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BUREAU OF ECONOMIC GEOLOGY

GEOLOGICAL SURVEY

# PRELIMINARY REPORT

# MINERAL RESOURCES ALONG THE CANADIAN NATIONAL RAILWAY, BETWEEN PRINCE RUPERT AND PRINCE GEORGE, BRITISH COLUMBIA

BY

F. A. Kerr

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Figure 1. Map of Hudson Bay mountain showing location of mineral deposits.

# THE MINERAL RESOURCES ALONG THE CANADIAN NATIONAL RAILWAY BETWEEN PRINCE RUPERT AND PRINCE GEORGE, BRITISH COLUMBIA.

By F.A.Kerr

## CHAPTER I

### THE COAST RANGE BELT: WESTERN SECTION

Leaving Prince Rupert the railway skirts the coast for a short distance and then swings inland along Skeena River valley, which is like the many other great fiords along the coast except that it has been extensively filled with delta deposits. Eastward it narrows and the low, rounded hills that border it at the coast give way to mountains increasing in height inland to where they rise in rugged, 8,000-foot peaks, but which farther inland drop away and at Remo are abruptly replaced by a great north-south valley with a width ranging from 1 to 10 miles. This wide, flat valley marks the inland edge of the western section of the Coast range. It extends southward for 40 miles to Kitimat arm and northward for an even greater distance, and is occupied by several rivers of very small size compared with the Skeena.

The base of this wide valley is largely covered with great thicknesses of gravel, glacial drift, and alluvium. Near Skeena river the valley is flanked by mountains that are either entirely granitic or have a shell of other rocks facing the valley. From Skeena river northwards to Kitsumgallum lake the granitic rocks of the slopes on the east side of the valley by their character, inclusions, and mineral deposits are clearly indicated to be border phases of the intrusion. On the southwest slope of Thornhill mountain from top to bottom contact conditions with numerous roof pendants exist. South of the Skeena, west of Lakelse lake, it is reliably reported that much limestone occurs. These features suggest that the rocks in which the great valley was developed were largely non-intrusives.

What little information is available about the western section of the Coast Range belt suggests that away from the coast the area is largely underlain by granitic rocks. In the narrow strip along the railway, examined by McConnell, Dolmage, and Hanson, the rocks are largely quartz diorite and granodiorite which judging by the absence of discoveries in them are mainly unfavourable for the occurrence of mineral deposits. It may be, however, that within them in places there are masses of older granitic rocks. Such masses, together with masses of non-intrusives such as have been observed near the railway, are favourable for ore deposition.

The fringe of older rocks flanking Kitsumgallum valley would appear to be favourable for the occurrence of ore deposits, but up to the present this area seems to have received little attention although some mineral deposits have been discovered. On the Martin group narrow, mixed sulphide veins carry up to 0.4 ounce in gold and 4 ounces in silver,[1] but underground work yielded

[1] Ann. Rept. Minister of Mines, B.C., 1928, p.71.

discouraging results. On the Mayou group quartz veins carry in places small amounts of galena and assay up to 0.2 ounce in gold and 9 ounces in silver.[2] On the Autumn group there are numerous

[2] Ann. Rept. Minister of Mines, B.C., 1928, p.71.

showings of pyrite-magnetite-chalcopyrite replacement deposits in limestone and andesite carrying in the main only moderate values in copper.[3] The original showings collectively seemed to indicate

[3] Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1925, pt.A, p.118.
Ann. Rept. Minister of Mines, B.C., 1929, p.76.

possibilities of good-sized bodies of milling ore being present, but some development work, especially underground, failed to yield

encouraging results.

Prospectors report mineral occurrences at other points, including quartz-pyrite in pockets high in gold on Kitsumgallum river, and molybdenite deposits on the northeast slope of mount Remo.

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Hanson, George: Prince Rupert to Burns Lake, British Columbia; Geol. Surv., Canada, Sum. Rept. 1924, pt. A.

# CHAPTER II

## THE COAST RANGE BELT: EASTERN SECTION

### GENERAL GEOLOGY

Beyond Terrace on the eastern side of the great north-south valley dividing the Coast range into two sections, the western and eastern, Skeena valley again enters a mountainous area. An unbroken succession of high and rugged peaks without systematic arrangement border it until Dorreen is reached. Beyond this the valley widens and the mountains do not tower directly above it, but at Cedarvale the mountains close in again and to the south are higher and more impressive than at any other point on the route. The eastern limit of the Coast range is marked by the Kitwanga-Kitsequekla valley. The eastern section of the Coast range adjacent to the railway is formed of sedimentary and volcanic strata and large and small bodies of granitic rocks.

#### Sediments and Volcanic Rocks

Except for a few isolated masses of older, possibly Permian, limestones, the sediments and volcanic rocks belong to two groups. The older, of Triassic and (or) Jurassic age, is made up of a thick series of extrusives (lava, tuff, etc.) and of intrusives (dykes, stocks, and sills). These rocks are largely dense and massive, mainly green but in places grey, red, purple, or brown, and are andesitic in composition. They are generally very irregularly fractured and, therefore, mineral deposits formed in the fractures are commonly small and irregular. In places, however, some strong fractures and well-developed shear zones occur and within some of these larger orebodies have been formed not only by fissure filling but by replacement.

The younger group, mainly of Jurassic age, includes black to dark grey argillites and quartzites, lighter grey conglomerate and greywacke, and green and grey volcanic rocks. There are at least three important conglomerate horizons, one of which at the head of Maroon creek carries an abundance of granitic boulders. The group is characterized by the presence of well-defined banding or bedding along which mineral deposits tended to form. Most commonly they occur in the crests of anticlines or where the beds are crumpled or faulted.

## Granitic Intrusives

The granitic rocks fall into a number of groups. The oldest noted in place are dark green augite diorite. These occur on Kleanza mountain in the older volcanic rocks, to which they are somewhat similar, and on the Treadwell property on Kitsumgallum lake in the younger volcanic-sedimentary group.

The second, younger group is made up of related albite granites, granodiorites, quartz diorites, and diorites. These range from dense, dark green and grey contact phases, not readily distinguishable from the volcanic rocks, to coarse, grey and pink granite and to porcelain white or light grey albitite. They have a great variety of peculiar textures. The various types occur both in sharp contact with one another and in gradational relationships. Related dykes occur abundantly, especially near the contacts both within and beyond the intrusive bodies. The contacts are almost invariably very irregular and in many large areas there is an intimate intermixture of older rocks and various types of the intrusives. There is considerable alteration of all these rocks and much evidence of the effects of related mineralizing solutions; the albitite dykes in places carry sulphides and low values in gold.

A third and still younger group includes light grey to pink rhyolite dykes which are common in sections along the Skeena.

Possibly pink, granitic dykes noted on Thornhill mountain and larger masses reported on Thornhill and Kleanza mountains belong to the same group.

A fourth group also younger than the albite-bearing rocks consists of andesine granodiorite. This rock is commonly fresh, light grey, and coarse textured and only rarely is it altered as by mineralizing solutions. The contacts of the bodies are sharp and well defined.

A fifth group present in the eastern part of the area away from the others consists of fresh, uniform, buff to pink, coarse-grained quartz monzonite.

Other small intrusive bodies include one of hornblendite and diorite, and another of orthoclase porphyry (syenite) on Fiddler creek, granodiorite and pink quartz porphyry on Kleanza creek, diorite and gabbro on Chimdemash creek, and syenite and diorite on Legate creek. Otherwise the stocks so far as known are mainly granodiorite.

Intrusive rocks possibly still older than any observed are indicated by boulders in conglomerates.

## ECONOMIC GEOLOGY

### Lode Deposits

Mineral occurrences are abundant throughout the eastern section of the Coast range. The important metals in most of them are one or more of the following: gold, silver, copper, lead, and zinc. Some deposits contain molybdenite and tungsten. The deposits most likely to be of value are mainly copper-gold and gold pyrite. A number of these are already indicated to have $100,000 to $600,000 worth of ore in them and there are many small pockets of high-grade ore which might be "gophered" out at a profit. Deposits of immediate prospective value occur, or may be expected to occur, mainly in the area west of the Skeena, south of Lorne, and west of

Kleanza creek, also at the head of Legate creek and possibly at the head of Chimdemash creek. The deposits so far as known are small. The copper-gold deposits, best developed on Kitsalas mountain, are least known. The gold-pyrite deposits, as indicated in many places, are mainly small contact deposits.

Silver deposits are scarce. High-grade silver-copper deposits occur at the head of Chimdemash creek. At the head of Legate creek silver deposits carry one or more of the following: copper, lead, zinc, and gold. Though development work here has proved disappointing and suggests the deposits are small the fact that 123 tons of high-grade silver-copper-lead float were gathered on one property suggests the possibility of at least profitable small-scale operations. High-grade silver-copper pockets occur along the contact of the younger andesine granodiorite on the southeast slope of Dorreen mountain. Some copper-gold-silver occurs on Kitsalas mountain. Silver occurs with gold on the Grotto, A and B, and Lead King properties. Silver has been indicated in some deposits in the Kitwanga-Oliver section.

Copper, lead, and zinc occur in gold and silver deposits and may of necessity be produced along with these.

Deposits bearing copper occur throughout the district, but most of those of high copper content lie in the area from Kitsalas and Bornite mountain eastward to Legate creek where only copper-bearing deposits occur. The best showings are probably southeast of the river and toward the head of Kleanza creek. In the main they are of moderate to low grade and have not been shown to be of large size.

Though lead and zinc occur in many deposits they rarely are the only important constituents. They are, however, generally the most important in the Kitwanga-Oliver section. They occur in important amounts on Legate creek also. At no place do there appear to be indicated possibilities of developing large quantities of ore containing much lead and zinc.

A molybdenite deposit on Thornhill mountain has afforded some very high-grade specimens. The molybdenite occurs over a considerable area, but the high-grade material is confined to small pockets. Small quantities of molybdenite have been noted in other sections. A tungsten deposit also occurs on Thornhill mountain, but development work has shown it to be small.

The eastern section of the Coast range has been subjected to a number of periods of mineralization related to the groups of intrusives described on a preceding page. That mineral deposits are associated with the earliest intrusives, the augite diorite, is perhaps not definitely established, but on the Treadwell property gold-bearing chalcopyrite, bornite and pyrite with little or no quartz occurs in a dyke of this rock and may be related to the dyke. Similar copper-gold deposits occur on the southwest slope of Kitsalas mountain on the Lucky Luke, and, possibly, the Cordillera property.

Most of the gold deposits of the area are related to the albite-rich intrusives that are known to occur throughout the area south of Lorne and Douglas creek between Kitsumgallum-Lakelse valley and Skeena and Kleanza valleys. In practically every locality where these rocks occur there are similar mineral occurrences with similar relationships. In the main the deposits are veins that occur at or near the borders of the albite-rich intrusives. In some localities they do not extend into intrusives, in others, especially where the contact phases are dark and fine-grained, they extend for a short distance into the intrusives and in still other places where small bodies (dykes, stocks, sills, etc.) occur the deposits may be wholly within them. The deposits are mainly quartz veins carrying pyrite, sphalerite, galena, and chalcopyrite; less commonly they hold free gold, pyrrhotite, hematite, tetrahedrite, and other minerals. In places they carry

albite and carbonates. Not all of the common sulphides are present in each deposit. Though in places some gold is free it is probably mainly in the pyrite. Gold assays commonly range from 0.5 to 1.25 ounces to the ton, though in many deposits they fall below this and may be absent altogether. The veins are in the main less than 3 feet wide, their length rarely exceeds 1,000 feet, and their extent down the dip is usually only a few hundred feet. Some are considerably larger and in most localities there are a number of veins.

In areas of bedded rocks most of the important veins either occur along the bedding mainly near anticlines, crumples, and faults, or they lie in and along large dykes, laccoliths, and stocks, and very rarely in sills. The veins in bedded rocks are generally the largest. Those occurring in anticlines are commonly thicker along the crest of the anticline and pinch out in both directions down the dip. In areas of volcanic rocks the deposits are in places in the form of many, small, irregular lenses and stringers, elsewhere they occur in joints or parallel shear zones. The deposits, however, are lenticular. They start near the edges of bodies of the albite-rich intrusives either within or outside of the intrusive body, and as they extend away from the intrusives they widen rather abruptly to their maximum thickness, and then tend to taper off, all in a range of one to several hundred feet.

Bornite-chalcopyrite-pyrite deposits with low gold and silver values occur in the rhyolite dykes on the Canyon, Grotto, Algoma, and other properties. Similar copper deposits, possibly related, occur throughout a wide area from Kitsalas and Bornite mountain northeastward to Sand and Legate creeks. As a rule, however, the grade of the ore is mainly low.

The younger andesine granodiorite shows evidence of associated mineralization by the presence at some contacts of quartz

veins, quartz-pyrite veins, quartz-tetrahedrite veins, and molybdenite deposits. The white quartz veins, in places loaded with pyrite, have so far been found to contain no ores of commercial grade. The quartz-tetrahedrite veins are very high in silver and copper, but so far as is known are small and uncommon.

No evidence was noted to suggest that the quartz monzonite was responsible for any ore deposition.

With many of the smaller isolated stocks of individualistic petrographic character, such as those on Legate, Chimdemash, and Kleanza creeks and near Woodcock, there is associated mineralization which like the stocks has its own characteristics.

## Placer Deposits

Free gold can be panned from the weathered portions of gold veins in many parts of the district, so it is only natural that placer gold has been found on such creeks as Lorne, Fiddler, Hardscrabble, Phillips, Chimdemash, Kleanza, Douglas, Hall, and Maroon. Of all these Lorne Creek has been by far the most important. Gold was discovered on this creek in 1883; and has been intermittently worked since that date. During the years 1903 to 1907 a costly plant was put in to hydraulic "Dry Hill", an old channel north of the creek where it emerges into Skeena valley, but apparently could not be operated at a profit. In 1907 W. Fleet Robertson wrote that "the ground undoubtedly contains gold in considerable quantity, but its recovery is rendered difficult by an exceedingly irregular bedrock and the presence of a great number of boulders which must be broken up". From this it would be inferred that these operations were on bedrock though Lay from observations in 1930 did not believe this to be the case. A 300-foot tunnel was driven on the channel in 1923 and 1924.

In the early workings five claims near the lower end of the present channel (probably at least 500 feet of channel) yielded most if not all of the gold at the rate of $5 to $10 a man a day. Above this stretch the pay is reported to have turned into the hill. In the "Dry Hill" channel 350 feet of a total length of 2,000 feet have been worked and have yielded according to known data probably $25,000, possibly more. This old channel is cut off by the present channel at its upper end. Beyond this Lay believes that the new channel conforms approximately with the old, but the writer believes that this is probably the case for only a distance of one-half mile or slightly more. In either case the present channel has cut away at least this length of the old channel and the gold found in the lower part of the present channel represented part or all of what came out of it. In 1934 in cleaning 75 feet of bedrock in the section previously worked only 11 ounces of gold was obtained. Total production from Lorne creek has probably been somewhat under $100,000 (5,000 ounces). Some further workings are reported slightly higher up and in the vicinity of the south fork.

Douglas creek in the lower 6 miles has been worked to a considerable extent over a long period of time and especially in recent years. The total recovery in 1931 amounted to about $1,000 and this amount was probably not greatly exceeded in any year as the creek is very difficult to work. Some gold was secured on Chimdemash creek. In 1914 operations were conducted on Kleanza creek by the Cassiar Hydraulic Mining Company and in 1902 to 1906 on Hardscrabble creek. In 1934 small recovery was secured from Phillips creek.

Except in the Lorne Creek, and possibly upper Porcupine Creek, sections the area in the main has been so glaciated by valley glaciers that it is unlikely any important placer deposits remain. Fiddler valley, for instance, has been occupied by a

glacier to its lower end which has probably largely removed any important concentrations. Douglas creek has also probably been fairly thoroughly glaciated. In recent times the glaciers extended to the big bend and thus the upper section has probably been entirely cleaned out. Below the big bend the creek is in a canyon which has been somewhat protected from active scouring by ice, so some gold remains and some has been carried down from the washing of drift from the upper part of the valley and from Lorne creek.

In the Lorne and Porcupine Creek sections conditions are different. Much of the area is low and the glaciers spread out and did not gouge so deeply into valley bottoms. Upper Lorne creek, however, has been swept clean by westward-moving ice and the centre and south forks by small mountain glaciers. It has not yet been shown that Porcupine creek in any part lies within the gold belt and it may never have had any gold. Thus the known favourable area is confined to about the lower 5 or 6 miles of the Lorne Creek basin.

Along Lorne creek are bedded strata which in the main dip at a low angle to the north. The north side of the valley in the lower section, therefore, is usually steep and there is no possibility for an old channel except the Dry Hill channel already noted. Higher up the north side is a vertical cliff for a considerable distance and the south side is largely drift. Here it seems most probable that the old channel is on the south side. Upstream from the cliff the old drainage may have been quite different from the present and old channels may occur on either side.

In the section from below the south fork to above the centre fork the location of the present drainage channel is probably considerably different from that of the earlier channel. It may be, for instance, that formerly the south fork pursued a

more nearly straight course and linked up with the old channel described above. In other places in this section there may be old channels. Possibly some of the present Lorne drainage originally went to Porcupine creek. Porcupine creek for much of its distance appears to be in a post-Glacial channel. Lode gold deposits are known in the area of the headwaters of the tributaries of Lorne, so most probably higher sections of the old channels carried gold to the same extent as the lower channels. Gold in the vicinity of the south fork may have come from the washing of thick deposits of drift here, and this material most likely came out of the south fork.

## Other Mineral Resources

At Lakelse lake there are hot springs. Clay deposits at Terrace have been found suitable for making brick. Crystalline limestone and marble 1,000 feet thick occur on Thornhill mountain. The albite-rich granite and granodiorite rocks are not of good quality for building purposes because of their great variability and because they are considerably sheared and faulted in most places. The best materials of this type occur just east of Terrace, the younger andesine granodiorite probably is more satisfactory. It may outcrop along the railway between Pitman and the first creek from Dorreen mountain. The green volcanic rocks are in the main not suitable for building stone as they are highly metamorphosed, but in places to the east suitable stone may occur in the sedimentary series.

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Dawson, G.M.: Port Simpson on the Pacific Coast to Edmonton; Ann. Rept. 1879-80, p. 1B.

McConnell, R.G.: Geological Section along the Grand Trunk Pacific Railway from Prince Rupert to Aldermere, B.C.; Sum. Rept. 1912, p.55.

Hanson, George: Skeena River to Stewart; Geol. Surv., Canada, Sum. Rept., 1922, pt. A, p.35.

Kitsault River to Skeena River; Geol. Surv., Canada, Sum. Rept. 1923, pt. A, p.23.

These two reports deal with the area north of Skeena river on either side of Kitsumgallum valley.

Prince Rupert to Burns Lake; Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p.38.

Zymoetz River area; Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 100.

The area covered is that along Skeena from Terrace to Dorreen and to the southeast.

Marshall, J.R.: Lakelse Lake Area; Geol. Surv., Canada, Sum. Rept. 1926, pt. A, p. 35.

The area includes that south of Skeena river from Zymoetz river west.

Nash, Fred, Surveyor, Terrace, B.C. Prince Rupert Sheet; Geol. Surv., Canada, 1933, Mineral Properties in the Vicinity of Terrace, B.C.

Map of greater part of area.

Maroon Mountain; Map of Maroon Mountain area.

The Annual Reports and Bulletins of the Minister of Mines of British Columbia contain a great wealth of information gained by W. Fleet Robertson, J.D. Galloway, Douglas Lay, G.A. Clothier, H.T. James, J.T. Mandy, and others. They contain data about prospecting, development, mining, and milling at the various properties in the district and also much general and geological data.

## Detailed Descriptions

### Kleanza Mountain Area

On Kleanza mountain there are a number of widely scattered gold deposits. The rocks over a large part of the mountain are the albite-rich granitic types ranging from granite to diorite, with associated green albite porphyry and light brownish grey albitite dykes. They cut a complex that mainly occupies the top of the mountain and is made up of dense to fine-grained, dark grey to green

rocks that are chiefly altered volcanic rocks, but include some intrusives, notably augite diorite. The contacts are extremely irregular. There are many small inclusions and roof pendants of the older rocks in the intrusives and areas of the intrusives in the volcanics.

Columario.[1] The Columario property of Columario Consolidated

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[1] Northern Miner, January 31, 1935, April 11, 1935. Ann. Repts. Minister of Mines, B.C.: 1930, p. 136, 1933, p.96. G. Hanson: Geol. Surv., Canada, Sum. Rept. 1925, pt.A, p. 117; reports, maps, etc., belonging to the mining company.

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Gold Mines, Limited, is a consolidation of a number of groups and claims including Golden Crown, Valhalla, Tenderfoot, Dakota, Kleanza, and Red Gulch, and covers a large part of Kleanza mountain. Much development work has been done and many veins located in various sections of the property. In 1934 a mill was erected and mining and milling operations were commenced. Most of the ground covered by the property is heavily wooded and rock is poorly exposed.

There are a large number of quartz veins, most of them being less than 3 feet wide and none wider than 5 feet. Many over most of their length are too narrow to be workable, but in places some of these increase to widths of 1 to 3 feet. The veins for the most part strike north and dip east at angles of 30 degrees to 60 degrees. They appear to occur along fractures somewhat of the nature of joints that in places have been subjected to considerable shearing. In places, instead of single veins, the quartz forms a zone of stringers.

The metallic minerals present in the veins are pyrite and minor quantities of other sulphides. In the main workings on the Valhalla group the gold, so far as is known, occurs entirely with the pyrite, and no free gold has been noted, but in veins on

other sections of the property free gold is present and has been recovered by small mills. The main mine workings are on three veins that lie rather close to one another. Company samplings give returns for the ore shoots of 0.6 ounce in gold. Development work has been confined to a very small part of the area kown to contain veins. The mill has handled 30 tons a day; its rated capacity is 50 tons, and a concentrate assaying 5.25 ounces of gold a ton is secured by flotation.

The veins that are related to the albite-rich granitic rocks extend from within this material out into the bordering volcanic rocks. Most of the veins are widest and richest near the contact and away from it diminish in width and richness. In the volcanic rocks they are for the most part straight and regular, but where they cut albitite dykes or other albite-rich intrusives they pinch and are less regular.

Work on the Valhalla showings has shown that veins in the albite-rich granitic rocks do not carry gold in appreciable amounts and what values there are diminish rapidly in the direction away from the contact, both along the strike and down the dip. The veins are made up of quartz carrying pyrite and in most cases some molybdenite and chlorite which in this locality generally indicates the lack of important gold values. On the Golden Crown group veins in the granitic rocks carrying gold indicate that locally the mineralized zone may extend into the granitic rocks, but probably not very far. On the Valhalla and Kleanza groups the veins have been traced upward and observed to pinch out. From the available data it is concluded that the valuable parts of the veins are in the main confined to a zone of a few hundred feet which in places may extend to as much as 1,000 feet and that the upper limit of this zone roughly parallels the contact between the albite-rich granitic rocks and the

volcanics. Areas where the granitic rocks outcrop are below the zone which there has been entirely eroded away or at least has been so deeply eroded that probably only the roofs of the veins have been left. In such places as the Kleanza and possibly the southern Valhalla showings where the tops of veins have been observed it appears that the top of the zone has been cut into. Thus it seems probable that the whole depth of the zone is present over the large area between these showings and the main workings and beyond wherever the volcanic rock continues. This large area probably represents the roof of the granitic intrusives. Such a position is generally considered to be most favourable for mineralization.

Silver Bow. On this property albite-rich granitic intrusives are exposed in a cliff about 100 feet high at the top of which they are in contact with volcanics. Two mineralized zones have been traced for 300 feet or more in volcanics and are 1 to 3 feet wide. In the volcanic rocks, the contact, the zones, and the fracturing and shearing are parallel. One mineralized zone which is said to be the best so far found is within a few feet of the contact for a distance of 300 feet, and continues in the intrusives in both directions. In a shaft and in an adit, the deposit at shallow depths becomes much poorer. Mineralization in the central part of the 300-foot stretch, apparently at the point farthest from the intrusive, includes much galena, sphalerite, pyrite, and chalcopyrite in quartz and in the sheared and altered rock; elsewhere there is only pyrite and chalcopyrite and these become less abundant with increasing depth within intrusives. The best mineralized part is reported to run as much as 2 ounces in gold, but more commonly about 0.5 ounce. Values die out in the intrusives and, though the vein is strong and may even carry pyrite, are negligible there.

From the location near the contact it would appear that only a small thickness of volcanic rocks and only the roots of the veins remain. Other veins are reported to occur on the property and it may be that at some point where the shell of volcanics is thicker better results could be obtained.

On the property there are flat faults along which the top is shifted to the west. One of these at least was formed during the period of mineralization as it displaces the mineral zones and is also mineralized. The veins are cut by dark green porphyritic dykes.

Silver Cliff and Terrace. The Silver Cliff is 500 feet lower on the creek than the Silver Bow. Here there are a number of small inclusions or roof pendants of volcanic rocks in the albite-rich granitic intrusives which extend up the steep walls for long distances. Small veins of quartz up to 6 inches wide that carry much pyrite and are said to assay up to 2 ounces gold and 39 ounces in silver occur mainly in the volcanic rocks. At one point a pocket 4 feet wide is reported.

On the Terrace group still lower down a mass of volcanic rocks about 20 feet across lies on granodiorite. Confined to this is a lens of quartz containing galena, sphalerite, and pyrite. This is a rather striking example of the inhospitality of the granodiorite to mineralization.

Zymoetz. On the Zymoetz property there are a number of deposits. On one of these near river level a short crosscut adit was driven in 1934. This deposit occurs partly in a very small volcanic mass and partly in albite-rich diorite. On the surface in the volcanics there are two veins 5 inches and 1 foot wide separated by 4 feet of unmineralized rock slightly sheared near the veins. Upward on the walls of the creek canyon here the smaller vein tends to pinch out,

In the adit a few feet from the river and 25 feet below surface showings, the two veins have come together and constitute a vein 2 feet 6 inches wide. The vein strikes about east-west along the wall of the river and dips 45 degrees north. It is well mineralized with pyrite, chalcopyrite, galena, and sphalerite. One channel sample assayed 0.23 ounce in gold and 1.52 ounces of silver a ton. At 50 feet to the west the volcanics end. The shear zone continues for 170 feet in the diorite, and contains a quartz vein or stringers of quartz across a total width of 1 to 3 feet. The quartz carries much pyrite in places and some chalcopyrite. Beyond this stretch for more than 40 feet the zone is about 1 foot wide and holds quartz and pyrite. The intrusive continues to the west. Sixty feet east of the adit the main vein is 1 foot wide, but seems to be less well mineralized than at the adit. Diorite occurs on the trail about 100 feet north of the river here and continues to the east along the trail, so that the body of volcanics is either very narrow or, more likely, terminates. The mineralization in the diorite changes and appears to be poorer than in the volcanics; thus the common tendency for the important values to die out going into the diorite is suggested. The volcanic mass can hardly have any great depth since it is surrounded on at least three sides by the diorite. The river is on the other side of the exposure.

## Kitsalas Mountain Area

Kitsalas mountain is largely underlain by massive, green, volcanic rocks cut by many dykes of various kinds and ages and invaded, on the southwest slope and possibly elsewhere, by albite-rich diorite and andesine granodiorite of quite different ages. The rocks are cut by many faults and are sheared and highly altered along many zones.

Deposits carrying bornite, chalcopyrite, pyrite, and gold constitute the most important mineral deposits so far found on the mountain. The abundance of copper minerals, especially bornite, and the relative scarcity of quartz in one of the deposits seem to distinguish these deposits from those associated in origin with the albite-rich granitic rocks.

Veins of quartz with chalcopyrite, sphalerite, pyrite, and galena, and gold, occurring on the southwest slope of the mountain, are similar to those found elsewhere associated with the albite-rich intrusives. Copper deposits with low values in gold are also present. These may be related to the rhyolite dykes. Some mineralization similar to that noted in other localities may be associated with the younger andesine granodiorite.

Lucky Luke.[1] On this property a well-defined shear zone strikes

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[1] Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1926, pt. A, p.117; Ann. Repts. Minister of Mines, B.C.; 1924, p.13; 1928, p. 146.

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about north 75 degrees west and dips 70 degrees north. It follows a fault and is mineralized over widths of from 1 to 6 feet, in most places 1 to 3 feet, with bornite, chalcopyrite, pyrite, and gold. Two adits 60 feet apart vertically have been driven along the zone, the upper for a distance of about 140 feet and the lower for 230 feet. The zone has also been opened up above the upper level, between the two levels, and by a winze 80 feet deep from the lower level, that is for a vertical distance of over 150 feet and probably nearly 200 feet. Though showing irregularities the zone is fairly well maintained throughout and is strong at the lowest point reached. There are minor faults on both levels, especially at the present faces. On the lower level drifting has been carried along the fault in the hope of picking up the mineralization to the south, but

evidence visible in 1934 did not clearly indicate that displacement was in this direction.

In 1924 twenty-six tons of ore which required very little sorting, held per ton: 0.73 ounce gold, 12.7 ounces silver, and 22.44 per cent copper.

Cordillera.[1] Extensive geological work by geologists employed by

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[1] Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1926, pt. A, p.115; Ann. Rept. Minister of Mines, B.C., 1930, p. 136.

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the mining company showed that the rocks on the Cordillera are volcanics, largely dacite and andesite, cut by fine-grained dykes of at least four kinds, namely, rhyolite porphyry, hornblende granite porphyry, hornblende-oligoclase diorite, and granite porphyry. The rhyolite porphyry and the hornblende granite porphyry may cut the mineral deposits. The rocks in places are schistose and considerably altered. Faults, some earlier, others later, than the mineralization, are numerous.

At the surface one vein, in places up to 10 feet wide but averaging about 4 feet in the central part, was traced 500 feet and three others of good size were opened up. The main vein carried in one place 0.40 ounce gold, 3.8 ounces of silver a ton, and 7.1 per cent in copper. The minerals include quartz, bornite, chalcocite, and coarse, free gold. It is said that the gold goes with the copper. Extensive underground work on the property was very discouraging. Veins were picked up on two levels 150 feet and 230 feet below the showings on the main vein. In the upper level the main vein, which dips 35 degrees, was drifted on for 150 feet. For about 75 feet to the south it is 1 to 2 feet wide but pinches out in this direction, and for a similar distance to the north there are only small lenses. No sulphides were noted in the quartz. This vein shows a fair amount of regularity, apparently occupying a fault confined to the softer schists.

Two other veins were struck in the two levels before reaching the main vein and much work was done on them. They describe horseshoe turns, range from flat to vertical, and pinch and swell. On rolls thicknesses of over 10 feet were obtained, but in the main the veins are less than 2 feet, and commonly less than 1 foot, wide. Where they continue in a vertical direction they are in most places much split up and attempts to trace them laterally have in most places revealed a pinching out. Besides the larger veins there are many irregular masses and stringers of quartz. Sulphide content in the quartz seems to be more sparse in the lower level than above.

A small mill was built on the property. Little work has been done in recent years.

Homestake, Nugget,[1] Lucky Strike, Copper King.[1] These properties

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[1] Ann. Rept., Minister of Mines, B.C., 1928, p.145.

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are on the southwest slope of Kitsalas mountain. The rocks are mainly massive, green volcanics, but on the lower slopes they are cut by intrusives which include the older albite-rich granitic rocks, the young andesine granodiorite, and possibly other diorites, thus representing rocks of two and possibly three or more distinct ages. The rocks are much faulted in places. Mineralization of several different kinds is scattered over the slope. Work in many places shows the deposits to be either small and irregular or to be close to granitic rocks into which they do not, or are unlikely to, continue. There are some gold-bearing quartz-sulphide veins similar to those found elsewhere associated with the albite-rich granitic intrusives. Copper deposits both with low and high gold values also occur. Some of these may be related to the young granodiorite, whereas others are similar to those on the Treadwell

property and appear to be related to a similar green diorite.

On the Homestake near the cabin a quartz vein (or quartz veins), up to 28 inches wide but mainly much narrower, has been exposed by three cuts for about 150 feet. The vein is well mineralized with pyrite, galena, and possibly other sulphides. It is said to return assays up to 1 ounce in gold a ton. An adit driven at a level about 50 feet below the lowest showing failed to strike the vein, but the rocks are much faulted and the adit does not continue to below the lowest showing.

On the Lucky Strike a 2- to 3-foot quartz vein sparsely mineralized with chalcopyrite, bornite, and magnetite is traceable for 70 feet. Other veins on the Nugget group and elsewhere up to 3 feet in width have been traced for distances up to 50 feet. Some of these, and other scattered deposits, carry free gold and values up to and over 1 ounce a ton in gold. At the base of the mountain, on the Copper King group, there is said to be much copper mineralization scattered over a considerable area and extending up the slope in some sections. Some of this is reported to carry good values in gold.

Other Properties. The Triune property includes the upper part of the mountain, where there is sparse copper mineralization with low silver values and probably similar to that at the Copper King property. On the Jackie group, on the Lowrie Creek slope of the mountain, a zinc deposit has been found. Sparse pyrite-galena-sphalerite mineralization without values in gold or silver occurs on the April and May group.

## Thornhill Mountain Area

Thornhill mountain is underlain mainly by albite-rich intrusives cut by related green albite porphyry dykes, white (like porcelain) or light cherty-grey albitite dykes, and in some places pegmatites. The north end of the mountain is of light grey granitic

rocks, whereas the southern end is formed of darker grey to dark green types. Throughout this area of darker rock, extending from the top down the west slope to the base, there are innumerable roof pendants or inclusions of older rocks, mainly of volcanic rocks, rarely of limestone, which are altered and made schistose and largely altered to garnet and epidote. Presumably the upper surface of the albite-rich intrusive body corresponded roughly to the present surface of Thornhill mountain except at the north end where Skeena valley has cut very deeply into the intrusive mass.

Mineralization is abundant everywhere. Much of it is confined to the masses of older rock and in places where this does continue into the albite-rich intrusives it dies away or becomes poorer. At some places where mineralization occurs in the intrusive it becomes poorer with depth. Practically all the mineral occurrences are so nearly alike as to indicate that they are related. In the inclusions most of the deposits hold sphalerite, galena, chalcopyrite, and pyrite; in deposits in the intrusives sphalerite and galena are less abundant or are lacking; chalcopyrite and pyrite are the common metallic minerals. In places in the lighter grey granitic intrusives, presumably deeper within the intrusive bodies, molybdenite occurs. The mineralization is related to the albite-rich intrusives, though it is later than some phases, including the green albite porphyry and albitite dykes. As most of the contact zone has been eroded away, most of the mineral-bearing zone has also been removed.

The known deposits are small and are valuable for their gold content which in places is very high. Three small pockets of a few tons each are reported to have yielded about $4,500 worth of gold. Some high-grade silver deposits are also reported. One deposit contains tungsten, and another molybdenite.

St. Paul, Ptarmigan, Society Girl, Sadie.[1] The greater part of the

[1] Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p.117.
Marshall, J.: Geol. Surv., Canada, Sum. Rept. 1926, pt.A, p.41.
Ann. Repts. Minister of Mines, B.C. 1929, p.78; 1930, p.78.

St. Paul and adjacent properties lies on the relatively flat top of Thornhill mountain. A white albitite dyke with a width up to 20 feet extends for about a half mile across the top of the mountain, with a southeast strike swinging to easterly and slightly northeasterly toward the east, and continues down both the east and west sides of the mountain. On the mountain top, 400 feet from the northern edge, a shear zone and fault striking northeast, cross the dyke and extend down the west slope where they are prominent on the A and B group. Northwest of the shear zone the white albitite dyke branches. The branch, known as the Sadie dyke, follows a more easterly course than the main dyke and continues to the shear zone where it apparently narrows and ends. The main dyke, known as the St. Paul, continues across the shear zone, though probably offset a little.

The rocks bordering the Sadie and St. Paul dykes exhibit considerable shearing and shattering and the dykes in places are also affected. In places in this sheared and shattered rock, on one side or the other of the dyke or in the marginal part of the dyke, there is mineralization and the rocks are silicified and changed to white mica. In places the mineralization widens to 3 feet of solid vein-quartz. One lens with this width is 60 feet long. In the main, however, the mineralized zone is narrow or intermixed with the country rock and there are long stretches where little if any mineralization occurs. It consists of quartz and albite with galena, sphalerite, chalcopyrite, pyrite, and, it is reported, free gold. Values in places are said to run as high as 1.5 ounces in gold and the dyke is also said to carry 0.02 ounce of gold to the ton.

Down the slope on either side of the mountain the mineralized zone dies away and on the mountain top the best showings are on the highest parts. These features suggest that only the roots of the deposit have been preserved from erosion.

On the east slope of the mountain, 300 to 400 feet below the top, in a light grey part of the granite-diorite body, there is a small quartz-sulphide lens like the showings on the mountain top except that scheelite and barite occur with the quartz, albite, pyrite, galena, sphalerite, chalcopyrite, pyrite, and free gold. Some specimens containing much scheelite have been secured.

A and B, Beaver, Lucky Seven.[1] In the area occupied by these claims and on much of the nearby western slope of Thornhill mountain the small inclusions and roof pendants in the albite-rich intrusives are highly altered to dark green and, more rarely, light grey material. A shear zone followed by a creek extends north 55 degrees east up the mountain and dips from 45 degrees northwest to vertical. In most places the shear zone shows some evidence of having been slightly mineralized and it is said also to carry small lenses of quartz and sulphides.

There are many mineral showings on the hillslope. The deposits have a very varied content, but most are quartz veins with chalcopyrite, galena, sphalerite, and pyrite, and some carry free gold and some hematite. Practically all the showings observed by the writer are in or near small masses of dense green rocks. In places where it extends from the volcanic rocks into the albite-rich intrusives the mineralized zone may be clearly seen to dwindle and cease. The deposits locally are small lenses,

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[1] Marshall, J.R.: Geol. Surv., Canada, Sum. Rept. 1926, pt.A, p. 40. Ann. Rept., Minister of Mines, B.C., 1928, p.75.

pockets, stringers, or irregular masses. In one place three of these have been mined out and the total production was only a few tons. In some places widths of 3 to 6 feet are observable, but most of the bodies are lenticular and some of the widest are perhaps only 10 to 50 feet long. The sizes of the deposits appear to be related to the sizes of the volcanic masses in which they occur. Many of the deposits are approximately horizontal and are related to the main shear zone. Stringers can be traced in places directly to the shear zone and it would appear that solutions moving along this zone left it to enter the small fractures along its sides.

Some very rich pockets have been found. It is reported that 200 ounces of gold was secured from one small lens and 35 ounces from two other small pockets. Some was so rich that the gold was mortared out of the quartz. On the average, however, the gold assay are reported to have been less than 0.5 ounce a ton.

Golden Globe, Golden Nib, Star.[1] On the Golden Globe the deposit

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[1] Marshall, J.R.: Geol. Surv. Canada, Sum. Rept. 1926, pt.A, p.39. Ann. Repts., Minister of Mines, B.C., 1926, p.75; 1928, p.75.

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occurs in a shear zone in a dark phase of the albite-rich intrusives. The zone strikes north 45 degrees east and dips south at an angle of 70 degrees. It runs directly up the slope and is traceable for over 800 feet. Beyond this length exposures down the slope and workings up the slope show that the zone either does not continue or is poorly developed. At a central adit it has a maximum width of 10 feet, but is mainly 5 to 6 feet wide. Above and below the central adit it narrows, but maintains a width of more than 2 feet and is well defined for a distance of 400 feet up the slope to an upper adit, and for a distance of

about 100 feet down the slope to a lower adit. The wide part at the central adit is heavily ribboned with quartz carrying much pyrite and some chalcopyrite, and these minerals are massive as if replacing the schist for widths of several inches. Thirty tons of this material, hand-sorted, yielded on an average: gold, 1.6 ounce to the ton; silver, 1.4 ounce; and copper, 1.1 per cent. Both down and up the slope from the central adit the deposit becomes poorer as the zone narrows and the intensity of the schistosity decreases.

In the upper adit a short distance from the entrance, the shear zone is replaced by 3 feet of practically barren quartz carrying chlorite. In the lower adit, 25 feet vertically below the central adit, the zone is also replaced by quartz 18 inches wide at a point 80 feet from the portal, but increasing in width to 12 feet at the face 130 feet from the portal. The quartz carries some pyrite in places, but at the face of the adit it is largely barren and assay returns yield no values.

The diorite in which the shear zone lies varies from north to south in a manner that suggests the approach to a contact. This and the change in character of the mineralization to barren quartz with chlorite suggest that the deposit formed near the contact of the intrusive and carried values for only a short distance within the intrusive body. In this case the contact possibly corresponded roughly to the present surface but was some distance above this plane. If so it would appear that the best part of the deposit has been removed and only the root left, and that at any place barren quartz will be reached in a short vertical distance.

Other Deposits. Molybdenite occurs scattered in albite granite on the Eureka claim.[1] On the Ptarmigan claim[2] a shear zone contains

[1] Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1925, pt.A, p.118. Ann. Repts., Minister of Mines, B.C.; 1927, p.125; 1930, p.78.

[2] Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1925, pt.A, p.118

disseminated galena, grey copper, chalcopyrite, and pyrite, chiefly over a width of 8 feet, and a section of rock ribboned with quartz veinlets (making 40 per cent of the total) is sparingly mineralized with chalcopyrite and pyrite and carries a little gold. On the top of the mountain on the Overlooked Fraction chalcopyrite and pyrite are sparsely distributed in zones along dykes, or, as on the Sunset claim, in shear zones without dykes. These zones have been traced for lengths of 300 feet. On Brunsing's property[3] shear zones in

[3] Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1925, pt.A, p.115

diorite carry pyrrhotite, chalcopyrite, and pyrite, and some gold. On the Lead King in a zone along the contact between volcanic rocks and the albite-rich intrusives, and mainly in the former, there are veins, one of which contains much galena with some pyrite and sphalerite and, according to an assay, carries gold 0.16 ounce, silver 21.5 ounces a ton, lead 34 per cent, zinc 0.5 per cent. Another vein carries arsenopyrite, but an assay showed only a trace of gold and silver.

## Zymoetz River

Dardanelle Group.[4] On the Dardanelle property, 14 miles up Zymoetz

[4] Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1926, pt.A, p.115. Ann. Repts., Minister of Mines, B.C.: 1914, 1918, 1921, 1927.

river, there is a 20-foot "aplitic" dyke, with a fairly well-defined trend, that has been traced for more than half a mile.

It has been suggested that this dyke is a continuation of the albitite dyke on the St. Paul property on Thornhill mountain, but attempts to trace them through have not met with success.

The dyke on the Dardanelle property is probably partly in granitic rocks, said to be similar to those on Thornhill mountain, and partly in "greenstone" which may be of volcanic origin, or a dense phase of albite-rich diorite. Along the dyke on either side for 600 feet and possibly much farther, veins have been found at intervals in natural exposures, pits, trenches, shafts, and adits. The veins range in width from 1½ to 7 feet. They consist of quartz containing galena, sphalerite, chalcopyrite, and pyrite. Their gold content according to assay returns ranges from a trace to 1 ounce a ton. The rocks in which the veins lie exhibit shearing and the veins also have been somewhat sheared. The dyke is said to carry low values in gold.

## Lower Kitsumgallum Valley

The lower part of Kitsumgallum valley lies along the contact between a large body of albite-rich granitic intrusives to the east and a considerable area of older volcanics and other rocks to the west. Numerous, large and small inclusions of these older rocks lie in the granite-diorite assemblage as displayed on the east side of the valley. Around Kitsumgallum lake numerous small veins occur and many of these carry values in gold. Narrow veins were observed southeast of the end of Kitsumgallum lake and quartz-gold stringers occur on the knolls northeast of Terrace where small remnants of albite diorite are sharply cut by albite granodiorite. In most of the localities the deposits are so well within the intrusive bodies that only the roots are likely to be left.

Kalum Lake Mines.[1] On the Kalum Lake Mines property granodiorite is

[1] Ann. Repts., Minister of Mines, B.C.; 1925, p.48; 1927, p.63; 1930, p.74.

cut by dykes of albite syenite(?). Small irregular quartz veins and shear zones traversed by stringers cut these rocks and in turn are cut by andesite or basalt dykes. One vein with an average width of 1 foot has been developed by a shaft. The vein is made up of pyritized quartz with a little chalcopyrite and carries free gold. A representative sample of 500 pounds of vein matter assayed 3½ ounces of gold a ton, of which 3 ounces were free. Southwest of the shaft a shear zone up to 2 feet wide, and holding stringers of quartz carrying pyrite with rare specks of galena and chalcopyrite, has been traced for about 200 feet. It carries little gold. Elsewhere there are irregular zones of stringer, up to 5 feet wide.

## Head of Kleanza Creek[2]

At the head of Kleanza creek, 12 to 22 miles from the

[2] Hanson, G.: Geol. Surv., Canada, Sum. Rept., pt. A, p. 113. Ann. Rept., Minister of Mines, B.C., 1917, p. 94.

railway, in and near stocks of granodiorite, there are a number of copper deposits generally with low silver and no gold. They occur in shattered or sheared zones or replace volcanics or limestone. Some sparsely mineralized zones have considerable widths, and zones or series of zones have been traced for considerable distances. The properties include: North Star (Avon, Lowrie), Peerless, Wells, Montana, and Lucky Jim.

## Head of Chimdemash Creek[3]

At the head of Chimdemash creek mineral deposits occur

[3] Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1925, pt.A, p.113. Ann. Rept., Minister of Mines, B.C., 1924, p.88.

near and just within a stock of diorite and gabbro and are probably related to it. The deposits are in the form of veins that are mainly small, but in places form zones ranging in width up to 6 feet. The veins are well defined and persist for considerable lengths. The minerals are mainly tetrahedrite high in silver, with some veins mainly of bornite, or of bornite and chalcopyrite, or of other sulphides. Other minerals present are galena, pyrite, chalcopyrite, chalcocite, and native silver. Assays show silver to nearly 200 ounces and copper to 25 per cent. Gold is generally low, but some assays reported by owners run up to 1.36 ounces.

The important properties include the Silver Basin and Silver Crown, the Coffee Pot, and the Banner-Homestake group. The mineralization on the Banner-Homestake group may not be related to the stock. Work was done on these properties mainly between 1923 and 1926.

## Legate Creek Area[1]

Legate Creek area, which is 12 miles by a good route

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[1] Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1925, pt.A, p.111. Ann. Repts., Minister of Mines, B.C.: 1928, p.147; 1929, p.153.

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with easy gradient from the Skeena, was the subject of much interest prior to 1929, when the Consolidated Mining and Smelting Company after two season's work on two of the properties withdrew from the district. Since then little attention has been paid to the section. In 1917, 123 tons of high-grade float (20 per cent copper, 25 per cent lead, 25 ounces silver) was gathered on one property and shipped out.

All the showings are located near or just within a stock of diorite and syenite, or along or near quartz-feldspar porphyry dykes or sills that are probably related to the stock. There are sufficient similarities to suggest that all the deposits are related to one another and were formed at about the same time,

but from place to place in each deposit and from deposit to deposit there is a very wide range in composition. Most of the deposits carry only low values in gold, but the gold content ranges to as high as 1.21 ounces (on the Zona May). It is also reported to be high on the Nabob. Silver values are good to high in sections of all properties, but many assays where other metals are high show low silver, and in places where other metals are low silver may be high. Copper, lead, and zinc, all three, any one, or any two, may be high to very low, or absent. Tungsten occurs in one deposit. The minerals present include chalcopyrite, bornite, tetrahedrite, galena, pyrite, chalcocite, sphalerite, hematite, scheelite, native silver, and probably, free gold.

The properties include the Frisco, M and K, M and M, Zona May (White Bear and South Fork), Regina, Nabob, Independence, Hidden, and Grey Copper.

## Dorreen Mountain to Kitsalas Mountain

Along the northwest side of Skeena river between Dorreen and Kitsalas mountain there is a large area of volcanics bounded on the northwest by granitic intrusions, in part albite rich, and in part andesine granodiorite, and cut by innumerable small masses mainly of these two types and of rhyolite in the form of dykes and sills. Although geological conditions appear to be favourable, the number of mineral deposits as yet found is not very large. A mixed sulphide gold deposit occurs on Hardscrabble creek. Chalcopyrite-bornite-pyrite deposits with low amounts of silver and little or no gold occur on the Canyon group associated with rhyolite dykes. Many other similar deposits occur in this section. On the Phoenix group the mineralization is mainly in the form of veins heavily loaded with pyrite, but lacking, so far as known, important values. On the Prosperity group there is a small pocket of very high-grade tetrahedrite mineralization. On the Helen claim silver-copper-zinc mineralization occurs.

Grotto.[1] On this property for about 400 feet along Hardscrabble

[1] Ann. Rept., Minister of Mines, B.C.: 1931, p.71; Bull. no. 1, 1932, p.56.

creek there are numerous small gash veins of quartz, pyrite, chalcopyrite, hematite, and sphalerite with, in places, important amounts of gold and silver. The veins cut volcanic rocks or possibly the rock is a dense form of albite-rich diorite. Some of the veins cross the creek, whereas others parallel it. A number, completely exposed in the creek bed, are lenses 10 to 60 feet long and up to 4 feet wide. Some of the veins that cross the creek appear to be about the same size, as they can be seen to pinch out in places and only a few are visible on both sides of the creek. Where most abundant the lenses do not make up more than 10 per cent of the rock. At one place in an area about 20 feet square, numerous small stringers make up 5 to 30 per cent of the rock. At the main workings a very irregular mineralized zone has been found, possibly for 100 feet, along a zone exhibiting shearing. This occurrence appears to be better defined than any other, and though in places it widens to 3 to 4 feet, elsewhere mineralization is absent or it is sparse. A few feet away from it is a mass of andesine granodiorite, 75 feet long and 25 feet wide. Upstream the granodiorite appears to underlie the zone as if cutting it off. In an adit that follows the main zone there is a dyke of the same granodiorite which, however, is dark grey and dense. This dyke is believed to follow the zone partly in it and partly on either side. The texture of the intrusive mass is medium grained and porphyritic and suggests that the mass is small. Nevertheless it is exposed over a considerable area and most probably cuts off the mineral zone at no great depth.

Assay results show an unusually high silver content for this type of deposit, in places 10 to 40 ounces; the highest silver

assay return was from a sample with much hematite. Gold, which seems to be present mainly with the chalcopyrite, ranges up to 1.74 ounces and some assays much higher have been reported, but in the main are less than a half ounce.

Lay reports that an "aplite"[1] dyke, reported by

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[1] Dykes identified as rhyolite have commonly been called aplite in other reports.

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prospectors to be the same as that on the Canyon claim, sparsely mineralized with chalcopyrite, gave selected samples that assayed: gold, trace, silver, 0.2 ounce, and copper, 1 per cent.

Canyon.[2] In the cliffs on either side of Hardscrabble creek

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[2] Ann. Repts., Minister of Mines, B.C.; 1929, p. 152; 1931, p.71.

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there is a flat-lying, 3 to 10-foot rhyolite dyke cutting albite-rich diorite porphyry. The dyke and the adjacent rock are sparsely mineralized with bornite, hematite, and chalcopyrite that undoubtedly originated in the dyke. On the west side quartz veinlets carrying the same minerals are reported to continue for some distance in the country rock. Samples of the best rock from the dyke assayed: gold, 0.14 ounce to the ton, silver, 0.8 ounce, to the ton, copper, 2.8 per cent; and from the veinlets beyond the dyke: gold, a trace; silver, 6.2 ounces; and copper 19.5 per cent.

Phoenix Group.[3] On this property, on a tributary of Nicholson

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[3] Ann. Rept., Minister of Mines, B.C., 1928, p.145.

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creek, andesine granodiorite is in sharp contact with massive, green and grey volcanics. There is much mineralization in the granodiorite near and along the contact. Quartz veins heavily loaded with pyrite and up to 6 feet wide cut the granite. Some barren quartz veins or lenses of a similar thickness follow the contact. In places a little molybdenite was noted. Three samples

of various types of the most highly mineralized rock failed to yield any gold and showed a maximum of 1.39 ounces of silver.

Prosperity. On this property on Dorreen mountain the main showings are in a spur of argillite that extends into, and appears to form, a thin shell lying on andesine granodiorite or quartz diorite. It follows the bedding and strike across the spur which is 500 feet wide at this point. Both below and above the property, the granodiorite, which is extensively exposed, contains only small quartz gash veins that are mainly barren. The main deposit is exposed intermittently along a length of less than 300 feet. Over a length of 50 to 60 feet the deposit is a vein 12 to 18 inches wide, varying in composition from quartz with moderate amounts of tetrahedrite and pyrite to massive sulphides. The massive tetrahedrite carries about 200 ounces in silver and 0.12 ounce in gold to the ton. One hundred feet higher the vein has the same width, but is of barren quartz and in a short distance becomes a series of barren stringers, narrows, and ends against the granodiorite. In places the granodiorite crosses the course of the vein, and in such places the vein is lacking. The evidence suggests that the mineralization is related to the granodiorite but that it occurs outside the intrusive, and, therefore, is not likely to continue to any great depth. It is possible, but less probable, that the deposit is older than the granodiorite and has been cut off by it.

The rocks along the contact are well exposed and the mineralization appears to be largely confined to the area in which the argillite lies on the granodiorite in a relatively thin shell. Elsewhere the contact appears to dip steeply. Slightly mineralized showings were observed at a number of other points on the mountain. Quartz veins, most of them barren or nearly so,

occur along the contact of the granodiorite to the head of Knauss creek and reported by prospectors along the south forks of Fiddler creek.

Helen.[1] On this claim, quartz, chalcopyrite, galena, sphalerite,

[1] Ann. Rept., Minister of Mines, B.C., 1933, p.85.

and pyrite are very irregularly distributed along a very schistose bed of argillite and in fractured parts of adjacent, black, dacitic tuff or greywacke. The mineralized zone is 5 feet wide in places, strikes about 40 degrees west of north, and dips 35 degrees southwest. The rocks are cut by a large, black, basaltic dyke that is somewhat sheared and mineralized, and this in turn is cut by an oligoclase-diorite dyke 100 feet wide, which may be responsible for the mineralization. A younger sill of fine-grained material follows the mineralized section, divides it in places, and includes blocks of mineralized rock. The deposit is well exposed over a large area because a stream has cut into the soft schist along the sill and the mineral deposit is seen to lie like a blanket on the surface. The heavier mineralization appears to be localized in a small area, since up and down the hill the schist zone is only sparsely mineralized. An assay across 3 feet of the better part of the zone gave: gold, trace; silver, 10.5 ounces per ton; copper, 3.5 per cent; zinc, 4 per cent.

Other Properties. Between Lowrie and Nicholson creeks there are a large number of showings,[2] mainly of sparse chalcopyrite, bornite,

[2] Ann. Rept., Minister of Mines, B.C.: 1928, p. 144; 1930, pp. 134 and 136.

and pyrite with low to moderate amounts of silver.

St. Croix to Kleanza Creek

A large number of mineral deposits have been discovered throughout the lower parts of the drainage basins of St. Croix, Chimdemash, and Kleanza creeks. Some are related to dykes that, judging by written reports and information from prospectors, are similar to the rhyolite dyke on the Canyon property. The mineralization on most of the properties is described as consisting in the main of sparsely distributed chalcopyrite and bornite with low values in silver. Some of the mineral deposits, such as those on the Shenandoah claim and on Bornite mountain, appear to continue over lengths unusually great for this district. On Bornite mountain gold values in average samples range up to 0.3 ounce.

On the Algoma property[1] near granitic intrusives there

[1] Ann. Rept., Minister of Mines, B.C., 1931, p.71.

is some evidence of copper minerals in volcanic rocks. On or near this property it is reported that dykes similar to that on the Canyon property are similarly mineralized with copper. At the St. Elmo property[2] chalcopyrite and hematite occur sparingly. In a quartz stringer on the Golden Cache[3] some free gold was found. On the Shenandoah[4] extensive operations were conducted on a zone

[2] Ann. Rept., Minister of Mines, B.C., 1929, p. 151.
[3] Ann. Rept., Minister of Mines, B.C., 1932, p. 83.
[4] Ann. Rept., Minister of Mines, B.C., 1928, p. 14; 1929, p. 150

said to be at least 1,800 feet long and 4 to 5 feet wide, holding in places relatively lean silver-copper-lead-zinc mineralization and elsewhere copper-low silver mineralization. At depth in one place it was found to be very low grade. On the Mitts,[5] zones

[5] Ann. Rept., Minister of Mines, B.C., 1930, p. 135

that are fairly wide in places carry sparsely distributed chalcopyrite and bornite and hold, in places, small amounts of silver and lead. On Bornite mountain, on the Emma, Four Aces, Usk,[1] and Bornite King[2]

[1] Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1926, pt. A, p. 116.
[2] Ann. Rept., Minister of Mines, B.C., 1931, p. 70.

claims, especially the first named, some well-defined veins give promise of continuing some distance. They are sparsely mineralized with chalcopyrite and bornite and hold low values in silver and in places in gold (up to 0.3 ounce). On the Toulon property[3] a deposit with sparsely disseminated chalcopyrite and bornite low in silver follows an "aplite" (rhyolite?) dyke in andesitic volcanics. On the Big Boy[4] there is a deposit with some chalcopyrite and abundant

[3] Ann. Rept., Minister of Mines, B.C., 1929, p. 150.
[4] Ann. Rept., Minister of Mines, B.C., 1932, p. 84.

pyrite contains small amounts of silver.

## Lorne-Maroon Section

The Lorne-Maroon section includes most of the area of the drainage basins of Maroon, Hall (Falls), and Douglas creeks, tributaries of Kitsumgallum lake, and of Fiddler and Lorne creeks, tributaries of the Skeena. To the south the boundary of the section is the contact of a large area of granodiorite. The section has attracted much attention because of the occurrence of placer gold in the creeks and the presence of numerous lode deposits carrying a high gold content.

The area is mainly underlain by the bedded rocks of the younger, sedimentary-volcanic group. Conglomerate and tuff in places occur in thick, massive beds. There are several separate conglomerate horizons. Albite-rich intrusives occur throughout the area. There are dykes, most of which are nearly vertical, and sills which, following the bedding, have lower dips. Individual

dykes and sills may be as much as 200 feet wide and continuous for miles. There are also laccoliths where sills widen out and assume mushroom shape, and small stocks. Some of the granodiorite of the extensive areas to the south is believed to be of the same character, but large areas in the east are of the younger andesine granodiorite and there are bodies of hornblendite, diorite, and syenite that are not believed to be related to the albite-rich intrusives.

Mineral deposits, which are fairly abundant, have been found near, or less commonly in, practically all stocks of the albite-rich intrusives and in, or less commonly near, laccoliths and dykes. Sills show a little, but in the main unimportant, mineralization. The deposits are mainly small veins of quartz with some carbonate and carry pyrite, black sphalerite, galena, free gold, minor amounts of chalcopyrite, and less commonly, pyrrhotite. Many assayed samples carries more than one ounce in gold, but only relatively low values in silver. Other deposits, either well mineralized or sparsely mineralized, carry low values in gold.

Most of the important deposits that occur outside but near intrusive bodies lie along bedding planes below massive beds of conglomerate or tuff and near or over anticlinal axes. The deposits formed in such positions are almost invariably thickest on the crest of the fold and thinner down the dip. The Black Bear, Black Wolf, Fiddler, and many less important veins are believed to be of this type. A zone of possible merit on the Scenic and Log Cabin groups may be of this type or it may not be related to the bedding. In the sediments in many places, especially near these veins, innumerable, small veins fill fractures that have resulted from the folding or other causes.

Members of another large group of deposits occur in nearly vertical dykes cutting across the strata. Deposits of this type are in the main unlikely to be of economic importance. They are chiefly veins confined to the dykes or extending very short distances beyond them. They parallel the dykes or cut obliquely across them. In places the veins follow along the walls of the dykes. They are generally short, lenticular, and of the nature of gash veins. Some, however, are probably at least 100 feet long and as much as 5 feet wide. In places they are so numerous that sections of the dykes could be mined as a whole. Where the extent of mineralization is great the dykes are in places completely altered to a light grey, rusty weathering aggregate of carbonate, mica, quartz, etc. Assays of this material have not shown the presence of important values.

Other known types of deposits are rare or unimportant. On the Belway property one deposit occurs in a schistose zone and another carrying bornite and gold occurs in a dyke or sill of green augite diorite. Similar occurrences to this are seen farther east along Maroon creek.

Fiddler.[1] On the Fiddler property, on the west side of Knauss

[1] Ann. Rept., Minister of Mines, B.C.: 1916, p. 102; 1925, p. 131; 1926, p. 125.

Creek valley, a thick series of andesitic volcanics overlies a thick series of argillites. The contact between the two series is fairly regular and strikes about east to 30 degrees south of east and dips north 20 degrees to 30 degrees. On the east side of the valley the strike of the strata is roughly 20 degrees to 40 degrees east of south and the dip is 40 degrees to 60 degrees east. Knauss creek appears to be located on the crest of an anticline plunging steeply north.

The Fiddler vein occurs on the steep valley side west of Knauss creek where it lies along or close to the contact between the argillites and the volcanics. It is visible in natural exposures and in cuts for a distance of nearly 1,000 feet, and over a range in elevation of 500 feet, and is reported to continue 1,000 feet farther up the hill. In the lower 1,000-foot stretch it is 6 inches to 4 feet wide, averages about 2 feet, and tends to narrow toward both ends of this part. An adit driven in a westerly direction, almost directly into the valley wall from a point at about the middle of the 1,000-foot stretch, follows the vein for about 290 feet. In the adit the vein pinches and swells and narrows westward to 2 to 5 inches. In two raises from the drift, of considerable length, the vein decreases in thickness in an upward direction. Since the raises are inclined so as to parallel the valley slope, the thinning of the vein in them seems to indicate that at levels above the adit the vein also decreases in thickness to the west. In an adit near the lower limit of the 1,000-foot stretch the vein is 1 to 10 inches wide.

The vein is unusually continuous and is well mineralized throughout with pyrite, galena, sphalerite, and some chalcopyrite. The sulphides in places are concentrated in the middle of the vein. Values in gold as indicated by assays, range from 0.25 ounce to 6.54 ounces a ton. In 1926, 100 tons of ore from the vein were shipped. One lot of 35 tons averaged 1.28 ounces of gold and 5.3 ounces of silver a ton, 6.1 per cent lead, and 3.8 per cent zinc.

The character of the vein closely resembles that of the veins on the nearby Patmore property. Only a small part of the Fiddler vein has been removed. Mining has been most extensive on the wider parts of the vein which were also the most accessible.

The vein widens markedly in small rolls of the enclosing strata and without doubt the development of the vein was governed

by the structure of the bedded rocks.

A younger andesine granodiorite dyke about 200 feet wide cuts the vein on the surface and in the main adit. Offshoots from the dyke in places follow the vein.

Patmore. The Patmore group, discovered in 1934, covers most of the north side of the mountain above Knauss creek. In this area the rocks are largely argillites, but tuffs are also present and in places form beds of considerable thicknesses. The bedded rocks are cut by numerous dykes of albite diorite, some of which are 50 to 200 feet wide. Two or more sills are distinctly visible on the higher slopes where they extend to the top of the mountain. The dykes appear to be offset in places by faults.

The albite diorite in places near some of the many veins occurring in the dykes is completely altered to a light grey rock that weathers rusty brown due to the decomposition of pyrite and is traversed by innumerable carbonate-quartz stringers, some of which follow fissures, whereas others replace the rock.

The veins on the Patmore property are mainly confined to the diorite dykes, but in places extend a short distance beyond them or follow along their borders. Most of the veins are gash veins less than 2 feet wide at the maximum and fairly short. Most of them strike parallel to the dykes, but some crosscut them. In the main workings the veins have widths up to 5 feet, are irregular in strike and in thickness. It is notable that the larger veins occur in the lower workings and the smaller veins higher up the mountain, and that well up toward the top of the mountain the dykes do not appear to carry veins. The alterations of the diorite also markedly decreases as the mountain is ascended. The higher veins are fill fissures and consist of quartz, carbonate, galena, chalcopyrite, sphalerite, and pyrite. In the lower workings they are in part replacement bodies. A sample considered

to be representative of one of the best veins assayed 0.26 ounce gold and 6.74 ounces of silver a ton. Channel samples are reported to assay from a trace to somewhat over 1.5 ounce in gold and selected samples have yielded over 6 ounces.

The veins occur in a heavily wooded area where rock exposures are mainly of the diorite and the individual exposures are small. They extend up the slope for about 1,000 feet and over a vertical range of 600 to 800 feet. The main showings occur along the hillslope for a few hundred feet. Above the main workings the showings are largely confined to one dyke 100 feet wide in the upper part and possibly 200 feet or more wide near the main workings.

At the main workings very little rock is exposed and it is not possible to determine how many separate bodies of diorite there are, nor to what extent they are offset by faulting. The best veins that have been discovered have been disclosed by stripping. Some veins and zones of veins have widths up to 5 feet and in one place 10 to 15 feet. The veins and zones are irregular in trend, width, and in extent of mineralization, and are faulted. In places, allowing for faulting, the mineralization continues for at least 30 feet, but in other places the deposits seem to be very short. Where exposed the main deposits, together with smaller veins, constitute a small percentage of the total area of diorite.

Black Bear and Black Wolf.[1] On the Black Bear, Black

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[1] Hanson, G.: Geol. Surv., Canada, Sum. Rept. 1923, p. 43.
Ann. Rept., Minister of Mines, B.C.: 1927, p. 63; 1930, p.74.

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Wolf, and adjacent claims the strata lie in an anticline which strikes north 65 degrees east and plunges steeply northeast. The anticline is somewhat irregular, so that beds along the flanks do not show regular strike and dip. A massive conglomerate bed is

present and to the southeast forms a prominent cliff. In the face of this cliff are the main showings on both properties. On the northwest side of the anticline the conglomerate occurs only in narrow remnants in the base of a minor syncline. The rocks are cut by dykes of albite diorite or granodiorite. On the Black Wolf one of these dykes weathers rusty brown, is grey on fresh surfaces, and contains some mineral deposits of minor importance. Numerous small gash veins of quartz occur in and near the dykes and in fractures in the other rocks. Irregular masses of quartz of considerable size occur in places, especially in shattered areas along dykes. In the main these deposits are barren or low grade.

The more important deposits are veins that follow the bedding in the lower part of the conglomerate or in an underlying series of argillite and greywacke or tuff. These veins carry pyrite, galena, sphalerite, and some pyrrhotite and free gold, in a gangue mainly of quartz but with some carbonate and chlorite. The veins pinch and swell and in many places this is clearly related to minor contortions of the enclosing strata. Where the containing beds are greatly contorted the veins also twist and turn. They are not sufficiently shattered to suggest that the structure was developed after the formation of the veins, though they do display some shearing.

On the Black Wolf the veins occur at two or more horizons. One vein at the south end of the showings lies under and in conglomerate and is traceable from a fault for over 100 feet and maintains a width of about 1 foot. It is considerably contorted. Another vein, to the north, in a lower horizon in argillites, may continue for 300 feet. Its maximum width is 1 foot, but for the most part it is much narrower than this. A third vein in the same section as the second is 1 foot wide in places. Extensions of these or two other veins of about the same size occur to the northeast and are traceable for some distance.

The total distance over which these veins are exposed is probably about 1,000 feet. A distance of about 1,000 feet, wherein rock exposures are few, separates these showings from those on the Black Bear. Mineralization in other horizons parallel to these is in the main slight. Some ore has been shipped to the smelter from the Black Wolf and a few tons remain sacked at the property.

On the Black Bear one vein has been traced by open-cuts and natural showings for over 1,400 feet, beyond which, in both directions, pits have failed to show much mineralization. It follows the bedding and along most of its length lies in argillites below a bed of greywacke or tuff, and 75 to 100 feet below the conglomerate. It has a general strike of north 60 degrees east and dips 60 degrees south. For the first 600 feet, commencing at the most westerly exposure, the vein for the most part varies in width between 1 and 2 feet and, locally, in rolls attains a width of 4 feet or more. In the next 500 feet the vein is mainly less than 1 foot wide. At the end of the 500-foot section, the vein appears to be offset 75 feet, beyond which it continues for over 300 feet, but for the most part is only a few inches wide. Throughout the traced length of 1,400 feet the vein pinches and swells and in places it splits and is intermixed with argillite or greywacke (or tuff). In places it is greatly twisted as a result of following contortions in the argillites.

Underground the vein has been followed for a length of about 90 feet at a place about 70 feet below one of the better sections visible at the surface. In the drift, the vein over a length of 20 feet ranges in width between 6 and 10 inches, for the next 30 feet it is absent, and for the next 40 feet it averages 10 inches with a range of 6 to 18 inches.

The vein is well mineralized. In order to ascertain the feasibility of milling these ores, 50 pounds of ore were sent to

the Mines Branch. From the complete report the following data has been extracted.

".....The gangue material consists almost wholly of white, fine-textured vein quartz. .... The following ore minerals are present: pyrite abundant, marcasite, pyrrhotite, galena, sphalerite, chalcopyrite, arsenopyrite, limonite, and free gold. .....

"Native gold occurs in very close association with the disseminated type of pyrite, and is present in the polished sections only where the pyrite is exceptionally abundant .....

"Analysis showed the ore to contain:

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|---|---|---|---|
| Gold | = | 1.30 | oz. a ton |
| Silver | = | 3.41 | " |
| Lead | = | 6.25 | per cent |
| Zinc | = | 8.75 | " |
| Copper | = | 0.45 | " |

"Conclusions from Experimental Tests. It is apparent, both from the character of the ore and from the results of these amalgamation tests, that a low recovery of the gold content will result from any simple and cheap method of treatment. The galena in the ore covers the amalgamation plates so that no gold is saved.

"Barrel-amalgamation recovers 42.5 per cent of the gold from the raw ore.

"Amalgamation of a concentrate does not effect any appreciable recovery.

"The ore should be an ideal concentrating proposition, preferably by selective flotation .... No cheap and simple operation on a small scale can be expected to make appreciable recoveries from this class of material."

Treadwell (Belway).[1] The Treadwell property is located in a belt

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[1] Ann. Rept., Minister of Mines, B.C., 1927, p.63.

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of mica and quartz schists that are due to metamorphism of bedded rocks. Mineralization occurs in two places: at one locality in

a dyke or sill of green augite diorite that is about 100 feet wide and has been considerably sheared, silicified, and otherwise metamorphosed. The dyke is traversed by irregular fractures with light green borders due to epidotization. It is irregularly mineralized with bornite and is said to carry free gold. On the old Crown group on Maroon creek 5 miles away similar green rock is said to carry lenses of bornite but no gold values.

At another point on the property in a highly sheared section in sericite schist there is a zone 2 feet wide that is rusted, is stained with malachite, carries lenses of pyrite and quartz, and is reported to hold fair values in gold. Mineralization is best where shearing is greatest. A short drift has been run in the zone and along this drift the zone appears to split; the main part may leave the drift on the north side.

Other Mineral Deposits. On the west side of the most easterly fork of Hall creek quartz-pyrite veins and stringers occur along the bedding in argillite below massive greywacke or tuff near an albite-quartz porphyry dyke. A shattered zone largely confined to the dyke carries quartz-pyrrhotite-chalcopyrite mineralization and below what appears to be a laccolithic expansion of the dyke is a vein of fair width and length which could not be examined. Some of these veins are reported to carry fair gold values. At the head of Maroon creek on the Scenic and Log Cabin claims[1]

[1] Ann. Rept., Minister of Mines, B.C., 1928, p. 71.

in an area of dykes, scattered mineralization occurs not far below a massive conglomerate bed. One zone is reported to be 8 to 10 feet wide, and to contain stringers of pyrite and chalcopyrite. A sample taken across a width of 5 feet assayed 0.54 ounce in gold, 4 ounces in silver, and 0.5 per cent copper. Lower on the creek, along the north side, narrow lenses of bornite are reported to carry low values in gold.

On the Virginia and Comstock claims north of the head of Hall creek, a narrow, low-dipping dyke of albite-rich diorite holds gash veins of quartz carrying pyrite, sphalerite, galena, and a little chalcopyrite and, it is said, free gold. Assays of samples indicated a low content of gold. Mineralization is reported on the north side of Goat mountain, and on the east side of Douglas creek near its head. In both localities there are said to be quartz-sulphide veins with fair gold values. Farther north, near the head of Lorne creek, albite-rich diorite dykes carry small gash veins composed, in one place, of quartz with pyrite, galena, and sphalerite, and in another place, pyrrhotite, chalcopyrite, galena, and sphalerite. A sample of highly altered dyke rock was found to carry neither gold nor silver. Some showings in this area, it has been stated, are of fair size and carry gold in amounts as high as 0.6 ounce a ton and silver as high as 13 ounces. A quartz-sulphide vein carrying good values in gold occurs on the spur between the centre and south forks of Lorne creek.

## Oliver-Kitwanga Section

The Oliver-Kitwanga section includes the area on the west side of the Skeena from Lorne creek to Kitwanga river and on the east side from Oliver creek to Kitsequekla river. Throughout the area the rocks are mainly well-bedded strata, chiefly argillite, sandstone, and conglomerate, but interbedded in various sections there is also much dacitic and andesitic tuff and probably some lava. The dominating features is the Seven Sisters dome. The sedimentary beds forming the top of the mountain appear to be nearly horizontal, whereas the strata on the sides of the mountain dip outwardly at angles mainly of 10 to 40 degrees. The core of the mountain as exposed in the bottom of deeply glaciated valleys is quartz monzonite. Possibly the mountains along the trend of

the range to the north are of similar nature and the intrusive may be a correlative of masses of similar quartz monzonite that extend in a belt in the eastern part of the Coast range from south of Atlin lake to north of Iskut river. Small intrusive bodies, probably mainly granodiorite, occur near the Windfall property on Porcupine creek, north and south of the river near Woodcock, and in the vicinity of the Dynamiter property farther south. Possibly they are related to the intrusives of Bulkley mountain to the east rather than to the Coast Range intrusives to the west.

Mineralization and evidence of it in the form of rusty exposures is widespread throughout this section. Most of the deposits carry lead, zinc, and (or) copper with low values in gold and silver, and occur along bedding planes as fissure veins and replacements, or in or near the small granodiorite intrusive masses. In many exposures throughout the area sparse mineralization can be seen along the bedding planes. Larger amounts generally occur between beds of different character and where the regular structure of the strata is disturbed by minor anticlines, crumples, faults, or other features. Deposits, such as those on the Windfall, Seven Sisters, and Waverley claims, appear to lie in the crests of minor anticlines and mainly in or over tuff beds. On the Windfall and Seven Sisters claims and in many other places it is clear that the mineralization dies away in a very short distance down the limbs of the folds. On the Seven Sisters claim similar deposits occur at successively lower horizons on the axis of the fold.

Saline deposits of finely divided calcium carbonate in demand locally for land dressing occur 1 mile west of Ritchie.[1]

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[1] Ann. Rept., Minister of Mines, B.C., 1932, p. 91.

Waverley.[1] The Waverley showings occur on a comparatively level

[1] Ann. Rept., Minister of Mines, B.C.: 1929, p. 153; 1930, p.137

bench, in an area about 1,000 feet long. Within this stretch sulphides occur in a number of areas 50 to 100 feet long and 5 to 25 feet wide and are also scattered widely in still smaller amounts. The mineralized areas as seen on the surface are not continuous with one another and there is no reason to believe that they are continuous beneath the surface. The mineralization is in the main sparse, but massive sulphides, including galena, sphalerite, and pyrrhotite and small amounts of chalcopyrite, occur in pockets, stringers, and in breccia. A sample of a section rich in sulphides assayed 39 ounces of silver to the ton, 23.2 per cent lead, and 9.2 per cent zinc.

The rocks are mainly argillite, sandstone, and conglomerate and they dip south at angles of about 25 degrees but are considerably contorted near the deposits. With the clastics there is some completely altered rock that is probably dacite tuff or flow but may be intrusive. Mineralization has been largely confined to shattered zones in this altered rock. It occurs both as cavity filling and as replacements. In places it is flat lying and much of it may be of the nature of an irregular blanket that has been to a considerable extent eroded.

Seven Sisters Group.[2] On the Seven Sisters group scattered

[2] Ann. Rept., Minister of Mines, B.C.: 1927, 1928, 1929.

mineralization occurs along the mountain slope at about the same level for about 4,000 feet. It occurs in pockets, in stringers, in irregular fractures, and along one zone of alteration dipping easterly into the mountain at an angle of about 45 degrees. It occurs mainly in volcanics that are overlain by conglomerate,

argillite, and sandstone or greywacke. On the higher parts of the spurs on the mountain slope there are some large masses of solid sulphides. Between the spurs the mineralization as it is followed down the dip into the valley of a creek becomes progressively poorer, and sinking on the main zone has shown little mineralization. The mineralization is mainly pyrrhotite and zinc blende with some galena, pyrite, and chalcopyrite. Published assays show low values in silver.

At the property the geological structure is not entirely evident because of the massiveness of the volcanics. Elsewhere over the whole mountain side it is evident that the strata dip west except where, because of minor folds, they dip east for a few hundred feet. To the south, along the strike of the showings, a small knob is capped with conglomerate which with an underlying mineralized zone can be seen to lie in the crest of an anticline, and the main mass of mineralization north of the creek has the appearance of being a saddle-shaped deposit in the crest of an anticline. From these data it appears that mineral occurrences are localized along the crest of a minor anticline and lie between beds and in and along fractures in the massive volcanics. The fractures resulted from the folding. They tend to be radial and widen out away from the axis, as is clearly displayed in some of the workings. Between the spurs the best part of the deposit has been eroded away. Mineralization occurs at least at two separate horizons on the crest of the fold.

Windfall.[1] On the Windfall property mineral showings occur in

[1] Ann. Rept., Minister of Mines, B.C., 1931, p.71.

the crest of a sharp anticline that trends about east and west. The strata of the north limb dip north at an angle of 55 degrees and those of the south limb dip south at 45 degrees. The mineralization occurs under a thin band of argillite partly

between it and shattered andesite tuff and partly in the tuff. On the north limb there is little mineralization. On the crest of the fold the zone is 5 feet to 12 feet thick. Down the dip on the south limb it narrows to 2 feet in about 8 feet to the lowest part of the showing. The exposure is on the wall of a canyon that trends obliquely to the strike of the rocks. The point, therefore, where the anticline would occur if present on the opposite side is some distance upstream. The mineralization in the small lens exposed consists of the common sulphides and is in part replacement and in part fissure filling in the shattered and sheared andesite in the crest of the fold. A sample taken across a width of 5 feet assayed: gold, 0.01 ounce; silver, 7 ounces a ton; lead, 7.2 per cent; zinc, 24 per cent; copper, 0.9 per cent.

Morning Star.[1] On the Morning Star property a small stock of

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[1] Ann. Rept., Minister of Mines, B.C., 1931, p. 129.

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partly altered granodiorite (or granite) porphyry cuts argillite, sandstone, and conglomerate. Mineralization that probably is related to the stock is shown by workings scattered over an area at least 1,000 feet long. It extends from just beyond the contact to areas that appear to be well within the granodiorite mass and seems to be localized in certain areas. The cause of the localization or a relationship between the mineralized areas was not observed, but much mineralization occurs at the contact in one area about 100 feet long and is largely stringers and impregnations of quartz and pyrite in and along fractures and faults at right angles to the contact. Different mineral associations which include pyrite, arsenopyrite, galena, sphalerite, chalcopyrite, and molybdenite, are found in several areas. Two selected samples showing galena, sphalerite,

arsenopyrite, and pyrite assayed: gold, 0.02 and 0.04 ounce, and silver 3 and 8 ounces a ton. In one showing molybdenite with pyrite is abundant in stringers of quartz and in the porphyry. Most of the showings are approximately 6 to 20 feet wide by 10 to 30 feet long and the well-mineralized parts 3 to 6 feet wide. These parts have no well-defined trends and in the main that at one pit is not definitely indicated to be the continuation of that at another.

# CHAPTER III

## THE BULKLEY AND BABINE BELTS

### GENERAL GEOLOGY

Bulkley mountains lie east of the Coast range, being separated from it near Skeena river by Kitwanga and Kitsequekla valleys. Farther south, however, the two mountain belts fuse. East of Bulkley mountains is a great northwest valley occupied in part by the section of Bulkley river that the railway follows from Houston to Hazelton, and in part by Skeena and Kispiox rivers for some distance northwest of Hazelton. East of this great valley are the Babine mountains. Bulkley mountains are most prominent in the section west of that part of the Bulkley-Upper Skeena valley followed by the railway. Northward, north of the Skeena, and southward, south of Morice river, they tend to die out. Babine mountains lie mainly between the westward-flowing part of Bulkley river and Babine river, which is some distance north of Hazelton. To the northwest and southeast beyond the limits of both ranges as defined there are isolated peaks and hills which probably belong to the same belts.

The Bulkley and Babine belts are made up of many individual mountains, or mountain groups, isolated from one another by wide, low areas or great valleys. The Bulkley-Upper Skeena valley widens and narrows according to the proximity, size, and abundance of the isolated mountain areas. It is not a normal erosional valley as it does not widen with the increase of volume of water carried. Near Hazelton most of the mountains are high and rugged but southward there is a general decrease in heights near Bulkley valley except for Hudson Bay mountain which rises to 8,500 feet. Well to the west, however, where the Bulkley and Coast ranges fuse there is a chain of mountains that

surpasses in size and ruggedness anything else in the vicinity of the railway in either the Coast or Bulkley mountains.

The rocks of Bulkley and Babine mountains are largely volcanics and sediments cut by small, granitic, intrusive bodies. These bodies commonly form the cores of the isolated mountains and mountain groups, or of prominent hills. They are largest and most abundant near Hazelton where the mountains are the highest and the mountainous areas most extensive. They occur elsewhere mainly in prominent mountain areas, but in places they are marked only by small hills. Granitic and related dykes occur in many other mountainous parts, especially the less prominent ones to the south in Babine mountains. They are much more abundant in the mountains than in the extensive low areas. The relationship of these intrusive bodies to the mountain areas is of great importance since the mineral deposits are related to, and occur near or in, them. The mountain areas, therefore, are the most favourable for the occurrence of metallic mineral deposits and it is in them that all but a few have been discovered.

## Sediments and Volcanic Rocks.

The sedimentary and volcanic rocks of Bulkley and Babine mountains are mainly Mesozoic, ranging from Jurassic and possibly Triassic to Upper Cretaceous. Out of the various groups into which the Mesozoic rocks have been subdivided in the different areas studied only one, the Lower Cretaceous or Skeena formation, stands out as a fairly readily identifable unit in all sections. It is largely sedimentary with minor amounts of tuffs. The other rocks so far as this report is concerned do not need to be carefully classified. They have been subdivided largely on lithological bases. Some of the groups, one of which includes the oldest rocks and others of which are probably considerably younger, consist largely of massive volcanic rocks. These are

mainly fine-grained to dense, and green, grey, red, brown, or purple. Due to irregularity in texture, shape, and size of individual members they are generally fractured and sheared irregularly and, therefore, the mineral deposits formed in the fractures and shear zones are commonly irregular and discontinuous. In places, however, unusual stresses or dykes caused the formation of zones favourable for deposits of greater extent and regularity. These rocks where sheared or fractured were favourable for replacement mineralization. The massive volcanic rocks are by far the most extensive in both Babine and Bulkley mountains southward from near Porphyry creek.

The other groups, which are younger than most of the massive rocks but in part are intermediate between them, show distinct banding due to well-defined bedding. They include mainly argillites, quartzites, greywackes, conglomerates, and tuffs with locally some lavas and limestone. Because of their bedded character they are not so badly fractured as the massive rocks, but the many well-defined though irregular bedding planes afforded excellent channels along which mineral deposits tended to form. Except in the case of the rare limestone members and included volcanics the rocks were not favourable for replacement deposits. These rocks are extensively exposed in the northern parts of the mountain ranges and they continue south to near Porphyry creek. In the southern parts of the ranges they commonly occur in relatively small areas and are probably not very thick. The rocks older than the Skeena formation are commonly designated as the Hazelton group.

The Skeena formation occurs extensively in the low areas between the mountains. Here it is made up mainly of nearly flat-lying, soft shales, sandstones, conglomerates, and bituminous coal. On the east slope of Hudson Bay mountain

rocks previously classified as older were found to contain fossils definitely identifable as belonging to the Skeena formation. The formation here extends nearly to the top of the mountain in a thin shell.. On the western slope it likewise extends up the mountain in a thin shell. A small mass occurs near the top of Hunter mountain and other masses occur in Skeena valley near Hazelton and on the slope of the mountain to the west. The Skeena formation in all these localities is decidedly different from that in the extensive low areas. The strata as previously noted by Leach[1] are badly deformed and dip away from the peaks toward the

[1] Leach, W.W.: The Telkwa Mining District, B.C.; Geol. Surv., Canada, Sum. Rept. 1907, p. 36.

valleys. They are metamorphosed rocks which are indistinguishable from older formations and include anthracite instead of bituminous coal. On the west slope of Hudson Bay mountain the metamorphosed, deformed rock can be followed and found to grade to the unmetamorphosed and undeformed material. Similar stratigraphic successions, the presence of coal, and gradations from one type to another in many localities, as brought out by Leach, offer proof that these metamorphosed masses have been correctly classified as Skeena formation.

Overlying the Mesozoic complex on Driftwood creek and possibly at other places in the region are Upper Eocene or Oligocene sediments including sandstone, shale, conglomerate, lignitic coal, and some white, rhyolitic to glassy tuffs. Younger Tertiary basalts and andesites which form a cliff 1,500 feet high south of Houston cover like a blanket an extensive area southeast of this.

## Granitic and Related Intrusives

The intrusive rocks in the larger bodies are mainly granodiorite, rarely diorite and granite; smaller bodies may be similar or are porphyries (granodiorite, quartz, feldspar, etc.) and rhyolites of similar composition. Most are light coloured and readily recognizable except where altered by mineralizing solutions. The porphyries and rhyolites are merely finer grained phases of the granitic rocks. Many of the granitic bodies are similar in character and relationships and most of them may be related and of approximately the same age. They have been considered by some writers to be Tertiary and by others to be Mesozoic. One body of mount Nadina south of Houston has been classed as Tertiary because it cuts Upper Cretaceous rocks.[1] Since the ore-bodies are considered to be

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[1] Lang, A.H.: Owen Lake; Geol. Surv., Canada, Sum. Rept. 1929, pt. A, p. 62.

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related to the granitic intrusives their age is important, as all rocks younger than the intrusives would be unfavourable for the occurrence of mineral deposits. In 1934, mineralization similar to that in many of the deposits on Hudson Bay mountain was discovered in the Lake Kathlyn Coal mine in rocks bearing Skeena formation fossils. One of the veins on the west side of the mountain also was found to continue into the Skeena formation. In the same year on Viking hill an extensive deposit of pyrite was found in sandstone and conglomerate believed to be of Upper Eocene or Oligocene age owing to the fact that the beds are close to, have the same strike as, and resemble lithologically, strata of that age which outcrop on Driftwood creek. In view of these observations it seems advisable, until the ages of intrusive bodies and the mineral deposits can be definitely

established, to consider that in the main the granitic intrusives are younger than all the Mesozoic rocks of the area, and possibly the Upper Eocene or Oligocene rocks, and that any of these rocks may contain mineral deposits.

## ECONOMIC GEOLOGY

Hundreds of mineral deposits have been found in the Bulkley and Babine belts. Many were known before the projection of the Grand Trunk Pacific railway (now Canadian National) through this district and many have been discovered since that time, which naturally stimulated search and development. Discoveries have continued from year to year and probably many others will be made. Sufficient work has been done on the discoveries to indicate in a general way the nature, size, and mineral content of the most common types of deposits. The Rocher De Boule, the Duthie, and the Silver Standard have recovered, respectively, over $1,350,000 from 39,833 tons of copper ore containing silver and gold, $1,000,000 from about 44,000 tons of silver ore with important amounts of lead, zinc, gold, and copper, and $500,000 from 14,500 tons of ore, mainly silver but also high in lead and zinc and important in gold. A number of other mines have had a small production. On many properties throughout the district much development work has been done. The results indicate that there are deposits, probably containing 5,000 to 50,000 tons with gross valuations of $200,000 to $2,000,000 at average metal prices, that may be expected to yield a profit on small-scale operation. Valuable deposits of much larger size are not normally to be expected, though exceptions may occur, especially where ore-bodies like some of those on Rocher Déboulé mountain are found. Mineral deposits of a grade not as yet indicated to have ore-making possibilities occur on a larger scale. There are many small bodies of high-grade ore containing up to 5,000 tons that might

yield a profit to "gophering", or in some cases to more extensive operations on the part of individuals or very small companies, or in conjunction with other operations.

The important minerals in the deposits include one or more of the following: gold, silver, copper, lead, and zinc. Some deposits on Rocher Déboulé mountain carry important quantities of cobalt, arsenic, molybdenum, and tungsten, which are mainly most likely to have value only as by-products. Bismuth-bearing rock occurs in small pockets in Glacier gulch on Hudson Bay mountain. In the main the deposits carrying important amounts of gold or silver are the most important at a time when base metal prices are at or below the average of the last twenty years. In nearly all of the ores the silver and gold are bound up with pyrite or copper, lead, or zinc sulphides in such a way that they cannot be separated by simple methods. Because of the high cost of transportation from mine to railway and then to the smelter, the base metal content during times of low prices is to a large extent a detriment. When metal prices are high the zinc, lead, and copper in some deposits become important and in some cases deposits with important quantities of these and only little gold or silver may be worked profitably.

Good to high-grade gold deposits and silver deposits are common in many parts of the district, average values being up to and over 1 ounce a ton for gold and 50 to 200 ounces for silver. Districts in which gold values indicate possibilities of profitable mining include Rocher Déboulé, Hudson bay, and Dome mountains. High gold assays have been secured from some prospects in the Ninemile-Fourmile area, in the Driftwood area, on Grouse mountain, at Owen lake, and elsewhere. High silver assays have been secured in most sections, with exceptions mainly in the southern parts of the two belts. The best indications for profitable silver mining appear to be in the following sections: Ninemile-Fourmile, Hudson bay, Driftwood, Hunter basin, and Owen lake. Lead, zinc, and copper are found in all well-prospected and developed sections except Dome mountain

(gold), Hunter mountain (copper-silver), Howson basin (copper), and Morice mountain (copper). Large bodies of mineralized rock that have so far not been indicated to have economic value include Porphyry Creek, Viking, Bob Creek, and Owen Lake deposits. It is notable in connexion with these that impregnations of pyrite in unaltered or highly altered rock have not yet been shown to contain important amounts of valuable metals. However, this should not entirely discourage the testing of other bodies of this type since in the Richfield property at Topley some fair assays have been obtained. In places very low average assays are secured in large dykes, as on the Silver Bell and Fortune Hill properties near Hazelton.

With some exceptions, mainly on Rocher Déboulé mountain, which will be discussed later, the nature of the exposed granitic rocks indicates that the intrusive bodies were formed by simple rather than multiple intrusion. In the main deposition of mineral deposits is closely related to the intrusion, cooling, solidification, and contraction or settling of these bodies. Where mineral deposits occur in the intrusive rocks they are either near the contact or in masses of such small size that they solidified and cooled quickly. In the main it appears that the intrusive bodies were too hot for the harbouring of mineral deposits during this period of mineralization. Some dykes which probably cooled too rapidly to permit of escape of the mineralizing solutions contain metallic minerals sparsely scattered through them.

The fine-grained character of many of the intrusive bodies indicates that they cooled and solidified rapidly. Many characteristics of the mineral deposits indicate that they formed in rocks that were hot only near the intrusive bodies. The distance which the deposits lie beyond the intrusive bodies and the extent to which they continue away from them increases

to a considerable degree with the increase in size of the intrusive bodies. On Hudson Bay mountain where the main intrusive body is not exposed but is probably fairly large, deposits have been clearly shown to have vertical depths of over 600 feet and a similar range away from the intrusive body, assuming that it occupies the core of the mountain. The lengths of the deposits are over 3,700 feet and the vertical ranges from end to end over 1,200 feet. The dimensions are probably much greater over the tops of intrusive bodies as on Hudson Bay mountain than on the sides of deeply eroded masses such as those of Rocher Déboulé mountain.

The largest mineral deposits have been found on or near the largest mountains, such as Hudson bay, Rocher Déboulé, Fourmile, etc., and near the largest intrusive bodies. On smaller mountains, notably in the southern part of the Babine range, and near the smaller and the finer grained intrusive bodies (porphyries and rhyolites) much development work on many deposits has failed to yield deposits of a size comparable with those on larger mountains.

On Rocher Déboulé mountain some of the mineral deposits occur well within a large granitic body. Some of these are of a type that commonly is formed where low temperatures prevail. Therefore, the granitic mass must have solidified and cooled considerably before the deposits were formed. The deposits are thus considerably later in age than the enclosing granitic rocks and must be related to some other deep-seated source. Thus there are indicated possibilities, not only for Rocher Déboulé mountain but for other parts of the district, for the occurrence of deposits with different relationships from those commonly found.

The distribution of deposits in any one locality and the grade of ore in individual veins have in the main shown that

the richest gold ore may occur relatively close to, or far away from, individual intrusive bodies and at various elevations or depths. But there is nothing to suggest that the many low-grade veins exposed naturally or in workings over a considerable vertical range may, at greater depths or in any particular direction, carry more gold. The character of the mineralization changes from place to place in many deposits due to variations in the mineralizing solutions from time to time, and changes in the courses which they followed due to shifting of the rocks.

Secondary enrichment and deep leaching whereby low-grade material is changed to high-grade material near the surface probably occur in many sections. Some of the small, high-grade copper-silver veins may be due to this. Good examples of leaching are found on the Mount Evelyn property on the northern peak of Hudson Bay mountain, and of enrichment on the Santa Maria property, Howson basin.

Information, from geological studies and development work of exceptional value to an interpretation of conditions found in the belt as a whole, is to be found in the descriptions of the following sections: Hazelton (Rocher Déboulé and Ninemile, etc.), Driftwood, Hudson Bay mountain, Dome mountain, Owen lake, and the Plateaux belt at Topley.

Undeveloped sections that appear to be especially favourable for prospecting include the mountains east of the Skeena north of the Kispiox, Suskwa mountains, and mountains between Rocher Déboulé and Hudson Bay mountains. There is, of course, much scope for prospecting in all of the developed areas where the character of deposits likely to be found is already indicated.

## Placer Deposits

Placer deposits are known in only one locality. For 2,000 feet or more below the lower end of the canyon on Bob creek, representing a stretch starting not far above the mouth of the creek, there are old placer diggings. No accurate knowledge of the production is available, but it is probable that it was not great nor highly remunerative. Diggings in recent years have yielded very low returns. The deposits are of interest because of their bearing on the source of the gold. Very little black sand is found with the gold near the canyon, but lower down where the overburden is clearly heavy there is much. The black sand was undoubtedly derived from the drift. Going up the stream toward the canyon the gold appears fresher and rougher. Gold from near the canyon has attached to it material that resembles the altered rock and vein material of the nearby lode deposits as well as quartz. The ratio of gold to silver, 717 to 255 and 732 to 257, of the placer gold is fairly constant whether it is derived from near the canyon or the sections where much drift has been washed. From the foregoing data it would appear certain that the gold came from the altered rock in the canyon section. The amount of rock eroded from the present canyon might be approximately 5,000,000 tons. It becomes apparent, therefore, that the yield of free gold from the rock is probably relatively small.

The gold is in the main fine and much might have been carried away beyond the placer workings. Nuggets range up to 68 cents at $35 an ounce.

Bob Creek now flows in a canyon for a distance of about 1,500 feet. The upper end of the canyon is marked by a contact with Tertiary lavas and the lower end by the mill on this property. The canyon is new and cut out of the rotten

gold-bearing porphyry and volcanics. The pebbles in the creek and fine materials are largely of the country rock. Undoubtedly much of the placer gold has been derived from this rock during the process of cutting the canyon. North of the canyon is an old channel filled by drift. Below the mill in places the old and the new channels conform in position. The old channel might contain more than the present channel, but considering the extent of overburden it would appear probable that there is not enough gold to make it workable. Profitable workings, if such are possible, would appear to depend on having shallow ground that could be mined cheaply.

## Other Mineral Resources

Coal deposits that are bituminous and in places anthracitic in character occur in the Skeena formation at many places in the Bulkley and Babine belts. Lignite occurs in the Upper Eocene or Oligocene strata, on Driftwood creek. In the main the coal areas near the railway are small and although they have been known for many years only small mines have been developed. The individual areas are described in detail in a later part of this report.

Nothing in the character of the geology so far as known encourages the belief that oil may be discovered in commercial quantities. All of the older rocks and most of the rocks of the Skeena formation are too much deformed and metamorphosed to retain any oil that may have been in them. The less metamorphosed parts of the Skeena formation and the Tertiary rocks, besides being non-marine and, therefore, not very likely to be sources of oil, occur in too small areas, in such unfavourable structural positions, and so close to the surface as to be unlikely to retain any oil if it had been present. Small quantities of

inflammable gas escape from the Skeena formation on Telkwa river, and cause a continual bubbling in a spring at the old Beattie mine on the north side of the river. The gas probably emanates from coal seams which at this locality are high in volatile content. Such occurrences may have little significance as to the possibilities of obtaining natural gas in commercial quantities by drilling.

There are some good clay and sand deposits that could be used locally, but they are not known to be superior in quality to materials found abundantly in other parts of British Columbia. Green, volcanic rock may, in some parts, especially to the south, be suitable for building and ornamental stone.

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Areas South of 55°00', North Lat. and West of 125°00' West Long.

The Annual Reports and Bulletins of the Minister of Mines of British Columbia contain much information gained by W. Fleet Robertson, J.D. Galloway, Douglas Lay, and others. Bulletin No. 4, 1915, gives a comprhensive review of the two belts.

## Detailed Descriptions

### Rocher Déboulé Mountain

On Rocher Déboulé Mountain[1] is located the Roche De

[1] O'Neill, J.J.: Economic Geology of Hazelton District; Gool. Surv., Canada, Mem. 110 (1919).

Boule mine, one of the most important in the district. The former extensive activity in this section was due to the presence of fairly good copper deposits and to the high price prevailing for this metal during the war. Besides the copper deposits, which contain silver and gold as well, a number of

deposits include gold, gold-molybdenum, gold-cobalt-arsenic, tungsten, zinc, silver-lead, and mixtures of those. Very high-grade, hand-sorted gold-cobalt-arsenic and gold-molybdenum ores were produced in small quantities. High-grade silver ore also occurs. The area appears to have prospecting possibilities for all these types of deposits and there seem to be good chances of finding small, valuable gold, gold-molybdenum, or gold-cobalt-arsenic deposits.

Rocher Déboulé mountain has a large core of granodiorite that cuts bedded rocks consisting mainly of tuffs. Most of the deposits occur within the granodiorite or extend a short distance into the tuffs beyond the contact. They occur along fissures and cut dykes in the granodiorite. Other deposits have been found half a mile or more beyond the contacts.

Rocher De Boule Mine.[1] Rocher De Boule mine, between 1915 and

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[1] O'Neill, J.J.: Economic Geology of Hazelton District: Geol. Surv., Canada, Mem. 110, p.7, (1919). Ann. Repts. Minister of Mines, B.C., 1929, p. 155; 1930, p. 138.

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1918, mined and shipped 39,833 tons of ore and recovered 4,214 ounces of gold, 62,865 ounces of silver, and 5,746,306 pounds of copper with a gross value of about $1,350,000. In 1929 seventy-two tons of hand-sorted ore was shipped and assayed: gold, 0.14 ounce; silver, 40 ounces a ton; and copper, 4 per cent. Production occurred mainly when the price of copper ranged between 22 and 32 cents and ceased when the price fell below these levels. All liabilities had been paid off and a considerable return on investment was made. A considerable amount of milling ore was proved and it had been planned to install a concentrator.

The ore deposits are of two types, copper and silver-lead, which occur together and separately. Besides the copper, silver, and gold there is considerable iron, lead, zinc, and arsenic, and minor amounts of amtimony and molybdenite. There are four veins in granodiorite near the contact; one extends beyond the contact.

Delta.[1] The Delta property is another copper property similar

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[1] O'Neill, J.J.: Economic Geology of Hazelton District; Geol. Surv., Canada, Mem. 69, p. 14 (1919).

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to the Rocher De Boule and was thought to have considerable promise in 1918 when the price of copper was very high. Little work has been done on it since then.

Red Rose.[2] The main vein on this property occurs in a shell of

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[2] Ibid., p.18; Hurst, M.E.: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p.44; Ann. Rept. Minister of Mines, B.C., 1926, p. 126.

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sediments or bedded tuffs and in the underlying granodiorite from 5,400 feet to 6,500 feet in elevation. The veins range from 2½ feet in width in the lower part to 12 feet in the upper part. They are almost wholly milky quartz sparsely mineralized, but contain shoots up to 30 inches wide that are high grade and carry from 0.30 to 0.84 ounce in gold, 2 to 4 ounces a ton in silver, and 3 to 8 per cent in copper. The fact that this vein is at the contact may cause some doubt as to its continuity at depth into the granodiorite. However, other veins nearby have been shown to continue. The high gold content suggests that small-scale, profitable mining might be possible and there is hope because of the size and length of the vein for the discovery of bigger shoots than have been exposed. A tungsten deposit of no economic value at present also occurs on this property.

Hazelton View.[1] In 1926, 25 tons of hand-picked ore shipped

[1] New Hazelton Gold Cobalt Mines, Aurimont Gold Mines, Victoria, O'Neill, J.J.: Mem. 110, p. 20; Ann. Repts. Minister of Mines, B.C.; 1928, p. 159; 1927, p. 132; 1926, p. 126.

averaged: gold, 4.65 ounces a ton; cobalt, 4.6 per cent; arsenic, 42.3 per cent. In 1928, 23 tons were shipped. The ore varies greatly and from the same deposit a hand-sorted product running 7.4 per cent $MoS_2$ and $10 in gold was obtained. Molybdenum occurs up to 20 percent in places. The ore occurs irregularly in shoots 3 to 18 inches wide in a strong vein 18 inches to 4 feet wide. The deposit has been worked in granodiorite, but continues into the sediments.

Other Properties. On the Great Ohio parts of the deposits are high in silver. On the Brian Boru[2] in volcanics ½ mile from

[2] O'Neill, J.J.: Mem. 110, p. 19, Ann. Rept. Minister of Mines, B.C., 1926, p. 127.

the contact with the granodiorite a vein 10 feet wide in places carries 20 per cent zinc with a little silver. Elsewhere there are small silver-lead-zinc veins. The Comeau[3] is a copper-silver

[3] Cap, O'Neill, J.J.: Mem. 110, p. 23; Ann. Rept. Minister of Mines, B.C., 1929, p. 155

deposit consisting of small shoots separated by barren material in a strong vein. On the Golden Wonder veins up to 30 inches carry copper with a little gold. The Daly West vein is similar in mineral content but values are low. On the Black Prince[4]

[4] O'Neill, J.J.: Mem. 110, p. 26; Hurst, M.E.: Geol. Surv., Canada, Sum. Rept. 1924, p. 45.

there is a tungsten deposit, and a narrow but well-mineralized copper-molybdenum vein. Other properties include the Brunswick,

MacDonald, Killarney,[1] the Preston,[2] Summut, True Blue, and Black Pilot.[3]

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[1] Ann. Rept., Minister of Mines, B.C., 1926, p. 126.

[2] O'Neill, J.J.: Mem. 110, p. 23.

[3] Ann. Rept. Minister of Mines, B.C., 1930, p. 139.

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## Ninemile, Fourmile, and Glen Mountains

Ninemile, Fourmile, and Glen mountains are three separate mountain groups each of which has a core of granodiorite cutting the Hazelton group. The three have similar silver-lead and silver-lead-zinc deposits and are described in detail by O'Neill. Two of the properties are equipped with mills: The Silver Standard, which mined and milled ore of a gross value of about $500,000 prior to 1923, and the Silver Cup, in operation prior to 1928. Neither operation was profitable. Considerable work has been done on a number of other properties.

On most properties there are a number of closely spaced deposits in steeply dipping fracture zones in the Hazelton group at or near granodiorite masses to which they are probably related. All the deposits so far developed are small.

Some of the deposits may be workable at a profit by small-scale, low-cost operations at times when metal prices are fairly high. Further prospecting for small veins high in silver and gold may result in the discovery of deposits which, worked by a few miners or in a small way, might yield a fine profit, and there is a chance of finding deposits of fair size.

Silver Standard.[4] Between 1913 and 1917 the Silver Standard

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[4] O'Neill, J.J.: Mem. 110; Ann. Repts. Minister of Mines, B.C., 1923, 1922, 1921, etc.

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mined and shipped hard-sorted ore; between 1918 and 1923 it mined, milled, and shipped concentrates. From 14,500 tons of

ore mined, the approximate production was 1,100 ounces of gold, 626,000 ounces silver, 1,225,000 pounds of lead, and 1,400,000 pounds of zinc with a gross value of $500,000. The lead concentrates carried 200 to 225 ounces of silver a ton and the zinc concentrates 80 to 125 ounces. When closed in 1923 prices for lead and zinc ranged above 6 cents a pound and silver was above 55 cents an ounce, so that it seems improbable that similar ore could be mined at a profit unless higher metal prices prevailed. In O'Neill's assay plans it is notable, however, that No. 1 vein carries 0.435 ounce in gold over 2 to 5 feet, and a shoot 100 feet long and 20 inches wide averaged 0.35 ounce of gold and 10.72 ounces of silver a ton. Moreover, 2,000 tons of high-grade ore shipped during earlier years of operation averaged about 0.25 ounce of gold and 125 ounces of silver. Therefore, the gold content of some of the veins may be sufficient, in view of the higher price prevailing for gold, to permit of profitable mining.

There are seven fissure replacement veins that are nearly parallel, steeply dipping, and cut across the bedding in sedimentary tuffs. They lie 500 to 1,500 feet away from a granodiorite porphyry mass. The ore was secured from shoots in two or more of these deposits.

Silver Cup.[1] A mill was constructed on this property and 5,710

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[1] Duke Mining Company, O'Neill, J.J.: Mem. 110, p.34; Ann. Repts. Minister of Mines, B.C., 1929, p. 158; 1928, etc.

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tons were mined and milled to produce 571 tons of concentrates averaging 25 to 30 per cent lead, 16 to 18 per cent zinc, and 126 to 153 ounces of silver a ton. The mill feed for one month assayed: 14.7 ounces of silver a ton, 3.3 per cent lead, and 4.00 per cent zinc; and for the second month, 19.6 ounces of silver a ton and 3.96 per cent lead and 6.85 per cent zinc.

The average assay values of mine samples across an average width of 1.82 feet were: silver, 43.82 ounces a ton, lead, 9.98 per cent, and zinc, 9.67 per cent. The veins on the property occur in sedimentary tuffs at the contact with granodiorite. The latter, where struck in the workings, was not penetrated by the veins. The operation was unsatisfactory and showed that a profit could not be made under the conditions existing at that time.

Other Properties. A number of other properties occur on Ninemile, Fourmile, and Glen mountains. On several properties considerable work has been done and some have had a small production. In the main the deposits are similar in nature and size to those of the Silver Standard and Silver Cup and carry similar values. They include: American Boy,[1] Sunrise,[2]

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[1] O'Neill, J.J.: Geol. Surv., Canada, Mem. 110, p. 32 (1919). Ann. Repts. Minister of Mines, B.C.: 1927, p. 131, 1924.

[2] O'Neill, J.J.: Mem. 110, p. 34. Ann. Repts. Minister of Mines, B.C.: 1927, p. 131; 1926, p. 126; 1925, p. 94; 1921, p. 86.

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Mohawk,[3] Comet,[4] Empire,[5] Barber, Bonnie, Silver King.[6]

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[3] Erie Group, Ann. Repts. Minister of Mines, B.C.: 1928, p. 156, 1921, p. 86.

[4] Ann. Rept. Minister of Mines, B.C., 1921, p. 87.

[5] Ibid., 1924, p. 106.

[6] Ibid., 1928, p. 155.

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## Mountains West of Kispiox and Skeena River

From a distance the high southern peak of the mountains west of Skeena river appears to be in part intrusive and the bedded rocks nearby appear to dip outward. Coal formations are reported to occur on the southern slope. At the foot of a large hill near Skeena river is located the Silver Bell deposit. Prospecting in the mountains to the west is reported to have yielded poor results.

Silver Bell.[1,2] On the Silver Bell property a granodiorite dyke,

[1] Ann. Rept. Minister of Mines, B.C., 1933, p. 97.
[2] Examined by the writer.

30 to over 100 feet wide, which cuts and in places follows the bedding in argillites of Skeena or older age, is mineralized. There are scattered veinlets up to 4 inches wide carrying pyrite, arsenopyrite, chalcopyrite, pyrrhotite, sphalerite, and galena in a gangue of quartz and carbonate, and sparse impregnations of pyrite and possibly other sulphides, especially near the veinlets. There are no well-defined zones and the total quantity of mineralized material is small. A selected sample assayed: gold, 0.15 ounce, and silver 3.3. ounces a ton. The dyke continues from the main showing to the mouth of Kispiox river, a distance of 1,500 feet, but in the main shows only impregnations of pyrite.

## Fortune Hill[1]

[1] Examined by the writer.

Fortune hill is a prominent hill in the middle of the great valley occupied to the west by the Kispiox and to the east by the Skeena. It is made up mainly of bedded rocks that are cut in places by granodiorite or diorite and probably are of Skeena and older ages. Mineral deposits occur on the southeast slope on the Fortune Hill group and are reported to occur 2 miles farther up the Skeena. Fortune Hill.[2] The deposits on the

[2] Ann. Rept. Minister of Mines, 1933, p. 97.

Fortune Hill property are confined to one or more bands of rock which parallel the bedding in a series of tuffs and argillites and are altered dykes or volcanics. The mineralized rock is largely quartz with calcite and sulphides, containing mainly disseminated, but in places massive, sulphides including pyrite,

arsenopyrite, pyrrhotite, sphalerite, and chalcopyrite. The mineralized part is usually confined to widths of less than 4 feet and is in the main sparse. A selected sample assayed: gold, 0.22 ounce, and silver 8.5 ounces a ton. This mineralized zone strikes directly toward that at the Silver Bell.

## Mountains East of Skeena River and North of Kispiox

Much of the mountain area east of the Skeena and north of Kispiox consists of granitic rocks. Bedded rocks occur between Skeena river and the area of granitic rocks and appear to show a marked upturn toward the contact. Around the north end of the intrusive mass and in other localities near the intrusive the rocks are rusted, thus suggesting that they contain pyrite or other sulphides.

## Thoen Basin

Thoen basin lies north of Suskwa river at the head of Thirtyonemile creek (31 miles from Hazelton) in rugged mountains that are fairly continuous in this section. Granodiorite intrudes sediments and both rocks carry sulphides of silver, lead, and zinc. The properties include O.K.,[1] True Fissure,[2] and Babine.[3]

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[1] Ann. Repts., Minister of Mines, B.C.: 1929, p. 160; 1921, p.96.
[2] Ibid., 1927, p. 133.
[3] Ibid., 1921, p. 96.

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## Mountains between Rocher Déboulé and Hudson Bay Mountains

Little is known of this area except that it is rugged and mountainous; geologically it is apparently similar to the Rocher Déboulé area. It has been little prospected but should be favourable.

On Boulder creek the Sultana group[1] had a good showing

[1] Ibid, 1924, p. 107; 1922; 1921.

of high-grade copper-silver ore, but on development it was found to pinch out at depth. Three miles north of Evelyn the rocks near a porphyry dyke[2] are sparsely mineralized and at Porphyry creek

[2] Patriotic, Ibid., 1918, p. 118.

extensive areas of volcanics, probably andesitic, have been altered to a rusty weathering grey material impregnated with pyrite. A random sample of the altered material assayed 0.35 ounce in silver a ton and no gold. The deposit is of interest because it indicates that a wide area has been mineralized.

## Suskwa Mountains, South of Suskwa River and East of Bulkley River

A large granodiorite body occupies the central part of a rugged, mountainous country which continues south from Suskwa river for 12 miles and ends abruptly. Along Bulkley river the rocks in the northern half of this area appear to be mainly bedded, whereas to the south they appear to be massive volcanics. The southerly mountain of this group on Bulkley river shows many rusty zones.

## Hudson Bay Mountain

Hudson Bay mountain has been an outstanding centre of prospecting and mining for many years. There are probably at least one hundred known deposits that contain one or more of the following metals in important quantities: gold, silver, lead, zinc, and copper. Most of the important types of deposits are found in four of the six mineralized sections, namely Southwestern slope, Glacier gulch, Toboggan creek, and Simpson creek. In all of these there are possibilities for the development of small profitable gold and/or silver mines with metal prices as prevailing

in the first half of 1935. Production has been made of hand-sorted gold ore assaying 0.5 to 1 ounce a ton (3 ounces in one case) and of silver ore assaying 100 to 200 ounces a ton and such results are to be expected on some properties. Milling grade is not likely to be over 0.5 ounce for gold and for silver 50 ounces. Vein lengths up to 3,700 feet are known, but workable lengths have been demonstrated for only as much as 1,100 feet. Widths of 4 to 6 feet for 600 to 700 feet in the case of gold deposits are known. Widths in silver deposits are generally about 1 foot. Workable veins are known to extend for 600 feet below the surface.

Around the outer part of the main mountain there are three areas of Lower Cretaceous or Skeena sediments two of which occur in part as thin shells on the mountain slope. Similar sediments are probably extensive below the drift in the large valleys surrounding the mountain. It is believed that the series once completely covered the main part of the mountain south of Toboggan creek. Erosion has removed most of it and has cut into the core, which as now exposed is made up mainly of massive volcanic rocks. In the centre of these there is believed to be an inner granitic core, which may occur below the ice in Glacier gulch and which may also be represented at the surface by small stocks on the northern peak and at other places by dykes. In the gravels of Glacier gulch there is such an unusual abundance of granitic boulders that the presence of granitic rock below the glacier is strongly suggested. North of Toboggan creek volcanic rocks occur above the Skeena sediments.

It is believed that the granitic rock in the centre was intruded under great force and caused doming of the rocks, as well as many minor deformations, much fracturing, induration, and alteration. The sedimentary beds of the Skeena formation originally were in flat layers and, therefore, adjusted themselves

fairly readily by sliding layer on layer, but the older complex of deformed and largely massive Hazelton rocks below was subjected to great and irregular strain, and adjustment was to a considerable extent by fracturing and shearing. After the granitic rock had started to solidify, but before much cooling set in, mineralizing solutions were given off and tended to seek out the fractures, shear zones, and bedding planes. Mineralization continued over a considerable period of time and changed in character so that at different times different minerals were deposited. Cooling and consequent contraction and settling during this time tended to close some fractures and open others and, therefore, the solutions continually changed their courses and deposited different minerals in different places.

Similarities in the character of the mineral deposits seem to show that all, except possibly certain tetradymite-gold deposits, were formed by mineralizing solutions from the same magmatic source. So far as the writer was able to discern, they do not show any zonal arrangement. Silver-lead (low temperature) deposits are found at all elevations from the lowest to the highest (Duthie to Silver lake) and pyrrhotite-chalcopyrite and arsenopyrite-gold (high temperature) deposits have a similar range (lake Kathlyn to Iron King). Evidence from individual deposits such as the Duthie and others on the southwestern slope does not seem to support the common belief that better gold values will be found at depth or toward the core of the mountain.

The mineral deposits occur under several different structural conditions, most of which may have been developed at the time of doming. Most of the important and large deposits occur in fracture or sheeted zones that are fairly straight, strike mainly toward the peak, and dip from 45 degrees to vertical. These fracture zones are best developed in the central

part of the exposures; away from this part, both on the surface and at depth, the zones have fewer and less well-defined fractures or the fractures are more scattered. The fractures were formed by tension and were open when mineralized. In a few places there is shearing along the zones, and much of this was developed during and after ore deposition. Most of the deposits on the southwestern slope and near Simpson creek, the silver-lead-zinc-gold deposits of Glacier gulch and the silver-lead deposits of the Silver Lake and Silver Creek groups and probably others in the Toboggan Creek section are in this type of fracture zone. The deposit on the Silver Creek group parallels Toboggan creek instead of striking toward the peak and indicates that locally there are exceptions in regard to strike.

In general the deposits of this type are found on the outer slope of the mountains, that is, on spurs rather than in valleys or cirques. Many are near the remnants of the sedimentary shell that once covered the mountain. In fact, it appears that with few exceptions the deposits occur in a zone a few hundred feet thick that originally underlay the sediments. Where but little erosion has taken place since the removal of these rocks the deposits are still largely intact, but with increase in extent of erosion there is a decrease in number and size of deposits.

Localization of the mineral deposits in a zone below the sediments probably was due in part to more intense fracturing there and it may be that the sediments acted as a barrier to further progress outward of the mineralizing solutions. This appears to be shown by the scarcity of important mineral deposits within the sediments. If this be true the best mineralized material would be expected immediately below the sediments and beyond this it would tend to become poorer.

If the foregoing conclusions are correct the search for further deposits should be directed to unprospected areas near the sediments. Judging by the number of deposits in Glacier gulch and Simpson creek it is to be expected that hundreds of others lie under the sedimentary shell that covers the slope of the mountain between these points. Likewise, but to a lesser extent because of a steeper contact dip, they may be expected between Glacier gulch and Toboggan creek. The strike of the deposits between Simpson creek and Glacier gulch is very likely to be in the main toward the peak. The dip may swing from southwest near the former locality to southeast near the latter. North of Glacier gluch the attitude is not easily determined because cross-folds occur on Toboggan creek and probably have influenced the fracturing.

Where the sedimentary series is relatively thin it might be possible to discover underlying deposits by means of electrical prospecting. It is improbable that deposits underlying the sediments are much superior to those near the edge already discovered, but somewhat large deposits comparable with those on the southwestern slope may occur, especially if there is well-defined vertical fracturing.

Deposits, probably fairly abundant, occur in other very irregular fractures where differential movement has taken place between rocks of different types, as between the Skeena sediments and massive volcanic rocks (silver-lead-zinc deposit on the north side of Glacier gulch). Mineral deposits occur along the bedding and in shear zones on anticlines in the Glacier Gulch tetradymite-gold deposit, Homestake, and others, in shear zones in granodiorite (Silver creek) and as replacements in limestone (Silver creek). It may occur along sedimentary beds or unconformities (Rio Grande). In the Duthie mine one vein occupies a fault and elsewhere deposits may be in fractures of quite different types than those noted.

The deposits of Hudson Bay mountain occur in six isolated areas which are discussed under separate subheadings: Southwestern slope, Glacier gulch, Toboggan creek, Simpson creek, Southeastern slope, and Northern peak.

SOUTHWESTERN SLOPE OF HUDSON BAY MOUNTAIN. Most of the deposits on the southwestern slope of Hudson Bay mountain belong to the most common type; that is, they occur in vertical or nearly vertical fractures that strike northeast toward the peak of the mountain. Most of them show some replacement of the wall-rock and in some places the altered rock may be classed as ore. The deposits range in length up to nearly 3,700 feet and in width to 8 or 10 feet, but in the main they are fairly short and narrow. They generally are widest in the central part and tend to pinch out toward both ends. Development work suggests that with depth the deposits become narrower and in general poorer. The Henderson vein was mined along a length of 1,100 feet for a maximum depth of 600 feet. The Mamie vein for 680 feet out of a total of 3,700 feet probably averages 4 to 6 feet wide. In general the longest are also the widest.

The Henderson (Duthie) vein is very high in silver, has very important quantities of lead and zinc, and is low in gold. The Mamie is high in gold, high in zinc, and relatively low in silver. The Victory is mainly high in silver, lead, and zinc, and moderately high in gold. The Coronado is high in silver, gold, lead, and zinc. Other veins in this section carry approximately the same mineral content. Copper occurs in places in small amounts. There are certain important groupings of constituents: silver is high with tetrahedrite (freibergite), is moderate to high with galena, and low with zinc blende; gold occurs mainly with arsenopyrite. There is no apparent rule for

the distribution of the metals. High gold content occurs from near the base of the mountain (Coronado) to near the top (Mamie), but gold is absent in nearby veins that occur in the same range. Silver and lead are abundant near the base of the mountain in the Henderson and Coronado, but to a 600-foot depth in the former there is no change. Galena occurs in the Victory, Mayflower, Canary, and Neepawa in places in fair amounts at elevations well above the Mamie where none is reported throughout a very considerable range up the slope.

The production of over $1,000,000 worth of ore from the Henderson vein and the developed showings and grade of ore indicate that some veins of this type have economic value under most conditions of metal prices. The deposits, in andesitic, dacitic, and rhyolitic volcanics, occur mainly on the lower and steeper part of the mountain. Above them where the slope for a stretch is less steep the rocks are in the main well exposed, and show little evidence of fracturing or of mineralization. The deposits occur near an area of Skeena formation which just below the dump of the lowest adit on the Victory vein lies as a shell on the mountain slope and has dips of 60 degrees and less to the southwest. A 2- to 3-inch weathered vein in the Skeena formation occurs directly on the strike of, is similar to, and believed to be a continuation of, the Victory vein. This and other similarly mineralized, gash veins in the Skeena indicate that the formation is older than the mineralization.

Mamie.[1] A series of open-cuts and natural exposures indicate that

[1] Jones, R.H.B.: Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 132; B.C. Dept. of Mines, Bull. No. 1, 1932, p. 52.

the Mamie deposit may be continuous for almost 3,700 feet from somewhat above the lowest adit at 4,270 feet nearly directly up the mountain to 5,500 feet. In the central part the deposit is

stripped for 290 feet and above this section is opened by six cuts for 390 feet farther through a vertical range of about 250 feet. This stretch of 680 feet shows widths of the well-mineralized part up to 8 feet and probably averages 4 to 6 feet. Wall-rock alteration and slight mineral impregnation on either side increase the width of the zone in places to 40 feet. Toward the upper end of the 680-foot section the mineralized zone appears to become less. The next cut 110 feet farther along the strike of the vein shows 40 feet of altered rock with three fairly well-rusted zones. As yet it is not shown that a well-mineralized section occurs in this cut. Beyond in the valley of Henderson creek, about 75 feet lower, there are numerous fractures on the projection of the strike of the vein and some show altered wall-rock. Over a width probably in excess of 100 feet there are a number of well-mineralized stringers and one zone 12 inches wide with bands of similar widths on either side of somewhat less-mineralized, altered wall-rock. Some distance above Henderson creek the deposit is again visible in an extensive steep rock exposure. Here there is a zone of 4 feet of well-defined parallel fractures, which contains a well-mineralized part about 6 inches wide with relatively little wall-rock alteration. In 30 to 40 feet the deposit pinches to $\frac{1}{2}$ inch and a little farther on at the limit of exposed rock the fracture zone is much less pronounced. In the upper section it thus appears that the deposit is badly split up and tends to pinch out with the failure of the fracture zone in which it occurs. As all exposures on the lower part of the deposit are limited in the main to narrow trenches it is possible that the mineralized zone may be wider as is the case in the valley of Henderson creek. The depth gained in the creek valley does not appear to suggest improvement of conditions downward.

An adit driven from the lower end of the stripped (680 foot) section of the deposit showed widths of 3 to 4 feet in 100 feet of drifting on the deposit. Farther down the mountain slope the surface work suggests that the fracture zone is less well defined, and that it is less mineralized. An adit driven 650 feet along the strike at 4,270 feet lies 150 feet below the upper adit and the lower end of the stripped zone and overlaps this zone by 40 feet. Cross cuts have tested a zone 50 feet wide extending on either side of the vertical projection downward of the deposit. "Mineralization in this tunnel is poor. A number of minor stringers carry ore minerals, and in places crosscuts show a general zone of mineralization which is probably too low grade to be classed as ore." (Jones).

The mineralized zone consists of a vein or veinlets or cement in breccia and of replacement of the volcanics. The chief minerals present are sphalerite and arsenopyrite. Pyrite is abundant, chalcopyrite common, and pyrrhotite was noted in the main adit. Stringers of one mineral cut masses of another and it is clear that minerals were not all deposited at the same time. In some places the vein is dominantly one sulphide, in others mainly another sulphide. Gold is obtained in the central section of the deposit and is the most important. Channel samples over narrow widths assay in some cases over one ounce to the ton and over average width range mainly from 0.2 to 0.6 ounce a ton. Silver ranges mainly from 1 to 8 ounces a ton. The zinc content is high in places, but its average is probably only moderate. Assay returns suggest that the gold may be mainly with the arsenopyrite and the silver with the zinc.

Victory.[1] On the Victory one fracture zone has been defined by

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[1] Jones, R.H.B.: Geol. Surv., Canada, Sum. Rept. 1925, p. 134; Ann. Repts., Minister of Mines, B.C.: 1930, p. 140, 1914, p.216; B.C. Dept. of Mines, Bull. No. 1, 1932, p. 53; Bull. No. 4, 1915, pp. 50-51.

four adits, a number of open-cuts and trenches, and natural exposures for a total distance of over 2,400 feet, from an elevation of 3,870 feet to 4,625 feet. The fracturing is not as well confined as at the Mamie and mineralized parts are more scattered and in the main aggregates a smaller width. As at the Mamie mineralized section is in part made up of veinlets in fractures and in part is due to replacement.

In general the minerals in the deposit are erratic. In the lower adit for 25 feet there is a width of 1 to 2 feet of vein material which when sorted assayed: gold, 0.18 ounce, silver, 78.1 ounces a ton; lead, 52.8 per cent; and zinc, 11.3 per cent. Beyond this the deposit is split up and there are only a few small veinlets. For 500 feet up the slope and for 200 feet higher vertically the rocks are well exposed and mineralization is seen to be spotty and irregular. One good section 15 to 20 feet long and 12 to 15 inches wide assayed: gold, 0.13 ounce, silver, 33.7 ounces a ton; copper 1.5 per cent; lead, 23.6 per cent; zinc, 33.6 per cent. At the upper end of this 500-foot section the mineralized part swings 50 to 100 feet off the strike. At the upper limit of this section where No. 2 adit is located the mineralized zone which is 15 feet wide, is badly split up. Though the mineralized parts of this zone are as much as 3 feet wide in places, they do not maintain this width and show wide ranges in extent both on the surface and in 160 feet of drifting. Vein widths and other conditions in the adit (No. 2) do not agree with those on the surface. In 250 feet to No. 3 adit the deposit as exposed by a few cuts also is irregular. In places mineralization is sparsely spread out over 15 to 20 feet; at other places it is within a zone of a few feet and again in places is represented by only a few stringers. The average width of good grade is probably low as the wide parts are

in the main low grade. From No. 3 adit up the slope for a distance of 300 to 500 feet, including No. 4 adit at 250 feet up, appears to be the best part of the deposit. The deposit in places is 6 to 8 feet wide, but is not everywhere well mineralized across the full width. At one place in No. 4 adit, two sections 12 and 8 inches wide on the outer edges of 3½ feet of poorly mineralized rock assayed: gold, 0.44 ounce, silver, 15.4 ounces a ton; lead, 12.6 per cent; and zinc, 13.8 per cent. Beyond the upper limit of the better section the slope becomes less steep and the deposit is exposed along the valley of Halley creek toward which it trends. In this section, because of the stream valley, the deposit is exposed at successively lower levels below the normal mountain slope. In the last 750 feet in three scattered exposures the zone though fairly well defined becomes narrower and in the last exposure after a gap of 350 feet it is merely a single fracture that in one place shows 2 inches of rusty vein material. Beyond this, along the strike, the rocks are well exposed in places and no evidence of a continuation of the fracture zone or the deposit was noted.

The minerals are mainly sphalerite and galena. Pyrite, arsenopyrite, and chalcopyrite are present and in places are abundant. Sphalerite and galena occurring together or separately were noted in all sections of the deposits. In the uppermost showings galena in places is as abundant as any other sulphide.

Several (possibly five or more) other veins have been noted on the Victory group. They are in the main parallel to and southeast of the better section of the main vein. They are of the same type but are narrower and shorter; at least it is clear that they do not extend far up the mountain, for above 4,300 feet there are extensive exposures of massive, mainly unrusted, volcanics cut by no veins.

Duthie.[1] The Duthie property is completely equipped with a

[1] (Henderson) Jones, R.H.B.: Geol. Surv., Canada, Sum. Rept. 1925, p. 130A; Leach, W.W.: Sum. Rept. 1908; Ann. Repts. Minister of Mines, B.C., 1930, p. 139; 1929, p. 161; 1928, p. 159; 1927, p. 134; plans, 1926 to 1922.

modern mining plant, mill, and power house. Though considerable mining was done prior to 1922 the main period of activity followed that year. Up to 1927 there was shipped from the property, 4,788 tons of hand-sorted ore having a gross value of $523,745. An output of 2,872 tons in lots of 297, 1,625, and 950 tons prior to 1926 yielded average assays: gold, 1.16 to 0.2 ounce, silver, 116 to 185 ounces a ton; lead, 16 to 26 per cent; and for zinc in the last lot 14 per cent. 5,500 tons milled in 1927 yielded: 37 ounces of silver a ton, 4.8 per cent lead, and 5.2 per cent zinc. In 1928, 14,980 tons were milled; in 1929, 12,500 tons were mined and after sorting 10,370 tons were milled. In 1930 about 3,000 tons were produced. Since 1930 the property has been inactive.

The main deposit from which most of the ore was obtained is the Henderson (Main) vein or vein system. This probably has a length of over 2,000 feet. Lay in his 1930 report refers to the Henderson vein on the Canary claim. It is not known whether the Henderson vein extends through the intervening Humming Bird claim. If the vein on the Canary claim is the same then the length would be 2,500 feet greater. The Henderson vein, however, near the Humming Bird claim, appears to be pinching out. The part of the vein that has been worked and to which the better ore is confined is probably about 1,100 feet long, though an exact description of the system toward the lower end has not been given. On the surface there is one nearly vertical vein trending up the mountain and striking about north 62 degrees east. Below the surface this splits into two, the main vein

being nearly vertical and a "fault" vein dipping about 55 degrees south. Two other veins, the Big Stranger and Little Stranger, found in underground working, appear to be offshoots. The main and fault veins were the most important; it is not known that either of the others developed ore. The vein for 1,000 feet on the surface, as exposed by open-cuts, has lenses, in places, of solid sulphides 18 inches wide. In the workings mineralized sections up to 5 feet wide and more occur, but in the main the vein is narrow, and high-grade sections probably average about 1 foot in width.

The workings are at an elevation of about 4,025 to 3,225 feet, but most of the ore was secured between 3,850 and 3,225 feet. The data available in the published reports seem to indicate that in general the ore zone becomes continuously shorter on each successively lower level. Of the lowest (600-foot) level, which was reached by shaft and was run below the part of the mine that yielded most ore, Lay stated in his 1929 report, "Generally speaking development to November 10, 1929 (four months before closing down) disclosed narrow seams of ore in the Henderson, Fault, Plane, and Big Stranger veins with the exception that at that date the drift on the Henderson vein was running into considerably wider ore than had hitherto been encountered on this level. In view of the ore met with on the mill level (100 feet above) it would seem reasonable to anticipate productive stopes on both the Henderson and Fault veins above the 600-foot level." The section in which most ore was found and which seems to be bounded fairly well on all sides by workings in poorer material is about 1,100 feet long down the slope of the hill and has a maximum depth of about 600 feet. Ore was not continuous in this section but occurred in shoots. Undoubtedly some material of the same grade as mined still remains in the mine.

On the Duthie property there are two other veins, Ashman and Gill. The Ashman is similar to the Henderson, but is shorter, narrower, and not so rich in silver, though there was an improvement at depth. On the Mill level this vein yielded some productive stopes. The Gill vein was discovered late in the mining history of the property.

Coronado.[1] Two veins occur on the Coronado at low elevations,

[1] Jones, R.H.B.: Geol. Surv., Canada, Sum. Rept., 1925, p. 132; B.C. Dept. of Mines, Bull. 14, 1915, p. 48; Ann. Rept. Minister of Mines, B.C., 1933, p. 97.

3,000 to 3,500 feet on the mountain slope. Both have been developed to a considerable extent and a small amount of ore was sorted out. One has been traced for 800 feet and may continue as a smaller vein for 400 feet or more. This vein in places is 2 feet wide, but for the most part is narrower. The other probably is smaller. The better grade materials in the veins show gold 0.2 ounce to 0.76 ounce a ton, which is comparable with the ore of the Mamie and it is probably associated with the arsenopyrite. Galena is the most abundant mineral. Silver occurs with the galena and consequently is high, ranging up to 50 ounces with one assay of 129.4 ounces. Gold, silver, lead, and zinc are all high in some places, but silver and lead may be low where gold is high.

Other Deposits. The Iron King[2] is interesting because it occurs

[2] Ann. Rept. Minister of Mines, B.C., 1914, p. 216.

well up the slope of the mountain. It shows arsenopyrite, sphalerite, and chalcopyrite along fracturing. Assay returns showed: gold, trace, silver 3.6 ounces a ton; copper 0.8 per cent; and zinc, 15.8 per cent. The Mayflower deposits[3] show a

[3] Ibid., 1930, p. 139; 1929, p. 162.

different mineral association from that of other deposits described, but is similar in most other respects. One deposit 3 feet wide is opened up for 100 feet. It does not continue up the slope but may continue down. It contains mostly pyrrhotite with sphalerite and pyrite. Lay describes three veins; one is 18 inches wide and is mineralized with pyrrhotite, galena, arsenopyrite, pyrite, and some chalcopyrite, assaying gold, 0.02 ounce, and silver, 5 ounces, a ton. Two hundred feet east is a vein sparsely mineralized with pyrrhotite and pyrite and 500 feet southeast one 4 feet wide with 18 inches of solid pyrrhotite assaying 0.04 ounce gold 1.7 ounces silver a ton.

The Canary, Humming Bird,[1] King Tut,[2] Neepawa,[3] and White Swan[4] are in the main smaller or lower grade deposits of the

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[1] Ann. Rept. Minister of Mines, B.C., 1929, p. 161; Jones, R.H.B., Geol. Surv., Canada, Sum. Rept. 1925, p. 130.

[2] Ibid., 1925, p. 132.

[3] Ann. Rept. Geol. Surv., Canada, Sum. Rept., 1929, p. 163.

[4] Ibid., 1914, p. 215.

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same types as the others on the southwestern slope.

GLACIER GULCH AREA, HUDSON BAY MOUNTAIN.[5] The Glacier Gulch area

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[5] Examined by the writer

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has attracted much attention because of a small production from a number of pockets of very high-grade gold-bismuth ore of a unique type. There are also a number of other deposits, some of which have been developed, of the common types, containing, mainly, gold, silver, lead, zinc, and copper. With the exception of one vein under development in 1934 most of these are very small and lie in irregular fractures.

The dominating feature of the area is the great gash which the glacier has cut in the mountain. The location of the

cut in this particular place may be due to a syncline, or a syncline and anticline, which plunge toward the northeast parallel to the valley. To the southwest of the deposits there are reverse dips of the strata indicating the possibility of a local domal structure. Owing to the extensive erosion of the Skeena formation, which alone gives a clue to the structure, only remnants of such structures are visible along the valley walls.

Most of the deposits and all that appear to be important or that have been developed lie in the volcanics within a very short distance of the contact with the sediments. The sediments have been only slightly mineralized. On the south side of the gulch where the contact is fairly well defined a zone of rusty rock a few hundred feet thick lies below the contact, whereas above and farther below it there is notably less rustiness. On the north side below what would be the position of the contact projected there is intense rustiness, which dies out downward, and much mineralization is reported. The rusty mineralized zone appears to be definitely related to the contact, but the geology is not clear. The wall is very steep and largely inaccessible, but can be seen from the south side. Large areas of the valley floor are scoured clean by the glacier and by water from it, yet there is comparatively little rustiness or evidence of its having been mineralized; only one small deposit is reported and it occurs on the crest of a steep cliff, which is the part that was probably nearest the contact.

Apart from the tetradymite-gold deposit, which is considered to be a distinct type, there is great variety in the metal content of the deposits, including lead-zinc, silver-lead-zinc, silver-gold-lead-zinc, copper, high-grade silver-copper, and some largely of iron sulphides. The different varieties are in different deposits and these do not grade into one another.

In many cases it is clear that there is no gradation from one kind of deposit to another in such a way as to suggest that by following one variety another might be found, that is, that zoning occurs. For instance, pyrrhotite and chalcopyrite (high-temperature) occur in the Lake Kathlyn coal mine at a point that must be farther from the core than many of the silver-lead (low-temperature) deposits. However, there is enough similarity between the deposits to indicate that they are related.

Only one deposit, the silver-lead-zinc-gold deposit on the south side of the gulch, was observed that was considered to occur in a fracture zone of the common type, such as occur on the southwest slope. The others are mainly in small irregular fractures related to differential movement along the contact and to other adjustments in the volcanics. The tetradymite-gold deposits occur in small, irregular shear zones and open places in the crest of a minor fold. These high-grade tetradymite-gold deposits are a type that at least by "gophering" have yielded a profit. In the silver-lead-zinc-gold deposit on the south side there is shown sufficient continuity, regularity, and grade to indicate that such deposits if of good size may be expected to yield a profit to small-scale operations.

Glacier Gulch-Tetradymite.[1] (bismuth telluride $Bi_2 Te_3$). A car-

[1] Gold (Ann. Rept., Minister of Mines, B.C.: 1933, p. 97; 1930, p. 140; 1929, p. 164; B.C. Dept. of Mines, Bull. No. 1, 1932, p. 54.

load of 28 tons of hand-picked ore "gophered" out by a few miners and shipped in 1933 averaged 3.095 ounces of gold a ton. A second car-load of 40 tons was shipped in 1934. The ore is said to carry considerable bismuth, and Lay reports one assay of: 13.2 ounces of gold, 1.8 ounces of silver a ton; and 5.2 per cent bismuth.

Detailed study led to the following conclusions, briefly summarized. Very small, irregular, and discontinuous, but in

places very rich, tetradymite-gold deposits occur in sheared zones and in open spaces in massive volcanics. Bedded rocks, including argillite, conglomerate, greywacke, and tuff, believed to be part of the Skeena formation but not readily distinguishable from older rocks, occur dipping into the hill just above the deposit and in small patches dipping toward the valley near the deposits. The deposits, therefore, are probably largely confined to the crest of a minor fold which trends south 40 degrees west up the slope of the mountain toward the peak. Any continuity of the favourable zone is very likely to lie along the trend of the fold. The greater part of the anticline, including much of the crest and northwest limb in the vicinity of the deposits, has been eroded away. Farther up the hill more of it may be preserved. However, the deposits may owe their localization to a nearby feeder fracture and the mineralizing solutions may not have migrated far along the anticline. Other shear or fracture zones may also have carried the solutions and may also have been mineralized, as is indicated in the workings, but nothing suggests the presence of fractures that might carry valuable deposits. Field and microscopical studies did not offer a definite clue as to a possible nearby source for these deposits nor was there any definite suggestion as regards relationship to intrusive bodies. Doming of the rocks locally may have some significance and it is clear that the deposits were formed after most of the structures were developed and, therefore, are probably of about the same age as the other deposits on the mountain. All may be related, but the mineral association certainly suggests some difference.

The ore occurred in a number of small pockets scattered mainly for about 200 feet along the steep slope (over 50 degrees) of the south wall of the valley at elevations between 4,050 and 4,175 feet. The pockets in some cases yielded less than one ton.

Most of the ore, however, came from three pockets which were at about the same elevation, 4,150 feet, were confined to about 100 feet along the slope, and were nearly continuous. Good natural exposures and workings show that there are many pockets containing from a fraction of a ton up to say 20 or 30 tons of material similar to the ore, except that it is not high grade. These are scattered along the mountain slope for more than 1,000 feet in a zone that continues mainly southwest of the pockets that were mined at gradually increasing elevations. The material of the pockets in places grades into the country rock, though for the most part it is quite distinct in character. Consequently, the pockets tend to be connected either by narrow bands of the pocket material or by material somewhat similar in character. They are very irregular in shape, size, and relative position, so that except for the indefinite limits of the whole zone there is no good criterion that would suggest where pockets are most likely to occur.

The property has been developed by numerous cuts, some of which have penetrated fairly deeply into the cliff, and by a number of adits. Underground work has been done largely to determine whether the deposits are continuous or to locate the zone at greater depth and to trace it into the valley wall. This development work has yielded very little new ore; only a few small pockets have been found and where a pocket was followed from the surface it was found to pinch out. The work yielded little information as to where continuity might be expected, except that certain fractures locally showed ore material. The underground work tended to confirm deductions made from the evidence of the slope exposures, that the material is in small, irregular pockets.

The volcanics, mostly massive but in places bedded, are normally dark grey to black and resemble argillite. They are

as a rule dacitic tuffs and in places show large grains of quartz. They are extensively altered to light grey material that looks like rhyolite and locally, mainly where sheared or bedded or along fractures, they are entirely changed to a chalky white material. Gold where present generally occurs with tetradymite, but tetradymite appears to be more widespread and scattered.

Glacier Gulch. Silver-gold-lead-zinc, south side. This deposit is a new discovery made in 1934. A number of cuts expose what appears to be a single fracture that runs almost straight up the cliff from its base at an elevation of 2,620 feet to 3,350 feet, strikes 20 to 40 degress east of north, and dips 30 to 60 degrees west. In the fracture there is in most places a vein up to 12 inches and possibly more in width which is bordered by heavily mineralized wall-rock. At the bottom of the cliff the vein is about 3 inches or less; it is mostly 8 to 12 inches at the main adit at 2,900 feet, and is generally 8 to 10 inches above this. Thus it appears to pinch toward its lower end where it is also the most poorly mineralized. In one adit at 3,050 feet it pinched to 1 inch from 9 inches in 20 feet. At the upper end the vein is split and appears to have entered more shattered ground.

The vein is in massive, green and grey volcanics and carries much galena and sphalerite with some pyrite in a quartz and carbonate gangue. In places, notably in the main adit, it carries an abundance of needle-shaped crystals of arsenopyrite. This mineral also occurs in a 6-inch band along the upper side of the vein. Elsewhere the wall-rock is also intensely altered and heavily impregnated with pyrite and arsenopyrite and probably carries some precious metal. At the base of the hill much pyrite and some pyrrhotite were noted with sphalerite, carbonate, and galena. Assay results obtained in the vein or in the wall-rock

are not known definitely, but it is reported that good silver assays were obtained and possibly a good gold content may occur in some sections such as those high in arsenopyrite.

Other Deposits. On the north side of the valley at an elevation of 3,000 feet, 500 feet above the creek and less than 15 feet below the base of the Skeena formation, a series of irregular stringers dipping from 10 degrees west to vertical carry galena, sphalerite, pyrrhotite, pyrite, possibly chalcopyrite, and other minerals in a quartz gangue. The basal beds of the nearby Skeena formation and probably the contact have approximately the same strike (north 10 degrees west) as the stringers, but dip 70 degrees east. The rocks of the Skeena formation are intensely sheared, especially along the coaly horizons, which are now graphitic. The fractures appear to be related fairly definitely to this contact, and were probably developed along it because of differential movement between the two formations.

Along the north side of the gulch just west of these deposits and still near the contact other similar stringers are reported, one or more of which is reported to be high in silver. Good specimens of pyrite and chalcopyrite are reported to come from a good lead on the north side just above the junction of the two streams. Higher up there is said to be a flat vein containing tetrahedrite, which carries 2,000 ounces in silver, and still higher a considerable deposit of pyrrhotite and pyrite. A poorly mineralized gash vein is said to occur between the two streams below the glacier. The presence of pyrrhotite and pyrite in the Lake Kathlyn coal mine has already been noted.

TOBOGGAN CREEK. Toboggan Creek valley as far up as Schufer lake is in the Skeena formation which in the upper part of this section strikes parallel to the valley and dips steeply north, though in the base of the valley the dip appears to flatten and

may even be toward the south. North of the valley volcanic rocks occur above the sediments, either overturned[1] or unconformably.

[1] Jones, R.H.B.: Geol. Surv., Canada, Sum. Rept.,1925, pt.A, p.124.

Higher up the valley the sediments pinch out between the volcanics.

In Toboggan valley there are greater variations in the mode of occurrence of the mineral deposits than in other localities. There are replacement deposits in limestone (Iron Vault), bedding plane deposits in volcanics (Homestake, etc.), and possibly in sediments (Rio Grande), deposits along an unconformity (Rio Grande), and in a small granodiorite mass. Most of these have not been indicated to have prospective value. Other, somewhat better deposits are of the most common type that occur on the mountain. A number of these on the Silver Lake group are nearly parallel, strike toward the peak, and are vertical. On the slope of Toboggan creek there are others (Iron Vault, etc.) which strike parallel to the creek and dip south.

There is the same variety of mineral content in the deposits on Toboggan creek as on the southwest slope of the mountain and in Glacier gulch and all deposits appear to be related. High-grade, silver-copper deposits (Silver lake) carry bornite and native silver, which may be secondary with tetrahedrite. The Silver Lake silver-lead deposits indicate possibilities of developing commercial ore, but they are unfortunately situated where costs will be high.

Homestake, Mammoth, Iron Mask, Etc. In the base of Toboggan Creek valley between Schufer lake and the divide there are a number of small, flat-lying replacement deposits containing pyrite, sphalerite, and other minerals. They dip south on the south side and north on the north side and occur along certain horizons marked by a change in the formation and rusty rock.

To the west with the rise in the valley they converge toward its centre and appear to represent an anticlinal structure.

Silver Creek.[1] (Schufer property, Iron Vault claim). West of the

[1] Jones, R.H.B.: Geol. Surv., Canada, Sum. Rept. 1925, p. 138; Ann. Rept. Minister of Mines, B.C., 1926, p. 130. Map.

cirque on the spur that rises south of the divide at the head of Toboggan creek there are three distinct types of mineralization: pyrrhotite-sphalerite replacement deposits in limestone, galena-silver veins and replacement deposits in fracture or shear zones that cut volcanic rocks and limestone, and arsenopyrite-sphalerite-chalcopyrite mineralization in shear zones in granodiorite. The very steep northerly slope of the main valley and at right angles to this the very steep western wall of the cirque afford a good opportunity for study of the nature of the deposits at depth. The bedrock is extensively exposed except toward the west where the spur is cut away somewhat and covered with much talus.

The pyrrhotite-sphalerite type is confined largely if not entirely to limestone. It occurs at an elevation of about 5,500 feet in small lenses widely scattered in one belt extend-

[1] Ann. Rept. Minister of Mines, B.C., 1926, p. 130.

ing from the wall of the cirque 1,000 feet northwest and in two smaller pockets 125 feet and 225 feet higher at the edge of the cirque. On the wall of the cirque the main belt of limestone, 15 feet thick, pinches out downward in about 100 feet between two walls of volcanic rocks. The mineralized zone, 15 feet wide at the top, pinches out downward in about 15 feet. in an adit that struck the zone farther west than this showing it was found to be narrow; the pinching appears to continue westward. The two higher pockets are in shallow shells of limestone overlying volcanics. Assays show: gold, 0.14 ounce, silver 1.5 ounces a

ton; and zinc 16 per cent.

The mineralization is dependant upon the distribution and extent of the limestone, and as the formation strikes 30 degrees to 45 degrees south of east it is well exposed in the southern wall of the cirque. It is clear in both places that the limestone dips north and that there are a number of drag-folds. The two higher pockets on the spur occur in the bases of synclines, and the limestone in the main belt may also be in a syncline. Mineral deposits occur only in a small part of the total amount of limestone.

The galena-silver mineral deposits occupy shear or fracture zones that bear no relationship to bedding planes in the rock. There are three zones: one is at the crest of the cirque wall at 5,600 feet, strikes about 80 degrees east of north and dips south about 55 degrees; another, at 5,700 feet, strikes about east-west and dips north 50 to 60 degrees; a third, at 5,500 feet, strikes about east-west and dips north at 70 degrees. The last two are not important since they are only slightly mineralized.

The main fracture zone is mineralized with galena, sphalerite, pyrite, tetrahedrite, and chalcopyrite. The deposit has a maximum width of about 18 inches. Surface showings and three adits driven into the wall of the cirque show that the deposit narrows toward the west and at depth; it has a maximum width of only 5 inches in a distance of 38 feet in No. 1 tunnel at 5,420 feet. A continuation of this deposit may occur on the east wall of the cirque where a mineralized zone shows up directly on the projection of the strike of the deposit. As seen from the top of the cirque on both sides the zone (or zones) appears to pinch out downward and there is no evidence of it in the exposed rocks in the base of the cirque. It would appear,

therefore, that this deposit occupies a fracture zone of the common type on the mountain and that it pinches out to the west and east and at depth.

Where this zone cuts the limestone on the crest of the spur the vein widens to 10 feet and shows an intermixture of the two types. The relationships show that deposition of different minerals took place at different times and that the solutions followed different routes; hence, different types of deposits were formed in different places. At this locality the high-temperature pyrrhotite-sphalerite deposit is cut by the low-temperature galena-silver type. Evidence of rock movement during and subsequent to the mineralizing processes also occurs.

In the granodiorite nearby, the shear zones are slightly mineralized with arsenopyrite, sphalerite and chalcopyrite.

Silver Lake,[1] White Heather Section. At an elevation of 6,200

[1] Jones, R.H.B.: Geol. Surv. Canada, Sum. Rept.1925,p.41, Ann.Rept. Minister of Mines, B.C., 1916, p. 124.

feet on the same spur as the Silver Creek deposits a number of irregular and tiny fractures or shear zones occur in massive, red volcanics. They are mineralized to a maximum width of 1 foot with massive bornite and tetrahedrite and in places native silver. A few tons of hand-picked ore shipped averaged: gold, 0.45 ounce, silver, 120.1 ounces a ton; and copper, 47.8 per cent. In 1934 the remaining showings were very small and irregular. Comparatively steep slopes on either side of the main workings showed only similar small zones that did not offer encouragement for improvement at depth.

Silver Lake and Trade Dollar.[2] Farther south on the same group

[2] Ann. Repts. Minister of Mines, B.C.: 1933, p. 97; 1931, p. 73; 1929, p. 165; 1928, p. 164; map, etc.

at elevations from 6,500 to 6,800 feet there are a number of other deposits. The slope of the mountain here is gradual, the rocks are badly shattered for a depth of more than 15 feet, and the whole area in many cases remains covered both winter and summer with a blanket of snow. Four veins have been opened up and others are indicated by float. Three have been traced by pits at intervals not exceeding 200 feet, for, respectively, 1,500, 800, and 700 feet. They strike southeast up the slope toward the peak and dip about vertical. All are curved and one changes direction by 40 degrees. Lay states that the vein traced for the longest distance contains massive sulphides in lenses, 1 to 30 inches wide, for at least 1,200 feet, and that galena and sphalerite at the lower end change to arsenopyrite, sphalerite, and chalcopyrite at the upper end. The other veins are similar. A width of 6 feet showing bands of sphalerite, chalcopyrite, and galena was noted in one place. An assay on the lower part of the main vein for 2.5 feet gave: gold, 0.14 ounce, silver, 90 ounces, a ton; lead, 64 per cent; zinc, 0.2 per cent. This is representative of the part of the vein that contains much galena. It is understood that the other parts of the veins are higher in gold.

The structure of the rock where the veins occur is complex and includes a sharp anticline on the northeast side and an open syncline to the southwest, both of which plunge steeply to the southeast. The rocks are older than the Skeena formation and their structure has no bearing on the dome structure of the mountain related to the intrusion since they may have been greatly deformed long before the doming. The veins cut across the formation in places at right angles to the bedding and it is clear that the main veins are not related to the structure of these rocks. They probably occur in fracture zones of the common type found on

the mountain. Toward the northwest, down the slope, 50 to 500 feet beyond the traced limit of the veins, the dip of the slope steepens and bedrock is well exposed, but the veins do not appear to continue. Up the mountain beyond the traced limits of the veins the slope steepens and the rock is well exposed.

Rio Grande. An old caved-in adit on the Rio Grande property is probably that noted by Jones[1] as showing pyrite and copper staining. In 1934 the dump showed argillite cut by stringers of pyrite and quartz. An open pit above the adit, now largely caved, discloses some rusty and slightly altered volcanic material, and in a dump nearby the rock is well mineralized with fine-grained arsenopyrite, said to assay 1 ounce a ton in gold. No other workings were noted on the property, but the rock is well exposed along the hill slope. Diamond drilling had commenced at the time of visit in September, 1934. The location of these operations is of interest because of the presence of another type of structural conditions that might be favourable for ore occurrences. Along the slope of the mountain to the east below 4,500 feet is the sedimentary series. The beds strike in the main between 40 degrees and 60 degrees south of east oblique to the hill slope and dip northeast 15 degrees to 80 degrees, mainly 30 degrees to 50 degrees. Above 4,500 feet are massive green volcanics. The contact continues along the mountain slope at about the same elevation, striking slightly north of east and sharply truncating the sedimentary beds, so that if conditions remain the same toward the west the sedimentary series would be cut out completely and the upper volcanics would lie on the lower. The dip of the base of the volcanics is northward, but its exact angle was not determined, and is probably irregular. The adit which is only 35 feet below the contact and is 150 feet long was entirely in

[1] Geol. Surv., Canada, Sum. Rept. 1925, p. 142.

sediments indicating that the dip here must be relatively low.

The sedimentary series includes interbedded black argillite, usually much sheared, sandstone, and conglomerate. The argillite is said to be the most mineralized. The volcanics are fairly fresh in appearance and are rusty in the main only near the base. Springs that deposit much iron oxide were noted issuing from the sediments some distance to the east on the trail.

NORTHERN PEAK (MOUNT EVELYN), HUDSON BAY MOUNTAIN. The northern peak of Hudson Bay mountain has as its core the largest mass of granodiorite exposed on the mountain. A number of deposits have been found surrounding the mass. They appear in the main to be small or are sparsely mineralized. Mineralization generally is similar to that characteristic of the main mountain and shows the same variations in each deposit and in different deposits. On the Mount Evelyn[1] property veins up to 3 feet, which are entirely

[1] Carroll, Jones, R.H.B.: Geol. Surv., Canada, Sum. Rept., 1925, p. 142; Ann. Repts. Minister of Mines, B.C.: 1917, p. 114; 1928, p. 164.

leached of the original sulphides, show gold up to 0.36 ounce and in silver to 9 ounces, and a 3-inch galena stringer yielded: gold, 0.04 ounce, silver, 160 ounces a ton; and lead 73 per cent. Similar assays were secured on the Evelyn,[2] which in places shows similar extensive oxidization of the veins. Other properties include Rico Aspen[3] and Trixie.[4]

[2] Jones, R.H.B.: Geol. Surv., Canada, Sum. Rept., 1925, p. 143; Ann. Rept. Minister of Mines, B.C., 1923, p. 110.

[3] Jones, R.H.B.: Geol. Surv., Canada, Sum. Rept. 1925, p. 142.

[4] Ann. Rept. Minister of Mines, B.C., 1926, p. 131.

SIMPSON CREEK. Numerous mineral deposits occur in a relatively narrow band along Simpson creek and extend from the base of the mountain toward the peak up to at least 5,500 feet. They lie in

fracture or shear zones which strike mainly north 10 degrees west to north 55 degrees west, and dip 45 degrees to 75 degrees southwest. As a rule the deposits are small, fracture-filling veins less than 2 feet wide, but in places zones of veins and replaced wall-rock up to 5½ feet, and even wider, occur. As a rule these wider zones are not well mineralized for the full width and in places are mineralized only sparsely. The maximum distance any deposit is reported to have been traced is about 350 feet and it appears that most have not been shown to be continuous for any great lengths. A number of short tunnels driven on the deposits do not usually show any better mineralized sections.

Gold associated in places with arsenopyrite occurs up to 0.64 ounce a ton on two properties (Yukon and Jessie) and on the Empire property up to 0.78 ounce in a 5-inch stringer containing no arsenopyrite. Silver, mainly with tetrahedrite and to a lesser extent with galena, is fairly high on the Jessie, Empire, and Snowshoe properties. As illustrative of the results of hand sorting of the material from these deposits it is notable that 3 tons shipped from the Empire property yielded 245 ounces of silver a ton and 40 per cent lead. At least some possibilities of profitable, small-scale mining appear to be indicated.

From a study of the deposits of this area some important information and deductions may be drawn. The deposits occur in volcanic rocks and are abundant near the contact with the overlying sedimentary shell. No deposits are known to occur in the sediments and they decrease in number in the volcanics away from the contact. The sedimentary rocks formerly extended over the deposits and probably no great amount of erosion has taken place since their removal. The extent of erosion probably increases southward away from the contact where also there is a decrease in number of deposits.

Thus it appears probable that the deposits are confined to a narrow zone which originally lay just below the sediments. The nature of the mineralization is similar to that of the group of deposits on the southwestern slope. Variations from place to place may be due to changes in the composition and courses of mineralizing solutions. Shearing of galena in the Empire shows very late movement along the veins. There is no evidence of zoning. The fractures, like those to the west, strike toward the peak, but unlike them dip southwest instead of being nearly vertical.

References to published descriptions of properties in this area are as follows: Yukon,[1,2] Yukon,[3] (1929, page 164; 1928, page 162; 1925, page 136); Empire[3] (1929, page 164; 1928, page 160); Lone Star[3] (1916, page 122); Dorothy (Wade); Cascado[3] (1923, page 10); Vancouver[3] (1926, page 132); Heather[3] (1931, page 73); Snowshoe[3] (1929, page 163; 1928, page 162); Jessie[3] (1933, page 97; 1928, page 162).

SOUTHEASTERN SLOPE OF HUDSON BAY MOUNTAIN. Several deposits occur low on the southeastern slope of the mountain in zones trending toward the peak: Zobnic,[4] Smithers Copper,[5] and Canadian Citizen.[6] Values are mainly in silver and copper, but lead and zinc are also present in some of the deposits.

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[1] Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 137.

[2] Jones, R.H.B.: Geol. Surv., Canada, Sum. Rept. 1925, p. 137.

[3] Ann. Repts. Minister of Mines, B.C.

[4] Ann. Rept. Minister of Mines, B.C., 1927, p. 137.

[5] Ibid. 1930, p. 140; 1929, p. 165.

[6] Jones, R.H.B.: Geol. Surv., Canada, Sum. Rept. 1925; Ann. Rept. Minister of Mines, B.C., 1929, p. 136.

Driftwood Area

Driftwood area is a rugged, mountainous section lying east of Bulkley valley directly opposite Hudson Bay mountain. It is bounded on the north by an extensive, relatively low area and on the south by Carr (Canyon) creek. Most of the section is included in the Driftwood Creek map-area, which was mapped and described in detail by Hanson.[1] The rocks are largely sediments

[1] Hanson, George: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, p. 19.

and volcanics and include two series of more or less massive volcanics and two of bedded rocks that are largely sedimentary. All of these rocks are cut by a number of stocks and dykes of diorite, quartz diorite, and quartz porphyry of different ages. Near or within the intrusive areas and in places clearly associated with them are mineral deposits.

"All the mineral deposits occur as veins, mostly narrow and comparatively short quartz veins. Their silver content, however, is in some instances very high, and several of the veins could no doubt be mined on a small scale with profit." The gold content is high in only a few of the deposits. "Copper, lead, and zinc are present in considerable proportion in some of the veins, but values in these base metals merely supplement the value in silver. With the present means of transportation only high-grade ore can be mined at a profit; consequently, it is not surprising to find properties idle which would have considerable merit were they more favourably located. It is believed that many of the mineral deposits are essentially local in origin, and that the metal-contributing sources were of small volume. It is expected, therefore, that small mineral deposits will be the rule. The sporadic distribution exemplified by lens-shaped, discontinuous veins is probably due largely to the diverse

physical natures of the rocks, which fracture in different ways when subjected to stress and strain..... A few deposits appear to be related to more deep-seated and perhaps more prolific sources of ore. These have more promise of permanency. A number of narrow veins in the district contain ore of high grade and in some instances may yield substantial profits on ore shipped. Deposits suitable for concentration have small tonnages, but probably sufficient for low profits."[1] At the time this was

[1] Hanson, op. cit.

written silver had a value of 55 to 60 cents an ounce, about the same as prevailed during the latter part of 1934 and early 1935. Base metals were much higher. With metal prices such as prevailed in 1934, the base metals could only be considered a detriment since the cost of transportation from the mine to the railway alone would be more than their value. Successful operation under these conditions, therefore, would seem to depend largely on the possibility of obtaining a product of high silver content either through hand picking or milling.

The properties described by Hanson include Babine Bonanza Mining and Milling Company, Debenture, Hyland Basin, Victoria (Lorraine Copper Mines, Limited), Little Joe, Haig, Social, Iroquois, Harvey, Wright (includes Rainbow), Silver King, and Reiseter Creek. Since the report was written the road up Driftwood creek has been extended and the road up Carr creek improved. Trucks have travelled over both roads for considerable distances into the district, but the roads are in the main poor. Considerable work was done on the Babine Bonanza property from 1929 to 1931[2] with some favourable results. The Harvey group

[2] Ann. Repts. Minister of Mines, B.C.: 1931, p. 173; 1929, p. 168

was optioned by Consolidated Mining and Smelting Company in 1929.[1] Other properties are Cimbria,[2] Fisher,[3] Home,[4] and Judges.[5]

Lay reported high gold assays from new discoveries on the Rainbow:[6] samples taken across 5 feet of a well-mineralized

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[1] Ann. Rept. Minister of Mines, B.C., 1929, p. 165.

[2] Ibid.: 1932, p. 85; 1927, p. 138.

[3] Ibid.: 1929, p. 168.

[4] Ibid.: 1929, p. 168.

[5] Ibid.: 1930, p. 140.

[6] Ann. Repts. Minister of Mines, B.C.: 1932, p. 185; 1930, p. 140; 1929, p. 165.

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zone assayed: gold, 0.6 ounce, silver, 32 ounces a ton; and copper 9.4 per cent. An earlier assay showed 1.52 ounces gold, 30 ounces silver a ton; and 8 per cent copper. The property occurs on a steep hillside in volcanic rock. Scattered over an area about 300 feet along and 200 feet up the slope are a number of small and very irregular mineralized zones, in part shear and in part fracture. No systematic arrangement of the zones is apparent and the main zone, from which the assays were secured, though 5 feet wide, pinches out in a short distance and is not continuous up the hill-slope for much more than 50 feet. Other zones are similarly irregular. The zones are also irregularly mineralized, and in places only sparsely, compared with those that yielded the high assays. Faulting subsequent to mineralization has further contributed to the irregularity. Minerals present include tetrahedrite, chalcopyrite, and pyrite.

High gold assays have been secured from the Hyland Basin, two selected samples (probably massive sulphides) showing 1.60 and 4.12 ounces of gold a ton.

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[7] Ann. Rept. Minister of Mines, B.C. 1926, p.133; 1922, p. 105.

In view of the high gold assays on two properties in Driftwood area and to the south in the Dome mountain area it seems possible that other gold deposits may be discovered.

Viking Group. During 1934 considerable interest was aroused by mineral discoveries on Viking hill, which lies north of Driftwood creek at the western limit of the rugged mountainous area. The rocks observed on the hill include a series of sandstones and conglomerate, largely quartz, a series of argillites and quartzites, and a mass of diorite. On the Viking group nearly flat-lying conglomerate and sandstone are extensively, though in the main sparsely, impregnated with, and cut by, stringers of pyrite carrying low values in gold and silver. Mineralization outside the stringers is by replacement and appears to have been best developed in the conglomerate. Pits on the hillside in an area about 700 feet long show a fairly widespread mineralized zone. The mineralizing solutions may be related to the diorite and this suggests that the hill is a favourable prospecting area.

## Dome Mountain Area[1]

[1] Ann. Repts. Minister of Mines, B.C.: 1924, p. 96; 1932, p. 112; 1922, p. 100, detailed map; 1918, p. 122.

Dome Mountain area includes the high area 20 miles east of Telkwa lying between Guess and Deception lakes on the south and Carr creek and Fulton river on the north. Dome mountain, 5,500 feet high, occurs in the southeastern part and another similar peak, somewhat higher, to the northwest.

On the northeastern slope of Dome mountain in an area 2½ miles long by 1½ miles wide there are numerous, rich gold deposits that have been developed to a considerable extent. From Telkwa the area is reached by 23 miles of road suitable for winter use and possibly for wagons in the dry season. The

road has an excellent grade, is well located, and could easily be made suitable for trucks. Except for a small area on top of the mountain the area is well timbered and rock is poorly exposed. The rocks are mainly volcanics, probably andesitic and of the oldest Mesozoic series, which appear to the writer to be intricately infolded with schists that are similar to Palaeozoic schists found elsewhere in northern British Columbia. Galloway,[1] however, states that the whole area has been affected by regional metamorphism

[1] Ann. Rept. Minister of Mines, B.C., 1922, p. 100.

with the result that broad bands of schistose rocks occur. Small masses of quartz porphyry occur and are believed to be the source of the gold deposits.

Discovery of the deposits took place prior to 1914, but the main period of activity began in 1918. After considerable work had been done the Dome Mountain Gold Mining Company, a subsidiary of the Federal Mining and Smelting Company (a Guggenheim subsidiary), became interested and in the succeeding two years did considerable work, mainly on one showing. Since then the properties still held by the company have lain idle. Considerable work, however, was done on more recent discoveries, especially on the Babine Gold property during 1933 and 1934.

The deposits appear to be small, but a number are very likely to average over 1 ounce in gold and a very high-grade concentrate might be obtained. It seems unfortunate considering the high price of gold at present that many deposits with apparently good surface showings should not be further investigated. Possibly, small-scale, co-operative mining and milling of the deposits in this section would meet with success.

Mineralization consists of fissure vein filling with in places some replacement. Quartz is the chief gangue mineral

and some carbonates also occur. The metallic minerals include pyrite, arsenopyrite, chalcopyrite, galena, and sphalerite, and near the porphyry on the Babine claims some hematite was noted. Free gold is abundant in places. Pyrite and arsenopyrite are the most abundant sulphides and carry most of the gold. On the Babine, Free Gold, property, pyrite alone is present, and it carries a high gold content, most of which seems to be embedded in the pyrite. In the weathered rock it occurs as coarse grains. In places the galena content is appreciable and is of some importance because it carries one ounce of silver a ton to the unit of lead.

Galloway[1] notes that the gold veins occur largely in

[1] Ann. Rept. Minister of Mines, B.C., 1922, p. 100.

the schist belts. Where observed by the writer the schistosity was very irregular as if it followed bedding planes and was intricately folded rather than straight and regular as it commonly is in shear zones. Many of the veins probably follow the schistosity and conform to irregularities in the structure of the deposits, so that most veins in the schists as well as in the volcanics are likely to be irregular.

On the Babine Gold property the gold deposits occur away from the area of schists in massive andesitic volcanics. They appear to be confined to a narrow zone of a few hundred feet near a mass of quartz porphyry to which they are related. They occur in innumerable, small, and irregular fractures and shear zones and in a few that are fairly regular and well defined.

Further work on Dome mountain might best be confined to following the ore in the well-defined, fairly straight, and steeply dipping zones, even though they do not have as impressive widths as other showings. Many of the deposits are flat-lying and as a consequence in places make impressive showings. These

flat-lying deposits, however, appear to be the most irregular. Areas around porphyry masses such as occur on the Babine Gold property are favourable prospecting ground.

Dome Mountain Gold and Other Groups Except Those Controlled by Babine Mountains Gold Mining Company.[1] So far as can be judged from data obtained the Dome Mountain Gold property as

[1] Ann. Repts. Minister of Mines, B.C.: 1924, p. 96; 1922, p.100; 1918, p. 122.

now constituted does not include all the older discoveries on the mountain, but represents a consolidation of a large number of claims centered around the Forks group, the position of which is shown on the map in the report of the Minister of Mines, B.C., for 1918, page 122.

The deposits consist of a series of quartz veins, which belong partly to the filled fissure type and partly to the replacement type. In width they range from a few inches to 3 feet, but in places where veins cross or where they swell to unusual width they range up to 25 feet. Gold assays from 1 to 8 ounces a ton were secured from samples taken across the full widths of the veins. In places the veins appear to show good continuity on the surface and afford very encouraging showings. Development work, however, proved that the favourable surface showings upon which work was carried out were not continuous laterally or at depth and it was believed that further work was not justified. However, it is understood that the properties have been held in good standing.

Babine Gold Mines, Free Gold.[2] The Free Gold showings occur at

[2] Ann. Rept. Minister of Mines, B.C., 1933, p. 98; B.C. Dept. of Mines, Bull. No. 1, 1932.

4,400 feet on the heavily timbered eastern slope of Dome mountain where the rock is largely obscured. Many trenches, pits, and

underground workings show mineralization in andesitic volcanics in an area mainly less than 500 feet wide lying south and east of a quartz porphyry mass that has offshoot dykes extending into the mineralized area.

The mineralized zone consists mostly of fissure veins bordered by completely replaced and highly mineralized rock and somewhat altered wall-rock. In places shear and fracture zones are traversed by these veins and are in part extensively replaced. There are many tiny veins; a number for short distances range from 6 to 18 inches. Some zones of fissure veins and replaced rock range up to 3 feet and with the altered wall-rock to somewhat more. On the surface three main zones, Nos. 2,3, and 4, may have lengths of 800 feet, 400 feet, and 300 feet, respectively. No. 2 deposit for 300 feet has one vein 0 to 18 inches, but chiefly 4 to 6 inches, wide, bordered in places by 1 foot of well-mineralized rock and 2 feet of altered wall-rock; No. 3 for 300 feet has a fissure vein 6 to 12 inches wide and a well-mineralized zone up to 4 feet in width. A fourth vein has only a few inches of vein material. In underground workings (at a depth very roughly estimated to be 100 feet) No. 3 deposit for 100 feet beyond the southern limit of the surface showings is made up of a vein mainly 6 to 8 inches wide, and for 25 feet below the best surface showings is a zone 3 feet wide that is badly split up and occurs in a dyke of quartz porphyry. What may be No. 4 extends at least for 75 feet and contains a vein 4 to 6 inches wide and well-mineralized rock up to 18 inches. The minerals are mainly pyrite in quartz with free gold; minor quantities of hematite, galena, sphalerite, and carbonate are also present. The veins assay up to several ounces of gold to the ton. Assays are erratic but results suggest that the vein material and completely replaced wall-rock are probably high-grade. It is improbable that the less altered wall-rock can be regarded as being of value.

These main showings lie in an area traversed by many nearly parallel and steeply dipping fractures and by a few mineralized fracture and shear zones. However, all the mineralized fractures and zones are discontinuous, they are curved, strong zones split up, and there are many flat-lying offshoots and other irregularities. The main fracture zones curve around and trend obliquely toward the porphyry mass to the north.

The porphyry mass on the Free Gold property may not be very large. Dykes of quartz porphyry that are larger and more abundant near the main mass than at other places are as a rule very irregular. They show a main trend parallel to the better developed shear and fracture zones and in places lie in these and are themselves sheared, fractured, and traversed by veins that also are disrupted and in places traversed by still later veins. The porphyry in the main mass and in the dykes carries some pyrite. It is clear that development of the zones, intrusion, and mineralization were closely related and that both fracturing and mineralization took place over a considerable period of time.

Beyond the main showings toward the adit portal there is no systematic fracturing; veins of various sizes, many of which are flat, form an intricate network. Some of the flat veins are a foot or more thick and have been exposed by trenching for about 100 feet. They are made up mainly of glassy quartz with pyrite, and they are relatively low grade.

## SOUTHERN BABINE MOUNTAINS

The southern part of Babine mountains as herein designated includes a large area lying between the Dome Mountain road (Guess and Deception lakes) and on the railway to the south. It is a moderately rugged country, much of which lies above 4,000 feet elevation, but only one peak (Grouse mountain) reaches 5,000

feet. The area is largely underlain by massive Mesozoic volcanics, but in places there are some of the bedded formations. These rocks are cut in places by granitic intrusives, mainly in the form of dykes. These are very abundant on Grouse mountain and Mineral hill, which together constitute the most outstanding physical feature of the area and which so far have proved to be the most highly mineralized. The intrusives here are clearly indicated to be of different types and different ages, but they may be related.

Mineral deposits have been discovered throughout the area, most abundantly in readily accessible sections and least so in the more remote parts. The chief metals present, though not all three occur in all deposits, are copper (in chalcopyrite), zinc (in sphalerite), and lead (in galena). Silver assays are low (15 ounces to the ton or less), though in rare, very small veins carrying much tetrahedrite, on Grouse mountain and on Mineral hill, they are high (about 150 ounces). The amount of gold is in most cases unimportant, though rare good or high assays have been secured on Grouse mountain. Pyrite is usually abundant and in a number of places, widely separated, hematite and magnetite are also abundant.

The deposits are small, without much regularity or continuity. Development has been disappointing: good showings at the surface in places were found not to continue to depth and surface work failed to show continuity. The very rich deposits are mostly measured in inches, deposits of fair grade are wider, and of poor grade still wider. However, given high base metal prices the small deposits indicated might be worked profitably, especially where there are a number in a limited area near transportation. More favourable conditions than have been demonstrated by development work may have caused the formation of larger concentrations. Although valuable gold deposits have not been discovered up to date the position between Dome mountain

and Bob creek, two areas of high-grade gold veins that are similar, indicate some possibilities.

Properties in the north include Paradise[1] near Guess lake, Bulkley,[2] 6 miles southwest of Dome mountain, and Chisholm[3] which may be the same as a "copper showing" reported 14 miles up Deep creek. The Deep Creek group[4] occurs 7 miles up Deep creek and the Ivanhoe group,[5] 4 miles north of this.

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[1] Ann.Rept. Minister of Mines, B.C., 1918, p. 122.
[2] Ibid., 1929, p. 170.
[3] Ibid., 1918, p. 122.
[4] Ibid., 1928, p. 168.
[5] Ann. Rept. 1928, p. 168.

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On Grouse mountain (Sawmill camp) the following have been described: Copper Crown (Cassiar Crown Copper)[6,7] (1926, page 136, map; 1925, page 135; 1923, etc.), Lakeview[7] 1925, page 141; 1924, page 113), Cornu Copia[7] (1926, page 136), Black Fox[7] (1926, page 136), Hidden Treasure[7] (1929, page 169; 1928, page 169; 1914), Rainstorm[7] (1926, page 135), Solo[7] (1926, page 135), Joe B.[7] (includes Rainstorm and Black Fox) (1928, page 169); on Mineral Hill[7] (Venus, Lone Pine) (1926, page 137; 1925, page 141; 1914), Mickey[7] (1926, page 137), Butte[7] (1927, page 138), Grafter[7] (1914, page 226), Silver King[7] (1914, page 226); east and south of Mineral hill and northeast of Houston: Mamoth, Mison, and B.C. Leader[7] (1931, page 74; 1929, page 176), Lucky Day[7] (1930, page 143), Mikado[7] (1929, page 176), Bluff[7] (1918, page 127), Lakeview[7] (Three Lakes) (1926, page 137).

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[6] MacKenzie, J.D.: Geol. Surv., Canada, Sum. Rept. 1915.
[7] Ann. Repts., Minister of Mines, B.C.

Mountains between Telkwa and Morice Rivers

Between Telkwa and Morice rivers is a rugged, mountainous country mainly of early Mesozoic volcanics which are cut in places by small, granitic stocks. In the northern half of the area a considerable number of mineral deposits have been discovered. They are characteristically confined to relatively narrow areas near the intrusive bodies and occur at relatively high elevations in three well-separated areas, in the east Hunter mountain, in the centre Howson basin, and in the west the Milk-Clear Creek section. The areas are from 15 to 25 miles from the railway at Telkwa and are not readily accessible.

Hunter Mountain and Howson Basin. Hunter mountain and Howson basin are described by Leach, 1907. Hunter mountain is further described by MacKenzie[1] (King, Jackpot, Colorado, Hunter), by Galloway[2] (1914, page 222) (Idaho, Mohock, Colorado, Tribune, Hunter, Hannah, Gipsey Queen, Blue Grouse, Highgrade, Loring, and Forest), the Hope property by Lay[2] (1932, page 85), and Howson basin by Galloway[2] (1917. and 1916, page 125).

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[1] MacKenzie, J.D.: Geol. Surv., Canada, Sum. Rept. 1915.
[2] Ann. Repts., Minister of Mines, B.C.

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Copper and copper-silver, with as a rule a small gold content, have been discovered at Hunter mountain and Howson basin. The deposits in Hunter basin and nearby Hankin and Dominion basins are small veins which appear either in narrow, irregular fissures or as replacements along lines of crushing. The grade in some is high with silver up to about 70 ounces (one 298 ounces) a ton, and copper up to 6 per cent (one 25 per cent). "It is probable", wrote MacKenzie in 1914, "that with the increased facilities of transportation that will be afforded by the wagon road now building toward the basin and with careful mining they may be worked on a small scale at a profit." This would apply only during times when

prices for copper and silver are moderately high. In Howson basin mineralization has taken place along fracture zones in volcanics, or along the walls and in granitic dykes. The minerals are mainly copper with low silver and traces of gold. Most deposits (Duchess, Evening, Silver Heels) are irregularly and sparsely mineralized, although in some places as much as 5 per cent of the veins contain minerals. On the Santa Maria a well-defined replacement vein along the bedding has been traced for 450 feet with a width of 5 feet, in which there are irregular bands and streaks of massive sulphides, but these are not continuous in the vein. The massive sulphides are usually less than a foot of the total, but in places range up to the full width of the vein. At a depth of 120 feet no ore was found in the northern part of the vein. The ore is largely chalcocite, which is secondary, and bornite, which may be in part primary. From mining operations on one small section of the vein 239 tons were obtained by hand sorting and shipped to give returns of 17 per cent copper and 9.05 ounces of silver to the ton. The primary minerals are believed to be chiefly chalcopyrite and pyrite. The vein has a marked iron cap. This deposit is of special interest because of the apparent secondary enrichment. This appears to be limited to less than 120 feet in the workings and in places probably is not present since elsewhere primary minerals occur at the surface.

Two groups, the Duchess and Contention, were optioned and worked in 1928 and 1929 by the Consolidated Mining and Smelting Company, but were dropped.

Milk-Clear Creek Section. The Milk-Clear Creek section is 35 miles or more from the railway. It lies either between two intrusive bodies or in a big embayment in one. Leach[1] considered

[1] Leach, W.W.: Telkwa and Vicinity, B.C.; Geol. Surv., Canada, p. 10 (1907).

these intrusive rocks to be different from the other intrusives and related to the Coast Range batholith. The ores here are copper, zinc, and lead. On the Big Four property on Clear creek, where the showings are reported to be large, the gold content is unimportant and it is also low in silver. On Milk creek silver assays are usually good (12 ounces to 70 ounces a ton). The deposits are mainly small veins (6 inches to 4 feet wide), though wide quartz veins high in gold and low in silver (2 ounces to 5 ounces a ton) are said to occur on the Kitchener in granodiorite near the contact.

On the Milk-Clear Creek section the following are described: the Big Four deposits[1] (1929, page 17; 1926, page 38; 1920, page 90; 1917, page 120; and 1914, page 229), the Milk Creek deposits, Surprise (Morning Star and New York)[1] (1920, page 91), Kitchener Group[1,2] (1925, page 138) and Grandview[1] (1929, page 170).

Southern Part. Not a great deal is known about the southern part of the area between Telkwa and Morice rivers, but some granitic masses have been reported. Sparsely mineralized deposits, mainly copper-silver, occur low down on Sunrise creek which the railway crosses between Wolcott and Barrett[1] (Black Bear and Silver Stream, 1931, page 75, Confederation and Vaino, 1928, page 170), and a prospector reports having found mineralization on the north fork of the Morice, some of which gave high gold assays. In the main it would appear probable that this section, which is not very accessible, has been prospected relatively little.

## Morice River and Lake

Morice lake can be reached either by river boat or trail from Houston. Lay describes the area[3] and notes that in

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[1] Ann. Repts., Minister of Mines, B.C.
[2] Dept. of Mines, B.C., Bull. No. 1, 1932.
[3] Ann. Rept. Minister of Mines, B.C., 1929, p. 178.

places granitic intrusives cut volcanics and that certain areas are favourable for prospecting.

## Bob Creek and Buck River

The Bob Creek and Buck River section has attracted much attention because of hopes to develop a large low-grade gold mine. A great number of attempts culminated in 1934 with the starting of a small mill, which after some short, unsatisfactory runs was closed. Placer gold deposits, already described, which have afforded a small yield, have also contributed to the interest aroused by this section. Unlike most other mineralized sections it is not mountainous but is located in the main on a small hill.

The nature of the main deposit and the conclusions reached by the writer may be briefly summarized as follows: Bob Creek canyon affords a section 1,500 feet long and as much as 150 feet deep across a very large, very low-grade mineral deposit. Other exposures indicate a length in excess of 1 mile and widths at least comparable with the canyon section. Mineralization occurs around and in a core of porphyry which is so badly altered as to be largely unidentifiable in the midst of similarly altered volcanics. All this altered rock is impregnated with pyrite and carries very low or no values. Scattered irregularly throughout are stringers carrying gold, in part free, up to 1.4 ounces a ton (average for four assays 0.6 ounce a ton), silver to 24 ounces a ton(average 10 ounces a ton), considerable zinc (one assay returned 18 per cent), and a little lead. These represent even in the best ground less than 5 per cent of the total rock. The grade of ore, therefore, as reported to be confirmed by extensive assaying is very low, probably averaging less than 0.05 ounce a ton in gold. The deposit as a whole or in sections is not yet indicated to have prospective economic value. Since in the canyon section the mineralized zone occurs in and

at the contact of porphyry from which it has most probably been derived there is nothing to suggest the probability of better ore being found elsewhere. The placer gold has been formed by the weathering of the altered rock, which decomposed very readily and the values found in the placer deposits also offer some clue to the values likely to occur in the deposit.

To the east, at the head of the canyon, the deposit is overlain by Tertiary lavas which are definitely younger than the mineralization, and dip eastward so as to cut off any possible extension at or near the surface in this direction. The older volcanics are mainly grey and green, massive andesites and tuffs. Quartz-feldspar porphyry in the canyon section can be recognized mainly by the presence of rounded quartz phenocrysts and less commonly feldspar phenocrysts. In places neither is visible. Some dykes of similar and different porphyries, all probably related, occur beyond the altered zone where they are readily recognizable by their light grey or pink colour. They are generally considerably altered.

The volcanics and porphyry in the deposit area are altered to a light grey, very rotten material made up of quartz, sericite, and mica, or in some places to a hard material made up largely of quartz. The altered zone is exposed for over 1,500 feet in the canyon and southward, on the Ruby group and in other exposures, to the showings on the Ark property on Back river one mile above the bridge. Beyond this zone, especially on Bob creek and on Buck river below the creek, there are narrow, altered zones where the green, unaltered volcanics can be seen grading to the light grey, altered material, which borders dykes, mineralized stringers, and fractures along which mineralizing solutions moved. The extent of alteration is not always greatest where the largest and most abundant stringers occur, but in general the highly altered sections are probably the best mineralized.

In the main the stringers are at most only a few inches wide both within the central altered section and beyond. They follow in the main straight fractures but show no systematic arrangement; they are most commonly vertical but may be at any angle. Attempts have been made to work the stringers both within the main deposit zone and beyond, but so far no vein has been disclosed that seems to offer hope of making ore. Within the main deposit zone on Bob creek the stringers in places carry sphalerite, pyrite, and lesser quantities of galena and possibly arsenopyrite; on Buck river they carry all except the last, and tetrahedrite. Tests by the Mines Branch, Ottawa, on three small samples (two of decomposed vein matter assaying low in gold) failed to find free gold. Tests by the company engineer and others have shown free gold, and small flakes are reported to occur on the walls of Bob Creek canyon. Much of the gold in the veins probably is not free or is very finely intermixed with the sulphides. There are some differences in the character of the stringers; probably they were formed at different times, and contain different minerals and values. Thus some sections with a certain type of stringers might go much higher in gold or silver than others.

Stringers beyond the main deposit zone carry the same minerals, pyrite, sphalerite, galena, and quartz, though they may have somewhat more galena and quartz. Assay values of one (1,000 feet below the end of the canyon) showed 7.8 ounces of silver and 0.23 ounce of gold, and another[2] a trace of gold and

[2] Ann. Repts. Minister of Mines, B.C.: 1927, p. 140; 1928, p.173

42.5 ounces of silver a ton, with 7 per cent lead and 7 per cent zinc.

Golden Dyke Mining Syndicate (Houston Gold Mines, Limited, Bob Creek Porphyry Dyke, Gold Brick, Horseshoe).[1,2] This property covers the whole of the canyon section on Bob creek. It is equipped with a mill which, operating in 1934, milled 202 tons in 182 hours. Company officials report that mill feed assayed 0.01 ounce a ton in gold and the highest concentrate was 0.12 ounce a ton in gold. This, however, cannot be considered as a fair test as the rock being milled was porphyry from what appeared to be the poorest section of the deposit. The company assayer reports that sampling in the canyon showed values of a trace to 0.1 ounce. Published results suggest low values. Four hundred samples taken by a private engineer are reported to have ranged up to 0.1 ounce, but averaged less than one-fourth of this.

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[1] Lang, A.H.: Geol. Surv., Canada, Sum. Rept. 1929, pt.A, p.93
[2] Ann. Repts. Minister of Mines, B.C.: 1933, p. 98; 1928, p.172.

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ARK. The Ark group showings are about one mile above the bridge on both sides of Buck river. The total extent along the river of altered and mineralized rock is 250 feet. Upriver, this grades to green and purple volcanics. Downstream, 500 feet at the next exposure, there are green, purple, and brown volcanics. The values obtained in assays from the altered zone as a whole range in gold from 0.025 to 0.12 ounce and in silver 0.4 to 0.74 ounce a ton.

RUBY (Bellefield, Risk, and Hope).[3,4] Between the Ark and Bob Creek canyon deposits there are exposures of altered and mineralized rocks. Cutting these and also altered in places are hard, grey, rhyolite or dacite dykes, carrying some pyrite,

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[3] Lang, A.H.: Geol. Surv., Canada, Sum. Rept. 1929, p. 92.
[4] Ann. Rept. Minister of Mines, B.C., 1928, p. 172.

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which are probably related to the porphyry of Bob creek. Probably much the same features occur below this ground as those much better exhibited on the other two properties.

## Morice Mountain

On Morice mountain Lay states that granitic rocks intrude limestone and other sediments and volcanics. Mineralization occurs on the northern and southern slopes. Values are mainly in copper. Some narrow veins carry as much as 10 per cent copper, and 106 ounces a ton of silver. Properties include Croesus[1] (1931, page 74), Sholto[1] (1930, page 142), Peacock[1] (1929, page 175), O.K., Hazelton, Morrison, Quinn, Bull Moose[1] (1930, page 143), and Copper King[1] (1929, page 175).

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[1] Ann. Repts. Minister of Mines, B.C.

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## Owen Lake

The Owen Lake area[2] lies about 28 miles south of

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2 Lang, A.H.: Geol. Surv., Canada, Sum. Rept. 1929.

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Houston, west of Buck river, and is a continuation of the Bulkley belt to the south. It is a semi-mountainous area, but contains mount Nadina, 7,065 feet, the most outstanding landmark in the district. Granite, which constitutes part of this mountain, and diorite intrude andesitic volcanics and a limited amount of indurated Upper Cretaceous(?) sediments. Copper, zinc, and lead deposits, which are most important because of their silver content, have in places undergone considerable development. There is a wide range in the abundance of each metal even in one vein. Silver ranges from very low to about 150 ounces, and gold up to about 0.5 ounce a ton; the average for any considerable body would appear at best to be only moderate. There are in places numerous high-grade veins, but

these are small, and larger mineralized zones are generally lower grade. There is in places fair persistency to the deposits. Development work has in the main been disappointing. However, it is possible that with favourable silver prices some small-scale operations might be carried on profitably.

Lang (1929) gives some useful data about the nature of the mineralization, which are believed by the writer to be largely applicable to the Bulkley and Babine belts as a whole, and though not necessarily typical offer excellent clues as to what may be expected elsewhere. The intrusive bodies are considered to be very young and the mineralization to be associated with them. Evidence is considered conclusive that the deposits were formed relatively near the surface under low temperature and pressure conditions. The various minerals were deposited at different times. There is no evidence of zonary arrangement. Pyrite is the only mineral showing any tendency to penetrate the wall-rock and this pyrite carries little in the way of values.

Besides the properties included under the Owen Lake Mining and Development Company Lang described the Snowstorm, IXL, Dick, and Grubstake. Detailed descriptions are also given by Lay.[1,2]

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[1] Ann. Repts. Minister of Mines, B.C.: 1929, p. 17; 1928, 1927, 1925, 1924, 1923, 1916.

[2] B.C. Dept. of Mines, Bulls. Nos. 1 and 2, 1929.

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## Coal[3]

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[3] Much of the general information about coal has been secured from D.B. Dowling's report, "Coal fields of British Columbia", Mem. 69, p. 57 (1915).

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Coal occurs at many localities in the Babine and Bulkley belts, but mainly in small basins ranging in size from a few acres to 40 square miles and possibly more. It is known

to occur in Jurassic, Lower Cretaceous or Skeena, and Tertiary rocks. In the Jurassic rocks the known deposits occur in tiny seams and as carbonaceous shale, which are not likely to have commercial value. The Tertiary coals are lignitic and have not yet been demonstrated to have commercial value. They are also probably of very small extent. All of the coal so far indicated to be commercial or likely to be commercial is confined to rocks either identified as Skeena or correlated with these.

The Skeena rocks do not carry coal in all localities; they show wide variations in this respect from basin to basin and even within short distances in one basin. Most of the coal, however, is confined mainly to the lower part of the series. The characteristics exhibited suggest that the coal-bearing rocks were not laid down continuously over the whole area, but undoubtedly they were much more extensive than now.

The coal has been greatly affected by the intrusion of the granitic bodies both in regard to quality and structure. It shows a complete range from normal bituminous coal to anthracite and even graphite. The coal-bearing strata have been upbowed, deformed, and faulted near and over the areas of intrusion. They now occur mainly in topographical basins in the form of structural basins--that is, in the central part of these areas the beds are flat and around the edges they are turned up and in places extend up the slopes of the mountains in relatively thin shells.

In the larger valleys and low areas the coal-bearing strata are little deformed and faulted and are soft, and quite different from the older rocks. As a consequence they have been more readily eroded and now are extensively obscured by drift. In narrow valleys the coal measures are more steeply folded and more faulted and the coal is more altered. Where the coal

measures extend up the mountain slopes and approach the granitic cores they become more and more deformed, faulted, cut by dykes, and altered. In places they are so altered as to be similar to the older rocks. The alteration and deformation of the coal measures are most strikingly illustrated in the Cedar Creek and Skegunia-Kispiox coal fields near Hazelton and on Hudson bay and Hunter mountains.

Thus, with the original variations in the coal seams, the smallness of the areas of coal formations, and the many other factors tending to destroy the quality and minability of the coal the total amount now of commercial value, or likely to be in the near future, is small compared with most of the important coal areas in Canada.

In the vicinity of Hazelton, amid large and abundant intrusive masses, the exposures of coal so far found are highly altered, deformed, and faulted, and are cut by dykes and, therefore, do not offer much hope of profitable mining on an important scale. The extensive Zymoetz River area probably has good structural conditions, but is 30 miles from the railway. The Telkwa coal basin indicated by Leach to be about 10 miles square is the only one so far demonstrated to be of commercial value. It is the only one known to have favourable structural conditions and good coal seams within 10 miles of the railway. There are some possibilities of developing an anthracite deposit in Lake Kathlyn area. In localities where semi-anthracite coal has been found mining conditions are commonly poor and there may be few areas where they are really good.

In the Morice River section there is one large field of 40 square miles and two or three smaller ones that seem to offer hope of containing extensive areas of easily minable good seams. The most accessible of these, however, which is the least proved, is 30 miles from the railway.

Some consideration may be given to the possible discovery of new coal fields, since the coal measures in the valleys are largely obscured. Coal measures occur at the north and south end of the Aldrich Lake - Pine Creek valley southwest of Hudson Bay mountain. They may be continuous throughout the valley under the drift and if they contain good minable coal, especially near the north end, they might be an important asset to the development of mineral claims on the southwest slope of the mountain. It is possible that coal measures carrying valuable coal underlie the drift and possibly also younger rocks in part of Bulkley valley above and Below Smithers. Leach[1] notes

[1] Leach, W.W.: Geol. Surv., Canada, Sum. Rept. 1907.

that Telkwa coal measures may be much more continuous than indicated between the areas now shown, to the north of Telkwa river and to the east. Coal measures may underlie some of the extensively drift-covered areas along Bulkley valley from Telkwa to Houston and along Morice valley to the southwest. Low areas in the Babine belt, such as that between Driftwood and Suskwa mountains, seem to present some possibilities. Along the east slope of Babine mountains, not easily accessible from the railway, are extensive, low, largely drift- or lava-covered areas that may contain other coal basins than the one on Fulton(?) river already reported.

The Groundhog Coal area of about 900 square miles[2] with

[2] Dowling, D.B.: Geol. Surv., Canada, Mem. 69, p. 189; Malloch, G.S.: Geol. Surv., Canada, Sum. Rept. 1912, pp. 69-100.

many seams of anthracite is located 110 miles north of Hazelton. This, together with the Sustut Coal area[3] and possibly other areas in the central part of the province, offers possible large reserves of coal.

[3] Op. cit.

## Detailed Descriptions of Coal Areas

A comprehensive review of some of the coal fields is given by Dowling.[1] Unless otherwise noted reference is to this report.

[1] Dowling, D.B.: Geol. Surv., Canada, Mem. 69.

Kitsequekla Coal Area. Above Kitsequekla river, on Skeena river, there are coal seams, narrow, impure, crushed, and considerably deformed.

Cedar Creek.[2] Eight miles west of Hazelton there is semi-

[2] Ann. Rept. Minister of Mines, B.C., 1921, p. 114.

anthracite, which is graphitic, poor burning, 3 to 4 feet thick, badly crushed, deformed, broken, and discontinuous; the basin is several miles long and probably there is better coal in other places.

Skegunia-Kispiox. A large area along Skegunia, Kispiox, and Skeena rivers contains coal to 5 feet thick which is dirty, badly crushed, deformed, faulted, and cut by dykes.

Babine Portage. The coal formation occurs along Suskwa river.

Babine Lake. Seventeen miles up Tuchi (Fulton?) river (or a few miles below Chapman lake?) seams of fair width are reported.

Bulkley River above Hazelton. O'Neill in 1918 reported possible coal measures.

Seaton. (Bulkley river of Dowling and Leach)(Wright).[3] A shallow, synclinal basin 1½ or 3 miles by 4½ miles contains a large number of seams 12 to 40 inches, but even the best are very high in ash.

[3] Ann. Repts. Minister of Mines, B.C.: 1927, p. 161; 1916.

For several miles above this, Jurassic rocks contain much carbonaceous shale and coaly material that has been staked for coal (Ashman).

Driftwood. (Tertiary rocks).[1] 1.8 feet of Clean coal, 1.8 feet, occurs in 15 feet of coal and shale. The coal is lignitic in

[1] Fossils collected from here in 1934 were examined by W.A.Bell and regarded as Upper Eocene or Oligocene.

character and only slightly deformed, but nearby underlying strata are considerably deformed and faulted.

Lake Kathlyn.[2,3] The rocks in which coal occurs here belong to the Skeena formation.[4] The character and succession of the rocks,

[2] Hanson, George: Geol. Surv., Canada, Sum. Rept. 1925, p. 119.

[3] Ann. Repts. Minister of Mines, B.C.: 1926, p. 161; 1917, p.125.

[4] W.A. Bell reports that a collection of fossil plants collected at the Lake Kathlyn coal mine in 1934 are considered to be Lower Cretaceous in age and to be more probably of Lower Blairmore age than Kootenay. The formation containing them is considered to be the same as that at Goat creek, Telkwa river (Skeena formation).

the presence and position of the coal seams near the base of the series, the changes in extent of metamorphism from place to place, and other features of the Hudson Bay mountain coal-bearing series, even without the fossil evidence, suggest correlation with the Telkwa River series.

Six seams, three of which are over 3 feet thick, are known. They dip 40 degrees to 70 degrees toward Bulkley valley and are much deformed, faulted, sheared, and crushed.

In 1934 a low-level, cross-cut adit about 100 feet above the base of Glacier gulch was in 400 feet. It passed through a series of shale, argillite, and sheared argillite, with parts that are highly carbonaceous and coaly and have some small coal seams. At the face there was a rather complex mass of clean, unbroken coal, sheared and graphitic coal, hard argillite, and graphitic and carbonaceous schist. There appeared to be two seams, a thin seam of 1 foot or less, and another which on the south side showed 5 to 6 feet of material that was mostly clean

coal with some shale. The coal is an anthracite[1] with tiny

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[1] Analysis of Lake Kathlyn coal:

| Condition of Sample | As received | Dry |
|---|---|---|
| Moisture | 9.6 | |
| Ash | 12.0 | 13.3 |
| Volatile matter | 4.1 | 4.5 |
| Fixed carbon (by difference) | 74.3 | 82.2 |
| Sulphur | 0.7 | 0.8 |
| Calorific value: | | |
| Determined, in calories per gram, gross | 6,025 | 6,665 |
| Determined in B.T.U. per lb. gross | 10,850 | 11,990 |
| Fuel ratio, fixed carbon/Volatile Matter | | |
| Softening temperature of ash °F. | 2,160, | Noncoking |

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films of graphite along lines where movement has taken place. The coal ordinarily does not burn well, but under forced draft it burns much better.

The extent of the coal formation below the coal in the adit is probably something in the order of 100 to 400 feet. The rocks in the adit strike from north 10 degrees east to south 60 degrees east and dip east 40 degrees to 60 degrees. Up the mountain slope the character of the formation changes rapidly. In about 1,500 feet along the bedding the materials become much coarser and include more sandstone, and the coal seams appear to become smaller and dirtier. In another 1,500 feet what is believed to be the same formation shows no coal, little argillite, much sandstone, and considerable conglomerate.

The coal is probably metamorphosed due to proximity to the granitic core of Hudson Bay mountain and to the deformation of the strata. Farther west along the south side of Glacier gulch there is a minor anticline. This and other features lead to the belief that the coal formation is more disturbed near Glacier gulch than it might be to the south. The probability of improvement in quality and thickness at depth and to the south would seem to be sufficient to warrant further exploration for a

deposit of commercial value. The remainder of the coal series below the seam now opened up may yield other coal seams, but the six seams reported higher up the slope are probably consolidated here into a smaller number.

The extent of the coal formation between Glacier gulch and Simpson creek is fairly well determined. It seems improbable, however, that, at best, much commercial coal could be derived from above the level of the present adit. Also, it is improbable if commercial coal is found at this level that it would be continuous even to near Simpson creek. The coal formation continues down into Bulkley valley where the rocks are covered with drift. Throughout a large area in Bulkley valley the rocks observable along the main roads are mostly sandstone, shale, and conglomerate, which in appearance suggest Skeena or later age. The Carr Creek coal may also be of Skeena age. Some areas (Driftwood) already outlined are of Tertiary age and, of course, could be underlain by Skeena rocks. Thus it is possible that a part of Bulkley valley here is underlain by the coal formation. The fact that the rocks in most places are considerably deformed and no Skeena coal is known elsewhere except on Carr creek is not encouraging.

Glacier Creek, Southwest slope of Hudson Bay Mountain.[1] Small

[1] Leach, W.W.: Geol. Surv., Canada, Sum. Rept. 1918, p. 43.

seams 4 to 9 inches thick occur with steep dips southwest. "It would seem probable that the large seams of Telkwa river are here split up into a number of small ones though it is possible larger ones do exist. Coal here is very hard with all the appearance of an anthracite but one sample analysed was too high in ash."

Carr (Canyon) Creek. Coal is reported by prospectors to occur 9 miles above the mouth of Carr creek, to be very thick "anthracite", to contain 40 per cent ash, and to burn well with blue flame.

Zymoetz River.[1] A large area of coal formation which holds

[1] Hanson, George: Geol. Surv., Canada, Sum. Rept. 1925, pt.A, p. 119; Ann. Repts. Minister of Mines, B.C.: 1921, p. 111 (drill cores); 1920, p. 104, 1914.

coal seams over 3 feet thick occurs 30 miles from the railway. Other areas of Skeena rocks in Zymoetz River area are not known to carry coal.

Telkwa.[2] Aveling on north side of river,[3] Jefferson-Dockrill, Dockrill, Telkwa, south side on Goat creek.[4] In Telkwa River

[2] Dowling, D.B.: Geol. Surv., Canada, Mem. 69, p. 175.
Leach, W.W.: Telkwa River and Vicinity, p. 14.

[3] Ann. Repts. Minister of Mines, B.C.: 1922, p. 111; 1921, p.104.

[4] Ann. Repts. Minister of Mines, B.C.: 1932, 1931, etc.; 1926 map; 1924, 1923, analyses; 1922, etc.

valley there is a fairly large total extent of the Skeena formation in numerous troughs, containing as a rule good grade bituminous coal seams up to 14 feet thick which have been worked profitably on a small scale for many years; the present production is 4,000 to 6,000 tons annually. The strata are only a little disturbed and faulted at the main workings near Telkwa river. Farther south (Cassiar and the Transcontinental), however, the coal changes to semi-anthracite and the strata become much disturbed and faulted.

Morice River. Some data about the Morice River coal fields are given by MacKenzie,[5] and some on the Prince Rupert Coal fields,[6] but the older descriptions by Leach and Dowling give the most information.

[5] Geol. Surv., Canada, Sum. Rept. 1915, p. 69.

[6] Ann. Rept. Minister of Mines, B.C., 1917, p. 122.

(1) Coal Creek (most northerly area) (also Telkwa M.M. and D. Company).[1] There probably are four good workable seams of

[1] Leach, W.W.: Geol. Surv., Canada, Sum. Rept. 1907, p. 18

semi-anthracite 4 to 7 feet 3 inches thick. The strata are deformed and faulted. The area of the coal formation is 1½ miles long and very narrow and occurs at an elevation of 4,500 to 5,000 feet.

(2) Gold Creek (Goldstream).[2] Good coal, in the main bituminous

[2] Idem, 1910.

occurs in three seams 3½ to 8 feet thick. The coal formation is in the form of a basin not greatly deformed, with an area of 2 to 3 square miles, and occurs at an elevation of 4,200 to 5,000 feet.

A small area of a little over ½ square mile occurs lower on Gold creek.

(3) Clark Fork. A large area of coal formation extends down the Clark fork (or North fork) of Morice river from the main forks for at least 8 miles and probably to Morice river. The coal basin is ¾ of a mile wide at the upper end and tends to widen out downward. One coal seam of 12 feet of good bituminous coal is known. The strata have a low, uniform dip.

(4) Chisholm Creek. On Morice river, Chisholm creek, and Chisholm lake, there is a coal area of probably over 40 square miles, which has been little prospected. One seam 3½ feet thick, including clean, shaly, and hard, blocky coal and a thin shale parting, is separated from another less than 1 foot thick by 2 feet of shale.

The last area is 30 miles from the railway along Morice river which has a wide valley and even gradient. The other areas are much more distant by this route. Coal Creek area is 35 miles from Telkwa by a different route up the south fork of Telkwa river.

# CHAPTER IV

## PLATEAU BELT

### GENERAL GEOLOGY

The Plateau belt extends from Babine mountains eastward to Prince George and beyond. In the western half, west of Fort Fraser, the railway follows wide, open valleys in a moderately rugged country with rare mountains rising 2,000 to 3,000 feet. The grade, rising first about 300 feet from the west to Rose lake and then dropping 150 feet, gives a good idea of the general flatness of low lands throughout this area. This section, commonly known as the "Lakes District", contains more lakes, large and small, than any other part of the province, and also the largest lake (Babine) in the province.

In the eastern half of the Plateau belt, though the railway drops 380 feet in following Nechako river from Fort Fraser to Prince George, it passes through one of the largest, nearly flat areas in British Columbia. The land slopes up from the central part in all directions like a great basin. In the distance to the north there are a few low hills, and to the south hills and mountains rise from the plain.

Throughout the Plateau belt the low areas are extensively covered by lakes and by drift, in places several hundred feet thick. Extensive, and deep, deposits of sand, clay, and bedded gravels occur in areas formerly occupied by lakes, notably where a large lake covered all the low land (below 2,585 feet in elevation) of Vanderhoof area from near Isle Pierre westward. Long arms of this lake extended over Stuart Lake area, westward to Bulkley valley and southwestward to include François lake. Deposits similar to those of this area are now forming in the present lakes. Thus extensive areas have practically no mineral possibilities except such as

might be found in the sands, clays, and gravels. These unfavourable areas may be flat, as in the case of old lake bottoms or river benches, or they may be very rough with hills rising several hundred feet where recessional or terminal moraines occur.

Extensive areas covered with Tertiary rocks can also be eliminated from serious consideration so far as mineral resources are concerned. The Tertiary rocks include a series of shale, sandstone, conglomerate, and lignite, which as determined by W.A. Bell from a fossil collection are of upper Eocene or Oligocene age and correlate with the rocks on Driftwood creek in Babine mountains. The series is known to occur in scattered patches throughout the part of the belt west of Engen. The strata are commonly flat, but may be considerably deformed. This series in all sections where it has been noted has white, rhyolitic tuffs interbedded in the upper part and is overlain by a series of white to pink, rhyolitic tuffs, flows, and breccias, and locally soft, chalky, white, powdery ash. Unconformably above these and somewhat folded are dark grey, black, red, brown, or green, andesitic, dacitic, and basaltic lavas which in places are as much as 2,000 feet thick. This series is so widespread throughout the Plateau belt that at one time it must have covered all but the highest mountains. The rocks are generally readily recognizable by their horizontal or low-dipping, well-defined banding due to individual flows or tuff horizons. Locally they break into slabs and look like slate.

The Tertiary lavas occur extensively in low areas and, therefore, low areas in the main are unfavourable for prospecting except along deeply cut streams or river valleys where older rocks may be exposed. The hills and mountains made up of these unfavourable Tertiary rocks commonly have long, gradual, even slopes with steep cliffs in contrast with the very irregularly

rounded surfaces of the older rocks. Some black, cone-shaped mountains such as occur south of Babine lake near the Burns Lake road may also be Tertiary.

Between Hutchison and Miworth there are extensive areas, mainly of shales with some sandstone and conglomerate, which Dawson[1] described as Nechako series and considered to be

[1] Dawson, G.M.: Exploration in British Columbia; Geol. Surv. Canada, Ann. Rept. 1874-75.

late Mesozoic. However, the general features suggest a greater resemblance to Tertiary rocks. The shales, commonly grey, in places are red, yellow, and white, probably due to alteration. Some of the beds, judging from descriptions, may be rhyolitic tuffs like those in the late Eocene or Oligocene rocks. The strata are considerably deformed and are cut by dark coloured (basaltic? or andesitic?) intrusives.

Schists, quartzites, slates, phyllites, and gneiss, probably mainly Palaeozoic, occur in scattered areas throughout the eastern half of the Plateau belt. Limestone, probably of late Palaeozoic age, occurs east of Wedgewood on the railway. A group of volcanics overlies the Palaeozoic rocks in many patches in the eastern half of the belt and is fairly extensive in the western half. The volcanics are largely massive and commonly dark green. Rarely they are grey, red, purple, and other colours. They are probably Triassic or possibly Jurassic. They very likely occupy most of the large area extending south from the railway between Decker lake and Savory, broadening to include most of the south shore of François lake. There are probably numerous small areas in the section between the railway and Babine lake such as occur at Poison creek and in the vicinity of Taltapin mountain. A younger group of volcanics described by Hanson and Phemister[2] as lying unconformably on granitic

[2] Hanson, George, and Phemister, T.C.: Topley Map Area; Geol. Surv. Canada, Sum. Rept. 1928, pt. A, p. 50.

intrusives, and which were observed by the writer to cut the older, Triassic(?) volcanics, are similar to these and not readily distinguishable from them. They appear, however, to be somewhat less chloritized and altered. The fact that these rocks rest unconformably on granitic rocks cutting the older volcanics has led the writer to consider them as Cretaceous or possibly late Jurassic. They may occur extensively in the Topley section. They would be unfavourable for mineralization of the types associated with the older granitic rocks upon which they rest.

The intrusive rocks largely fall into four main groups, two of which are probably Jurassic and the other two Tertiary. One of the older groups is largely diorite and gneiss. South of Silver Island landing on Babine lake, in Taltapin district, andesites grade to schists and these appear to grade to diorite gneiss and to diorite. Diorite, which is commonly dark grey, is of different ages and in places sharply cuts the gneiss and schist. In places the gneiss is very well banded and shows a wide range in composition from pegmatitic and granitic materials to hornblendite. There is no clear-cut evidence that magmatic differentiation in situ was a major factor in development of this complex, though some seems to have occurred. Much of the material appears to have developed by alteration and replacement above and at the upper limit of a magma chamber. Prospectors state that this type of material occurs abundantly in areas between and near Divide lake and Taltapin mountain and farther east. The second group of older, Jurassic(?) intrusives is of granite which in many places grades to granodiorite and even to quartz diorite. It cuts the diorite and is younger, but could possibly be related to it. The rock ranges from red and white to dark grey, closely approaching the diorite. It ranges from very coarse material, like pegmatite, to fine grained; in places it is

porphyritic and may carry orthoclase phenocrysts of 2½ inches in length. The granite is commonly red or pink and the granodiorite white to grey. The rocks range considerably in composition, but all types grade to one another. The differences appear to be due to magmatic differentiation. Locally the rock is gneissic. The granite is believed to occupy most of the area of pre-Tertiary rock in a section of over 1,600 square miles extending from Topley district and Topley landing on Babine lake to east of the east end of Babine lake and to Fort Fraser. A spur is reported to extend northward to Cunningham and Stuart lakes. Other granitic intrusives possibly related cut volcanic rocks near Prince George.

The older group of Tertiary intrusives are commonly light brown or pink rhyolite (or rhyodacite) and porphyry, and rarely granite (or granodiorite). These rocks are widespread and abundant from Babine mountains (and Bulkley mountains) and Ootsa lake east to Egen. There are abundant, narrow, dense, cherty white or light grey dykes, many porphyry dykes 50 to 100 feet wide, and a number of stocks. Many of the isolated mountains or high hills contain stocks or an unusual abundance of the dykes and are believed to owe their greater height to doming at the time of intrusion, or to the presence of these intrusives, or to induration caused by them. They include Tachek (Black), McCrea (Huckleberry), Taltapin, Boo, and knobs east and southeast of Fraser Lake, and at the head of Stellako river on François lake. Between Babine lake and Taltapin mountain complete gradations from a granitic stock through dykes to extrusive lavas of Tertiary age, both in field and microscopic characteristics fairly definitely correlate this intrusive body as of Tertiary age. Similarly, west of Tchesinkut lake a peculiar green, brown, and red intrusive breccia was traced to

extrusive breccia of the Tertiary series there. Marked similarities everywhere in composition and character of both intrusives and extrusives, seem to indicate that all these intrusives are about the same, Tertiary, age.

Andesitic and basaltic dykes related to the younger Tertiary flows are abundant. However, owing to their dark colour, like older volcanics, they show up well only in the areas of the lighter diorites, granites, and porphyries. There are a few stocks and possibly some of the mountains are in the nature of volcanic cones.

Sinkut mountain south of Vanderhoof is made up mainly of a basic intrusive, pyroxenite, which is cut by small, quartz diorite masses. Both are of unknown age.

## ECONOMIC GEOLOGY

### Lode Deposits

Mineral deposits occur in many sections of the western part of the Plateau belt and a few have been found in the eastern half. Some possibilities are indicated of profitable, small-scale operations on high-grade silver-lead-zinc-copper deposits in Topley district. Chances of finding molybdenum deposits of economic value in the areas of granite are indicated. In the main, however, the deposits appear to be small or low grade. They are mainly of lead, zinc, and copper. In a few localities such as Topley and Taltapin high values in silver and gold occur. Properties in both these localities have been developed to a considerable extent. Otherwise there has been little development work. Probably considerable prospecting has been done in most sections.

The widespread occurrence of intrusive bodies of different types and ages in the Plateau belt, especially the western part, provides geological conditions that might be

favourable for the occurrence of mineral deposits. The three earlier of the main groups of intrusives, including the Jurassic (?) diorite, Jurassic(?) granite, and Tertiary granite, are possible sources of valuable mineral deposits. The later Tertiary basalts and andesites in places are stained with malachite and contain small veins, but in the main the intrusives now exposed that are related to these were probably too small and too close to the surface to yield valuable deposits.

The diorite and its contact zones are well exposed north of Burns Lake and in Taltapin district. No deposits of economic value or suggested possible value, that might be ascribed to the diorite, have yet been found in these areas. On the Radio property much quartz and abundant pyrite and magnetite indicate that solutions such as are responsible for mineral deposition were given off in considerable quantities. The deposits, however, have not been shown to be of economic importance. It may be that farther away from the diorite better deposits may occur, but the range of known deposits from the contact is already great and there is no evidence of important improvement.

Main contacts of Jurassic granite were examined in a number of places, notably south of Burns Lake, Poison creek, and between Savory and Priestly, and roof pendants were studied in the Burns Lake district. Along all the main contacts deposits, consisting largely of drusy and vuggy quartz and/or coarsely crystalline calcite, were found. Fluorite occurs in places south of Burns Lake and is mainly of earlier age than the quartz. None of these deposits was observed to carry important quantities of metallic minerals. Similar calcite and quartz deposits are reported by prospectors to carry small amounts of galena. On the Elks group, in small roof pendants,

sparse sulphides were noted in similar drusy quartz veins, in fracture or shear zones, and as impregnations in the granite. Similar sparse sulphides (pyrite and chalcopyrite) are reported in other granite areas. None of these deposits offers much encouragement for the belief that valuable mineral deposits occur in the contact zones of the Mesozoic granite. Throughout the granite, mainly in rocks of granite rather than granodiorite composition, and at some points that must have been well within the granite body, quartz deposits related to the granite are abundant. These and nearby granite in places carry an abundance of molybdenite occurring both in the quartz and lining vugs. In the same localities and elsewhere the quartz carries minor amounts of galena, mainly in vugs, pyrite, and possibly other sulphides. There is evidence in the nature of these deposits and in the showing at the Stella group that favourable conditions exist for the occurrence of molybdenite deposits of economic value.

Deposits that are probably related to the granite include those northeast of Burns Lake, Hiyou,[1] northeast of François lake, Sonya-Hectoria,[2] and southeast of Fort Fraser, Nechako.[3]

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[1] Ann.Rept. Minister of Mines, 1933, p. 99.
[2] Ibid., 1928, p. 180.
[3] Ibid., 1929, p. 182.

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In Topley, Taltapin, and Babine Lake areas Tertiary granitic intrusives have associated mineral deposits, mainly of small size and similar in most respects to those of the Babine and Bulkley belts. The ores at Topley are chiefly those of silver, gold, lead, zinc, and copper, and at Taltapin silver, lead, zinc, and copper. A large copper deposit, too low grade to be economic, occurs on Babine lake. It indicates some

possibilities of the discovery of large, low-grade deposits. Many of the Tertiary granitic intrusives probably are too small, too far removed from the main magma source, and probably were formed too near the surface to be expected to produce deposits of economic value. Most of the mineral deposits in the western part of the Plateau belt are believed to be associated with Tertiary granitic intrusives. The position of these intrusives and the favourable ground nearby is in most places marked by prominent hills or mountains. Small deposits occur scattered throughout the area south of Decker lake. Other widely scattered deposits that may have similar relationships include, south of François lake, Wee McGregor,[1] and Uncha[2] in the mountains east of Uncha lake low-grade gold and silver deposits reported to occur in conglomerate and north of Tchesinkut lake, Kathleen Jane.[3]

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[1] Ann. Rept. Minister of Mines, B.C., 1930, p. 146.
[2] Ibid., 1929, p. 181.
[3] Ibid., 1926, p. 144.

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In the eastern part of the Central Interior belt some minerals, the relationships of which are largely unknown, have been reported in the following localities: copper volcanics north of Nechako river 7 miles below Nautley river, and in gneiss and schist west of Sinkut mountain. Quartz veins are abundant in some of the schists, especially around Stuart lake and west of Prince George, and in places these rocks are similar to the gold-bearing series of Cariboo district, but so far the veins have not yielded ore and they are more probably a characteristic of the rocks than an indication of mineral possibilities. A stibnite deposit is reported west of Stuart lake and gold deposits are said to occur on Sowchea river. No important ore deposits were noted near the granitic masses on Sinkut mountain or near Prince George.

## Placer Deposits

Search for placer deposits has met with most encouragement in the eastern part of the Plateau belt, though some work was done on Fox creek south of Bulkley lake. In general there is very little hope for the areas near the railway west of Prince George. Practically all placer deposits are found on or near the bedrock from which the gold has been derived, or they occur at higher levels near such a source. Glaciers have swept away many placer deposits and distributed the gold so widely that in the main it cannot be recovered economically even though concentrated by a river cutting through the drift. Undoubtedly the glaciers have carried much gold into the district from Omineca and Cariboo mountains, thus accounting for its presence in many streams. Near Cariboo mountains the gold is sufficiently abundant in places to be worked profitably, but farther way is probably too widely scattered. There is no evidence that deposits with a source within the district are likely to occur; in any case they would probably be so deeply buried under drift and possibly also lava as to make discovery most unlikely and working conditions extremely difficult.

## Other Mineral Deposits

Coal occurs in the Tertiary rocks southeast of Fraser lake, north of Engen, and, as already noted, at Driftwood creek in the Babine belt, and is also reported on the north side of Babine lake near the east end. Other coal deposits may be expected in the Tertiary sediments. The coal is of inferior quality, being lignitic; and could be used only locally. The best deposits known, at Fraser lake, though up to 12 feet in thickness, are so intermixed with volcanic ash and shale as to reduce greatly the chance of finding a good seam.[1] At Engen

[1] Ann. Rept. Minister of Mines, B.C., 1921, p. 109.

the same may be the case, though large blocks of clean coal are reported. The areas of rocks that might produce coal are so small and the coal is of such a character as to make it improbable that important quantities will be found. The important coal-bearing Skeena formation of the Bulkley and Babine belts has not been recognized in the Plateau belt near the railway.

Small veins of asphaltum[1] have been found north of

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[1] Ann. Rept. Minister of Mines, B.C., 1924, p.101; 1923, p.121.

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Francois lake in Tertiary lavas. These lavas overlie sediments that are probably Tertiary, so that it seems most likely that the asphaltum was derived by natural distillation of coal seams in these beds. The deposits are unlikely to be of economic value.

No rocks were observed in the Central Interior belt that have any chance of yielding important quantities of oil or gas. Little is known about the sedimentary series between Hutchison and Miworth, but what information is available offers little encouragement. The series is considerably deformed and badly cut by intrusives, and much is intensely altered. It is probably thin and does not appear to be a type likely to yield oil or gas. Its position in a relatively shallow syncline with all the beds upturned at some point would lead to the belief that if there were oil-bearing horizons important oil seepages would have been discovered long ago.

Limestone of high calcium contant ($CaCO_3$ 98.34 per cent, $MgCO_3$ 1.44 per cent) occurs on the railway near Wedgewood. An exposure of similar rock on the highway to the south suggests the possibility of a large body there. Shales west of Miworth are reported to include yellow, red, brown, and grey bands that might serve as paint clays. Shales in the same series are largely of clay substances, but contain a considerable calcium carbonate content which shows up readily under the acid test.

Possibly some of these would be devoid of this content and might be serviceable as flint clays (95-99 per cent clay substances). Surface clays are abundant throughout the Central Interior belt, but by far the greatest development is in the Vanderhoof Lake area. Here clay and sand deposits probably up to 400 feet thick underlie several hundred square miles; probably high quality clays are abundant. They are most likely to be free of grit in the large, relatively flat section west of Vanderhoof. However, good quality surface clays are abundant 25 miles east of Prince George[1] and elsewhere in British Columbia, so that only a high-

[1] Richmond, A.M.: Some Undeveloped Clay Deposits of British Columbia. Report British Columbia Department of Mines.

grade deposit exceptionally easy to handle at or near the railway is likely to be of value. There are no reasons for believing that the clays of the area have exceptional therapeutical or other properties. They are reported to carry some bentonite in places.

Some of the red granites in the areas near Endako are of beautiful appearance, and might be serviceable for building stone, although they generally contain considerable biotite.

On Sinkut mountain there are pyroxenite masses which in places are serpentinized and carry veins of serpentine and possibly chrysotile asbestos. Some sections carry amphibole in asbestos form but are brittle and not serviceable as asbestos. Nothing was observed that would lead to the belief that commercial asbestos deposits are likely to be developed here.

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## Detailed Descriptions of Districts and Properties

### Topley

Topley district was the scene of considerable activity during the years 1926 and 1929 subsequent to the discovery of and during extensive development of the Topley Richfield property. Mineral deposits containing gold, silver, copper, lead, and zinc were discovered scattered over a large area and considerable work was done on a number of these without, in the main, much encouragement, except that at the Golden Eagle a small vein high in silver was mined. About 30 tons of very high-grade, hand-sorted ore was accumulated over a considerable period of time. It was proposed to ship this in the autumn of 1934.

The area of pre-Tertiary rocks in Topley district probably extends northward from the railway near Topley and Rose Lake to Babine lake near Fulton river. It may be bounded on the east by a belt of Tertiary rocks extending from an area of these along the railway north to another area on Babine lake, or it may be continuous through to Burns Lake area. To the west it is bounded by a wide, low-lying, flat area largely covered with drift and probably underlain by Tertiary rocks. A smaller area of Mesozoic rocks lies northwest of Topley and may continue to Babine mountains. Both areas are largely underlain by massive to poorly bedded volcanics which include near their base some sediments. These rocks rest on a basement of granite with

inclusions of volcanics. All are cut by dykes and small masses of rhyolite and rhyolite porphyry. It seems probable that the mountains Tachick (Tackek) and McCrea owe their existence to the presence of these intrusives and induration caused by them and that the ores are associated with them or with closely related intrusives, most probably of Tertiary age.

Mineral deposits have already been found to be widespread in both the area northeast of Topley and north of Perow, despite the fact that even in the more rugged parts much of the area is heavily drift covered. The deposits, like those of Babine mountains, are small, and occur mainly in innumerable, small, and irregular fractures and shear zones rather than in well-developed and continuous breaks. Work on the Richfield, Gold (Box and Cup), and Golden Eagle groups, however, clearly demonstrates that there was a sufficient quantity of mineralizing solution in some localities to form deposits of economic value providing deposition was concentrated in a few zones. On the Golden Eagle and Box groups structural conditions favourable for such concentration do occur. In the main, however, mineralized parts are too scattered and too irregular to be of any economic value. The best deposits, so far as rock conditions are concerned, are probably those situated in straight, vertical, well-developed fracture or shear zones. Continuity of a zone on the surface cannot be considered as a criterion that corresponding depth may be expected, in fact, in view of experience here and elsewhere, it is not reasonable to expect much vertical depth for an individual deposit even though deposits have been found over vertical ranges of from 600 feet below the surface (3,550 feet) on the Richfield property to 4,800 feet on McCrea mountain, and 4,500 feet on Tachick mountain.

One very favourable feature of the district is the extremely high-grade ore secured on some of the properties. A series of five assays on a 6- to 18-inch vein on the Golden Eagle gave: gold from 0.14 ounce to 0.34 ounce, and silver 212 ounces to 374 ounces (one of 820 ounces a ton), and copper 1.8 to 7.5 per cent, lead 10 to 25 per cent, and zinc 8 to 30 per cent. High assays (0.5 to 1.24 ounces a ton) in gold among many that are moderate to low have been secured from other properties such as the Richfield and Jack Rabbit. In the main, values are considerably lower than these. There is a wide range in the grade and all metals are not represented in all sections of each deposit or in different deposits, probably because mineralization took place over a considerable period of time during which it changed in character and followed different channels. Many of the mineral deposits are due to filling of open fractures, but others are of the replacement type. Probably all were formed comparatively near the surface, not far from their source, and have been restricted to a limited range because of a rapid decrease in temperature away from their sources. Hanson's and Phemister's report of 1928 covers the Topley map-area, gives references to older reports, and describes the following properties: Topley Richfield, Golden Eagle, Cup, Box, Evergreen, McCrea, and Kylling, Haven's, northwest corner of Tachick mountain (Beaver Dam,[1] 1926, page 143), Watson's, Ailport's (Joker), Johnny David's (Jack Rabbit), Byman Creek, and Lucky Sunday. Detailed reports of the properties are given by Lay: Richfield (Red Top, Topley Richfield,[1,2] 1929, page 178; 1928, page 174; 1927, page 140; plans), Golden Eagle (Topley Silver,[1] 1933, page 99; 1931, page 75; 1930, page 143; 1929, page 179; 1928, page 174; 1927, page 144), Cup[1] (now Gold, 1930, 1928, 1927), Box[1] (now Gold, 1927), Evergreen[1] (1930 and

[1] Ann. Repts. Minister of Mines, B.C.
[2] B.C. Dept. of Mines, Bull. No. 1, 1929.

1928), Sheila[1] (1929 and 1928), Rainbow, Maple Leaf, Victor Topley[1] (1928), Haven[1] (1929), Gold Pot[1] (1930), Joker[1] (1930, page 145). The following properties lie north of Perow: Jack Rabbit[1] (1930, page 144; 1928, page 177) and Randolph and Cat[1] (1928, page 177).

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[1] Ann. Rept. Minister of Mines, B.C.

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Golden Eagle (Topley Silver) and Gold (Box Section). On the Golden Eagle property, which is mainly drift covered, there are three shallow shafts and a number of pits and trenches. One main vein and two or more other veins have been developed to a small extent and during the process have produced about 30 tons of high-grade, hand-sorted ore. The Gold group (Box section) lies about 300 feet east of the main vein on the Golden Eagle and contains similar, though lower grade, mineral deposits. The deposits here are exposed in natural outcrops and in a number of trenches and pits.

In an area extending from about 300 feet east to about 1,200 feet west of the Golden Eagle-Gold line five or more mineralized zones have been opened up; they are more or less parallel and strike from south to south 45 degrees east and dip nearly vertically. The ore occurs in what appear to be moderately well, to well developed fracture zones within which in places there is some shearing. There are other parallel fractures and in general it appears that there was a strong tendency to fracturing or shearing in this direction, and other parallel zones may be found. The best zone of all, No.2, on the Golden Eagle has been traced from the main shaft for over 300 feet to the south where it curves off the trend and becomes less well defined. Within a distance of 400 feet to the north, where there is heavy overburden, two pits lie on the

strike of the vein, but in the farthest one the strike of the mineralized zone is about 20 degrees off the trend, thus suggesting that it may be a different vein from that to the south. It is reported that the vein has been traced considerably farther, but a total of 500 feet is about the limit that is assured by present workings. Other zones have been traced intermittently for a few hundred feet and range up to about 5 feet in width. They have offshoots and irregularities, and on the Golden Eagle to the southeast there appear to be a number of mineralized zones of considerable irregularity.

The zones are sparsely mineralized being in places largely quartz with little sulphides; elsewhere they are made up of altered volcanics with some quartz and sulphides. However, in parts of some of the zones there are narrow, high-grade veins. In the main part of No. 2 zone on the Golden Eagle that lies south of the shaft the high-grade band is mainly less than 18 inches and probably averages about 6 inches. It is fairly well defined and the high-grade material can be easily separated out by hand sorting. The high-grade band is present in most of the workings except to the south where it seems to pinch out. There is no pronounced change in about 50 feet of sinking in the main shaft. In a second parallel but less well-defined and less steeply dipping zone and possibly in other irregular zones on the Golden Eagle similar ore was found. On the Gold claims there is some evidence of similar very narrow bands of lower grade. The high-grade sections contain much tetrahedrite and probably polyargerite.

Gold (Cup Section). A series of adits and cuts along the canyon wall of Richfield creek for more than 1,000 feet disclose a network of irregular, flat veins and lenses with irregular, oblique veins rising and connecting them. The veins range up

to 4 feet but are mainly less than 18 inches and there are many tiny stringers. Thicknesses vary greatly and in short distances so that the wide sections are really lenticular in form. The veins are mainly fissure filling with some wall-rock alteration and replacement. They are largely quartz with sulphides and show a wide variation in metal content, the gold is low, silver 1 to 30 ounces a ton, rarely higher, and considerable quantities of lead, zinc, and copper. The appearance of the vein system suggests that subsequent to intrusion there was shrinkage at depth; that collapse and breaking of the overlying rocks developed irregular fractures, many of which were nearly flat; and that during the period of mineralization, movements in the rock continued, causing further irregularity by faulting and changing the courses of the mineralizing solutions. The many showings cannot be considered as one continuous vein, but as many veins linked together.

Richfield (Topley Richfield, Red Bluff). At the Richfield property, after extensive development on the surface and underground to the 200-foot level, and after extensive diamond drilling, it was considered that further work was not justified. Extensive geological and assay plans prepared by the operators, together with published reports, give a comprehensive picture of conditions. The main workings are located in volcanics extensively altered from the surface to a depth of at least 600 feet. In places alteration is spread over wide areas; elsewhere it is confined to numerous narrow zones along fractures. The fractures are in places occupied by veins and in places there are tabular replacement deposits. All appear to be somewhat lenticular. They show great irregularity in attitude from flat to vertical, though there is a more common strike direction. The ores are erratic, the gold ranging up

to 0.5 ounce a ton and the silver up to 35 ounces a ton. The altered wall-rock in places carries gold up to 0.13 ounce a ton with some silver. However, the high-grade deposits are too small and irregular to be of economic value and no zone is indicated that might be workable as a whole.

To the east of the main workings are two or more well-defined veins in fairly well marked fracture zones. On the surface in places these have widths up to 2½ feet, but underground work was disappointing and suggested that they become poorer at depth. There is abundant evidence that the zones have been widely but sparsely mineralized; consequently the deposits have little merit.

Hanson's and Phemister's studies of these deposits revealed much valuable data. The deformative movements in the rocks took place during mineralization and continued afterwards, and many of the fractures were open at the time of mineralization. The mineralizing solutions carried distinctly different minerals at different times, thus accounting for difference in the character of mineralization from place to place. As a result the deposits are folded, broken, and sheared to various extents.

Some intrusives were found in later work in the mine, but it is not known whether a possible source for the mineral deposits was disclosed. It is believed, however, that the rhyolite dykes found in this section are related to the source, which is probably nearby. The deposit resembles somewhat the one at Bob creek.

## Babine Lake

North of Topley, district on Babine lake, Mesozoic rocks are again exposed. On McDonald island (Richmond and Robin Hood)[1] a medium-grained diorite and quartz diorite porphyry

[1] Ann. Repts. Minister of Mines, B.C., 1929, p. 180; 1927, p.49

cuts volcanics. The porphyry is impregnated with, and cut by, stringers of chalcopyrite, bornite, and pyrite. Smaller amounts of magnetite, galena, and sphalerite occur. Diamond drilling and surface exposures (Richmond) indicate 8,000,000 tons assaying 0.01 ounce gold, and 0.15 ounce silver a ton, and .8 per cent copper. In the volcanics (Robin Hood) there are narrow silver-lead-zinc deposits. The description of the Richmond deposit suggests some similarity to the Owen Lake deposits and again indicates the possibility of large, low-grade deposits.

Copper-zinc mineralization is reported on Newman peninsula 13 miles north of Topley Landing.

## Taltapin Mountain

In the Taltapin Mountain section the geology is complex, but a brief study of the field relationships and rocks offers certain suggestions about the mineral deposition. There were two (possibly more) distinct periods of igneous activity, each accompanied by deposition, so that two different types of deposits have been developed. North of the mountain intense metamorphism of andesite has developed a band of schist and gneiss which is in part diorite and is invaded by diorite dykes and perhaps larger masses. The diorite in places carries an abundance of pyrite and magnetite. Associated with this diorite in the contact zones there is much glassy quartz, epidote, magnetite, and pyrite of a peculiar bright golden bronze colour, and very minor amounts of other sulphides. The features of the deposits as displayed on the Radio property suggest that they were developed under very intense metamorphosing conditions that were not favourable for the development of valuable deposits. It has not yet been demonstrated that deposits of probable value are associated with this metamorphic and intrusive phase.

On the west side of the mountain there is an intrusive body of granodiorite (quartz diorite to quartz monzonite) which is reported to cover a considerable area; there may be several separate masses here and others near Babine lake. Rhyolite (also rhyodacite and dacite) dykes believed to be related to the granodiorite occur in the area to the north probably as far as the hills on the north side of the lake, and they are said to be abundant on Taltapin mountain. The dykes are hard, dense, and light grey like chert. The larger intrusive bodies are light grey and show gradations from material like the dykes, not always readily distinguishable from the adjacent andesites, to rocks of granitic texture. With these intrusives, both the main masses and the dykes, there are associated silver, lead, zinc and copper minerals, and in places the dykes themselves carry sulphides. It is believed that all the deposits of the west slope of Taltapin mountain and on both sides of Babine lake belong to this class. Mineralization associated with the dykes appears in the main to be sparse and of small extent. Deposits, judging by those on the Taltapin property and by Lay's descriptions of the others, occur in andesite within a range of a few hundred feet of the contact. They are mainly small, irregular, lenticular veins carrying silver, lead, zinc, and copper. In the main they do not penetrate the granodiorite, but probably in places, especially where the masses are small and of chert-like material, they may continue within it for short distances. They appear to be most abundant or larger over the larger intrusive bodies. In places they are fairly high grade. It is probable that by following the contact many more similar deposits can be discovered. Taltapin mountain probably owes its existence to this granodiorite intrusive, its dykes, and its influence on the surrounding rocks. Therefore,

the high ridge extending southeast suggests possibilities of the extension of this belt in that direction.

Extensive reports on the Taltapin property and surrounding district are given by Lay and Galloway[1] and on the Radio.[2]

Silver deposits occur on Silver island[3] and silver-lead

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[1] Ann. Repts. Minister of Mines, B.C.: 1927, p.150; 1926, p.145, 1925, 1920.

[2] Ibid., 1933, p. 99.

[3] Ibid., 1936, p. 122.

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deposits are reported on the Boling(?) property north of the lake. The latter deposits occur in granite which is probably Mesozoic and unrelated to the granodiorite intrusives south of the lake.

Radio. Considerable work has been deon on the Radio property. There are two shafts, a number of pits, and many trenches. Several types of showings have attracted attention here in the schist-gneiss-diorite zone. In the western part of the property there are large lenses, pockets, or irregular masses of glassy quartz which carries very minor amounts of pyrite and other sulphides including chalcopyrite. These masses, which in places are 30 or 40 feet thick, are flat lying or have a steep dip. They are shown to be 100 to 200 feet long in places, but it is clear that they are not continuous for any great length and are irregular in shape, size, and attitude. There is nothing to suggest that they may have economic value.

Farther east in a section opened up by shafts and pits somewhat similar quartz masses occur. These are nearly vertical and more vein-like in form. They do not maintain their strike, thickness, or dip for more than short distances. In part the quartz is fracture filling and in part replacement. In the quartz and country rock there is some pyrite, molybdenite,

and chalcopyrite. In places there is intergrowth of hornblende and pyrite.

Near these quartz masses in the diorite there are two or more circular areas about 50 feet in diameter that are largely epidote. In the central part hornblende, chlorite, epidote, pyrite, magnetite, a little chalcopyrite, and probably other minerals occur intermixed in varying proportions. The metallic minerals also occur scattered in the country rock. The deposits appear to be in the nature of segregations or replacements.

South of all these a shaft is sunk in rock which is mainly dense to fine-grained, green material, in part diorite and in part andesite, as well as some coarser diorite, but no true gneiss or schist. The veins are chiefly quartz, quartz-calcite, or pegmatite, but other types of veins, including epidote stringers, are present. In some of these and in the country rock pyrite similar to that in the deposits just described has been found.

Several samples of the most highly mineralized rock from various sections of the property yielded on assay insignificant amounts of silver and gold. It is possible that conditions at the time of mineralization in the gneiss-diorite zone were unfavourable for the development of gold or silver deposits. If this is the case no improvement can be expected at depth. In the andesite-diorite rock to the south farther away from the main intrusive bodies mineral deposition is less abundant and indicates that improvement in grade of ore may be expected away from the contact.

Taltapin (now part of the Radio group). On the Taltapin property a shaft and a number of adits supplement excellent natural exposures of a number of small copper-lead-zinc-silver veins. A canyon 100 feet deep on Anderson creek cuts through

andesitic volcanics that are intruded by granodiorite (quartz diorite to quartz monzonite). Going downstream for 400 feet granodiorite is exposed with small inclusions, probably roof pendants of volcanics, then 200 feet of volcanics, then 200 feet of granodiorite, which does not reach the top of the canyon wall, then volcanics with more granodiorite. The present exposures indicate approximately the roof of the granodiorite, which is uneven and has a general dip downstream to the north. The mineral deposits, in volcanics, occur in the roof pendants, overlying the granodiorite masses exposed in the canyon, in between the granodiorite masses, and just beyond the mass farthest downstream. In places the deposits appear to be in the granodiorite, but in these cases it is clear that the rock is at or near the original roof which has just recently been uncovered by erosion. Quartz veins occur in the granodiorite but are mainly barren. Deposits observed lie within 150 feet of the contact. The contact is sharp but not always clear because of similarity in colour of the two rocks. There are irregular protuberances of granodiorite, some of which occur along the bedding and are flat lying. The volcanics are bedded in places and deformed as if by the intrusion. They include some sedimentary beds that contain graphite, probably developed from carbon by the intrusion. The deposits are mainly quartz veins carrying some feldspar and sulphides, but some include replacement of the volcanics by these and other minerals. The veins are irregular and lenticular and have attitudes from flat to vertical. Some follow bedding planes. In places they have bulbous terminations at pre-mineral faults. The lengths as exposed in the canyon walls or adits as a rule are less than 100 feet and widths are less than 2 feet but are reported up to 4 feet. In the main the deposits are sparsely mineralized with pyrite, galena, sphalerite, chalcopyrite, and

some molybdenite. Samples of selected portions of some of the vein material taken by Lay proved to be mostly low in copper, lead, zinc, and silver, and very low in gold. There are, however, wide variations and some well-mineralized rock was secured in the workings.

Decker Lake

A rugged area, mainly of massive Mesozoic volcanics, extends southward from Decker lake. Quartz porphyry occurs in the hills west of Tchesinkut lake. The high hill south of Burns lake is made up in part of Mesozoic granite and granodiorite which cut the volcanics.

Mineral deposits, mostly small and similar to those related to Tertiary intrusives, occur at a number of places in this area. There is no evidence of important mineralization associated with the granodiorite south of Burns lake, but there are peculiar segregations and veins of pegmatite-like material that carries quartz, carbonate, and fluorspar.

On the Three Star property[1] and elsewhere on Boo mountain abundant sulphides, including chalcopyrite and pyrite,

[1] Ann. Rept. Minister of Mines, B.C., 1930, p. 145.

and hematite having little or no gold and silver, have been exposed in a fracture zone for about 300 feet and over widths up to 10 feet; in addition the zone is sparsely mineralized over widths of more than 20 feet. In one direction the zone pinches out to tiny stringers, and in the other it narrows or splits, then spreads out and is sparsely mineralized. At depth the workings show that the zone has a marked tendency to narrow and split.

On the Golden Glory and Silver Glance[2] (1930, page 146)

[2] Ann. Rept. Minister of Mines, B.C.

south of Decker lake there is extensive alteration of the volcanics to a light grey material. Irregular, narrow deposits carry copper, or copper and zinc; they are low in gold. An assay of the altered volcanics showed no gold nor silver.

West of Tchesinkut lake on the Northern light property (Mona[1](?) 1929, page 181) in andesite porphyry near a small quartz porphyry stock narrow widths of rock are sparsely mineralized with copper, lead, zinc, barite, and fluorspar, low in silver. On the Gamble[1] (1930, page 145) property, 1½ miles north of this, there are similar narrow deposits sparsely mineralized. The Oakla property[1] (1924, page 119) near François lake is of interest because a very narrow vein of quartz and pyrite showed 0.54 ounce a ton of gold.

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[1] Ann. Repts. Minister of Mines, B.C.

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In general the deposits of this area carry very little gold and silver and are in the main small and irregular.

## Burns Lake (Burns Lake to Sheraton)

The Mesozoic rocks here are mainly granodiorite and to a lesser extent granite, which appear to grade into one another and are probably of the same age. They show a wide range in texture and in colour from red to green. They cut and include many masses of volcanics (andesite and dacite) and diorite. They are cut by innumerable dykes of dark and light green andesite and basalt, which though much younger in age, cannot in many places be distinguished in the field from the older volcanics. They are also cut by dykes up to 100 feet wide of brown quartz and orthoclase porphyry. The contacts of the granodiorite with the older volcanics in places are sharp, but elsewhere because of original variations in the rocks and considerable alteration of all the rocks the granodiorite is not readily distinguishable.

Near the contacts in the volcanics on Poison creek there are coarsely crystalline calcite veins, and on the Elks group in or near small inclusions or roof pendants of volcanics and of diorite there is sparse mineralization of chalcopyrite, pyrite, and magnetite in irregular, drusy quartz carbonate veins and as scattered impregnations. The mineralized zones are narrow and very limited in length. They occur mainly along fractures or shear zones which continue in both volcanics and granodiorite and show considerable alteration along their walls. There are some impregnations of sulphides along the edges of granodiorite, but the rocks now exposed probably represent approximately the top of the granodiorite-granite batholith. However, the intrusive history may be complex and more favourable aspects may occur elsewhere.

## Fraser Lake Section

Throughout a large area around Endako and Fraser lake the Mesozoic rocks are mainly intrusive. Around Endako, especially to the south, there are extensive areas of coarse, red granite.

Stella.[1] The most important showings on the Stella group occur on two pronounced east-west ridges 200 to 400 feet wide and

[1] Ann. Rept. Minister of Mines, B.C., 1929, p. 182.

separated by a low area of about the same width. The ridges may owe their prominence in part to the greater resistance to erosion of the mineral deposits. They are made up of granite, partly unweathered and partly decomposed and rotten, which with soil and drift constitutes a thin covering over everything. Scattered in this debris along each ridge for 500 to 1,000 feet are numerous blocks of quartz up to 2 foot cubes which usually carry a considerable amount of molybdenite. The

blocks are approximately in place, having been released by the weathering of the granite. Considerable work has been done on the ground, but it has been spotty and as a rule does not follow the deposits sufficiently closely to give a clear picture of their nature.

In places masses of quartz up to 3 feet 6 inches in width have been exposed. One of these has been demonstrated to have a length of 60 feet and some may be longer, but most of them appear to be lenses of shorter lengths. Wide showings pinch to a few inches or disappear in 10 or 15 feet. Most of the deposits strike between north 60 degrees east and east, but there are other quite different trends. The dips are from 30 degrees north to 40 degrees south. An assay of one 2-foot vein, according to Lay, gave 2.43 per cent molybdenite ($MoS_2$) or 1.46 molybdenum. The grade mined on a 1,000-ton scale in the United States is about 0.5 per cent molybdenum.[1]

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[1] Lindgren, Waldemar: Mineral Deposits, p.770.

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Besides the quartz veins the granite itself is impregnated with molybdenite. These impregnations have not been shown up sufficiently well to form any true conception of their extent, especially as they appear to be very irregular. In one place where unweathered, possibly silicified, rock is exposed the bordering granite on one side for 2 to 3 feet is fairly well impregnated, but to a lesser extent than the veins, and 10 to 20 feet is very sparsely impregnated.

The veins are mainly quartz with molybdenite in ribbon structure in the better grades and scattered in the poorer grades. Similar types of deposits occur in other places on the Stella property, also 3½ miles southwest of Savory, and elsewhere. As a rule, however, quartz masses that are common in the granite appear to be largely barren. The quartz is similar to that in

the grains in the granite, carries feldspar, or is lined with it on the outer edges of the veins. It shows crystal texture, grades to the granite in places, and contains vugs which in places are lined with molybdenite. These molybdenite-quartz deposits were clearly derived from the granite and formed during a late stage in the cooling in a manner similar to pegmatites. Pyrite and hematite occur very sparsely in a very few places in the deposits. There is nothing except possibly some fine-grained sections in the granite to suggest proximity to a contact. The general distribution of the molybdenite deposits scattered here and there in the granite and not near known contacts suggests they may have been formed well within the granite. The general geological conditions here are favourable for the occurrence of an important deposit. The showings, however, suggest that the veins are too scattered and the intervening rock for the most part too lean for large sections of the rock to yield a good molybdenite content.

Hidden.[1] In granite on the Hidden property there are lenses of

[1] Ann. Rept. Minister of Mines, B.C., 1931, p. 75.

quartz up to 6 feet wide, but of no great length. This quartz is crystalline and contains vugs; it grades to the granite and is closely related to it and the lenses are believed to be in the nature of pegmatites. Some of the vugs are lined with galena. Some pyrite also occurs. The rocks are cut by two or more types of Tertiary dykes (andesite and hornblende andesite) which in places carry considerable pyrite and weather rusty. The pyrite and rustiness are, of course, in no way related to the quartz veins. The deposits have been worked because of the galena content which carries some silver, but it is most unlikely that deposits of this character will have any economic value so far as lead or silver are concerned.

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