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A Microscopic Study of the Ore Minerals from the Mines in the Northern Part of the Zosell (Emery) Mining District

John P. Joyce

A MICROSCOPIC STUDY OF THE ORE MINERALS FROM THE MINES IN THE NORTHERN PART OF THE ZOSELL(EMERY) MINING DISTRICT

By

John P. Joyce

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

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A MICROSCOPIC STUDY OF THE ORE MINERALS FROM THE MINES IN THE NORTHERN PART OF THE ZOSELL(EMERY) MINING DISTRICT

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INTRODUCTION

Any investigation of the many gold silver producing districts of Montana will necessarily include the name Zosell. The Zosell Mining District, often referred to as the Emery District, was never a major producer in the state; however, its location, history, type of deposit, and character of ore, has drawn the interest of many prominent investigators of the mineral industry.

The district consists of numerous mines spread out over an area covering 3 square miles (Plate I). The two largest mines, the Emery and Bonanza, are located in the southern part of the district, and have been studied and reported on by Harold C. Elliot (3) and Francis A. Stejer (10). When the author, in search of an undergraduate thesis at the School of Mines, approached the Geology Department, it was suggested that a microscopic study of the ore minerals from the mines in the northern part of the district might prove both interesting and beneficial. Since this was the type of work the author wanted to do, and since there was considerable material available for study, it was chosen as a thesis problem to partially fulfill the requirements for graduation.

The author wishes to express his appreciation to Dr. Perry and Professor Robertson of the Geology Staff at the Montana School of Mines for their valuable assistance in correlating the laboratory work, to the Montana Bureau of Mines, who, through Professor Robertson, made available the ore minerals, maps, and thin sections used in conjunction with this report, and to Mr. Robert Gale of the Senior Class for his assistance in the reconnaisance work done on the district.

GEOGRAPHY

The Zosell Mining District, Powell County, Montana, lies in sections 2, 3, 10, and 11; T. 7 N.; R. 8 W. The mines with which this report is concerned lie in the northern part of the district in section 2, T. 7. N.; R. 8. W. The district is 10 miles southeast of Deer Lodge, Montana, and may be reached easily by a gravel road of moderate uphill grade (Fig. 1). Deer Lodge is serviced by two transcontinental railroads, the Chicago, Milwaukee, St.

Paul and Pacific, and the Northern Pacific, as well as U. S. Highway No. 10. The Anaconda Smelter is located 35 miles south, and along with the excellent transportation facilities has proved a valuable asset in lowering operational costs of the mining district.

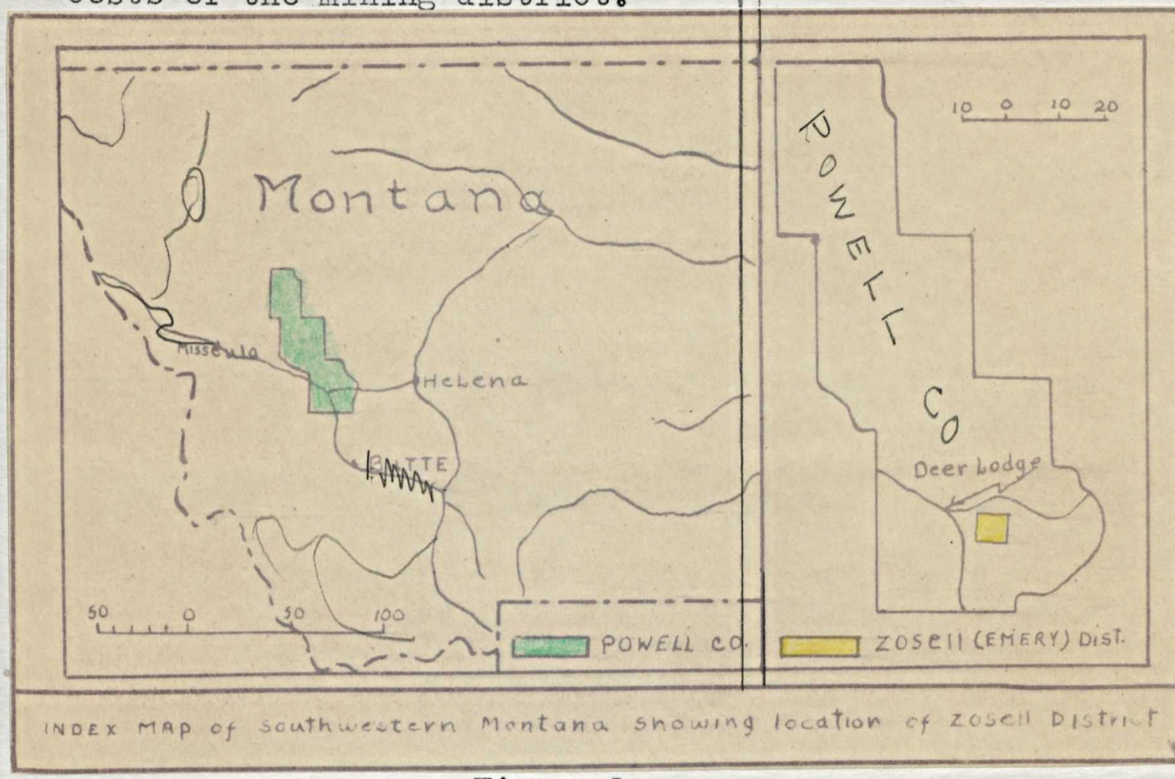


Figure 1

PHYSIOGRAPHY

The region considered herein lies to the north of, and in the drainage basin of, Rocker Gulch (Plate II). The elevation ranges from 6200 to 6600 feet above sea level. The Deer Lodge valley west of the district is approximately 34 miles long and 15 miles wide. Its elevation is 5200 feet at its southern tip and 4400 feet at the northern end.

A few miles east of the district lies the rugged mountain masses of the Boulder Batholith which reach an elevation of 10,000 feet.

In general, the area is one of deep gulches and timbered slopes. The district consists of gentle sloping hills carpeted with range grass and lightly timbered with lodge pole pine (Fig. 2). The pine is of such size and quantity as to have more than satisfied the timber requirements of the mines.

Figure 2

HISTORY

Mining operations began in the Zosell District in 1872, when H. L. Hoffman, a prospector, discovered placer gold in Rocker gulch. For 20 years thereafter the gravels of Spring gulch and Deep Gulch, as well as Rocker gulch were mined extensively and yielded over $100,000 in gold. With the exception of a few ounces of gold panned in 1933, all placer mining was abandoned in 1889. (7; 270)

In 1887, a lode deposit was discovered in the northern part of the district and worked to some extent under the name of the "Hidden Hand" mine. This mine is reported to have produced about $45,000 in gold, silver, and lead in the period covering 1887-1926. In 1888, the Emery Lode, the largest and most important deposit in the district, was discovered. Since that time a score or more of mines have been developed and operated intermittently throughout the district.

The Emery Mine has far overshadowed all the others in extent of development and production. It supported a small community at one time, which consisted of numerous homes and buildings as well as a school house. The Bonanza mine, which started operating in 1895, is said to have been the second largest producer in the district. Production from all the lode deposits has exceeded $2,000,000 of which about 45 percent was gold, 45 percent silver and the

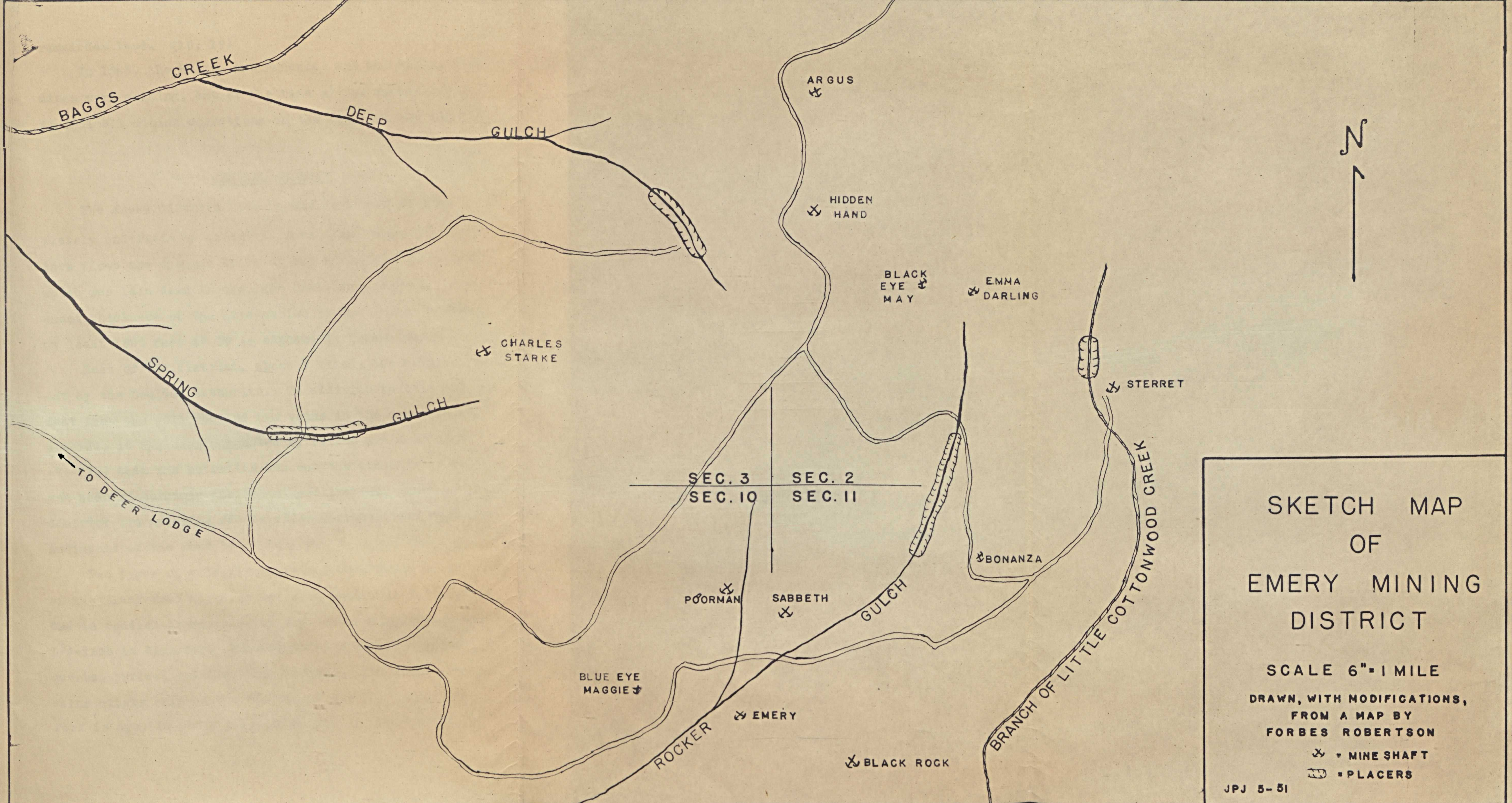
PLATE I

SKETCH MAP

OF

ZOSELL(EMERY)

MINING DISTRICT


BAGGS CREEK
DEEP GULCH
SPRING GULCH
TO DEER LODGE
CHARLES STARKE
ARGUS
HIDDEN HAND
BLACK EYE MAY
EMMA DARLING
STERRET
SEC. 3
SEC. 2
SEC. 10
SEC. 11
BONANZA
POORMAN
SABBETH
ROCKER GULCH
BLUE EYE MAGGIE
EMERY
BLACK ROCK
BRANCH OF LITTLE COTTONWOOD CREEK
N
SKETCH MAP OF EMERY MINING DISTRICT
SCALE 6" = 1 MILE
DRAWN, WITH MODIFICATIONS, FROM A MAP BY FORBES ROBERTSON
= MINE SHAFT
= PLACERS
JPJ 5-51

remainder lead. (10; 19)

In 1948, the Emery, the Bonanza, and the Hidden Hand mines were working, but at the time of the author's visit in 1951 all mining operations in the district had ceased.

GENERAL GEOLOGY

The Emery district lies in the center of an area completely underlain by andesitic lava flows (Fig. 3). The lava flows are thought to be of the Livingston formation which was lain down in the late Cretaceous Period. The exact thickness of the lava series is not known; however, at least 1000 feet of it is exposed in Rocker Gulch.

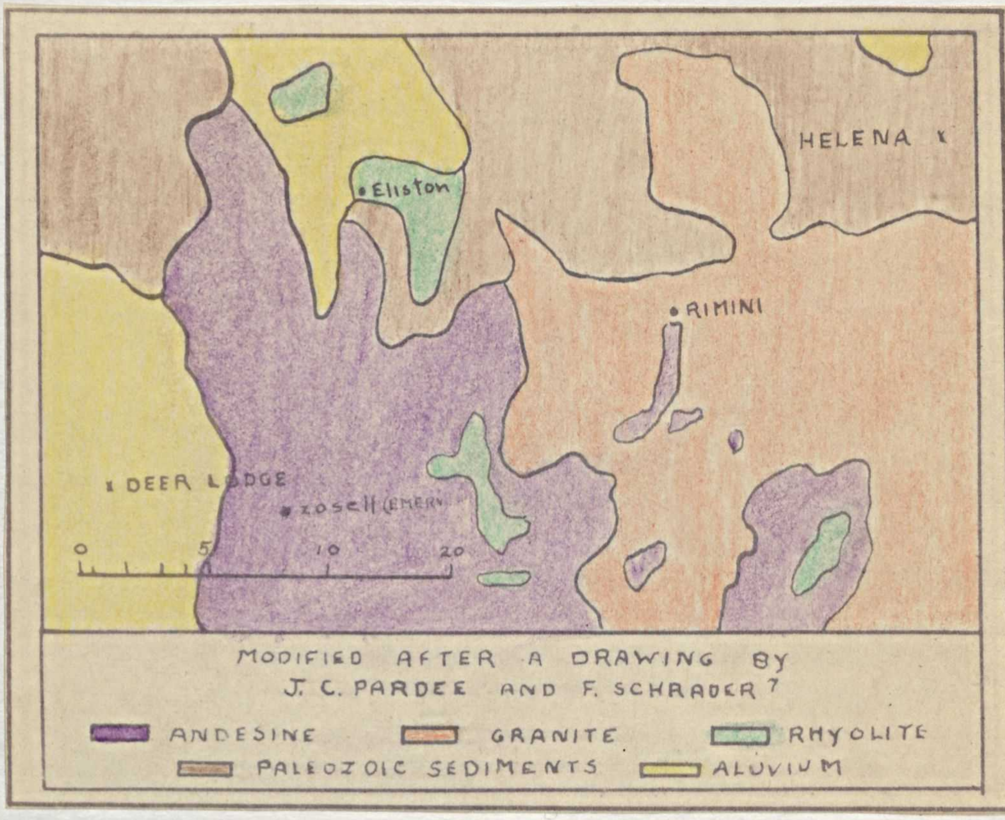
East of the district, about 7 miles, the andesite is cut by the Boulder Batholith. In addition to this and the fact that the wall rock of the veins in the district are altered, it has been suggested by Pardee and Schrader (7; 273) that the batholith has cut the andesite at depth and been responsible for the mineralization. West of the district the andesite passes under Tertiary lake beds and sediments of the Deer Lodge valley.

Two types of volcanic rocks had been found on the dump of the Black-Eyed May mine and were available for study. One is reddish-brown in color and contains amygdules about 1/4-inch in diameter. The amygdules are filled with quartz, pyrite, calcite, and chlorite. The reddish-brown color exists only on the surface of the rock; when the rock is cut, it shows a greenish gray color with an aphanitic texture.

In thin section this rock shows a very fine aphanitic groundmass of plagioclase microlites and altered ferromagnesium minerals. Phenocrysts of plagioclase and augite are abundant, with the plagioclase in places having been altered to sericite and the augite altered to epidote and chlorite. The plagioclase feldspar is labradorite with a composition of about Ab_{44} An_{56}. The ferromag minerals could not be determined as they were too fine; however, opaque minerals were observed in the thin section which the author believed to be magnetite. This rock, according to the Johansen classification, is an amygdaloidal basalt.

The second rock was a dark greenish black color, finely peppered with white feldspar phenocrysts. In thin section the rock was not as fine grained as the other, and the groundmass had more of a porphyritic texture. The feldspar phenocrysts were plagioclase of composition Ab_{40}-An_{60} (labradorite). In places they had been highly altered to sericite. Augite phenocrysts were also present and highly altered. Some of the altered products were chlorite, epidote, and hornblende. Magnetite was also observed in the thin section of this rock. According to the Johansen classification, this rock is a black porphyritic basalt.

At the time of the author's visit to the district, the area was covered by a blanket of snow, and the amount of each type of rock and its position could not be determined. However, the amygdaloidal basalt was observed at several exposed places, whereas the black porphyritic basalt could not be found.



MODIFIED AFTER A DRAWING BY J. C. PARDEE AND F. SCHRADER 7

Figure 3

ORE DEPOSITS

The veins of the Emery District are believed related to a granitic intrusion, probably the Boulder batholith which is exposed a few miles to the east. (Fig. 3) They are of two types, vertical fissures and bedding plane fissures. Their mineralogy suggests that they were formed at a moderate to shallow depth by hydrothermal solutions. Pardee and Schrader (7; 273) report that "the Zosell deposits differ from those of the neighboring Elliston and Rimini districts because of an absence of tourmaline. As the rocks in the Zosell district show no contact metamorphism, inferences may be drawn that the igneous body which induced the mineralization is far below the present surface, and that the deposits exposed are beyond the zone in which high temperatures, such as would produce tourmaline, prevailed."

Among the material collected from the Hidden Hand Mine was a dark luster gangue mineral which the lessor believed to be an intergrowth of quartz and tourmaline. Megascopically the material showed characteristics typical of the tourmaline-quartz intergrowth found at many places throughout the Boulder batholith. It has a dark luster and black brilliance on fresh fracture.

The author, after grinding the material to fine particles, immersed it in oils of known refractive index. Under the petrographic microscope quartz could be readily identified, but the mineral, earlier thought to be tourmaline, was opaque. Upon finer grinding the mineral was still opaque, and showed no criteria suggestive of tourmaline. Chemical and blow pipe tests were successful only in showing that the mineral had a slight magnetic attraction. With the help of Dr. Perry, it was therefore concluded that the dark color in the gangue material was due to some opaque mineral, probably some sulphide mineral that was approaching colloidal suspension and was undeterminable.

The author was pleased with this phase of the investigation, in that it proved the gangue mineral was not an intergrowth of quartz and tourmaline, and substantiated Pardee and Schrader's statement in regard to the mineralization of the district.

LABORATORY TECHNIQUE

As was mentioned earlier in this report, virtually the whole thesis problem was the identification and paragenesis of the minerals of the ores from the mines in the northern part of the Emery Mining district. The previous work that had been done in the district, particularly the reports by Elliott and Stejer on the Emery and Bonanza mines, proved beneficial in one respect and harmful in another. Beneficial because the author had a good idea as to what minerals were present, and harmful because some of the minerals found in those mines were not found in the mines in the north.

Outline of Work

The first step, after accepting the thesis problem, was to gather together all of the materials available for study. These materials consisted of ore from the Black-

Eyed May mine, the Emma Darling mine, the Hidden Hand mine, and the Argus mine, also the lava rocks from the surface of the area.

The lava rocks were sent to the thin section laboratory in Butte to have sections prepared. The ore was carefully looked over megascopically in an effort to select the most suitable specimens for polished sections. It was decided that 3 polished sections from the ore of each mine would be sufficient to gain the information desired.

Twelve rectangular sections, averaging about 1-in. long and 3/4-in. wide were cut from the ore by means of a diamond saw. Polishing was accomplished by first grinding the flat surface of the section with No. 100 carborundum abrasive, followed respectively by No. 400 and No. 600, and final polishing made use of a broad cloth lap with an alundum abrasive.

Ordinarily, if sufficient time and care is spent at each step of this process a section will be polished well enough for microscopic study; however, due to the complex mineralization and range of hardness of the minerals present in the ore, this method was not satisfactory. Only moderate success was obtained using a nylon, a satin, and a silk lap, combined with alundum abrasive. Specimens were then mounted in lucite and the Graton-Vanderbilt polishing machine in the Mineral Dressing department was used.

This machine is electrically operated and uses a cast iron lap for fine grinding and a lead lap for finished polishing. After using the machine it was still necessary to polish the sections, for a short time, on a silk lap; however, by this time the minerals achieved a satisfactory polish and were acceptable for study and photomicrographing.

Methods of Study

The chief method of study was the use of the metallographic microscope in conjunction with hardness, etch, and microchemical tests. Megascopic study, using the hand lens, was employed on the ores from the different mines and the petrographic microscope was used both for thin section and immersion media study. The binocular microscope was used to a small degree, and several blowpipe tests were made.

The metallographic microscope was used to identify the minerals in the polished sections and to determine their paragenesis. Hardness and etch tests were in many cases unreliable, and it was necessary to run microchemical tests on all the minerals before definite identification could be made.

Megascopic study of the ore was helpful in the initial stages of identification, and although not used to any extent, it proved valuable as a stabilizer on the microscopic examinations. The volcanic rocks described earlier were studied under the petrographic microscope by means of thin sections. The gangue material, at first believed to be a tourmaline-quartz intergrowth, was studied by immersion media processes under the petrographic microscope. The binocular microscope was used mainly as a check on the hand lens.

MINERALOGY

The minerals identified from the ores of the Black-Eyed May, Emma Darling, Argus, and Hidden Hand mines located in the northern part of the Zosell (Emery) Mining District are: pyrite, arsenopyrite, sphalerite, galena, chalcopyrite, and quartz. The Emery mine, in the southwestern part of the district has reported, in addition to the minerals above, tetrahedrite, jamesonite, ankerite, and native gold. (3; 20) With this in mind, the author was extremely careful in checking identifications of any mineral that showed different characteristics from those already identified; however, only those mentioned could be found both microscopically and megascopically.

Quartz (SiO_2)

White quartz is the most abundant gangue mineral found associated with the ore minerals. In hand specimens it can be seen as large crystals filling open spaces and projecting outward from the walls to form comb structures in small vugs. Under the microscope the quartz is a light gray color and can be observed as tiny veinlets filling fractures in the ore minerals. It can be found in both the massive and crystalline forms.

Pyrite (FeS_2)

Pyrite is the most abundant sulphide mineral found in the ores. It is found as large euhedral crystals intimately associated with quartz in the many vugs of the hand specimens. Its dull yellow color and extreme hardness readily identify it under the microscope. As a general rule it is fractured and shattered and can be found in both massive and crystalline form (Plate III, A).

Arsenopyrite (FeAsS)

Arsenopyrite is very abundant in all of the polished sections. In hand specimens it is identified by its silvery luster and well-developed crystal forms. Under the microscope it is observed most commonly as diamond-shaped blebs of various sizes; however, it does occur in the massive form and its white color and hardness make it easy to recognize.

Galena (PbS)

The softness, white color, and triangular pitting of galena make it easily recognizable under the microscope.

In hand specimens it is identified by its cubic cleavage, grey color, and softness. It is not abundant in the polished sections and the triangular pitting, in most cases, is absent. Etch and micro-chemical tests were employed constantly to check that the mineral being observed was galena and not jamesonite. Galena stains iridescent with $FeCl_3$, while jamesonite gives a negative reaction. Micro-chemical tests would show Fe in jamesonite but not in galena. The author, not being familiar with jamesonite, was extremely cautious in always identifying the galena. As mentioned earlier, jamesonite was not found in the ores under observation.

Sphalerite (ZnS)

Sphalerite, while being rather difficult to identify in the hand specimens, was identified easily under the microscope. In most cases it was accompanied by tiny irregular-shaped blebs of exsolution chalcopyrite confined within its boundaries. It is a darker gray than the quartz and often highly pitted. It is not abundant in the polished sections but in hand specimens can be found abundantly associated with galena.

Chalcopyrite ($CuFeS_2$)

Chalcopyrite could not be observed in any of the hand specimens. Under the microscope it was identified easily by its brass-yellow color, its softness, and its association only with sphalerite. Mainly it is an exsolution product of sphalerite, and occurs as tiny irregular blebs in the crystal structure of the zinc sulphide. Previous investigators of this district report chalcopyrite as having occurred other than as an exsolution product, and the author is of the opinion that it does, however only in very minor quantities.

ORE MINERALS

The ores of the Emery district are mined chiefly for their gold and silver content. It was first thought that an intense microscopic study of the polished sections would reveal some gold in the free state; however, of all the sections studied, not one single piece of free gold was observed. Investigation of earlier reports on the district revealed that the gold is mainly in the arsenopyrite, probably in molecular combination and not as a free and separate mineral. The silver also is present in the galena and sphalerite probably in molecular combination, and not as definite silver minerals. Elliott (3; 8) ran assays on the ore of the Emery mine with the following results:

	Ounces per ton	
Mineral	Gold	Silver
Arsenopyrite	0.65	3.9
Pyrite	0.10	5.9
Sphalerite	0.15	9.9
Galena	0.10	59.4
Chalcopyrite	trace	72.9

Elliott was of the opinion that the high silver content of the chalcopyrite was due to microscopic inclusion of tetrahedrite, which was commonly found in it.

PARAGENESIS

The mineral sequence, or paragenesis, for this suite of ore samples was determined chiefly from crystal growth and relationships observed in the polished sections under the microscope. The mode of formation was predominantly fissure filling accompanied by replacement. This is evident from observing such characteristic features as the size and shape of the individual crystals as well as the regularity and outline of the crystal boundaries.

In hand specimens, the presence of vugs showing comb structure further substantiate this theory. That replacement accompanied the fissure filling is evidenced by such characteristic criteria as the cutting of grain boundaries by tiny veinlets, thinning and widening of veinlets, irregularity of boundaries between minerals, and the presence of advanced islands of the replacing mineral in the host mineral.

The author wishes to make clear that the ore samples from which the polished sections were cut, were collected from the ore dumps of the different mines. Their exact location in relation to the veins is not known. This is mentioned because the paragenesis determined by the author does not follow exactly that determined by earlier workers in the district. Keeping in mind the fact that the earlier investigators (Pardee, Elliott, Stejer) had the advantage of observing the veins in suti, and collecting their samples from known locations, the author was extremely careful in verifying every mineral sequence and establishing definite replacement criteria. Photomicrographs are included and referred to here to verify the author's results. Considerable overlapping of mineral deposition and replacement has made definite age relationship difficult.

Pardee and Schrader (7;273) report; "Among the first substances that came into the veins were iron and manganese, which carried into the walls for some distance and, in the form of ankerite and pyrite, partly replaced the rock minerals." Although ankerite was not found in any of the polished sections it was observed intimately associated with quartz and pyrite in the hand specimens. The exact age relationship of these three minerals cannot be clearly established. In studying a vug under the binocular microscope, the author observed crustification, in which it appeared that the quartz was the first mineral deposited. In polished sections, the pyrite can be seen as well developed crystals in the quartz groundmass (Plate III; A) and appears to be replacing the quartz; however, tiny veinlets of quartz are seen filling fractures in the pyrite. (Plate III; B). The author is of the opinion that these two minerals were deposited with considerable overlap and that the quartz preceded the pyrite by only a very short time.

Arsenopyrite followed closely the last stages of pyrite deposition. This is evidenced by observing the aggregates of arsenopyrite cutting the grain boundaries of the pyrite. (Plate III; C). Further evidence to support this sequence is the presence of advanced islands of arsenopyrite in the pyrite cutting the crystal boundaries of both quartz and pyrite. Plate III; C, Plate IV; A).

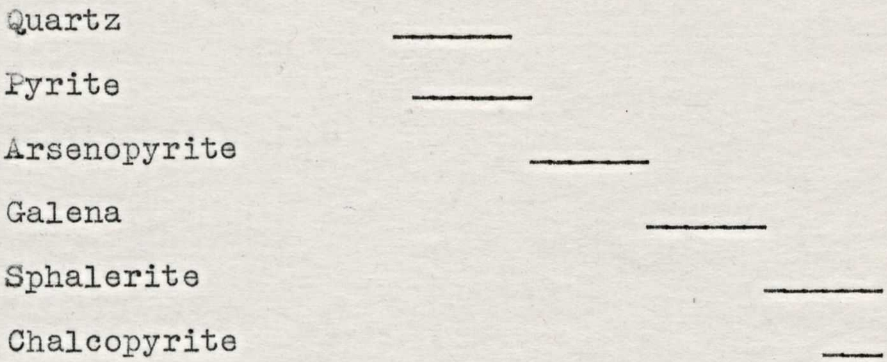
Galena was introduced after the deposition of arsenopyrite. This can be seen by observing the tiny feathery veinlets of galena replacing the arsenopyrite (Plate IV; B). That it was later than quartz and pyrite is evidenced by the irregular boundaries it exhibits when in contact with these two minerals. (Plate IV; B, C, D).

Sphalerite was the last mineral introduced as evidenced by its replacing all the earlier formed minerals. The manner in which it replaces galena is the best example of replacement criteria in this suite of ores. Tiny inclusions, as well as feathery veinlets of the sphalerite can be observed replacing the galena along grain boundaries (Plate V; A, B). Sphalerite occurs as tiny replacement veinlets in the arsenopyrite and can be observed cutting the grain boundaries of the pyrite and quartz. (Plate V; C, B).

Chalcopyrite was observed only in the confines of the sphalerite (Plate V; D). Its presence has been identified as an exsolution process because of the even disrribution of the tiny blebs which follow directly the crystal structure of the zinc sulfide. No widening or enlargement of the grain boundaries could be observed and all other criteria necessary for replacement was missing. The writer is of the opinion that the chalcopyrite precipitated out of a solid solution as it began to cool, and was therefore the last formed mineral in the sequence.

The paragenesis table illustrated on the following page is the author's attempt to summarize the mineral sequence for this suite of ore minerals, and in no way is to be interpreted as an accurate or exact measurement of probable overlap.

Paragenesis Table



MINES

Since the discovery of placer gold in Rocker gulch in 1872, the veins of the Zosell (Emery) Mining district have supported a score or more of mines (Plate I). Operations have been carried on by so many different parties and at such irregular intervals, that complete records are almost impossible to obtain. It is estimated that from $2,500,000 to $3,000,000 worth of gold, silver, and lead has been extracted (10;9). Undoubtedly some lessees have gained large profits, but as indicated by the large number of mines and prospects, a great deal of money has been spent developing the district. Two mills are reported to have been constructed at the Emery mine, neither of which were very successful (3;4). One valuable asset to the district in mining operations was that little timbering was necessary due to the soundness of the wall rock.

The mines in the northern part of the district have been worked intermittenly since 1887 and, although the major producers are located in the south, have played an important role in the total ore production.

Black-Eyed May Mine

The only available information that could be found on the Black-Eyed May Mine was in the report by Pardee and Schrader (7;282). They report, that in 1926 the mine was inaccessible to examination, but that it had shipped ore valued at $43 a ton. The vein is vertical with an east-west strike, and developed to a depth of 100 feet. No production figures were available, and at the time of the author's visit the shaft was caved and only remnants of a head frame were standing. (Plate VI; A).

Emma Darling Mine

The Emma Darling is reported to have been worked extensively during the early 1900's. The large waste dump and loading chute (Plate VII; A) indicate that considerable ore was removed. The vein strikes N. 70° W. and dips about 80° N. A vertical shaft said to be 90 feet deep, was inaccessible at the time of the author's visit, and only bare remnants of the headframe and hoist house were standing. Pardee and Schrader (7;282) report that ore shipped from the Emma Darling yielded as much as $45 a ton in silver, lead, and gold. The ore samples studied were characteristic of the district in that pyrite, galena, sphalerite and arsenopyrite could be observed.

Argus Mine

The Argus Mine consists of numerous horizontal addits, none of which were accessible at the time of the author's visit (Plate VII; B). The vein strikes N. 10° - 20° E. and dips 20° - 30° East. Pardee and Schrader (7;282) report that ore was shipped from this mine, prior to 1926, valued at more than $15,000. One carload was said to have averaged 60% lead and 105 ounces of silver. Between the years 1937 and 1947 Mr. William Howard worked the Argus Mine as well as the Hidden Hand Mine.

Hidden Hand Mine

The Hidden Hand Mine is said to have been the first lode deposit discovered in the Emery District. It consists of several inclined addits as well as the recently worked horizontal addit (Plate VIII; A). Prior to 1926, Pardee and Schrader (7;273) report an ore production exceeding $45,000. The vein strikes N. 30° - 40° E. and dips 30° - 40° - N. E. Mr. William Howard worked the Hidden Hand Mine intermittenly between 1937 and 1950. Available smelter returns shows total production between 1937 and 1947 of 6,194 tons valued at $62,536.

The addit of the Hidden Hand Mine shown on (Plate VIII; A) was the only mine workings in the district accessible to the author. It is approximately 100 feet long, terminating in a small circular room. A raise has been driven to the surface from this room. The wall rock is a highly altered andesite cut by veins of brown-weathering carbonate, which in turn are cut by quartz veinlets. The quartz veinlets are liberaly sprinkled with pyrite, arsenopyrite, sphalerite and galena.

The composite map (Plate II) shows the many addits and prospect holes that have been dug in the area. The vein, shown on the map as a dotted line, is believed to extend southward in the district and been worked through the Bonanza Mine.

SUMMARY AND CONCLUSIONS

The Mines in the northern part of the Zosell (Emery) Mining District are located on two types of veins. The Black-Eyed May and Emma Darling on vertical fissures, and the Argus and Hidden Hand on bedding plane fissures. The ore from these veins is an aggregate of base metal sulphides in a gangue of quartz, and altered country rock. The sulphide minerals listed according to their paragenetic order are: pyrite, arsenopyrite, galena, sphalerite and chalcopyrite. The paragenesis is the same for all four mines.

The total production for the entire Zosell (Emery) District has exceeded $2,000,000. The mines in the north have produced approximately 20% of this total from ores mined chiefly for their gold, silver, and lead content.

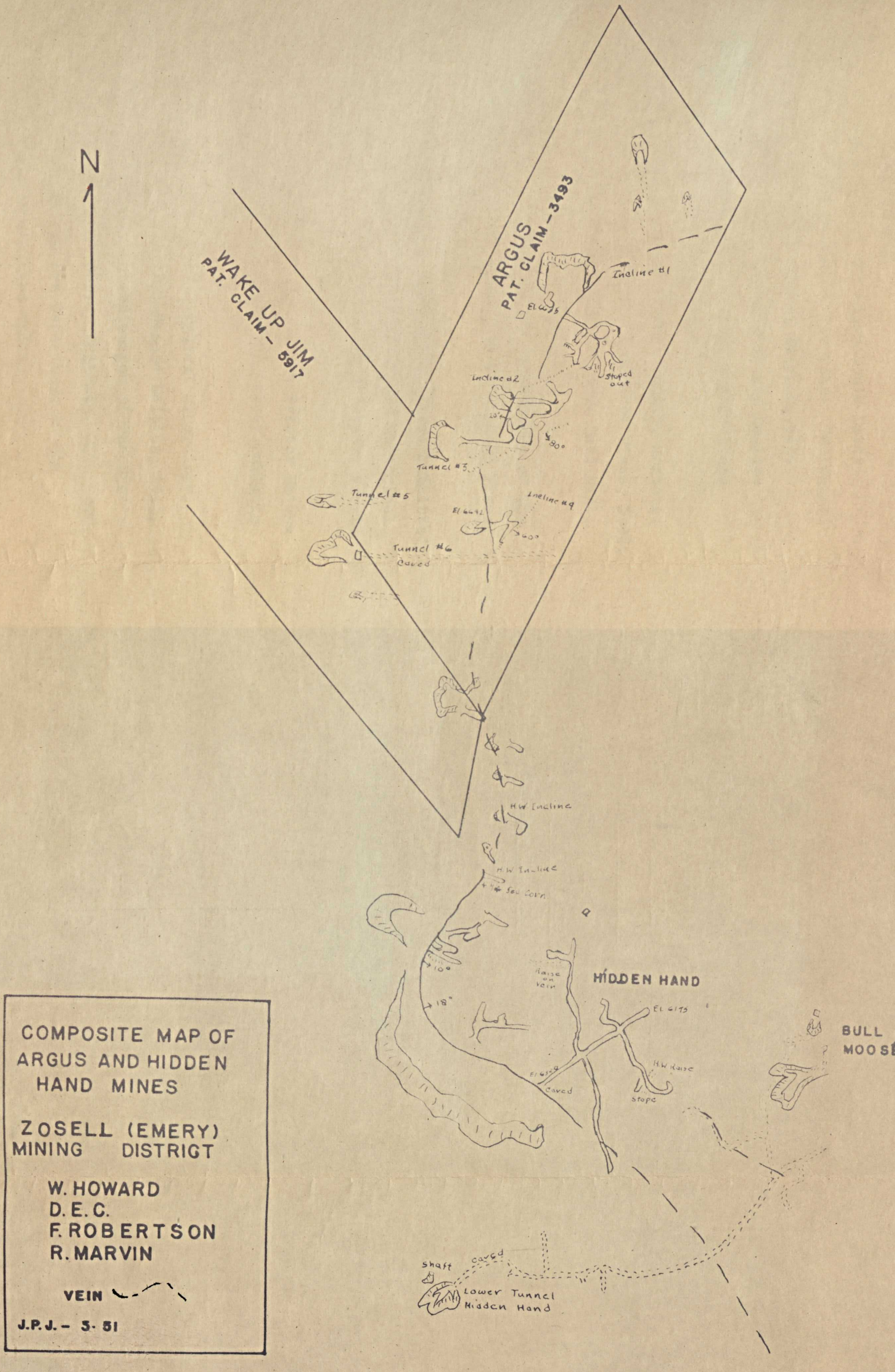
The district, to all outward appearances, would seem to have been completely worked out. If, however, the present price of gold should go up, mining operations in the northern part will likely be renewed. The veins in this part are not developed to any depth, and mining operations in the southern part of the district have shown that mineralization does not decrease at depth. Should the price of gold raise high enough to allow the present owners to develop the mines deeper, valuable ores equivalent to those already produced, can probably be recovered.

Plate II.

COMPOSITE MAP

OF

HIDDEN HAND
AND
ARGUS MINES



N
ARGUS
PAT. CLAIM – 3493
WAKE UP JIM
PAT. CLAIM – 5917
Incline #1
Stoped out
Incline #2
20°
80°
Tunnel #3
Tunnel #5
Incline #4
Tunnel #6
Caved
H.W. Incline
H.W. Incline
10°
18°
Raise on Vein
HIDDEN HAND
H.W. Raise
Stope
Caved
BULL MOOSE
Shaft
Caved
Lower Tunnel Hidden Hand
COMPOSITE MAP OF ARGUS AND HIDDEN HAND MINES
ZOSELL (EMERY) MINING DISTRIGT
W. HOWARD
D.E.C.
F. ROBERTSON
R. MARVIN
VEIN
J.P.J. – 3-51

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Plate III

PHOTOMICROGRAPHS OF ORE MINERALS

A. Euhedrad crystal of pryrite in the quartz groundmass.

B. Veinlets of quartz filling fractures in pyrite.

C. Aggregates of arsenopyrite cutting grain boundaries of pyrite and quartz.

D. Aggregates of arsenopyrite and pyrite in contact.

Plate III

A.

B.

C.

D.

Photomicrographs of the ore minerals from the mines in the northern part of the Zosell (Emery) mining district

Plate IV

PHOTOMICROGRAPHS OF ORE MINERALS

A. Advanced island of arsenopyrite in the pyrite.

B. Galena replacing arsenopyrite and quartz.

C. Galena replacing pyrite.

D. Galena replacing pyrite and being replaced by sphalerite.

Plate IV

A.

B.

C.

D.

Photomicrographs of the ore minerals from the mines in the northern part of the Zosell (Emery) mining district

Plate V

PHOTOMICROGRAPHS OF ORE MINERALS

A. Sphalerite replacing galena (observe triangular pitting of galena in A and B).

B. Sphalerite replacing galena and pyrite.

C. Veinlet of sphalerite replacing arsenopyrite.

D. Tiny irregular blebs of chalcopyrite in sphalerite.

A.

B.

C.

D.

Photomicrographs of the ore minerals from the mines in the northern part of the Zosell (Emery) mining district

Plate VI

Remnants of Headframe and Hoist-house at the Black-Eyed May Mine in March 1951.

Waste Dump and Headframe of the Emma Darling Mine in March 1951.

Waste Dump and Horizontal Addit of Argus Mine in March 1951.

Plate VIII

Waste Dump and Horizontal Addit of Hidden Hand Mine in March 1951.

Horizontal Addit of Hidden Hand Mine in March 1951.