# HIGHLAND BELL, LIMITED



An Essay submitted during the
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University of British Columbia

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Dr. H. C. Gunning
Dean of the Faculty of Applied Science
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Vancouver 8, British Columbia

Dear Sir:

Enclosed you will find two copies of my summer essay "Highland Bell, Limited". This essay has been rewritten and is submitted as my Geology 398 Essay to comply with the requirements for summer essays as set forth on pages 240 and 245 in the Calendar of the University of British Columbia for the Thirty-Ninth Session.

The appendices in my original essay are applicable also to this essay. Although they are listed in the contents of this essay, they are not included because they were retained by the University when my original essay was submitted for marking.

Yours sincerely,

J. Werner

## CONTENTS

## ILLUSTRATIONS

## PREFACE

This essay is based on personal experience and on reading. The experience was gained while I was employed by Highland Bell, Limited, at Beaverdell, British Columbia, for the period from September, 1952, to April, 1953. While I was working at Highland Bell, Limited, I developed an interest in the geology of the mine and of the Beaverdell district, so that when I came to write this essay the reading material was supplemented by observations made during my stay at Beaverdell.

Additional pertinent data for this essay were obtained during a field trip to the mine in May, 1954, as part of the Geology 410 Field School course.

I wish to express my sincere thanks to Dr. W. H. White, Professor of Geology, at the University of British Columbia, who read and constructively criticized my original essay.

JWerner

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# HIGHLAND BELL, LIMITED

## Introduction

This essay will deal with some points of general interest about the mine owned by Highland Bell, Limited. The general geology of the mine area and the economic geology of the mine will be the main features dealt with, and will be followed by a description of the ore minerals. An historical outline will be included, and to round out this essay the mill and the mine and their operations will be described briefly.

Highland Bell, Limited, is at present the only producing mine on Wallace Mountain. The mine is three and one-third miles by road east of Beaverdell, British Columbia.

## Location

The town of Beaverdell is situated in the valley of the Westkettle River within the southeast corner of the interior plateau of

British Columbia. It is in the Greenwood Mining Division fifty-one miles north of Greenwood on the Kettle Valley line of the Canadian Pacific Railway. Most of the mines of the district are in a belt one and one-half miles long and one-half mile wide on Wallace Mountain, directly east of Beaverdell.

Highland Bell, Limited, operates a silver-lead-zinc mine, the ore from which is processnd in a mill three-quarters of a mile beyond Beaverdell on a spur of the Kettle Valley Railway. The Westkettle River flows one-quarter of a mile northeast of the mill.

## Historical Outline

Highland Bell, Limited, is the result of an amalgamation in 1936 of two operating companies, Bell Mines, Limited and Highland Lass, Limited. For the next ten years the mine was successfully operated. In March 1946, Leitch Gold Mines, Limited, a Toronto group, obtained effective control of Highland Bell, Limited, and an adjoining mine, the Sally. The properties were combined and operationa continued as Highland Bell, Limited.

Interest in Wallace Mountain was due initially to gold-seeking prospectors using the Westkettle valley in their rush to the Thompson in 1857. Gold was discovered in the district in 1859, and in 1900 development work began. To date over five million dollars worth of ore have been taken from Wallace Mountain.

Geological structure has complicated the search for ore, so much so, that at times in the history of the mine further mining operations were doubtful. The complex structures of the ore-bearing zones of Wallace Mountain have offset and interrupted the ore so that rarely is it continuous for more than a few tens of feet. However, some oreshoots have been exceptions and have been fairly continuous for distances of a few hundreds of feet. Even these are cut and offset by a few faults. At depth the ore formatian has some features similar to those found at the old gold workings at Carmi, a few miles north from Beaverdell, but the lack of final terminating structhres and no downward changes in minerology do not indicate a bottom for the general ore zone.

Beaverdell has been a silver-mining centre for more than fifty years, but prior to 1950 no milling had been done on Wallace Mountain. Crude ore had been sorted out underground or in sorting sheds at the portals. Then the sorted ore had been sent directly to a smelter. Many large dumps of lower-grade material mixed with waste have thus accumulated on the surface. Underground other large amounts of waste and low-grade material were used as backfill in some of the cut-and-fill stopes.

In 1950 a mill with a rated capacity of fifty tons per day was constructed by Highland Bell, Limited.

Occasionally low-grade materials from surface dumps and abandoned stopes is shipped to augment the regular mine output and to assist in maintaining daily mill tonnage.

## The Mill

Mill operations to treat the silver-lead-zinc ore from the Highland Bell mine were started on September 9, 1950. The ore is trucked from the mine and is dumped from a ramp into the coarse-ore bin. The crushing plant consists of a coarse-ore feeder, a coarse-ore conveyor, a screen, a pick-up belt, a jaw crusher, an exhaust fan, and a fine ore conveyor which discharges fine ore to the fine ore bin.

The mill consists of a fine-ore feeder which supplies a ball mill, a duplex jig, and a rake classifier in a closed circuit. The classifier overflow is pumped to six flotation cells which selectively float the lead-silver ores. The suppressed zinc ores then pass through a four-foot diameter conditioner to six flotation cells which float the zinc ores. Both the lead-silver and the zinc concentrates are filtered by a four-foot, four-disc filter and then drop into concentrate storage bins. The jig products are sacked, and the tailings are dumped into a tailings pond outside the mill. All the concentrates are shipped to the Consolidated Mining and Smelting Company of Canada Limited smelters at Trail.

## The Mine

Compressors, power plant, steel shops, and ore transfer bins are at the portal of Number 4 level. This is the main haulage level and it is at an elevation of 3,976 feet. Number 7 and Number 8 levels are connected with Number 4 level by a thirty-four degree winze. A second winze connects Number 8 level with Number 9 and Number 10 levels. The other levels in the older section of the mine are now abandoned. Open stoping, shrinkage stoping, and cut-and-fill stoping are the main mining methods employed in the Highland Bell mine. Broken ore is scraped into chutes or loaded directly into one-ton ore cars. The cars are hauled up the winzes, two at a time, and then to the surface. Then they are dumped into a transfer chute from which the ore is loaded into trucks.

At present the principal mining operations are carried on in the Highland Lass mine. Extensive workings on several of the company's claims are abandoned and partly caved but geological work is done occasionally in some of these workings.

## General Geology of the Mine Area

Dr. Leopold Reinecke reported on the Ore Deposits of the Beaverdell Map-Area for the Geological survey of Canada[1]. Map Number 37A[2] accompanies this report. Another report of note on Silver Mineralization at Beaverdell, B. C., is by N. E. McKinstry[3]. Maps Number 538A and Number 539A[4] contain the results over a larger area of further work done for the Geological Survey of Canada. The most modern and most comprehensive report on the geology of the mine area is by Dr. W. H. White[5].

Prior to Dr. White's report, which covers the Beaverdell silver camp, Dr. Reinecke's report, which covers the Beaverdell map-area, was the most detailed geological work done about Beaverdell. Although according to standards of today Dr. Reinecke's work appears to be in part a sea of verbiage the date of his work must be kept in mind. He ranks

1) Memoir 79, G.S.C., 1915.
2) The topographic work for Map Number 37A was begun in the autumn of 1909 and the final report, Memoir 79, G.S.C., was prepared in the winter of 1914.
3) Economic Geology, Volume 23, 1928, pages 434 to 441.
4) Maps Number 538A and 539A, 1939, have the geological compilation done by C. E. Cairnes, 1936.
5) B. C. Minister of Mines Report for 1949, pages 138 to 148.

high among his contemporaries. Dr. White disagrees with Dr. Reinecke on some technical points, but Dr. White's work is the more recent, more detailed, and hence the more acceptable source material for this essay. It is for this reason that the long quatations that are used here are taken from Dr. White's report.

About the general geology Dr. White writes in part as follows: "The western half of Wallace Mountain is an instrusive mass mapped by Reineke[6] as part of a larger, very irregular body known as the 'Westkettle Batholith'. East of the sinuous contact that trends northerly and dips gently eastward lie metamorphosed sedimentary and volcanic rocks of the Wallace formation that partly 'roof' the intrusive mass. Reineke mapped as 'Beaverdell batholith', intruding the Westkettle batholith, a stock-like mass about 1 mile in diameter found at Beaverdell and apparently extending westward across the valley beneath the valley fill. Large exposures of the Beaverdell batholith occur elsewhere in the district."

"The Westkettle batholith," continues Dr. White, "as seen in the productive belt of Wallace Mountain is composed of an even-grained granitic rock having an average grain size of about 1½ millimetres. It has a speckled grey appearance, due to approximately equal amounts of dark- and light-coloured grains. Some of the feldspar has a pinkish tint. The productive veins of the camp are found only in the rocks of the Westkettle batholith. This rock, according to the classification used by the Department of Mines, is granodiorite." It was classified by Reinecke as quartz diorite.

6) Reineke is the incorrect spelling used for Reinecke in the B. C. Minister of Mines Report for 1949.

"The Beaverdell stock," says Dr. White, "is light-coloured pinkish rock resembling granite, having a grain size of about 5 millimetres. Rock of similar appearance in hand specimens, locally termed 'aplite', is fairly common in the mine workings as discontinuous lenses and dykes." The Beaverdell stock was classified by Reinecke as quartz monzonite.

Going on to discuss minor intrusives Dr. White writes that "Minor intrusives in the productive belt of Wallace Mountain include dykes of at least three different ages. The oldest are the discontinuous pink aplite dykes, mentioned above, which have various strikes and commonly have gentle dips. The next oldest is a very fine-grained chocolate-brown dyke. It cuts an aplite dyke and in turn is cut by a dark-green dyke, which is somewhat amygdaloidal and has phenocrysts of augite and plagioclase. A similar dark-green amygdaloidal dyke, about 30 feet wide, known as the 'Idaho dyke', occurs in the Highland Lass mine, where it is subparallel to the vein. Apparently the Idaho dyke was emplaced during the period of mineralization."

Faults are of major importance at Highland Bell and about them Dr. White writes: "The most striking geologic feature of Wallace Mountain is the multiplicity of the faults; some are pre-mineralization in age, some are mineralized, and many occurred later than the mineralization. Some later movement has occurred on nearly all faults and may obscure the time relations. The fault pattern is complex, and as the faults cut and displace the ore-bearing parts of the veins, consequently knowledge of the fault pattern is of great importance in searching for and in mining ore. The faults have been classified in five types on the basis of faults having common orientation, kind of movement, and age relationship."

Table 1 is a tabulation of some of Dr. White's statements of fault classification.

Table 1

Fault Classification

| Type | Description and Remarks |
| --- | --- |
| 1 | High-angle, Northerly Striking, Normal Faults<br>These faults strike from north to north 20 degrees east and dip from 85 to 50 degrees eastward. All appear to be younger than the ore. Several such faults, on which the movement probably amounts to hundreds of feet, cut the productive belt of Wallace Mountain into several large blocks. |
| 2 | Low-angle, Northerly Trending, Strike-slip Faults<br>Dips range from 18 degrees to as much as 50 degrees westward. Striations on fault surfaces are essentially horizontal. Although late movement has occurred on most of these low-angle faults, it is thought that they originated prior to the period of mineralization. |
| 3 | Northeasterly Striking, High-angle, Normal Faults<br>Faults of this set, dipping at moderate angles to the northwest, are numerous and constitute the most serious obstacle to systematic mining and exploration. In many cases these faults are spaced but a few feet apart, chopping the veins into short segments, each of which has moved downward to the northwest. The relative age of these faults is not everywhere evident. In most places the veins are cut by the normal faults and drag ore can be seen in the fault plane. On the other hand, there is some evidence that the original movement on these faults antedated the period of mineralization. |
| 4 | Northeasterly Trending "Slice" Faults<br>Further complications arise from the presence of faults which cut across the veins, making very acute angles with them in both strike and dip. The ore appears to pinch out gradually along some slice faults, but others simply cut the ore. It appears that the slice faults are in part pre-ore in age and may have had some effect on the distribution of mineralization. |

| | |
|---|---|
| 5 | Cross-faults<br>These northerly striking faults, dipping in either direction, cause either small normal or reverse displacements of the orebodies. |

## Economic Geology

Drawing further from Dr. White's excellent report he says about the controlling geological structures that "The mine is in a fault block some 1,300 feet wide in an east-west direction, bounded by Type 1 faults, known respectively as the West and East Terminal faults. There are not final terminating structures because they are clearly younger than the ore deposits. However, the West Terminal fault effectively isolates the orebodies of the Highland Lass mine from those of the adjoining Bell mine, and on the East Terminal fault the contact of the granodiorite and the overlying Wallace rpcks is down-faulted an undetermined distance below explored horizons. The contact of the Wallace rocks and granodiorite constitutes a third terminating structure, in this instance of a final nature because the veins pinch out in the Wallace sediments within a few feet of the contact."

"The veins," writes Dr. White about the mineralization, "are in zones of altered granodiorite or sodic granite up to 50 feet wide, locally known as 'ore ground'. These zones are easily recognized and are important guides to exploration. While still retaining its granitic texture, the altered rock is soft and appears speckled with small purplish blotches. The ore occurs in simple veins, composite branching veins, and stringer lodes. The oreshoots generally range in width from a few inches to several feet and average about 12 inches, but massive ore several feet wide and stringer lodes as much as 15 feet wide have been mined. Commonly the veins have a banded structure produced by rude parallelism of sulphide stringers. Undulating fault surfaces bound the veins. The walls for distances of 1 to 5 feet from the veins are soft, brecciated or sheared rock, highly altered and containing much clayey mud or gouge."

The zones in which the veins are found are called by Dr. Reinecke mineralized shear zones. Metallic ore deposits also occur as stocks and contact metamorphic deposits, but only the mineralized shear zones have been mined at a profit.

The remainder of this section on economic geology is essentially a condensation of part of Dr. White's report. This is done to reduce the information of his more extensive work to within the limits and scope of this essay.

The main veins, or vein segments are referred to as the "Lass lode." It has been followed on nearly all levels to the Wallace contact, and many of the largest and richest stopes were within 400 feet of the contact. Ore shoots, disrupted by only a few faults, and fairly continuous for horizontal distances ranging up to 500 feet, have been mined.

A short distance below Number 7 level the Lass lode is cut by the Mid-Mine fault, which strikes north 30 degrees east and dips from 55 to 60 degrees northwest. This is a normal fault having a dip slip of about 160 feet, which is very much greater than that of any other fault of this type in the mine.

The main stope in the area southeast of the Mid-Mine fault, in which section the structure is far more complex than in the upper parts of the lode, has been developed extensively.

The Idaho dyke zone is in part a pre-mineralization structure and may have had an important effect on the distribution of mineralization. A group of veins known as the "Idaho lode" is in ore ground southeast of the Idaho dyke zone. This lode has a general mineralogic similarity to the Lass lode, yet is sufficiently different in its structural features to suggest that it is a distinct lode rather than the faulted contimuation of the Lass lode. Native silver is particularly prominent in the lower levels of the Idaho lode. The Idaho lode has not been completely explored.

## The Ore Minerals[7]

The silver minerals in the veins are freibergite, pyrargyrite, polybasite, acanthite, and native silver. Galena, sphalerite, pyrite, and tetrahedrite are associated with them, as well as much less widespread arsenopyrite and chalcopyrite, in a gangue of quartz, calcite, and sericitic remnants of wall rock. The mineralogic changes include abundant development of sericite and kaolin, calcite, chlorite, epidote, and hematite. Specular hematite, molybdenite, and scheelite have been found, but they are rare. Ankerite or siderite have been noted, and fluorite is found with specimens of native silver and acanthite. Stephanite and the arsenical silver minerals have been suspected but not identified.

7) The following statements on ore minerals have been obtained almost entirely from the report by A. B. Staples and H. V. Warren on Minerals of the Highland Bell Mine, Beaverdell, British Columbia.

Freibergite (argentian tetrahedrite) is dull-grey and fine-grained in the Highland Bell ore, and is consequently rather inconspicuous in hand specimens. It is generally disseminated in the ore. Much of the tetrahedrite is too finely disseminated to be detected by the naked eye, but occasionally it occurs in masses large enough to be seen. In such cases it is closely associated with galena and difficult to separate from this mineral.

One of the best known and most conspicuous of the silver minerals in the mine is pyrargyrite. It occurs disseminated in various other minerals, massive in lenses and stringers, and as crystals in vugs and irregular cavities. Pyrargyrite is an important contributor of silver. The host minerals are galena, and more rarely, sphalerite, freibergite, and quartz.

Polybasite was not recognized in the early days of the camp, partly because the mineral is rere in Canada and consequently not expected, and partly because it may be mistaken for tetrahedrite. Like pyrargyrite it occurs disseminated, massive in lenses and stringers, as crystals in vugs and cavities, and as a coating on other minerals. Disseminated polybasite is less conspicuous than disseminated pyrargyrite, but it probably contributes largely to the silver value of the ere.

Acanthite has been found in all levels of the mine. It occurs principally as coatings along joints and minor faults, and as masses and crystals in vugs.

Although specimens of native silver of a pound or two have been found in the mine, the native metal is net the most important contributor of the silver value of the ore. Evidently it is of primary origin and is found throughout a vertical range of at least 1,000 feet. It occurs in cavities, along joints, faults, and slip planes, and disseminated in massive sulphides and sulpho-salts. In cavities native silver is found "growing" in arborescent and wiry forms with reddish-yellow tarnish, from massive and crystallized acanthite, less commonly from polybasite, and rarely from pyrargyrite. Less conspicuous is the native silver which occurs in shreds, minute grains, and as flakes ("paint").

Sphalerite varies in color from light-amber to black. The amber-coloured material is apparently purer than the black, which shows inclusions of copper, iron, and silver minerals. The copper is probably due to included chalcopyrite, while manganese may explain the black stains which appear to be derived from weathered sphalerite.

Galena is widespread and abundant, usually coarsely crystalline, but also fine-grained. Inclusions of tetrahedrite, pyrargyrite, polybasite, and native silver are found, the last two minerals rarely.

## Conclusion

The complexity of the geology which is due mainly to the many types and multiplicity of the faults encountered, is a very serious obstacle to mining at Highland Bell, Limited. Previously abandoned mines, low-grade fill underground, and low-grade surface dumps may be, in the future, of a grade high enough to make many readily available sources of ore. The West and East Terminal faults are not final terminating structures, nor is bottoming of the ore zone evident. Therefore, bold, progressive, and intelligent investment in all phases of development may return handsome dividends.

It is of interest to know that since this essay was started a new level has been started at an elevation close to the valley floor to come under the existing workings.

WORKS CONSULTED

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4. The Mill Superintendent, The Highland Bell Mill, Western Miner, Vol. 24, pages 94 - 99.

5. Map 37A, Beaverdell, Yale District, Ottawa, Government Printing Bureau, 1915, Department of Mines, Canadian Geological Survey.

6. Map 538A, C. E. Cairnes, Kettle River West Half, Similkameen and Osoyoos District, Geological, Ottawa, King's Printer, 1939, Canada, Department of Mines and Resources.

7. Map 539A, C. E. Cairnes, Mineral Localities, Kettle River West Half, Similkameen and Osoyoos District, Ottawa, King's Printer, 1939, Canada, Department of Mines and Resources.