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The Lucky Hit Mine of Jefferson County, Montana

Bruce B. Goddard

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THE LUCKY HIT MINE
OF
JEFFERSON COUNTY, MONTANA

By
Bruce E. Goddard

A thesis
Submitted to the Department of Geology
in Partial Fulfillment of the
Requirements for the Degree of
Bachelor of Science
in
Geological Engineering

MONTANA SCHOOL OF MINES
Butte, Montana
June, 1953
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THE LUCKY HIT MINE, JEFFERSON COUNTY, MONTANA

By

BRUCE B. GODDARD

INTRODUCTION

Many mines in the Cardwell Mining District have been more or less steady producers of gold, silver, lead and zinc since 1850. The area first came into prominence with the discovery of gold at the Mayflower Mine in 1896. Soon after the Mayflower discovery, many claims were located in the nearby Saint Paul Gulch area, northeast of Whitehall. The Lucky Hit Mine is located in Saint Paul Gulch area of the Cardwell Mining District.

The Golden Sunlight Mine in the eastern part of the district and the Mayflower Mine in the southern part have the greatest production records. These mines have produced in excess of $7,000,000 in gold and silver. For many years, lessees have operated the Carbonate Group of claims, which are in the northern part of the district, for their lead-silver ores. The New Deal Mine, near the mouth of Saint Paul Gulch, produced manganese oxide ores during World War II.

Since the Lucky Hit Mine is an operating mine producing ores of gold, silver, lead, copper and zinc, and is situated in a mineralized portion of the Cardwell Mining District, it was chosen for a thesis problem by
the author as a partial fulfillment of the requirements for the Degree of Bachelor of Science in Geological Engineering. The necessary field work and research was done in the winter and spring of 1952-53.

The author hopes that the thesis may be of interest to Mr. George Wolfe, the owner of the Lucky Hit Mine, who so kindly allowed the examination. Also, the author wishes to thank Professor W. S. March, of the Geology Department at the Montana School of Mines for his help and suggestions in the preparation of this thesis.
LOCATION

The Lucky Hit Mine is located in Section 19, T.2.N., R.3.W., about seven miles northeast of Whitehall, Montana, and may be reached from this community by a county road which serves the various mines in the Saint Paul Gulch area. Whitehall is located on U. S. Highway No. 10, and on the Northern Pacific Railroad.

PHYSIOGRAPHY

The region herein considered is on the west side of Bull Mountain and in the upper part of the south fork of Saint Paul Gulch. Bull Mountain, which reaches a maximum elevation of 7200 feet, extends northward a distance of twenty miles. Saint Paul Gulch extends southwesterly from near the crest of the ridge down the slopes and across benchlands to the Jefferson River.

The topography is one of moderate relief, with gradual slopes and low rolling hills. Mine timber is not available in the immediate vicinity. However, the wall rock in the Lucky Hit Mine is competent and underground timbering is not extensively required. The mine is at an elevation of 6300 feet, so storms are frequent and yearly temperature changes vary as much as 120 degrees. However, winters in the area are usually mild with little snowfall, making continuous year round operations possible.
PLATE I

Photographs of Lucky Hit Mine and Adjacent Area
PLATE I

1. Surface view of the Lucky Hit Mine taken from the west end line of the claim. The head frame is over the Wolfe shaft; the adit was driven into the Melbourne Workings (behind).

2. A view of the workings looking north. Bull Mountain, which extends north towards Basin, Montana, can be seen in the background.
GENERAL GEOLOGY

The Cardwell Mining District lies in the intensely folded and faulted mountain ranges of southwestern Montana. Strata exposed at Bull Mountain vary in age from the Pre-Cambrian upper Belt Series of the Algonkian system to the Cretaceous Livingston Formation. The bedding has a general northwest strike and a flat northeast dip. These sedimentary formations are covered by Quaternary lake beds to the west and to the south of the mountain. Further north, the Mesozoic sediments are capped by Tertiary lava flows. (Fig.2). It is generally believed that the Boulder batholith was intruded into the sediments and earlier Cretaceous andesitic lavas in the late stages of the Laramide orogeny, probably in Paleocene time. Igneous activity has been described as a three phase disturbance which started with Cretaceous andesite flows, followed by a Paleocene granitic intrusion, and ending with Eocene rhyolitic extrusions. A long period of stability followed, during which erosion cut deeply and removed great portions of the sedimentary formations, much of the rhyolite, and leaving only roof pendants of Cretaceous lava flows. Much of this eroded material was deposited in large glacial lakes during the Quaternary period. The lakes were later drained either by stream
MODIFIED AFTER A DRAWING BY A.F. RAMBOSEK

- QUAT. LAKE BEDS
- CRET. LIVINGSTON FM.
- MISS. MADISON LS.
- DEV. JEFFERSON FM.
- CAMBRIAN FMS.
- PRE-CAM. BELT SERIES.
- IGNEOUS ROCK - LATITE.

Scale in miles

0 2
piracy, or by faulting. Subsequent erosion and faulting have given the district its present topographic form.

**BELT SERIES**

The country rock exposed in the vicinity of the Lucky Hit and adjacent claims is the thin-bedded, calcareous shale of the upper portion of the Belt Series of the Algonkian System. This widespread formation is a poorly sorted coarse-grained sandstone, commonly referred to as an arkose. A typical hand specimen has an abundance of angular to subangular rock fragments embedded in a fine grained matrix of clay. According to Pettijohn's classification of arenites (8:227), the Belt sandstone is a graywacke.

**INTRUSIVE PORPHYRY**

The strong fissure vein on the Lucky Hit claim is accompanied by a fine grained light gray porphyry dike that has abundant quartz phenocrysts. Specimens of the porphyry were taken from the mine and thin sections were prepared by Dr. Charles Meyer, and examined by the author for an identification of the rock. However, the porphyry dike had been altered to such a degree by the mineralizing solutions as to make positive identification impossible. The porphyry in all probability is either a rhyolite or a quartz latite dike.
GEOLOGIC MAP of LUCKY HIT MINE

Surveyed January 1953 by Bruce B. Goddard

SCALE 1" = 40'
The groundmass resembles a fine-grained sandstone, a light gray in color, with a very regular texture. The phenocrysts are of well defined quartz grains. The grains are of transparent quartz and are as large as five millimeters in diameter. The pre-mineral dike was emplaced after the granitic intrusion had fissured and sheared the country rock. After the quartz latite or rhyolite intrusion, further cooling of the granitic mass developed the mineralizing solutions that formed the fissure vein. The dike was highly altered, sericitized, and pyritized by these mineral bearing solutions.

The porphyry dike is slightly more resistant to weathering than the enclosing Belt sediments, and can be discerned on the surface. On weathered surfaces, the rock varies between a light-cream to a dark-brown color. A dark-gray lichen grows with profusion on these weathered surfaces.

STRUCTURE

The force of the intruding Boulder batholith and subsequent cooling are believed to have caused fracturing and fissuring throughout the batholith and its margins. These fissures then served as conduits for deep seated ascending mineral bearing solutions. It may
be possible that the calcareous shale of the upper Belt Series, in which the Lucky Hit is located, was fractured by the intrusion and its later cooling, or by regional stresses which are believed to have been in operation during this period of time.

The fissure was first filled with quartz; was then reopened, and later sulphide minerals filled the openings and in part replaced the quartz. The vein strikes N.75 E and dips irregularly 47 to 60 degrees S. The vein varies from 1.0 to 6.0 feet in width and is traced for 2000 feet along the strike. (See Claim Map). In places the fissure is partially filled by a quartz latite porphyry dike which is older in age than the mineralization. The vein filling is mainly quartz with minor pyrite, galena, sphalerite and chalcopyrite. Small amounts of cerrusite and secondary chalcocite were noted. Although the fissure is continuously mineralized, the ore occurs irregularly and in lenticular pockets. The vein weakens to the east, and may pinch out or be faulted, as it has not been found on the Wegener claim. However, there is no evidence of a fault on surface. A blue-gray gouge of crushed country rock forms the walls of the vein, and allows the ore to be mined without wall rock dilution.
CLAIM MAP
OF
LUCKY HIT MINE
Surveyed January 1953
by
Bruce B. Goddard
SCALE 1" = 40'
DEVELOPMENT

Several surface trenches, cuts and pits were dug along the strike of the vein to prove the existence of an orebody on the Lucky Hit claim. (See Claim Map). The Melbourne shaft was sunk to a reported depth of 425 feet. This old shaft and the workings therefrom are now inaccessible, and little is known regarding the amount of work done on that property. The Wolfe inclined shaft, located 130 feet west of the Melbourne shaft was sunk 173 feet on the dip of the vein. At fifty feet below the collar, a drift east was driven and holed the old Melbourne workings. Two other drifts have been advanced from the Wolfe shaft. The first, located 150 feet down below surface, was driven 100 feet west, while the other drift, near the bottom of the shaft, was driven east and west a combined total of 325 feet.

Most of the ore developed by these workings has been stopped, and only a small tonnage of possible ore remains between the face of the drift and the west end line of the claim. This ore will become available by continuing the west drift advance on the bottom level. Also, new ore may be developed by sinking the shaft and driving drifts at a lower elevation.
PLATE II

Photographs of Mine Workings
PLATE II

3. A surface trench that was dug along the strike of the vein to prove the existence of a vein of the Lucky Hit claim.

4. Photograph of a stope on the Melbourne property that was used to mine the ore to surface. Most of the workings of this type have caved making the mine inaccessible in such places.
SAMPLING AND ORE SHIPMENTS

The 150 feet level west drift from the inclined shaft exposed a fairly wide vein of massive sulphides. Samples of remnants of this vein taken from the back of the drift and from the back of a mined stope, averaged 6.8 feet wide, 0.9% copper, 1.2 ounces silver, 0.562 ounces gold, 1.3% lead and 2.6% zinc. A composite sample taken from the lower level assayed 0.55% copper, 2.2 ounces silver, 0.280 ounces gold, 3.0% lead and 2.9% zinc. This assay also constitutes the approximate grade of the ore now being selectively mined and stockpiled for later shipment. The vein varies between 1 and 6.5 feet in width on the lowest level.

Samples taken of the four dumps aggregating 10,000 tons on the Lucky Hit claim average 0.2% copper, 0.8 ounces silver, 0.118 ounces gold, 0.8% lead and 0.8% zinc. This material is too low in grade to constitute shippable ore at present, and the tonnage available in the dumps is too small to warrant the construction of a mill.

PRODUCTION OF THE LUCKY HIT MINE

Since its acquisition by Mr. Wolfe in 1934, the Lucky Hit Mine has had a continuous production of gold, silver, copper, lead, and zinc ores. The mine has produced over 5,000 tons of comparatively high grade gold
ore. During the period between 1937 and 1948, inclusive, over 3500 dry tons of ore were mined and shipped to the smelter. Payments were for assay values between 0.550 and 0.900 ounces gold per ton, 2.50 to 3.00 ounces silver per ton, and from 3 to 4% lead.

MINERALOGY

The mineralogy of the Lucky Hit ores is simple and the major minerals can be readily identified in hand samples. These minerals are pyrite, galena, sphalerite, chalcopyrite, chalcocite, malachite and cerrusite, which comprise 99% of the mineralogical occurrences of all metals. (2). Other minerals may be present, but in such small quantities as to make positive identification beyond the scope of this paper. The minerals were identified by study under the reflecting microscope, substantiated by etch and micro-chemical tests.

The most abundant gangue mineral which is intimately associated with the ore minerals, is a smokey gray quartz. It is found in both the crystalline and massive varieties of ore minerals and is noted in all polished sections. Although quartz is not included in the classification of opaque minerals, it can be easily recognized under the reflecting microscope, by its extreme hardness, and negative reactivity to all chemical etch tests. (5).
PLATE III

5. Photograph of leached, or oxidized rock that was found on surface near vein outcrop (not boxworks).

6. A typical hand specimen of Lucky Hit ore that has been cut to show voids which occurs throughout the rock.
The deposit is a hydrothermal figure-setting vein.

Figure 5

Figure 6

The deposit is a hydrothermal figure-setting vein.
PARAGENESIS

The mineralization sequence for the Lucky Hit ores was determined by studying the mineral textures in polished sections under the reflecting microscope. The size and shape of the individual crystals, and the regularity and outline of their boundaries are factors that are considered in determining this sequence.(5). In observing these factors, it appears that the mode of formation was predominantly replacement. Smooth irregular boundaries and unmatching vein walls further substantiate this view.

The deposit is a hydrothermal fissure-filling which was formed by intermediate temperature minerals. According to Bateman, (2:40) chalcopyrite, galena, and sphalerite are mesothermal-type minerals, and he states that an association of any two of these minerals is diagnostic of intermediate temperature deposits. In the suite of ores examined, quartz was emplaced first, probably in the high mesothermal range of temperatures. Pyrite was the first sulphide mineral to replace the quartz. This relationship was observed in all sections by the smooth crystal boundaries, and well formed pyrite crystals which were developed in the quartz groundmass. Solutions containing zinc attacked the pyrite, and sphalerite was the next mineral developed. The sphalerite was then readily replaced by galena.
Later solutions, carrying copper invaded the sulphide minerals above, and chalcopyrite was developed, apparently the youngest of the ore minerals to be formed. After a preliminary study of the rock, it was believed that solutions carrying zinc and copper attacked the pyrite and crystallized. With a lowering of temperature, this state became unstable, and the chalcopyrite precipitated out as an ex-solution process. However, further investigation revealed evidence that established the chalcopyrite as the youngest ore mineral. After the emplacement of chalcopyrite, no further deposition took place.

Even though the gold values in the ore shipped averaged 0.9 ounces per ton, none could be seen in hand specimens and polished sections of the ore. An effort was made to determine which minerals carried the gold and silver. This was done by fire assaying ore minerals, which had been selectively sorted. However, the results were inconclusive. It is believed that each stage of mineralization emplaced some gold, with the later stages of mineralization (galena and chalcopyrite) contributing the most gold to the ore. The primary sulphide minerals containing the gold were later attacked by a process of chemical leaching, the gold removed, and subsequent secondary enrichment took place. Voids and vugs containing gold probably owe their existence to the removal
PLATE IV

Photograph of Alteration Products
PLATE IV

7. Photograph showing intense sericitization of feldspars, specimen from igneous dike.
of sulphide minerals by circulating ground water.

(Plate III). Most of the gold is deposited below the
leadout section of the vein, in the supposedly enriched
zone, and the amount of gold present has been found to
decrease with an increase in depth.

AERIAL CES RECONNAISSANCE

The picture illustrates the occurrence of stanniferous
pyrite, which carries the most gold, in the ore mineral. If it is found in increased
proportions with other minerals, the gold values will probably
remain high, and rich ore shoots could be worked profitably.

In the Lucky Hit Mine, the vein has been fairly
uniform in width because of its uniform dip. However,
a flattening of dip would produce loci for large, side
of sulphide minerals by circulating ground water. (Plate III). Most of the gold accumulated below the leached portion of the vein, in the secondarily enriched zone, and the amount of gold present has been found to decrease with an increase in depth.

FURTHER ORE POSSIBILITIES

The Lucky Hit vein is a narrow fissure type structure that contains ore of widely varying grade. The ore occurs in small irregular shoots, and selective mining and sorting are required to make a shippable product. Recent mining has been near the bottom of the oxidized or leached zone. The ore now mined on the bottom level contains chalcopyrite, pyrite, galena and sphalerite, with minor sooty chalcocite, malachite and cerrusite. It is now apparent that the ultimate future of the mine will depend upon the values found in the hypogene minerals, although deeper mining of the supergene ore is still possible by establishing a lower level and drifting. Chalcopyrite, which carries the most gold, is a key mineral. If it is found in increased proportions with depth, the gold values will probably remain high, and rich ore shoots could be worked profitably.

In the Lucky Hit Mine, the vein has been fairly uniform in width because of its uniform dip. However, a flattening of dip would produce loci for large, wide
ore deposits.(7). Since the Belt Series, on which the Lucky Hit is located, is more than 3000 feet thick, little variation in vein mineralization due to changes in composition of the sediments is to be expected.

Definite possibilities for ore have been overlooked on the Lucky Hit claim. On the lowest level of the mine, in the east drift, branches of the vein appear to extend into the hanging wall. It is a possibility that the wall as it occurs here is a false one and the true hanging wall has not been found.

The presence of other mineralized fissure veins on the property should not be overlooked. Smaller dikes, having the same general strike as the main fissure, were noticed on the claim. The dikes could have filled the fissures in the same manner as was described above, and hence may be cognate and possibly conjugated fissures.(1). If the fissures are mineralized and if they intersect with depth, the possibility for a wide mineralized zone is most favorable.

Some prospect pits have been dug on the structure south of the main vein, but probably not to the extent necessary to determine if this fracture has been mineralized. A shaft is now being sunk on a minor structure on the Sunny Corner claim, west of the Lucky Hit, on the premise that it may be a split off the main fissure vein.
BIBLIOGRAPHY