THE MINERAL DEPOSITS OF SWAKUM MOUNTAIN

(20)

Geology 9

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THE MINERAL DEPOSITS
OF SWAKUM MOUNTAIN

Lying within a radius of two miles from the summit of Swakum mountain, Nicola mining division, is a series of mineral deposits, all showing somewhat similar characters and presumably all derived from the same deep seated source. None of these peposits, however, have so far proved to be extensive and probably some at least are too small to be mined profitably.

Attention was first drawn to this area by the discovery in 1917 by O.A.Schmidt of what is now the Lucky Mike property. Since that time, Mr Schmidt and others have discovered no less than four more prospects, the Almeda, Gold Gossan, Corona (or Verona) and Thelma mines. Various companies including the Northwestern Mines Ltd (Spokane) and Granby Consolidated have at times carried on preliminary development on the properties and at July 1939 the Sheffield Gold and Silver Mines Ltd. was operating the Thelma mine with the intention of establishing a small mill. At that time, however, none of the other properties were being worked.

Most of these mineral deposits were briefly examined by the writer or his associates, A.R.Allen and D.C.Holland, while working under Dr.W.E.Cockfield of the Geological Survey of Canada on the geological reconnaisance of the east half of the Ashcroft Sheet.

Geology

The following geological notes were obtained by the geological survey party under Dr.Cockfield and are of a preliminary nature. Other than a very general description of the area by Dr.Dawson in the Report of Progress of the Geological Survey of Canada 1894, no geological information is yet in print.

Table of Formations

Period	Name	Character
Pleistocene and Recent	-	Glacial till, outwash, alluvium etc.
	Unconformity	
Upper Jurassic or Cretaceous		Aplite etc.; quartz diorite, granodiorite, graphic granite
	Intrusive contact	
Upper Jurassic or Lower Cretaceous	Swakum formation	Flows, flow breccia, flow agglomerate, limestone breccia
	Unconformity	
Middle or Upper Jurassic		Quartz diorite or granodiorite
	Probable intrusive contact	
Upper Triassic	Nicola formation	Altered flows and pyroclastics, limestone, argillite.
	Probable unconformity	
Permo-carboniferous	Cache Creek group	Schists, gneisses etc.

The oldest rocks of the Swakum mountain area (as mapped) belong to a group of highly metamorphosed sediments, now quartzites, mica schists, gneisses etc., forming the roof over the batholith exposed at the eastern edge of the area. They possibly represent the Cache Creek group of Permo-Carboniferous age.

Underlying most of the area west of Clapperton Creek, are the rocks of the Nicola formation. These rocks, chiefly metamorphosed extrusives and pyroclastics may be described under the general term greenstones. Apparently near the top of the Nicola formation and forming the highest horizon yet recognized is a series of flows, perhaps a thousand feet in thickness, composed of a coarse green or grey porphyry with feldspar phenocrysts from ¼" to 1" in length. Immediately underlying these flows is a single bed of massive blue limestone up to 200' in thickness. These rocks are considered to be of Upper Triassic age.

Overlying the Nicola formation with a slight angular unconformity is a second group of volcanic rocks, which, for lack of a suitable correlation,may be tentatively called the Swakum formation. At the base is a rock, which for want of a better name may be called a flow agglomerate, consisting of foreign fragments, including quartz diorite or granodiorite embedded in lava, not tuff. This basal agglomerate may be in contact with the feldspar porphyry, the limestone or occasionally, along the east limb of the main anticline, with still lower members of the Nicola formation. Elsewhere in the Swakum formation, the rocks are almost indistinguishable from those of the Nicola formation, being composed of green flows and very frequent flow breccias. Lenses of "limestone breccia" composed of a rather pure blue limestone matrix in which are embedded numerous relatively fine grained foreign particles, are not uncommon at the base of the formation, particularly near the massive limestone of the Nicola formation. The Swakum formation is thought to form only a comparatively thin mantle over the Nicola formation across the Nicola plateau near Swakum mountain. This formation is thought to be of Upper Jurassic or Lower Cretaceous age.

The origin of the quartz diorite or granodiorite fragments at the base of the Swakum formation has not yet been determined. Since these fragments are very localized, occurring only at the top of Swakum mountain, and are large, angular and somewhat interlocked, it has been suggested that they were derived from a nearby stock now buried under the Swakum formation. Alternatively, they may have been transported from a distant intrusive and deposited in hollows in the Jurassic erosion surface, to be picked up later in the basal flows of the Swakum formation. Similar fragments are nowhere found in the Nicola formation and it is probable that the intrusive is post-Upper Jurassic, but being older than the Swakum formation is pre-Cretaceous or pre-Upper Jurassic.

Considered to form the core of Swakum mountain, at no great depth, is an intrusive body not yet exposed at the surface. Aplite dikes and the ore deposits, cutting both the Nicola and Swakum formations, and, therefore, not earlier than the Upper Jurassic, are the only evidence of such an intrusion. Whether the intrusive connects at depth with the large batholith at the eastern edge of the area is not known.

The intrusives exposed at the eastern edge of the area are part of a multiple or composite batholith, six to eight miles wide and extending for about thirty miles N10°E from Nicola Lake towards Kamloops. Probably half a dozen distinct intrusives are present but whether they have been derived from one or more magmas is not known. Only one of the intrusives has been mapped separately, a graphic granite stock about two miles in diameter. Other than that these intrusives cut the Nicola formation, little is known of the age and relation of the component parts of this batholith.

Structure

In the absence of well developed bedding planes throughout the area, the structure is not well understood except, fortunately, in the vicinity of the mines. Here is found an assymetric anticline, tilted to the east, trending N5°E between the Thelma and Corona properties. South of the Thelma mine, the axis of this anticline has a slight pitch to the south so that the beds of the upper Nicola formation plunge under the Swakum formation, only to reappear a mile and a half farther south. North of the Thelma mine, the limestone horizon of the Nicola formation on the east limb of the anticline has been traced more or less continuously for over two miles, but the same horizon on the west limb has not been followed north of the Corona mine, and the location and plunge of the axis is, therefore, not definitely known. As well as the Nicola formation, the Swakum formation has been partly involved in the folding.

At the southeastern edge of the area are two normal faults striking northeasterly and with slips of probably a thousand feet or more each. Partly perhaps as a result of poor exposures, no other important faults have been discovered in the area.

Description of Properties

Lucky Mike

B.C.Minister of Mines Report 1917 - Pages 233, 450
B.C.Minister of Mines Report 1918 - Page 239
B.C.Minister of Mines Report 1924 - Page 136
B.C.Minister of Mines Report 1927 - Page 213

The Lucky Mike deposits occur in and near the massive limestone horizon of the upper Nicola formation, and consist of bornite and chalcopyrite with only traces of silver and gold. A shipment of twenty two tons of ore from this property in 1918 assayed 4.5% copper. The deposits have been explored by a shaft to a depth of fifty feet.

This property was not visited by the writer or his associates during the field season of 1939 and no further information is available on the deposits.

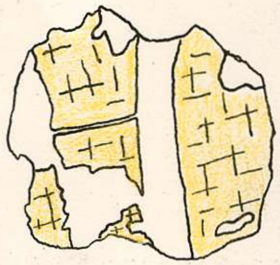
Almeda

B.C.Minister of Mines Report 1924 - Page 136
B.C.Minister of Mines Report 1925 - Page 183
B.C.Minister of Mines Report 1927 - Page 213

The mineral deposit of the Almeda property consists of a siliceous vein striking north and south and dipping 45° to the west, said to be twenty two inches wide. It has been explored to a depth of 125' by an inclined shaft. A trial shipment of the ore of 76 sacks assayed 3.80 oz of silver, 0.19 oz of gold, 22% of lead and 36% of zinc. Another shipment of ten tons assayed 11 oz of silver, 0.20 oz of gold, 14% of lead and 27% of zinc. Material said to be from 76' down the shaft assayed 3 oz of silver, 0.30 oz of gold, 6% of lead and 8% of zinc.

Unfortunately, at the time of visiting the mine, the shaft was flooded and the writer was unable to examine the vein as it occurred in place. Sufficient samples were obtained, however, from the dump to acertain the character of the ore and some of the sulfide relations.

Pyrite - One of the earliest minerals of the deposit is pyrite, occurring usually as euhedral crystals, either cubes or pyritohedrons from .25mm to several centimeters across. In places the pyrite shows a remarkably good cubic cleavage along which some of the later quartz veinlets have been injected. It is found as large single crystals or masses of crystals embedded in quartz or as distinct and relatively pure crystal aggregates. The relations of the pyrite to the quartz with which it is associated is not altogether clear; it is in part suspended within a mass of coarsely crystalline quartz apparently in contact with no other mineral, yet it is cut by veinlets of quartz that is quite indistinguishable from that in the matrix. The pyrite may have developed in some other material, say



X1

Figure 1. Pyrite cut by quartz, showing the relations of the cleavage in the pyrite to the contacts

ankerite, which was later completely replaced by quartz, it may have grown as crystals within an open space against walls of quartz or it may ehave replaced earlier quartz while preserving its crystal form, and then was cut by later quartz, identical in properties to the earlier generation. The pyrite contains most if not all of the gold in the deposit, assaying 1.04 oz per ton, but contains little if any silver. No gold was observed in the sections and its mode of occurrance is not known.

Quartz - Milky white quartz occurs in coarse but rarely euhedral crystals as much as 12.5mm long, closely associated with the pyrite. As already mentioned, its relations to the pyrite are not clear but it was undoubtedly early in the order of crystallization.

Sphalerite - Sphalerite occurs as very coarse and usually euhedral crystals up to several centimeters in diameter, and forms a very large part of the sulfide of the deposit. Two varieties of sphalerite have been observed, one dark brown and the other, less common, light yellow.

The color distinction has apparently little significance as both varieties have been found in a single crystal where, however, the yellow sphalerite was the later. The contacts with other sulfides usually follow the smooth crystal boundaries of the sphalerite crystals and are often occupied by narrow fissures of a later generation of quartz, but there is little doubt that the sphalerite is distinctly later than the pyrite and some of the quartz. Since there was, apparently, lots of available space while the sphalerite was being precipitated, replacement of the pyrite was not extensive. The sphalerite is rather barren of any of the precious metals, assaying only 1 oz in silver and a trace of gold, both of which may have been derived from other sulfides not completely separated from it.

Chalcopyrite - Chalcopyrite is extremely rare in the deposit, having been found in the sections associated with two minute fragments of sphalerite in a brecciated part of the vein. The chalcopyrite was presumably derived from the sphalerite by unmixing.

Galena - Galena occurs as coarse crystals, rarely euhedral, from 5mm to 50mm long, in or closely associated with the sphalerite. It is also found replacing some of the pyrite. It carries much of the silver in the ore, assaying 28 oz, but little if any of the gold.

After the deposition of these sulfides, the vein was subjected to movement, by which an ore breccia was produced. The fragments in the breccia are generally of brown sphalerite from 80 microns to 1 centimeter in length, and oriented

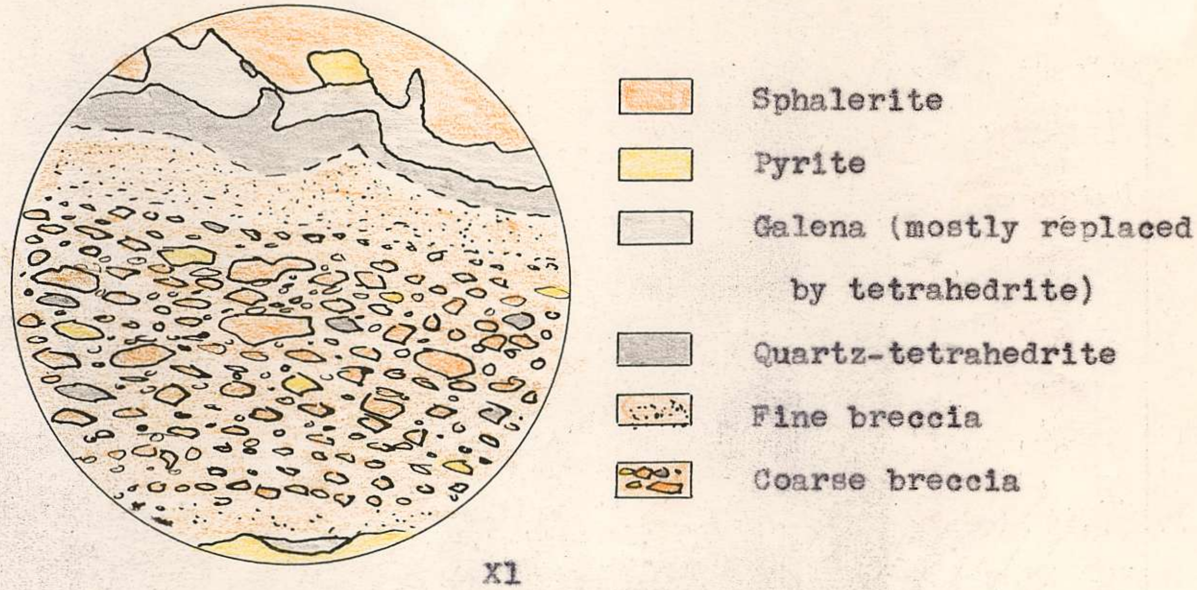


Figure 2. Cross section of brecciated zone

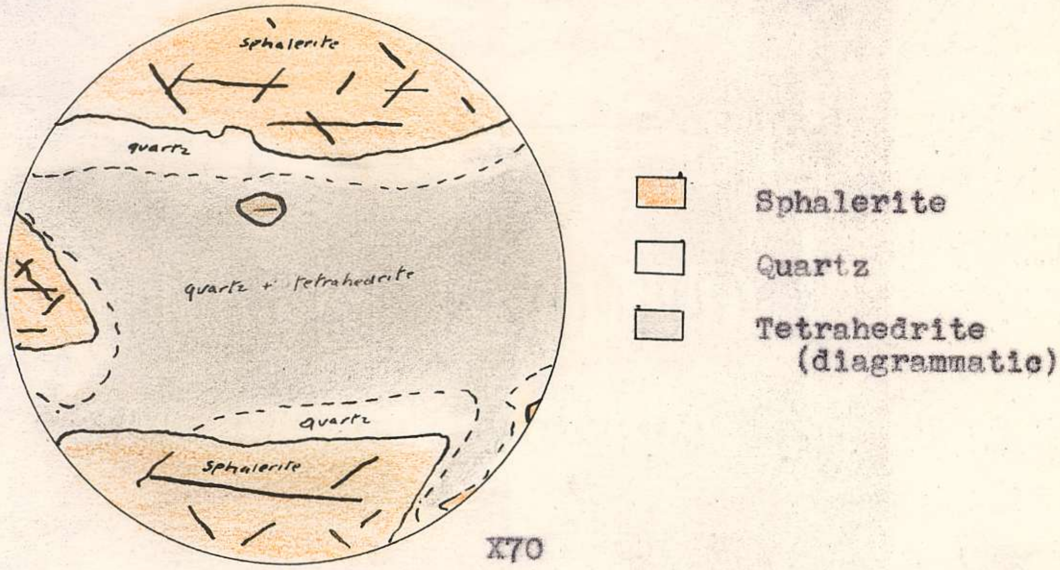
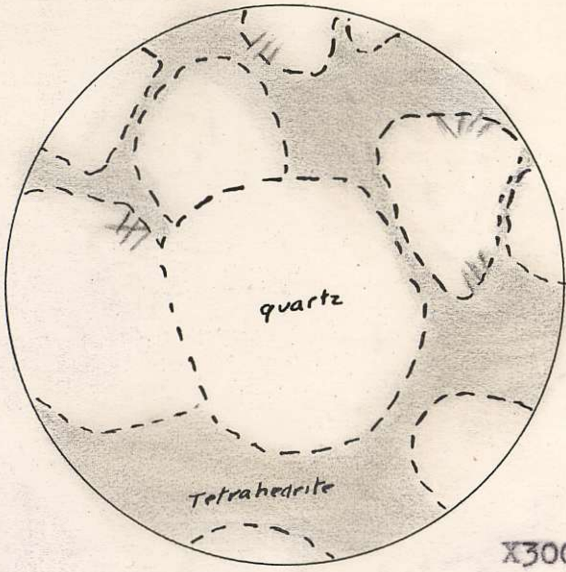


Figure 3. Thin section of brecciated zone showing distribution of tetrahedrite

parallel to the plane of shearing. Fragments of galena, pyrite, quartz and yellow sphalerite are also found in the breccia. The cementing material is dark in color and consists of a fine grained mixture of quartz and tetrahedrite.

Quartz - A second generation of quartz is found as veinlets cutting the sphalerite, galena and pyrite, or as part of the matrix of the sulfide breccia. The veinlets are parallel to the brecciated zone and it is highly probable that the same movement produced both the breccia and the parallel fractures, now filled with quartz. $till other smaller veinlets fill fractures crossing between those of the master set. This veining wuartz is generally free from any impurities. The matrix of the breccia is composed chiefly of nearly spherical crystals of quartz from 10 to 120 microns in diameter. Frequently along the surfaces of the sulfide fragments in the breccia there is a tendency for the quartz to develop comb structure, and there the quartz is comparatively pure. Elsewhere in the breccia matrix, there is a dark metallic mineral filling the spaces between the quartz grains or in places replacing the grains themselves. Microchemical tests indicate that this mineral is tetrahedrite which also occurs in massive form along the edge of the brecciated zone. A comparatively small fraction of the tetrahedrite is sufficient to impart to the matrix a dark grey or even black color.

Tetrahedrite - As has already been mentioned, tetrahedrite occurs either as a massive deposit, replacing galena or less often the sphalerite, or as part of the matrix of the sulfide breccia. In no case was the tetrahedrite found as a fragment in the breccia but in practically every case, the tetrahedrite was found adjacent



X300

Quartz

Tetrahedrite

Figure 4. Thin section showing relation of tetrahedrite to quartz in breccia matrix - a very coarse grained phase

to the brecciated zone. Apparently the brecciated zone was, even after some cementing by quartz, sufficiently porous to conduct the solutions, and the massive sulfides of the walls of the zone, the galena and sphalerite, were readily replaced by the tetrahedrite. Replacement of the fragments in the breccia, was, however, rare, perhaps because of an impervious layer of quartz on their surface. The tetrahedrite carries at least 87 oz of silver per ton but because of its comparatively small bulk probably does not exceed galena in its importance as a silver mineral. In addition, the tetrahedrite contains a small amount of arsenic.

The various minerals from the Almeda specimens were separated by hand and assayed. The following results were obtained:

	oz/ton Silver	oz/ton gold
Galena	28.14	0.06
Pyrite	2.56	1.04
Sphalerite	1.08	trace
Tetrahedrite	87.72	0.04

	% arsenic	% antimony
Tetrahedrite + some quartz	0.75	9.50

"Swakum mountain"

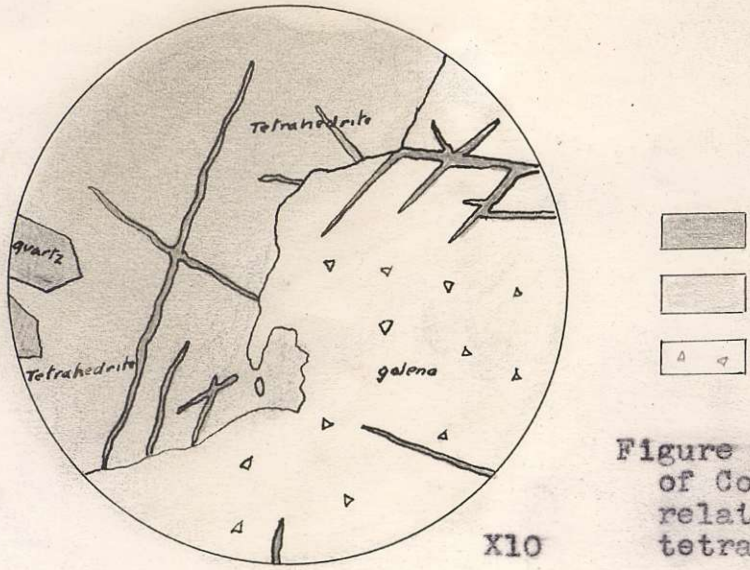
A short distance south of the Almeda property and about one third of a mile east of the summit of Swakum mountain is an open cut on a narrow fissure vein in the Swakum formation. The following minerals were noted: quartz, ankerite, calcite, pyrite, galena and sphalerite. The quartz was an early mineral developing in comb structures crystals from 2mm to 10mm long. Pyrite replaced either the quartz or the ankeritized wall rock as did the galena. Sphalerite replaced only the wall rock. Calcite developed crystals in the open spaces at the terminations of the comb-quartz crystals.

Gold Gossan

Another property, the Gold Gossan occurs on the limestone horizon of the upper Nicola formation just west of the summit of Swakum mountain. This deposit was not visited by the writer and no information is available on it from the minister of mines reports.

Corona (or Verona)

Occurring again on the limestone horizon of the upper Nicola formation, this time on the west limb of the anticline, is the Corona (also known as the Verona) property. This deposit has been explored by a vertical shaft, now flooded, and numerous open cuts. The following minerals were observed: quartz, calcite, galena, tetrahedrite, azurite and



X10

Figure 5. Polished section of Corona ore showing relations of quartz, tetrahedrite and galena.

malachite. Quartz occurs in two generations, either as euhedral crystals later surrounded or replaced(?) by tetrahedrite and galena, or as veinlets cutting both the tetrahedrite and galena. In the galena, these veinlets are parallel to the cleavage directions, in the tetrahedrite they have random orientations, but no veinlet was found to pass across the contact of the two minerals. The irregular contact of the tetrahedrite and galena indicates that replacement was involved in the mineral deposition but the relative ages of each sulfide is not clear. Azurite and malachite are oxidation products of the tetrahedrite.

<u>Thelma</u>

The Thelma deposit occurs as a replacement within the limestone horizon of the upper Nicola formation. It has been explored by two shafts one 200' deep and the other over 100' deep, and open cuts, drifts and crosscuts along a length of almost 2000'. The ore is not continuous over this length and it is possible that the limestone bed itself may be discontinuous as it lies immediately below the Jurassic unconformity. In the vicinity of the shafts, the deposit consists of one or more high grade shoots within a much less valuable replacement body. Veinlets, composed largely of pyrite, penetrate from this deposit into the basal member of the Swakum formation. An assay from a crosscut driven from one of the shafts into a 4½ foot vein gave silver 95 oz/ton, gold 0.04 oz/ton, lead 8% and zinc 1%.

The following minerals have been observed in the sections: quartz, galena, sphalerite, tetrahedrite, pyrite. Marcasite and native silver have also been reported from the property but none was observed.

Pyrite, an early mineral, is scattered in small quantities through the specimens, but composes a large fraction of the vein matter in the basal flow-agglomerate of the Swakum formation.

Sphalerite has a dull brown color and a rather poor lustre, and occurs as distinct masses, made up of a number of small crystals from 1mm to 5mm in diameter.

Galena is found replacing either the pyrite or sphalerite, again in relatively small masses up to 10mm across.

Tetrahedrite replaces the sphalerite but its relations with the galena are not clear.

Secondary minerals include a small amount of cerrusite, malachite and limonite.

Conclusions

All the mineral deposits examined show, considering the two distinct types of deposits, a remarkable similarity in their mineral assemblage. It can safely be assumed, therefore, that, with the possible exception of the Lucky Mike, the solutions responsible for the deposits were similar in composition and in all probability derived from the same magmatic source. Deposition of minerals from these solutions was possible in either the easily replaceable limestone or in open fissures in the more brittle lavas.

Although it must be admitted that the final factors involved in the concentration of the solutions and the deposition of the minerals are not properly understood, the following suggestions may be of value in further development or prospecting within the area.

1. Ary limestone bed may be a favorable site for a replacement body. Where, however, the limestone horizon of the upper Nicola formation lies immediately below the Jurassic unconformity, its continuity cannot be depended on, and the deposits are liable to be small.

2. Tensional fractures, or shears may be favorable for mineralization. The mineralized fissures already noted (Almeda and "Swakum mountain") are apparently genetically related to the development of the anticline and adjacent syncline. The fractures are in all probability concentrated close to the axes of the folds, especially where the folding has been intense.

3. From a standpoint of value of the associated precious metals, the important minerals of the area are tetrahedrite and galena for silver and pyrite, which is confined chiefly to fissure veins, for gold.

Bibliography

Geology

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Lucky Mike

B.C.Minister of Mines Report 1917 - pages 233, 450
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B.C.Minister of Mines Report 1924 - page 136
B.C.Minister of Mines Report 1927 - page 213

Almeda

B.C.Minister of Mines Report 1924 - page 136
B.C.Minister of Mines Report 1925 - page 183
B.C.Minister of Mines Report 1927 - page 213

"Swakum mountain"

None

Gold Gossan

None

Corona (or Verona)

B.C.Minister of Mines Report 1928 - page 515
B.C.Minister of Mines Report 1934 - page D23
B.C.Minister of Mines Report 1935 - page D14

Thelma

B.C.Minister of Mines Report 1926 - page 199
B.C.Minister of Mines Report 1927 - page 213
B.C.Minister of Mines Report 1928 - page 224
B.C.Minister of Mines Report 1929 - pages 246, 440
B.C.Minister of Mines Report 1930 - page 207
B.C.Minister of Mines Report 1934 - page D23
B.C.Minister of Mines Report 1935 - page D14

Reference to Specimens

Lucky Mike

No specimens

Almeda

Hand Specimen 1. - Pyrite and quartz

Hand specimen 2.- Pyrite and quartz, pyrite shows distinct cleavage

Hand specimen 3. - Quartz, pyrite, sphalerite, galena and tetrahedrite; second generation of quartz.

Hand specimen 4. - Quartz, pyrite, sphalerite, galena and tetrahedrite; showing sulfide breccia

Polished section 1. - From hand specimen 4, shows sulfide breccia

Polished section 2. - From hand specimen 3, shows pyrite, sphalerite and some galena, cut by a second generation of quartz

Polished section 3. - From hand specimen 1, shows quartz and pyrite

Thin section - From hand specimen 4; showing sulfide breccia, matrix and tetrahedrite

"Swakum Mountain"

Hand specimen 5. - Three parallel fissure veins with comb quartz, pyrite, sphalerite, galena, calcite and ankerite.

Gold Gossan

No specimens

Corona

Hand Specimen 8 - Quartz, galena, tetrahedrite, azurite and malachite

Polished section 6 - From hand specimen 8; shows quartz, galena, tetrahedrite and malachite

Thelma

Hand specimen 6 - Galena, sphalerite, tetrahedrite, quartz

Hand specimen 7 - Galena, sphalerite, tetrahedrite, quartz, pyrite

Polished section 5 - From hand specimen 6; galena, sphalerite, tetrahedrite, quartz

Polished section 6 - From hand specimen 7; galena, sphalerite, tetrahedrite, pyrite, quartz