GEOLOGICAL FEATURES OF THE BEAVERDELL AREA WITH REFERENCE TO THE HIGHLAND BELL MINE

An Essay submitted during the
Third Year of the Course in
Applied Science at the
University of British Columbia

by

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1312 East 41 st Avenue,
Vancouver 15, B.C.,
November 15, 1953.

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

Dear Sir :

Enclosed you will find two copies of my summer essay "Geological Features of the Beaverdell Area with Reference to the Highland Bell Mine". This essay is submitted as my Geology 398 Essay as set forth on pages 240 and 245 in the Calendar of the University of British Columbia for the Thirty - Ninth Session.

Yours sincerely,

JWerner

J. Werner

WWW - It looks like a 25 N 50 in your part. 60

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Proc.	35	15
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PREFACE

This essay is based both on personal experience and on reading. The experience was gained while I was employed at Highland Bell Limited for the period from September 1952 to April 1953. While I was working under - ground I developed an interest in the geology of the mine where I was able to obtain firsthand information which I have supplemented with raeding material to expand this essay.

J W emer

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Purpose and Scope of This Essay

This essay will be a general consideration of some of the geological features and mineralization in the vacinity of Beaverdell, British Columbia. Particular reference will be made to the Highland Bell Limited, the only producing mine now on Wallace Mountain, three and one - third miles by road from Beaverdell.

Much complex faulting, successive intrusions and consequent metamorphism, unconformable deposition, glacial drift, and recent alluvium, make the geology of the district around Beaverdell very complicated. However, the immediate vacinity and beyond is well enough mineralized that there has been production from Wallace Moutain for over half a century. This was initially due to the rush of gold - seeking prospectors using the Westkettle valley on their way north to the Thompson (1857); the discovery

of gold in the district (1859); and the beginning of developement work in 1900. Continued interest will undoubtably maintain production, although it must be slow by reason of the geological difficulties encountered.

Location

The village of Beaverdell is ~~situated~~ in the valley of the Westkettle River within the southeastern corner of the interior plateau of British Columbia. Beaverdell is in the Greenwood Mining Division, about twenty - five miles east of Penticton and about thirty miles north of the International Boundary. It is on the Kelowna to Rock Creek road, fifty - five miles southeasterly of Kelowna and thirty - two miles northerly of Rock Creek. Approximately two - thirds of the district is rolling upland, the remainder consists of steep-sided valleys with flat terraced bottoms, and the streams within them are of low grade.

The Highland Bell Limited operates a producing silver, lead, zinc mine on Wallace Mountain, one mile ~~from~~ east of Beaverdell. Ore ~~from the mine~~ is processed in a mill three - quaters of a mile further away on the Kettle Valley line of the Canadian Pacific Railway, 344 miles east of Vancouver, and 163 miles west of Trail, ~~British Columbia~~. ~~The Westkettle River with its heavily timbered valley~~ flows one - quarter of a mile ~~northeasterly~~ of the mill.

General About Highland Bell Limited

Highland Bell Limited is the result of an amalgamation in 1936 of two former operating companies, Bell Mines Limited and Highland Lass Limited. In March 1946, after ten years of successful operation, Leitch

Gold Mines Limited, a Toronto group of which Mr. K.J. Springer is president, obtained effective control of Highland Bell Limited and an adjoining mine, the Sally. The properties were combined and operations continued as High - land Bell Limited.

Prior to 1950 no milling had been done on Wallace Mountain, but crude ore after sorting out underground or on the surface, had been shipped directly to a smelter. This practise has resulted in the accumulation of numerous large dumps of mined lowgrade material ~~more or less admixed with waste from developement headings~~ and development waste. Other large quantities of waste and of low grade ore sorted out underground, remain in the mines as packwalls, where they where used in place of timbers.

In 1950 a mill was constructed. Mill operations ~~were started~~ began on September the ninth of that year. The capacity of the mill is fifty tons per ~~diem~~ day. ~~and treats a silver, lead, zinc~~ Mill Feed averages ore containing fifty - five to sixty ounzes per ton of silver, one to two per cent of lead, and two to three per cent of zinc.

Capacity treats ?

~~The~~ ore ~~is~~ tructed from the mine ~~and~~ is dumped from a ramp into the coarse ore bin. It then passes through a primary jaw crusher into the fine ore bin, then through a ball mill, mineral jig, and ~~rack~~ Ke classifier, in a closed circuit with the ball mill. ~~The overflow from the~~ classifier overflow is pumped to a battery of floation cells in which the lead and silver ~~ores~~ minerals are selectively floated. The suppressed zinc ~~float~~ then passes through an agitator to the zinc floation cells. Both concentrates are filtered into concentrate bins. The jig products are sacked for shipment, and the tailings are dumped just outside the mill. About eight to twelve tons of jig concentrate, ~~about~~ fifty tons of lead concentrate, and ~~about~~ thirty tons of zinc concentrate are shipped monthly.

The concentrates ~~produced~~ are now all sold to the Consolidated Mining and Smelting Company of Canada Limited. They are loaded directly into boxcars on a rail spur from whence they are shipped directly to the smelters at Trail, British Columbia. The recovery ~~of minerals is~~ ranges from nintey - five to nintey - seven per cent, ~~with~~ and net smelter returns ~~of~~ range from eighty to eighty - two per cent ~~of the mill head value~~.

In all, more than over five million dollars of ore have been taken from Wallace Mountain. For production ranging over better than half a century this may not seem at all noteworthy, yet when the extreme difficulties of the geological situation are realized this is truly a significant amount. It is also interesting to know that all of the silver mined at Highland Bell Limited is eventually sold to Eastman Kodak Limited.

General Geology

The geological formations of interest and within the scope of this essay are ~~the rocks of~~ the Wallace group, the Westkettle batholith, and the Beaverdell batholith.

The oldest rocks of the district are those of the Wallace group, parts of which have been correlated ~~on the ground of~~ by lithological and stuctural similarities with the Phoenix volcanics and with the upper Triassic - ~~Jurassic~~ Nicola group. The Wallace group is made up of a complex of rocks of which over nintey - five per cent are of igneous origin. The oldest are white to grey, coarse, crystalline limestone, and fine - grained grey hornfels. Over these lie banded, dense, hornblende andesite tuffs of var - iegated colour, and dark grey andesite lavas. A number of basic coarse - grained intrusives are probably of the same age as the andesite. The youngest members of the group are dykes of grey hornblende diorite porphyry.

Nearly all the igneous rocks weather to a rusty brown.

All of the Wallace group has been metamorphosed; the limestones recrystallized, the calcite was replaced in part by contact metamorphic minerals, and the hornfels and andesites recrystallized. The most intense mashing is shown by the schists of the group. ~~As well~~, the whole group has been faulted and partially brecciated.

The Westkettle batholith of quartz - diorite intrudes the Wallace group. This batholith has been referred to the Jurassic, and is gneissic in certain places near many of the contacts of the younger Beaverdell quartz - monzonite, and near its centre. The Westkettle batholith has been severely metamorphosed along certain shear planes and has been block faulted, presumably due to vertical ~~strain rather than lateral thrust~~.

The Beaverdell bahtolith of quartz - monzonite follows the Westkettle batholith orogenically and is unfoliated. It is considered to be Eocene. Large pink orthoclase phenocrysts characterize the rock. Mineral composition varies vertically in the Beaverdell quartz - monzonite, and it is faulted generally in a direction east of north, although otherwise comparatively unaltered.

Economic Geology

Metallic ore deposits of the Beaverdell district are of three types. Of these only the "mineralized shear zones" have been mined at a profit and will be mentioned here. The other types are "Stocks" and "contact metamorphic deposits".

The shear zones carry values in silver and consist of galena,

sphalerite, pyrite, tetrahedrite, pyrargyrite, polybasite, and acanthite, in a gangue of quartz and sericite; native silver, calcite, chlorite, and kaolin are secondary. There are also in the shear zones dykes of andesite and aplite intruded prior to the ore formation. These dykes lie between two well -defined walls and partly replaced fragments of country rock, quartz, and the ore minerals.

The ore - bodies are tabular in shape and vary rapidly in value in a lateral direction, that is, they are pockety. Many closely spaced faults which strike north by west to northeast and generally dip to the west have displaced the ore. Glacial action is thought to be responsible for the practical absence of oxidized material on the surface. As a result the depth of the zone of oxidation is not great.

Hot ascending solutions derived from the magma of the Beaverdell quartz - monzonite bahtolith formed the shear zone ore- bodies. They passed freely through the well - defined fractures of the Westkettle quartz - diorite, to be deposited in cavities in the shear zones. The Wallace group stopped further circulation of the solution, As well, the tight blanketing by the Wallace group increased pressures and temperatures very greatly. The results give an anomoly of deposits formed at depths between 4,000 and 12,000 feet, whereas deposition occurred at depths actually not over 2,000 feet. Deposition was partly metasomatic replacement, but more largely by cavity filling. The ore - bodies formed in this way are probably of Eocene age. They are preceded by Epcene quartz - monzonite in the Eocene, followed by a period of north - south faulting in the Oligocene, and closely following the intrusion of the Beaverdell batholith.

The Ore Minerals

The ore-bearing veins of the Highland Bell Limited lie in the Westkettle quartz - diorite, around the later Beaverdell quartz - monzonite. The veins are from a few inches to a few feet in thickness, with an aver - age of about one foot. The silver minerals in the veins are freibergite, pyrargyrite, polybasite, acanthite, and native silver. These minerals and the sphalerite and gelena associated with them are all described below. Quartz and pyrite are found in abundance, but calcite and arsenopyrite are less widespread. Specular hematite, molybdenite, and scheelite have been found, but they are rare. Ankerite or siderite have been noted, and fluorite is found with samples of native silver and acanthite. Stephanite and the arsenical silver minerals have been suspected but not identified.

Freibergite (argentian tetrahedrite) is dull grey and fine - grained in the Beaverdell ore, and consequently rather inconspicuous in hand specimens. It is generously disseminated in the ore. A black mineral with high metallic lustre, resembling some occurrences of tetrahedrite, proves to be polybasite. Much of the grey copper ore (tetrahedrite) is too finely disseminated to be detected by the naked eye; but occassionally it occurs in masses large enough to be seen. Insuch cases it is closely asso- ciated with gelena and is difficult to separate from this mineral. Assays run up to twenty - six per cent silver and are remarkable in their high values, as compared to the range of silver, five to eighteen per cent, in analysis oftypical argentian tetrahedrite. The economic significance of this tetrahedrite can be appreciated when it is realized that one per cent of this mineral will give a silver value of seventy - five ounzes per ton.

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. Although disseminated, pyrargyrite is an important contributor of silver. The host minerals are galena and more rarely, sphalerite, freibergite, and quartz. The lenses and stringers of this mineral are ~~are~~ for the most part only a few feet long, a few feet high, and from a fraction of an inch to two or three inches thick, and occassionally yield magnificant specimens. Smaller bodies grade down to the dimensions of the disseminated material.

Polybasite was not recognized in the early days of the camp, partly because the mineral is rare in Canada and cosequently not expected, and partly because it may be mistaken for freibergite. Like pyrargyrite, it occurs disseminated, massive in veinlets and stringers, as crystals in vugs and cavities, and also as a coating. Disseminated polybasite is less conspicuous than disseminated pyrargyrite, but it probably contribytes largely to the silver value of the ore. The largest veinlets and stringers might reach a foot or two in length and a quarter of an inch in thickness; much commoner are bodies an inch wide and a sixteenth of an inch thick.

Acanthite was formerly taken to be argentite at the Highland Bell Limited. It has been found from top to bottom of the mine. This mineral 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 Highland Bell Limited, the native metal is not the most important contributir of the silver value of the ore. Native silver is of late formation. It occurs in cavities, along joints, faults, and slip planes,

and disseminated in massive sulphide and sulphosalts. 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. The cavities may reach several cubic inches in size and they also contain crystals of quartz, calcite, and fluorite. ~~Less conspicuous is the~~ also silver which occurs less conspicuously as ~~in~~ shreds, minute grains, and as flakes (paint), ~~in both the upper and lower~~ on all levels of the mine.

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

Gelena is widespread and abundant, usually coarsely crystalline, but ~~also~~ some is fine - grained. It is commonly associated with pyrite and sphalerite. Inclusions of tetrahedrite, pyrargyrite, polybasite, acanthite, and native silver are found, the last two minerals rarely.

Conclusion

The district around Beaverdell is an example of some of the most complex geology encountered in the search for mineral wealth. In summary, high temperture replacement deposits are related to adjacent intrusive masses, with their period of formation probably antedating the vein and replacement deposits occurring in fissures and shear zones which intersect the intrusive masses and the intruded formations. However, prospects in the district are many and scattered, with the Highland Bell Limited as proof that mining , despite of the obstacles encountered, and even though

restricted, can be profitably accomplished.

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5. Map 37A, Beaverdell, Yale District, Ottawa, Government Printing Bureau, 1915, Department of Mines, Canadian Geological Survey.
6. Map 538A, Kettle River West Half, Similkameen and Osoyoos District, Geological, Ottawa, King's Printer, 1939, Canada, Department of Mines and Resources.
7. Map 539A, Mineral Localities, Kettle River West Half, Similkameen and Osoyoos District, Ottawa, King's Printer, 1939, Canada, Department of Mines and Resources.

Appendices

I Map of the Beaverdell District.

II Map of the Mineral Localities of the Westkettle River.

Missing