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Geology of a portion of the Hand Mine, Argenta Mining District, Beaverhead County, Montana

John Thomas Richards

GEOLOGY OF A PORTION OF THE HAND MINE, ARGENTA MINING DISTRICT, BEAVERHEAD COUNTY, MONTANA.

A Thesis
Presented To
The Department of Geology
Montana School of Mines

In Partial Fulfillment
of the Requirements for the Degree
Bachelor of Science in Geological Engineering

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ABSTRACT

The Hand Mine is located in the Argenta Mining District near the town of Argenta. The area surrounding the Hand Mine is characterized by intense thrusting, folding, and igneous activity. The igneous activity consists of quartz monzonite stocks of probable Eocene age. These stocks are believed to be closely related to the Boulder Batholith 30 miles to the northeast. Mississippian and Pennsylvanian sedimentary are in contact with one of these small stocks at Argenta. The Amsden formation of Pennsylvanian age forms the country rock at the Hand Mine. The Amsden formation originally consisted of interbedded calcareous shales and limestones, which have been metamorphosed to hornfels and re-crystallized limestone locally.

The ore bodies at the Hand Mine are found in north and northwest trending faults and in a brecciated zone in the bedding. The ore consists of cerussite and minor amounts of galena and anglesite.

The area mapped by the author is in the southeast portion of the mine and differs from the rest of the mine in that no commercial ore has been found. The writer concludes that the steep faulting and flat-lying bodies are of two different ages, and that intense oxidation has altered the ore minerals to plumbojarosite.

INTRODUCTION

PURPOSE AND SCOPE

The field work consisted of mapping, with a Brunton compass and tape, several hundred feet of drifts and crosscuts in the southeast portion of the Hand Mine as shown by Plate 3. This portion of the mine contains low-grade lead ore, but has the same structural relationships as the commercial ore bodies.

This particular area was mapped to bring out the structural relationships and to use these relationships to explain the ore genesis. The ultimate purpose is to find more minable ore for production.

LOCALITY

The Hand Mine is located in the NW $\frac{1}{2}$ section of T. 6 S., R. 10 W., and is situated on a low hill a few hundred yards to the northwest of the town of Argenta in the Argenta Mining District, Beaverhead County, Montana. It can be reached by 14 miles of country road from Dillon, Montana. Plate 1 shows the location of the Argenta Mining District.

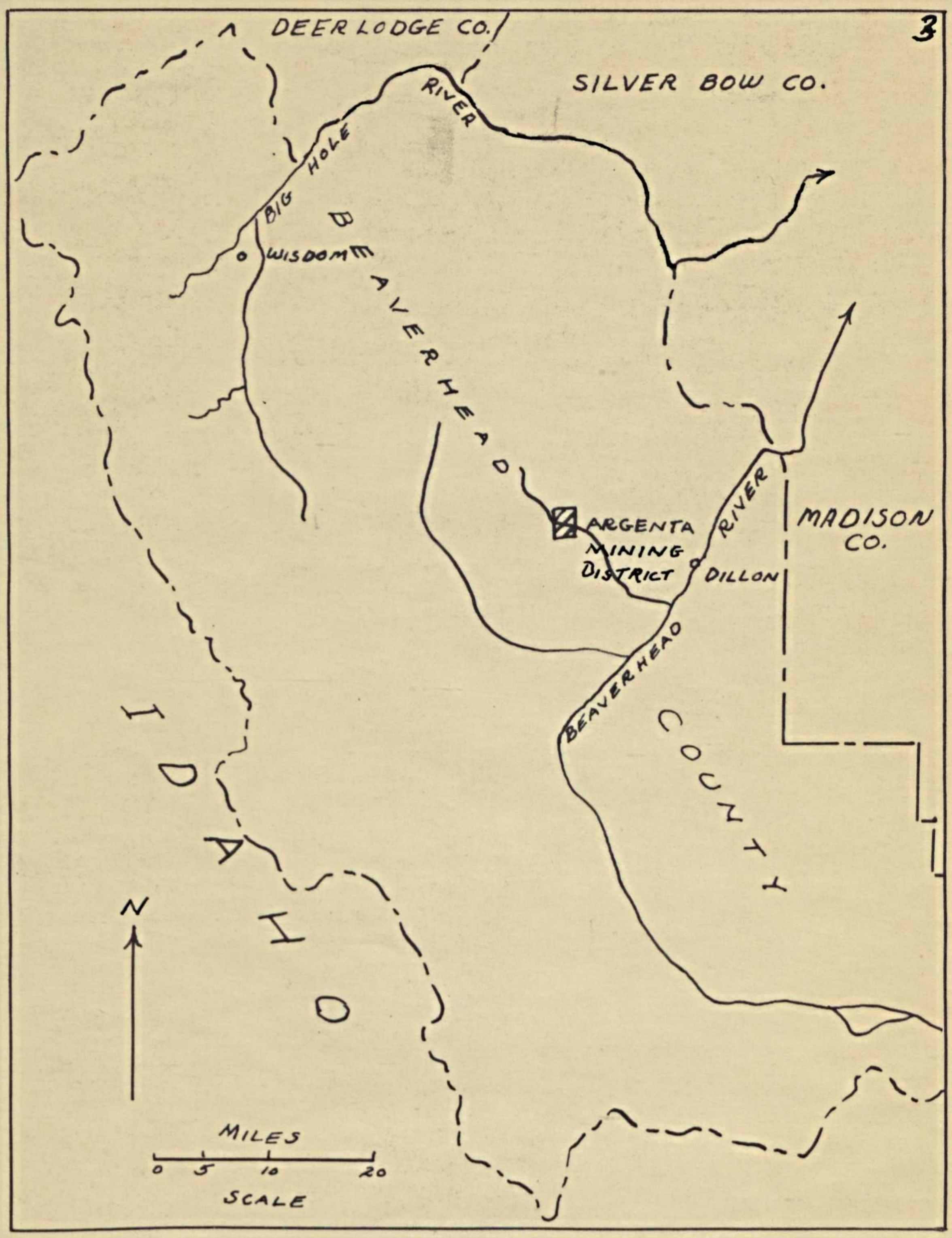

PLATE I. INDEX MAP OF BEAVERHEAD COUNTY, MONTANA, SHOWING LOCATION OF THE ARGENTA MINING DISTRICT.

ACKNOWLEDGEMENTS

The writer wishes to express his appreciation to William Hand and his family for their co-operation with the field work; also to professors W.S.March and R.R.Reid for their assistance and counsel during the preparation of this report; and to Mr. Ted Eyde who assisted the writer with the field work.

GENERAL GEOLOGY

CHARACTER AND DISTRIBUTION OF THE ROCKS

The sedimentary rocks in the vicinity of the Hand Mine consist of Paleozoic limestones, shales, and quartzites that have been locally metamorphosed into marbles, hornfels, and quartzites along the contact of a small quartz monzonite stock. These sedimentary rocks have been strongly folded and thrusted. Plate 2 shows a geologic map of the region surrounding the Hand Mine.

SEDIMENTARY ROCKS.

Shennon (7) has mapped the rocks at Argenta as Paleozoic limestones, undiferentiated. He includes in the Paleozoic limestones the Tilden, Ermont, Brazer, and Madison limestones. The Tilden limestone is tentively correlated with the Cambrian Silver Hill, Hasmark, and Red Lion formations of the Phillipsburg quadrangle, and the Ermont formation is correlated with the Jefferson formation of the Three Forks region. Shennon does not name the limestone forming the country rock at the Hand Mine.


SCALE 1: 31,680
1000 0 1000 2000 3000 4000 5000 FEET
1/2 0 1 MILE
1952
PLATE 2.
GEOLOGY MAP OF A PORTION OF THE ARGENTA MINING DISTRICT FROM W. B. MYERS. (6)
EXPLANATION
FAULT
THRUST
MINE
1 HAND
2 BROWNELL
3 ANACONDA
4 FERDINAND
5 JACK RABBIT
6 GOLDSMITH
IGNEOUS ROCKS
QUARTZ MONZONITE
EOCENE
SEDIMENTARY ROCKS
Qtg COVER, SLOPE WASH
Qal ALLUVIUM, SAND AND GRAVEL
QUATERNARY
Ts TERTIARY SEDIMENTS
TERTIARY
Cq QUADRANT QUARTZITE
Ca AMSDEN
PENNSYLVANIAN
Cm MISSION CANYON
Cl LODGEPOLE
MISSISSIPPIAN
THREE FORKS
DEVONIAN
N
RATTLESNAKE CREEK
ARGENTA
Qal
Ts

Myers (6) on the other hand, in a later report, has deferentiated between the Paleozoic rocks and identifies the limestone at the Hand Mine as the Pennsylvanian Amsden formation.

These formations lie on the east limb of the broad Humbolt Mt. anticline which plunges to the South. These Paleozoic formations are underlain by Pre-cambrian Beltian rocks which dip to the north. Locally these Paleozoic formations dip to the southeast.

IGNEOUS ROCKS

The only igneous rock in the immediate vicinity is the small stock of quartz monzonite. It is described by Shennon (7) as grey and medium to coarse-grained with biotite, hornblende, and magnetite constituting the bulk of the dark minerals. It is commonly believed to be an outlier of the Boulder Batholith to the north. (7)(9) At the Iron Mt. Mine 1000 ft to the west of the Hand Mine the igneous contact at a depth of 150 ft dips 50° N, but the dip decreases with increasing depth. (9) The quartz monzonite is exposed in gulches and shafts to the north and outcrops again two miles to the north.

STRUCTURE

STRUCTURE

The area about Argenta is characterized by intense folding and thrusting. Along the flanks of the Humbolt Mt. anticline numerous low angle thrusts are found, the largest of these, the Kelly Thrust, four miles to the West of the Hand Mine, has been traced along the strike for $12\frac{1}{2}$ miles. The Kelly thrust strikes N-S and carries Beltian rocks over Paleozöic and Mesozoic strata. The Ermont thrust with an E-W strike outcrops $1\frac{1}{4}$ miles to the south of the Hand Mine. The Ermont thrust carries Carboniferous strata over Paleocene pyroclastic rocks.(6)

Myers has noted the following periods of folding and faulting.(6)

1. Late Pre-cambrian Beltian sediments were folded by faults of large displacement before deposition of middle Cambrian sediments.

2. Middle Cambrian rocks and underlying Beltian rocks were block faulted and locally folded before the deposition of upper Cambrian rocks.

3. Mild local folding occurred during post Triassic-pre-upper Jurassic erosional interval.

4. Folding at the end of Cretaceous time was followed by strong folding and thrusting during the Eocene epoch.

5. There is a suggestion that minor additional uplift and folding may have resulted from the intrusion of plutonic igneous masses after most of the faulting and prior to deposition of the lower Oligocene volcanic rocks.

6. Later steep faults cut the Oligocene volcanic rocks.

The later steep faulting forms two distinct systems, one system strikes NW-SE, and the other strikes N-S. These faults do not follow any previous structural patterns. Myer(6) states that a period of steep faulting follows each period od thrusting. In the vicinity of the Hand Mine these faults cut into the quartz monzonite and are therefore younger than the intrusion. The north and northwest steep faults contain the principal ore bodies in the area.

DETAILED GEOLOGY

At the Hand Mine there are several processes which formed the present ore bodies. These are: folding, thrusting, faulting, metamorphism, mineralization, and oxidation. These processes have been studied by the writer in order to gain an understanding of the genesis of the orebody.

STRUCTURE

In the area mapped there appears to be two main types of faults, as can be seen in Plate 3. The low-angle tabular vein is the major structure in the area mapped. This tabular vein is cut by high- angle faults.

Low-angle Tabular Vein — The low-angle tabular vein parallels the bedding planes of the limestone. The bedding consists of alternating beds of hornfels and limestone. As far as the writer has determined, the vein has a hornfels hanging wall and a limestone footwall. The beds have been compressed into several tight folds, which plunge to the southeast. Only one crosscut has penentrated through these folds. In this crosscut the vein dies out along the northeast flank.

There have been several explanations proposed for the formation of this vein. Myer states (6), " The upper limit of commercial mineralization in at least several of the veins is formed by the intersection, in the eastern block of the vein block, of the fault surface and the base of a thick series of sheared sericitized hornfels overlying carbonate beds." Shennon, (7) on the other hand, states, " The slickensides and brecciated material are believed to have formed from slumping due to the shrinkage which resulted from the removal of material during oxidation of the sulfide ore."

The writer believes Myer's statement correct but not definite as to the cause of shearing. Shennon's statement does not seem to be completly true. The writer believes that the brecciation and slickensides were formed along with the folding, The more compact and massive limestones will brecciate whereas the shale will give. Therefore as the folds are formed the limestone will be fractured and brecciated. The clay gouge and slickensides on the foot and hanging walls will largely result from this action, but in one place a red fault gouge was noticed inside the fault gouge. This would indicate that movement took place after oxidation, therefore some movement is due to oxidation. Also several structures were noted as in Plate 3 which can best be expained as slumping of the bed, leaving blocks of the vein topped by impervious fault gouge.

Myer (6) states, " Beneath the Kelly thrust the Paleozoic and Mesozoic rocks are folded into a series of narrow synclines and anticlines, overturned towards the east and broken by relatively minor thrusts. These faults, which vary in number from four to eight at different localities, form a two-mile-wide zone which simulates the undulating trace of the major thrust."

The writer believes that this tabular vein in the Hand Mine is one of these minor thrusts which has been mineralized and is contemporaneous with the folding. The faults mentioned by Myer appear to have an imbricate structure, but he has not mentioned it in his report and the writer has seen no evidence to form an opinion.

High-angle Faults — The north-south faults are the only high-angle faults mineralized in the area mapped, although Bill Hand* has told the writer of mineralization in northwest trending faults in other parts of the mine. These north-south fissures found in the area mapped are a reflection of the control ex~~c~~ercised by the regional structure. In this area the high-angle faults are younger than the intrusion.

* Personal communication

They follow, however, the trend of earlier faults. This is no doubt due to stresses and zones of weaknesses formed previously. Concerning this Myers[6] states," ... suggesting in the crosscutting relationships shown by the early Tertiery faults that the orogeny took place in several episodes of thrust movement, each followed by an episode of steep faulting. No evidence has been found to suggest long intervals between the episodes." Several mining Districts such as the Blue Wing, Bannack, and Argenta are located along these fault systems. Myers[6] states," The alignment of these small camps disregard the superficial structural patterns, and while no more than intriguing, permits the speculation that a thorough-going basement lineament may have been a fundemental control in the location of the ore districts."

Although no displacements were noted in the area mapped, Bill Hand*has noted displacements in other parts of the mine.

Post Mineral Faulting -- There appears to be some post-mineral faulting, but these faults are of minor importance. No definite system of faulting has been noted. These faults contain a white clay gouge, but in some instances where close to the N-S mineralization the clay becomes chocolate-brown in color due to oxidation processes. The

Displacements -- The amount of displacement in the low-angle tabular fault is not known. The displacement of the Kelly thrust is believed to be several miles. But as the hanging wall is the same folded formation, a maximum displacement of several hundred feet would be expected.

Along the high-angle faults no displacement can be found in the mapped area. But Bill Hand*states that the low-angle tabular vein has been displaced by high-angle faults in other places in the mine. Myers(6) stated that the displacement could be up to 200 feet, but the faults in the region are fairly short along the strike, which makes that much displacement somewhat unfeasible. The writer believes that little displacement has taken place along these faults in the area mapped, as the tabular vein where intersected by the steep faults show no offset horizontally or vertically.

The post-mineral faults do not appear to cut the previous faults any significant amounts. At one or two places displacements of two inches were noted involving post-mineral faults.

CONTACT METAMORPHISM

The Amsden formation forms the country rock at the Hand Mine. It has been recrystallized along the contact with the quartz monzonite.

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* Personal communication

Weed states (8), "It has been found that metamorphism of the sedimentary rocks would be practically completed before solidification of the magma begins and completed while the magma was able to act hydrostatically and transmit lateral pressure." It can be safely concluded then that the metamorphism would have no effect on the mineralizing solutions. But metamorphism has played a part in the deposition of the solutions by forming an impervious cap of hornfels over the brecciated zone thereby localizing the ore body.

MINERALIZATION

The writer believes that the mineralizing solutions entered the Amsden formation using the north-south fissures as channels. The solutions upon entering the brecciated tabular bed tended to replace the limestone.

The mineralization in both the low-angle bedding vein and the high-angle vein is the same. The dominante minerals found in this area are hematite and limonite. Specular hematite, jasper, calcite, magnetite, and quartz are also present. A typical cross-section across the low-angle tabular vein will contain about 2 to 6 inches of clay gouge on the foot wall, 3 to 4 feet of banded, earthy, red hematite and y~~r~~llow-brown limonite with varying amounts of lead, probably present as plumbojarosite.

This bed id

This bed is brecciated, and contains thin streaks of fault gouge throughout. Commonly masses of unoxidized specular hematite and magnetite are found in the vein. Horses of highly altered limestone are also found in the vein. Horses of highly altered limestone are also found in places. There is usually 2 to 6 inches of fault gouge on the hanging wall, and in one place an additional 6 inches of hematite-stained fault gouge is found.The writer believes the primary mineralization was predominatingly pyrite and galena with minor amounts of chalcopyrite and sphalerite. These minerals are present on several waste dumps in the general area around Argenta.

OXIDATION

Oxidation has been very active throughout the area. At the Ermont Mine oxidation has reached 500 feet. The ore throughout the Hand Mine is largely oxidized. There are minor amounts of unoxidized galena. In the mapped area one steep vein contained galena oxidizing to red-brown limonite.

The bulk of the lead ore at the Hand Mine is cerussite. A polished section of a sample of this ore showed a kernal of galena altering to a dark gray anglesite which in turn alters to cerussite.

In the mapped area no cerussite was found. Samles taken of the veins showed very spotty values of lead; some assays showed 25% lead while others taken close by assayed as low as 1%. The cerussite in this deposit has no doubt been further oxidized to yellow plumbojarosite.

Lindgren (5) states that free sulfuric acid or ferric sulfate or ferric chlorides will render lead somewhat mobile, and therefore some migration is possible. Abundant iron as pyrite is present in the district as can be seen on the dump of the Jackrabbit Mine just to the south of the Hand Mine. Also there has been a great amount of oxidation, especially in the area studied. The area mapped is within 50 feet of the surface, therefor it has been more intensely oxidized than the rest of the Mine, which lies at a deeper depth. It is the writer's opinion that some of the lead has been carried away by this prcess.

There are two features of the geology of the mapped portion of the Hand Mine that the writer has noted that defy complete explanation by the author. The first of these is the presence of pipe-like structures formed at the intersection of the low-angle tabular vein with the high-angle veins. At this intersection the high-angle fault stringers out into the low-angle vein somewhat like the roots of a tree. The writer believes that this structure indicates that the high-angle vein is later than the low-angle vein. The high-angle fault as it approaches the low-angle fault tends to stringer out in order to follow the path of least resistance.

The other structure that is difficult to explain is the banding found in both veins. The writer believes this structure is caused by the mineralizing solutions. The mineral solutions as the fill the space between the breccia particles will form a flow structure.

CONCLUSIONS

From studying available literature and from detailed mapping the writer proposes the following sequence of events in the forming of the ore bodies at the Hand Mine.

1. Amsden formation laid down under oscillating conditions in shallow water, marine enviorment, producing alternation of limestone and clastic units.

2. Folding and thrusting at the close of Cretaceous time. The low-angle tabular fault being formed at this time.

3. Igneous intrusion during Eocene time. Myers (6) has noted the igneous bodies cutting Paleocene volcanics but not cutting Oligocene volcanic rocks.

4. Metamorphism before complete solidification and fracturing.

5. Fracturing following pre-existing zones of weakness associated with earlier folding and thrusting. These are the steep north-south veins that cut the quartz monzonite.

6. Mineralization — solutions originating from the quartz monzonite, rising along the north-south fissures and into the brecciated bed.

7. Oxidation of the mineralized faults, which masked much of the original structure and mineralization.

From the detailed mapping work it appears to the writer that the axis or axes of the folds trend to the southeast and to the south. The larger structure in the mapped area appears to be plunging to the south with its axis slightly to the east of south. Two smaller folds plunge southeast. These folds are no doubt the result of the thrusting. The tabular vein can be traced to the west where it was mined along a saddle of a fold dipping to the southeast.

RECOMMENDATIONS FOR FUTURE DEVELOPEMENT

The first recommendation the writer would make would be to advise assaying the area for gold content; it seems to be the same type of material that has been mined for gold in other mines in the district. The most logical recommendation for future developement would be to suggest opening a lower drift. The oxidation will probably extend to the contact with the quartz monzonite, and primary veins should be found below this. There is an indication that silver, and copper enrichment will occur with depth. As for continued drifting in this area, it appears to the writer that the best chances for finding more ore would be to continue drifting along the main drift. The bed should turn towards the west along the north flank of the south-plunging fold. This will bring more depth and thus more chance to get below the intense oxidation.

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PLATE 3.

GEOLOGY MAP OF
A PORTION OF THE
HAND MINE
JOHN RICHARDS
MAY 1955

SCALE 1": 40'

FOLD AXIS

VEIN

FAULT

BRECCIA

L - LIMONTE H - HEMATITE
J - JASPER C - CALCITE
G - GALENA