per cent of arsenopyrite. A representative sample of the vein assayed: gold, nil; silver, 0.08 ounce a ton.

About 1,000 feet farther northeast on the Kootenay claim, a 33-foot adit is driven southwest on a narrow quartz vein at elevation 5,260 feet. The adit is on the north side of the mountain at the top of a bluff that drops vertically for several hundred feet. The vein in the adit ranges from 3 to 6 inches in width, strikes west, and dips 20 degrees south. The quartz gangue carries galena, jamesonite, and sphalerite. A very similar vein outcrops at the portal of the adit, strikes west, and dips 35 degrees north. It has been stripped along the surface and a little ore is piled near the adit. Both veins occur along slickensided faults in argillaceous rocks close to the granodiorite stock that lies along the north side of the mountain. Offshoots from the granodiorite mass cut the sediments 40 feet east and 30 feet west of the adit. A representative sample of the ore assayed: gold, a trace; silver, 9.85 ounces a ton; lead, 22.98 per cent; zinc, 14.57 per cent.

Spaulding Group (37)

This property is about 1 mile south of the Rocher Déboulé mine, which is 6 miles south of New Hazelton on Rocher Déboulé Mountain. It is reached by a trail that runs in a southerly direction from the Rocher Déboulé mine camp.

At elevation 4,250 feet an adit is driven northeast into the mountain in greywacke, argillite, and hornfels. A cavein prevented examination of the adit and no vein was seen nearby. At elevation 4,475 feet a second adit 160 feet long is driven northeast in similar sedimentary rocks, which strike northeast and dip 40 degrees northwest. The adit discloses a number of small stringers up to 1 inch wide that lie parallel with the bedding. The stringers are composed of fine black magnetite and chalcopyrite.

Sultana Group (42)

References: Ann. Repts., Minister of Mines, B.C.: 1921, p. 100; 1922, p. 99; 1923, p. 107. Geol. Surv., Canada, Sum. Rept. 1910, p. 97.

This property is on the south side of the basin at the head of the south fork of Boulder Creek, 8 miles due west of Seaton railway station. The claims are 10 miles distant from the main highway by way of the

pack-trail that follows along the south side of Boulder Creek. Brewer Brothers were the first to discover silver and copper minerals in a sheared zone on this property, and staked the Last Chance and Little Wonder claims in 1912. A. R. MacDonald and J. S. Hicks, about 1920, restaked the ground with a group of four claims named the Sultana, Sultan, Mugwump, and Delores claims. The sheared zone was prospected by several open-cuts, and in 1923 Granby Consolidated Mining, Smelting, and Power Company put down a single diamond drill-hole about 80 feet. G. Christensen of New Hazelton carried out some surface work in 1939. Louis Parent of New Hazelton restaked the property in 1951 and improved the trail to it along Boulder Creek.

A mineralized sheared zone is exposed on a bench at elevation 5,200 feet in the coarsely crystalline grey granodiorite that forms the core of Rocher Déboulé Mountain. The mineralized outcrop is 60 feet long and ranges from 10 to 20 feet in width. It consists of sheared and altered granodiorite replaced by pyrite, tetrahedrite, galena, and chalcopyrite with some quartz gangue. Samples collected by J. D. Galloway (Minister of Mines Report 1922) assayed about 50 ounces of silver a ton with about 5 per cent of copper and a little gold. The zone strikes north 70 degrees east and much of the slicing within it dips 45 degrees southeast. In the open-cut at the northeast end of the outcrop the dip of the slicing changes from 45 degrees southeast on the northwest side of the zone to 80 degrees northwest on its southeast side. It appears that the major fissuring was about vertical along the southeast border of the zone and that the slicing that dips southeast merges with it there. The drill-hole put down in 1923 is located 40 feet southeast of the mineralized zone, at a point opposite the centre of the outcrop. It was not ascertained whether the hole was bored vertically or inclined, as it is concealed by boulders. The borehole would probably have missed the mineralized zone unless inclined towards it.

Sunrise Group (6)

References: Geol. Surv., Canada: Mem. 110, 1919, p. 34; Sum. Repts.: 1909, p. 66; 1910, p. 97. Ann. Repts., Minister of Mines, B.C.: 1909, p. 84; 1911, pp. 79 and 104; 1914, p. 204; 1915, p. 76; 1918, p. 117; 1919, p. 102; 1920, p. 86; 1922, p. 98; 1923, p. 106; 1924, p. 94; 1926, p. 126; 1927, p. 131.

The Sunrise group, of five mining claims, is on the north slope of Nine Mile Mountain, 8 miles northeast of New Hazelton station. The claims are bounded on the east by the Lead King and Slocan groups. The Silver Cup property lies about 1 mile west. The prospect is reached from New Hazelton by way of the Nine Mile Mountain road, over a distance of 13 miles to Silver Cup Basin at elevation 3,400 feet and an additional 2 miles east by a good pack-horse trail to the Sunrise cabin at elevation 4,250 feet. The showings are on the mountain slope above the cabin, between elevations of 4,800 and 5,200 feet (See Figure 8). Quartz veins carrying abundant jamesonite, galena, and sphalerite were discovered there in 1909. Hazelton Sunrise Mines, Limited, was organized in 1911 and carried out some development work. In 1915, a shipment of 74 tons of hand-sorted ore, mostly solid sulphides, was made to the smelter, but results are not recorded. J. Errington secured an option in 1918 and did some surface stripping, and American Smelting and Refining Company

carried out further development work in 1920. Trethewey Brothers carried on work for several seasons beginning in 1923, and were responsible for driving the main crosscut adit 400 feet. The work was resumed in 1927 by Hazelton Sunrise Mines, Limited, the main adit being extended to a total length of 750 feet with a 60-foot raise from the face driven up at 45 degrees. During the 1937 season this company carried out a program of surface trenching and exposed several new veins.

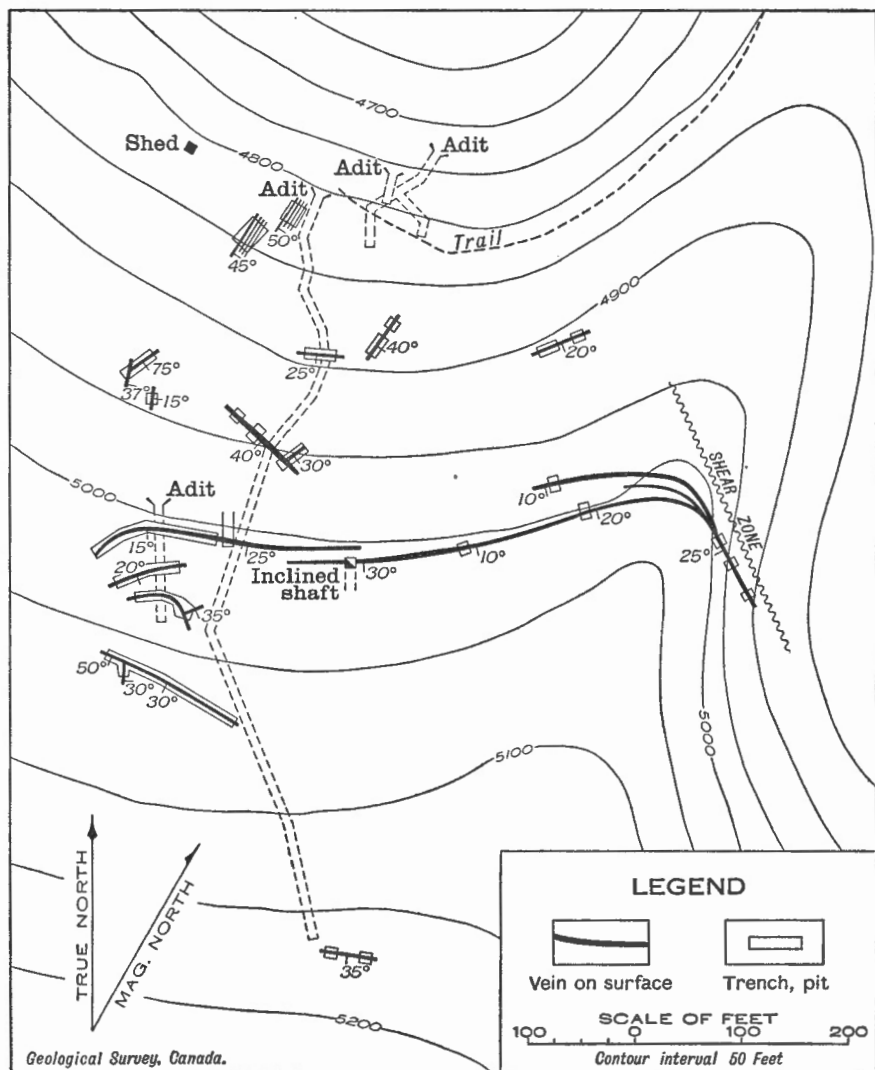


Figure 8. Plan of part of Sunrise group.

The veins occur in coarsely crystalline, grey granodiorite in intersecting fault fissures along which there has been minor displacement. The granodiorite forms a stock 3 miles long from east to west, and 3,000 feet wide.

It intrudes sediments along the north side of the mountain. The veins are in a disturbed zone that measures 700 feet in width from north to south and 1,000 feet in length from west to east across the Sunrise property, and extends an additional 1,500 feet east across the adjoining Lead King property. The main fracture zone lies between elevations of 4,700 and 5,200 feet, and its north boundary is about 500 feet south of the sedimentary contact. The continuity of the outcrop of the vein occurrences on the Sunrise group and on the neighbouring Lead King group is interrupted by a steep-walled glacial cirque measuring about 900 feet across from wall to wall. The floor of this basin is talus covered, but veins outcrop on both the east and west walls. The dividing line between the two properties lies near the centre of the basin.

There are two intersecting sets of veins on the Sunrise property. One set strikes northeast and dips from 30 to 50 degrees southeast. The other set strikes east and dips from 10 to 40 degrees south. The veins range from 100 to 500 feet in length and from 3 inches to 4 feet in width. They commonly occur in parallel groups or may be arranged *en échelon*. Many of the veins consist of almost solid sulphide, but there is commonly an abundance of quartz gangue. The metallic minerals present, in order of their abundance, are: jamesonite, sphalerite, galena, cosalite, pyrite, arsenopyrite, argentite, and tetrahedrite. The ore contains appreciable amounts of silver, lead, zinc, antimony, and bismuth.

In an open-cut 20 feet above the portal of the main adit are four parallel fissures spaced at intervals of 3 feet. They strike northeast and dip 50 degrees southeast. Small, quartz-sulphide, lens-like veins ranging from 2 to 6 inches in width occur along these fissures. The ore consists of massive sphalerite and jamesonite with a little galena and minor quartz gangue. The granodiorite wall-rock is altered near these veins and is replaced in places by small veinlets of quartz, sphalerite, jamesonite, and galena. At elevation 4,840 feet the four fault fissures are exposed in a second large open-cut, but three of them are mostly barren.

The main adit, at elevation 4,800 feet, was driven south into the mountain to explore the veins exposed by the two large open-cuts. The adit follows the fissured zone in a south by west direction for 445 feet, turns southeast, and continues 280 feet through massive granodiorite. From the portal a 4-inch quartz vein carrying about 30 per cent sulphides is followed south for 40 feet to where the adit swings more easterly, and 30 feet farther along exposes two quartz-sulphide vein lenses each 1 foot wide and 10 feet long, arranged *en échelon*. A 12-inch channel sample taken across the best mineralized lens, containing about 60 per cent of sulphide, assayed: gold, 0.005 ounce a ton; silver, 4.77 ounces a ton; lead, 5.98 per cent; zinc, 3.96 per cent. At 140 feet from the portal there is a 3-inch quartz-sulphide lens 20 feet long with a dip of 30 degrees east. A representative sample from this lens assayed: gold, a trace; silver, 0.85 ounce a ton; lead, 1.02 per cent; zinc, 4.72 per cent; antimony, 0.51 per cent. Between 165 and 190 feet from the portal a 6-inch vein dipping 30 degrees east is exposed. The fracture along which this vein occurs is followed south to the point 445 feet from the portal where the adit swings southeasterly. For most of the distance the fissure has no vein filling, but at intervals, several short, narrow, quartz-sulphide lenses appear.

As there are four parallel fractures over a width of 12 feet in the surface cuts above the portal of the main adit, it is apparent that a true picture of the vein system is not seen in the main adit as it is only 6 feet wide. Short crosscuts driven east and west from within the adit would intersect nearby parallel veins if present. Raises driven on the vein between 150 and 300 feet from the portal might intersect members of the other vein set, which strike east and dip south at low angles.

Forty feet below the main adit a sparsely mineralized shear zone ranging from 1 foot to 3 feet in width is followed south by a 32-foot adit. The shear zone dips 45 degrees east and is evidently a downward continuation of the fracture zone followed by the main adit. Sixty-five feet below the main adit an exploratory adit runs 117 feet southwest, with a 50-foot crosscut to the southeast at a point 55 feet from the portal. The shear zone is cut off at the portal of this adit by a fault that strikes northeast and dips 30 degrees west.

Between the main adit at elevation 4,800 feet and an upper adit at elevation 4,985 feet, eight or ten veins have been opened up by stripping through light overburden. Most of these are shown on the accompanying plan (*See Figure 8*). One of these veins, at elevation 4,950 feet, is traced for 70 feet by three pits. It ranges from 6 inches in width at either end to 3 feet in width at the central pit. In the east pit it is joined by a cross vein ranging from 4 to 8 inches in width. The main vein strikes southeast and dips 40 degrees southwest, and the cross vein strikes northeast and dips 30 degrees southeast. The quartz gangue of both veins is abundantly mineralized with sulphides. A 36-inch channel sample, taken across the vein in the centre pit, assayed: gold, nil; silver, 1.10 ounces a ton; lead, 2.96 per cent; zinc, 0.40 per cent. In a pit 100 feet farther west there is a 4-inch seam of solid sulphide, largely of finely crystalline galena and jamesonite with minor sphalerite. A piece of this ore weighing about 4 pounds assayed: gold, 0.01 ounce a ton; silver, 99.13 ounces a ton; lead, 37.58 per cent; zinc, 5.59 per cent; antimony, 0.54 per cent.

The upper adit, at elevation 4,985 feet, is driven due south 110 feet, and intersects two veins in this distance. The first is a 3-inch quartz vein 55 feet from the portal, which carries about 10 per cent of sulphides. It strikes east and dips 28 degrees south and is doubtless the downward continuation of the strong vein that outcrops 25 feet south of the portal at elevation 5,000 feet. A branch vein comes in on the east wall of the adit near the 3-inch vein and is followed to within 15 feet of the face, where it enters the west wall. This vein ranges from 4 to 12 inches in width and is composed of almost solid sulphides. It strikes north by east and dips 65 degrees east. A 6-inch channel sample, taken across the latter vein 65 feet from the portal, assayed: gold, a trace; silver, 33.27 ounces a ton; lead, 13.74 per cent; zinc, 17.02 per cent; antimony, nil; arsenic, 1.35 per cent; bismuth, nil. A sample taken across the 3-inch vein assayed: gold, 0.05 ounce a ton; silver, 0.54 ounce a ton; lead, 0.31 per cent; zinc, 0.81 per cent.

On the surface immediately south of and above the upper adit, four strong veins have been trenched between elevations of 5,000 and 5,075 feet. They strike east and dip from 15 to 35 degrees south. The larger of these outcrops 15 feet above the portal and has been traced for 250 feet. In the main trench it ranges from 12 to 18 inches wide and the quartz gangue is

well mineralized. A 12-inch channel sample taken across this vein above the adit assayed: gold, 0.015 ounce a ton; silver, 22.76 ounces a ton; lead, 11.37 per cent; zinc, 14.37 per cent; antimony, 2.59 per cent; arsenic, 2.09 per cent. In a cut 75 feet southeast of the adit the vein consists of 3 feet of almost solid sulphides, chiefly jamesonite, sphalerite, and cosalite. A representative sample of a 1-ton pile of ore taken from the open-cut assayed: gold, 0.005 ounce a ton; silver, 45.35 ounces a ton; lead, 62.24 per cent; zinc, 11.93 per cent; antimony, 5.97 per cent; bismuth, 8.50 per cent; tin, 0.07 per cent; arsenic, 1.35 per cent; copper, 0.18 per cent.

The second vein, 40 feet farther south, is trenched for 60 feet. It is only 3 to 4 inches wide, but consists of 75 per cent sulphides. A representative sample assayed: gold, 0.01 ounce a ton; silver, 2.73 ounces a ton; zinc, 19.86 per cent; antimony, 2.31 per cent; arsenic, 3.05 per cent; lead, not tested.

The third vein, an additional 30 feet up the slope, is stripped for 50 feet and is joined by another vein striking northeast and dipping 35 degrees southeast, at the east end of the trench. The main vein has an average width of 12 inches, the branch vein ranges from 2 to 6 inches in width, and both are well mineralized.

The fourth vein is stripped for 135 feet, ranges from 3 to 18 inches in width, and has an average width of about 12 inches. It consists of white quartz carrying about 20 per cent of banded sulphides. A 14-inch channel sample taken across this vein midway along its outcrop assayed: gold, a trace; silver, 27.21 ounces a ton; lead, 11.63 per cent; zinc, 2.91 per cent; antimony, 2.28 per cent; bismuth, 9.10 per cent; arsenic, 2.43 per cent.

A 40-foot shaft inclined at 30 degrees is sunk on a strong vein 185 feet east of the upper adit. The vein strikes east and dips from 10 to 30 degrees south into the mountain. It is exposed at intervals by trenches through the overburden, for 50 feet west and for 360 feet east from the shaft. The quartz gangue is well mineralized throughout. At the shaft the vein is 4 feet wide, but 30 feet east it narrows to 12 inches. In a pit 100 feet east of the shaft it is 6 inches wide, and in a pit 225 feet east it consists of 3 inches of solid sulphides. About 30 feet below the latter pit there is a parallel vein 7 inches wide that carries 40 per cent of the lead-zinc-antimony sulphides. This vein joins the main vein 150 feet to the west below the nose of the ridge on the side of the cirque mentioned earlier. There are several other short parallel veins ranging from 2 to 3 inches wide on the nose of the ridge. In the pits on the steep wall of the cirque the main vein has an average width of 15 inches and carries abundant sulphides. One hundred feet down the slope the veins are hidden by talus.

Forty feet northeast of the main vein, on the nose of the ridge, there is a strong shear zone 10 feet wide. It strikes northwest and dips vertically. The sheared granodiorite is bleached and rusted and is cut by numerous, small, sparsely mineralized quartz stringers.

Small tonnages of high-grade silver-lead-zinc ore, from which an appreciable recovery of antimony and bismuth might be made, could be won from this property by shallow surface mining.

Surprise Group (17)

References: Ann. Repts., Minister of Mines, B.C.: 1912, p. 112; 1913, p. 106; 1915, p. 76; 1917, p. 107.

The Surprise claims are immediately north of and adjoin the Silver Standard property. In 1912 and 1913 a crosscut adit was driven and one vein was explored by a drift and raise. There is no record of work done since 1917 when the original owner, W. Thompson, sold the claims to B. R. Jones.

The Surprise adit is at elevation 1,485 feet, the portal being 1,250 feet northeast of the portal of the main crosscut adit on the Silver Standard property. The adit is driven south 37 degrees east for 740 feet, and 200 feet from the portal a drift runs northeast for 96 feet and southwest for 20 feet from the crosscut. From the northeast drift two raises were driven through to the surface. The drift follows along a 6-inch vein of quartz and calcite, which is sparsely mineralized with pyrite. At the face of the northeast drift the vein has decreased to a 1-inch stringer, and 6 feet from the face of the southwest drift the vein ends against a cross fracture.

The rocks exposed in the adit are like those on the Silver Standard property, consisting of grey, coarse- to fine-grained, massive arkose beds with interbedded tuffs and finely laminated argillites. These sedimentary rocks strike dominantly northeast and dip from 10 to 25 degrees southeast.

A 6-inch channel sample taken across the vein in the roof of the drift 25 feet northeast of the crosscut assayed: gold, 0.01 ounce a ton; silver, 0.028 ounce a ton; lead, a trace; zinc, 0.10 per cent. Another 6-inch channel sample, taken across the vein in the roof of the drift 40 feet northeast of the crosscut, assayed: gold, 0.04 ounce a ton; silver, 0.35 ounce a ton; lead, a trace; zinc, 0.10 per cent.

At 430 feet from the portal, a 2-inch vein of quartz and calcite dipping 45 degrees east is cut. The adit is a few feet short of striking a possible continuation of the main vein from the Silver Standard mine.

True Fissure Group (12)

References: Ann. Repts., Minister of Mines, B.C.: 1921, pp. 98-99; 1927, p. 133; 1929, pp. 159-160.

This group is situated in the basin immediately west of Thoen Basin, on the mountain 4 miles north of the junction of Suskwa River and Twenty-nine Mile Creek. The veins occur on the steep walls of the basin between elevations of 5,000 and 6,000 feet. The property is reached by a trail $\frac{1}{2}$ mile long that branches off from the trail leading to the O.K. group.

The claims were first staked about 35 years ago by Gordon McLennan and Pete Jennings. J. A. Rutherford held both the True Fissure and O.K. groups in 1930, at which time they were known locally as the Suskwa Mines.

The country rock is tuffaceous sandstone, quartzite, and argillite cut by dykes of porphyritic granodiorite. The strata strike north 40 degrees east and dip 35 degrees northwest. At an elevation of approximately 6,000 feet these sediments are intruded by the granodiorite stock that occurs to the west.

The main ore occurrence is a replacement type of vein occupying a shear zone. The vein varies in width from 10 inches to 2½ feet, strikes north 75 degrees east, and dips 60 degrees to the southeast. It consists of sphalerite, galena, pyrite, tetrahedrite, and chalcopyrite in a gangue of quartz, carbonate, and altered wall-rock. In places the vein is considerably leached and consists largely of iron oxide.

At an elevation of 5,200 feet, an adit has been driven along the vein for 30 feet. Here the vein is from 10 to 12 inches wide and well mineralized with pyrite, tetrahedrite, and sphalerite. According to Ann. Rept., Minister of Mines, B.C., 1921, a sample across this width assayed: gold, trace; silver, 54 ounces a ton; lead, nil; zinc, 4 per cent. One hundred and seventy-five feet farther up the slope the vein has been exposed by an open-cut. At this point it is 2½ feet wide and contains much pyrite and a little sphalerite in an 8-inch band next to the foot-wall. A sample across 10 inches assayed: gold, trace; silver, 3 ounces a ton; lead, nil; zinc, 6 per cent. What appears to be the same vein is exposed at an elevation of 5,900 feet, where it is 2 feet wide. Selected ore samples assayed: gold, 0.06 to 0.08 ounce a ton; silver, 76.5 to 203.4 ounces a ton; lead, 22 to 36 per cent; zinc, 20 to 30 per cent.

Another shear zone lies 500 feet north of the silver-lead vein close to a granodiorite dyke. The zone ranges from 2 to 4 feet wide where it runs up a steep rock gulch. It is mineralized with arsenopyrite and pyrrhotite.

A number of small shear zones that contain some finely disseminated chalcopyrite occur in Copper Basin immediately north of True Fissure Basin but they lack appreciable continuity.

Victoria Group (28)

(Western Tungsten Copper Mines Limited)

References: Ann. Repts., Minister of Mines, B.C.: 1916, pp. 89 and 114; 1917, p. 103; 1918, p. 112; 1925, p. 134; 1927, p. 132; 1928, p. 159; 1940, p. 76; 1941, p. 41; 1948, p. 80; 1949, pp. 82-93; 1950, p. 99. Geol. Surv., Canada, Mem. 110, 1919, p. 20.

The Victoria group includes the Victoria, Belle, View Fraction, Belle Fraction, Mammoth, Red Cross, Monoplane, and Bowl Fraction claims. These were once under the same ownership as the nearby Hazelton View group, but are now owned by Western Tungsten Copper Mines Limited. This company operates the adjoining Rocher Déboulé and Red Rose mines. The property is on the northwest slope of Rocher Déboulé Mountain about 5 miles south of South Hazelton station. A pack-horse trail leads from Comeau's ranch at the foot of the mountain to the mine camp at elevation 4,100 feet. The workings are on a steep rocky mountain side between an elevation of 5,500 feet and the crest of the mountain at 6,120 feet.

The claims were acquired by New Hazelton Gold Cobalt Mines, Limited, in 1916, and were developed continuously until 1919. Two adits were driven and a tramline constructed from the workings to the camp. During 1918, a carload of ore was shipped to the Ore Testing Laboratories, Mines Branch, Ottawa. The car contained 53,288 pounds dry weight of ore, which carried: gold, 1.24 ounces a ton; molybdenite (MoS_2), 1.40 per cent;

molybdenite (MoO_3), 0.18 per cent; cobalt, 1.12 per cent; nickel, 0.60 per cent; and arsenic, 8.98 per cent. Further work was done in 1925, and the following year 22 tons of ore were shipped, which assayed: gold, 4.65 ounces a ton; arsenic, 42.3 per cent; and cobalt, 4.6 per cent. The property was operated by Aurimont Gold Mines, Limited, during 1928, and an additional 23 tons of the gold-cobalt-arsenic ore were shipped.

Jack Lee and A. S. Barker of Hazelton did some mining on the property in 1940 and shipped three lots of ore to the Prince Rupert sampling plant, with the following assay results:

Year	Tons	Gold	Silver	Zinc	Cobalt	Arsenic
		Ounces a ton	Ounces a ton	Per cent	Per cent	Per cent
1940.....	7.663	2.18	0.20	Nil	2.60	6.6
1941.....	7.266	2.02	0.20	0.60	1.40	6.1
1941.....	3.406	3.92	0.30	4.40	.....	33.3

The property was acquired by Western Uranium Cobalt Mines Limited (now called Western Tungsten Copper Mines Limited) in 1949, and further development work was done both in 1949 and 1950 to evaluate the gold, cobalt, and uranium resources of the property.

No. 1 Vein. Most of the surface and underground exploratory work has been done on a fissured zone in the grey, coarsely crystalline granodiorite boss that forms the core of Rocher Déboulé Mountain. The fissured zone and ore shoots that occur along it are known as the No. 1 vein. It strikes east and dips from 40 to 65 degrees north. On the west the vein extends nearly to the metamorphosed sedimentary rocks of the Hazelton group but has not been traced into them. The sedimentary rocks are seen below an elevation of 5,200 feet at this point, whereas the granodiorite occupies the higher terrain and the contact extends in a southerly direction. The fissured zone has been traced by open-cuts and adits for more than 1,500 feet up a steep slope between elevations of 5,168 and 6,025 feet and for several hundred feet farther east along the mountain top overlooking Juniper Creek. It ranges from 1 inch to several feet in width, and consists in large part of sheared, altered, and brecciated granodiorite. Ore shoots occur where the wall-rocks are replaced and where the fissures are filled by veins of quartz, feldspar, hornblende, and metallic minerals. The ore minerals include arsenopyrite, cobaltite, cobalt bloom, cobalt-nickel sulpharsenides, molybdenite, chalcopyrite, sphalerite, uraninite, and gold. Most of the gold occurs as small grains scattered through the arsenopyrite and cobalt-nickel sulpharsenide minerals. The arsenopyrite and cobalt-nickel sulpharsenides generally occur as short streaks or veinlets of solid sulpharsenides from $\frac{1}{2}$ inch to several inches wide and from 1 foot to 10 feet or more long. They also occur disseminated as fine crystals or as aggregates of crystals in the hornblende, feldspar, and quartz gangue. The molybdenite occurs in thin films and as small nodules, and the uraninite as small black octahedral crystals that range from microscopic size up to

$\frac{1}{8}$ inch in diameter. A little gummite, a common yellow oxidation product of uraninite, is also present. The gangue minerals include a few, small, cream-coloured apatite crystals, small grains of titanite, some dark brown allanite, and, rarely, some light-coloured scapolite.

The No. 1 vein has been explored by five adits: the lowest, at an elevation of 5,168 feet, is 247 feet long; the second, at 5,250 feet, 540 feet long; the third (or main adit) at 5,500 feet, 725 feet long; the fourth, at 5,757 feet, 40 feet long; and the fifth, at 5,916 feet, is 250 feet long. The highest working is an open-cut 30 feet long, 3 feet wide, and 10 feet deep on the crest of the ridge at elevation 6,121 feet.

The lowest adit is driven as a crosscut for 225 feet with a 22-foot drift along No. 1 vein. A 20-inch sample collected across this vein, at the face, assayed: gold, 1.64 ounces a ton; cobalt, 1.08 per cent. A 'vein' known as the Cross vein is intersected in the adit about 100 feet from the portal. It strikes northwesterly, dips 50 degrees northeast, and like the No. 1 vein consists of hornblende and pink feldspar with scattered sulpharsenides. A 10-inch channel sample collected across the Cross vein in the adit, assayed: gold, 2.21 ounces a ton; cobalt, 0.83 per cent; and uranium oxide, 0.71 per cent. This 'vein' is exposed for 20 feet in an open-cut 110 feet west of the portal of the No. 2 adit, and a 14-inch channel sample collected there by J. S. Stevenson (Ann. Rept., Minister of Mines, B.C., 1949) assayed: gold, 0.89 ounce a ton; silver, nil; cobalt, 1.1 per cent; molybdenum, a trace; and uranium oxide, 0.12 per cent.

In the second adit, at elevation 5,250 feet, the fissured zone is intersected 55 feet from the portal and is followed for 485 feet east to the face of the drift. For the first 200 feet the vein zone averages 12 inches in width. It consists largely of sheared granodiorite with much chlorite, finely crystalline hornblende, and considerable glassy quartz, and contains occasional small seams of the cobalt and nickel sulpharsenides. A 12-inch channel sample taken across a particularly rich looking part of the zone containing a 2-inch seam coloured with crimson cobalt bloom, 150 feet from the portal, assayed: gold, 2.04 ounces a ton; silver, 0.26 ounce a ton; nickel, 0.02 per cent; and cobalt, 1.81 per cent. Midway along the drift the fissure pinches to a single fault line marked by vertical striæ, but widens again within 50 feet. For 200 feet at the east end of the drift the width of shearing and alteration ranges from 1 foot to 3 feet, but the altered rock contains very little quartz or sulphide. A 12-inch sample of the altered granodiorite, collected 150 feet from the face, assayed: gold; a trace; silver, a trace.

The third (main) adit, at elevation 5,500 feet, is 475 feet distant from the second adit up a 31-degree slope. It follows the fissured zone for its full length of 725 feet. At 375 feet from the portal a raise goes up 80 feet, from which a drift runs 85 feet west, and at 450 feet from the portal a 25-foot winze is sunk in the zone. For 100 feet from the portal, the zone ranges from 6 to 12 inches in width and consists mostly of rusty gouge, with occasional bands of glassy quartz and seams of finely crystalline hornblende. A short raise 75 feet from the portal provided some ore. Between 100 and 170 feet from the portal there is an open fissure 4 to 12 inches wide containing neither gouge nor vein filling. The open fissure extends downward for about 100 feet and upwards almost to the surface; beyond it the fissured

zone is normal, consisting of from 6 to 12 inches of brecciated, altered granodiorite, with seams of hornblende and quartz and occasional veinlets of arsenopyrite and cobalt sulpharsenides. At 230 feet from the portal the zone is offset 5 feet southeast by a cross fault. An 8-inch channel sample collected across the zone a few feet east of the fault, where there was considerable calcite, assayed: gold, 0.015 ounce a ton; silver, 6.53 ounces a ton. A 6-inch sample taken across 3 inches of quartz, hornblende, and chloritized altered rock 50 feet farther east, assayed: gold, 0.03 ounce a ton; silver, 2.40 ounces a ton.

A dark, fine-grained trap dyke follows along or close to the No. 1 vein on the 5,500-foot level for 600 feet from the face. This dyke is brecciated and altered where the fissured zone crosses it, so that in places it forms part of the vein gangue. The zone is entirely enclosed within the dyke between 580 and 690 feet from the portal and becomes a sheeted zone 3 feet wide, with alternating bands of hornblende and pink feldspars and bands of dyke rock. The shearing narrows to 4 inches where it cuts through a felsite dyke between 355 and 410 feet from the portal and the drift ends at a second felsite dyke.

The British Columbia Minister of Mines report for 1949 lists twenty-six samples collected at intervals by J. S. Stevenson along No. 1 vein in the main adit to determine the uranium content of the different types of vein material. These samples were all radioactive and their uranium oxide equivalent content ranged from 0.001 to 0.42 per cent, with an average of 0.08 per cent. The width of vein matter ranged from 4 to 24 inches and averaged about 10 inches. As the uranium content of the vein is less than 0.1 per cent it is below ore grade, but uranium might be recovered as a by-product from ore shoots mined for their gold and cobalt content.

During the 1951 field season the writer observed several short streaks of hornblende vein gangue that displayed a greenish yellow fluorescence under ultra-violet light. These streaks contain unusually rich concentrations of uranium oxide, and the fluorescent mineral is a pale yellow oxidation product of uraninite. One of these highly fluorescent bands 2 inches wide and 3 feet long was seen 350 feet from the portal. At 400 feet from the portal, a band 7 inches wide of dark hornblende fluoresces for several feet, and at 445 feet yellow fluorescence was seen on the south wall. A sample of the hornblende ore collected 350 feet from the portal contained 0.89 per cent uranium oxide equivalent, and another 400 feet from the portal contained 2.28 per cent. The latter sample consisted of fine, black hornblende, with a little pink feldspar, and was intersected by a pale yellow, fluorescent mineral band $\frac{1}{8}$ inch wide.

The fourth adit, at elevation 5,757 feet, is only 40 feet long. A 14-inch channel sample collected across the fissured zone at the face assayed: gold, 1.80 ounces a ton; cobalt, 0.25 per cent.

The fifth or upper adit, at elevation 5,916 feet, follows No. 1 vein for 250 feet. Some 30 tons of ore were taken from the roof of this adit 150 feet from the portal in 1925. The present owners extended the drift from 170 to 250 feet, and found some additional ore near the present face. An 11-inch channel sample from the vein 240 feet from the portal assayed: gold, 1.74 ounces a ton; cobalt, 0.44 per cent. A sample collected across 10 inches of hornblende and cobalt-nickel sulpharsenides 150 feet from the

portal assayed: gold, 2.81 ounces a ton; silver, 0.2 ounce a ton; cobalt, 3.2 per cent; uranium oxide equivalent, 0.12 per cent; and nickel, 0.2 per cent.

An open-cut 30 feet long, 3 feet wide, and 10 feet deep on the crest of the ridge, at elevation 6,121 feet, is reported to have yielded some high-grade ore. A hand specimen of cobalt-nickel sulpharsenides and hornblende vein gangue from this cut assayed: gold, 7.88 ounces a ton; silver, 1.1 ounces a ton; cobalt, 5.9 per cent; uranium oxide equivalent, 0.75 per cent; nickel, 2.8 per cent; and molybdenum, 0.81 per cent. Two other samples from this cut contained 0.53 and 0.18 ounce of gold a ton respectively.

The No. 1 vein has been traced along the mountain top for about 475 feet east from the 30-foot open-cut. A selected specimen collected by Stevenson (1949) from a 4-inch band of sulpharsenides about 325 feet east of the 30-foot cut assayed: gold, 5.66 ounces a ton; silver, 2.9 ounces a ton; cobalt, 2.4 per cent; molybdenum, 0.9 per cent; and nickel, 4 per cent. Three other samples collected nearby contained from 0.17 to 0.73 ounce gold a ton, 0.4 to 0.5 per cent cobalt, and 0.04 to 0.13 per cent uranium oxide equivalent.

The trap dyke with which the No. 1 vein fissuring is associated in the third or main adit, also appears in the fifth or upper adit and lies close to the vein in the surface exposures along the mountain top. There was recurrent fault movement along the fissured zone, as two sets of fault striæ are exposed along the walls of the large open-cut. One set is vertical, the other dips westerly at 45 degrees. The trap dyke was injected along and sealed the primary fissure.

No. 2 Vein. On the View Fraction and Belle Fraction claims, a 30-foot feldspar porphyry dyke cuts the granodiorite for 2,000 feet along its strike between elevations of 5,075 and 6,220 feet. The dyke strikes east and dips about 60 degrees north. It lies about 1,000 feet south of No. 1 vein, extends up the west slope of the mountain, and crosses the divide overlooking Juniper Creek at an elevation of 6,220 feet. Talus conceals the dyke about 100 feet east of the divide. A well-defined hornblende vein lies along or near the foot-wall of the dyke below an elevation of 5,850 feet, but higher up the mountain it occurs along the hanging-wall side. This vein ranges in width from 6 to 24 inches. It contains scattered crystals of pink feldspar, grains of cobalt-nickel sulpharsenides, and a little uraninite. Two selected samples of vein matter collected by Stevenson (1949) at an elevation of 5,400 feet assayed: gold, 0.14 and 0.02 ounce a ton; silver, nil; cobalt, trace; and uranium oxide (U_3O_8), 0.49 and 0.93 per cent respectively. Several samples collected by Martin Jasper for the owners, higher on the mountain, contained much less uranium oxide but more gold and cobalt. At elevation 5,940 feet, the porphyry dyke is crossed by a shear zone that widens locally to 8 feet adjacent to the south wall of the dyke. A sample taken across 8 feet assayed: gold, 0.61 ounce a ton; uranium oxide (U_3O_8), 0.011 per cent.

In the next draw to the south of the No. 2 vein, many large blocks of hornblende gangue containing cobalt-nickel sulpharsenides are strewn at intervals along a talus covered slope, suggesting that the vein from which the hornblende blocks have broken away may underlie the talus. Several

other veins occur in altered sedimentary strata 100 feet south of the granodiorite contact on the south side of the draw. One of these, a quartz vein 12 inches wide, containing a little galena, ankerite, sphalerite, and scheelite, strikes north 5 degrees east and dips at 30 degrees east into the mountain. It extends several hundred feet northerly into the granodiorite at elevation 5,700 feet. Narrow hornblende veins that contain a little chalcopyrite cut the sedimentary strata near the quartz vein.

The high gold content of the arsenopyrite and cobalt-nickel sulpharsenides is an outstanding feature of the Victoria group property. The average uranium oxide content of the veins too, judging from thirty-six samples collected by Stevenson, is nearly the minimum required to form an ore of uranium. The uranium should prove a valuable by-product to a gold mining operation.

MINERAL DEPOSITS OF THE SMITHERS AREA (HUDSON BAY MOUNTAIN)

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Canadian Citizen Group (69)

References: Ann. Repts., Minister of Mines, B.C.: 1925, p. 137; 1927, p. 137. Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 138.

The Canadian Citizen prospect is on the southeast slope of Hudson Bay Mountain about 2 miles from Smithers. It lies west of the road to the Duthie mine, at an elevation of 2,180 feet. The ground was held by T. Costello in 1925 and later by C. Stoughton and Ira Mitchell.

The prospect is in andesite overlain by andesitic breccia. Mineralization occurs in a shear zone striking north 50 degrees west and dipping 77 degrees southwest, along which the wall-rock is intensely bleached.

The principal exploratory work has consisted of an open-cut 20 feet long normal to the shear zone. The ore minerals are chalcopyrite, bornite, chalcocite, and malachite; these are confined to veins in the shear zone and no replacement of the wall-rock was observed. The veins vary in width from narrow stringers up to 1 inch. A sample taken across 4 feet 6 inches assayed: gold, trace; silver, 4 ounces a ton; copper, 3 per cent.

Carroll Group (47)

References: Ann. Repts., Minister of Mines, B.C.: 1917, p. 114; 1927, p. 136; 1928, p. 163.

The Carroll property is on the south slope of Mount Evelyn, on the north side of Toboggan Creek, 7 miles due northwest of Smithers. A branch trail leaves the main Toboggan Creek trail at elevation 3,900 feet and leads northeast along the slope to the camp at elevation 4,200 feet.

The claims are underlain by andesitic volcanic rocks intruded by granodiorite stocks and aplitic dykes. Several hundred feet below the camp the volcanic rocks are in contact with the older sedimentary rocks that occupy the lower slopes of the valley of Toboggan Creek.

In 1917, Mr. Jobe prospected two galena veins at elevations of 4,600 and 5,200 feet by two adits 100 feet and 90 feet in length, respectively. The veins in both adits are greatly leached, but selected samples showed that they were composed of argentiferous galena with a low gold content. Both veins are short and discontinuous.

During 1928, Mount Evelyn Mines, Limited, drove a 210-foot crosscut adit into the mountain in andesite at elevation 4,100 feet. At 108 feet from the portal a drift was run 55 feet northeast along a sheared, altered, and silicified alaskite dyke. The dyke strikes north 50 degrees east and dips 65 degrees southeast. It maintains an average width of 18 inches. The altered dyke rock contains finely disseminated pyrite. A selected sample of the altered dyke rock collected from the dump assayed: gold, a trace; silver, 1.26 ounces a ton. This dyke outcrops for a short distance on a steep slope about 125 feet vertically above the adit, where it is prospected by a 10-foot shaft.

Cascade Group (60)

References: Ann. Repts., Minister of Mines, B.C.: 1923, p. 110; 1925, p. 136.

The Cascade group is on the southeast slope of Hudson Bay Mountain about $3\frac{1}{2}$ miles from Lake Kathlyn railway station, and the workings and cabin are on Simpson Creek at an elevation of about 3,600 feet. Assessment work is recorded as having first been done on this property in 1912, but most of the exploratory work was done between 1920 and 1930 by the owners, A. S. Miller and M. E. Leblanc of Smithers. The trail to the property is at present (1951) blocked by heavy timber that was felled several years ago by wind.

This property was not visited by the writer, and the following information is from reports listed above.

The main showing is a shear zone 18 to 20 feet wide in andesitic volcanic rocks of the Hazelton group. The zone contains numerous bands of vein quartz sparingly mineralized with pyrite, arsenopyrite, and sphalerite. A crosscut adit about 350 feet long is driven towards this zone 93 feet vertically below the surface showings.

A vein that outcrops along Simpson Creek above the main showing contains galena, pyrite, and sphalerite. An 18-inch channel sample taken across this vein assayed: gold, 0.26 ounce a ton; silver, 1.5 ounces a ton; and lead, 25 per cent.

Coronado Group (75)

References: Ann. Repts., Minister of Mines, B.C.: 1911, p. 118; 1912, p. 114; 1913, p. 107; 1914, p. 213; 1915, p. 77; 1919, p. 102; 1933, p. 97. Geol. Surv., Canada, Sum. Repts.: 1908, p. 44; 1925, pt. A, p. 132.

The Coronado property is on the southwest slope of Hudson Bay Mountain about 16 miles west by road from Smithers. The workings are $\frac{1}{2}$ mile northwest of the Duthie mine and lie between elevations of 3,400 and 3,650 feet. A good road crosses the claims a short distance below the mineralized zones.

This group is one of the earliest mineral locations staked on Hudson Bay Mountain. In 1905, the owners, J. R. McDonald, Simpson, and Fleming, sent out 4 or 5 tons of hand-sorted galena ore by pack-horses to Hazelton and thence to the smelter via boat on Skeena River. Between 1912 and 1914, extensive development work was undertaken, the zones being explored by four adits and by open-cuts and stripping. A shipment of 60 tons of silver-lead ore was made early in 1915. In 1919 the Skeena Mining and Milling Company was organized to develop the Victory and Coronado groups. Mining machinery and a 50-ton capacity Faust water concentrating mill were purchased, and some of this equipment was hauled to the property. Fred Griffin carried out shallow surface operations during 1938 and 1939 and shipped selected silver-lead ore in both years. The property was acquired by Sil-Van Consolidated Mining and Milling Company Limited in 1950.

There are two parallel zones on the property, 950 feet apart, that strike north 45 degrees east and dip from 75 to 85 degrees southeast. The zones are in rhyolite and andesite flows and andesitic flow breccias. They are fault or sheared zones, along which the wall-rock is bleached and silicified. Galena, sphalerite, tetrahedrite, and arsenopyrite, with a little chalcopryrite, occur as fissure fillings replacing the altered rock, and are accompanied by a little quartz gangue. Arsenopyrite is the dominant sulphide in the wall-rock, and assays shows that it is accompanied by some gold.

The more westerly zone is prospected for 600 feet along its strike by three adits and several open-cuts. The No. 1 or lower adit, at elevation 3,430 feet, follows the zone for 260 feet. From the portal a single fissure, sparsely mineralized, is followed for 20 feet to where it splits. The two branches lie 2 to 3 feet apart and continue along the walls of the adit. Between the two fissures, altered silicified rhyolite is cross fractured and traversed by small stringers of sulphides. A lens 8 inches wide, containing over 60 per cent sulphides, occupies the west branch between 20 and 30 feet from the portal. Another sulphide lens, 12 inches wide, 110 feet from the portal carries about 50 per cent sulphides. From there to the face of the adit, the two fissures lie from 3 to 6 feet apart and carry sulphide lenses up to 6 inches in width. At the face, 36 inches of sheared, silicified rock is replaced by about 3 per cent of arsenopyrite. A 36-inch channel sample taken across the face assayed: gold, 0.035 ounce a ton; silver, 0.63 ounce a ton.

No. 2 adit, 90 feet in length, is 250 feet farther up the hill and 75 feet vertically above the lower. For 20 feet northeast from the portal ore has been stoped from the back of the drift. Between 20 and 40 feet from

the portal the zone is 12 inches wide, and beyond this gradually narrows until it pinches out entirely at the face of the drift. The better parts of the zone are solid sulphides, consisting of about equal amounts of argentiferous galena, arsenopyrite, and sphalerite, with a little tetrahedrite and chalcopyrite. Several tons of ore is piled in a dilapidated cabin near the portal. A representative sample of this ore assayed: gold, 0.36 ounce a ton; silver, 20.66 ounces a ton; lead, 16.96 per cent; zinc, 12.06 per cent.

No. 3 adit is 80 feet farther up the slope and 30 feet above No. 2 adit. It follows two parallel zones 3 to 4 feet apart. Both sheared zones are under 3 inches in width and are very sparsely mineralized.

In an open-cut 150 feet farther up the hill, at an elevation of 3,610 feet, the zone ranges from 12 to 30 inches in width and carries about 30 per cent of sphalerite, arsenopyrite, and galena. In a second cut, 60 feet farther along, the zone has a maximum width of 2 feet and consists of three parts: a vertical, sheared zone 6 inches wide, carrying 5 per cent of arsenopyrite; a 4-inch fissure zone containing 50 per cent arsenopyrite; and 2 feet of intervening, altered breccia, cross fractured, silicified, and mineralized with about 2 per cent of arsenopyrite.

The more easterly zone is traced for 400 feet along its strike by an adit and several open-cuts. The adit, at elevation 3,400 feet, follows two or more roughly parallel fissures 4 to 5 feet apart, for a distance of 62 feet. These are largely barren for 40 feet from the face of the adit, but near the portal carry narrow sulphide seams ranging from 2 to 6 inches in width. Above the adit some ore was removed years ago, as evidenced by a trench 6 feet deep that follows along the zone for 75 feet. In a large open-cut 350 feet up the hill from the adit there is a 12-inch zone of brecciated, sheared rhyolite carrying galena, sphalerite, and a little tetrahedrite. The zone strikes north 35 degrees east and dips 75 degrees southeast. Along its northwest side, in a distance of 12 or 15 feet, it is joined by several branch fissures. They lie several feet apart, strike south 65 degrees west, and dip steeply southeast. They do not extend over 20 or 30 feet from the main fissure but near the latter carry 1 inch to 2 inches of almost solid sulphides, chiefly galena, sphalerite, and some tetrahedrite. At the surface this ore is oxidized to a soft, rusty, friable material dusted over with a yellowish white oxidation product. A sample of this material assayed: gold, 0.06 ounce a ton; silver, 24.42 ounces a ton; lead, 11.13 per cent; zinc, 7.83 per cent.

Empire Group (63)

References: Ann. Repts., Minister of Mines, B.C.: 1908, p. 64; 1914, p. 225; 1920, p. 90; 1925, p. 137; 1928, p. 161; 1929, p. 164.

The Empire group of five claims covers the basin at the head of Simpson Creek on the southeast slope of Hudson Bay Mountain. The mineral showings are approximately 6 miles from Smithers, and are easily reached by way of a trail that leads up the mountain from a point 1 mile north of the town. The property was staked by Simpson Brothers of Smithers in 1908, and D. C. Simpson prospected the claims from time to time over a 30-year period.

A vein containing silver, lead, and zinc minerals is exposed on the mountain slope on the north side of the south fork of Simpson Creek. It follows a well-defined fault fissure in volcanic flow breccias of Jurassic age. These are invaded by a small diorite stock east of the vein fissure. At an elevation of 4,700 feet, an adit is driven 40 feet northwesterly along the vein, which strikes north 55 degrees west and dips 60 degrees southwest. At the portal the vein is 12 inches wide, and consists largely of massive galena and sphalerite, with minor chalcopyrite and pyrite. The vein narrows along the adit, and the fault fissure is barren at the face. The vein also pinches out 60 feet above the adit along a 36-degree slope. A second adit driven 15 feet towards the vein on the drift-covered slope 50 feet southeast and 25 feet below the upper adit did not reach the vein. A 12-inch channel sample collected by the writer across the vein at the portal of the upper adit assayed: gold, 0.08 ounce a ton; silver, 18.90 ounces a ton; lead, 18.20 per cent; and zinc, 16.60 per cent.

On the south side of the basin of the South Fork of Simpson Creek, a well-defined shear zone extends for 600 or 700 feet up steep bluffs of andesitic volcanic rocks. The zone strikes north 35 degrees west and dips southwest 75 to 80 degrees. The wall-rocks are bleached to a pale yellow along the shear zone, and the altered rock contains stringers of galena and sphalerite. At an elevation of 4,725 feet the shear zone is prospected underground by a 135-foot drift at the end of a 70-foot crosscut adit. A sample collected from a small heap of ore at the portal of the adit assayed: gold, 0.03 ounce a ton; silver, 7.45 ounces a ton; lead, 7.17 per cent; and zinc, 4.31 per cent.

Near the top of the bluffs, at elevation 5,200 feet, the same shear zone is prospected by a 50-foot drift adit and a 10-foot shaft. This adit was driven in 1914, and some 3 tons of ore are reported to have been shipped at the time from these workings. According to the Annual Report of the Minister of Mines for 1914, the ore occurred as bunches of galena and sphalerite along the course of the adit, with a narrow streak of ore in the shaft. A specimen of the best looking ore assayed: gold, 0.06 ounce a ton; silver, 207 ounces a ton; lead, 25.3 per cent; and zinc, 18.6 per cent.

Another showing, at an elevation of 5,200 feet at the head of the basin, is described as follows in the Annual Report of the Minister of Mines for 1929:

"It consists of a wide zone in volcanics striking north-south and dipping west, mineralized with galena and zincblende. Very little work has been done, but the zone can be traced on the surface for a considerable distance, and it is claimed that there are good showings farther up the mountain, but at the date of inspection the higher levels were under recent snow, so were not visited. A sample from a small cut across 24 inches of mineralized vein matter assayed: gold, 0.30 ounce a ton; silver, 6.0 ounces a ton; copper, 1.0 per cent; lead, 25.2 per cent. Another sample from a small cut about 700 feet north, across a stringer 5 inches wide, assayed: gold, 0.76 ounce a ton; silver, 7.0 ounces a ton; copper, 1.0 per cent; and zinc, 23.4 per cent. This zone appears to merit further exploration."

Evelyn Group (46)

References: Ann. Repts., Minister of Mines, B.C.: 1923, p. 110; 1925, p. 136.

The Evelyn group, owned by Angus McLean of Smithers, is on the northeast slope of the northern segment of Hudson Bay Mountain, about 3 miles due southwest of Evelyn station. The property is reached from the station by a good trail about 4 miles long.

A mineralized, sheared zone in andesite has been traced by a dozen open-cuts for 1,000 feet in a horizontal direction and 385 feet in a vertical direction up a 27-degree slope between elevations of 5,150 and 5,535 feet. The sheared zone strikes north 55 degrees east and dips about 45 degrees southeast. It is mineralized with various amounts of arsenopyrite, pyrite, galena, sphalerite, and tetrahedrite. A boss of granodiorite that lies to the southeast approaches within 600 feet of the vein.

The most extensive shearing and vein formation were seen in two large open-cuts 45 feet apart at elevation 5,250 feet. In the west cut, the andesite is sheared, altered, and silicified over a width of 7 feet. The altered rock is replaced by finely disseminated pyrite and arsenopyrite, and is traversed by fine veinlets of galena and sphalerite. A chipped sample taken across 7 feet of the altered and mineralized rock assayed: gold, a trace; silver, 0.91 ounce a ton; lead, 0.29 per cent. In the cut 45 feet farther east there are two parallel sheared zones 6 feet apart that strike north 60 degrees east and dip 40 degrees southeast. The upper zone ranges from 6 to 12 inches in width and the lower from 12 to 16 inches in width. The zones consist of silicified, sheared andesite that contains up to 10 per cent of arsenopyrite with small amounts of galena, sphalerite, and tetrahedrite. A 15-inch channel sample taken across the lower zone in the floor of the cut assayed: gold, 0.0075 ounce a ton; silver, 10.70 ounces a ton; lead, 0.42 per cent.

In an open-cut 160 feet farther down the slope there is a sheared zone 15 feet wide that is mineralized throughout with a little arsenopyrite, galena, and sphalerite. In the lowest cut 50 feet farther down the slope, the sheared zone is 12 feet wide and is only sparsely mineralized with arsenopyrite.

In the west end of a 47-foot crosscut trench, 100 feet up the slope from the first described open-cut, there is a 12-inch zone containing up to 10 per cent of sulphides, most of which is arsenopyrite. Several, small, sparsely mineralized, sheared zones are exposed in the east end of the trench. The zone is also located by an open-cut 70 feet farther up the hill, but this cut was caved at the time of our visit. The zone is not exposed for 500 feet up the slope but is seen on the shoulder of a ridge at 5,535 feet elevation. From the shoulder of the ridge it continues for several hundred feet along the precipitous east wall of a deep glacial cirque. Where examined on the shoulder of the ridge, it ranges from 4 to 12 inches in width and consists of silicified andesite carrying up to 10 per cent of arsenopyrite with a little galena and sphalerite. A 12-inch channel sample taken across this zone in a small cut on the south side of the ridge assayed: gold, 0.005 ounce a ton; silver, 1.08 ounces a ton.

Glacier Gulch North Side Group (56)

(Glacier Gulch Mining Company Limited)

References: Ann. Repts., Minister of Mines, B.C.: 1926, p. 131; 1927, p. 137; 1928, p. 163; 1929, p. 164; 1934, p. C5; 1937, p. C21; 1951, p. 113.

This property, staked by S. F. Campbell, Grover Loveless, and Wesley Banta of Smithers, is on the north side of Glacier Gulch on the east side of Hudson Bay Mountain, 5 miles northwest of Smithers. The workings are at an elevation of 2,900 feet about 400 feet above the Glacier Gulch motor road.

Surface work in 1926 and 1927 disclosed four small veins containing considerable zinc with various amounts of gold and silver. F. H. Taylor sank a shaft 23 feet on the larger vein in 1928 and found that it contained much less zinc and silver at that depth. During the 1937 season Messrs. Campbell, Loveless, and Banta constructed a short tramline from the shaft to the road and got out a carload of ore. Glacier Gulch Mining Company Limited acquired the property in 1950, and 500 feet of diamond drilling was done north of the creek in 1951 (*See Glacier Gulch South Side group*).

The veins occur in fine-grained, dark, andesitic volcanic rocks close to a fault contact with younger sedimentary rocks that lie to the east. An albite porphyry dyke 12 feet wide intrudes the andesitic rocks, but does not appear to have any connection with the mineralization. The dyke is exposed on the steep face of the gulch (54-degree slope there) about 75 feet west of the shaft. It strikes north 25 degrees west and dips 80 degrees east. A sheared zone follows along or close to the west wall of the dyke, but contains no sulphides. The sedimentary rocks lie 20 feet east of the shaft. Their contact with the volcanic rocks is marked above this point by a narrow, steeply rising gully, but below 2,925 feet the contact is covered by talus. In the gully the contact strikes north and dips from 60 to 70 degrees east. The steeply rising andesite walls on the west side of the gully are slickensided by fault movement. The sediments are rusty weathering quartzite, greywacke, slate, and conglomerate, with coal seams near the base of the formation. Two of these coal seams 50 feet east of the shaft are 12 inches and 8 inches wide and are separated by 16 inches of shale. Two other seams, 1 foot and 2 feet in width, respectively, were noted at points 50 and 100 feet farther east. All of these seams are dirty and none of them has been opened by test pits. In this vicinity the coal-bearing strata strike north and dip from 45 to 60 degrees east.

At the shaft (elevation 2,950 feet) the main vein outcrops along the surface for a distance of 60 feet. It consists largely of dark sphalerite with minor amounts of arsenopyrite, pyrite, pyrrhotite, galena, and chalcopyrite. These sulphides are accompanied by a little quartz gangue. The vein strikes north 10 degrees east and dips from 50 to 60 degrees west. It ranges from 4 inches to 2 feet in width and has an average width of a little under 1 foot. The vein is a fissure filling along a fault of small displacement. The fissuring extends to the fault contact of the volcanic rocks with the sedimentary rocks north of the shaft, but appears to be poorly mineralized near this contact. The shaft is reported to be 23 feet deep, and at a depth of 12 feet a drift extends 11 feet north of the centre of the shaft. At

the bottom of the shaft the vein consists of 9 inches of mineral, almost entirely pyrrhotite. The British Columbia Minister of Mines report for 1937 states that a sample collected by D. Lay from the bottom of the shaft assayed: gold, 0.06 ounce a ton; silver, 0.6 ounce a ton. Another sample collected by Mr. Lay across 18 inches on the face of the drift assayed: gold, 0.20 ounce a ton; silver, 6.8 ounces a ton; lead, 2 per cent; zinc, 5.4 per cent. An 8-inch channel sample collected by the writer across the vein 6 feet south of the shaft assayed: gold, 0.33 ounce a ton; silver, 2.39 ounces a ton; lead, 1.57 per cent; zinc, 27.56 per cent.

In an open-cut 85 feet south of the shaft there is a sphalerite vein 15 feet long that ranges from 3 to 5 inches in width. Commencing 60 feet farther southwest a vein is exposed for 40 feet in a horizontal direction along the steep slope. This vein has an average width of 1 foot, and consists of about equal parts of vein quartz and pyrrhotite with a little chalcopyrite. An 8-inch channel sample collected across this vein assayed: gold 0.36 ounce a ton; copper, 0.54 per cent; nickel, none.

There is an open-cut on another small vein 75 feet southeast of the shaft. This vein is exposed for 40 feet and ranges from 3 to 12 inches in width. It consists largely of solid sphalerite with 5 to 10 per cent of quartz gangue and a little galena, pyrrhotite, and chalcopyrite.

Glacier Gulch South Side Group (57)

(Glacier Gulch Mining Company Limited)

References: Ann. Repts., Minister of Mines, B.C.: 1929, p. 164; 1930, p. 140; 1933, p. 97; 1934, p. C5; 1935, p. C35; 1950, p. 100; 1951, p. 113. Geol. Surv., Canada, Paper 36-20, 1936, p. 93.

The Glacier Gulch South Side property is on the south side of Glacier Gulch 5 miles northwest of Smithers, on the east slope of Hudson Bay Mountain. The property is 2½ miles west of the Canadian National Railway station at Lake Kathlyn and is reached by way of a good motor road that follows up Glacier Gulch to an elevation of 2,600 feet. There are three separate mineral occurrences on the property, of which a gold-bearing lode that lies between elevations 3,150 and 3,400 feet is best known. A switchback trail leads up to this prospect and an aerial tramline connects the workings with the end of the road. A silver-lead-zinc vein outcrops 700 feet easterly from the tramline between elevations of 2,800 and 3,300 feet and a molybdenum prospect occurs over 1,000 feet west of the gold lode near the foot of Glacier Gulch Glacier. The property was acquired by Glacier Gulch Mining Company in 1950 and underground exploration of the silver-lead-zinc vein was begun.

Glacier Gulch is a narrow, U-shaped, steep-walled ravine nearly a mile long and trending northeasterly. At the head of the gulch, the ground rises as a precipitous bluff for 1,000 feet to a glacial, ice-filled valley. The melting ice supplies an abundant flow of water throughout most of the year. Rock outcrops are plentiful on both sides of Glacier Gulch, but prospecting is hindered by the steep slopes, which commonly fall away at angles exceeding 40 degrees.

Gold-bismuth Lode

Gold associated with bismuth minerals was discovered on this property by Stewart F. Campbell, Grover Loveless, and Wesley Banta in 1929. Exploratory work during the next few years by these men disclosed several small shoots of high-grade gold ore. In 1933 they shipped 26 tons of ore that contained a total of 82 ounces of gold and 15 ounces of silver, in addition to bismuth for which no payment was made. R. W. Wilson held an option on the property during 1934, and made another shipment of ore. The owners resumed work in 1935 and shipped an additional 30 tons of high-grade gold ore. In the autumn of 1937 some ore was shipped from the silver-lead-zinc vein that lies 700 feet east of the gold-bearing veins. Further shipments of gold ore were made to the sampling plant at Prince Rupert by Campbell, Loveless, and Banta as shown in the following table:

Year	Dry tons	Gold	Silver	Bismuth
		Ounces a ton	Ounces a ton	Per cent
1938.....	0-175	3-000	1-20	.....
1939.....	0-146	5-085	1-10	1-9
1939.....	12-235	1-442	0-60	1-2
1939.....	6-175	1-044	0-29	0-5
1939.....	10-239	1-212	0-20	.....
1939.....	2-042	3-49	0-10	5-6
1940.....	0-027	28-32	7-80	15-10
1941.....	0-184	4-38	2-20	.....
1941.....	0-061	5-87	3-40	.....
1941.....	0-221	4-01	1-00	3-7

The gold-bismuth deposits occur along sheared and altered zones in massive, finely crystalline tuffs, with which some beds of argillite are interstratified. Most of the sheared zones lie parallel with bedding planes and appear to have formed as a result of relatively small movements produced when these rocks were folded. These zones have a predominant southeast strike and dip 20 to 40 degrees southwest in the lower, more westerly occurrences. The upper and more easterly zones strike south and dip 20 degrees east and some are linked together by steeply inclined shear zones. The productive zones are largely confined to the crest of an anticlinal fold, the axial plane of which is about vertical and which trends in a southwest direction. The fold has a pitch of about 25 degrees to the southwest. A short distance above the deposits the rocks are largely argillites with some interbedded greywacke and conglomerate. These beds strike southwest and dip about 50 degrees southeast. Below the deposits the tuffs pass downwards into a thick series of andesite flows. A silver-lead-zinc vein occurs along a fault fissure in these andesitic rocks about 700 feet northeast of the gold-bismuth deposits. About 400 feet farther northeast the andesites are in faulted contact with younger sediments. These sediments are slate, quartzite, argillite, and conglomerate, and contain numerous narrow coal seams near the base of the formation. No intrusive rocks were seen in the immediate vicinity of the mineral deposits, but boulders of coarse porphyritic granite were noted near the foot of the glacier at the head of Glacier Gulch. The volcanic rocks at the foot of the glacier are intruded

by lamprophyre dykes up to 20 feet in width, and joint planes in one of these dykes contain seams of calcite and molybdenite up to half an inch wide.

The bulk of the gold ore was quarried from a relatively small area, measuring possibly 150 feet in length and rising through a height of 75 feet. The sheared and altered zones commonly exceed 100 feet in length and have an average width of from 1 foot to 2 feet. There are five or six of these zones roughly parallel with one another in the productive area. The ore shoots range from a few inches up to several feet in width and from a few feet up to 50 feet in length. The ore occurs in the most altered parts of the sheared zones, where the tuff is bleached to a dull white colour. This type of rock grades along the sheared zones into less altered, dull yellowish brown rock. Several samples of the less altered rock were assayed for gold with negative results. In some cases the altered rock is replaced by considerable quartz. The limited number of samples collected seems to indicate that the vein quartz carries gold in economic amount only where tetradymite is present.

The high-grade ore is a white, silicified tuff holding the bismuth telluride, tetradymite. This mineral occurs as very thin seams along the planes of shearing and as irregular replacements, and is always accompanied by fine native gold. Some ore contains only 2 or 3 per cent of the tetradymite, but in the richest ore the bismuth mineral constitutes up to 50 per cent of the mass. The tetradymite occurs both as compact, steel-grey crystals ranging from a small fraction of an inch up to 3 inches in length and as a mass of crystals in the altered rock. The platy crystals are commonly dark due to a thin film of iridescent tarnish. The altered rock consists of albite and quartz with calcium carbonate, talc, and sericite. Rock alteration was followed or accompanied in many places by introduction of vein quartz. The quartz is present both as veins along the centre of the sheared zones and as fine veinlets or irregular pockets in the altered rock. In an open-cut above the tramway terminal, altered tuff is replaced by coarsely crystalline quartz, from which some excellent specimens of both tetradymite and bismuthinite (bismuth sulphide) were collected. Fine grains of native gold were observed along the platy cleavage in both the tetradymite and bismuthinite. Gold was also seen in the vein quartz and in the altered rock close to small crystals of the bismuth minerals.

The main adit at elevation 3,200 feet is driven south 27 degrees east for 40 feet as a drift. Then it turns at right angles, extending northeast an additional 41 feet. At 12 feet from the face a raise has been driven up 30 feet to the surface along a sheared zone that strikes south 35 degrees east and dips 45 degrees southwest. Considerable ore is reported to have come from the upper part of the raise, where the shearing and alteration widens to 6 feet. Between the raise and the face of the adit there is a small fold in the tuffs, which are partly altered over a width of several feet. An 18-inch channel sample taken across the central part of the altered zone on the face of the adit assayed: gold, none. For 40 feet from the portal the adit follows another altered zone from 1 foot to 2 feet in width, which strikes south 25 degrees east and dips 20 degrees southwest. Channel samples of the altered rock taken 4 feet from the portal and

midway between the drift and raise gave negative assays for gold. In both cases the samples were of light brown, altered, silicified tuff, but contained no tetradymite.

Sixty feet northwest of the main adit and 57 feet lower down the bluff an adit is driven 43 feet along a sheared zone that strikes south 50 degrees east and dips 40 degrees southwest. The sheared zone carries a quartz-calcite vein that ranges from 6 to 12 inches in width, but pinches 4 feet from the face. The tuff on either side of the vein is altered to a yellowish brown colour over a width of 1 foot. The vein does not carry any sulphides or bismuth minerals, and a 9-inch channel sample taken across it 20 feet from the portal assayed: gold, none.

Fifty-five feet northeast of the main adit and 10 feet lower, an adit is driven 27 feet along another sheared and altered zone in tuffs. This zone strikes south 50 degrees east and dips 25 degrees southwest. A 22-inch channel sample taken across it 10 feet from the portal assayed: gold, 0.005 ounce a ton.

From the floor of a quarry 75 feet southeast of the main adit and 40 feet higher, an adit has been driven 28 feet south along the upward continuation of the zone on which the raise was driven. At the portal the zone is 3 feet wide, but it narrows to 10 inches at the face. It strikes south and dips 20 degrees east. A branch drift runs 33 feet east along this zone from a point 10 feet from the portal. Throughout the adit the sheared rock is replaced by considerable quartz, but contains only 1 to 2 per cent of tetradymite. An 18-inch channel sample taken across the vein 10 feet from the portal assayed: gold, 0.055 ounce a ton.

Four other short adits were driven into the base of the cliff from the floor of the quarry, and all explore similar sheared and altered zones. In some cases they were driven on small pockets of high-grade ore.

During the 1938 season the owners were mining an ore shoot about a foot in width on a narrow ledge about 20 feet above the floor of the quarry. Some of this ore consisted of over 50 per cent of tetradymite and averaged 3 ounces of gold a ton. Considerable, white, altered tuff containing from 1 to 3 per cent of tetradymite is scattered on the floor of the quarry and has evidently been discarded as too low grade to ship. A representative sample of this material collected near the collar of the raise assayed: gold, 0.32 ounce a ton; silver, 0.28 ounce a ton; bismuth, 0.05 per cent. Fragments of similar ore of milling grade lie on the talus slide below the workings.

In an open-cut 125 feet northeast of the quarry, there is a sheared and silicified zone 26 inches wide, which strikes north 50 degrees east and dips 30 degrees southeast. A 26-inch channel sample taken across the zone in this cut assayed: gold, 0.02 ounce a ton.

Other sheared and altered zones occur at intervals for over 500 feet southwest of the quarry along the steep slope. Three of these, prospected by small open-cuts, disclosed small amounts of tetradymite, and samples taken assayed only a trace in gold.

At elevation 2,890 feet, directly below the main workings, a band of tuff is silicified over a width of 2 feet along its upper contact with andesite on the northeast side of the talus slide. A 2-foot chip sample taken across silicified tuff 40 feet south of the trail to the silver-lead-zinc vein, and a few feet northeast of the talus slide, assayed: gold, 0.045 ounce a ton.

It must be borne in mind that assays from channel samples collected from deposits such as this one, in which the gold occurs free and is erratically distributed, may be misleading. The actual grade of the veins can probably be more accurately judged from samples in bulk.

Silver-lead-zinc Vein

A silver-lead-zinc vein lies exposed between elevations of 2,850 and 3,300 feet about 700 feet northeast of the gold-bismuth deposits. It extends up a steep slope through a vertical distance of 450 feet and a horizontal distance of 500 feet. The vein occurs along a fault fissure and is enclosed in fine-grained andesite flows except at the upper end where it passes into tuffs. It strikes from south 20 to 40 degrees west and dips from 40 to 60 degrees northwest. The vein consists of banded alternations of calcite, siderite, galena, sphalerite, arsenopyrite, and pyrite, with a little quartz and in places some tetrahedrite. It ranges from 4 to 18 inches in width. The wall-rock adjoining the vein is bleached for widths of a few inches to 1 foot or 2 feet.

At elevation 2,950 feet an adit has been driven 80 feet southwest along the vein. In the adit the vein ranges from 5 to 10 inches wide and is mineralized throughout. An 8-inch channel sample taken across the vein from the roof of the adit, 10 feet from the portal, assayed: gold, 0.015 ounce a ton; silver, 6.5 ounces a ton; lead, 4.41 per cent; and zinc, 1.66 per cent. A 6-inch channel sample taken across the vein at the face of the adit assayed: gold, 0.06 ounce a ton; silver, 17.69 ounces a ton; lead, 1.10 per cent; and zinc, 2.66 per cent.

Above the adit the vein is exposed for 180 feet up a 47-degree slope. In this distance it has an average width of 6 or 8 inches and is well mineralized. At an elevation of 3,085 feet, in a 14-foot adit, the vein is 4 inches wide and contains abundant sulphides. A 4-inch channel sample taken across the vein in the roof of the adit, 3 feet from the portal, assayed: gold, 0.14 ounce a ton; silver, 18.14 ounces a ton; lead, 9.55 per cent; and zinc, 9.54 per cent.

In an open-cut at elevation 3,235 feet the vein consists of 6 inches of sheared and silicified andesite replaced by stringers of pyrite, arsenopyrite, galena, tetrahedrite, and sphalerite. A 6-inch channel sample taken across the vein in this cut assayed: gold, 0.05 ounce a ton; silver, 28.75 ounces a ton; lead, 2.39 per cent; and zinc, 1.26 per cent.

In the uppermost cut, at elevation 3,285 feet, the vein is enclosed in volcanic tuffs, and consists of 5 inches of sheared and altered rock carrying about 10 per cent pyrite.

In 1951, the Glacier Gulch Mining Company drove a 400-foot adit, at elevation 2,600 feet, to explore the downward extension of the silver-lead-zinc vein described above. In this adit the vein strikes from south 50 degrees east to south 5 degrees east, and dips 30 degrees southwest. It is 2 to 6 inches wide, and consists largely of calcite, galena, and sphalerite. A sample collected at the face, assayed: gold, 0.01 ounce a ton; silver, 17.51 ounces a ton; zinc, 2.60 per cent, and lead, 1.10 per cent.

A raise was driven up 200 feet from the new adit to connect with the older workings above. The raise is in two parts, each part being 125 feet long up a 51-degree slope. The raise connects with the surface by way of a 125-foot drift, in which the vein is about 6 inches wide but is sparsely mineralized.

Molybdenum Lode

Molybdenum was seen in a trap dyke on the south side of Glacier Gulch a short distance below the glacial ice front. The molybdenum occurs as veinlets about $\frac{1}{4}$ inch thick along joints and fractures in the fine-grained black trap rock. The showing is reached by climbing the north side of the gulch, and by crossing to the south wall just below the ice front: there is attendant danger of being struck by sliding ice blocks that break periodically from the steeply sloping front of the glacier.

Groundhog Group (70)

Reference: Ann. Rept., Minister of Mines, B.C., 1911, p. 119.

The Groundhog and Cariboo mining claims were staked by A. S. Millar in 1911 at an elevation of about 5,500 feet on the east side of Pine Creek on the southeast shoulder of Hudson Bay Mountain.

A shear zone is exposed in volcanic rocks on the side of a small basin at an elevation of 5,650 feet. The zone strikes north 15 degrees west, ranges from 6 to 12 inches in width, and carries a little pyrite, galena, and chalcopryite. A hand specimen of the ore collected from an open-cut assayed: gold, 0.08 ounce a ton; silver, 8.1 ounces a ton. Another sample taken from the same vein higher up on the bluff, assayed: gold, 0.08 ounce a ton; silver, 5.2 ounces a ton; lead, 3.2 per cent; and copper, 0.75 per cent.

Heather Group (62)

Reference: Ann. Rept., Minister of Mines, B.C., 1931, p. 73.

The Heather prospect is on the ridge between the north and south forks of Simpson Creek, near the head of the north fork. The claims, staked by H. C. Wade in 1931, are reached by following the trail to the cabin on the Jessie claim and then climbing the mountain.

At an elevation of 5,350 feet on the north side of the ridge, between the forks of Simpson Creek, an open-cut exposes a shear zone 4 feet wide in the volcanic rocks of the Hazelton group. The shear zone is mineralized with arsenopyrite and sphalerite across a width of 2 feet 9 inches. A sample collected across the vein by D. Lay (1931) assayed: gold, 0.10 ounce a ton; silver, 0.5 ounce a ton; and zinc, 3.4 per cent. The zone strikes north 5 degrees west and dips westerly at 50 degrees. A zone of similar attitude is exposed in an open-cut on the south side of the ridge between the forks of the creek, in the south fork basin, at an elevation of 5,375 feet.

Henderson and Hummingbird Groups (Duthie Mine) (76 and 72)

(Sil-Van Consolidated Mining and Milling Company Limited)

References: Ann. Repts., Minister of Mines, B.C.: 1908, p. 64; 1914, p. 216; 1922, p. 109; 1923, p. 108; 1924, p. 94; 1925, p. 135; 1926, p. 129; 1927, p. 134; 1928, p. 159; 1929, p. 161; 1930, p. 139; 1934, p. C9; 1940, p. 55; 1941, p. 55; 1946, p. 86; 1947, p. 98; 1950, p. 100; 1951, p. 112. Geol. Surv., Canada, Sum. Repts.: 1908, p. 45; 1925, pt. A, p. 130; Prel. Rept., Paper 36-20, 1936, p. 88.

The Duthie mine (See Figure 9, in pocket, and Figure 10) is on the southwest slope of Hudson Bay Mountain $7\frac{1}{2}$ miles west of Smithers. The principal mine workings are between elevations of 3,200 and 4,500 feet on the Raven, Raven Fraction, Henderson, and Hummingbird mining claims. These claims belong to the Henderson group, which includes the Canary, Galena Queen, Dome, Dome Fraction, White Swan, Pacific, and Vancouver Crown-granted claims. The mine is reached by way of a good motor road about 14 miles long that connects with the Canadian National Railway at Smithers.

Annual Reports of the Minister of Mines for British Columbia record surface work by Boyd and J. K. Ashman on the Henderson claim, and by M. Hannah, G. Holbrook, and Geo. Charlton on the Hummingbird claim, in 1908. On the Henderson claim the early work was confined to the Ashman vein-lode, but following the discovery of the Henderson vein-lode in 1921 and the disclosure of its high silver content, the property was bonded by J. F. Duthie. Underground operations commenced in 1922 with the driving of three drift adits known as the Compressor, McPherson, and Thompson levels. In 1923, the Federal Mining and Smelting Company obtained a controlling interest, and an operating company known as Duthie Mines Limited was formed. A vigorous development campaign was carried out, and some high-grade ore was shipped, but work stopped in August 1924. Mining was resumed by Duthie Mines Limited in July 1925, and in 1926 further shipments of high-grade, hand-sorted ore were made. In 1927, a modern 50-ton flotation mill was built, 5,500 tons of ore were treated by the end of the year, and a 680-foot crosscut adit was driven at the mill level to reach the Henderson and Fault Plane lodes. Development continued on this level in 1928, and 14,980 tons of ore were milled. In the same year, Duthie Mines Limited became associated with the Atlas Exploration Company of Ottawa and Mining Issues Corporation of Toronto. A new boarding-house, bunkhouse, and other surface buildings were constructed in 1929, and extensive mining development was accomplished. A 600-horsepower, steam driven, electric power plant was completed and a three-compartment shaft was sunk from the mill (500) level to the 600 level. During the year, 12,500 tons of ore were mined and 10,370 tons milled. The Hummingbird and Canary claims were purchased towards the end of the year, giving an additional 2,000 feet along the northeasterly continuation of the Henderson lode for further operation. Mining operations were suspended in March 1930, owing to the depressed metal market.

Small-scale mining by Smithers Mines Limited, in 1940 and 1941, produced 456 tons of ore containing 101 ounces of gold and 72,699 ounces of silver. During 1946 and 1947 Duthie Mines (1946) Limited built a new diesel power plant, carried out a diamond drilling program, and

extended the drift on the 3,800 level. Drilling proved that mineralization extended for more than 1,500 feet beyond the face of the drift on the Henderson-Ashman vein-lode on the 3,800 level. Sil-Van Consolidated Mining and Milling Company of Vancouver took over the property in 1950, together with the adjoining Mamie group, and underground work was commenced to block out ore on both the Henderson-Ashman vein-lode and on the Mamie vein-lode. Two new adits were driven along the Henderson-Ashman vein-lode on the Hummingbird claim at elevations of 4,100 and 4,250 feet. By the autumn of 1952 stopes had been prepared to yield 4,400 tons monthly to the reconstructed mill, with a grade, after allowance for dilution, of: gold, 0.13 ounce a ton; silver, 11.7 ounces a ton; lead, 6.7 per cent; zinc, 9.6 per cent; and some cadmium.

The following statement of past total production from the Duthie mine is from the Annual Report of the British Columbia Minister of Mines for 1934:

"4,788 tons of hand-sorted ore yielding gross smelter returns of \$523,744.92, leaving net smelter returns of \$411,705.72, after deducting freight and treatment rates of \$23.40 a ton; 31,956 tons of ore milled yielded 1,663 tons of lead concentrates and 1,834 tons of zinc concentrates. Values contained in the tonnage milled were as follows: gold, 776 ozs.; silver, 739,055 ozs.; lead, 1,920,487 lbs.; zinc, 1,606,014 lbs. The following may be taken to represent the average tenor of the various products:

"Feed: Silver, 37.2 ozs. per ton; lead, 4.8 per cent; zinc, 5.2 per cent.

"Lead Concentrates: Gold, 0.27 oz. per ton; silver, 430.8 ozs. per ton; lead, 48.6 per cent; zinc, 10.9 per cent.

"Zinc Concentrates: Gold, 0.093 oz. per ton; silver, 36 ozs. per ton; lead, under 1.4 per cent; zinc, 47.2 per cent. Savings effected, 95 per cent of silver contents, 95 per cent of lead contents, and 80 per cent of zinc contents."

The principal vein-lodes, known as the Ashman, Henderson, and Fault Plane, are developed by several miles of underground workings and have furnished all the ore taken from the mine. There are eleven levels, six of which are adit drifts. From top to bottom they are named or numbered as follows: Hummingbird 4,250 level, Hummingbird 4,100 level, Thompson or 10 level, McPherson or 65 level, Intermediate or 145 level, Compressor or 245 level, Mill or 500 level, and sub-levels 265, 300, 400, and 600. The numbers applied to the Intermediate and lower levels denote the vertical distances below an elevation of 3,840 feet, 10 feet below the Thompson level.

The property is underlain by rhyolite, dacite, and andesite flows and flow breccias and by rhyolite tuffs (See Figure 9). The mine workings above the 500 level (the 600 level was not examined) are in rhyolite flows and silicified rhyolite tuffs. These rocks are overlain on the east and south by rhyolite, dacite, and andesite flow breccias. Light-coloured, fine-grained rhyolite is the most common rock in the vicinity of the workings. It exhibits well-developed flow structure, and some of the individual flows are packed with spherulites. Thirty feet north of the McPherson portal, an outcrop of spherulitic rhyolite is composed largely of spherulite ranging from $\frac{1}{8}$ to $\frac{3}{8}$ inch in diameter, arranged in parallel bands through flowage. A specimen of spherulitic rhyolite taken from the dump of the Compressor level contains spherulites up to an inch in diameter. The rhyolite tuffs are very fine-grained, light yellowish white to grey rocks. Most of them are finely laminated and have been silicified so that they are as hard and brittle as the rhyolite. A small mass of rhyolite flow breccia is inter-

calated with the rhyolite flows 500 feet north of the north portal of the Compressor level and another small mass occurs on the surface 150 feet northeast of the Thompson portal.

The flow breccias, in which the Dome and the combined Henderson-Ashman vein-lodes occur, are dominantly dacites, but some are andesites and some are rhyolite. These lavas contain abundant angular fragments ranging up to 3 inches in diameter with an average size of about $\frac{1}{2}$ inch (See Plate V B). There are both chert-like fragments of the same composition as the matrix and variegated white, purple, grey, and black fragments of tuff and lava.

Near the McPherson portal, spherulitic rhyolite and tuff beds strike northwest and dip 70 to 80 degrees northeast. Farther northeast the rocks have a comparable strike and may be seen in many places dipping 60 to 85 degrees northeast. Two hundred and fifty feet southwest of the McPherson portal the flows also strike northwest, but dip 65 degrees southwest, and 400 feet southwest of the portal the structure is interrupted by a strong fault (No. 1 fault), which strikes northwest and dips 80 degrees southwest. Tuff beds southwest of this fault on the 500 level strike from north to northwest and dip 30 degrees southwest to west, but commencing 300 feet northeast of the fault the rocks on this level strike northwest and dip from 25 to 87 degrees northeast. The major structure, then, is an anticlinal fold, the axial plane of which strikes northwest and appears to dip at a steep angle to the southwest. On the surface the crest of the anticline lies about 150 feet southwest of the McPherson portal and the No. 1 fault extends along its southwest limb. This major fold is masked by smaller folds, which were seen on the surface south of the No. 1 fault and also north of the north portal of the Compressor level. The anticline plunges at a low angle to the southeast, judging by the presence of overlying flow breccias in that direction.

One diorite dyke, a quartz-albite porphyry dyke, and numerous dykes of lamprophyre and albite porphyry intrude the volcanic rocks (See Figure 9). Medium to coarsely crystalline, grey diorite forms a dyke, 50 to 60 feet wide, which trends northwesterly across the Henderson claim and dips about 80 degrees northeast. This dyke is intersected by the McPherson adit 775 to 830 feet from the portal, and is entered for 21 feet at the face of the Mill level drift along the Henderson vein-lode. Where crossed by the Henderson vein-lode on the McPherson level, it is fractured, altered, and bleached, but the fissures do not carry vein minerals.

The quartz-albite porphyry dyke is exposed on the road to the Compressor level at an elevation of 3,475 feet and is intersected in the Mill level crosscut 160 feet from the portal. It ranges from 20 to 40 feet in width, strikes northwesterly, and is at least 700 feet long. The rock is light grey, very fresh, and contains abundant, small phenocrysts of glassy quartz and grey albite in a finely crystalline groundmass.

Most of the lamprophyre dykes strike either northwest or northeast and have nearly vertical dips. They range up to 35 feet in width, but most of them are less than 10 feet. The rock is dark grey to black and finely crystalline. Many of these dykes occur in the mine workings, and are intersected by the vein-lodes. In several places underground they are offset to the left along these lodes, the displacement amounting to as much as 10 feet along the Henderson vein-lode.

The albite porphyry dykes are fine-grained, grey rocks carrying small albite phenocrysts partly altered to epidote and chlorite. They are not as numerous as the lamprophyre dykes, but several small ones were noted in the mine workings. One outcrops 500 feet south of the portal of the 500 level; it ranges from 6 to 20 feet in width, and has been traced easterly for 500 feet. Another such dyke was observed on the 500 level in the 40-foot crosscut to the north where the Henderson vein-lode is first intersected. This dyke has a chilled margin in contact with the lamprophyre dyke and evidently intrudes it. The relative ages of the other dykes are not known.

The mineral deposits occupy four main fault zones, originally known as the Ashman, Henderson, Fault Plane, and Dome. These mineralized fault zones or "vein-lodes" strike northeasterly and have dips that vary from 50 degrees southeast to 70 degrees northwest. They range from a few inches to 8 feet in width and from 700 to more than 3,500 feet in length. The vein-lodes are sliced, sheared, and brecciated zones along which occur sulphide veins and replacement deposits, the latter associated with some vein quartz and carbonate. The principal ore minerals are galena, sphalerite, tetrahedrite, ruby silver (pyrargyrite), pyrite, arsenopyrite, gold, and chalcopyrite; ore from the Henderson-Ashman vein-lode also contains some pyrrhotite and marcasite. All the ore contains gold, but rarely in visible form. It is generally associated with arsenopyrite. The ore is associated with minor amounts of quartz and carbonate gangue, and is cut in places by younger chalcedony veins up to 2 inches wide. There is a progressive change in mineralization along the Henderson vein-lode; in a northeast direction, towards the granitic core of the mountain, galena-sphalerite-tetrahedrite-ruby silver ore gives place to arsenopyrite-sphalerite ore that contains more gold and zinc but less galena and silver.

The Henderson vein-lode is marked by stronger slicing and brecciation than the other vein-lodes, and has proved to be the most productive on the property. It outcrops at intervals for more than 2,000 feet between elevations of 3,550 and 4,200 feet, at which point it is joined by the Ashman vein-lode. Beyond this point the combined lodes have been traced up the hill northeasterly in line with the Ashman lode for a distance of 1,500 feet to an elevation of 4,450 feet. The Henderson lode has an average strike of about north 65 degrees east and a dip that varies from 50 degrees southeast to 80 degrees northwest. The Ashman lode has been traced for about 1,700 feet to the southwest of its junction with the Henderson. As exposed in surface cuts this lode is not sliced or brecciated as severely as the Henderson and the vein deposits that occur along it are relatively small. The Ashman and Henderson vein-lodes come together on the McPherson level 1,240 feet northeast of the portal. Their line of junction between this level and the surface plunges 75 degrees to the southwest.

At an elevation of 3,575 feet northeast of the No. 1 fault, and just below the Compressor level, the Henderson vein-lode is joined by the Fault Plane vein-lode. The line of junction of these two lodes plunges at a low angle to the southwest. The stronger, Henderson vein-lode has a vertical dip below the junction, whereas the Fault Plane vein-lode strikes roughly parallel with the Henderson but dips at 55 to 60 degrees to the southeast.

A fourth vein-lode, the Dome, lies 1,350 feet southeast of the Henderson.

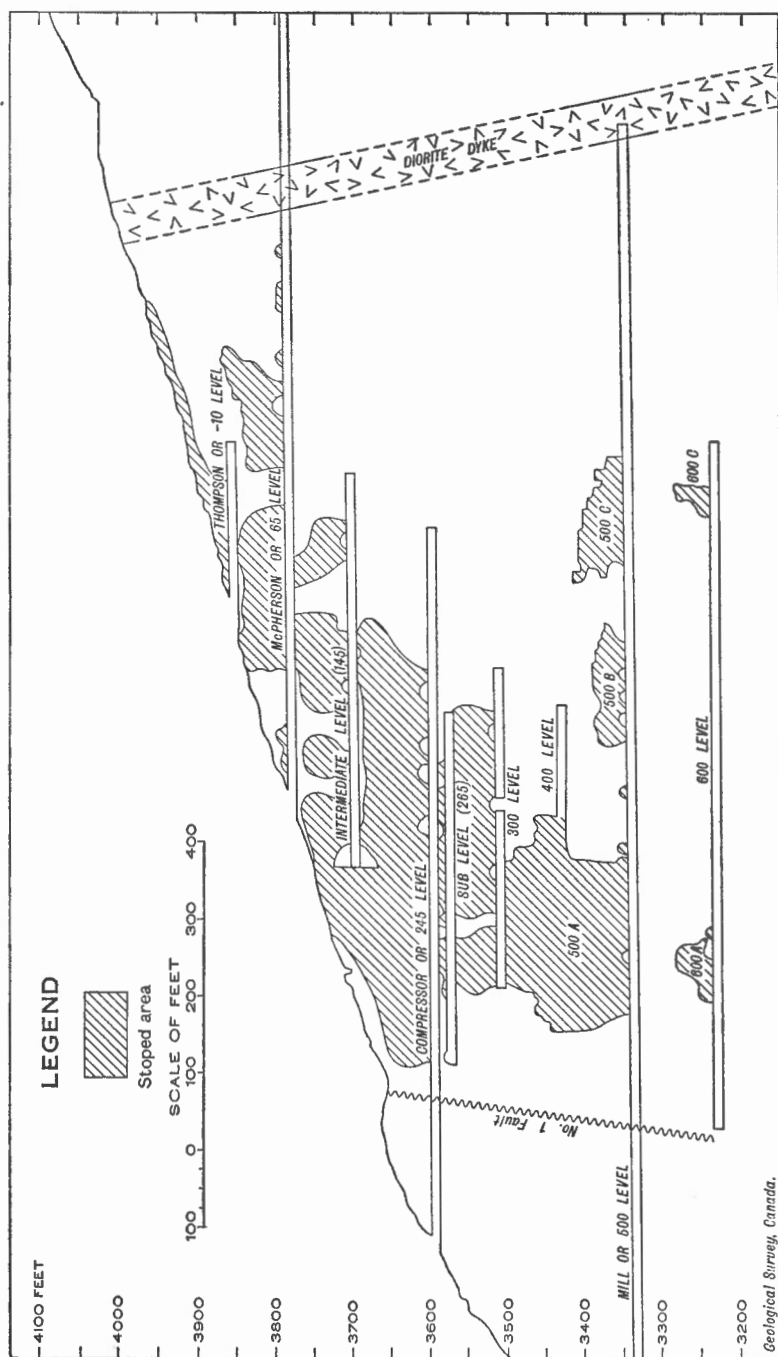


Figure 10. Vertical section along Henderson vein-lode, Duthie mine; showing stope areas.

In the old workings, the Henderson vein-lode was drifted on for 250 feet on the Thompson level, 1,450 feet on the 65 level, 500 feet on the 145 level, 950 feet on the Compressor level, 425 feet on both the 300 and 400 levels, 1,250 feet on the Mill level, and about 900 feet on the 600 level. An extensive system of stopes extends from the 500 level through to the surface, and there are two small stopes on this vein-lode on the 600 level (See Figure 10). The silver-lead-zinc vein deposits were mined over a length of 1,050 feet at the surface and for 750 feet along the 500 level. The eastern boundary of the ore follows a line that plunges 70 degrees southwest from the upper end of the open stope above the Thompson level. The western boundary of the stoped areas follows a line plunging 77 degrees northeast so that, in longitudinal section (See Figure 10), this composite zone of ore shoots is seen to narrow at depth. Judging from mine assay plans, the ore mined ranged from 6 inches to 4 feet in width and assays exceeding 100 ounces of silver a ton were not uncommon over widths of 12 to 15 inches. A series of fifty-three samples taken at 5- or 6-foot intervals along the roof of stope 500A, 90 feet above the 500 level, over a length of 280 feet (March 1929), ranged from 7 to 48 inches in width and assayed from 4.6 to 1,120.4 ounces of silver a ton. The average width of the fifty-three samples was 20 inches, and the average grade was 106 ounces of silver a ton. A series of eighteen samples taken close to the present roof of stope 500C (September 1929), over a length of 100 feet, gave an average assay of 51.3 ounces of silver a ton across an average width of 9 inches. Below the 500 level, the vein-lode is narrower and values are lower. According to mine assay plans, a series of fifteen samples from stope 600A, taken 30 feet above the floor of the 600 level (December 1929), ranged from 4 to 10 inches in width and assayed from 4.2 to 230.6 ounces of silver a ton. The average width of the fifteen samples was 6.2 inches and the average grade 76.2 ounces of silver a ton. The plans show that the vein-lode in 600C stope also averaged about 6 inches in width, but that the veins assayed less than 20 ounces of silver a ton.

Near the portal of the McPherson adit, the Henderson vein-lode includes seven parallel fissures spaced across a width of 4 feet. The rhyolite wall-rock is greatly fractured between these fissures, and in one zone is brecciated across a width of from 2 to 12 inches. The brecciated rock fragments in this zone are cemented by vein quartz, sphalerite, arsenopyrite, galena, tetrahedrite, pyrite, and chalcopyrite. Sulphide veins composed of similar minerals occur along the other fissures. These veins range from $\frac{1}{2}$ inch to 6 inches in width, and average about 1 inch or 2 inches. This condition is characteristic of small ore shoots seen elsewhere along the Henderson and Fault Plane vein-lodes and probably also applies to much of the ore mined from these lodes.

As the diorite dyke is approached on the McPherson level, the Henderson vein-lode narrows. Individual fissures unite to form two or three tight fractures, and there are no cross fractures and no sulphide-bearing veins. On the northeast side of the dyke, the lode is offset for possibly 10 feet to the southeast by a cross fault that lies close to the dyke. From the dyke northeast to the face of the drift, the vein-lode is well defined. For 200 feet northeast of the dyke there is a single strong fracture along which the rhyolite is replaced across widths of from 2 to 6 inches by quartz, arsenopyrite, sphalerite, and pyrite. A shattered zone 25 feet long, ranging from

1 foot to 2 feet in width, occurs 240 feet northeast of the dyke. Brecciated rock fragments from 1 inch to 6 inches in diameter are cemented by sphalerite, arsenopyrite, and vein quartz, with a little galena and tetrahedrite. Four hundred feet northeast of the dyke a strong fissured zone, evidently the Ashman vein-lode, joins the Henderson vein-lode from the northwest. At the junction of these two fissured zones, the rhyolite is highly fractured and silicified for a length of 20 feet and across a width of from 2 to 10 feet. The silicified rock is traversed by a network of sphalerite and arsenopyrite stringers, so that the mineralized zone contains about 10 per cent of these sulphides. From 50 to 130 feet northeast of the junction of the two vein-lodes, vein matter consisting largely of sphalerite, arsenopyrite, and vein quartz, with a little galena, tetrahedrite, and pyrite, forms the matrix of a shattered zone of rhyolite, from 1 foot to 3 feet wide, composed of small, angular fragments. From 25 to 50 per cent of the lode consists of sulphides, sphalerite being the predominant mineral. The ore is traversed by a few chalcedony veinlets up to 1 inch in width and by a few banded, chalcedony veinlets up to 2 inches wide. Recent work (1952) by Sil-Van Consolidated Mining and Milling Company Limited has shown that other ore shoots occur farther northeast in the newly driven part of the McPherson or 3,800 level. A recently discovered ore shoot there has a developed length of 115 feet, an average width of 4.35 feet, and a grade of: gold, 0.02 ounce a ton; silver, 4.0 ounces a ton; lead, 3.0 per cent; and zinc, 14.9 per cent. Five other shoots on this level are reported to carry ore of similar grade.

On the 500 level, the northeast drift along the Henderson vein-lode ends 20 feet within the diorite dyke. For 400 feet along the drift to the dyke the vein-lode consists of two or more parallel fissures, which here and there contain veins less than 4 inches wide. A fault, striking southeast, crosses the drift at the rhyolite and diorite dyke contact and appears to have offset the vein-lode to the southeast. The lode probably continues through and beyond the dyke, as it did on the McPherson level.

The Ashman vein-lode has been driven on for 210 feet on the McPherson (65) level, 247 feet on the Compressor (245) level, 425 feet on the Mill (500) level, and 100 feet on the 600 level. On the 65 level there are two small stopes in the roof, each about 40 feet long and 20 feet high. No remaining ore was noted. A lamprophyre dyke, from 2 to 10 feet wide, partly follows the vein-lode on this level and extends down along the vein-lode to the Compressor and Mill levels. At the southwest face (65 level) a lamprophyre dyke, 2 feet wide, dips 70 degrees northwest, and is in contact along its hanging-wall with 12 inches of sheared rhyolite. The rhyolite is traversed by numerous small calcite stringers, which carry a little pyrite and sphalerite. At the northeast face of the same level, a lamprophyre dyke 7 feet wide is cut by several vertical fissures, but no veins occur along them. Southeast of the dyke the rhyolite is fissured across a width of 1 foot and contains numerous small veinlets of sphalerite with a little galena and tetrahedrite. This vein zone dips to the southeast at 60 degrees. On the Compressor level, the Ashman lode was stoped to a height of 15 feet for a distance of 20 feet. Where the crosscut from the Henderson lode meets the Ashman lode on this level there is an 8-inch vein consisting of brecciated angular fragments of rhyolite cemented by grey quartz, sphalerite, and arsenopyrite. At the southwest face a sheared

zone 20 inches wide follows the contact of lamprophyre dyke and rhyolite. The dyke is bleached and partly replaced by carbonate, and the sheared rock contains about 1 per cent each of sphalerite, pyrite, and arsenopyrite. At the northeast face there are two fault fissures 6 feet apart dipping 50 degrees southeast, but neither carries any vein matter. From the 500 level a stoped zone 240 feet long extends from 50 to 100 feet upwards along the Ashman vein-lode. Mine assay plans disclose that this part of the vein-lode gave a high silver content, and some of the ore remains in the roof of the adit between the ore chutes. Eighty-five feet southwest of the cross-cut there are seven parallel fissures within a width of 5 feet. A lamprophyre dyke $3\frac{1}{2}$ feet wide follows along the back of the drift with rhyolite to the southeast. Both dyke and rhyolite are sliced, and for 8 to 12 inches along the contact the two rocks are highly fractured and brecciated, and the rock fragments are cemented by sphalerite, galena, and tetrahedrite, which constitute up to 75 per cent of the lode matter. The ore minerals are associated with a little quartz, carbonate, and pyrite. The parallel fissures in the lamprophyre contain small stringers and veins of these sulphides ranging from $\frac{1}{8}$ inch to 2 inches in width. At the southwest face of the drift (500 level) the fissuring is confined to a lamprophyre dyke 4 feet wide. Calcite stringers occur along three of the fissures, but no sulphides were seen. There is a sheared zone 1 foot wide in rhyolite at the northeast face, but it contains only barren calcite stringers. The Ashman vein on the 600 level was not examined as these workings were flooded.

On the surface, at the northeast end of the combined Henderson-Ashman vein-lodes, are two shallow shafts 140 feet apart (*See Figure 9*). The No. 1 shaft exposes 2 to 3 feet of fissured and altered dacite flow breccia largely replaced by sphalerite and arsenopyrite, with a little galena and tetrahedrite. The lode is not well exposed at the No. 2 shaft (elevation 4,445 feet), which is full of water but appears to be about 5 feet wide. A large pile of ore on the dump consists of altered flow breccia replaced by the same ore minerals as at the No. 1 shaft. Mine assay plans (1929) indicate that the ore from these shafts averaged about 0.3 ounce of gold a ton, with good values in zinc and a little silver and lead.

In 1951, the Sil-Van Consolidated Mining and Milling Company Limited reported an ore shoot 760 feet long and 2 feet wide outlined in the lower Hummingbird adit at an elevation of 4,100 feet. An ore shoot was also developed in the upper Hummingbird adit at elevation 4,250 feet. The No. 1 raise completed in 1952 from the 4,250 foot horizon showed continuous ore for a length of 160 feet, with an average width of 3.15 feet, and a grade of: gold, 0.165 ounce a ton; silver, 11.45 ounces a ton; lead, 8.4 per cent; and zinc, 13.4 per cent.

The Fault Plane vein-lode has been drifted on for 400 feet on the 300 level, for 620 feet on the 500 level, and for 360 feet on the 600 level. A steeply dipping branch vein from this lode is intersected on the 600 level between the shaft and the 360-foot drift. This vein, known as the Little Stranger, has been drifted on for 80 feet. There are three stopes on the Fault Plane vein-lode, two above the 500 level and one above the 300 level. Where seen on the 500 level, this vein-lode contains from two to seven parallel fissures across widths of from 1 foot to 3 feet. There is, however, very little brecciation of the rhyolite and tuff beds, and the vein deposits are narrow and few.

A small vein known as the Gerrard is intersected by a crosscut 75 feet north of the Ashman vein on the 500 level. Along a 50-foot drift it averages 3 inches in width and consists of carbonate with a little quartz, arsenopyrite, and sphalerite.

Another vein-lode known as the Gill is exposed in an open-cut at elevation 3,925 feet, 300 feet east of the Thompson portal, where there are five vertical fissures spaced a foot apart with vein fillings from 1 inch to 3 inches wide occupying the outside fissures. The veins consist of quartz and carbonate with considerable sphalerite and a little arsenopyrite. The continuity of the lode has not yet been determined.

Vein quartz seems to have been deposited throughout the period of mineralization of the Ashman, Henderson, and Fault Plane vein-lodes. Of the metallic minerals, pyrite and arsenopyrite were introduced first and galena, sphalerite, tetrahedrite, ruby silver (pyrargyrite), and chalcopyrite followed. Deposition of carbonate, in the form of calcite, and rhodochrosite stringers and veins, in part preceded and in part followed the period of metallic mineralization.

The Dome vein-lode lies 1,300 to 1,400 feet southeast of the Henderson. It strikes north 65 degrees east, dips 75 to 85 degrees northwest, and is well defined for a distance of 700 feet, from the portal of a 200-foot adit, at elevation 4,150 feet, to an elevation of 4,350 feet. Below the adit, the lode splits into two fissured zones, which continue down the slope at a small angle to each other for a distance of several hundred feet. Southwest of the split the fissures carry occasional small veins, but none of importance was seen. At the adit, the vein-lode ranges from 7 feet at the portal to 3 feet in width at the face of the drift. Dacite flow breccia is sheeted by eight parallel fissures at the portal, but several of these join farther within the adit. The fissures contain sulphide veins up to 3 inches wide. The wall-rock is altered and partly replaced by sulphides, and cross fractures contain sulphide stringers. The ore minerals, in order of abundance, are arsenopyrite, sphalerite, pyrite, galena, chalcopyrite, and tetrahedrite. A little vein quartz is associated with these sulphides. Above the adit the rock is strongly fissured across widths ranging from 1 foot to 6 feet, and one or more sulphide veins ranging from 2 to 10 inches in width may be seen in each of the open-cuts up to an elevation of 4,350 feet. Farther northeast the vein-lode is concealed beneath a flat, grassy meadow. Parts of the Dome lode could supply a fair grade of silver-lead-zinc ore.

The horizontal component of movement along the Henderson fault zone is about 10 feet, as lamprophyre dykes are offset this amount to the left where they strike across this vein-lode. In the drifts along the Ashman and Fault Plane vein-lodes these dykes are offset only a few feet to the left. The Henderson vein-lode was obviously affected by stronger fault movements than were the Ashman or Fault Plane vein-lodes and is, consequently, marked by stronger slicing, sheeting, and brecciation than the others. These features are partly responsible for its having been the most productive at the mine. It follows that ore of just as good grade might be expected along the course of the combined Henderson-Ashman vein-lode now being explored by Sil-Van Consolidated Mining and Milling Company.

Jessie Group (64)

References: Ann. Repts., Minister of Mines, B.C.: 1927, p. 136; 1928, p. 162; 1933, p. 97.

The Jessie group is on the east slope of Hudson Bay Mountain on the spur between the forks of Simpson Creek. The property is about 5 miles by trail from Smithers. The Jessie cabin is on the north bank of the south fork of Simpson Creek at an elevation of 4,275 feet, and the prospect workings are a short distance above the cabin. The property was staked by L. S. McGill and associates in 1926. Jessie Gold Mines Limited, of Smithers, carried out some development work in 1932 and 1933.

At elevation 4,400 feet, an adit is driven westerly in finely crystalline rhyolite and andesite to prospect a mineralized zone that outcrops immediately above the portal. This zone exposes two principal mineralized fissures, one 12 feet above the other; both strike northerly, dip west at a low angle, and contain vein quartz and considerable pyrite, arsenopyrite, sphalerite, and galena. Some of the rock between these fissures is also fractured, and small sulphide veinlets occur along these minor fractures. Wherever the rock is fissured it is altered and bleached, probably by the action of hydrothermal solutions at the time of vein formation.

The two main veins are traced by strippings and open-cuts for about 400 feet in a northerly direction from the adit to an elevation of 4,500 feet. Their strike changes gradually north of the adit to due west and the dip is south at about 35 degrees. They also diverge from one another in a northerly direction and are about 30 feet apart 125 feet north from the portal of the adit. Where exposed 60 feet south of the portal, the fissured zone strikes south 45 degrees west and dips 35 degrees northwest. The fracture pattern appears, then, to be saucer-shaped with one saucer lying above the other.

In most places the sulphide-rich quartz veins range in width from 6 to 16 inches. A 10-inch channel sample collected across the vein 75 feet north of the adit, assayed: gold, 0.34 ounce a ton; silver, 3.21 ounces a ton; lead, 0.60 per cent; and zinc, 12.60 per cent. Some of the fractured rock adjoining the main veins also constitutes ore, particularly where the main fissures are joined by branches. A typical sample of ore from the dump at the portal of the adit, assayed: gold, 0.14 ounce a ton; silver, 4.86 ounces a ton; lead, 5.55 per cent; and zinc, 13.10 per cent.

Josie Claim (54)

The Josie claim is on the east shoulder of a cirque immediately east of the Van Anda claim of the Silver Creek group. A trail leads up to the workings from the lowest crosscut adit on the Silver Creek group.

At elevation 5,300 feet two parallel sulphide veins in andesite are prospected by an open-cut and a 6-foot adit. The veins are 20 inches apart and range from 1 inch to 8 inches in width. They are composed of sphalerite, pyrrhotite, and pyrite. The veins strike north 70 degrees east and dip 57 degrees southeast. They are covered by talus 10 feet west of the open-cut and pinch out 20 feet east of the cut.

Another sulphide vein outcrops 50 feet higher up the slope in similar andesitic rock. This vein is 50 feet long and averages 6 inches in width, but at the open-cut midway along its outcrop narrow mineralized fissures extend

over a maximum width of 3 feet. The vein strikes north 40 degrees east and dips 65 degrees southeast. It consists largely of dark, solid sphalerite with minor pyrrhotite and pyrite.

King Tut Group (77)

References: Ann. Repts., Minister of Mines, B.C.: 1924, p. 96; 1927, p. 136; 1928, p. 161.

The King Tut prospect is on the southwest slope of Hudson Bay Mountain, 7 miles west of Smithers and $\frac{3}{4}$ mile south of the Duthie mine. The vein and workings are on the west bank of a small creek about $\frac{1}{4}$ mile east from the motor road to Smithers. The property was owned by R. L. Gale, but is now open. In 1924, Milligan Brothers sank a 50-foot shaft on the vein and exposed it in several open-cuts. J. J. O'Brien and F. H. Taylor held an option in 1927 and 1928 and explored the vein from the creek level by a 350-foot crosscut and a 65-foot drift.

The claims are underlain by volcanic rocks, and in the vicinity of the workings rhyolite, andesite, tuff, and andesite flow breccia are the predominant types.

A sheared zone ranging from 1 foot to 4 feet in width has been traced by open-cuts and a 50-foot shaft for about 500 feet between elevations of 3,400 and 3,600 feet. It lies about 225 feet above the bed of a small mountain stream and runs parallel with the stream. The shearing strikes north 65 to 70 degrees east and dips from 70 degrees southeast to 70 degrees northwest. In general the sheared zone is very sparsely mineralized. The sheared rock, in most places rhyolite or andesite, is altered and bleached, but contains only a little pyrite, siderite, and arsenopyrite. On the dump at the shaft a few specimens of altered rhyolite were seen that carry up to 3 per cent sulphides, mostly sphalerite with a little galena and chalcopyrite associated with siderite stringers.

At elevation 3,200 feet a crosscut adit is driven north 24 degrees west for 350 feet from the bed of the mountain stream. The adit passes through 105 feet of tuff breccia and then enters a zone of rhyolite and andesitic flows. The contact of the flows and tuff breccia strikes north 40 degrees east and dips 35 degrees southeast. The sheared zone is intersected at 310 feet from the portal and is followed by a 65-foot drift to the northeast. It ranges from 1 foot to 2 feet wide in the drift and is very sparsely mineralized. In places it carries 1 or 2 per cent of arsenopyrite. A 12-inch channel sample taken across this vein at the intersection of the crosscut and drift assayed: gold, a trace; silver, 0.32 ounce a ton.

Last Chance Claim (49)

References: Ann. Repts., Minister of Mines, B.C.: 1918, p. 118; 1926, p. 131.

The Last Chance claim is on the north side of the pass at the head of Toboggan Creek, 8 miles northwest of Smithers. The workings are at an elevation of 5,150 feet, a few hundred feet above the tractor road to the Silver Creek group. The property was held for several years by O. Hanson and J. Sealey.

Several, small, irregular sulphide veins in andesite have been prospected by open-cuts and a short adit. The veins are composed largely of magnetite, with considerable pyrite and a little chalcopyrite.

Three of the sulphide veins are exposed in a shallow open-cut 60 feet long. They occupy fractures that strike from north 55 to north 70 degrees west and dip steeply north. One vein at the east end of the cut is 20 feet long and ranges from 1 inch to 12 inches in width. Near the west end of the cut, two veins lie parallel, one 20 feet long with an average width of 6 inches, the other 6 feet long and 3 inches wide. All three veins terminate against small cross faults. The andesite wall-rock is somewhat altered, but is only sparsely mineralized.

About 100 feet farther west another vein outcrop is exposed by a small open-cut. This vein is 30 feet long and ranges from 3 to 12 inches in width. It strikes north 55 degrees west and dips 85 degrees northeast. The vein consists of massive magnetite and pyrite cut by small chalcopyrite stringers. A selected sample of this vein, collected by D. Lay in 1926, assayed: gold, a trace; silver, 2 ounces a ton; copper, 2.5 per cent. At the foot of a bluff 20 feet below the vein outcrop, an adit driven 75 feet along a bearing of north 20 degrees east fails to disclose any mineralization of importance. A representative sample of a small amount of vein material collected from the dump assayed: gold, 0.02 ounce a ton; silver, 0.09 ounce a ton; copper 3.75 per cent; zinc, 0.16 per cent.

Mamie Group (73)

(Sil-Van Consolidated Mining and Milling Company Limited)

References: Ann. Repts., Minister of Mines, B.C.: 1917, p. 113; 1919, p. 103; 1921, p. 107; 1922, p. 107; 1923, p. 108; 1924, p. 96; 1934, p. C7; 1935, p. C35; 1950, p. 100; 1951, p. 112. B.C. Dept. of Mines, Bull. No. 1, 1932, p. 32. Geol. Surv., Canada: Sum. Rept. 1925, pt. A, p. 132; Ec. Geol. Ser. No. 4, 1927, p. 40.

The property is on the southwest slope of Hudson Bay Mountain, 7 miles due west of Smithers. It is reached by a branch trail half a mile in length from the Duthie mine camp, which is connected with Smithers by a 15-mile motor road. The Mamie group consists of the Myrtle, Iron King, Dome Extension, Florence, Evinrude, and Mamie claims. The Mamie "vein" outcrops on the last-named claim and extends northeasterly up the mountain towards the adjoining Evinrude claim.

Prior to 1919 the Mamie "vein" was developed by surface stripping, open-cuts, and a 20-foot shaft. An option was obtained in 1919 by J. R. Turner for J. F. Duthie, and early in 1920 an adit was driven 125 feet along the Mamie "vein" at elevation 4,427 feet. During 1922 the drift was continued to 165 feet and two winzes, 50 feet apart, were sunk to depths of 25 and 17 feet, respectively. An adit was started from the Henderson Creek gorge at elevation 3,840 feet, 587 feet below the upper adit. This adit, designed to intersect the Mamie vein 950 feet from the portal, was driven 200 feet before work ceased. During 1923 Duthie Mines started a new adit along the strike of the Mamie vein 154 feet below the upper adit. The Federal Mining and Smelting Company, which held a 55 per cent interest in Duthie holdings in 1934, continued this adit to about 660 feet to a position nearly below the No. 1 winze of the upper adit. In

1934, W. R. Wilson and Sons obtained an option. The upper adit was extended to a total length of 240 feet and some surface work was done. In 1941, J. J. Herman shipped 14 tons of ore from the mine to the Prince Rupert sampling plant. The lot returned: gold, 0.97 ounce a ton; silver, 4.10 ounces a ton; copper, 0.90 per cent; zinc, 11.20 per cent; and lead, nil. The property was acquired by Sil-Van Consolidated Mining and Milling Company Limited in 1950 together with the adjoining Henderson group (Duthie mine), Canary and Hummingbird claims, and the Victory and Coronado groups.

Massive, finely crystalline tuffs and andesite flow breccias containing fragments over an inch in diameter, form the country rock in the vicinity of the "vein". These rocks range from dark grey to light grey, and adjoining the "vein" have been altered and bleached.

The "vein" is a sheared zone carrying sphalerite and arsenopyrite with a little chalcopyrite and, rarely, some galena. Parts of the zone are brecciated and consist of small, angular rock fragments cemented and partly replaced by the sulphides.

The zone strikes north 65 degrees east and dips about 80 degrees southeast. It is exposed by stripping for 300 feet along its strike up an 18-degree slope between elevations of 4,444 and 4,540 feet. In this distance it ranges from 2 to 8 feet in width. At the lower end it carries more than 50 per cent of sulphides across 7 feet. About 120 feet northeast it consists of 12 inches of greyish white quartz containing 10 per cent of arsenopyrite with 3 feet of adjoining, sparsely mineralized, sheared, altered tuff. The zone at the 20-foot shaft (elevation 4,510 feet) contains from 25 to 30 per cent sulphides across 6½ feet. At the northeast end of the stripped section, the zone carries 15 to 20 per cent of arsenopyrite and sphalerite across 7½ feet.

The following assays are of samples collected and assayed by Duthie Mines, Limited, in 1930. A sample across 6.5 feet at the lower end of the stripped zone assayed: gold, 0.57 ounce a ton; silver, 2.40 ounces a ton; zinc, 9.5 per cent. A sample across 6.5 feet, taken 60 feet southwest of the shaft, assayed: gold, 0.24 ounce a ton; silver, 1.2 ounces a ton. At the shaft a sample across 3.5 feet assayed: gold, 0.50 ounce a ton; silver, 17.60 ounces a ton; zinc, 21.5 per cent. A sample across the remaining 3 feet assayed: gold, 0.24 ounce a ton; silver, 1.3 ounces a ton. At the northeast end of the stripped zone a sample across 7.5 feet assayed: gold, 0.27 ounce a ton; silver, 2.0 ounces a ton; zinc, 3.9 per cent.

The upper adit at elevation 4,427 feet follows the zone below the stripped section for 200 feet. The zone ranges from 6 feet in width at the No. 1 winze to 3.6 feet at the face of the drift. It contains up to 80 per cent arsenopyrite and sphalerite across several feet in the richest looking parts of the vein. At the face the zone carries 30 per cent sulphides across 2 feet and 5 per cent of sulphides across the remaining 20 inches. A 33-inch channel sample collected by the writer across the zone in the face assayed: gold, 0.98 ounce a ton; silver, 2.02 ounces a ton; zinc, 12.89 per cent. Samples collected at 5-foot intervals and assayed by the company, from near the No. 1 winze, gave: across 5.6 feet, 0.32 ounce of gold a ton; across 3.0 feet, 0.76 ounce of gold a ton; across 3.5 feet, 0.46 ounce of gold a ton; across 4 feet, 0.90 ounce of gold a ton.

The lower adit, at elevation 4,273 feet, follows the zone for 660 feet. On this level there are several, small, parallel zones over a width of 30 or 40 feet. In general the mineralization is weak in comparison with that in the upper adit. At 65 feet from the portal, a 24-foot crosscut to the northwest intersects a 2-foot sheared zone that carries an average of 5 per cent of sphalerite and arsenopyrite across 20 inches. Company assays for this part of the zone are as follows: across 3.5 feet, gold, 0.10 ounce a ton; across 0.5 foot, gold, 0.47 ounce a ton; silver, 16.4 ounces a ton; zinc, 11.2 per cent. This zone strikes north 75 degrees east and dips steeply. It is intersected again by the main adit drift 100 feet from the portal, and there passes into the east wall of the drift. About 40 feet farther along the drift a small fissure appears and is followed northeast for 400 feet. At 540 feet from the portal the drift turns east as a crosscut and the fissure runs into the north wall at the bend. For the greater part of the 400-foot stretch the fissure carries a vein filling of arsenopyrite and sphalerite ranging from 1 inch to 4 inches in width. For a distance of 100 feet, between 350 and 450 feet from the portal, the deposit is wider, consisting of a mineralized sheared zone ranging from 1 foot to 4 feet in width. According to company assays, twenty-one samples collected at 5-foot intervals along this section give a weighted average of 0.2 ounce of gold a ton across 1.58 feet.

From 540 to 600 feet from the portal, the drift runs east as a crosscut and from 600 to the face at 660 feet it runs northeast again, following three roughly parallel "veins". These "veins" lie 30 to 40 feet southeast of the fissure followed for 400 feet and may connect with the sheared zone that crosses the adit 100 feet from the portal. The three "veins" are 150 feet vertically below the rich sector of the main zone exposed in the southwest end of the upper adit. Presumably, they unite somewhere between the two levels to form the wider zone. Where visible for 60 feet along the drift and in short crosscuts, the three "veins" range from 1 inch to 10 inches in width and are well mineralized with arsenopyrite. Company assay plans show for a length of 35 feet from the face of the drift, 0.03 to 0.07 ounce of gold a ton across widths of 5 feet. These samples include several feet of barren rock.

The extent of the zone northeast of the 300-foot stripped section is not well known. Two open-cuts along the strike, 140 and 335 feet, respectively, northeast of the stripped section, are now slumped in and only small amounts of rusty, altered rock are visible on the dump. In a third cut, 70 feet farther along, there is a 3-foot wide sheared and silicified zone that carries 3 to 5 per cent of arsenopyrite associated with quartz. This sheared zone strikes north rather than northeast and dips steeply. Bedrock is visible in three trenches that lie between elevations of 4,650 and 4,700 feet, but in none of them is there evidence of the presence of the zone. In the bed of Henderson Creek 1,000 feet northeast of the stripped section there is a sheared zone, 4 feet wide, exposed for about 50 feet. The sheared rock is altered and bleached and contains narrow, sparsely mineralized lenses of quartz. In the northeast bank of the creek, one of these attains a width of 12 inches and carries up to 20 per cent of arsenopyrite and sphalerite with a little chalcopyrite. A 12-inch channel sample taken across it assayed: gold, 0.285 ounce a ton; silver, 1.01 ounces a ton; zinc, 5.74 per cent.

Other small exposures of vein materials occur farther northeast along the same general strike.

Since the writer's examination of this property in 1939 the new owners have extended both adits. By the close of 1951, some 807 feet of drifts and crosscuts had been run on the 4,427 level and 458 feet on the 4,273 level together with 395 feet of raises. At latest report (1952), some 61,000 tons of high-grade gold ore had been outlined.

Mammoth Claim (50)

The Mammoth claim is on the divide between Toboggan Creek and Silver Lake, at an elevation of 5,000 feet. It is on the south side of the new trail to the Silver Creek group above Schufer's camp.

A vein has been traced in volcanic rocks for 300 feet by four open-cuts. The vein strikes west and dips steeply south. At the most easterly cut the vein averages a foot in width and consists of pyrrhotite, arsenopyrite, and sphalerite, with a little galena. In the more westerly cuts the vein narrows to 4 inches and consists largely of quartz with considerable pyrite and a little chalcopyrite.

Matuss Group (55)

This property, owned by Joe Matuss, of Driftwood, is about 8 miles due northwest of Smithers, on the west side near the foot of the Toboggan Creek Glacier. A trail half a mile long leads southeast to the claim from Schufer Lake on the tractor road to the Silver Creek group.

At elevation 4,600 feet an adit has been driven 90 feet along a quartz-arsenopyrite vein that lies in a shear zone in massive andesites. The shear zone is exposed for 500 feet up a 35-degree slope and contains vein filling for most of this distance. The vein strikes southwest and dips from 50 to 70 degrees southeast. About 425 feet north of the adit the volcanic rocks are in sharp contact with shale, argillite, and greywacke. The volcanic rocks are hard, tough, and resistant, whereas the sediments are soft, characteristically rust stained, and weather into small slabs. The upper surface of the andesite beneath the sediments is smooth, but is irregular with depressions up to a foot in depth and anywhere from 5 to 25 feet in diameter. These are filled by fine argillite, which grades up into coarse greywacke composed largely of rounded grains of andesite. The greywacke is succeeded by dark slate. At the contact these formations strike west and dip 70 degrees north. Both the volcanic and sedimentary rocks are intruded by light-coloured quartz-albite porphyry dykes, most of which range from 4 to 10 feet in width and from 500 to 1,000 feet in length. One of these dykes, 7 feet in width, intersects the vein 15 feet from the portal of the adit. The dyke is clearly later than the fissuring.

At the portal of the adit the sheared zone ranges from 3 to 4 feet in width and contains a quartz-arsenopyrite vein 1 foot wide. The vein consists of about 40 per cent quartz and 60 per cent arsenopyrite. Other quartz-arsenopyrite stringers lie in both walls of the sheared zone. The vein narrows gradually within the adit, consisting of 7 inches of almost solid arsenopyrite 20 feet from the portal and 3 inches of arsenopyrite with quartz 35 feet from the portal. Where it narrows to 3 inches another

quartz-arsenopyrite vein, 6 inches wide, comes in along the hanging-wall side of the sheared zone. The latter vein maintains an average width of 6 inches for 50 feet to the face of the adit, and for this distance lies along the hanging-wall side of a sheared zone 15 inches wide. A 5-inch channel sample taken across the quartz-arsenopyrite vein 40 feet from the portal assayed: gold, 0.36 ounce a ton; silver, 0.05 ounce a ton.

In an open-cut at elevation 4,650 feet, the sheared zone is 4 feet wide with 12 inches on the hanging-wall side replaced by arsenopyrite. At the next open-cut, elevation 4,715 feet, the mineralization has changed. A lens consisting of black sphalerite and pyrrhotite cut by stringers of chalcopyrite occurs along the fissured zone. The lens is 30 feet long, with an average width of 6 inches. The andesite wall-rock is mineralized over a width of several feet on either side of the 30-foot lens by small stringers of similar sulphides. The bedrock is washed clean for 30 feet at elevation 4,800 feet, and there the sheared zone is 8 inches wide. A parallel sheared zone 6 inches wide lies 12 feet to the southeast. Both are well mineralized with arsenopyrite, but are leached and oxidized by surface weathering. In a natural exposure 100 feet farther up the slope there are three parallel sheared zones, 6 and 10 feet apart, respectively. They are each 3 inches in width and contain very little arsenopyrite.

Neepawa Group (71)

Reference: Ann. Rept., Minister of Mines, B.C., 1929, p. 163.

The Neepawa group is on the southwest slope of Hudson Bay Mountain northeast of the King Tut group and between elevations of 3,500 and 6,000 feet. Six claims were recorded here by L. S. McGill in 1929, namely, the Alice, Manitoba, New Neepawa, Nee, Pa, and Wa.

The main showing is a vein that has been traced for about 1,000 feet at an elevation of about 5,500 feet on the Alice claim. The vein strikes north 18 degrees east and dips westerly at 85 degrees. It is prospected in one place by an adit 36 feet long, at the face of which sheared volcanic rocks of the Hazelton group contain considerable arsenopyrite across a width of 3 feet. On the Manitoba claim, about 1,000 feet farther down the mountain slope, a trench has uncovered another vein of like strike and dip at an elevation of 5,040 feet. It is fairly well mineralized with sphalerite, arsenopyrite, and some galena. A sample of selected ore from the dump assayed: gold, 0.38 ounce a ton; silver, 3.8 ounces a ton; and zinc, 6.2 per cent.

On the Nee claim, about 2,000 feet farther down the slope, another vein showing is prospected at an elevation of 4,450 feet by a 20-foot shaft and an open-cut. This vein strikes north 15 degrees east. It is sparsely mineralized, but contains a larger percentage of galena than the upper showings.

Rio Grande Group (48)

References: Ann. Rept., Minister of Mines, B.C., 1934, p. C8. Geol. Surv., Canada, Paper 36-20, 1936, p. 103.

The Rio Grande group is on the south slope of Mount Evelyn on the north side of Toboggan Creek, 8 miles in a straight line northwest of Smithers. The property consists of eight Crown-granted claims, the Rio

Grande, Spondulix, Rico Aspen, Little Joe, Iron Dollar, Last Hope, Jumbo, and Big Hope Fraction. The lower workings are a few hundred feet from the Toboggan Creek trail.

During 1913, J. Sheedy and J. Fisher, original owners, shipped 2 tons of ore from the property to Granby smelter, which assayed: gold, \$2.50 a ton; silver 84.5 ounces a ton; copper, 7 per cent. A. C. Gardé secured an option on the claims in 1933, and the following year Rio Grande Syndicate was formed to develop the property. A camp was built at elevation 4,500 feet, a short adit was driven, and a little diamond drilling was done by Boyle Brothers. The claims now belong to the Fisher estate and to David Bird.

The claims blanket the south slope of Mount Evelyn from an elevation of 4,000 feet at Toboggan Creek up to the peak of the mountain at elevation 6,600 feet. The lower part of the valley is occupied by rusty weathering shale, sandstone, greywacke, and conglomerate beds, with a few thin seams of coal. At elevation 4,700 feet the sedimentary rocks are in contact with volcanic rocks that extend up the slope to the peak. At the contact the sedimentary rocks strike a little south of east and dip 40 degrees north, so that they underlie the volcanic rocks. The volcanic rocks are intruded by two granodiorite stocks. One of these forms the core of the highest peak of Mount Evelyn and the other extends down the slope for over 1,000 feet from the saddle east of the peak and easterly for 1 mile down the east shoulder of the mountain.

At elevation 4,600 feet an adit is driven north in the sedimentary rocks to their contact with the volcanic rocks and a short drift runs easterly along the contact. A 3-foot depth of water backed up by a cavein at the portal prevented examination of this adit during the 1938 season. On the dump there is a small amount of black shale traversed by fine pyrite seams. In an open-cut on the contact of the sediments with andesitic rocks 75 feet above the adit, there is much rusty oxidized rock impregnated with arsenopyrite and pyrite. Similar mineralization was noted in other cuts farther east along the contact. The cuts are largely caved, but mineralization was seen to extend over a width of at least 2 feet.

At elevation 5,150 feet, two narrow fissures in granodiorite are prospected by a short adit and two open-cuts. The fissures carry up to 2 inches of rusty cellular gouge, but contain no sulphides. A sheared zone 1 foot wide occurs in the granodiorite several hundred feet farther up the slope. In an open-cut at elevation 5,500 feet this sheared zone is rust stained and holds much chlorite, but is otherwise barren. Both the fissures and sheared zone strike north 30 degrees west and dip from 55 to 75 degrees southwest.

A narrow, mineralized zone has been followed down the southeast side of the peak of Mount Evelyn between elevations of 6,600 feet and 6,475 feet by a short adit and several open-cuts. The zone occurs in fine-grained granodiorite along a fault that strikes north 10 degrees west and dips 60 degrees southwest. It is narrow, rarely exceeding 2 inches in width, and in places pinches to a fraction of an inch. It consists of altered rock replaced by considerable tetrahedrite. This is evidently the occurrence from which 2 tons of ore was shipped in 1913.

Silver Creek Group (51)

References: Ann. Repts., Minister of Mines, B.C.: 1908, p. 64; 1913, p. 108; 1916, p. 123; 1917, p. 114; 1918, p. 118; 1919, p. 103; 1920, p. 90; 1926, p. 129; 1927, p. 137; 1935, p. C39. Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 139.

The Silver Creek group (See Figure 11, in pocket), owned by Peter Schufer of Smithers, B.C., is on the northwest slope of Hudson Bay Mountain 8 miles due northwest of Smithers. There are six claims in the group, Copper Queen, Iron Mask, Texado, Lily Fraction, Iron Vault, and Van Anda. The property is reached from Smithers by motor road and a 4-mile long tractor road that was improved during the 1938 season by the Department of Public Works. The tractor road extends from elevation 2,400 feet at Toboggan Creek to the mine workings at elevation 5,500 feet. The mine camp is at elevation 4,700 feet, at the head of Toboggan Creek.

The property was staked in 1908 by P. Schufer and L. Woods, following the discovery of pyrrhotite-sphalerite ore. Hudson Bay Mining Company bonded the group in 1910 and carried on development work until 1914. In 1917 the owners shipped 9,205 pounds of ore from a newly discovered deposit to the Trail smelter, which assayed: gold, 0.26 ounce a ton; silver, 246.1 ounces a ton; lead, 41.8 per cent; zinc, 18.8 per cent. The following year, a 30-ton carload of similar ore shipped to the Silver Standard mill for concentration averaged \$175 a ton gross in all values. British Canadian Silver Corporation, Limited, explored the silver-lead occurrence in 1926 with a 200-foot drift; W. R. Wilson and Sons carried out further work during 1935 and 1936. Sil-Van Consolidated Mining and Milling Company Limited purchased the property in 1950.

On the Iron Vault claim, dark green and purple andesites with some interbedded tuffs are separated from a series of greenish tuffs by a band of fossiliferous limestone. The green tuffs pass upwards to the south into a thick formation of purple tuffs. The tuffs are mostly fine grained and massive, but some beds are well laminated. These bedded rocks strike easterly and dip from vertical to 50 degrees north. The top of the series is believed to be to the south, so that where the dip is to the north or northeast the strata are overturned. These rocks are intruded by a stock of granodiorite outcropping at the south end of the Iron Mask claim and extending westerly across the Copper Queen and Lily Fraction claims. The stock ranges from 400 to 1,000 feet in width and approaches 3,000 feet in length. The granodiorite is cut by a lamprophyre dyke 30 feet wide and dipping at a low angle to the south.

The limestone band is cut off on the west by the granodiorite stock. It is followed by natural exposures and a series of cross trenches for 1,450 feet in an east to southeast direction to where it ends along a fissured zone near the top of a steep bluff at elevation 5,475 feet. The limestone formation is lenticular in outline, attaining a maximum width of 65 feet midway along its outcrop. Lens-shaped orebodies consisting of a pyrrhotite-sphalerite-pyrite replacement of limestone occur at intervals along the limestone horizon. The mineralization appears to be localized to zones where small faults pass into the limestone. Recrystallization and flowage have absorbed differential movement within the limestone, so that fissures do not penetrate this formation beyond a few feet. Consequently, the orebodies are commonly along the contact of the limestone. The orebodies are short and lenticular in surface outline, but may be pipe-shaped.

About 150 feet south of the easterly end of the main limestone band there is a smaller body of limestone lying on the south side of a fault. This mass is 60 feet wide where it borders the fault, but narrows and ends 300 feet to the southeast. Midway along its strike it splits and the south-east branch, ranging from 4 to 10 feet wide, runs down the north wall of a small, steep ravine for about 150 feet. This limestone body is believed to have formerly been an upward extension of the main limestone horizon, and to have been downfaulted to its present position. At the contact of the limestone with the fault there is a replacement orebody that resembles the pyrrhotite-sphalerite-pyrite type, but here the replacement minerals include galena, arsenopyrite, and chalcopyrite. Northeast of the limestone, where the wall-rocks along the fault are andesitic flows and interbedded tuffs, there is a calcite vein containing silver, lead, and zinc sulphides.

About 275 feet from the east end of the main limestone band there is an outcrop of solid sulphides along the south side of the limestone at its contact with green tuffs. The sulphide body is lenticular, 50 feet long, and with a maximum width of 15 feet. It consists of solid sulphides, there being about 40 per cent black sphalerite, 40 per cent pyrrhotite, and 10 per cent pyrite. A shallow shaft is sunk at the centre of the orebody and about 20 tons of ore from the shaft is stockpiled. A grab sample of this ore assayed: gold, 0.165 ounce a ton; silver, 1.30 ounces a ton; zinc, 17.43 per cent; nickel, none.

At distances of 30, 45, and 60 feet, respectively, east of the 50-foot sulphide lens trenches cut across the limestone disclose a heavily rusted, oxidized zone 10 feet wide. About 140 feet farther east, near the east end of the limestone band, there is an oxidized zone 12 feet wide exposed in an open-cut near the top of a steep bluff. The oxidized zone grades downward within a few feet to unmineralized limestone. It evidently is merely fragments of rocks cemented by limonite derived from oxidation of a nearby sulphide lens. A little farther down the steep slope the limestone pinches out abruptly, and from its tip a sheared zone continues down the slope. The sheared zone strikes east and dips 70 degrees north. At elevation 5,375 feet an adit is driven 125 feet along this sheared zone in andesitic rocks, but does not disclose any mineralization. The face of the adit is roughly 125 feet below the east tip of the main limestone horizon. If this adit is driven farther west it will doubtless enter the downward projection of the limestone band along which the sulphide lenses are found.

Other sulphide lenses are exposed in open-cuts along the north side of the limestone band at distances of 500, 650, 800, and 900 feet, respectively, west of the shaft. These occur along the north border of the limestone along small faults, both as fissure fillings and as replacements of the wall-rocks. The mineralization in the cut 500 feet west of the shaft is a replacement of the limestone. The mineralized rock is of irregular outline, averages 2 feet in width, and is exposed for about 30 feet. In the cut 150 feet farther west is a sulphide lens about 25 feet in length that has a maximum width of 7 feet. It consists largely of sphalerite and pyrite with minor amounts of pyrrhotite. A representative sample of the ore from this cut assayed: gold, 0.075 ounce a ton; silver, 1.45 ounces a ton; zinc, 12.94 per cent. The two most westerly pits are 90 feet apart and are sunk on the same body. It ranges from 2 to 5 feet in width in

these cuts and is well mineralized with pyrrhotite, sphalerite, and pyrite. It is a replacement of calcareous argillite along a sheared zone lying 6 feet south of the fossiliferous limestone.

At 100 feet north of the east end of the main limestone horizon, a 20-foot long trench is sunk on a sheared zone 2 feet wide in andesite. The sheared rock in the cut is lightly rust stained and is sparsely mineralized. The shear zone strikes east and dips 70 to 80 degrees south. West of the open-cut it runs into the limestone bed where its identity is lost. No mineralization was noted at the contact of this fissure with the limestone. East of the open-cut the sheared zone is exposed for 400 feet in a horizontal direction and 375 feet in a vertical direction down the face of a steep bluff. Where examined at the foot of the bluff, the shear zone is 6 inches wide and is replaced by a little pyrite. From a convenient point at elevation 5,150 feet, and 120 feet north of the vein outcrop at the foot of the bluff, a crosscut adit was driven 25 years ago to intersect the shear zone and explore the ground farther south. The adit is driven 345 feet in a southwest direction and the shear zone is intersected 150 feet from the portal. Here the shear zone is less than a foot wide and contains a sphalerite vein with a little pyrite ranging from 2 to 6 inches in width.

A calcite vein occurs along a fault in andesitic rocks between 70 and 150 feet south of the east end of the main limestone band. The vein consists of brecciated and sheared andesite cemented by calcite with various amounts of galena, sphalerite, tetrahedrite, arsenopyrite, and pyrite. It ranges from 6 to 18 inches in width and has been traced for 350 feet in a horizontal direction and 225 feet in a vertical direction by two adits and by open-cuts. Below an elevation of 5,425 feet the vein is covered by a steep talus slide. The fault in which the vein occurs has a marked vertical displacement. The fault has a curving strike, changing from south 80 degrees west to south 30 degrees west, and dips from 55 to 65 degrees southeast. At elevation 5,650 feet the fault is bordered on the south by a body of limestone 50 feet in width. The limestone has been heavily replaced along the fault by massive sulphides to form a body of lenticular outline measuring 30 feet long and 15 feet wide. The sulphides are present in the following order of abundance: pyrite, sphalerite, galena, arsenopyrite, pyrrhotite, and chalcopyrite. Southwest of the limestone body the fault is somewhat split up, but none of the branches contains any vein filling nor shows evidence of mineralization. At elevation 5,525 feet, an adit drift follows the calcite vein for 235 feet in a southwest direction. The limestone body is encountered 200 feet from the portal and continues along the south side of the vein fissure for 30 feet. The limestone is replaced by sulphides along the fault as at the surface 125 feet above. The percentage of sulphides present varies considerably from place to place, ranging from 3 or 4 per cent up to 95 per cent of the mass. In general sphalerite is the predominant mineral, and is accompanied by small amounts of galena, arsenopyrite, pyrite, pyrrhotite, and chalcopyrite. The heaviest mineralization occurs east from the fault, along the east edge of the limestone body. A 20-foot crosscut driven southeast along this contact, with a 10-foot winze sunk from the end of it, discloses continuous mineralization with several irregular-shaped replacements of almost solid sulphides. A representative sample of the ore, containing about 10 per cent of sulphides, collected at

the intersection of the drift and the 20-foot crosscut, assayed: gold, 0.01 ounce a ton; silver, 6.29 ounces a ton; lead, 2.04 per cent; zinc, 3.50 per cent.

Along the main drift the fissure vein ranges from 4 inches to 3 feet in width and shows wide variation in its mineral content. Near the portal it is 3 feet wide, consisting of brecciated andesite cemented by calcite, but containing no sulphides. At 25 feet from the portal it is mineralized with arsenopyrite over a width of 11 inches. At 40 feet from the portal the vein consists of 4 inches of solid sulphides, largely sphalerite with some galena, arsenopyrite, and tetrahedrite. From there to the limestone replacement orebody the vein ranges up to 3 feet in width, but in most places contains only small veinlets and replacements of sulphides. West of the limestone the vein pinches and it is barren at the face of the drift.

At elevation 5,445 feet an adit is driven 46 feet along the silver-lead vein. For 20 feet from the portal the vein ranges from 6 to 12 inches in width. It consists of brecciated andesite cemented by calcite and contains about 3 per cent of galena with a little pyrite and arsenopyrite. Beyond 20 feet the vein splits and the adit follows the smaller of the two branches. This branch narrows to 3 inches towards the face and is only sparsely mineralized. The vein is exposed for about 25 feet below the adit down the face of a steep bluff and then disappears under a long talus slide. Immediately above the talus, the vein consists of 6 inches of sheared andesite replaced by about 5 per cent of arsenopyrite. A 6-inch channel sample of this material assayed: gold, 0.12 ounce a ton; silver, 36.89 ounces a ton.

On the southeast part of the Copper Queen claim there is a mineralized sheared zone in the granodiorite stock. The vein strikes north 80 degrees east and dips 83 degrees north. It ranges from 2 to 4 feet in width and can be seen to continue along the surface for about 200 feet. The sheared and altered rock is traversed by small sulphide stringers and seams consisting of pyrite, arsenopyrite, and pyrrhotite. A 12-inch channel sample taken across the central part of the vein at the portal of the adit assayed: gold, 0.15 ounce a ton; silver, 2.86 ounces a ton.

A fault lies along the north side of the granodiorite stock at its contact with volcanic rocks, which outcrop on the north side of the pass. The fault strikes east and dips 70 degrees south. It is best exposed in an open-cut at elevation 5,000 feet, where there is 3 feet of sheared, rusted, altered rock. Elsewhere the fault is concealed by drift.

Silver Lake Group (52)

References: Ann. Repts., Minister of Mines, B.C.: 1917, p. 124; 1926, p. 130; 1927, p. 137; 1928, p. 164; 1929, p. 165; 1931, p. 73; 1933, p. 98; 1934, p. C6.

The Silver Lake group, owned by Peter Schufer of Smithers, is 8 miles due northwest of Smithers on the northwest shoulder of Hudson Bay Mountain. There are seven claims in the group, the Silver Lake No. 1, Silver Lake No. 2, Silver Lake No. 3, Bee, Cee, A Fraction, and Second Glacier. The principal mineral occurrences are on a plateau between elevations of 6,500 and 7,000 feet. The claims are due south of the Silver Creek group, from which they are reached by switchback pack-trail. A tractor road 4 miles long connects the latter property with the road to Lake Kathryn and Smithers near the foot of the mountain.

The property was located under the title of White Heather group by Frank Martin a few years prior to 1916, and a few tons of hand-sorted silver-copper ore were shipped at that time. L. S. McGill and P. Schufer restaked in 1926, and prospected several newly discovered silver-lead veins during the next few years. W. R. Wilson and Sons held an option on the property for several years commencing in 1929, and carried out considerable prospecting work by digging numerous open-cuts through the shallow covering of rock debris and by driving a short adit. The property was acquired by Sil-Van Consolidated Mining and Milling Company, Limited, in 1951.

The claims are underlain by red and green tuff, red breccia, and andesite flows. A banded limestone bed 6 feet thick is interbedded with the tuffs. These strike southeast and dip steeply north.

At elevation 6,400 feet an adit has been driven 110 feet south 14 degrees east in massive, poorly bedded, red tuff. The adit follows a tight fault fissure for 50 feet, but discloses no mineralization. The fault strikes south and dips vertically. In a large cut on the surface 40 feet above and 25 feet east of the face of the adit a small, irregular, sheared zone is exposed. It ranges from 1 inch to 4 inches in width and is traversed by stringers and veinlets of bornite. Its length does not exceed 100 feet. A few tons of ore were shipped from this cut in 1916, of which a representative sample collected at the time by Mr. Galloway assayed: gold, 0.45 ounce a ton; silver, 120.1 ounces a ton; copper, 47.8 per cent.

Commencing a few hundred feet farther south, above elevation 6,500 feet, is a gently rising flat some 3,000 feet in length from east to west and 1,500 feet wide from north to south. A well-built cabin stands on the north rim of the flat at elevation 6,450 feet. Over most of the flat the bedrock is concealed by a shallow covering of disintegrated rock. Several veins have been discovered south and southeast of the cabin by sinking test pits on the site of disintegrated vein material. In an open-cut some 500 feet south of the cabin, a galena vein occurs along a fault fissure striking south 50 degrees east and dipping 60 degrees northeast. The vein contains up to 5 per cent of chalcopyrite associated with solid galena. It ranges from 1 inch to 3 inches in width. Other open-cuts sunk at intervals for over 400 feet along the strike of the vein disclose a persistent fault fissure with a variable mineral content. In many of the cuts the fault fissure is narrow and contains very little or no vein filling. In a cut at elevation 6,700 feet a vein is exposed for 15 feet. The vein ranges from 3 to 12 inches in width, and consists of solid, coarsely crystalline galena with less than 1 per cent of chalcopyrite. A representative sample taken from a ton of the ore piled beside the cut assayed: gold, 0.10 ounce a ton; silver, 102.55 ounces a ton; lead, 83.58 per cent.

On the north rim of the flat 1,000 feet east of the cabin, a sheared zone in fine-grained andesite is exposed for 300 feet by five open-cuts. It strikes from east to south 60 degrees east and the dip ranges from vertical to 70 degrees south. In the west trench, at elevation 6,600 feet, the sheared zone is barren. In a large cut 50 feet farther east the sheared zone is 6 feet wide and there are three sulphide veins, two of them 12 inches wide and the other 3 inches wide, separated by 3 feet and 1 foot of barren rock, respectively. The vein filling consists of roughly equal parts of solid galena and dark sphalerite with a little chalcopyrite. A representative sample of this

ore assayed: gold, 0.24 ounce a ton; silver, 33.51 ounces a ton; lead, 26.21 per cent; zinc, 28.45 per cent; copper, 0.74 per cent. In the next cut, 60 feet farther east, there is a single, sparsely mineralized shear zone. In the fourth cut, 70 feet farther east, there is a sulphide vein, 2 inches wide, composed of sphalerite and galena with a little chalcopyrite. A similar vein ranging from 6 to 8 inches in width is exposed in a fifth open-cut, about 100 feet farther east. Here dark sphalerite is the more abundant mineral and it is accompanied by a little carbonate gangue.

Several other smaller veins are exposed in open-cuts in either andesitic or tuffaceous volcanic rocks near the centre of the flat.

Smithers Copper Group (68)

References: Ann. Repts., Minister of Mines, B.C.: 1926, p. 131; 1929, p. 165; 1930, p. 140.

The Pine Ridge group of four claims was staked by H. C. Wade in 1926 on the southeast slope of Hudson Bay Mountain about $1\frac{1}{2}$ miles from Smithers and a short distance north of the Canadian Citizen prospect. R. C. Mutch, S. F. Campbell, and G. E. Loveless restaked the property in 1929 and named it the Smithers Copper group. This ground was open in 1951.

Purple andesites of the Hazelton group are here sparsely mineralized with chalcopyrite, bornite, malachite, and azurite in several open-cuts at an elevation of 1,975 feet. The mineralization follows joint planes and poorly developed lines of cleavage in the andesites. An adit driven 90 feet below the open-cuts to trace the extent of mineralization failed to find anything of importance. The adit is 145 feet long on a bearing of north 55 degrees west. About 150 feet west of this adit and 190 feet vertically above it, copper mineralization is in evidence in a 20-foot adit where the andesite is sheared across a width of 6 feet. A sample composed of pieces of selected mineralized rock from the various exposures assayed: gold, a trace; silver, 3.6 ounces a ton; and copper, 1.8 per cent.

Snowshoe Group (65)

References: Ann. Repts., Minister of Mines, B.C.: 1928, p. 162; 1937, p. C19.

The Snowshoe group is on the southeast slope of Hudson Bay Mountain, near timber-line, about $\frac{3}{4}$ mile south of Simpson Creek. It is situated about $5\frac{1}{2}$ miles from Smithers, and is reached by following the Simpson Creek trail for 4 miles to a trail that branches westerly for $\frac{1}{2}$ mile and leads to the Snowshoe cabin at elevation 4,485 feet. The Snowshoe claims were staked in 1928 by G. Raymond, P. Berg, and H. C. Wade. R. C. Mutch, A. Sjolín, and H. Stork held an option on the property in 1937.

A mineralized shear zone has been traced by two adits and a dozen open-cuts for 700 feet along the gentle mountain slope between elevations of 4,475 and 4,500 feet at the foot of steep bluffs of Jurassic volcanic rocks. The shear zone strikes north 25 degrees west and dips 35 to 45 degrees southwest. The andesitic wall-rocks have been hydrothermally altered and bleached, and in places are silicified and impregnated with a little pyrite. Quartz and sulphide veins occur along the shear zone, but are generally less than 6 inches wide. The sulphide content consists largely of galena, sphalerite, arsenopyrite, and pyrite.

A grab sample of some of the best looking ore, collected by Douglas Lay (1937) from a 3-ton pile of hand-sorted ore, assayed: gold, 0.16 ounce a ton; silver, 173.7 ounces a ton; copper, 0.1 per cent; lead, 21 per cent; and zinc, 8.9 per cent. Another sample obtained by Lay from an ore heap at the portal of the main adit assayed: gold, 0.01 ounce a ton; silver, 48.5 ounces a ton; lead, 9.3 per cent; and zinc, 17.3 per cent.

Trade Dollar Group (53)

References: Ann. Repts., Minister of Mines, B.C.: 1928, p. 164; 1931, p. 73.

The Trade Dollar group of four claims was staked by Angus Chisholm, Alexander Chisholm, and E. Hassard in 1928 to cover the upper part of the elevated plateau of Hudson Bay Mountain, between elevations of 6,500 and 6,800 feet, about a mile southeast of Lower Silver Lake. These claims adjoin the Silver Lake claims, which lie to the north and east on the same plateau.

The following description is by Douglas Lay from the Annual Report of the Minister of Mines, British Columbia, for 1928.

"On the *Trade Dollar*, at elevation 6,650 feet, a shaft sunk 8 feet deep exposes a vein 34 inches in width, of which a width of 30 inches is remarkably clean galena, under an oxidized capping a few inches in thickness. This vein strikes N. 85° W. (mag.) and dips north-east at about 75°. A sample taken across 2.5 feet assayed: Gold, 0.14 oz. to the ton; silver, 90 ozs. to the ton; lead, 64 per cent; zinc, 0.2 per cent. A sample of the oxidized capping assayed: Gold, 0.34 oz. to the ton; silver, 57 ozs. to the ton; lead, 36 per cent. About 135 feet north-west of this point in the direction of the strike, and about 25 feet below the collar of the shaft, some galena-float shows in the debris. This shaft is close to the south-western boundary-line of the *Silver Lake No. 2* claim and the north-western continuation of this vein probably enters this claim.

"At the precipitous western edge of this plateau, at the upper edge of Loring basin, there is exposed a mineralized band of rock about 20 feet in width, which strikes N. 45° E. (mag.) and dips at 65° south-east. This shows at the upper edge of Loring basin a good mineralization of chalcopyrite. What is apparently the continuation of this mineralized band can be traced across the plateau and possibly extends to the upper edge of the Big Toboggan glacier. This band is about 1,000 feet or so south of the shaft previously mentioned."

Trixie Claim (45)

Reference: Ann. Rept., Minister of Mines, B.C., 1926, p. 131.

The Trixie prospect is on the northeast slope of Hudson Bay Mountain on an unnamed creek that flows into Toboggan Lake about a mile from Evelyn station. It was staked by F. Castell in 1926. The showing is described by Douglas Lay in the report listed above as follows:

"... A very feeble mineralization, showing slight copper stains occurring in decomposed sheared andesite, is exposed on the east bank of the creek for about 200 feet at an elevation of 2,105 feet. A sample of the more promising portion showed no values. A piece of siderite taken from another place was found to contain 10 per cent zinc and 3 per cent manganese, these two metals existing presumably as carbonate."

Vancouver Group (61)

References: Ann. Repts., Minister of Mines, B.C.: 1916, p. 122; 1926, p. 132.

The Vancouver group of four claims is on the lower east slope of Hudson Bay Mountain along Simpson Creek about 2 miles southwest of Lake Kathlyn. The property was first staked about 1914 by the Jennings

Brothers, and was known at that time as the Lone Star group. Fred Castell of Smithers restaked the property in 1926 and held it up to the time of his recent death. The trail to the property was obstructed in 1949 by fallen timber, the result of a local whirlwind, for a mile along the route.

The claims are underlain by Jurassic volcanic rocks, mostly purple hued, finely crystalline andesite flows that are intercalated with beds of red tuff and red volcanic breccia. Some of the lavas are green, and a few contain amygdules of quartz and calcite.

A mineralized shear zone is prospected by two adits at an elevation of 2,400 feet, one on the north and one on the south side of Simpson Creek. In the adit on the south side of the creek the zone strikes south 50 degrees east and dips 65 degrees southwest. It is 2 to 4 feet wide for 75 feet from the portal, and includes several parallel fissures. Between 75 and 140 feet from the portal these diverge to lend the zone a maximum width of about 18 feet, and from there converge to a more normal overall width of 4 feet at the face of the adit, 160 feet from the portal. Red andesite and red tuff beds that form the country rock are bleached to a greyish colour along the shear zone, and this altered rock is traversed by many sulphide stringers and veinlets, most of which are less than $\frac{1}{4}$ inch wide, with one lenticular vein increasing to 6 inches at 100 feet from the portal. The sulphide veins and veinlets are composed of sphalerite, galena, pyrite, and chalcopyrite. There is an insufficient concentration of sulphide along the course of the shear zone to afford a large, low-grade ore-body, but small shoots of ore grade are present along the zone. A representative sample of 2 or 3 tons of ore, collected by the writer from the dump at the portal, assayed: gold, 0.015 ounce a ton; silver, 7.65 ounces a ton; lead, 9.30 per cent; and zinc, 7.88 per cent.

In the adit on the north side of the creek the shear zone was intersected at 25 feet from the portal and is 12 inches wide. At 32 feet from the portal a 2-inch calcite vein was encountered and followed for 22 feet.

Another adit is driven towards the shear zone on the north side of the stream at a lower elevation. It was not examined by the writer but, according to the Annual Report of the Minister of Mines for British Columbia for 1916, was driven 150 feet by Jennings Brothers.

Victory Group (74)

References: Ann. Repts., Minister of Mines, B.C.: 1908, p. 64; 1911, p. 116; 1914, p. 216; 1917, p. 113; 1918, p. 118; 1919, p. 102; 1922, p. 111; 1923, p. 109; 1925, p. 136; 1927, p. 136; 1928, p. 161; 1930, p. 240. Geol. Surv., Canada, Sum. Repts.: 1908, p. 44; 1925, pt. A, p. 134. B.C. Dept. of Mines, Bull. No. 1, 1932, p. 53.

The Victory, Triumph, and Standard claims, owned for many years by Mrs. D. C. Simpson of Smithers, are on the southwest slope of Hudson Bay Mountain, 8 miles due west or 18 miles west by good motor road from Smithers.

The claims were staked by D. C. Simpson about 1906 and development work was carried out each year until 1918, when a carload of silver-lead-zinc ore was shipped to the smelter. In 1919 the Skeena Mining and Milling Company was organized to develop both the Victory and

Coronado groups. The company commenced work on the latter property, but operations were soon suspended. In 1927 and 1928 the John J. O'Brien Company did considerable underground work, but later dropped their option. During 1938 and 1939 small shipments of hand-sorted silver-lead ore were sent to Prince Rupert. The largest shipment in 1939 weighed 3.854 tons and assayed: gold, 0.525 ounce a ton; silver, 34.50 ounces a ton; copper, 0.9 per cent; lead, 20.2 per cent; and zinc, 8.6 per cent. This property was purchased by the Sil-Van Consolidated Mining and Milling Company Limited in 1950.

Rhyolitic and andesitic flows and flow breccia, tuff, and breccia outcrop in the vicinity of the workings and form the wall-rocks of the mineral deposits, which are sulphide replacements and fissure fillings along sheared zones and faults. The sulphides present, in order of abundance, are as follows: arsenopyrite, galena, sphalerite, tetrahedrite, and chalcopyrite. The sheared wall-rock adjacent the deposits is bleached to a light yellow colour and is silicified. Fault striæ commonly plunge 25 to 30 degrees southwest. In the vicinity of the camp buildings and elsewhere below an elevation of 3,750 feet, the volcanic rocks are concealed by a shallow covering of sedimentary rocks, conglomerate, slates, and greywacke, which dip in a southerly direction down the slope of the mountain. The basal member of the sedimentary series, a conglomerate, contains abundant dark-coloured pebbles and small boulders of volcanic rock and exceeds 30 feet in thickness. The main mineral deposit may extend southwest into the sedimentary rocks as a 3-inch wide fissure that was seen along its strike 200 feet southwest of the portal of the main adit above the road.

The main mineralized zone is richest in galena, sphalerite, and tetrahedrite near the sedimentary rocks. This type of ore is most valuable for its silver content. Farther northeast and at higher elevations it contains much more arsenopyrite and only a little sphalerite and galena. This arsenopyrite-rich ore commonly carries considerable gold.

The Victory zone, the main zone, is prospected by four adits and a dozen open-cuts for 1,300 feet up a 27-degree slope between elevations of 3,750 feet and 4,350 feet, and is known to exceed 1,600 feet in length. It ranges from 1 inch to 6 feet wide, strikes northeast, and dips steeply. Below 3,950 feet it splits, but higher up it is a single zone of shearing.

There are 820 feet of drifting and crosscutting in the main adit at elevation 3,750 feet (barometer reading). For 100 feet northeast from the portal, the zone in the roof of the adit ranges from 2 to 15 inches in width. It consists of sheared and altered rhyolitic rock replaced by galena, sphalerite, tetrahedrite, and arsenopyrite. From the portal for 25 feet northeast, the roof is stoped out for 4 feet upwards, and at 70 feet from the portal there is a stope 10 feet long and 8 feet high. Between 100 and 260 feet from the portal the adit follows a very narrow, sparsely mineralized fissure. Then the adit runs east as a crosscut for 355 feet. At 180 feet along the crosscut a vein is intersected and was explored by 117 feet of drifting. This vein ranges from 2 to 8 inches in width, with an average of 4 inches of solid sulphides, of which arsenopyrite is dominant. This is believed to be the downward continuation of the main zone, and the one followed for 100 feet from the portal is presumably a branch from the main zone. A 4-inch channel sample taken across the zone in the roof of the adit, 50 feet from the portal, assayed: gold, 0.65 ounce a ton; silver, 6.52 ounces a

ton; lead, 3.42 per cent; zinc, 11.90 per cent. A 5-inch channel sample taken across the main zone from the roof of the drift, 30 feet northeast from the 355-foot crosscut, assayed: gold, 0.42 ounce a ton; silver, 14.64 ounces a ton; lead, 23.45 per cent; zinc, 13.36 per cent.

No. 2 adit at elevation 3,965 feet follows the main zone for 160 feet. There the zone ranges from 1 foot to 4 feet in width, and its mineral content is variable. At the portal there are two sulphide seams, each 2 to 4 inches wide, separated by 4 feet of altered, cross-fractured andesite with numerous, small sulphide stringers. The zone narrows gradually towards the northeast. At a distance of 25 feet from the portal, it is 18 inches wide and consists of at least 90 per cent sulphides, there being about equal proportions of galena, sphalerite, and arsenopyrite, with some tetrahedrite and a little chalcopyrite. An 18-inch channel sample taken across this part of the zone, 30 feet from the portal, assayed: gold, 0.16 ounce a ton; silver, 13.62 ounces a ton; lead, 23.20 per cent; zinc, 27.93 pr cent. Farther along the proportion of altered rock increases. At 75 feet from the portal the zone is 3 feet wide and carries only 3 to 5 per cent of sulphides. Twenty-five feet farther along it narrows to 18 inches and mineralization consists of scattered sulphide impregnation along both sides of a narrow fissure. The drift leaves the vein for the next 50 feet, but swings back across it for 10 feet at the face. Ten feet from the face the zone is 22 inches wide and carries up to 15 per cent of sulphides, chiefly arsenopyrite but with some small pockets of galena and sphalerite. A 22-inch channel sample taken across the deposit at this point assayed: gold, 0.045 ounce a ton; silver, 2.44 ounces a ton; lead, 2.78 per cent; zinc, 2.11 per cent. At the face the sheared zone is 33 inches wide and carries about 5 per cent of arsenopyrite and 1 per cent of sphalerite.

No. 3 adit at elevation 4,080 feet, 225 feet farther up the hill, is 22 feet long. At the face the zone consists of 3 feet of altered and sheared andesite with stringers and pockets of arsenopyrite with a little galena and sphalerite. In an open-cut 70 feet farther up the slope the zone is similarly mineralized across a width of 6 feet. About 90 feet farther, at elevation 4,165 feet, the zone is 24 inches wide and carries over 20 per cent of sulphides, about half of which is arsenopyrite and the remainder sphalerite with a little chalcopyrite. The No. 4 adit at elevation 4,207 feet follows the zone for 41 feet. For 30 feet from the portal the zone consists of altered, fractured andesite well mineralized with stringers and impregnations of arsenopyrite with very little galena or sphalerite. At the face, a fracture on the northwest side carries from 1 inch to 3 inches of arsenopyrite and another on the southeast side of the adit lies in the middle of a zone 12 inches wide that is impregnated with disseminated arsenopyrite. The intervening rock is largely barren.

The following assays are of samples collected by Duthie Mines prior to 1930. A 31-inch channel sample from the face of No. 3 adit assayed: gold, 0.20 ounce a ton; silver, 9.7 ounces a ton; lead, 7.4 per cent; zinc, 9.2 per cent. A 55-inch channel sample taken across the zone in the cut 70 feet above No. 3 adit assayed: gold, 0.13 ounce a ton; silver, 3.6 ounces a ton; lead, 0.4 per cent; zinc, 3.8 per cent. From the next open-cut, 160 feet up the slope from No. 3 adit, a 29-inch channel sample assayed: gold, 0.16 ounce a ton; silver, 1.8 ounces a ton; lead, 1.2 per cent; zinc, 3.2 per

cent. A 48-inch channel sample taken from the zone in the cut at the portal of No. 4 adit assayed: gold, 0.65 ounce a ton; silver, 7.4 ounces a ton; lead, 6.4 per cent; zinc, 1.1 per cent.

According to D. Lay¹, there is an ore shoot in the immediate vicinity of No. 4 adit, 60 feet long, 3.7 feet wide, assaying: gold, 0.44 ounce a ton; silver, 10.45 ounces a ton; lead, 7.10 per cent; zinc, 5.49 per cent.

In a cut 100 feet up the slope from No. 4 adit, the zone continues as a sparsely mineralized sheared zone 18 inches wide. At elevation 4,340 feet, 250 feet up the slope from No. 4 adit, the zone consists of 6 inches of sheared andesite with stringers of arsenopyrite. It is 50 feet farther to the last open-cut, beyond which the zone passes under a small basin and is concealed by drift for several hundred feet. In the last open-cut the silicified sheared zone is 18 inches wide and carries about 3 per cent of arsenopyrite with a sparse dissemination of galena and sphalerite. An 18-inch channel sample taken across the zone in this cut assayed: gold, 0.165 ounce a ton; silver, 2.10 ounces a ton.

Yukon Group (59)

References: Ann. Repts., Minister of Mines, B.C.: 1925, p. 136; 1928, p. 162; 1929, p. 164.

The Yukon group of eight claims is on the eastern slope of Hudson Bay Mountain on the north side of the north fork of Simpson Creek. The property was staked by H. D. Thompson and A. Chisholm in 1924, and considerable development work was done during the next 6 years. C. W. Hodgson of Vancouver was registered as owner of the group in 1951.

The rock is largely andesite, with some rhyolite and some intercalated tuff and greywacke beds, and these are intruded at an elevation of 5,000 feet by a fine- to medium-grained granite stock. A strong shear zone has been traced by open-cuts and short adits for more than 1,000 feet in a southeasterly direction from the south side of the stock into the volcanic rocks. The shear zone strikes south 45 to 60 degrees east and dips 60 to 75 degrees southwest. Near the granite contact, dark, sheared tuffs are impregnated with some sphalerite, arsenopyrite, pyrite, and chalcopyrite across a width of 2 feet. About 200 feet farther southeast the zone is 30 inches wide where it is well exposed in an open-cut 10 feet wide. A 30-inch channel sample collected across the vein in the open-cut, assayed: gold, 0.12 ounce a ton; zinc, 0.90 per cent. A sample collected from the shear zone across a width of 24 inches in a stripped zone near the granite assayed: gold, 0.05 ounce a ton; silver, 0.56 ounce a ton; zinc, 1.60 per cent; and copper, 0.21 per cent.

A quartz vein occurs along the shear zone for several hundred feet beginning a short distance southeasterly from the open-cut mentioned above. It ranges from 6 to 10 inches in width and contains abundant arsenopyrite, with minor pyrite and sphalerite. The wall-rock along the shear zone is altered and bleached to a pale yellow hue. A typical sample of the vein quartz and arsenopyrite assayed: gold, 0.20 ounce a ton.

¹ B.C. Department of Mines, Bull. No. 1, 1932, p. 53.

Another quartz vein is exposed in two open-cuts, 8 feet deep and 30 feet apart, at an elevation of 4,750 feet, and is intersected 100 feet farther south by a short adit. The vein ranges from 12 to 18 inches in width, and the quartz carries abundant arsenopyrite and a little sphalerite. A typical sample assayed: gold, 0.10 ounce a ton; zinc, 0.60 per cent.

Zeolitic Group (67)

The Zeolitic group of four Crown-granted claims is on the lower southeast slope of Hudson Bay Mountain just west of Smithers. This ground was staked by Joseph Kelly and Randolph Haigh about 1912.

The lower slopes of Hudson Bay Mountain west of Smithers railway station are composed of reddish brown amygdaloidal rhyolite flows. The rhyolite exhibits poorly developed flow structure that strikes north 40 degrees east and dips 25 degrees southeast. About 60 feet above the road that skirts the foot of the mountain an adit is driven 65 feet southwest along a narrow sheared zone in the rhyolite. The zone strikes south 45 degrees west and dips 75 degrees southeast. It is sparsely mineralized with pyrite and chalcopyrite.

Zobnic Group (66)

Reference: Ann. Rept., Minister of Mines, B.C., 1927, p. 137.

The Zobnic group of two claims was staked by Alexander Zobnic about 1925 on the southeast slope of Hudson Bay Mountain. The property is about 1½ miles from Smithers and only a few hundred yards above the Smithers to Simpson Creek basin trail.

At an elevation of 1,800 feet, a sparsely mineralized shear zone in andesite is prospected by a short adit. The zone strikes north 75 degrees west and dips 60 degrees southwest. It carries small amounts of galena, sphalerite, and pyrite. Two other mineralized shear zones striking north-west are exposed by stripping 30 feet and 100 feet respectively above the adit. Both show copper stains, and the latter carries some tetrahedrite. A selected sample from the upper zone assayed: gold, a trace; silver, 104 ounces a ton; and copper, 1.5 per cent.

COAL DEPOSITS

Cedar Creek Coal Area (23)

Reference: Ann. Rept., Minister of Mines, B.C., 1922, p. 114.

The Cedar Creek coal area lies about 8 miles west and 1 mile south of Hazelton. It is on the south side of Cedar Creek, a small tributary of the Skeena above the town of Hazelton. Claims were staked here by W. S. Sargent, A. R. McDonnell, and Angus Beaton in 1922.

Sandstones, shales, and carbonaceous shales of the Hazelton group are exposed in a ridge of low hills along the south bank of Cedar Creek. They have a general northerly strike and a gentle dip to the west. Several small coal seams are exposed by a small slide along the hillside fronting Cedar Creek, but at this point the enclosing beds are considerably crumpled and

faulted and the coal outcrops are disconnected and discontinuous. The only important showing is part of a coal seam, which has a width of from 3 to 4 feet but is faulted at both ends. The coal is soft and crumbly, is much slickensided, and has apparently been partly altered to graphite so that it is slow burning and difficult to ignite. Although this seam is not of economic importance it reflects the presence of a field where more valuable coal seams might be discovered by prospecting less deformed beds nearby.

Evelyn Coal Area (44)

Reference: Ann. Rept., Minister of Mines, B.C., 1929, p. 188.

In 1929, a coal lease was staked by W. A. McMaster and Axel Peterson on Lot 3290 on an easterly flowing tributary of Toboggan Creek. The coal exposures are about $1\frac{1}{4}$ miles west of the highway, or $\frac{3}{4}$ mile from Mile 13 on the Canadian National Railway (Mile 13 is 4 miles west of Evelyn station and 3 miles east of Doughty station). Coal seams up to 9 inches thick occur in feldspathic sandstones between elevations of 1,600 and 1,700 feet along the banks of the creek. The strata strike east and dip 45 to 65 degrees north. The coal seams occur in one place at closely spaced intervals, separated by seams of bone. A sample of coal collected by Douglas Lay (1929) from a cut 8 feet deep yielded the following analysis: moisture, 1.2 per cent; volatile-combustible matter, 22.2 per cent; fixed carbon, 50.4 per cent; and ash, 26.2 per cent.

Kispiox Coal Area (3)

References: Geol. Surv., Canada: Mem. 69, pp. 163-167; Sum. Repts.: 1909, p. 67; 1912, p. 89.

Coal seams and carbonaceous shales occur at many places along Skeena and Kispiox Rivers from their junction to 7 miles above it. This area is underlain by greywacke, shale, and conglomerate. Fossil plants collected from the coal-bearing beds show a range in age from Kootenay to Blairmore. The strata are highly disturbed, faulting and overturning being the rule rather than the exception. Numerous dykes and sills of granodiorite and porphyritic granodiorite intrude the sediments.

A 3-foot coal seam is exposed on the western bank of Kispiox River $5\frac{1}{2}$ miles above the junction. This seam occurs on the north limb of a faulted anticline. On the eastern bank of the Kispiox about $\frac{1}{4}$ mile farther upstream another coal seam, with a maximum width of 3 feet, is exposed. The coal in both seams is very impure and crushed. Local inhabitants have used coal from these seams in their forges.

Three, small, dirty, and crushed coal seams were observed along the west bank of Skeena River between Kispiox village and a point approximately 5 miles north. At this point two seams are exposed. Normally

they are 6 to 12 inches wide, but due to faulting and folding they form pockets that are much wider. In an open-cut 15 feet above the river, one seam has been squeezed at its junction with a fault so that now the coal forms a pocket 4 feet in width and 20 feet in length along the fault plane. In a second pit, 50 feet higher, the second seam is exposed. It has migrated under pressure to the crest of a small anticline where it forms a body 20 feet long, 10 feet wide, and at least 6 feet thick. The local inhabitants use the coal from these two seams in their forges. A representative sample of coal collected from the pit 15 feet above the river and analysed by the Fuel Testing Laboratories at Ottawa gave the following analysis:

	As received Per cent
Moisture	7.6
Ash	30.9
Volatile matter	19.0
Fixed carbon	42.5

According to the A.S.T.M. (American Society Testing Materials) classification, this coal ranks¹ as medium volatile bituminous.

Seven miles above the junction of Skeena and Kispiox Rivers, on the west bank of the Skeena, a slide has laid bare a face of rock 300 feet high. The sedimentary section exposed on this face is broken by a fault. The thickness of the section below the fault is approximately 400 feet and above approximately 600 feet. The lower 400 feet of the series contains three coal seams, 1.9, 0.6, and 1.3 feet thick, respectively, and the upper 600 feet of the series contains four seams, 1.4, 0.9, 0.6, and 1.3 feet thick, respectively. According to Malloch² three samples of coal from these seams gave the following analyses:

	—	Moisture	Volatile matter	Fixed carbon	Ash
		Per cent	Per cent	Per cent	Per cent
1	1.9-foot seam below the fault....	1.07	20.43	51.26	27.24
2	0.6- and 1.3-foot seams below the fault.....	1.19	10.33	64.77	23.71
3	1.4-, 0.9-, and 0.6-foot seams above the fault.....	2.10	11.32	68.34	18.24

The rank of samples 1 and 3 is medium volatile bituminous and sample 2 ranks as low volatile bituminous.

¹ See Standard specifications for classification of coals by rank and by grade and their application to Canadian Coals; National Research Council Report No. 814, 1939.

² Geol. Surv., Canada, Sum. Rept. 1912, p. 101.

Three coal seams are exposed on the east bank of Skeena River 2 to 3 miles above the mouth of Shegunia River. The writer did not examine these seams, but according to Leach (1909), they are, respectively, 2, 2.1, and 5.1 feet thick. Analyses of the two largest seams gave the following results:

—	Moisture	Volatile matter	Fixed carbon	Ash
	Per cent	Per cent	Per cent	Per cent
2.1-foot seam.....	1.42	18.76	58.20	21.62
5.1-foot seam.....	1.18	20.63	57.27	20.92

The rank is medium volatile bituminous.

Lake Kathlyn Coal Mine (58)

References: Ann. Repts., Minister of Mines, B.C.: 1917, p. 125; 1926, p. 161; 1932, p. 90; 1933, p. 113; 1934, p. G32; 1935, p. G27; 1936, p. G43. Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 119.

The Lake Kathlyn coal mine (*See* Figure 12, in pocket) is 5 miles northwest of Smithers on the southeast side of Glacier Gulch. The property is 2½ miles by good road west from Lake Kathlyn railway station. In 1917 the property was reported to consist of ten coal leases owned by Frank X. Frank of Smithers. In 1926, British Columbia Anthracite, Limited, leased the prospect and explored two coal seams by short adit drifts. Lake Kathlyn Anthracite Coal Company, Limited, carried on exploration work in 1932 and 1933 by driving a main crosscut adit over 400 feet. Between 1934 and 1936 intermittent work was carried on by Northwest Anthracite Syndicate, headed by Thomas Campbell. A small tonnage of coal was mined and marketed locally.

The coal seams occur in a series of sedimentary rocks consisting of black, carbonaceous shale, carbonaceous sandstone, argillite, greywacke, and sandstone, with one or more beds of pebble-conglomerate above the coal horizons. The sediments have all been hardened, the sandstones, in particular, being indurated almost to quartzite. Surface exposures of these rocks have a characteristic light rusty coloration through oxidation of a small content of finely disseminated sulphide. Some of the shaly beds are distinguished by the occurrence of occasional round or oval-shaped ironstone nodules averaging 1 inch in diameter. Ripple-marked strata are not uncommon. The sediments strike from south 45 to south 60 degrees east and dip from 50 to 60 degrees northeast.

Fossil plants were seen in several argillaceous beds close to the coal seams, and a few poorly preserved fossil shells were picked up on the talus slope above the main adit. The plants collected were identified by W. A. Bell as Lower Cretaceous, and possibly of about the same age as the flora of the lower part of the Blairmore group of Alberta.

On the south side of Glacier Gulch development work has disclosed the presence of about twenty coal seams at irregular intervals throughout a 600-foot column of stratified rock. The total thickness of the formation as exposed on this side of the gulch is a little over 1,000 feet, and the coal is confined to the lower 600 feet. Most of the coal seams range from 6 to 12 inches in width, but there are two seams with widths up to 4 feet and two others with widths of 18 inches and 24 inches, respectively. There has been considerable fault movement along many of the coal beds with resultant pulverization and squeezing of the coal, so that these seams are in many places found to pinch suddenly along their strike. A strong fault contact between the sedimentary series and the older underlying volcanic and sedimentary rocks of Jurassic age is exposed on both sides of Glacier Gulch immediately below the coal seams. The fault strikes northwesterly and dips to the northeast at angles varying from 45 to 70 degrees.

On the north side of Glacier Gulch there are four small coal seams within 100 feet of the contact of the sedimentary series and the older volcanic rocks. The fault contact between the two formations strikes northwest and dips from 60 to 70 degrees northeast. It is marked by a narrow ravine with walls rising steeply for 50 to 100 feet. The hard, volcanic rocks along the foot-wall side are slickensided and grooved with fault striæ. At elevation 2,950 feet a 25-foot shaft is sunk on a small silver-lead-zinc vein 20 feet southwest of the contact in the volcanics. Opposite the shaft and 20 feet northeast of the fault contact there is a 12-inch and an 8-inch coal seam separated by 16 inches of shale. A 12-inch and a 24-inch coal seam outcrop on a steep slope 60 and 100 feet, respectively, farther east. These coal seams have not been prospected.

On the south side of Glacier Gulch (*See Figure 12*) the main adit at elevation 2,450 feet is driven south as a crosscut for 475 feet to a drift on two coal seams. In the roof of the drift at the crosscut, a 28-inch coal seam is separated from a 9-inch coal seam by 27 inches of carbonaceous sandstone. The larger seam is sheared and thins eastward along its strike. At the face of the east drift, 135 feet easterly from the main crosscut, the larger seam has thinned out to 8 inches of soft, dirty coal with 8 inches of sandstone separating it from the parallel seam, which consists of 6 inches of soft, sheared coal. The drift to the west follows these two seams for 133 feet and then passes through 90 feet of loose slide rock to emerge as an air adit at the surface, 20 feet above the adit level. At 85 feet west along the drift from the crosscut the main seam is 17 inches thick, and 15 inches of shale separates it from the parallel seam, which is 12 inches thick. A small amount of stoping has been done on these two seams above the end of the main crosscut. In the main raise 30 feet above the drift level, the larger seam is 4 feet wide and the parallel seam 10 inches wide, with 30 inches of shale between them. The 10-inch seam consists of firm, dull black coal, whereas the larger seam is a soft, dirty, sheared coal. Channel samples 112

and 113, collected by the writer across these two seams, were analysed by the Fuel Testing Laboratories at Ottawa and gave the following results:

—	No. 112 10-inch seam As received	No. 113 4-foot seam As received
	Per cent	Per cent
Moisture.....	16.6	14.0
Ash.....	9.5	15.7
Volatile matter.....	4.1	5.4
Fixed carbon.....	69.8	64.9
Sulphur.....	0.1	.....
B.T.U. per lb. gross.....	10,200	.....

Samples 112 and 113 rank as anthracite coal.

About 60 feet above the drift level the raise follows the main seam, but does not break through to the smaller, parallel seam. The main seam is 40 inches wide there and consists of highly pulverized, soft, sheared coal with glistening, slickensided, intersection surfaces throughout its mass. This coal crumbles and soils the fingers readily on handling. It is probable that this part of the seam has been thickened through flowage under pressure. A channel sample (No. 111) taken by the writer across this part of the seam and analysed by the Fuel Testing Division at Ottawa gave:

	As received Per cent
Moisture.....	14.9
Ash.....	28.1
Volatile matter.....	5.6
Fixed carbon.....	51.4

This sample ranks as anthracite coal.

From the end of the east drift, a crosscut extends 110 feet south and intersects six other coal seams at distances of 45, 56, 63, 68, 80, and 105 feet, respectively, south of the drift. These coal seams are all less than a foot thick. The beds strike southeast and dip 60 degrees northeast. There has been a little movement along each seam, judging by the somewhat sheared nature of the coal. Three other very similar coal seams, each about 6 inches wide, are intersected at 5-foot intervals in a 20-foot crosscut to the north from the end of the east drift. In the main crosscut 10 feet north of the drift there is a 12-inch coal seam of the soft, crushed type, criss-crossed by innumerable, shiny, slickensided surfaces. A parallel, 9-inch seam of comparatively firm, clean coal lies 20 inches farther north. Three other coal seams are intersected by the main crosscut at distances of 45 feet, 105 feet, and 175 feet, respectively, south from the portal. These seams are less than 6 inches wide, and there has been some crushing along each one. The seam at 175 feet from the portal appears to be the downward continuation of the seam explored in the No. 3 or upper adit (See Figure 12).

No. 2 adit is 75 feet northeast of the portal of the main adit and 40 feet higher. It is driven 33 feet along two coal seams, each of which is from 6 to 7 inches in width and is separated by 1 foot of carbonaceous shale. The coal is clean and black and is very little disturbed.

No. 3 adit is at elevation 2,700 feet, its portal being 400 feet south of the portal of the main adit and 250 feet higher. It is 203 feet long, with a 25-foot crosscut to the northeast 40 feet from the face. For the first 180 feet from the portal, the drift follows a coal seam that ranges from 3 to 4 feet in width. At 180 feet from the portal a fault crosses the coal seam at a small angle. The coal is squeezed out along the fault and its easterly extension has not been located. The coal seam exposed along the roof of the adit has suffered only minor crushing. It varies from glistening black to dull graphitic black and is comparatively firm and clean, with only minor slickensided cross fractures. The following analyses of this coal are of channel samples taken across the roof of the adit by the writer and analysed by the Fuel Testing Division at Ottawa. Sample No. 109 was taken 18 feet from the portal across 46 inches of coal. Sample No. 110 was collected 155 feet from the portal where the seam measured 37 inches, but included two beds of bone 2 and 3 inches thick, respectively, which were excluded from the sample.

	No. 109 46 inches As received	No. 110 32 inches As received
	Per cent	Per cent
Moisture.....	13.7	14.9
Ash.....	20.0	15.9
Volatile matter.....	3.1	3.2
Fixed carbon.....	63.2	66.0
Sulphur.....	.....	0.1
B.T.U. per lb. gross.....	9,100	9,790

The rank of sample 109 is meta-anthracite and No. 110 ranks as anthracite coal.

At elevation 3,000 feet, and roughly 500 feet south of No. 3 adit, three groups of coal seams are exposed by open-cuts (*See Figure 12*). The first group consists of five seams, which form part of a section, from north to south, as follows: 30 inches coal, 18 inches rock, 12 inches coal, 6 feet rock, 6 inches coal, 18 inches rock, 6 inches coal, 4 inches rock, and 24 inches coal. These seams strike south 45 degrees east and dip 55 degrees north-east. The 30-inch seam may be the upward continuation of the large coal seam in the main adit drift.

In open-cuts 75 feet farther south an 18-inch and a 12-inch coal seam, with 10 inches of intervening shale, are exposed. Carbonaceous shale immediately below the 12-inch seam is matted with stems and other plant remains. The 12-inch coal seam has undergone very little crushing and is

comparatively clean and hard. A channel sample, No. 114, taken across it was analysed by the Fuel Testing Division at Ottawa, and has the following composition:

	As received Per cent
Moisture	14.8
Ash	14.5
Volatile matter	7.1
Fixed carbon	63.6
Sulphur	0.1
B.T.U. per lb. gross	9,500

This sample ranks as semi-anthracite coal.

The third group of coal seams is exposed in a cut 60 feet farther east. Here is a 12-inch seam of firm, clean coal with several, parallel, 3-inch seams over a width of 4 feet. These outcrops are only a short distance from the fault contact of the coal-bearing sediments with the older underlying volcanic and sedimentary rocks (*See Figure 12*). The upward extensions of these groups of coal seams were seen to outcrop for several hundred feet farther up the precipitous slope.

The coal on this property is soft and soils the fingers, and has a roughly cubical fracture where it is not sheared. The sheared coal has a graphitic appearance. According to the A.S.T.M. classification of coal by rank and grade, this coal falls largely into the anthracite group, but some is semi-anthracite and some is meta-anthracite.

Seaton Coal Area (43)

References: Ann. Repts., Minister of Mines, B.C.: 1916, pp. 121-122; 1921, pp. 161-162. Geol. Surv., Canada: Sum. Rept. 1910, pp. 99-100; Mem. 69, pp. 179-181.

Outcropping along Bulkley River near Seaton (a flag station on the Canadian National Railway 20 miles southeast of Hazelton) is a series of gently dipping sedimentary rocks containing Upper Cretaceous or Tertiary plant remains. These rocks consist of greywacke, shale, and conglomerate, and contain seams of bituminous coal. They strike northwest and dip 30 degrees to the northeast.

This coalfield was developed by the Wright Coal Company in 1916 and the Bulkley Valley Coal Mines Syndicate in 1927. Since 1927 there has been no development work.

The seams that have been developed all occur on the west bank of Bulkley River. The main seam, known as No. 1, occurs about 400 yards south of Seaton. It was opened up by a 275-foot drift from the river level and a 30-foot inclined shaft sunk from a point above the drift. The shaft breaks through into the drift 100 feet from the portal. As the workings are now caved the writer was unable to examine this seam. It is reported to be 4½ feet wide, split by bands of shale. Lay¹ gives the following analysis on a sample from this seam:

	As received Per cent
Moisture	1.8
Volatile matter	17.7
Fixed carbon	36.7
Ash	43.8

This coal ranks as medium volatile bituminous.

¹ Ann. Rept., Minister of Mines, B.C., 1927, p. 161.

Four hundred yards downstream another seam (No. 2) is exposed. It is 17 inches wide, and a drift follows it for 15 feet. According to Lay a sample of clean coal gave the following analysis:

	As received Per cent
Moisture	3
Volatile matter	21.2
Fixed carbon	59.0
Ash	16.0

This coal is of medium volatile bituminous rank.

Along a third seam (No. 3), 3 feet in width, a drift was run 70 feet. Lay gives the following analysis of a sample from this seam:

	As received Per cent
Moisture	1.4
Volatile matter	19.5
Fixed carbon	43.4
Ash	35.7

The rank is medium volatile bituminous coal.

Several other seams have been found in the area, but have not been developed.

The seams are too small and contain too high a percentage of ash to have much commercial value.

MARL DEPOSIT

Robinson Lake Marl (18)

Robinson Lake is 6 miles northeast of Hazelton, a few hundred feet from the Nine Mile Mountain road. The lake is 1,900 feet long from north to south with an average width of 400 feet and a maximum width of 900 feet. It is a clear water lake, rarely over 5 feet deep except in the centre where there is 30 feet of water. Everywhere in shallow water the lake bottom consists of a thick deposit of soft, white to grey marl concealed in many places by a heavy growth of Chara, a plant whose cells and cell walls contain a deposit of lime. These plants have evidently contributed largely to the deposition of the marl, but some shell remains were also observed. At the north end of the lake a stream flowing through low, marshy land enters the lake and has deposited dark vegetable matter locally with the marl. The best quality of white marl is, consequently, found at the south, or outlet, end of the lake. There a 12-foot pole, pushed down into the deposit, does not reach its bottom. Elsewhere the calcium carbonate layer is at least 6 feet thick, as a pole can be thrust that far into it before striking any resistance, and comes up white covered.

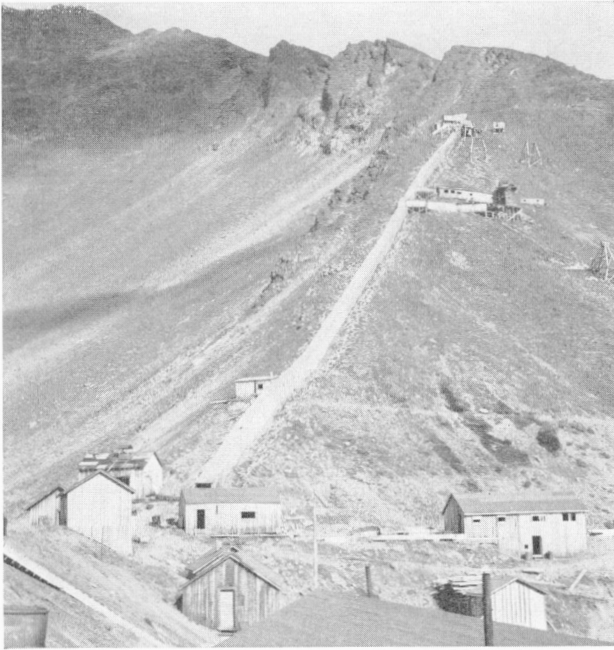
Marl is valuable as a land dressing and could be readily mined from the lake bottom by using a suction pump or small dredge.



A. Rocher Déboulé Mountains, looking south along Skeena River Valley (83399).
(Pages 4, 5, 14.)



B. Granodiorite terrain at head of Juniper Creek, looking east from Rocher Déboulé mine (83033). (Pages 4, 57.)



A. Red Rose mine and camp, Rocher Déboulé Mountains (106585). (Page 55.)



B. Milling plant at Silver Standard mine, Hazelton (106580). (Page 69.)



A. Hudson Bay Mountain, looking west towards Glacier Gulch Glacier (86161).
(Page 4.)



B. Hudson Bay Mountain, looking west along Toboggan Creek Valley (86162).
(Page 4.)



A. Peak of Hudson Bay Mountain, looking southwest over glaciers at head of Toboggan Creek (85198). (Page 4.)



B. Volcanic breccia at the Duthie mine, southwest side of Hudson Bay Mountain (85230). (Page 105.)

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