5-16-1952

The Birdie Mine Tungsten Deposit Butte Mining District, Silverbow County, Montana

Bernard A. Fahm

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A Thesis
Submitted to the Department of Geology
in Partial Fulfillment of the
Requirements for the Degree of
Geological Engineering

MONTANA SCHOOL OF MINES
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by

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INTRODUCTION

The importance of tungsten has encouraged the search for minerals of this metal, and consequently new deposits have been discovered, and known deposits have been re-examined. Western Montana has rather widespread deposits if low-grade types are also considered. Many deposits were known long ago, but abandoned because the use of tungsten was still in its beginning stage and therefore little attention was given to this type of mineral. As the importance of tungsten became known, many of the abandoned properties were reopened, and in the last few years tungsten has become a critical metal which is now eagerly sought.

The accompanying map (Fig. 1), of western Montana shows the important deposits known to exist at present. Some of the recent discoveries of fairly good sized low-grade tungsten deposits have been made in the Brown's Lake, Apex, Polaris and Birch Creek mining districts of Beaverhead County. It is estimated that these deposits contain 1,900,000 tons of ore that averages 0.35 per cent WO_3 (tungsten trioxide). The

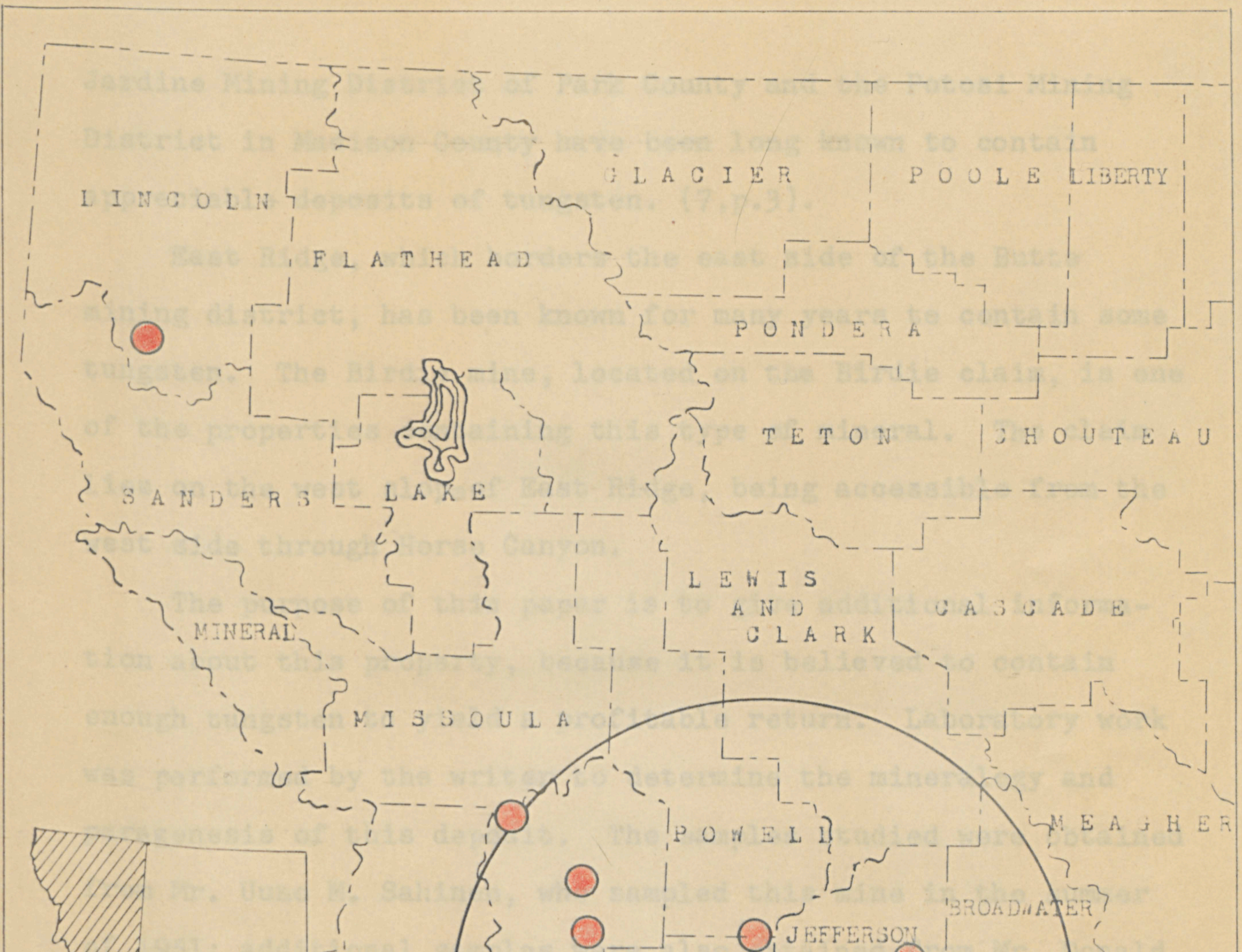


Fig. 1 MAP OF WESTERN MONTANA SHOWING DISTRIBUTION OF TUNGSTEN DEPOSITS
(Circles show important deposits known in 1951-1952)

Jardine Mining District of Park County and the Potosi Mining District in Madison County have been long known to contain appreciable deposits of tungsten. (7,p.3).

East Ridge, which borders the east side of the Butte mining district, has been known for many years to contain some tungsten. The Birdie mine, located on the Birdie claim, is one of the properties containing this type of mineral. The claim lies on the west slope of East Ridge, being accessible from the west side through Horse Canyon.

The purpose of this paper is to give additional information about this property, because it is believed to contain enough tungsten to yield a profitable return. Laboratory work was performed by the writer to determine the mineralogy and paragenesis of this deposit. The samples studied were obtained from Mr. Uuno M. Sahinen, who sampled this mine in the summer of 1951; additional samples were also obtained from Mr. Donald W. McGlashan, who conducted a study on the flotation concentration of this ore. The writer also collected samples in the mine.

Extreme weather conditions and deep snows prevented the writer from exploring this property during the winter, but several trips were taken later in the spring of 1952. The work performed by the writer at the mine, consisted in checking the geologic structures as they were recorded by Mr. Sahinen and his geologic map was complemented with some additional structures found. It was found that considerable difficulty exists in obtaining information regarding the history of this mine, consequently, the writer conducted several interviews with persons familiar with the property; the information gathered from them is presented in the following pages on the history of the mine. A thorough search through the Montana School of Mines library also was conducted, but only scanty articles were found that relate to the Birdie mine.

GEOGRAPHY

The Birdie claim lies in the rugged mountainous ridge, that borders the Butte mining district east of Butte in Silver Bow County, Montana. Drainage of the area passes through natural canyons such as the Park, Horse Canyon and several other smaller ones. The steepness of the slopes makes accessibility rather laborious and difficult. The claim of the Birdie mine lies on the western slope of the East Ridge, almost half way up the ridge from Columbia Gardens. The mine is accessible through Horse Canyon where a bulldozer road leads directly to the mouth of the adit. The location of the Birdie deposit with respect to the city of Butte can be seen in the accompanying map (Fig. 1). This map gives an approximate idea of the nearness of this deposit to the big mining city, which makes it very convenient, should actual operations be undertaken.

The Birdie claim lies in the NW 1/4, Section 14 and the NE 1/4, section 15, T.3N., R.7W., (Fig. 2). The mine lies approximately 4 miles east of the center of the city of Butte, at present it is being accessible through an unimproved road that leads behind Columbia Gardens, up through Horse Canyon. Extreme weather conditions and deep snows, that prevail during a large part of the year in this region, make the access to this mine almost impossible; therefore, special provisions should be made in considering the operation of the mine during the winter months. No active mining operations are being conducted at present on any of the surrounding claims to the Birdie claim. The main adit of the Birdie mine is at an approximate elevation of 7000 feet above sea level and nearly 1300 feet above the valley to the west.

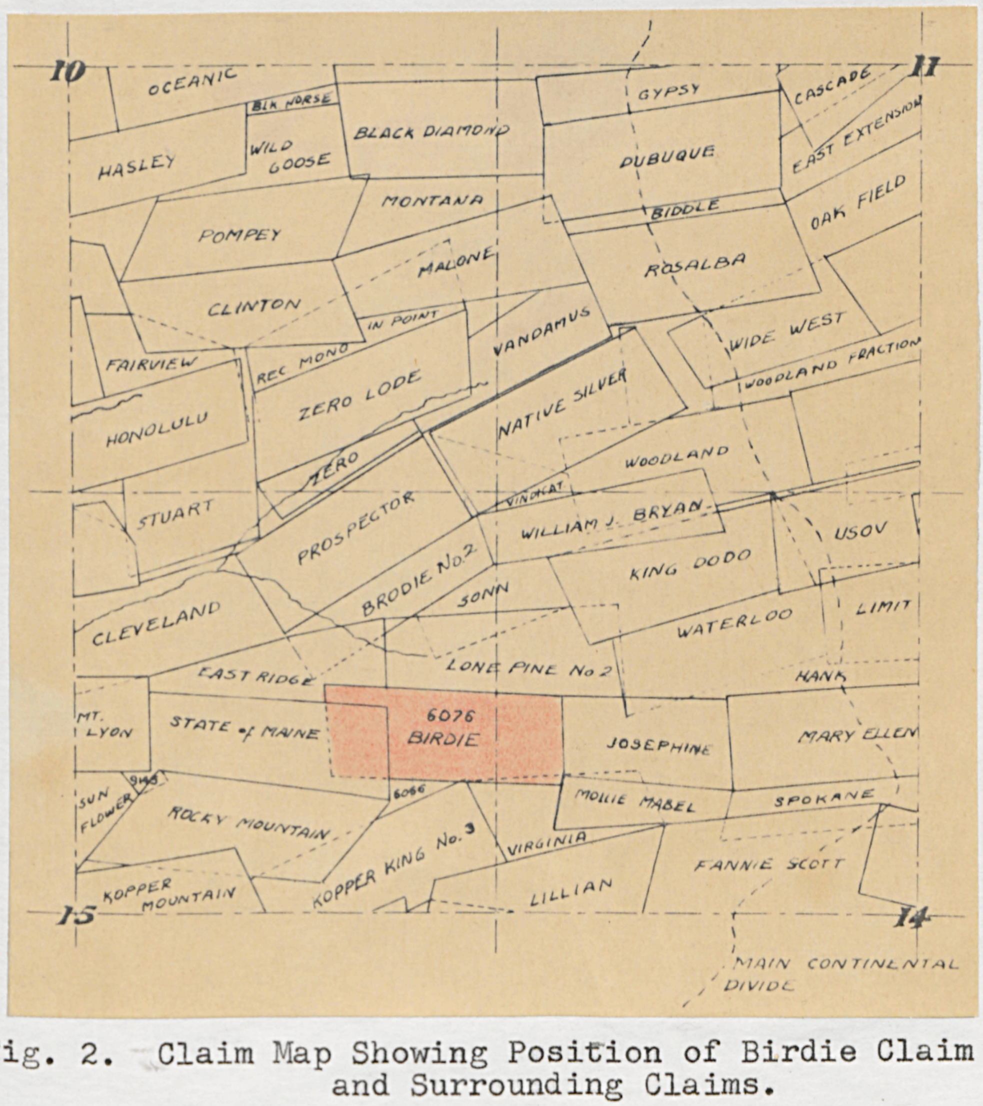


Fig. 2. Claim Map Showing Position of Birdie Claim and Surrounding Claims.

PHYSIOGRAPHY

The area in which lies the Birdie claim consists generally of barren hill slopes which are covered in places with patches of pine trees and alders. Drainage is mainly through Horse Canyon and adjacent smaller canyons. A thin layer of soil covers in part the granitic surfaces of the area and the exposed granite shows an advanced stage of weathering. The area adjacent to the claim is very similar to the claim area itself, being fairly consistent over the entire region that comprises the west slope of the Continental Divide.

Climatic conditions are about the same as for the Butte region, but heavier snows during the winter months are characteristic of the area. Temperatures are extreme during winter, ranging from a few degrees below freezing to 20 or even 30 degrees below zero. During the summer months, temperatures vary, from about 50°F to 80°F. The long winter months plus heavy snow falls make this climate rather unfavorable for winter outdoor operations, especially as far as mining operations are concerned. It is the writer's opinion that these extreme winter conditions are a handicap in the operation of the Birdie mine. Actually only four to five months out of the year are available for accessibility to the mine, and most operations would have to be performed during this short interval.

HISTORY

The location notice of the Birdie claim shows that this claim was registered under Survey No. 6076, Mineral Entry No. 4063, and Patent No. 35962. It was located in the late 1800's by Sampson Beers, who also patented it later on, and owned it for many years. Apparently, the mine was originally worked for silver, but no published records of production or smelter returns could be found in the literature and other informative sources. Several articles published in the early 1900's make reference to the Birdie mine, and parts of these are reproduced in the following lines.

F. Tomek (9,p.63), in 1908, wrote as follows about the Birdie: "There is only one mine known in Montana that contains huebnerite ore in commercial quantity and quality. No shipments of tungsten were ever made from Butte. The only shoot of huebnerite is in the Birdie mine, about 4 miles east of Butte, although a few pieces of the ore were found about 1/2 mile north and also about 1-1/2 miles east of this mine, but not enough to warrant expensive mining. The Birdie is an old silver mine, having produced thousands of tons of siliceous silver-bearing ore in former years. The mine is opened by a tunnel, 1000 feet long, drifts, crosscuts and an upraise to the surface (about 250 feet). The silver ore is all stoped out above the tunnel. The chimney shoot of huebnerite is at the west end of the silver bearing quartz, and is from 6 to 10 feet long. All the way from the back of the tunnel to the surface (250 feet) a winze has been sunk on the shoot, where the huebnerite is from 3 to 5 feet wide and about 20 feet long. The ore body seems to be increasing in length and width as well as the quantity of metal, as depth is gained, below the tunnel level."

The Mining and Scientific Press (1,p.705), made the following statements in the November issue of 1910: "Several fine deposits of tungsten have been discovered in the Butte Continental district, east of the city; high-grade tungsten ore is being mined from the Birdie claim by Fred Tomek and associates. The Birdie is owned by Samuel Beers and others, and is situated just east of the State of Maine and Mountain Lion claims, properties upon which considerable development work has been done, and is three claims west of the property of the Butte Continental Mining Co. There is an adit 1800 feet long on the Birdie in which several stringers of tungsten were cut. Samples of this ore were sent to Denver and the assays returned were high. Tomek and Beers sank on the stringers and opened a body of ore six feet wide; they then drove on this ore for 30 feet, the vein growing larger as the drift progressed. Thirty tons of the ore were concentrated, three into one; and the concentrate assayed 60 per cent tungsten .... Tomek, who is an experienced miner and engineer, says that there is a deposit of tungsten on the Louisiana claim of the Butte Continental Co. Preparations are made to develop the Birdie extensively."

Frank L. Hess (3,pp.711,713, and 4,p.722), wrote two articles on this property, as follows: "In Montana, huebnerite was produced at the Birdie mine, 4 miles east of Butte. The Birdie has been worked for a silver mine, and the tungsten ore is said to occur in a shoot at the end of a silver-bearing vein. The shoot is reached by a 400 foot tunnel at the depth of between 250 and 300 feet."

"The only tungsten ore known to have been mined in Montana during 1908 was a lot of huebnerite from the Birdie mine near Butte ...."

Another article was published in 1910, by Alexander N. Winchell (11,pp.163,164). He wrote as follows: "In Butte, huebnerite has long been known as a minor constituent of the ores, both in the copper veins and also in the gold-silver veins. The chief production of tungsten ore has come from the Birdie and Scottish Chief mines east of the great copper mines. The ore here occurs in gold-silver veins in quartz monzonite country rock. The chief gangus material is quartz; other associated minerals include pyrite, marcasite, and smaller amounts of galena, sphalerite, and silver and copper minerals. The huebnerite is usually in large thin-bladed crystals often arrayed in divergent groups."

The above articles give an idea on the extent of information that is available in the literature and the writer could not find any more written early information concerning this mine. From a conversation with Mr. John Maxwell, prospector and mining man, who has been residing on East Ridge for the last 45 years, it was said that to the best of his knowledge no tungsten was ever shipped out of the Birdie. He mentioned the fact, however, that approximately $100,000. worth of silver ore had been mined and shipped from the mine. On further conversations with Mr. Edward Shea and Mr. Charles Goddard of the Geological Department, Anaconda Copper Mining Co.; they also maintain that no tungsten ore had ever been shipped from the Birdie. The present owner of the mine, Mr. William J. Maretta, has the same opinion.

Mr. Uuno M. Sahinen mentions in his report on the Birdie that an old map (prepared about 1915) shows that 80 tons of tungsten ore was produced from an underhand stope just below tunnel level. Reports indicate that this ore carried 20 per cent tungsten trioxide, but there is no mention as to whether it was shipped out or not.

The Birdie mine apparently has been inactive for many years since it was worked last, and only during the summer of 1951 it was reopened for examination. This work was performed under the supervision of Mr. William J. Maretta and consisted of reopening and making accessible the main adit crosscut, 595 feet long, and approximately 235 feet of the main drift. Also some crosscutting was done for the purpose of exposing the hanging wall along the vein. A small test lot of ore was mined from the old raise, the sill of the underhand stope, and the hanging wall of the drift for the purpose of conducting flotation tests to determine the possibility of recovery. These tests were performed at the Montana School of Mines Mineral Dressing laboratories under the supervision of Professor Donald W. McGlashan. Mr. Maretta has intentions of performing additional development work at the Birdie in the near future.

GENERAL GEOLOGY

The eastern part of the Butte district in consideration, as well as the mountain ridge, properly known as East Ridge, lie in the great mass of igneous rocks known as the Boulder batholith. This batholith is a large intrusive mass which extends some 25 miles in width and about 70 miles in length, extending all the way from the Highland Mountain south of Butte to Helena, Montana. The rocks that compose this batholith in this district are essentially of very few types and are of similar mineral and chemical composition, but they are different in appearance. Porphyritic quartz monzonite characterizes the main type of rock in the Butte district, and is also one of the most abundant rock types occurring on East Ridge. The other important rock type present in these areas is aplite which has also a rather common occurrence. The Boulder batholith is the host rock of many of the important ore deposits in this region.

The rocks of the East Ridge are essentially of the same character as those of the Butte district, they have a very similar mineral and chemical composition. Aplites are abundant on East Ridge, but they do not occur in large portions and more commonly occur in the form of dikes and small irregular masses. Several of these were noticed in the Birdie mine while conducting the survey. An advanced state of weathering and decay of the quartz monzonite can be noticed in the vicinity of the Birdie as well as in some parts of the crosscut. The accompany-

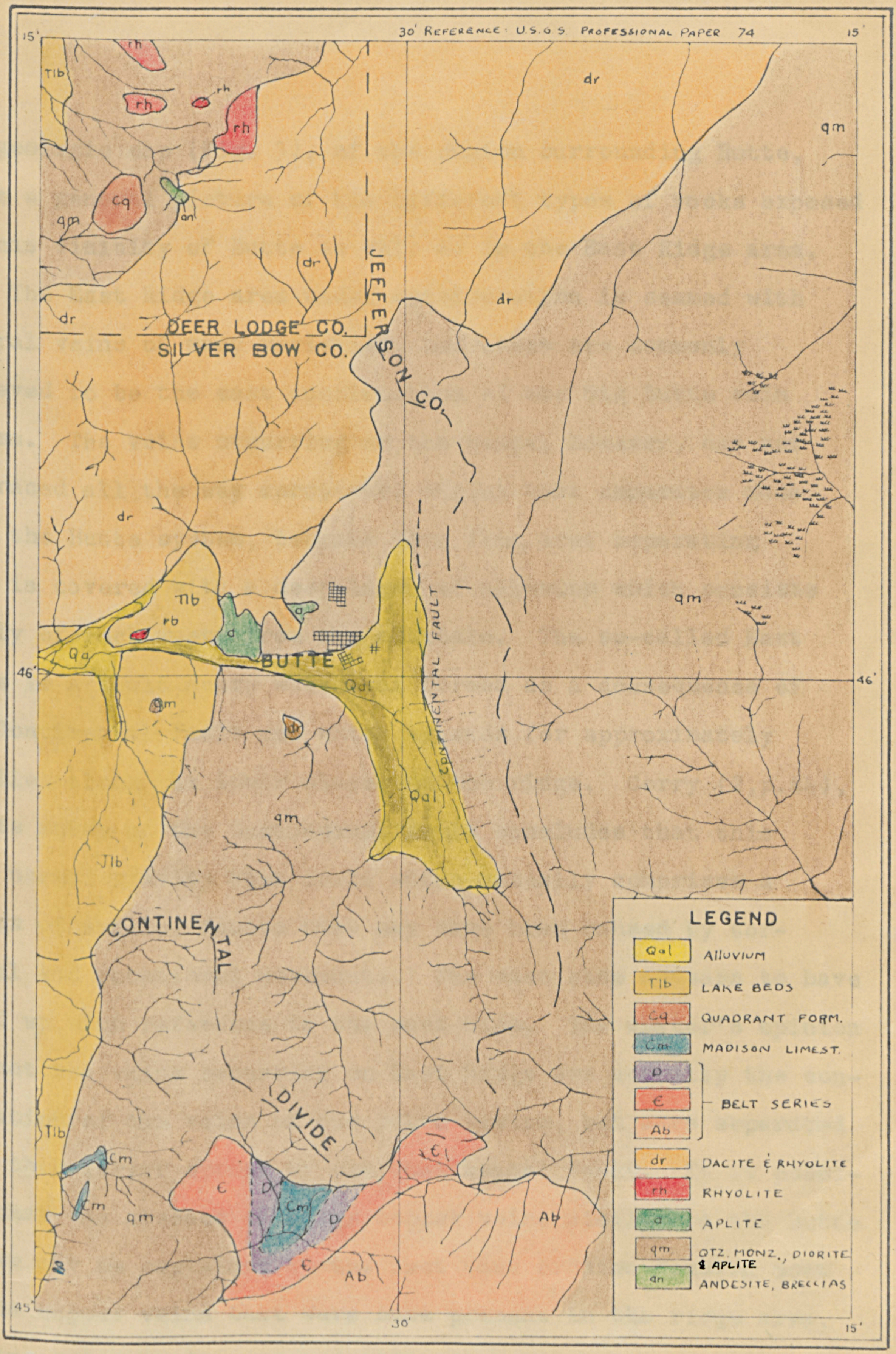


FIG. 3. GEOLOGIC MAP OF REGION SURROUNDING BUTTE

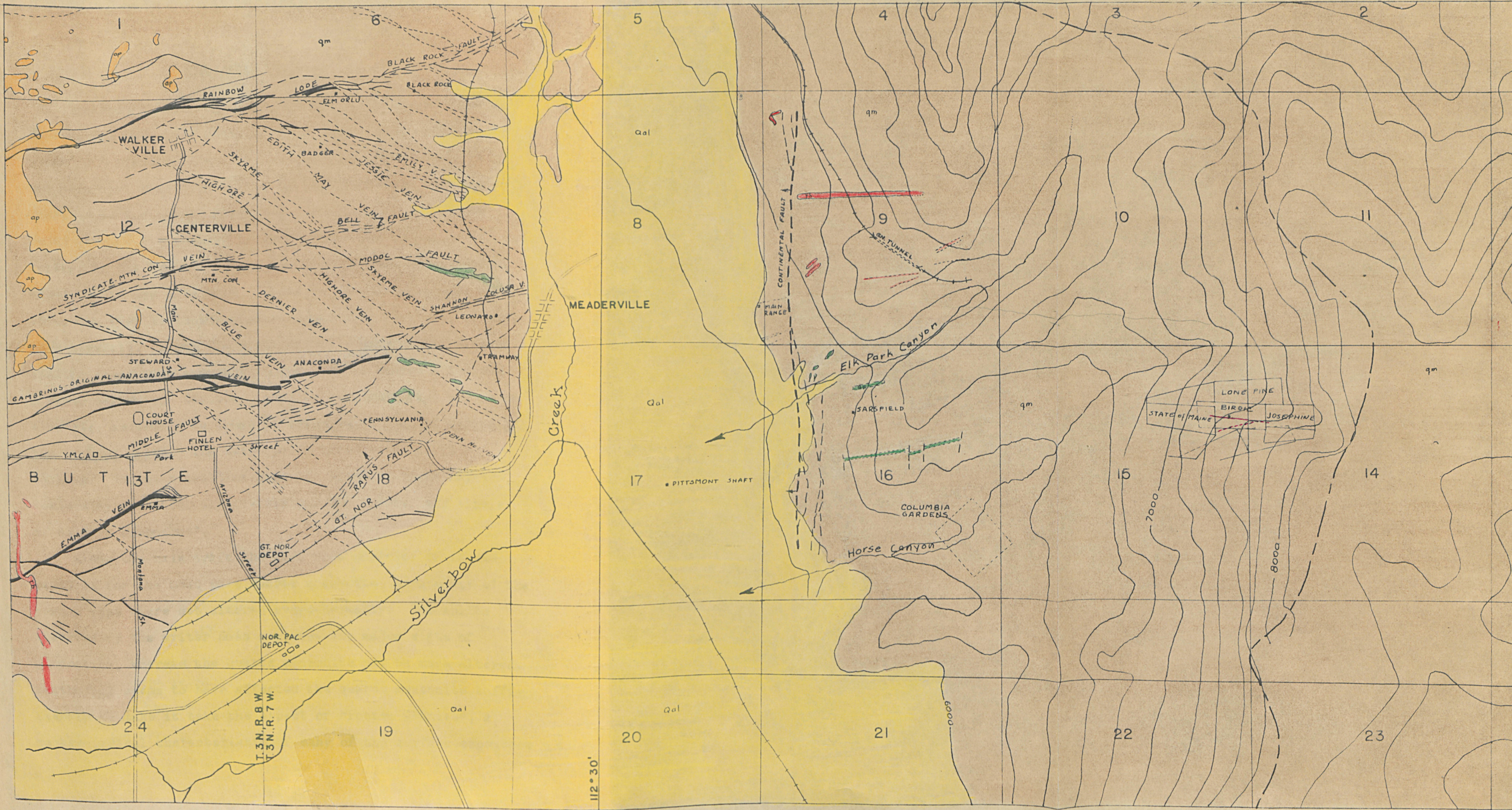
2 0 2 4 6 8 10 MILES

SCALE $\frac{1}{250,000}$

ing geologic map (Fig. 3), of the region surrounding Butte, gives a general picture of the different types of rocks exposed in this vicinity of Butte as well as in the East Ridge area.

The East Ridge area under consideration is seamed with mineral veins of many varieties, and these are commonly believed to be the east continuation of the big Butte vein system. The veins occurring on the ridge, however, can not be traced all the way across the valley that separates them from the Butte system, because this flat area separating them is covered with a deep layer of alluvium which consists mainly of rock waste from the mountain. The so-called East Ridge is a fault scarp which was formed as a consequence of the Continental Fault and which extends for approximately 15 miles along the lower slopes of the ridge. Corry (2,p.44), in his study of the Continental Fault concludes that this is a normal gravity type fault which actually comprises a series of smaller faults that may have been caused by torsional and rotational movements. The east side appears to have moved up with reference to the west side. The writer's opinion is that the veins occurring on East Ridge are actually the continuation of the veins of the Butte system, but were separated from this larger system by the Continental Fault. It is possible that the absence of large copper veins similar to the Butte system may be explained by the fact that erosion removed most of the copper veins that were once present in the ridge area, leaving only the deep-seated veins that are still present. It is interesting to notice that the veins on East Ridge show the same general east-west trend as the veins of the Butte system which may give some conclusive evidence of the relationship between these two systems.

A map was prepared by the writer (Plate I), which shows the relationship between the Birdie vein and the principal Butte veins. The Birdie vein has a definite east-west trend which falls nicely into the east-west trend of certain of the veins at Butte. Also, the occurrence of tungsten ore in some of the Butte mines, namely the Leonard and Gagnon mines, gives further indication of the possiblity that the tungsten deposit of the Birdie mine may be of the same type of mineralization as that of the Leonard and Gagnon mines. This is naturally a hypothetical assumption and should be regarded only as a possibility. The indications are that the Continental Fault is a post-mineralization fault and occurred after the mineral deposits were formed in the batholith.



WALKER VILLE
CENTERVILLE
MEADERVILLE
BUTTE
RAINBOW LODE
BLACK ROCK FAULT
BLACK ROCK
ELM ORLU
EDITH
BADGER
SKYRME
HIGH ORE
MAY
JESSIE VEIN
EMILY V.
BELL
FAULT
VEIN
SYNDICATE MTN CON VEIN
MTN CON
MODOC
FAULT
SKYRME VEIN
HIGHORE VEIN
DERNIER VEIN
BLUE VEIN
SHANNON
COLUSA V.
LEONARD
TRAMWAY
STEWARD
GAMBRINUS-ORIGINAL-ANACONDA VEIN
ANACONDA
COURT HOUSE
MIDDLE FAULT
FINLEN HOTEL
Y.M.C.A.
Park Street
PENNSYLVANIA
PENN No. VEIN
RARUS FAULT
GT. NOR.
GT. NOR DEPOT
EMMA VEIN
EMMA
Main St.
Montana St.
Arizona Street
NOR. PAC. DEPOT
Silverbow
Creek
T.3N.R.8W.
T.3N.R.7W.
112°30'
PITTSMONT SHAFT
Qal
qm
ap
CONTINENTAL FAULT
MAIN RANGE
TUNNEL
Elk Park Canyon
SARSFIELD
COLUMBIA GARDENS
Horse Canyon
LONE PINE
STATE of MAINE
BIRON
JOSEPHINE
6000
7000
8000
1
2
3
4
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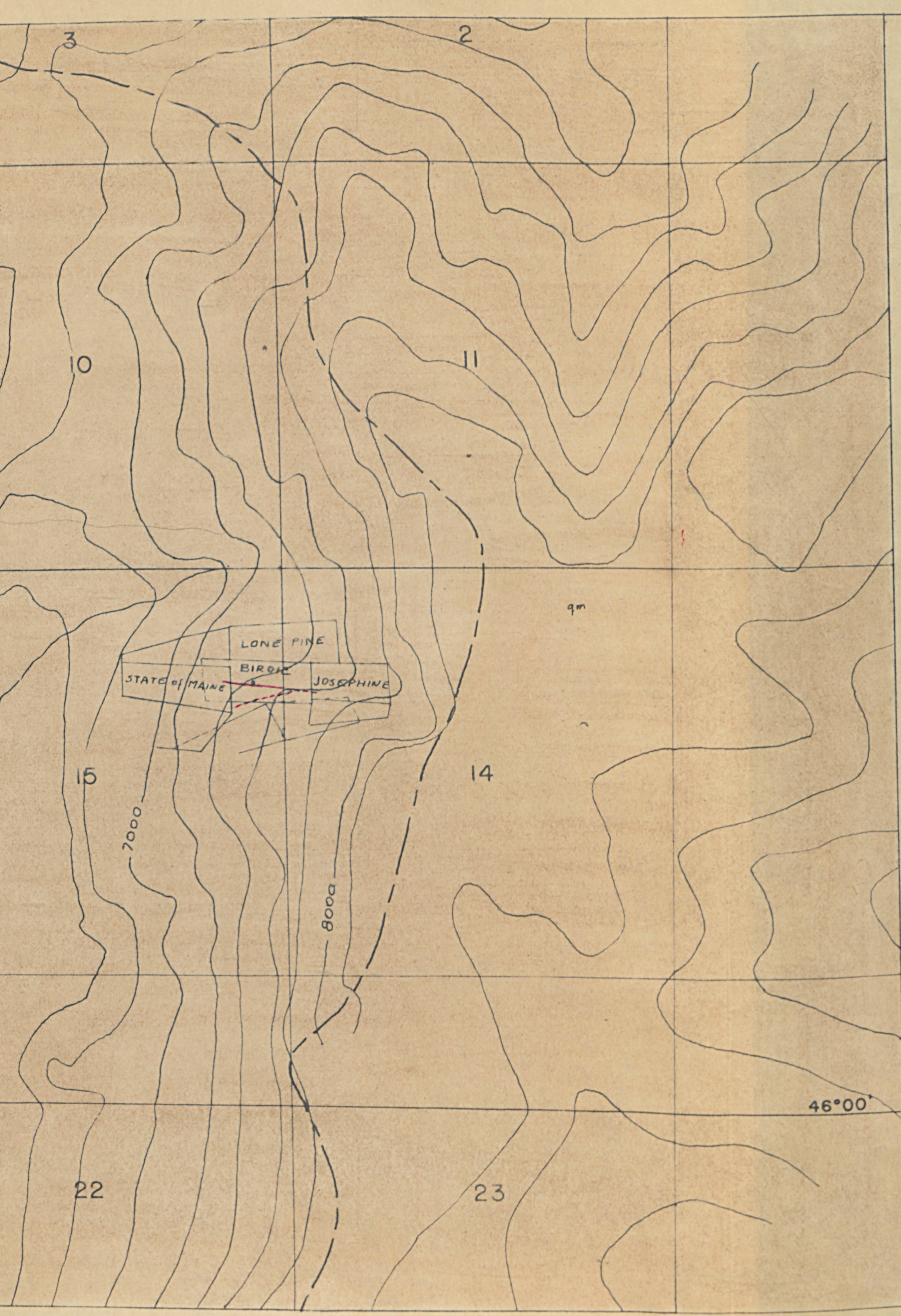


MAP SHOWING

RELATIONSHIP OF BIRDIE VEIN TO THE BUTTE VEIN PATTERN

COMPILED FROM GEOLOGIC CONGRESS 1933 GUIDEBOOK 23 EXCURSION C-2, AND UNITED STATES FOREST SERVICE MAP OF DEER LODGE FOREST, AND OTHER SOURCES.

BY

B. A. FAHM

LEGEND

SEDIMENTARY ROCKS

QUATERNARY
- Qal — ALLUVIUM AND WASH

TERTIARY
- Tlb — LAKE BEDS

IGNEOUS ROCKS

LATE CRETACEOUS OR EARLY TERTIARY
- rh — RHYOLITE
- qp — QUARTZ PORPHYRY (APLITE)
- ap — APLITE
- an — ANDESITE
- qm — QUARTZ MONZONITE

FAULTS AND VEINS

- ANACONDA OR EAST-WEST SYSTEM
- BLUE VEIN OR NORTHWEST SYSTEM
- NORTHEAST SYSTEM, FAULTS LATER THAN NORTHWEST SYSTEM
- BIRDIE VEIN

- MINE SHAFT

1,000 0 5,000 FEET

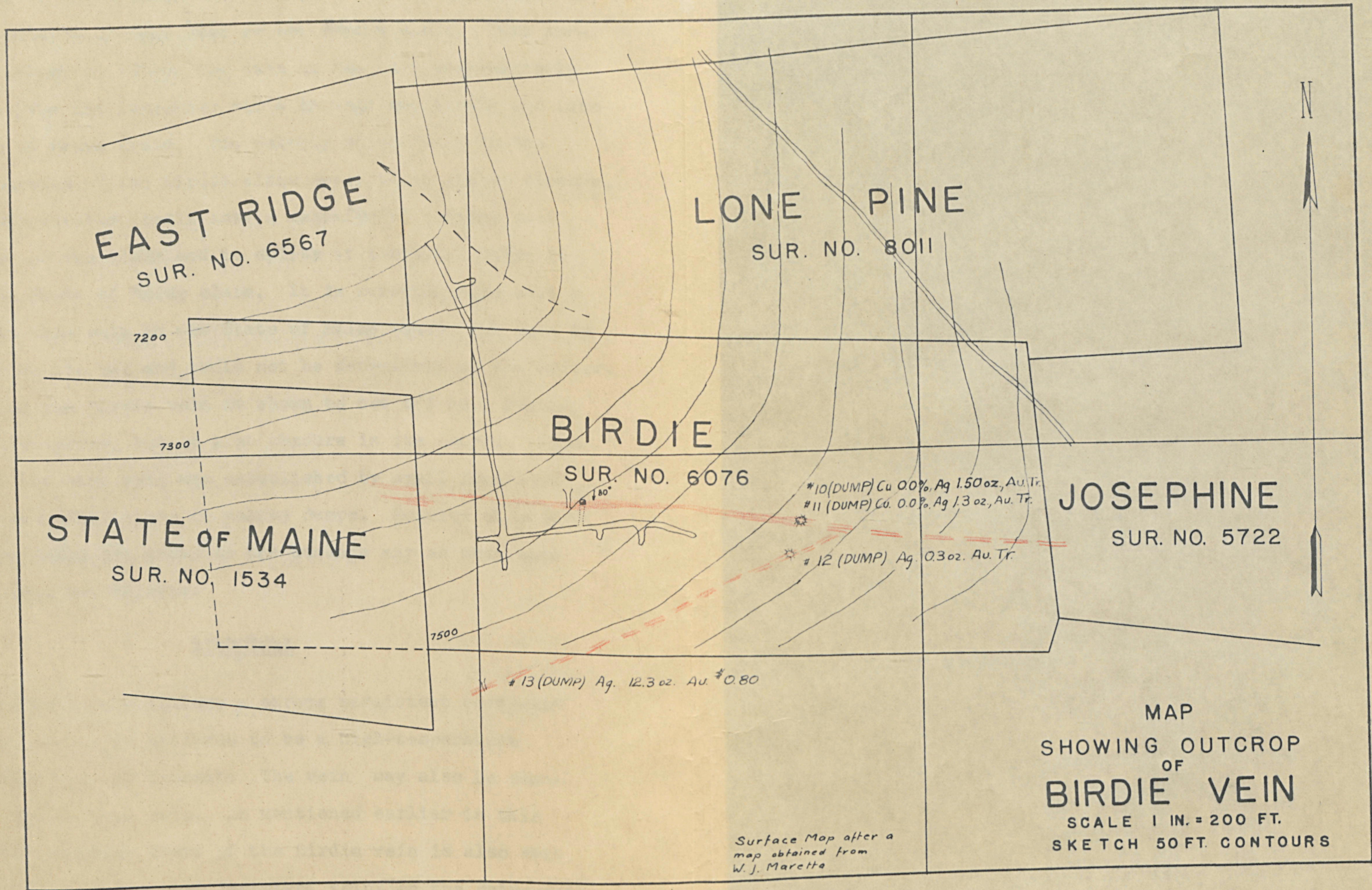
THE BIRDIE MINE

The Birdie mine, the plan of which is shown on Plate 2, lies in the rock type known as porphyritic quartz monzonite, which is a granitic rock and, as previously mentioned, is the principal rock type of the Boulder batholith. At the Birdie mine the quartz monzonite, more popularly known as Butte granite, is present in appreciable quantities. Aplite, in the form of dikes, can also be seen along several exposures in the main adit. Close to the portal of the main adit, the rock is light-colored, containing very few, if any, dark minerals. Along the walls of the cross-cut the exposed aplitic rocks have a sugary texture and in places a coarse-grained pegmatitic texture. Locally this rock type may be an alaskite, according to Spurr in Johannsen's Classification of the Igneous Rocks. The description given by Spurr is as follows: "Holo-crystalline-granular plutonic rocks characterized by essential alkali-feldspar and quartz, and little or no dark component".

Along the main drift the wall rock wherever it is exposed is for the most part quartz monzonite, apparently of the normal type where not altered hydrothermally. The aplite observed by the writer does not show any major signs of alteration, whereas the quartz monzonite may be much altered. Weathering seems to have affected the quartz monzonite sufficiently to make it take the aspect of "rotten granite", a rather typical characteristic of many of the surface exposures on East Ridge. Along the exposed part of the foot wall of the main drift the quartz monzonite is soft and altered, but still shows a distinct granitic texture. Many of the exposed parts of the hanging wall are a soft, white, highly-altered and sericitized rock which shows no evidence of granitic texture. In some areas aplite is present.

From the intersection of the main cross-cut with the drift, and continuing east for almost 50 feet along the foot wall, a thin quartz vein is exposed, but it disappears from the drift at this point. From this point going further east, the drift runs along a strong quartz vein, but the foot wall and hanging wall are obscured. The exposure of the foot wall from this point on east shows a great resemblance to the hanging wall; both showing hydrothermally altered and sericitized quartz monzonite. The hanging wall, although not exposed in the old drift is exposed in the main cross-cut, and in a short cross-cut some 165 feet farther east. Some recent work has exposed it also in two small "dog-hole" cross-cuts. The width of the vein at these small intermediate cross-cuts varies from 12 to 14 feet. This measurement was originally made by Mr. Sahinen and also was observed by the writer. The vein is not uniform and some inclusions of sericiticed rocks were noticed.

The surface exposure of the Birdie vein could not be determined by the writer at the time because deep snow was covering the area of the claim. A surface map furnished to

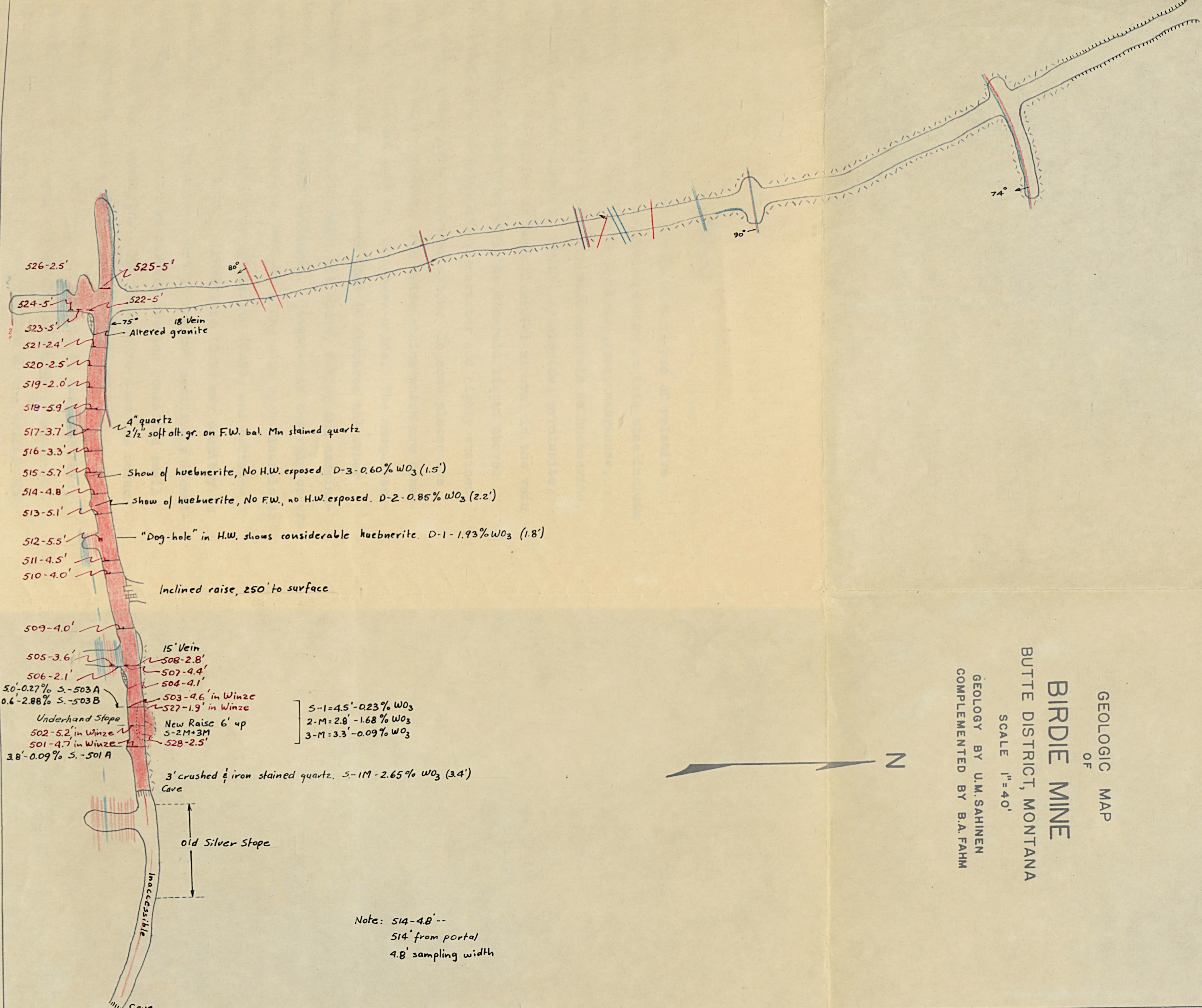

EAST RIDGE
SUR. NO. 6567
LONE PINE
SUR. NO. 8011
BIRDIE
SUR. NO. 6076
JOSEPHINE
SUR. NO. 5722
STATE OF MAINE
SUR. NO. 1534
7200
7300
7500
80°
#10 (DUMP) Cu 0.0%, Ag 1.50 oz., Au. Tr.
#11 (DUMP) Cu. 0.0%, Ag 1.3 oz., Au. Tr.
#12 (DUMP) Ag. 0.3 oz. Au. Tr.
#13 (DUMP) Ag. 12.3 oz. Au. $0.80
N
Surface Map after a map obtained from W. J. Maretta
MAP
SHOWING OUTCROP
OF
BIRDIE VEIN
SCALE 1 IN. = 200 FT.
SKETCH 50 FT. CONTOURS

the writer by Mr. Maretta, was therefore freely reproduced to show the outcrop of this vein on the Birdie claim. This surface map (Plate 2), shows the vein to run in a east-westerly direction from the Josephine claim through the Birdie and into the State of Maine claim. The outcrop of the vein in the eastern portion of the Birdie claim seems to be rather obscure, but it consolidates itself into a well-formed outcrop near the center of the claim and it splits at the point where it enters the State of Maine claim. It is reported also that a fault cuts this vein in the State of Maine claim, but this is not shown on the map and could not be determined by the writer. A branch of the Birdie vein is shown to cut off in a southwesterly direction, but is also obscure in its course. This branch of the main vein was established by small localized outcrops and indications on nearby dumps. Results of assays from these dumps are shown on the surface map as they were obtained from Mr. Maretta.

STRUCTURE

The Birdie vein follows a strong persistent east-west structure, and it is believed to be a high-temperature hydrothermal type of deposit. The vein may also be considered a fissure type vein. As mentioned earlier in this paper, the east-west trend of the Birdie vein is also very characteristic of the most important veins on the Butte Hill. The Birdie vein strikes approximately N. 83°E., and dips from about 77° SE to nearly vertical. Mr. Sahinen determined a strike of about N. 85° E., and a dip of 75° SE to vertical. The writer took various strike and dip readings along the vein with Brunton compass, and the average of these was computed and given as the result. The width of the vein where the main cross-cut intersects the main drift was measured to be from 18 to 20 feet. From the main cross-cut east, the main drift is accessible for about 235 feet, beyond that the drift is caved in solid and not accessible at the present.

The vein seems to be stronger in the western portion of the drift. It becomes slightly weaker going east, but it still is well developed in this area. A good-sized fault can be traced within the foot wall of the drift wherever the small cross-cuts and dog-holes expose it. It can be traced parallel along the vein, and possibly may have caused a certain displacement of undetermined nature. The other faults that were observed are of small size and occur mainly along the main cross-cut. They have not affected the vein, or produced any appreciable displacement. The geologic structures are shown in the accompanying geologic map of the Birdie mine (Plate 3), as they were recorded by Mr. Sahinen and complemented by the writer.



GEOLOGIC MAP
OF
BIRDIE MINE
BUTTE DISTRICT, MONTANA
SCALE 1"=40'
GEOLOGY BY U.M. SAHINEN
COMPLEMENTED BY B.A. FAHM
N
74°
90°
80°
526-2.5'
525-5'
524-5'
522-5'
523-5'
75°
18' Vein
Altered granite
521-2.4'
520-2.5'
519-2.0'
518-5.9'
4" quartz
2 1/2" soft alt. gr. on F.W. bal. Mn stained quartz
517-3.7'
516-3.3'
515-5.7'
Show of huebnerite, No H.W. exposed. D-3-0.60% WO3 (1.5')
514-4.8'
Show of huebuerite, No F.W., no H.W. exposed. D-2-0.85% WO3 (2.2')
513-5.1'
512-5.5'
"Dog-hole" in H.W. shows considerable huebnerite. D-1-1.93% WO3 (1.8')
511-4.5'
510-4.0'
Inclined raise, 250' to surface
509-4.0'
15' Vein
505-3.6'
508-2.8'
506-2.1'
507-4.4'
504-4.1'
5.0'-0.27% S.-503A
0.6'-2.88% S.-503B
503-4.6' in Winze
527-1.9' in Winze
S-1=4.5'-0.23% WO3
2-M=2.8'-1.68% WO3
3-M=3.3'-0.09% WO3
Underhand Stope
New Raise 6' up
S-2M+3M
502-5.2' in Winze
501-4.7 in Winze
528-2.5'
3.8'-0.09% S.-501A
3' crushed & iron stained quartz. S.-1M-2.65% WO3 (3.4')
Cave
Old Silver Stope
Inaccessible
Note: 514-4.8'--
514' from portal
4.8' sampling width
Cave

MINERALOGY

The mineralogy of the Birdie mine is one of relative interest. The important metals occurring in this mine include tungsten, copper, silver, zinc, antimony,iron, manganese, and lead. These metals occur in such minerals as huebnerite, chalcopyrite, tetrahedrite, pyrite, sphalerite, pyrolusite, and galena. Quartz is the most plentyful mineral in the vein and is closely associated with the minerals listed above. The quartz is of a white milky character and highly stained along the cracks with manganese oxide. In some places the quartz also shows abundant iron oxide stains which are sometimes intermingled with the manganese oxide. The manganese oxide is so abundant in places that it obscures the other materials present in the vein; therefore, making the examination of the vein rather difficult. Tungsten in the vein occurs in the form of huebnerite ($MnWO_4$), along with such minerals as pyrite (FeS_2), galena (PbS), sphalerite (ZnS), and tetrahedrite $(Cu,Fe,Zn,Ag)_{12}Sb_4S_{13}$. Covellite (CuS) may possibly be present in small quantities, but it was not positively identified even though a polished surface section contained small grains resembling covellite. The huebnerite does not occur in a uniform distribution in the vein but shows rather a disseminated form of occurrence. In general it seems to favor strongly the hanging wall and at the same time seems to increase in abundance in the east portion of the drift. It is hard to determine the total extent of the huebnerite occurrence since only parts of the hanging wall are exposed. A small raise that was recently opened by the present owner shows some huebnerite, but it is very disseminated. The best exposures were found where the small dog-hole cross-cuts cut into the hanging wall. Another fairly good exposure in the hanging wall was noticed on going east just before readhing the new raise. It is also reported that a good showing of this mineral was seen in the underhand stope, but this fact could not be checked by the writer because the stope was completely under water at the time of visitation.

The minerals found in the studies of the Birdie vein were determined with the usual characteristic tests on the polished surface sections. The following minerals were identified:

Quartz (SiO_2) This mineral makes up the large percentage of the gangue minerals and is mostly of the white variety. Manganese oxide and iron stains are abundant throughout the quartz, and commonly obscures the quartz. Under the reflecting microscope quartz is readily identified by its extreme hardness, grayness, transparency, and negative reaction to all chemical etch tests.

Huebnerite ($MnWO_4$) Color gray, like sphalerite; has a hardness of "D" to "E" and 5 in the Mohs scale. It can be scratched with a needle. Huebnerite is characterized by its strong anisotropism and its negative reaction to all chemical reagents. The specimen studied by the writer appeared all in radiating crystal groups which seem to be characteristic of the Birdie

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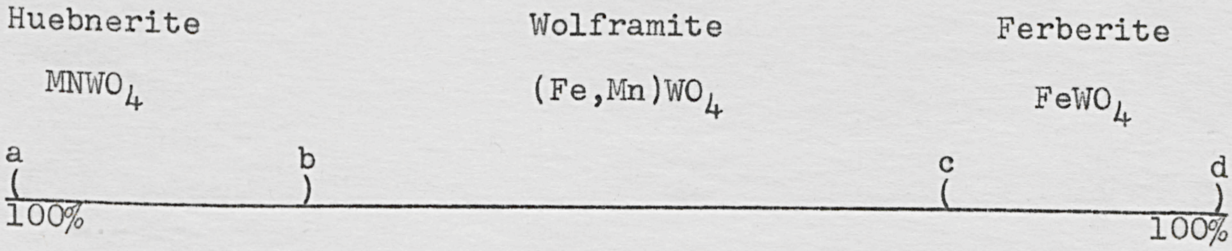
huebnerite. The writer found some thinly-bladed huebnerite crystals which much resembled covellite crystals because of their shape and their covering with dark manganese oxide. The thin-bladed crystals of huebnerite were observed in a handspecimen and it was believed that these may be wolframite crystals because they seem to have a monoclinic system. The determination of whether these crystals are huebnerite or wolframite was not definitely established as only chemical analysis could more definitely determine this. A sketch illustration of the transition between huebnerite and wolframite shows why a definite conclusion could not be reached at present. (5,p.4)



The above illustration shows how huebnerite at point (a) may gradually change into wolframite as the percentage of manganese decreases when approaching point (b). The division between huebnerite, wolframite, and ferberite is only diagramatic in the figure but illustrates the gradation of one mineral to another. It can be noticed that the composition of wolframite includes both manganese and iron in varying amounts. For practical illustration, if we consider point

(b) as the point where huebnerite changes into wolframite it can readily be seen that if the composition of the mineral under consideration falls closely on either side of point (b) it could be considered either huebnerite or wolframite. The microchemical tests performed on the polished surfaces for huebnerite did not reveal any iron tests, but no tests were performed on the handspecimens that display the thin-bladed tungsten mineral crystals which were believed to be wolframite.

Chalcopyrite ($CuFeS_2$) This mineral could not be definitely determined because it was only noted as exsolution blebs in sphalerite, where it appears as very minute specks. The typical yellow color suggests chalcopyrite, and its presence is further substantiated by the typical occurrence of chalcopyrite as an exolution product in sphalerite.

Tetrahedrite ($(Cu,Fe,Zn,Ag)_{12}Sb_4S_{13}$) The mineral was identified by its gray color, hardness "D", and the subsequent etch tests. Nitric acid fumes tarnished the mineral after more than a minute exposure. A similar tarnish was noticed when the mineral was exposed to aqua regia. Other reagents gave negative reactions. Additional microchemical tests revealed the presence of zinc, copper and antimony thus proving the presence of tetrahedrite. Isotropism also substantiated this conclusion.

Pyrite (FeS_2) The characteristic pale brass-yellow color plus its hardness of "F", made this mineral readily recognizable. It could not be scratched with the needle and tarnished in the presence of nitric acid fumes.

Sphalerite (ZnS) This mineral was seen to be the host for the chalcopyrite exolution grains. Additional evidence of its presence was established by its characteristic gray color, hardness of "C", and the dark brown stains produced when exposed to aqua regia. Microchemical tests revealed the presence of zinc.

Pyrolusite (MnO_2) This mineral could be readily identified in the handspecimens by its sooty black appearance. Under the reflecting microscope it appeared as a white grayish mineral, showing anisotropism. Etch test showed brown stains on the specimen when exposed to hydrochloric acid and aqua regia, the remaining reagents being negative. Hydrogen peroxide produced efferevescence but did not stain the surface.

Galena (PbS) Hardness "B", plus the typical galena white color made this mineral easily recognizable. Hydrochloric acid tarnished the mineral brown and microchemical tests revealed the presence of lead. Although, this mineral was not found in any appreciable quantities it was seen in several of the polished surface sections.

Covellite (CuS) The indications are that this mineral is present, but no definite tests could be performed by the writer to determine this accurately. The mineral suspected as being covellite could be seen replacing tetrahedrite and is believed to be covellite because of its typical indigo blue color. The mineral occurs in such minute quantities that it was impossible to perform any etch test on it to determine the accurracy of its identification. The conclusion for its possible presence was based only on the color and softness of this mineral.

Arsenopyrite ($FeAsS$) The presence of this mineral was noticed in a specimen obtained from Mr. Sahinen. The mineral occurs as very fine fissure fillings or veinlets in a quartz matrix and is of extreme hardness. Microscopic tests did not satisfactorily determine this mineral and its identification was performed by blow pipe tests which revealed the presence of arsenic. A chemical test showed the presence of iron.

PLATE IV

PHOTOGRAPHS OF HANDSPECIMENS

OF HUEBNERITE ORES

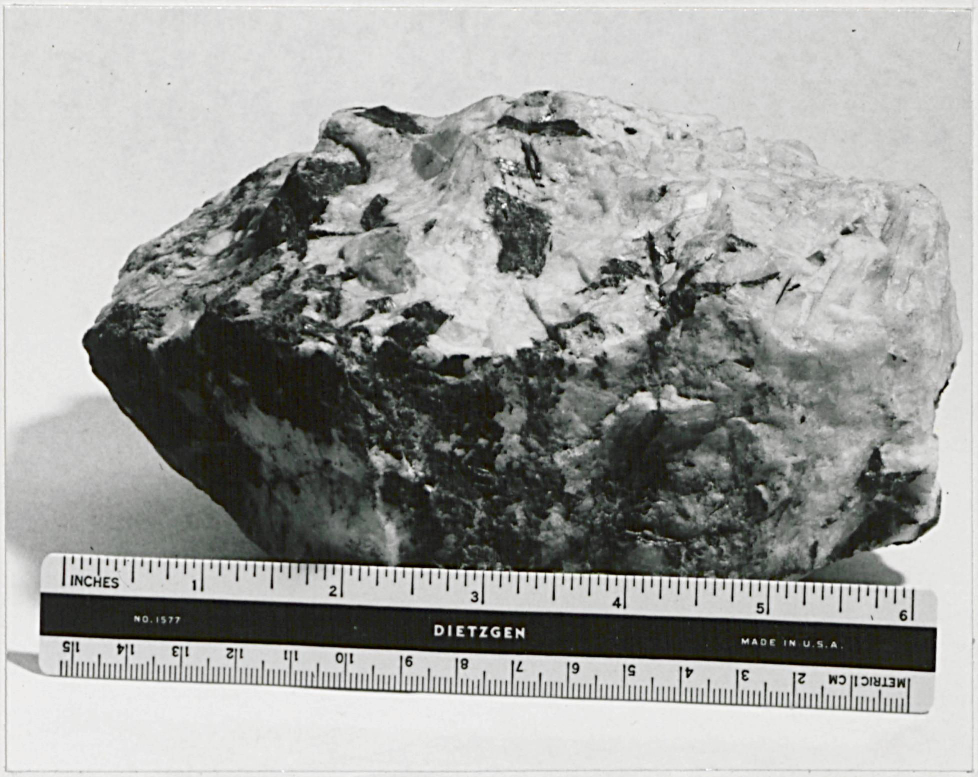
A.

Handspecimen from Birdie mine, Butte, Montana, showing huebnerite crystals in white, milky quartz.

B.

Handspecimen from Potosi Hot Springs, Montana, showing huebnerite crystals in white, milky quartz, A great similarity of specimens can be noticed, which indicates that both deposits may have been formed under similar geologic conditions.

A



B

PHOTOGRAPHS OF HANDSPECIMENS OF HUEBNERITE ORES

TENOR OF ORE

The ore mineral in the Birdie that is of most interest is the tungsten mineral huebnerite. Gold and silver occur in minor quantities. Pyrite, galena, sphalerite, and tetrahedrite occur in such small quantities at the Birdie that an economic recovery of these is practically out of question. The fact that the Birdie was worked originally as a silver mine, leads the writer to believe that this metal may have been recovered as an association product with such minerals as galena and tetrahedrite. Perhaps some of the silver may have been recovered in the native state. Since the old silver stope is caved in and inaccessible it is hard to verify this assumption.

A rather thorough sampling of the Birdie mine was conducted by Mr. Sahinen and Mr. Maretta, and chemical analysis of these samples were performed by local assay offices. The purpose of this was to determine whether the Birdie mine actually contained sufficient amount of tungsten ore to reopen this property and exploit it further. The writer has been given permission to reproduce these results as they were performed recently and could not have been reproduced by him in the time available.

In his report on the Birdie mine, Mr. Sahinen (8,p.6), states that an old map of 1915? shows that a series of samples taken over a length of 15 feet (184 to 199 feet east of the main cross-cut) showed a weighted average of 4.62 per cent WO_3

(tungsten trioxide) over an average width of 1.7 feet. The samples taken by Mr. Sahinen and Maretta showed that the tungsten content of the vein increases gradually from 0.60 per cent at a distance of 80 feet east of the main cross-cut to 2.63% WO_3 at 227 feet east of the main cross-cut. The results of the assays are as follows:

Sample No.	Dist. E. of X.C.	Width feet	% WO_3	Remarks
D3	80	1.5	0.60	HW side in "doghole" not exposed
D2	95	2.2	0.85	HW side in " " "
D1	115	1.8	1.93	HW side in X.C. White clay HW.
503A	185	0.6	2.88	HW side, 7' below sill in underhand stope, HW not exposed.
2M	195	2.9	1.68	HW side, 10 feet above sill in new raise. Average of two assays-1.50 and 1.68%
1M	227	3.4	2.63	Back of drift-average of two assays.

Mr. Sahinen, (8.p.6), states that, "the above samples do not include lower grade material on the foot wall. For instance, 2 samples in the raise showed 3.3 feet of 0.09% WO_3 and 4.5 feet of 0.23%, and in the underhand stope 2 more samples 5.0 feet of 0.27% and 3.8 feet of 0.09% WO_3." He further states that "if the above tabulated samples could be considered truly representative, which they cannot due to differences in intervals, they would give a weighted average of 1.75% WO_3, with an average width of 2.1 feet over a distance of 147 feet."

Mr. Sahinen also concludes that even though the 2.1 feet average width would be rather a narrow mining width, but that the presence of low-grade material in the foot wall could easily double the mining width and still hold the grade of ore so as not to drop below 1 %. He carries his calculations even further and states that if we consider the 2.1 feet width of ore over a distance of 147 feet and allow 12 cu. feet for each ton of quartz rock in place, 250 tons of ore of 1.75 % grade per foot of depth could be recovered. This shows that if such reasoning can be successfully set in practice a fair amount of ore would be recovered.

Sampling Results

Results reproduced from Mr. Sahinen's Report. (7,p.8)

No.	Width (feet)	Gold (ounces)	Silver (ounces)	Tungsten trioxide (per cent)	Remarks
1.	0.8	Trace	0.8	18.00	HW (Assay from old map (1915?)
2.	2.2	0.01	1.2	0.50	HW (" " " " ")
3.	1.5	0.01	2.0	5.60	HW (" " " " ")
4.	1.5	Trace	0.8	7.20	(" " " " ")
5.	1.2	0.01	2.0	0.75	( )
6.	1.2	Trace	0.9	2.70	( )
7.	0.8	0.01	2.5		( )
8.	1.4	0.01	1.2		( )
9.	1.3	Trace	0.7		( )

Sampling Results

Results reporduced from Mr. Shinen's Report.(8,p.8) Sampling for these results was done by Mr. Uuno M. Sahinen and Mr. William J. Maretta. The assays were performed by (L & W) Lewis and Walkers, Assayers, and (H & E) Hammond and Everly Engr. Co., Assayers.

No.	Width (feet)	Gold (ounces)	Silver (ounces)	Tungsten trioxide)per cent)	Remarks
502A	5.0	----	----	0.27	W. end Underhand stope
503B	0.6	----	----	2.88	W. end Underhand stope, HW streak
501A	3.8	----	----	0.09	E. end Underhand stope 22.5 feet
#1	4.5	----	----	0.23	W. wall new raise (low grade)
#2M	2.9	----	----	(1.50	HW side new raise (L & W)
				1.68 (	
#2M	2.9	----	----	(1.86	" " " " (H & E)
#3M	3.3	----	----	0.09	FW side raise (L & W)
#1M	3.4	----	----	(2.46	In drift 227' (L & W)
				2.63(	
#1M	3.4	----	----	(2.80	" " " (H & E)
#D1	1.8	----	----	1.93	HW-20' west of ind raise
#D2	2.2	----	----	0.85	HW-40' west of ind raise
#D3	1.5	----	----	0.60	HW-55' west of ind raise

PARAGENESIS

By observations made under the reflecting microscope and by direct observation of the vein in situ, the writer speculates that the Birdie vein was formed by the emanation of a quartz emplacement followed by a huebnerite emplacement which may have occurred simultaneously. The sulphide minerals seem to have come in at a later stage of mineralization, but it may be said that several quartz stages are characteristic because it occurs in vugs in well developed crystals, and in several occasions was seen to cut through late minerals. The sulphide minerals at the Birdie mine are not distributed regularly through the vein in the form of solid mineral aggregates but as sulphide blebs in late quartz. This characteristic occurrence was noted by the writer in most specimens prepared as well as in the vein in situ.

Huebnerite appears to have been emplaced simultaneously with the quartz as it shows well developed crystals in all the sections studied. These well developed crystals and smooth contact boundaries strengthen this evidence. The first sulphide replacing the quartz seems to be pyrite and also several well developed crystals of this mineral have been noticed. No relation could be established between huebnerite and any of the later following sulphide minerals because this mineral was not found in contact with any of the sulphide minerals present.

Sphalerite, the next mineral in the sequence of occurrence, was seen to be present only in very minor quantities, and it appears to be replacing the quartz and pyrite. This was determined by observing the boundaries of sphalerite with quartz and pyrite, and it can be seen displaying typical replacement boundaries with these two minerals. Another mineral, chalcopyrite shows very close relation to sphalerite in that it occurs as an exolution product in this mineral. Small blebs of chalcopyrite can be seen distributed throughout the sphalerite with the absence of chalcopyrite outside the sphalerite grains.

The position of arsenopyrite can not be definitely stated, due to its sole occurrence in quartz as a fissure filling material. The specimen observed under the reflecting microscope showed minute veinlets of arsenopyrite displaying parallel boundary lines with the quartz giving the criteria for fissure filling. The sequence of occurrence of this mineral as described by Edwards, in his book, Texture of Ore Minerals, places it after pyrite, and it is assumed by the writer to occur in this sequence in the Birdie suite. This assumption is taken, since no relation between this mineral and any of the other sulphide minerals could be seen.

Tetrahedrite has replaced pyrite and sphalerite. The criteria for these observations are the advanced "islands" of tetrahedrite in pyrite, a similar occurrence appearing in the sphalerite. Tetrahedrite also occurs as a very close intergrowth with the pyrite, and in several places the above criteria for replacement cannot be seen or determined.

Galena was seen in contact with pyrite and all the indications are that it replaces pyrite. Galena being a intermediate temperature mineral may well have been emplaced as an early sulphide mineral in the vein. The criteria for replacement are the uneven boundaries that galena displays with respect to pyrite but the writer could not definitely verify this replacement.

The presence of covellite, a secondary mineral in origin, indicates that some sulphide enrichment is present in the vein. This mineral can be seen replacing tetrahedrite in the form of veinlets, and also it forms halos around a few of the tetrahedrite crystals observed. The above speculation of secondary enrichment of the vein should be taken as hypothetical because the presentce of covellite was not definitely determined by the writer.

The mineral sequence is given in the order of replacement as they are believed to occur in the Birdie mine ore suite.

Quartz
Huebnerite
Pyrite
Arsenopyrite
Chalcopyrite
Sphalerite
Galena
Tetrahedrite

This list is a tentative sequencial relation and should be regarded as open to revision. The reason for this conclusion is the fact that some of the above minerals do not show a direct relation to each other and were placed in this order in a tentative form. Further study and determination may result in rearrangement of the order of deposition as listed above.

PLATE V

Photographs of Polished Surfaces
of Birdie Mine Ore Suite

Photograph A. Pyrite and galena in contact in quartz matrix. Galena apparently replacing pyrite. Small specks of galena were found in the pyrite crystal serving as an indication (advanced islands) of replacement. The contact between pyrite and galena shows the galena as if eating away the pyrite.

Photograph B. Arsenopyrite filling quartz fissures. The criteria for this conclusion is the parallel boundary lines of the small veinlets which indicates that the arsenopyrite is filling the quartz fissures.

Explanation of Symbols

Py -- Pyrite
Qtz -- Quartz
PbS -- Galena
Apy -- Arsenopyrite

A

B

PHOTOGRAPHS OF POLISHED SECTIONS

OF BIRDIE MINE ORE SUITE

PLATE VI

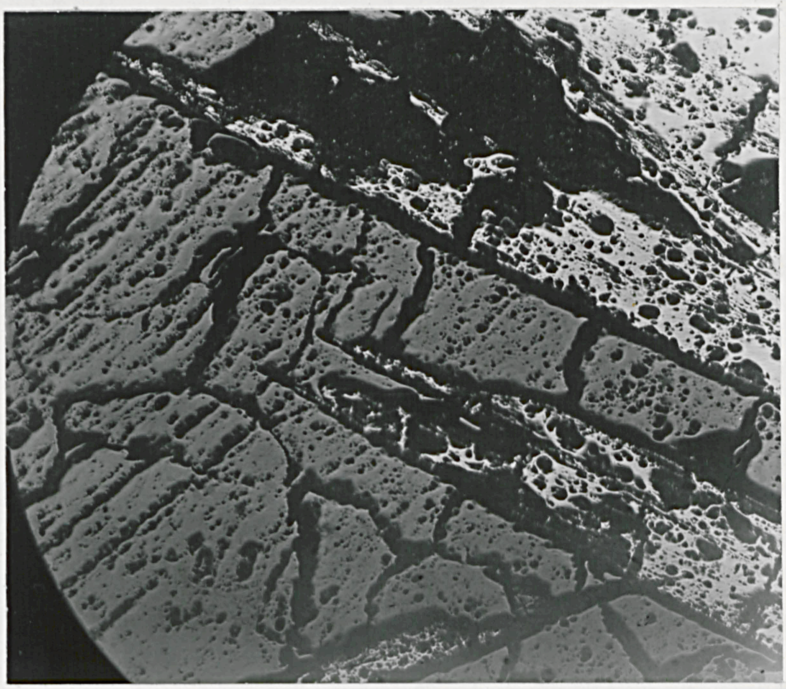
Photographs of Polished Surfaces
of Birdie Mine Ore Suite

Photograph A. Huebnerite crystals in quartz matrix showing well developed crystals. Indications are that huebnerite may have been emplaced simultaneously with quartz.

Photograph B. A different section showing huebnerite crystals in quartz matrix.

Explanation of Symbols

Hb -- Huebnerite
Qtz -- Quartz



A

B

PHOTOGRAPHS OF POLISHED SECTIONS

OF BIRDIE MINE ORE SUITE

Plate VII

Photographs of Polished Sections
of Birdie Mine Ore Suite

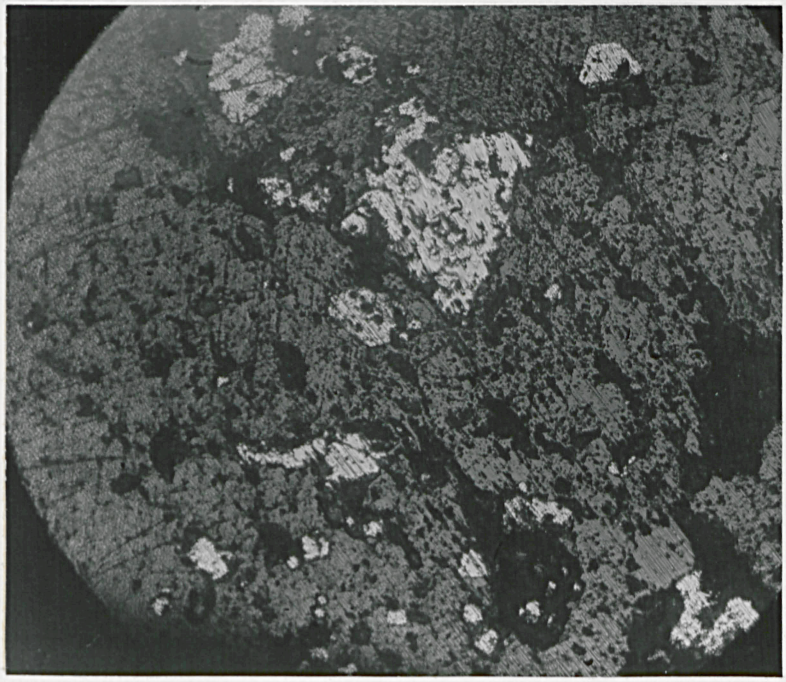
Photograph A. Tetrahedrite in quartz matrix. This mineral occurs in small grains and can be found in all the sections studied.

Photograph B. Tetrahedrite in contact with pyrite showing close intergrowth between the two minerals. Tetrahedrite can be seen replacing the pyrite.

Explanation of Symbols

Th -- Tetrahedrite
Py -- Pyrite
Qtz -- Quartz

A



B

PHOTOGRAPHS OF POLISHED SECTIONS

OF BIRDIE MINE ORE SUITE

CONCLUSION

The writer believes that further development work of the Birdie mine will reveal some more interesting geological facts that at the present can not be established due to the actual condition of the mine. This paper is far from being complete in many respects, but the writer hopes that the facts presented here will encourage further geological studies of this property. The reopening of the caved portion of the main drift will expose the old silver stope, and also valuable information will be made available regarding the continuity of the tungsten deposit. Further work in the raise and winze will also give more evidence of the extent of this deposit, and more conclusive reserve figures may be determined. The writer is of the opinion that only by doing more exploration work along the vein can better geological information be brought to light, and along with this information a better knowledge of the grade and tonnage of ore available.

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