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Geology of the Tuxedo Mining District

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GEOL OGY OF
THE TU XEDO MINING DISTRICT

By
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B. R. Tarrant
A. L. Gallagher

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

MONTANA SCHOOL OF MINES
BUTTE, MONTANA
May 1937
GEOL OGY OF
THE TUXEDO MINING DISTRICT

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MONTANA SCHOOL OF MINES
BUTTE, MONTANA
May 1937.
View from mine looking north at Rhyolite-Granite contact

Head frame and hoist house

Looking west from mine
INTRODUCTION

The Tuxedo mining district lies fifteen miles west of Butte on the south east end of Deer Lodge valley. The area included in this district is about 12 square miles and lies in Sections 20, 21, 22, 26, 27, 28, 29, 32, 33, 34, Townships 3N and 4N in range 9W. The workings in the center of the district can be easily reached by traveling twelve miles west on the Butte-Anaconda highway (U. S. 10) and then turning north on a fair dirt road for a distance of three miles.

Prospecting and mining has been carried on in this district for about 20 years. As a result many pits have been dug, several adits have been driven, and two or three shallow shafts have been sunk. At least two veins have been discovered; and considerable ore has been shipped from them. The ore was valued for its silver content, the silver bearing minerals being Argentite and Proustite with some Paragerite.

During the winter of 1936-1937 two properties were being operated. One, which is entered by an adit is an old mine containing large stopes. The other,
which is being worked through a shaft, is essentially a prospect in that the ore-bearing vein has not yet been found in the workings.

This district was chosen as a problem for research mainly because of the interesting type of vein structure to be observed and the occurrence of ruby silver as an ore mineral. The district is also of interest in that the veins cut beds of lava adjacent to a granitic intrusion. The report is offered as a thesis in partial fulfillment of the requirements for the degree of Bachelor of Science in Geological Engineering. Although the report is written jointly, and much of the field work was done by the writers working together, responsibility for the petrography was assumed by Mr. Leo Gallagher, for mine development, Mr. Bob Lawson; and ore deposition, Mr. B. R. Tarrant.

This work was carried on by means of a Plane table and telescopic alidade, open sight alidade and pacing or odometer, and by Brunton compass and pacing traverse. Field samples were taken and recorded. Later thin sections and polished sections were made from the samples at the school laboratory, and analysis and Leica pictures of the sections made. Pictures were also taken of the district with the authors' cameras.
The outline map of Montana shows the geographical features and major cities. The map includes cities such as Shelby, Kalispell, Missoula, Helena, Great Falls, Lewistown, Miles City, Butte, Dillon, Livingstone, and Billings.

Legend:
- Cities
- Rivers
- Roads

SCALE: 25 50 MILES

OUTLINE MAP OF MONTANA
INDEX MAP
The authors are grateful for the advice and assistance given by Doctors Perry, Scott, and Seager, and they greatly appreciate the courtesies extended to them by the operators of the various properties.

PHYSIOGRAPHY

The country is rugged due to differential erosion and active stream cutting of the formations. The maximum relief within the area mapped is fifteen hundred feet; the highest points being the tops of rounded hills on the east side of the district and the lowest point the floor of Deer Lodge valley. The drainage is through intermittent streams which enter Silver Bow Creek. This in turn enters Clark's Fork of the Columbia River.

The vegetation is spare consisting of scrub pine, fir, and juniper evergreen trees, sage brush, willows along the stream beds, grass, and other low growing grasses such as wild flowers of which the first were blooming as this report was being completed.
Looking north along contact of Andesite with first Rhyolite (Rhyolite to left)

Section of a Basalt flow
GENERAL GEOLOGY

The area mapped lies entirely within the mountainous portion of the state, falling between two large anticlinal areas, and is on the east edge of a synclinal area that lies between them, an area occupied by Deer Lodge valley.

The area is underlain by the Boulder Batholith which crops out in the northern part of the district, the remaining portion of which is probably underlain by it. This remaining portion is covered by a series of igneous volcanic rocks made up of rhyolites, andesites, and basalt. Fissure veins occur in the central part of the area cutting the earliest flows. Pegmatites and aplites are found intruding the granite near its southern edge. The bottoms of the stream beds are quite wide in places and are filled with alluvium. A uniform bed of volcanic ash averaging about four inches in thickness is usually found a few feet below the top of this alluvium, most of which is made up of lake deposits.
STRUCTURE

As mentioned before the area mapped lies entirely within the mountainous portion of the state, falling between two large anticlinal areas, and is on the east edge of the synclinal area between them that is occupied by Deer Lodge Valley. In other words, it occurs in the trough between two of the great folds that are part of the Rocky Mountains.

To the east lies the uplift resulting from the Boulder Batholith proper. To the west is the other fold and uplift in which lies the Anaconda and Mt. Powell ranges.

The area that is included in Plate No. 1. of this report or the area covered by the report is almost entirely made up of igneous rocks both intrusive and extrusive, the remainder of the rocks being Tertiary lake deposits and alluvium, the latter deposited filling the valley floors and the low parts of the area.

The hills to the east of the mine are very massive and rugged. This is due to the slight extent of the erosion of the relatively young
rhyolite of which they are composed. It is believed that one large hill is actually a remnant of the volcanic cone from which the last rhyolite was extruded.

It is believed by the authors that the structure of the region can be used to place the relative age of the deposition of the extrusives. The first rhyolite, the basalt, and the andesites all dip away from the granite. This means one of two things. There was an uplift of the granite mass after the laying down of the first flows, or the flows were laid down on a slope which dipped away from the center of the granite mass. This uplift of granite mentioned is not to be thought of as an intrusion of molten magma, because the contact of the granitic and rhyolitic rocks is unmetamorphosed. It is possible that the granite could have been uplifted, after being cooled, during the time that the aplite and pegmatite were being intruded. That such an uplift occurred after the laying down of the first of the andesites is proven by the intense faulting and brecciation that is present
STRUCTURE CONTINUED

in this early rhyolite and andesite. The second rhyolite, since it dips away from another center and seems to have flowed in channels similar to the present topography has not been subjected to any uplift or movement and is lying just about where originally laid down.

A definite contact between the extrusive flow rocks and the intruded granites were mapped for a distance of a mile and a half, this contact trending almost due north. On the northern end of this contact the extrusives are in contact with aplites, while the remaining portion of the contact is between granite and extrusives.
Rhyolite flow on Andesite in south east corner of the area mapped

Looking north east up valley which follows the Andesite-Rhyolite contact.
GEOLOGY

EXTRUSIVES

Most of the Tuxedo district is made up of igneous rocks. Of these over two-thirds of those seen on the surface are extrusives. The earliest of these is a rhyolite that since has been greatly silicified. On top of the rhyolite are a few isolated basalt patches and large areas of andesite flows. The latest flow studied is the huge area of rhyolite which covers most of the southern part of the map that is not covered by alluvium.

In the central part of the area about one-half mile north of the mines is a conspicuous gully which is a part of the drainage system of the district. Along this stream gully the intrusive granites come into contact with the extrusive rocks. This stream bed lies in a southwest northeast direction and has been chosen as a base of the stratigraphic column of flow rocks. A few small patches of green to gray rocks were found in the midst of the granite section; but as they were so highly altered or weathered it could not be decided whether or not they were remnants of flow rocks or merely granitic segregations. There is a possibility
that these patches may be the remains of the early andesites that have been described from Butte as being pre-batholith.

On the south east of the above mentioned contact is a close-grained aphanitic rhyolite that is found mostly as float. The reason for its occurrence as float may be that the unsilicified rhyolite that underlies the float may be mostly weathered away leaving only the float whose origin was the silicification of rhyolitic wall rock along the veins found outcropping on the hill above.

An interesting physiographic feature was noted in this rhyolite float on the east side of the main vein. A "U" shaped valley separated part of the float from the point of its origin, the vein, showing that a considerable thickness of vein has been leveled off since being deposited and that was the case before the time of the small mountain glacier which formed the valley.

On the southern and low end of the first rhyolite directly south of the mine, the rhyolite is capped by limited areas of very dark rocks which border on basalts. As these basalt cappings are so limited in this place their exact age in relation to the andesites
could not be determined. In the other places where they occurred the basalt was covered by an andesite which was very dark in color hinting that perhaps the basalt is only an early stage of the series of andesite flows. As to the basalt it is younger than the first rhyolite and older than the andesites or perhaps an early phase of that series.

Overlying the rhyolite is a thick series of andesites which like the rhyolite dip south and strike roughly southwest northeast near the mine. In the northeastern part of the map they seem to lay in tongues and broad sheets with strike and dip not determinable. The reason for this is the character of the flows. In certain places in this later section huge rolls of lava of roughly spheroidal shape were observed. When truncated off any number of dips or strikes can be observed and most of them naturally are wrong. The sequence of andesite flows seems to be roughly a very dark one, a purple to blue andesite, a brick red one, and a gray to purple andesite. Thin lenses of a brown andesite occurs in the midst of other flows. Near the Butte Anaconda highway a mile east of the intersection of the Tuxedo road, an early soft rhyolite is capped by one of these andesite flows.
On the top of this series of andesite flows are a series of rhyolites. In places the rhyolite has picked up and rolled chunks of the andesite and done other things which definitely show that the rhyolite flowed over an andesite surface. Near the top of the huge hill to the east of the mine a horizon marker of thinly bedded rhyolite was traced. It can be definitely found that the lava flowed over a rough surface and were laid on the edges of gulches much more steep than any found in the vicinity today.

To the southwest of the district proper there are a series of rhyolites which are relatively flat lying. These have the property of weathering to a Bentonite, which makes the beds potentially valuable. Like the other commercial deposits of the area these too, are tied up with litigation so that they can not be exploited.
The intrusive igneous rocks in the district seem to be restricted to the north and western parts of the region mapped. The intrusives vary from a very coarse-grained granite into diorite and finally into aplites and pegmatites. The later of course are the latest intrusives. All of these are characteristic of the Boulder Batholith, of which the intrusives are a part.

Billingsley in his report on the Boulder Batholith describes three varieties of border phenomena, a phenomenon that is found very plainly in the intrusives of this region. He says--Quote

"Evidence of Increasing Acidity in Magmatic Reservoir".

The granite itself exhibits three types of contact phenomena. On the southern edge of the batholith the contact is marked by a profusion of basic inclusions, normally under a foot in diameter, but ranging up to 50 feet. These inclusions are in general fine-grained diorite, slightly more basic than the batholith itself. They show a slight alteration on the edges, are generally of angular form, and are distributed within the granite impartially on limestone, quartzite, and andesite contacts. These facts, together with the absence of any phenomena suggestive of magmatic segregation, lead to the conclusion that the diorite fragments represent an early basic crust of the batholith, caught up and included in a further advance of the main magmatic mass.
The third type is of less common occurrence, and is found only where the more acid phases of the granite form the contact. It takes the form of increasing acidity in the outlying dikes and sills of the igneous rock. These, with crystalline continuity, grade from normal granite at the point of departure from the parent mass to alaskite and even pure quartz at their further terminations.

It seems possible to make these contact types conform to the conception of a general increasing acidity of the main magma. The primary contact was a basic segregation, which in a portion of the periphery still exists. Further intrusion on the south pushed the more acid residual magma through and beyond this border, while the more remote penetrations of the igneous rock became increasingly acidic.

The same sequence is evident within the mass of the batholith. The earliest crystallization—apart from the contact—took the form of quartz monzonite, with intruded by irregular masses of aplite, which,
in varying amounts, is of universal distribution and forms roughly, 10 per cent. of the present surface. This contains 75 per cent. silica and bears witness to the increased acidity of the reservoirs. The third stage is represented by siliceous injections within the aplite itself—quartz and jasper veins and stringers that, with the later addition of sulphide minerals, form the typical ore deposits of the batholith. Pyrite and chalcopyrite are associated primarily with these siliceous veins, but are not rare as primary minerals in the aplite, and are occasionally found in the monzonite itself. Both are of rare occurrence in the basic contact phases of the batholith, and are in general associated with the siliceous emanations of the later periods.
While still warm the monzonite was intruded by irregular masses of aplite, which in this area is in the form of irregular intrusions and tabular dikes. The aplite contains roughly 75% silica and bears witness to the increasing acidity of the reservoirs. The third stage is represented by siliceous injections within the aplite itself—quartz and jasper veins and stringers that with the later addition of sulphide minerals, form the typical ore deposits of the batholith. Near the section corner mentioned is an aplite in which a pegmatite dike occurs and the whole graduation from aplite with considerable pink orthoclase to pegmatite with a smaller proportion of feldspar to quartz with no feldspar can be observed in the cross section of the dike. In other places pure quartz, blowouts or veins occur. Some of which are as much as 20 feet in diameter. These occur as lenticular or circular outcrops. In the quartz veins in the rhyolite only small pieces of sulphide occur, which may represent the latest phase of the intrusion according to the theory of ore deposition.
In some places these dikes are almost flat lying. Bull quartz veins of both tabular and round masses are also found in the granite near the section corner. In this same area is a notable example of the cooling phases of a granite intrusion. Apparently the main mass of the granite is a normal bluish looking granite. Nearer to the edge of the granite this grades into a quartz monzonite and even closer to the edge of the contact into a large crystalized granitic rock, which is very high in quartz and almost lacking in ferromags or biotite.

It is through these border phases that the aplites are found intruded in both masses and in dikes. The dikes are in turn intruded by very large crystalline pegmatites which in places are almost pure quartz. The aplite is at least 75% quartz; the pegmatite from 85 to 100% quartz. This sequence illustrates very well the increasing acidity of the intrusions as the parent mass solidifies and cools.

As has been pointed out by many writers, this sort of thing is the result of a definite sequence in the solidification of a batholith. In this case the earliest crystallization took the form of a quartz monzonite, with about 63% silica.
Along the contact it is quite evident that the intrusive rocks are older than the extrusives because in places the extrusive rhyolite has apparently flowed around the irregularites in the granite erosion surface. This point is illustrated along the contact in places by bumps of granite sticking up through the rhyolite without any evidence of contact metamorphism.

There is quite a prominent gully that parallels this contact, the valley being formed by differential weathering and erosion of the rocks where they come into contact.

To the east of the valley and roughly paralleling it lies a brecciated zone about 50 feet wide and extending for a distance of several miles. The extent of this zone to the north was not mapped but the southern end terminates near the location of the Tuxedo Mine. (In fact it is believed that it terminates about 50 feet north of the mine in a cross fault). Along the brecciated zone are numerous small veins roughly paralleling the brecciated zone and probably representing the same set of forces. It is in these off-shoot veins that the ore is deposited, and is in one of these that most of the development work has been done.
The time relation of the intrusion of the igneous rocks of the area have been quite firmly fixed by various geologists who have worked in the vicinity (i.e. Butte). We found no evidence which was not compliable to their conclusions.

1. Middle Cretaceous.-Main Rocky Mountain folding.
2. Middle-Upper Cretaceous.-Extensive erosion and beveling of folds.
4. Upper Cretaceous.-Local intense erosion and formation of andesite conglomerates.
5. Late Cretaceous and Early Eocene- Uplift and folding followed by lateral thrusting which produced overthrust faults.
7. Middle Eocene to Early Oligocene-Stable land mass and pronounced erosion.
8. Early and Middle Oligocene-Intrusion of igneous stocks.
9. Middle Oligocene-Extrusion of large andesitic and basalt lava flows followed by block faulting and frontier development of intermountain valleys.
10. Late Oligocene and Early Miocene—Erosion and continued deposition in intermountain valleys.

11. Middle Miocene to Middle Pliocene—Normal faulting regional uplift and continued erosion, extrusion of Rhyolites.

12. Late Pliocene into Pleistocene—Development of Rocky Mountain peneplain and the beginning of our modern mountain drainage system.

13. Pleistocene—Glaciation carving many of the present valleys and canyons.

In the Tuxedo district nearly all of this history has left recognizable traces. The first part of the history is obscured by the later phases but the earliest rocks are probably the Early Eocene andesites, which are found in patches on the granite surface. The Granite is of the same intrusion and period as the Boulder Batholith. This was followed by the extrusion of Rhyolite flows in the following part of the Eocene. Erosion took place until the middle Oligocene when the Basalts and Andesites of the district were extruded. After that until late Miocene or Pliocene erosion and deposition in Deer Lodge valley went on. Then the late of the flows were extruded. Erosion and deposition in the stream bottoms has gone on since then. Some of the valleys show evidence of glacial action, at least one remnant of a hanging glacier was found high on the mountain east of the mine.
View looking east from the mine to hills of Rhyolite.

Head frame of mine

Head frame of mine with Tuxedo vein in background.
In the Tuxedo mining district there are two mines that were working at the time of the mapping, (in the fall of 1936). Besides these two operations there are a number of abandoned prospect holes.

Both of the active workings are located near each other in the center of the district on the western end of the Tuxedo vein, which is the most prominent vein in the district.

One of these mines is working the ore deposit by means of an adit that goes about 300 feet into the hill. This is the original working on the vein. The other working a shaft that is located up the hill and west of the adit opening. The ore that occurs in the workings is ruby silver occurring in a silicified rhyolite and chalcedony vein filling. (Ore deposits and their genesis are described in another part of this report).

The adit is on the north side of the vein and enters the hill about 150 feet down the north slope of the hill which the vein caps. It enters the hill at about south 45° East contacting the vein about 300 feet from the mouth of the adit.

The shaft has been sunk about 100 feet from the outcrop of the vein and was intended to strike the vein at about the 100 foot level.

This was not accomplished because of an offset of the vein which was not taken into consideration or was not known at the time the shaft was started. Because of litigation both of these working ceased work soon after this survey was started. Their production is still stopped.
FUTURE ECONOMIC DEVELOPMENT

 Unless more extensive ore deposits are discovered the district's mining activities will be confined to a few small prospects which may be able to make it pay by working the richest portions of the vein. The common experience of mines working small prospects is that they spend all of their money, and more, that is taken from the pockets of rich ore for development work looking for other pockets.

 There are several other mineral products which may be commercially valuable. The bentonite deposits in the southwestern end of the district have already been used to a small extent; but like the other workings in the district are also tied up in the courts in litigation. The fault gouge clay, which occurs in the large north south fault, may at some time be used in the ceramic industry.
IDENTIFICATION OF MINERALS

The mineable ore occurs on the foot wall side of a vein in silicified rhyolite country rock. Small fractures normal to the main vein penetrate a short distance into wall rock. The walls of these fractures may be mineralized with silver minerals to such an extent that after a blast when the wall is wet it looks blood red. This mineralization unfortunately is only skin deep and does not penetrate very deeply into the rock itself. These mineralized bands are a deep red color due to the presence of pyrargyrite or proustite and lots of red hematite.

The examination of an individual hand specimen reveals some extremely interesting features. The rock is banded chalcedonized material; these small bands have been fractured and faulted (if such small movements can be called faults). Around each of these small particles which make up the breccia there are a series of small chalcedony bands which cement it to the other parts of the breccia. The silver minerals occur in these onion skin bandings.

Polished sections of the ore material were made and carefully studied under the microscope. The red silver minerals were so finely disseminated that they
could not be identified by etch tests, but tests for argentite, run on patches of gray soft minerals which occurred near the red bands, show this mineral to be present. The tests used were from Short.

The test for iron was used and small yellow particles were identified as pyrite.

The work on the ruby particles could not be conveniently carried on at a magnification of greater than X 70, so that another method had to be used for the determination of the real silver minerals.

In an attempt to accomplish this identification disseminated silver minerals a specimen of the mineral was subjected to staining tests, which are being perfected for silver minerals by Mr. D. W. McGlashan of the Ore Dressing Department. The test consisted of immersing the polished surface of the specimen for exactly 20 seconds in a solution of one part methyl alcohol containing 2% iodine and one part concentrated sulphuric acid. The instant the specimen was removed from the solution it was washed with methyl alcohol to halt the staining action and then it was washed with acetone. The surface was then examined under a microscope at 1300 magnifications. The argentite
stained a beautiful light blue which confirmed the etch test. The pyrargyrite if present would stain yellow and the proustite would stain a dark blue, neither occurred.

This would indicate an absence of both of the ruby silver minerals, but upon very careful examination with an oil immersion lens and 1300 diameters magnifications it could be observed that the small red particles lay beneath the surface of semi-transparent quartz and were there protected from the stains; only at intervals did small parts of the red mineral come to the surface these were so small that the color could not be distinguished.

Polarized light was therefore resorted to and at the magnification of 1300 diameters internal refraction of the ruby silver minerals could be recognized but the minerals could not be identified between proustite or pyrargyrite, but is one of the two.

It was concluded that most of the silver carried by the ore was either proustite or pyrargyrite, but part of it occurred as argentite.
Appendix

The authors believe that the analysis of rocks both megascopic and microscopic belong in a separate portion of a report. In the taking of samples in the field and later in making thin section of these rocks the authors have tried to make representative samples. On the original plane table map the numbers of the samples were placed on the map at the points at which they were taken.

Tx 27

Megascopic examination shows a rather whitish, very close grained, almost vitreous matrix with large (3/8") phenocrists of feldspar that have been altered to a cream colored kaolin. There is very little biotite or ferromagns in the rock. About 20% of the rock is clearly quartz and the rest of the matrix appears to be silicified.

The rock is a silicified rhyolite with no traces of the original flow lines remaining. Rhyolite No. I.

Tx 36.

Megascopic examination shows flow lines to be present. There is 20 to 30% quartz, 7 to 10% biotite, rest of rock is aphanitic. The rock has not been subjected to compaction. Rhyolite No. II.
Tx 27 Thin section of red Andesite, plain light x 70

Tx 36 Thin section of flow rock with light cream colored feldspar phenocrysts. Crossed nicols x 70
**Tx 228**

Crystals of plagioclase-15%

Variety of feldspar-Andesine

Crystals of Hornblend-10%

Biotite-2 to 10%

Augite-2 to 3%

Rest is a dark gray black peppered mass.

**Tx 76**

Large crystals of biotite, orthoclase, in a matrix of olivine and plagioclase.

**Microscopic**

Orthoclase-15 to 20%

Biotite-10 to 15%

Plagioclase-40%

Quartz- none or very little

Hornblend- 1 to 3%

Olivine Diorite

**Tx 72**

Greenish matrix with large euhedral crystals of Plagioclase, small crystals of Biotite make up the euhedral part of the rock. The matrix has been altered or originally made up of chlorite.

Plagioclase-35%- altering to chlorite

Biotite 3 to 5%

Quartz 1%

Rest is mafic altered to chlorite

One variety of Andesite.
Tx 28. Flow Rock with Phenocryst of Feldspar

Tx 76 Olivine Diorite; crossed nicols X70

Tx 72 Andesite; crossed nicols X70
Brecciated Rhyolite

A light gray fragmentary rhyolite in a darker gray matrix which has a great many quartz or chalcedony stringers running through it makes up the rock. The dark gray material may be as a basalt which cemented the rhyolite together. Later chalcedony bearing solutions circulated through it and left stringers of chalcedony through it and filled in the cracks and crevices. In blow holes the solution allowed quartz to crystalize; in some rocks they completely filled the vug while other vugs were only partially filled. The Rhyolite is isotropic.

A fragment of a granite diorite inclusion in the granite. The fragments vary in size from 18 inches in diameter to only an inch. The granite diorite is relatively fine grained: The ferromag mineral grains are considerably smaller than are the felsic grains.

A thin section of the rock shows:

- Quartz - 20%
- Magnetite - 1%
- Biotite - 2%
- Plagioclase (Andesine) - 72%
- Small amounts of sericite in the center of plagioclase.
Tx 11. Thin Section of Breccia including a Vug; X70

Tx 81 Thin Section of Granite; crossed nicols X70
This rock is a Breccia composed of angular fragments of pinkish white chalcedony in a red matrix of microcrystalline jasperoid material.

At a magnification of 180 diameters the contact between the fragmentary material and the matrix was an indistinctive merger from one to the other. This indicates the sort of mineralization the rock has been subjected to.

The sample is a piece of ore from the stope. It is a siliceous rock which is exceedingly well banded. The bands are alternately dark and light material—all of it chalcedony. The banding is due to intermittent deposition. One of these bands in particular carries a streak of ruby silver minerals, pararogerite and proustite with a little gray argentite. Sulphides are disseminated in several bands. The band and fragmentary structure of the ore show that there has been a number of periods of movement and mineralization or silicification in between the movements along the fault zone which the vein now occupies. Both the silver minerals and the sulphides lay in small veinlets which follow the banding.
Tx 82 Thin Section of Breccia; plain light X70

Tx 17 Polished Surface Showing Veinlet of Sulphides X40
Tx. 17 Polished Surface Showing Vein
Plain light X70

Thin Section of Veinlet crossed nicols
X70
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United States Geological Survey, Bulletin No. 825
This supplementary report is to accompany the thesis report on the Tuxedo Mining District by Gallagher, Tarrant, and Lawson. Due to the fact that the property is tied up by litigation much information concerning claim boundaries and past production could not be obtained. Permission to inspect the property was also evaded for the same reason.

A detailed description of the location of the two properties and their accessibility has been given in the main report. The properties described are a Tunnel claim and a Shaft prospect. The latter has been patented.

Only a brief discussion of the mining development and a resume of the geology will be given in this supplementary report. Its purpose is to include a little of the actual economic geology which is not allowed to appear in the main thesis.

The name of the claim is unknown, but appears to lay just north of the Tuxedo claim (patent number 10527) in section 28, township 4 N and range 9W. The claim is made on the discovery work done by means of adit and possibly one or two pits above the end of the adit on the surface. The portal is in section 28, but at a distance of 240 feet passes into section 29 which is a Northern Pacific section. All the mining has been carried on in this section, and it has been said that the Northern Pacific R. R. was paid a royalty for the ore that has been removed from the tunnel. For the convenience of this report the claim will be referred to as the N. P. Mine.
A 270 foot adit gives access to the ore body which is cut at a vertical depth of about 100 feet from the surface and the apex of the vein. A drift follows along the vein for a distance of 108 feet. Above the drift the vein has been stoped for the full length of the drift and to a height of 83 feet above the main level. A small underhand stope was run near the east end of the drift to a depth of about 12 feet below the level. At the west end of the drift where it intersects the adit from the outside a winze was sunk. It is inclined at 85° to the north and cuts the vein at 32 feet. The vein has been stoped from that level to the adit level for a width of about 25 feet.

The stopes dip at an angle of 45° and follows a highly brecciated zone, which lies close to the foot wall of a large faulted zone that is completely chalcedonized. The stopes are from 3 to 5 feet wide and are supported by short sprags and are not filled.

The ore contains argentite and pyrargerite or proustite and small amounts of iron pyrite. Some of the highest grade ore occurs in fractures along the foot wall normal to the main fault plane. The ore is rich but pocketed according to the operators.

Examination indicates that most of the development work had followed a heavy soft hematitic layer which followed the main faulted zone quite closely. No samples
Cross-Section

Scale 1 in. = 20 ft.

Adit Level
for assays were taken, but by observing the mined areas it was concluded that this hematite did not carry high values.

On the top of the hill a little to the north of the outcrop of the quartz vein, on the Tuxedo Claim, a shaft has recently been sunk to a depth of 100 feet. From the bottom of this shaft a cross cut was driven 140 feet to the south. At a distance of 60 feet from the sump of the shaft the cross cut intersected a strong fault striking S 54° and dipping 45° to the north. There was about 19 inches of fault gouge or talc between the two striated edges of the fault plane. On the foot wall there was a small amount of mineralization which may have been drag.

The relation of this fault with the other mine workings could not be definitely established because of the limited time underground. The fault may lay a few feet above or below the stopes, but if the dip is contact the two would be parallel. The cross cut from the shaft did not strike any other ore or structure except the rhyolite country rock. The fault was not observed in the adit or stope, but the displacement of certain surface features indicate its presence there.

Much more work will be necessary before the continuation, if any, before the ore body can be located.

The future of the mine is unknown, scarcely any development work having been done beyond the present workings. Since the authors did no sampling or assaying, no opinion on the properties' future can be put forward.