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BONNINGTON MAP-AREA, BRITISH COLUMBIA

(REPORT AND MAP)

By

R. Mulligan

OTTAWA

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Bonnington Map-area, B.C.

INTRODUCTION

Bonnington Map-area (lat. 49°15' to 49°30', long. 117°15' to 117°30') extends south and west from Nelson, B.C., and includes most of the northern half of the Bonnington Range of the Selkirk Mountain systems.

Access is provided on the north, east, and south sides by railways and highways, from which mining and logging roads and trails lead into the heart of the area.

The country is rugged but subalpine in character, only eight peaks surpassing 7,000 feet. The maximum relief is almost 6,000 feet.

Modified cirque basins are recognizable at the heads of north-flowing streams that rise at high elevations - Giveout and Forty-Nine Creeks for example - but sharply defined cirques and cirque lakes are seen only in the granodiorite terrain. Here, particularly on northern exposures, the stream valleys are conspicuously U-shaped. Elsewhere, V-shaped valleys, dominantly the result of stream erosion, are the rule - particularly on southern exposures.

The topography has been considerably influenced by continental glaciation. Erratics are not common above 6,000 feet, but glacial striae have been reported within 100 feet or so of the summit of Toad Mountain, and ice may at times have covered the area completely. The direction of ice movement on Toad Mountain was from 10 to 30 degrees east of south.

Deposits definitely of glacial origin are not abundant. A hard clay-cemented gravel conglomerate occurs in considerable thickness a short way up Skilet Creek, and a heterogeneous bouldery drift forms 100-foot banks at about 2,800 feet elevation on Bird Creek. Fragmentary terraces in alluvial material are noticeable on Hall Creek and Barrett Creek, and are quite prominent along Erie Creek about the mouth of Craigtown Creek. No continuous terraces border Kootenay River, but extensive alluvial deposits occur in the vicinity of Taghum and old fans mark the mouths of larger tributary creeks. Parts of Nelson city are built on deltas of Cottonwood and Anderson Creeks. A drift veneer mantles the greater part of the area, supporting a thick growth of timber and bush, and exposures are remarkably poor considering the relief and steepness of slopes.

Geological work of a reconnaissance nature was carried on in the vicinity of the Toad Mountain properties by G. M. Dawson (8)[1] in 1898.

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[1]Numbers in parentheses refer to publications listed in the bibliography.

Mapping of the West Kootenay district, which includes Bonnington map-area, by R. G. McConnell and R. W. Brock (8) (13) was commenced in 1894. R. A. Daly (5) mapped the southern part of Salmo map-area in the course of his "Reconnaissance along the Forty-Ninth Parallel", 1901-1906. In 1911, O. E. LeRoy (9) investigated the chief mines then operating, and mapped an area about 10 by 11 miles in the vicinity of Nelson, B.C. In 1914, C. W. Drysdale (6) examined properties and mapped an area in the vicinity of Ymir, extending nearly 4 miles into Bonnington map-area. J. F. Walker (16) mapped the Salmo area in 1929-31, and W. E. Cockfield (4) examined and reported on the mines in the southern part of Bonnington and adjacent Ymir areas in 1936.

Investigations of mining properties by officers of the B.C. Department of Mines are recorded in the Annual Reports of that body, notably for 1915, 1928, 1932, 1933, 1937, 1945, and 1946.

The adjoining Salmo area has been recently mapped by H. W. Little (11), and the adjoining Ymir area by A. L. McAllister (12).

The work on which this report is based was commenced in 1948 by H. W. Little, assisted by the writer, W. Pollock, and P. Hughes, and completed in 1949 by the writer, assisted by W. R. Baragar, J. W. Antal and C. E. Jarvis.

The writer is indebted to Mr. W. Baker and other members of the staff of Kenville Gold Mines for valuable information regarding the local geology.

GENERAL GEOLOGY

TABLE OF FORMATIONS

Era	Period or epoch	Formation	Lithology
Mesozoic or Cenozoic	Cretaceous or Tertiary	Post-Nelson dykes and sills	Feldspar-quartz-augite porphyry, aplite, lamprophyre, diabase
			Relation unknown
			Monzonite chonoliths, pegmatite stock
			Relation unknown
Mesozoic	Cretaceous (?)	Nelson intrusions	Granodiorite, granite, diorite; quartz-diorite and diorite satellite facies
		Intrusive contact	
		Silver King Porphyry	Quartz diorite
		Intrusive contact	
	Jurassic or Cretaceous	Beaver Mountain formation	Augite andesite and basalt porphyry flows, breccia, agglomerate; minor tuff, conglomerate, argillite, limestone (?)
	Conformable contact		
	Jurassic and(?) Cretaceous	Hall formation	Siltstone, greywacke, conglomerate, argillite; quartzite, quartz-biotite and amphibole schist and gneiss; limestone. Minor flows, agglomerate, tuffs
	Essentially conformable, local erosional unconformity		
	Triassic and(?) Jurassic	Elise formation	Andesite, augite andesite, and basalt porphyry flows, breccia, agglomerate; minor tuffs and sedimentary rocks
	Conformable contact		

Triassic	Ymir formation	Chiefly massive black argillite
	Bonnington Complex	Syenite; age relation to Nelson intrusions unknown
		In part gradational, in part intrusive
		Pseudodiorite; pyroxene-hornblende-biotite rock. Believed to be derived from Mesozoic volcanic and sedimentary rocks; intruded by Nelson

YMIR FORMATION

The Ymir formation is not believed to outcrop within the map-area but may possibly do so in the extreme northeast corner. It consists chiefly of massive black argillite and sandy argillite and underlies a wide belt in the adjoining Ymir map-area where it has been described by McAllister (12). With increasing proportions of interbedded volcanic material it grades upward into the Elise formation. The Ymir formation is believed to be approximately equivalent to the Slocan series, of Triassic age.

ELISE-BEAVER MOUNTAIN GROUP

The Ymir formation is overlain on the west by an essentially conformable series of volcanic and sedimentary rocks. This has been subdivided throughout most of the map-area into a lower volcanic formation, the Elise, a middle, predominantly sedimentary formation, the Hall, and an upper volcanic formation, the Beaver Mountain. It forms part of the "Rossland Volcanic group", which, with younger intrusions, underlies the greater part of Bonnington and Rossland Mountains.

Because of lithological similarity between members of the lower and upper volcanic formations, these can generally be distinguished with confidence only by virtue of their position with reference to Hall sedimentary rocks. North of the head of Noman Creek these sedimentary rocks were not recognized and have apparently pinched out. In this part of the area, consequently, the rocks are mapped as the undifferentiated Elise-Beaver Mountain group.

ELISE FORMATION

The Elise formation conformably overlies the Ymir formation in Ymir map-area. It borders the Nelson area on the east, and extends into it on the northeast and southeast corners. A wide belt of it also outcrops around Copper Mountain and northwestward, and a narrow belt extends southward from the Second Relief mine.

The formation is dominantly volcanic, consisting of flows, agglomerates, and breccias, with some tuffs and interbedded, water-lain, clastic rocks. The volcanic rocks most characteristic of the formation in the map-area are aphanitic to porphyritic andesite greenstones and similar pyroclastic rocks with only plagioclase feldspar occurring commonly as phenocrysts. In thin section, these rocks are found to consist of highly saussuritized oligoclase-andesine, chloritized green hornblende, and alteration products, including much zoisite, albite, calcite, chlorite, actinolite, green biotite, and unidentified scaly material. The rocks are typical of the "green schist" metamorphic facies.

Rocks of this type outcropping along the eastern border of the map-area are dominantly schistose, elsewhere they are mostly massive. Bedding and other structures are rarely discernible.

In the northeast and to some extent the southeast corners, as in the Ymir area, the formation includes a large proportion of augite-porphyrite flows and (?) sills, agglomerates, and breccias, which are indistinguishable with any degree of certainty from the type rocks of the Beaver Mountain formation. On the whole they appear somewhat more altered, but microscopic investigation proves that this criterion is not to be relied upon.

Judging from the breadth of exposures the thickness of the formation may be 9,000 feet or more, but data as to attitudes are seriously incomplete and it may be much less.

The Elise formation is overlain by something of the order of 2,000 feet of sedimentary rocks lying below a probably late Lower Jurassic horizon, and is underlain by probable Triassic. It is, therefore, Triassic and/or Lower Jurassic in age.

HALL FORMATION

The Hall formation overlies the Elise with essential conformity, but varies from place to place in thickness and lithology, and north of upper Noman Creek and Red Mountain apparently pinches out entirely. Lateral gradation is pronounced and rapid, especially in an east-west direction. There is locally a suggestion of erosional unconformity between the formations.

Lithologically the formation consists of conglomerate, greywacke-sandstone, quartzite, banded siltstones and cherty quartzitic siltstones, and argillites, with minor intercalated flows, tuffs and agglomerates, and contemporaneous intrusions. Quartz-biotite and other types of schist, quartzite, and occasional conglomerate and argillite in the northwestern part of the area are also assigned to the Hall formation. The isolated limestone outcrops east of Taghum are tentatively included.

In the vicinity of lower Hall Creek, the type area, and southward, conglomerates and conglomeratic greywackes make up a large part of the formation. Both intraformational and basal conglomerates occur. The former are characterized by light buff to reddish weathering colours, and by large and small lenticular squeezed mudstone fragments oriented parallel with the bedding. The basal conglomerates are in thin lenticular patches of restricted distribution made up chiefly of sub-rounded pebbles of volcanic rocks similar to those in the Elise formation.

The greywackes contain from 10 to 50 per cent quartz in small rounded grains, feldspar and ferromagnesian minerals, and angular fragments of fine-grained volcanic and sedimentary material. The matrix contains some interstitial carbonate. A reddish iron stain emanates from decomposed ferromagnesian minerals. The proportion of quartz is statistically greater, that of rock fragments less, south of Hall Creek than north. This is analogous to an overall decrease in proportion of coarse clastics, and suggests a tendency to southward change from littoral to offshore conditions of sedimentation, though abundant intercalated argillite in the Hall Creek section indicates an oscillatory shoreline.

Finer grained clastic rocks - banded light and dark sandy argillites, and cherty quartzitic siltstones - are most characteristic of the Hall formation as a whole. These and the argillites commonly contain abundant pyrite, and weather to a rusty colour that is a conspicuous feature of the formation. Such rocks alternate with medium-grained, more massive, reddish and grey, quartzitic greywacke on Red Mountain and east of Erie Creek. In these areas especially intercalated flows and pyroclastic beds appear and become more numerous toward the top of the formation. Sills and dykes of augite porphyry identical with the Beaver Mountain intrude the sedimentary rocks in many places.

Both primary and secondary small-scale structures are poorly developed in the Hall rocks although grain gradation, crossbedding, and slaty cleavage have been used in top determination. Cleavage at an angle to the bedding is erratic in development and in attitude, and no well-defined, consistent attitudes of lineation or foliation are recognizable. The grade of metamorphism is low, and the rocks appear to be insufficiently indurated for the development of such structures.

In the northwest part of the area, however, brown quartz-biotite schist, green and white banded quartz-biotite schist with garnet-epidote nodules, and greenish banded quartzite-amphibolite gneiss point to a different environment of sedimentation and a fairly high grade of metamorphism. The higher grade metamorphic assemblages are found closest to the terrain underlain by the Bonnington complex.

A band of predominantly sedimentary rocks east of Nelson may be equivalent in age to the Hall formation, but its contact with the underlying Elise formation converges northward with the Elise-Ymir contact. The band may lie in whole or in part stratigraphically below the Hall formation.

No close estimate of the thickness of the Hall formation can be given. Over most of the area it appears to range from 3,000 to 3,500 feet.

Fossils collected in 1948 from the Hall formation on the ridge south of Barrett Creek have been reported upon by H. Frebold of the Geological Survey, as follows:

"Ammonites sp. indet. 1
This ammonite is possibly a Stephanoceras.
Ammonites sp. indet. 2
Imprint of a whorl fragment with finer undivided ribs and keel. May be comparable to some Dumortieria forms from the Upper Lias.
Age: lower part of Middle Jurassic possible for Ammonite sp. indet. 1; upper part of Lower Jurassic possible for Ammonite sp. indet. 2. No exact determination can be made. Possibly the boundary between Lower and Middle Jurassic is represented at this locality."

Fossils of probably late Lower Jurassic age have been collected from an horizon about 1,500 feet below the top of the formation in Salmo map-area (Little, 11, pp. 27, 28). Others, chiefly pelecypods, from near the base of the overlying Beaver Mountain have not been more closely dated than "Jurassic or Cretaceous". The formation is, therefore, mainly Jurassic but may extend up into Cretaceous and/or down into Triassic.

BEAVER MOUNTAIN FORMATION

The Beaver Mountain formation conformably overlies the Hall formation. It occupies the centre of a syncline that can be traced from the headwaters of Eagle Creek southward into the Salmo area. Beaver (renamed Kelly) Mountain, south of Benton Station, is the type locality.

Lithologically the formation consists chiefly of dark green augite and augite-feldspar porphyry flows, breccias, agglomerates, and contemporaneous intrusions. Highly porous amygdaloidal flows are conspicuous in some localities, and abundant coarse pyroclastic rocks are an outstanding feature of the formation. Some breccias are entirely autoclastic, with subrounded resorbed fragments of material practically identical with the matrix. Other breccias and agglomerates have rounded to angular fragments up to 2 feet in diameter, mostly composed of volcanic porphyries but including banded siltstone and quartzite, some limestone boulders, and occasional granite pebbles.

In thin section the rocks are seen to be highly altered for the most part. Original augite has been mostly replaced by uralitic hornblende, and plagioclase feldspar by sodic plagioclase and epidote-group minerals. Further breakdown of uralitic hornblende is generally to actinolite; in some cases augite and/or uralitic hornblende have altered to biotite and epidote, rarely to chlorite and calcite. In a few flows, relict plagioclase is identifiable as labradorite, in others as andesine; most appears to be oligoclase. These rocks are andesites and basalts.

Some exceptionally feldspathic flows have well-formed albite-oligoclase phenocrysts that appear to be primary. The association of augite with possibly primary sodic feldspar suggests affinity to the "spilitic kindred". Similar feldspar, with epidote, fills amygdules and is pseudomorphic after augite crystals in other flows. This records a segregation of either late-formed or secondary feldspathic components, and of epidote, subsequent to solidification of the flows, and suggests a deuteric or "autometamorphic" process of alteration of these rocks.

In the vicinity of Beaver Mountain, the type area, in Salmo map-area, the flows have remarkably fresh augite, although saussuritization of the feldspar is in most cases well advanced. Because of their fresh appearance, these rocks were considered by early workers to be younger than the surrounding volcanic rocks. The freshness of the augite here, in contrast with its uralitized condition elsewhere, is attributed to the fact that these rocks lie in the flat trough of a syncline, and were subjected to lower shearing stresses than those on the limbs of folds. Under such conditions augite may persist as a relict mineral in rocks even of the greenschist metamorphic facies.

The top of the Beaver Mountain formation has not been seen. An estimated minimum thickness of 4,000 feet is exposed. Overlying the Hall formation, and cut by early phases of the Nelson batholith, the formation is probably late Jurassic or early Cretaceous in age.

BONNINGTON COMPLEX

Rocks of this complex, comprising pseudodiorite, pyroxene-hornblende-biotite rock, and syenite, underlie an extensive terrain about Eagle Creek and the western part of Kootenay River Valley.

The pseudodiorite is a streaky, dark-coloured, medium-grained hornblende-feldspar gneiss. Along Kootenay River it grades imperceptibly into light-coloured pink hornblende-syenite in some places, in others it is cut by syenitic dykes. The contact with surrounding volcanic augite-porphyries is marked in places by coarsely recrystallized, heavy, pyroxene-hornblende-biotite rock with large, interlocking, composite ferromagnesian crystals and blurry interstitial patches of fine feldspathic material. This rock grades into both the pseudodiorite and the volcanic rocks. In Eagle Creek basin the pseudodiorite body appears to be contained within a synoline in Beaver Mountain volcanic rocks. Bands of limestone lie within the body at the Eureka mine. The pseudodiorite appears to be concordant with bedded rocks, and nowhere shows crosscutting relationships. It is definitely cut by Nelson granodiorite.

Thin sections of pseudodiorite show the essential mineral constituents to be saussuritized plagioclase feldspar largely reduced to granular albite and zoisite-epidote minerals, and pale uralitic hornblende with occasional identifiable augite cores. This mineral assemblage is practically identical with that of the volcanic augite porphyries. There is some suggestion that the "dioritic" texture has arisen from a segregation of ferromagnesian and feldspathic components. Further "segregation" results in a pronounced coarsening of grain towards contacts (e.g., the "coarse diorite" in the Kenville mine), and reaches its culmination in the coarse pyroxene-hornblende rock where this contact facies is developed. The latter is basically identical with the pseudodiorite in mineral constitution but shows definite evidence of extensive recrystallization and grain growth of ferromagnesian mineral, particularly augite.

Several sections of pseudodiorite and one of pyroxenite show fresh new andesine-labradorite cutting through and including albite-epidote saussuritization assemblages in poikiloblastic fashion. One section consists exclusively of fresh calcic andesine, brownish green hornblende, and brown biotite, with abundant coarse sphene, and looks igneous.

Pseudodiorites in the vicinity of the Kenville mine show extensive replacement of plagioclase, preferentially relict oligoclase, by fresh soda-potassic feldspar. Sericitization seems to be a preliminary stage, and alteration of original ferromagnesians to biotite and epidote is a concomitant process.

Similar replacement of plagioclase by soda-potassic feldspar, with decreasing proportion of ferromagnesian minerals, marks the transition from pseudodiorite into syenite. Here the change is accompanied by replacement of pyroxene and uralitic (?) hornblende by a deep blue-green alkali and/or iron-rich amphibole with distinctive optical properties: low 2V about X, with strong dispersion r greater than v, low gamma minus beta. This amphibole replacement extends beyond the transition zone, in places well into typical pseudodiorite and even into pyroxene-rock. Sphene is a prominent accessory in the syenite, but except for the igneous-looking phase noted above is not seen in pseudodiorite. The latter may, however, have ilmenite or titaniferous magnetite. Apatite, abundant in the syenite, is also widely distributed throughout the metadiorite.

The exact relationship between these rocks is a matter of conjecture. The pseudodiorite is a hybrid rock, derived by either assimilation or metasomatic reconstitution of (chiefly) altered volcanic rocks. Evident lack of severe disturbance attendant on reconstitution (e.g., unreplaced limestone bands) and absence of a definitely intrusive basic rock, favour the latter mode of origin. The field and petrographic data at hand suggest a metasomatic sequence from syenite through pseudodiorite and pyroxene-hornblende rock to unreconstituted volcanic rocks, with pyroxene-hornblende rock representing an ultimate "basic front". However, the presence in places of uralite-like borders and patches in the large recrystallized individuals of the pyroxene-hornblende rock, and doubt as to the age of the syenite raise the possibility of a considerable time break in the above hypothetical sequence.

The pseudodiorite, in its existing state, is younger than the Beaver Mountain formation, and older than the Nelson batholithic rocks. It is the host rock for important gold-quartz fissure veins. The syenite is also younger than the typical metadiorite; it differs in appearance and composition from the Nelson rocks. The possibility is not wholly excluded that it is related to younger alkaline batholiths of the district.

SILVER KING QUARTZ-DIORITE PORPHYRY

This distinctive rock forms a large stock and numerous tongues in the northeastern part of the map-area. Rounded altered feldspar phenocrysts rarely approaching ½ inch in length protrude from the weathered surface, and have a characteristic pearly lustre. The greenish grey, fine groundmass contains variable amounts of acicular hornblende and occasional large rounded quartz grains. The thinner tongues are conspicuously sheared and schistose, and in places closely resemble schists of volcanic origin. About Gold Creek there is a breccia consisting of angular fragments of porphyry in a greenish schistose matrix.

Thin sections show calcic oligoclase phenocrysts, extensively sericitized, particularly in outer zones, altered hornblende, and rounded, resorbed quartz grains in a fine groundmass composed chiefly of alteration products and quartz.

The porphyry intrudes Hall and Beaver Mountain formations and is fairly definitely cut by Nelson batholitic facies. It is probably an early phase of Nelson intrusion, emplaced after the main folding period, but prior to later movements that antedates the batholithic stage. A number of important orebodies seem to be related to this rock, probably structurally and in part chemically.

NELSON INTRUSIONS

These include massive granite, granodiorite, and diorite batholithic facies, and quartz-diorite and diorite satellite, border, and dyke facies. Both porphyritic and non-porphyritic granite and granodiorite occur. The textural facies are gradational, but most rocks have a porphyritic aspect.

Porphyritic "hornblende" granodiorite is the most abundant batholithic rock. It has well-formed white oligoclase-andesine phenocrysts up to about 2 inches in length. The medium-grained groundmass contains similar plagioclase and soda-potassic feldspar in proportion of two or three to one, about 20 per cent quartz, and variable proportions of amphibole, of which a deep blue-green variety, identical with that of the Bonnington syenite, is more common than hornblende. A little biotite appears occasionally. Sphene is a common accessory; apatite is scarce if not absent.

Around Nelson, more or less porphyritic biotite granite has large phenocrysts of potassic feldspar, a somewhat higher proportion of potassic feldspar to plagioclase, and more quartz. Microcline and myrmekitic quartz-feldspar intergrowths are common. A little blue-green amphibole is present. Sphene is prominent, apatite scarce.

Dioritic facies occur chiefly along the southern boundary of the map-area. These are medium- to fine-grained dark rocks composed of andesine, augite, hornblende, and biotite, with accessory apatite and titaniferous iron ore. The feldspar is lath shaped and the texture sub-ophitic. These rocks are cut by typical granodiorite.

The satellites and border-and-dyke facies lying east of the main batholithic areas are fine feldspar-hornblende porphyries, with minor quartz. The phenocrysts, about $\frac{1}{4}$ inch long, are generally conspicuous in a much finer dark grey groundmass, but in the interior of larger bodies the texture becomes sub-granitic. The feldspar crystals are sodic andesine, considerably altered. The body at the head of the south fork of Barrett Creek is a dark quartz-free rock with large augite crystals and abundant inclusions, around which feldspar and hornblende laths form complex fluidal patterns. These rocks are believed to be early phases of Nelson intrusion.

In the Red and Copper Mountain area a grey dioritic feldspar porphyry that cuts Elise greenstone is also associated in parallel bands with a fine porphyritic biotite granodiorite that intrudes the lower part of the Hall formation on Red Mountain.

The Nelson intrusions show sharp contacts, and distinct crosscutting relationships to folded rocks; there is little to suggest a metasomatic origin of the batholithic rocks, though lithological variations are believed to reflect variation in type of rock assimilated. Faults have probably been instrumental in controlling the emplacement of the large central batholithic wedge and other bodies.

The Nelson is younger than the bedded rocks, and the main periods of deformation. It is believed to be early Cretaceous in age.

POST-NELSON DYKES AND SILLS

These include distinctive feldspar-quartz and feldspar-quartz-augite porphyries confined mostly to the basin of Erie Creek, and a variety of aplites, lamprophyres, and unclassified diabasic rocks. They are indicated on the map only in a few places where especially prominent.

The Erie Creek porphyries are especially numerous in the Hall sedimentary rocks in this area, where they have a pronounced sill-like habit. They are characterized by oligoclase-andesine and in places augite phenocrysts an inch or more long, with smaller rounded resorbed quartz grains in a fine grey felted groundmass of feldspar laths and alteration products. Conflicting age relationships between augitic and non-augitic types have been recorded. They both cut the granodiorite and probably the Second Relief veins. Aplitic stringers cut the augitic variety.

Aplites are very fine granitic to aphanitic quartz-porphyries, with fine feldspar and biotite crystals in some, and in many pyrite. They vary considerably in mineral composition; some have potassic feldspar and abundant myrmekite, others plagioclase and no myrmekite. They are among the youngest rocks of the area but may not be all of the same age or affinity.

The lamprophyres include biotite kersantite, an unclassified orbicular biotitic rock, and pyroxene-hornblende odinite that has large prehnite filled amygdules. A fine-grained diabasic rock that cuts granodiorite has labradorite laths and fine augite in ophitic texture. Most lamprophyres in contact with mineralized veins are evidently younger but some, as at the Porto Rico mine, are reported to be older.

A number of fine diabasic sills or dykes intruding Hall rocks in lower Hall Creek have variously; large andesine-labradorite, augite, and biotite phenocrysts, amygdules, pebbly fragments, and occasional rounded resorbed quartz grains. Plagioclase laths, augite, and alteration products make up an ophitic groundmass. These dykes have conspicuous columnar jointing, unlike the Erie Creek porphyries, which they otherwise superficially resemble. They are of unknown age and affinity.

MONZONITE CHONOLITHS

Three small bodies of distinctive rock with typical monzonitic texture lie in the southeast corner of the map-area.

The two south of Stewart Creek lie on opposite sides of a unique pegmatitic stock. The westerly body has a remarkably straight northern boundary cutting sharply across the strike of bedded rocks. If this contact marks a fault line, the faulting took place prior to its emplacement. In these bodies, thin brown biotite lamellae nearly an inch across give a distinctive facetted appearance and lacy pattern to the rock, otherwise fine grained and medium to dark grey in colour. Thin sections show small augite, olivine, and possibly alkaline pyroxene phenocrysts embedded in a uniform, fine, felted mass of lath plagioclase, oligoclase to calcic andesine, and potassic feldspar. Biotite is mostly confined to the thin lamellae, which probably mark a complex system of fine shrinkage cracks.

A third small body north of Stewart Creek reported by H. W. Little is coarser grained, lacks the conspicuous biotite lamellae, and resembles a plug south of Ymir described by McAllister. One specimen shows a distinct trachytoid texture, with platy pink feldspar crystals commonly exceeding 2 cm. in length, subhedral to euhedral dark green pyroxene, and minor black biotite. A thin section shows also a considerable amount of quartz, apparently primary. The large feldspar crystals are fresh potassic and soda-potassic feldspar, the latter marked by patchy intergrowth texture. Twinned and zoned plagioclase, up to An_{38} in cores, occurs in much smaller scattered grains. The pyroxene, chiefly augitic, is rimmed by pale green hornblende and partly altered to brown biotite. There may be some enstatite or iron-poor hypersthene. Another specimen has a more even-grained appearance, with pale greenish somewhat less platy feldspar and rather more pyroxene and biotite. The large feldspars are mostly soda potassic intergrowth feldspar, much clouded by fine scaly alteration products. The smaller scarcer plagioclase grains, about An_{40}, are much sericitized, and often occur as inclusions in alkali feldspar. Hornblende-rimmed augite is also more altered, chiefly to biotite, but chlorite, calcite, epidote, and opaque unidentified material are also prominent, as is also quartz.

The monzonite bodies are remarkably fresh and uncrushed and are quite unlike any Nelson rocks. They are probably younger than the batholithic rocks at least. Similar monzonitic rocks elsewhere in the district have been thought to be Tertiary, by reason of their alkaline nature, but mineralized veins and aplitic rocks are reported to cut the monzonite at the Free Silver property in the southeast corner of the map-area.

PEGMATITE

A coarse to pegmatitic granite, consisting chiefly of very large crystals and irregular masses of pink potassic feldspar and coarse quartz, outcrops in the southeast corner of the map-area. It lies between two monzonite chonoliths, and cuts the nose of a drag-fold in Hall sediments. The rock differs from observed facies of Nelson intrusives, and may be younger.

STRUCTURAL GEOLOGY

FOLDS

Two moderately open major folds traverse the greater part of the area from north to south, interrupted by a batholithic intrusion. The approximate location of their axes is indicated on the map where there is nothing to suggest that the folds are other than simple. The eastern fold will be described as the Hall Creek syncline, the western one as the Erie anticline.

Hall Creek Syncline

North of Hall Creek and the granodiorite wedge in that locality, the axis of this fold extends to the vicinity of Toad Mountain, and for an unknown distance beyond. It is indeed probable that the pseudodiorite of Eagle Creek lies within the same structure. South of the granodiorite wedge, the Beaver Mountain terrain is especially broad. If the water-lain tuffaceous sandstone and conglomerate-agglomerate in the vicinity of the Porto Rico mine represents the top of the Hall formation, it follows that the syncline is a compound one and involves a further repetition of formations, with an intermediate anticline bringing the Hall formation to the surface. Farther south, the Beaver Mountain again becomes constricted, the intermediate anticline (?) apparently dying out toward the boundary of the map-area.

In the area south of Barrett Creek, the Hall formation, like the Beaver Mountain, outcrops in an especially broad belt. Near the fossil locality a synclinal drag-fold is delineated. A complementary anticlinal drag-fold just to the westward is not definitely established, but must be assumed to fulfil the structural requirements. South of Stewart Creek, the east-dipping sedimentary rocks near the eastern boundary are assumed to be overturned and a synclinal drag-fold east of the Pegmatite stock is indicated by the distribution of Hall and Elise rocks (See Structure Section on map). The complementary anticlinal axis lying to the westward is approximately defined. The overturned closed syncline suggests a southward increase in lateral stress intensity along the eastern boundary.

Erie Anticline

Northwest of Copper Mountain the axis of this fold is shown passing through the Elise volcanic terrain about midway between the divergently dipping Hall sedimentary bands. West of Bird Creek, a number of top determinations furnish satisfactory evidence that the presumed Hall rocks are right side up. East of Forty-Nine Creek, the succession of rock types leaves little doubt that this interpretation is correct, although the Hall formation is very sparingly represented. South of the granodiorite, the axis evidently coincides closely with the course of Erie Creek as far as the Nelson-Salmo boundary.

FAULTS

Considering the severity of the deformation to which the bedded rocks of the area have been subjected, remarkably few faults on a scale large enough to be mapped have been recognized. A fault of unknown but probably important displacement separates dark gneissic pseudo-diorite from leucocratic syenite south of Bonnington Falls. Just east of the lower Bonnington dam the contact is marked by a shear zone. Small-scale faults have been observed in many places, and the abundance of mineralized fissure veins testifies to the presence of others. Both pre- and post-ore faults have been described in many of the larger mines that have been examined in detail in former years. In view of the absence of distinctive marker horizons in the several formations, and the scarcity of exposures in many parts of the area, especially those underlain by bedded rocks, it is quite probable that many faults lie undetected. However, in the light of available information, it can only be concluded that post-intrusive faulting has been limited to small-scale local movements.

Pre-intrusive or contemporaneous faulting appears to have been an important factor in controlling the emplacement of batholithic intrusive masses, particularly the large wedge in the central part of the area. Here the trend of fold axes and contacts takes the form of an overall bulge around the mass, as though forcible intrusion of a plastic or fluid magma had bowed out and pushed aside the enclosing rocks. At the same time, the trends close to the contacts are such as would be expected from differential horizontal movement of the north side relative to the south, resulting in extreme "dragging" of the folded rocks. Furthermore, the breadth and altitude of exposed Elise formation rocks around Copper Mountain in contrast with the Erie Creek area suggest that the north side has been raised several thousand feet relatively to the south side. However, no complete break has been detected east of the "wedge". A "reverse drag" is also clearly indicated immediately adjoining the granodiorite contact east of Erie Creek. If faulting was instrumental in bringing about the observed distribution of the rocks, the resultant movement must have been rotational, the displacement increasing rapidly to westward of the present nose of the wedge.

SMALL SCALE SECONDARY STRUCTURES

Small scale secondary structures in the bedded rocks are not strongly developed or as a rule consistent in attitude. A schistose foliation, about parallel with the presumed bedding, is common in the volcanic rocks of the Elise formation along the eastern border, and a conspicuous schist zone, described below, lies northeast of Toad Mountain. A slaty cleavage, erratic in attitude, is common in the softer argillitic members of the Hall formation, but in the generally harder well-banded rocks the cleavage is less conspicuous and usually closely parallels the banding. Elongation and flattening of pebbles is especially noticeable in the "intraformational" conglomerates of Hall Creek.

Most of the Hall rocks appear to be insufficiently indurated or deformed for the strong development of structures independent of bedding. Even where the grade of metamorphism is relatively high, as in the northwest part of the area, the foliation of schists and gneisses evidently reflects the influence of original bedding.

The batholithic rocks are massive and coarsely jointed. Crushing and shearing are rare. Silver King porphyry tongues, evidently a pre-batholithic facies of intrusion, are, however, characteristically sheared and schistose.

TOAD MOUNTAIN MINES SCHIST ZONE

A northwesterly trending belt of schistose rocks lies northeast of Toad Mountain. It is a conspicuous feature of the area and an important locus of mineralization. The schistose rocks embrace andesitic greenstone, Beaver Mountain type augite porphyries, vaguely banded dark clastic-looking rocks, and tongues of Silver King feldspar porphyry. The schistose foliation strikes parallel with the long axis of the zone and dips dominantly southwestward. Banding, rarely discernible, has the same attitude. The zone is parallel with the regional trend and appears to lie along the east limb of a major syncline.

No evidence of faulting has been detected but good horizon markers are lacking. The Hall formation is not recognizable here and the volcanic rocks are not differentiated. Shearing and brecciation of Silver King porphyry tongues point to movement subsequent to their emplacement, which is believed to have been somewhat earlier than the main batholithic intrusion. The schistosity may be attributable to distortion of the previously folded rocks during, or immediately prior to, intrusion of the batholithic "wedge" already discussed.

ECONOMIC GEOLOGY

INTRODUCTION

The Nelson area has been the scene of mining activity since 1885, and a number of mines in the area have been important producers. Of these only one has been in active operation in recent years. The area is dotted with innumerable prospects, bearing witness to very extensive mineralization, and at the same time to the thoroughness with which surface exposures have been prospected.

The Silver King and other properties in the Toad Mountain area were among the earliest discoveries in the district. The wide attention thus attracted led to the location of numerous others in the northern belt, and the Silver King, Poorman, and Copper Queen (Queen Victoria ?) were all mentioned by Dawson in 1889. Within the following year the railroad was completed from Nelson to Sproat's Landing (Castlegar) at the foot of the Arrow Lakes, the waterway to the C.P.R.

line at Revelstoke. The "gold belt" had meanwhile been extended from Eagle to Rover Creek (the Royal Canadian, Whitewater, etc., properties), and placer mining was being carried on on Forty-Nine, Bird, and Hall Creeks.

By 1896 the Fern, Athabaska, Eureka, and numerous other properties had been opened up. This year saw the blowing in of a smelter at Nelson, operated by the Hall Mines Company, which held the Silver King group at that time. Reports for 1897 mention the Porto Rico mine, and for 1900, the Second Relief, Venus and Juno, and May and Jennie. Thus most of the properties that have proved valuable were known by the turn of the century. In 1907 the Hall Mines Smelter was closed down. Intermittent operation of most properties continued until the war years, when there appears to have been a decline in mining activity. The Second Relief and Granite-Poorman have been the scene of most activity in later years, but even these operated sporadically in spite of the impetus arising from the enhanced price of gold during the depression years.

In 1945 the Kenville Gold Mines Company was organized to take over the Granite-Poorman and adjoining properties. A new mill and mining plant was installed, but active operation of the mine by the company was suspended in 1949, parts of various properties being leased to employees.

Other properties worked on in 1949 were the Venango (Eagle Creek), the Golden Eagle and T-S. groups (Hall Creek), Lion Group (Quartz Creek), Fairview group (Bird Creek area), and minor leasing activities at the Daylight and Victoria-Jessie.

The important properties, and most prospects, were examined and reported upon by Dawson (8, 1889), Leroy (9, 1911), Drysdale (6, 1917), and Cockfield (4, 1936), when they were in operation and subsequently. Further descriptions and progress notes are to be found in reports of the

B.C. Department of Mines for the years 1887 to 1949. The properties are mostly abandoned, and the workings for the most part now inaccessible. Accordingly, the following notes are based chiefly on information derived from the above reports. Their aim is to give a general picture of the types of deposits found in the area, and their relations to the rocks and structures, as interpreted in this report.

Regarding these relationships, only a few generalizations may be made:

1. Ore deposits occur in the bedded rocks, in pseudodiorite, and in Silver King porphyry.
2. The main mass of Nelson granodiorite within the map-area appears to be practically barren, although in at least one case fissure veins are known to cut across the contact between granodiorite and bedded rocks.
3. The ore deposits are younger than the batholithic stage of Nelson intrusions but are probably related to these, as dykes that definitely cut granodiorite generally cut the veins also.
4. No major breaks to which a number of separate deposits may be attributed are apparent. A well-defined fracture pattern, however, exists in the pseudodiorite of Eagle Creek basin, and the conclusion may be hazarded that this represents an extension, into more competent rock, of the mineralized "schist zone" structure northeast of Toad Mountain.
5. A number of deposits seem to be related to the shape of the granodiorite contacts. Several are grouped around the convex nose of the large central wedge, and the Second Relief lies within an embayment in the contact.

Most important properties are indicated on the map. For description purposes the orebodies are grouped as follows:

I. Gold-quartz fissure veins and lodes, with minor lead, zinc, and copper.

II. Silver-copper-lead lodes and veins.

III. Copper, and copper-gold-silver replacements in limestone.

IV. Scheelite (tungsten) deposits.

The first of these is by far the largest group and includes numerous properties in addition to those listed. The second group is, with one exception, restricted to the Silver King and adjoining properties northeast of Toad Mountain. Of the third group the Eureka and Queen Victoria are the only examples. Group IV is exclusively represented only by the Stewart Creek property, although scheelite is known to occur in a few veins of Group I.

DESCRIPTION OF PROPERTIES

Group I, Gold-Quartz Fissure Veins and Lodes

Gold-quartz fissure veins are most characteristically developed in the pseudodiorite of Eagle Creek basin and westward, where they form part of a north-northwesterly striking fracture pattern. Of these, most important representatives are the Granite-Poorman and Royal Canadian. Fissure veins occur also in bedded rocks of Elise, Hall, and Beaver Mountain formations, as at the Fern, Porto Rico, and Second Relief. A few of these lie at or athwart Nelson granodiorite contacts, as at the Athabaska and Whitewater. Many deposits in bedded rocks are more properly lodes or even disseminated deposits. These generally have sulphides more prominent than in the fissure veins, but lack the dominant silver and base metal values of Group II.

Granite-Poorman (Kenville Gold Mines, Ltd.)

Location: Eagle Creek

Principal Refs.: Geol. Surv., Canada: Ann. Repts. 1889, p. 64B, 1911, p. 147; Mem. 191, p. 66.
B.C. Minister of Mines: Ann. Repts. 1889, 1915, p. 144; 1928, p. 320; 1945, p. A96; 1946, p. A138; 1947, p. A159; 1949, p. A163.

This property is one of the oldest and has been one of the greatest producers of the district. Up to the end of 1944, when taken over by the present holders, it was credited with a production of over $1,000,000 in gold.

The host rock is pseudodiorite, underlain by westerly dipping volcanic rocks, which are apparently on the east limb of a syncline in the Beaver Mountain formation. For about 150 feet from the contact, the pseudodiorite is distinctly coarser in grain than in the main mass of the body. Both normal and coarse facies of pseudodiorite in this vicinity show extensive replacement of plagioclase by soda potassic feldspar and of original ferromagnesian minerals by biotite and epidote.

The property was described by LeRoy (9, 1911), and by Hedley and Hughes (2, 1945, p. A96). According to the latter writers, the main veins, striking north 10 to 30 degrees west and dipping about 45 degrees northeast, are weak fault zones, the hanging-wall having moved up and southwards in each case. The vein matter in these breaks free, by reason of a gouge selvedge on the walls. Flatter offshoots, particularly in the foot-wall, have vein matter frozen to the walls, and are interpreted as tension cracks. Intersections of these with the steep shears form ore shoots that rake to the south. The veins are cut by faults, some of which are occupied by lamprophyre dykes. The vein matter is milky to glassy quartz carrying pyrite and a little galena and chalcopyrite. Galena is an indicator of high gold values.

Venango

Location: Eagle Creek

Principal Refs.: B.C. Minister of Mines: Ann. Repts. 1938, p. E37; 1942, p. A60; 1943, p. A64; 1945, p. A98; 1949, p. A163,
B.C. Dept. of Mines Bull. No. 10, 1943, p. 133.

At the Venango, two veins opened up are described (2, 1945, p. A96) as similar to those of the Granite-Poorman, and part of the same system of fracturing.

In September 1949, a new vein, described as the faulted extension of the vein originally discovered, was being drifted on by the Norcross brothers from a point about 210 feet at north 60 degrees west from the old shaft. At a point reported as 30 feet short of the projected fault extension, the drift swung left to crosscut a mica lamprophyre dyke, and picked up the vein striking about north 20 degrees west and dipping 40 degrees northeast. The vein matter here consisted of quartz with pyrite, coarse galena, red to black zinc blende, and a little chalcopyrite. Free gold was reported. Scheelite (3, p. 133) has been found in significant amounts but has not as yet been recovered.

The country rock is "normal" medium-grained pseudodiorite, not particularly mafic. A thin section of drill core from the Venango, like the sections from the Granite-Poorman area, showed conspicuous replacement of plagioclase by soda-potassic feldspar, and of ferro-magnesian mineral by biotite.

Royal Canadian and Nevada

Location: east of lower Forty-Nine Creek

Principal Refs.: Geol. Surv., Canada, Sum. Rept. 1911, p. 151;
Mem. 191, p. 72.
B.C. Minister of Mines: Ann. Rpts. 1890, p. 363;
1928, p. C321; 1933, p. A218.

The country rock consists of pseudodiorite. A reported green-schist inclusion at the Nevada is not exposed at the surface and the workings are inaccessible. According to the above authors, a north-south fissure vein in the Royal Canadian and an east-west vein at the contact of a greenschist inclusion on the Nevada have been developed and partly stoped out. The vein matter is quartz with gold-bearing pyrite and minor chalcopyrite. Scheelite has been reported.

Athabaska

Location: west of Giveout Creek

Principal Refs.: Geol. Surv., Canada, Sum. Rept. 1911, p. 148;
Mem. 191, p. 65.
B.C. Dept. of Mines: Ann. Repts. 1896, p. 87;
1933; 1934, p. E21.
Can. Min. Inst. vol. V, 1902.

Most of the vein matter has been stoped out in accessible parts of the workings, but a few high-grade stringers of galena and sphalerite remain in pillars. The vein, striking about north 40 degrees east and dipping 30 to 50 degrees northwest, crosses the contact between Nelson granodiorite and Beaver Mountain type augite-porphyry. The contact is quite sharp, and the volcanic rocks apparently little altered. No sign of the presence or influence of the nearby Silver King porphyry body is to be seen in the workings.

The flattening of the vein in passing from the granodiorite to the volcanic rocks has been emphasized (LeRoy, 1911) as has the enrichment in values at the contact. Fell (7) discusses two sets of post-ore step-faults that cut and offset the vein in the schist and granodiorite. The vein matter consists of a gold-bearing mixture of pyrite, galena, and zinc blende in a quartz gangue.

California

Location: east of Giveout Creek

Principal Refs.: Geol. Surv., Canada, Sum. Rept. 1911, p. 150.
B.C. Dept. of Mines: Ann. Repts. 1910, p. K102;
1941, p. A63; 1944, p. A60; 1947, p. A159.

The underground workings were not examined. Those adits seen lay at or near the granodiorite contacts, in schist, some of which is distinctly banded and evidently clastic in origin.

According to the above author the ore occurs as parallel stringers and lenses in schist, and consists of pyrite, galena, and zinc blende carrying gold and some silver, in a quartz gangue.

Fern

Location: south of Hall Creek

Principal Refs.: Geol. Surv., Canada: Mem. 94, p. 137; Mem. 191, p. 48.
B.C. Dept. Mines: Ann. Repts. 1894, p. 742; 1945, p. A99; 1946, p. 140.

This property was described in detail by Drysdale (6) and Cockfield (4). A northeasterly striking fissure vein partly localized by, but not confined to, a tongue of Silver King porphyry is faulted off on the south along a lamprophyre dyke. In 1945, according to B.C. Department of Mines reports, the vein was picked up beyond the fault, but apparently was not sufficiently strong or rich to repay exploitation. The country rock seen by the writer at an upper adit is Beaver Mountain augite-porphyry breccia of the "autoclastic" variety.

The vein matter consists of quartz and crushed country rock with pyrite and gold. According to Drysdale, the parts of the vein in contact with Silver King porphyry were the most productive.

Canadian Belle

Location: south of Hall Creek

Principal Refs.: B.C. Dept. of Mines: Ann. Repts. 1936, p. E44; 1937, p. E34; 1947-49.

According to B.C. Department of Mines report for 1937, a number of veins follow closely spaced fractures about parallel with the bedding of the Hall sediments, which form the country rock. Some also follow an east-west fracture system. The vein matter is described as chiefly arsenopyrite, fractured and veined by, and also intergrown with, pyrite and chalcopyrite. Gold occurs as minute grains in arsenopyrite.

The sedimentary rocks on the property and in the vicinity are extensively intruded by fine, porphyritic, quartz-diorite, sill-like apophyses from the nearby stock. A tongue of Silver King porphyry extends almost if not quite into the property, but was not seen in prospect pits examined. During 1949 a new low-level crosscut was collared beside Keno Creek but the project was discontinued.

Porto Rico

<u>Location:</u> Barrett Creek

<u>Principal Refs.:</u> Geol. Surv., Canada: Mem. 94, p. 128; Mem. 191, p. 46.
B.C. Dept. Mines: Ann. Repts. 1897, p. 531; 1905, p. J164.

No work appears to have been done on this property since it was examined by Cockfield (1936), and the workings are inaccessible. An upper caved adit exposes augite-feldspar porphyry country rock similar to, but distinctive in structure and texture from, Beaver Mountain volcanic rocks lying to east and west. The rock is an elongated sill-like body bordered immediately to east and west by pebbly tuffaceous sandstone, possibly an anticlinal outcrop of the Hall formation.

According to Cockfield and Drysdale, the northeasterly striking vein partly follows the foot-wall of an augite-kersantite (lamprophyre) dyke.

Second Relief

<u>Location:</u> Erie Creek

<u>Principal Refs.:</u> Geol. Surv., Canada, Mem. 191, p. 7.
B.C. Dept. of Mines: Ann. Repts. 1900, p. 847; 1915, p. K148; 1928, p. C337.

This property, except for the Granite-Poorman, has been the most persistently active in the map-area. It is mentioned in most reports of the B.C. Department of Mines since 1900.

The property was inactive in 1949, and the main adit flooded as a result of small cave-ins. Exposures are poor at the surface but most of the workings appear to be in Elise type greenstone, cut by numerous grey porphyry ("Erie Creek") and aplite sill-like bodies. The main vein is stoped through to the surface exposing a pre-mineral diorite porphyry dyke typical of the Nelson satellitic facies, which it follows. At one point it was seen to be cut without offset by a lamprophyre dyke.

According to the above authors the grey porphyry and aplite dykes cut the vein. Cockfield (4) suggests correlation with the Tertiary? Coryill batholith. His introductory description of the deposits is as follows:

> "The ore deposits are fissure veins occurring, chiefly, in the greenstone of the Rossland volcanics. The veins strike northeast and dip, generally, to the northwest at steep angles. The ore minerals consist of pyrite, pyrrhotite, and chalcopyrite. Molybdenite has also been reported. The gangue is country rock and quartz carrying some magnetite and, in places, garnet and epidote. Principal values are in gold and average about 0.4 oz./ton."

From further detailed description it appears that the veins lose continuity and value on passing from the greenstone into the sedimentary Hall formation.

A few other former producers that have been described at some length in the literature are here listed, with references of interest:

Whitewater (upper Snowwater Creek)

Refs.: B.C. Dept. of Mines: Ann. Rept. 1890, p. 366; 1895; 1941-44.

Note: according to description, the vein lies at the contact of Nelson granodiorite with Hall slate.

Venus and Juno (west of the Athabaska)

Refs.: Geol. Surv., Canada: Ann. Rept. 1911, p. 152; Mem. 191, p. 63.
B.C. Dept. of Mines: Ann. Repts. 1900-05, 1912-14, 1930, p. 267; 1933, p. 218.

Star and Alma N. (upper Eagle Creek)

Refs.: Geol. Surv., Canada, Mem. 191, p. 69.
B.C. Dept. of Mines, 1910, 1930, 1938, p. E36.

May and Jennie (east of Forty-Nine Creek)

Refs.: Geol. Surv., Canada, Sum. Rept. 1911, p. 152.
B.C. Dept. of Mines 1900, p. 845; 1905-08, 1940, p. 66.

Gold Hill (upper Forty-Nine Creek)
Ref.: B.C. Dept. of Mines, 1927, p. C316.

Perrier (on railway $3\frac{1}{2}$ miles south of Nelson)
Refs.: Geol. Surv., Canada: Mem. 94, p. 146; Mem. 191, p. 53.
B.C. Dept. of Mines: Ann. Repts. 1910-17.

Golden Eagle and T.S.

Location: Red Mountain

Ref.: B.C. Dept. of Mines: Ann. Rept. 1937, p. E34; 1938, 1945-49.

During 1949 Mr. Wm. Rozan was developing quartz veins in fine granitic porphyry near the crest of the west ridge of Red Mountain. The showings consisted of a northerly striking fissure vein, exposed by trenching for several hundred feet, and a flat-lying vein a short distance to the southeast. A tunnel was being driven beneath the latter. The veins contain pockets of oxidized sulphide ore reported to carry good gold values.

Lion

Location: Quartz Creek

In 1949, J. T. Graney and associates were drifting on a mineralized shear in black argillite of the Hall formation, striking about north 20 degrees west and dipping steeply east.

Group II, Silver-Copper-Lead Lodes and Veins

Silver King

Location: northwest of Toad Mountain

Principal Refs.: Geol. Surv., Canada, Ann. Rept. 1889, p. 57B; 1876, p. 27A; Sum. Rept. 1911, p. 154.
B.C. Dept. of Mines: Ann. Repts. 1887-1914.

This property, staked in 1886, is mentioned in reports of the B.C. Dept. of Mines, 1887 et seq. Dawson examined the area in 1889 and LeRoy in 1911. This and the adjoining properties situated along the axis of the "schist zone" of undifferentiated Elise-Beaver Mountain group constitute what was known in the early days as the "Silver-copper belt". The most important claims definitely belonging to this group are the Silver King, Kootenay Bonanza, Dandy, Grizzly, Ollie, and Iroquois. The Victoria, Jessie, Daylight, Berlin, etc., farther east within the schist zone apparently have values chiefly in gold.

The schists along this axis, although all in shades of green, appear to be in part clastic in origin, unlike those closer to Toad Mountain, whose origin as augite porphyry can still be recognized. "Sericite schist" is undoubtedly sheared Silver King porphyry, remnants of which are to be seen in unmined parts of the lode at the surface. Perhaps a tongue of this rock, more brittle than the volcanic-clastic rocks, proved favourable for development of the cross-fissures that have been repeatedly mentioned as the loci of deposition within the lode. "Compact magnesian limestone", mentioned in early reports of the B.C. Department of Mines, is not in evidence, but limestone blocks or lenses several feet in length were seen in volcanic schist on the ridge south of the mine. In the late summer of 1949 the lower adits, which were not caved, were still plugged with ice and snow, and little information is to be had from the surface workings.

Ore minerals seen in specimens collected are pyrite, chalcopyrite, bornite, tetrahedrite, malachite, azurite, and galena. They occur in fine stringers in country rock. Prominent in the sparse quartz-carbonate wall-rock gangue are large lamellar aggregates of a black, submetallic, rather hard mineral, probably manganite.

W. R. Baragar (1), who has studied the mineralography of a suite of Silver King ores, finds that stromeyerite, a copper-silver sulphide, is the only important argentiferous mineral, and that it and galena were deposited later than chalcopyrite, bornite, and tetrahedrite;

furthermore, that stromeyerite is associated chiefly with bornite. His classification of this orebody as a zeno-epithermal deposit is certainly in keeping with both the mineralogical contrast with the "gold-belt" properties, and with its proportionately greater distance, laterally and vertically, from probable deep-seated igneous sources.

Free Silver

Location: knoll northeast of Boulder Mill Creek

Ref.: Geol. Surv., Canada, Mem. 94, p. 123.

This property is included in this group because, although its characteristics are chiefly those of Group I, the values are apparently mainly in silver and lead. It is of interest in that, according to Drysdale, the fissure veins cut through the monzonite body in the southeast corner of the map-area and are in turn cut by fine-grained syenitic dykes, presumably aplite.

Group III, Replacement Bodies in Limestone

Eureka

Location: upper Eagle Creek

Principal Refs.: Geol. Surv., Canada, Sum. Rept. 1911, p. 153.
B.C. Dept. of Mines: Ann. Repts. 1904-1913; 1915, p. K138.

This property, which was a promising copper and gold producer in the early days of the camp, is especially interesting in that it reveals limestone bands "engulfed in" pseudodiorite (LeRoy, 1911). This part of the workings was inaccessible in late 1949. A low-level adit, open for about 1,000 feet, passed through pseudodiorite grading into greenschist in places, and cut by granitic and syenitic dykes. Diamond-drill cores show an imperceptible gradation from limestone to pseudodiorite.

According to the B.C. Mines Department report for 1915, two main veins follow limestone bands to some extent. The ore is, consequently, in part a replacement and in part a true fissure deposit, being higher in grade in the limestone. It is oxidized to the lowest level mined, and consists of secondary copper minerals with some chalcopyrite, and fair values in gold and silver.

Queen Victoria

Location: northeast of Beasely

Principal Refs.: Geol. Surv., Canada: Ann. Rept. 1889, p. 65B(?); Sum. Rept. 1911, p. 154.
B.C. Dept. of Mines: Ann. Rept. 1906, p. 149; 1907-1912; 1914; 1922, p. N207; 1928, p. 319.

This orebody is a contact metamorphic or skarn type of deposit. The workings are mainly open glory holes, and as such, still accessible. The lower workings are in a fine green to red rock, in places composed largely of garnet and epidote, with very abundant calcite in coarsely recrystallized stringers. Some epidote is also coarsely crystalline, and resembles tourmaline. Black amphibolite bands are common in the upper western workings. At the extreme west end the only bit of unrecrystallized limestone recognized was found pinching out between quartzite strata. Hard greenish quartzite immediately underlies the ore zone, and presumably overlies it in great thickness. Pseudodiorite lies not far below, and the general horizon seems to be about the same as that of numerous occurrences of pyroxenite and pyroxene-biotite rock farther east.

A thin section of typical fine green skarn rock consists largely of epidote, with diopsidic pyroxene, bluish green amphibole, and fresh anorthoclase and soda-microcline. Sphene and apatite are also present, but calcite is very scarce. The rocks and orebody are disrupted by small faults, and cut by fine grey feldspar-porphyry dykes.

A thin section of one dyke has much potassic and soda-potassic feldspar with some broken and altered plagioclase phenocrysts, in a fine, sutured, feldspathic groundmass with green biotite, epidote, some quartz, and accessory sphene and apatite. These dykes are unlike any common rocks of the map-area.

The metallic minerals are pyrite, chalcopyrite, and minor pyrrhotite and magnetite. The ore is low grade and the property has been idle for a number of years.

Group IV, Tungsten Deposits

Refs.: B.C. Dept. of Mines: Bull. No. 10, 1943, pp. 133, 150-152, 155; Ann. Rept. 1942, p. A79.

Stewart

Location: south of a point about 1½ miles up Stewart Creek from the eastern boundary of the map-area.

According to the above publications, scheelite mineralization occurs in one or more bands of skarn in sedimentary rocks of the Hall formation.

Other Occurrences

Scheelite has been reported in small quantities at the Poorman, Royal Canadian, Porto Rico, and Spotted Horse, and more abundantly in places at the Venango and Athabaska.

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