Geology of the Marget Ann Mine Butte District, Montana

Winston Martin Sahinen

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GEOLGY OF THE MARGEIT ANN MINE
BUTTE DISTRICT, MONTANA

By
Winston Martin Sahinen

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
May 15, 1953
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ABSTRACT

The Margett Ann mine, which is located in the extreme northwesternmost part of the Butte (Summit Valley) mining district, contains a large vein structure that is definitely related to other well defined structures comprising the Anaconda vein system. The veins found within the Margett Ann structure are mineralogically and structurally parallel to other known to be part of the Anaconda system.

Portions of the Margett Ann veins show evidence of being formed by hydrothermal replacement along a pre-existing fault, where other portions were apparently formed by open space filling. There was some movement along the vein fissures while mineralization was taking place. The mineral assemblage in the Margett Ann is the one normally found in this general zone. Wallrock alteration is also normal.

A large fault is apparent in the underground workings, which apparently can be classified as being related to the Middle Fault system. Many small faults transect the area between the two veins.

The Margett Ann structure is a strong one, and there is a possibility that the size of the ore deposits will increase with depth providing enough mineral content was present in the ore-forming solutions to cause more complete replacement of the wallrock intervening between the two veins.
GEOLOGY OF THE MARGET ANN MINE
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INTRODUCTION

The student of geology who, becoming interested in a particular locality, attempts to study the locality is invariably left with a desire to know the limits of the mineral productive area. Such is the case on my part, and it is hoped that in this thesis more will be made known of the ultimate limits of mineral production in the Butte district.

I first became interested in the Marget Ann mine through mention of it in trade journals when recent mining activity commenced. A natural curiosity was born concerning the relationship of the Marget Ann orebodies to the rest of the Butte mineral deposits; but very little information could be obtained. The Marget Ann mine proved to be an ideal problem for a Bachelor of Science thesis in Geological Engineering; and with this thought in mind, I decided to try and obtain permission to map this property for my Problem. The necessary preliminaries were made, and field work was begun in February, 1953.

The object of the thesis was to study the geology of the northwesternmost part of the Butte district through observations
made in the underground workings of the Marget Ann mine. The possibility that this study will help to extend the arbitrary economic limits of mining in the Butte area is presented because the structures found in the Marget Ann mine are obviously closely related to the rest of the structures in the Butte area. The study was originally intended to relate observed features of the Marget Ann orebodies to others of known economic value that have been described in other nearby mines.

As the field work progressed it became apparent that very little was known of the mineralogical associations of the precious metal constituents of the Marget Ann ore. A mineralogical study in excess of that originally planned was then decided upon to determine the affiliations exhibited by the silver and gold. With these objectives in mind, the laboratory and field work continued.

The problems involved in the writing of this thesis, then, are divisible into two major classes—structural and mineralogical. These two classes are in turn divisible into smaller units, each of which was taken into consideration in the examination. The structural problem was resolved into three phases, the structural relationships of the Marget Ann veins, the reasons for apparent pinch-out of orebodies, and the problem of finding new orebodies or the continuations of those dislocated by faults. The mineralogical problem was likewise subdivided into the determination of the mineralogical occurrence of the silver and gold, and the relationships of the precious minerals to other ore and gangue minerals. The solution of the problems was implemented by standard geologic methods.
The structure apparent in the accessible mine workings was mapped as proscribed by the "Anaconda" or "Cerro de Pasco" method, that is, surveyed with a Brunton compass and plotted to scale on coordinate paper. The solution of the problems was arrived at by interpreting the results of this mapping. The mineralogical manifestations were studied megascopically underground and microscopically in the laboratory. Polished sections of about fifteen selected samples were made and studied under a reflecting microscope. No petrographic studies were made, because the wall-rock is obviously typical of the Butte district, therefore such a study would have only duplicated the published work of others.

I would like to express my appreciation for the superb cooperation that I received from Mr. Ralph J. Seideman, Superintendent, and other members of the mine staff. I would also like to thank the officers and directors of the Mitchell Mining Company for allowing me access to the mine.

HISTORY

The Marget Ann claim was located in 1878 by Dennis Driscoll and John O'Donnell of Walkerville. The mine was operated from that time until 1882 when the property was shut down; During this period of operation, the shaft was sunk to the 190 (200) foot level where the ground-water level was encountered. Some drifting and raising was done on both veins, but no records of production for this period are available. Old claim maps show a mill on the property, which presumably treated Marget Ann ore. The factors which caused the cessation of operations are believed to be lack of minable ore, inability to sink deeper on account of
water, and a general decline in the price of silver.

The mine lay dormant until February, 1951, when the Mitchell Mining Company took over the property and proceeded to deepen the shaft to its present 400-foot level. Ore was developed on both the 300- and 400-foot levels in both vein systems, and mining has continued from that time to the present. At this time, development work is being done on a faulted vein segment on the eastern side of the 400-foot level.

LOCATION

The Marget Ann mine is in section 1, T. 3 N., R. 7 W. The mine is about a half a mile north of the city of Walkerville and about two miles north of the business district of the City of Butte. It lies about 2300 feet in a north-northwesterly direction from the famous Alice silver mine. The Marget Ann is included in the Butte (Summit Valley) mining district.

GENERAL AREAL GEOLOGY

The ore deposits at the Marget Ann mine are genetically related to the Boulder batholith, a late Cretaceous or early Paleocene intrusive of quartz monzonitic or granodioritic composition, as are the rest of the ore deposits of the Butte district.

The Boulder Batholith

The Boulder batholith extends southward from Helena to Divide, Montana, trending in a general northeast-southwest direction. It is exposed over an area of about 1200 square miles. The batholith is oblong in shape with the long dimension (north-south) of about 70 miles and a width (east-west) averaging about 20 miles. Many
mineral deposits are associated with this intrusive, but those of
the Butte district are by far the most important, both from the
standpoint of size and value of production.

The Butte District:—The relationships of the batholith to
ore deposition in the Butte district has been extensively studied
by many geologists, both those in the employ of the various mining
companies and those employed by other agencies. As a result of the
detailed study, the following time relationships in the formation
of the ore deposits are believed to be generally true;

1. Andesitic and dacitic flows.
2. Intrusion of the batholith.
3. Crystallization and segregation of aplitic bodies.
4. Fracturing caused by either shrinkage or some external force
5. a, Intrusion of both well-defined and irregular quartz
   porphyry bodies.
   b, Formation of the ore bodies by hydrothermal cavity-fill-
   ing and replacement along previously formed fissures.
6. Intrusion and extrusion of rhyolite porphyry.
7. Faulting probably due to Pliocene block-faulting.

However, all geologists who have studied the Butte district
in detail do not regard the above schedule as being completely
acceptable. For example, one school of thought proposes that the
quartz porphyry stage is contemporaneous with the aplitic stage
and occur as the result of magmatic segregation; whereas the op-
posing school of thought contends that the quartz porphyry intru-
sions are practically contemporaneous with ore deposition. The
latter appears to be the case as the quartz porphyry intrusives
and the veins have been observed to cut each other. It is of inter-
est to note that I have seen what appears to be two separate quartz porphyry intrusions in juxtaposition on the 2300-foot level of the Mountain Con mine.

Another point of disagreement between geologists is the exact relation of the veins to the fractures. One school of thought headed by R. H. Sales, believes that the ore deposition occurred in three stages, which coincide with the formation of the three fracture systems. In short, the theory states that the ore was first deposited in open east-west trending tension cracks (Anaconda system) caused by the contraction of the intrusive mass during cooling; next, ore was deposited by hydrothermal replacement in northwest trending fault fissures (Blue vein system) which displaced the veins of the Anaconda system; and finally, ore was deposited in a series of northeast trending faults (Stewart system) which displaced both preceding systems—deposition also by hydrothermal replacement. The other school of thought, followers of J. C. Ray, believes that ore deposition occurred in only one period, the ore being deposited at one time in all three systems of fractures, which were the result of a single diastrophic movement. To support his contention Ray has duplicated the Butte vein systems experimentally, and shows that simultaneous formation could have taken place. To further substantiate his theory, Ray argues that it is improbable that three distinct periods of mineralization could have produced identical mineral assemblages in the three vein systems. The Ray theory proposes that the Anaconda system of tension fractures

served as conduits for the metallizing solutions which deposited ore in such segments of the other two systems that it was possible for them to permeate. This theory further states that the fracture system was subjected to stress while mineralization was taking place, and that movement occurred along portions of the system.

I believe that the second theory is more plausible, and that the vein structure at the Margret Ann tends to bear out the theory.

**Zoning in the Butte District:**—The ore deposits of the Butte district are arbitrarily divided into three zones on the basis of mineralogical content—the central, intermediate, and peripheral zones. These zones are roughly concentric, hemispheroidal layers, which generally include all deposits showing the mineralogical assemblage characteristic of that zone. The center of the 'onion', so to speak, is at a point near the Leonard mine, and the zones range radially from this point. The 'domes' of the different zones have been removed by erosion, so as to give an outcrop pattern roughly approximating the shape of a target. The reason for this zoning is believed to be a loss of heat by the solutions as the distance from their source increased. As the temperature was lowered, certain minerals could no longer remain in solution, and, as a result, were precipitated.

The mineral constituents of the different zones have been well described in other writings, so I take the liberty to generalize and describe the constituents of the different zones as follows:

1. Central zone—Copper minerals as sulphides and arsenides.
2. Intermediate zone—Copper ferrosulphides, zinc sulphide,
and some lead sulphide.

3. Peripheral zone--Zinc and lead sulphides, manganese carbonate and silicate, and silver minerals.

Minerals such as quartz and iron sulphide are found throughout all three zones.

The number of aplite bodies increase as the distance from the central zone increases. On the outer fringe of the zone, the percentage of aplite and pegmatitic bodies grows comparatively large.

The mineralogical composition of the Margot Ann ore is as to be expected from its place in the peripheral zone, that is, the ore is composed of quartz, manganese carbonate and silicate, and minor amounts of iron, zinc, and lead sulphides, with small amounts of copper ferrosulphide.

Wallrock Alteration in the Butte district:--During the formation of the veins in the Butte district, the solutions that carried the ore minerals reacted with the quartz monzonite wallrock to alter certain of the minerals in the walls to new minerals. The intensity of this alteration and the width of the alteration envelope around the veins serve as a rough measure of the size and/or degree of mineralization of the veins in question. The intensity of the alteration also follows the zoning pattern, being most intense in the central zone and least intense in the peripheral zone for a given size of vein.

This relationship has been known for a long period of time, but only recently has a study been made of the alteration effects. (Sales and Meyers). The results of this study have shown this alteration to be divisible into three distinct zones ranging outward from the vein into foot-rock.
ward from the vein into fresh rock, a sericite zone, a white
clay zone, a green clay zone, and finally unaltered quartz monzoni-
te. In general, the ferro-magnesian minerals are most easily
altered, next the plagioclases, and finally orthoclase. Quartz
is not altered. The products of complete, or sericitic alteration
is a soft white rock consisting of the mineral quartz, sericite,
and some pyrite. The other types reflect the degree of mineral
change from fresh rock to sericite.

The wallrocks at the Marget Ann display an alteration con-
formable to the norm for the district.

Post Mineral Movement:--Post mineral movement in the Butte d
district is believed to be a result of orogenic uplift in Tertiary,
porbably Pliocene time. This movement took the form of block-
fauliting, examples of which are seen in the Continental and Whis-
key Gulch faults on either side of the mining area. This fault-
ing also produced many movements in the veins and faults already
established in the Butte district and caused the formation of a
very confusing fault-vein pattern.

The Marget Ann shows considerable evidence of post mineral
faulting as do the other mines in the district.

It can be seen from the foregoing that the Marget Ann exhibits
no startling divergence from the general pattern of the district,
and it may be assumed that these general relationships will hold
true for the Marget Ann.

GEOLOGY OF THE MARGET ANN MINE

The overall picture of the relation of ore to structure and
wallrock already being known, the definite correlation of the
veins and structures observed in the Marget Ann becomes the fusal
point of interest. Toward this objective is presented an account
of the examination of the Marget Ann and the results of this ex-
amination. These results as presented below and the set of maps
at the end of this report serve as a basis for the conclusions
presented in this thesis.

Field Work:--The field work for this Thesis was done under-
ground at the Marget Ann mine at different times from February
to May, 1953. Most of the work was done during the night shift
so as to cause the least interference with the operations of the
mine. On two of the underground trips I was accompanied by an
undergraduate student.

The scale used in field mapping was 20 feet to the inch,
which was reduced to 50 feet to the inch for the final maps at the
end of the report. The ground-line for most of the mine work-

ings was traced from Company maps in order to speed up the mapping
procedure. The ground-line on the 200-foot level was later modi-
fied to conform more closely to observed features.

Not all of the workings shown on the Company maps were acces-
sible at the time of the examination. Workings on the 200-foot
level, in particular, as shown on the accompanying map, were in-
accessible. In addition, most of the raises and stopes not being
worked at the time were either caved or in a dangerous condition.
A minimum of time was spent in the working places so as not to
interfere with the mining operations.

The sampling method used to obtain specimens for laboratory
observation consisted of either selecting samples from the chutes
or the breasts of the different working places. No systemmatic

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system of sample cutting was used; grab samples, taken as described above provided the majority of the specimens. In portions of the mine that were not actively being worked, samples were cut from the back or breast, whichever was at hand. In all, I believe that I obtained a fairly representative suite of specimens from the mine.

The results of the field work, the field maps and samples were then studied in the laboratory. The field maps were reduced in size and combined to the form shown in the back of the report. The specimens were first examined megascopically and some were selected to be made into polished sections, so that they could be studied microscopically.

Laboratory work:-- The laboratory work was divided into two phases, that having to do with the interpretation of the maps, and that having to do with the mineragraphic study of the selected specimens. The map interpretation phase consisted of the drafting of a generalized cross-section and interpretation of the observed structures.

The specimens were prepared as polished sections in the customary manner, but with considerable difficulty, owing to the fact that each specimen contained hard, microcrystalline ribs of quartz and/or rhodonite with very sulphides or rhodochrosite interspersed between them. Due to this condition, polishing tended to gouge out the softer minerals, leaving the hard ridges as highs. Finally about fifteen sections were examined under the reflecting, or mineragraphic microscope. It was hoped that photographs could be taken to illustrate this report, but the poor quality of the polished sections made this inadvisable. The sections were, however,
amply polished to allow a mineragraphic determination. Realizing that the mineralogy and association of the gold and silver bearing minerals were of particular interest to the Mitchell Mining Company I conducted the study with the determination of these points in mind. During the course of the examination, I was able to determine the paragenesis of the ore, but was not able to recognize nor isolate any precious metal-bearing compound. I am at a loss to explain this, because the ore from which the samples were taken was at that time being shipped as a silver ore. Examination of another suite of samples also failed to disclose any silver or gold mineral. However, a repeated megascopic examination of unpolished specimens disclosed a few threads of a wire-like nature which could have possibly been native silver. I was unable to obtain any of these threads for a chemical determination, but can be moderately certain that the wires were indeed native silver. The unquestionable occurrence of native silver in similar veins with similar mineralogies in the Alice and Lexington mines nearby lends some measure of substantiation to this premise.

I was later informed, by one of the miners, that the mineral tetrahedrite had been recognized in the ore. A renewed examination of the polished sections could not prove this, however. Another possibility is that the silver and gold bearing minerals occur as inclusions within the pyrite. I was unable to find any evidence of such an occurrence in the polished sections.

Interpretation of mapping results:-- The interpretation of the results of the investigation can be divided into two parts, structural, with reference to the maps made of the mine, and mineral-
logical, with reference to the study made of the ore specimens.

A study of the attached maps will show that the Marget Ann mine contains two strong, persistent veins, with numerous subsidiary veinlets. It is of interest to note that the veins are, so to speak, on the hanging and footwalls of a larger area which might be construed to be a structural unit in itself between them. It can be seen from an examination of the maps that the area between the veins is criss-crossed by numerous small faults and veinlets, and is extensively altered to a green clay type of quartz monzonite. On the footwall of the southern vein, and on the hanging wall of the northern vein, however, the alteration zones quickly grade into a hard, fresh quartz monzonite. This is disclosed by short crosscuts on either side, and by diamond drill holes to the north and south. It is said that the diamond drill holes did not intersect any ore. Therefore it appears that the north and south veins are the limits, beyond which no ore will presumably be found within a reasonable distance.

Another postulation can be made concerning the mineralogical change in the ore with depth. It was observed that the veins tend to include more wallrock with depth, and that the walls of the veins become more silicified and contain more stringers. The total sulphide content increases with depth, and, as is testified by the larger number of workings, so does the silver content. It must of course be realized that two hundred odd feet is hardly enough vertical extent to make definite statements concerning the probable value of the ore at depth, but there is a very vague implication that the tenor may increase.
Comparing the two veins, it will be seen that the south is apparently more siliceous and wider than the north, but apparently is of less value, as again is evidenced by the amount of stoping done. Although not enough of the veins are exposed, it might also be postulated that the workable ore shoots pitch nearly ninety degrees.

No definite fault pattern can be discerned, even though the area between the veins indicates that faulting has been rather intense. It might be postulated, however, that the post-ore fault shown cutting off the south vein in 307DS could be related to the Middle Fault system of Pliocene age; and further, that this fault could have faulted the south vein in such a manner so as to repeat it. If this is so, then the vein exposed in the two short drifts south of the 300 station might be the westward continuation of the south vein. There is no direct evidence to support this contention, however. If the foregoing were fact, then this fault would also explain the slickensiding of the altered quartz monzonite south of the 300 and 400 stations.

The anomalous south dip of the vein on the south side must be modified by the observation that, at other points, the dip is almost vertical. The fault correlation shown in the cross section is entirely speculative.

Interpretation of laboratory results:— The sequence of mineral deposition is, as determined by mineralographic examination, quartz, rhodonite-rhodochrosite, pyrite, galena, sphalerite, and chalcopyrite. In addition, examination of a cemented, brecciated ore body at the breast in 405DW showed evidence of an additional
generation of quartz, rhodonite, and pyrite, and also evidence of a third generation of quartz. This breccia was composed of angular fragments of ore and waste, surrounded by concentric rings of quartz and rhodonite with small grains of pyrite interspersed in them, and a matrix of vitreous quartz.

Mineragraphic evidence shows that the primary minerals are quartz, rhodonite–rhodochrosite, pyrite, and some galena. Sphalerite was observed to be replacing galena, and chalcopyrite was observed to be replacing sphalerite and galena. In addition, exsolution blebs of chalcopyrite were seen in the sphalerite.

This mineral assemblage is what is to be expected in this zone (peripheral), except for the additional generations of quartz, rhodonite, and pyrite.

Summary of the Geology of the Margret Ann Mine

The observed relations, and the inferences and postulations derived from them can be grouped under the headings ore, structure, and wallrock. The summary of each is given below.

Ore:— The Margret Ann contains a siliceous, manganiferous ore carrying minor amounts of base metal sulphides. The valuable constituent of the ore is silver, in an undetermined form, presumably wire- or native silver. The silver and sulphide content increase with depth, as does the amount of wallrock inclusion.

Structure:— The main structure of the mine is a zone of alteration between two faults that have been mineralized to form the north and south veins. A large fault, possibly related to the Middle Fault system, cuts the south vein, and apparently offsets it to the northeast. Multitudinous small faults traverse the area be-
tween the two veins, but have no definite pattern, other than a general northerly dip, which is common to the whole structure.

Wallrock:— The wallrock is altered to the green clay, or moderately argillized quartz monzonite over a wide zone between the north and south veins. Alteration on the sides of these two veins away from the argillized zone extends to a depth of only a few feet. The alteration is normal for this part of the district. The reason for alteration on such a large scale between the two veins is the fact that the numerous fractures in this area acted as channelways for the hydrothermal solutions, resulting in a pervasive green clay alteration. The regular alteration sequence is displayed even by stringers only a half inch in width.

Relation of the Marget Ann to other Butte Structures

In my opinion the main structure at the Marget Ann is directly related to the Anaconda vein system; specifically to the Rainbow vein. Structural and mineralogical parallelism make this conclusion obvious. This premise is strengthened by the fact that several writers have stated that the Rainbow vein in its westward extension curves gently southward, and gradually changes from a tension fracture to a shear fracture. I do not believe that the Marget Ann structure is part of the Rainbow vein, but that it was formed at the same time under the same influences, to the north of this structure.

SUMMARY

The Marget Ann veins were formed by hydrothermal replacement and fissure filling in a structure that is genetically related to the Rainbow vein. The relation is substantiated by an observed
structural and mineralogical parallism. The valuable constituent, silver, occurs in an undefined mineral form associated with minor base metal sulphides in a manganiferous siliceous gangue.

CONCLUSIONS

The Marget Ann structure is directly related to the Anaconda vein system, and owing to its strength, will probably persist in depth. Additional mineralization might be found at depth, but the considerable distance that the structure lies from the accepted center of mineralization decreases this possibility.

Faulting in the mine can probably be resolved into a relation with the Middle Fault system.

The pinchouts of the veins can be explained as caused by irregular replacement by hydrothermal solutions.

Therefore, if these premises be true, the continuation of mining at the Marget Ann is dependent on economic conditions, because the geological conditions appear to be favorable for long-continued operation.
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