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Czarina Mine, Butte, Montana

Prodyot K. Das

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CZARINA MINE
Butte, Montana

A THESIS
SUBMITTED TO
THE DEPARTMENT OF GEOLOGY
MONTANA SCHOOL OF MINES

IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
BACHELOR OF SCIENCE IN GEOLOGICAL ENGINEERING

BY
PRODYOT K. DAS
JUNE 28, 1950
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ABSTRACT

The Czarina mine operated for a short time during the last Great War, lies in the southwestern corner of the Butte mining district of Montana. This area was worked during the extensive silver mining in Butte during the 1890's, and was prospected from time to time in later years. The orebody of the mine consists of fissure fillings of manganese mineral oxidised to a certain depth, in a fracture zone of the Boulder Batholith.

Alteration of the granite is intense, especially where it is in contact with the veins, and except for quartz all minerals have been altered and some completely removed. The Batholith has been intruded by a rhyolite dike close to the mine.

Minerals found in the orebody are pyrolusite, psilomelane, wad, rhodochrosite, and manganese. Primary mineral rhodochrosite is completely oxidised in the oxidised zone.
INTRODUCTION

The Czarina mine is located in the well-known mining district of Butte, in Silver Bow County. It is in the southwestern corner of Butte, and about a half of a mile south of Big Butte Hill. The mine is on the southern slope of the Big Butte, near which Montana School of Mines is located.

Fig. 1 INDEX MAP OF MONTANA Scale 1' = 100 miles

The town of Butte is a well-known mining camp throughout the United States. Its significance in the
defense program in the production of strategic minerals during the World War II was immense. Czarina mine was then operated for a short period.

Innumerable articles have been published on the geological features, production and other interesting features of almost all of the Butte mines, which are still working. However, little, if any, information has ever been published about the Czarina mine, it seems so insignificant when compared to other Butte mines. Therefore, the following report has been compiled as a possible aid for future reopening of the mine. It includes geologic maps of surface and underground workings, as well as an interpretation of the geology.

U. S. Highways No. 91 and 10 pass through Butte. The mine is located about 1000 feet north of the intersection of Emmet Avenue and these highways, and is accessible by several dirt roads from Butte proper.

The writer wishes to express his appreciation to Dr. Eugene S. Perry, Professor of Geology at Montana School of Mines, for his advice and suggestions in preparation of this report.
The physical features of the area is simple. The Big Butte hill lies at the north end of an intermontane valley in a rugged mountaneous region characteristic of the Boulder Batholith. The drainage is to the west. The area is covered with a thin mantle of detrital material, often called "wash", which came from the mountain slopes. Areas covered by waste dumps are scattered all around the place. These unconsolidated deposits conceal the nature of the underlying bed rock, but are not more than a few feet thick. The area around the mine is gently rolling, and slopes down towards the south.

Vegetation is sparse. The surface is covered with granular material, which does not favor the growth of vegetation. The area is dissected by few intermittent streams.

The annual average temperature is around 40°. Most recording stations have reported a maximum temperature close to 100°, and the minimum as low as minus 50°. The daily temperature range is quite wide, especially in the summer months.

Because of extreme low temperature of the rocks, weathering is confined chiefly to disintegration only. The annual precipitation is not high. In winter the
whole region is covered by thick snow, which prevents weathering almost completely.

HISTORY OF MINING

The mining history of the region began around 1864, when the placer deposits were worked for gold. These were exhausted within a few years, and the miners sought other fields.

Around 1874, W. L. Forlin located few claims, and developed the black ledges near Big Butte which proved to be high in silver content. This brought back the miners who left after the depletion of the placer gold.

The veins in this part of Butte were first mined for their silver content. Under the management of the Colorado Mining and Smelting Company, large scale mining was started. The Czarina veins was operated for silver during this time. No detail information is available now, except the claim map (Plate No. V) where the Czarina claim has been shown located before 1901. It was prospected from time to time in later years. Manganese which was produced in the concentration process, was used as smelt-
ing flux only.

Many of the properties were in the hands of smaller operators, who individually could not operate on sufficiently large scale to make their venture profitable, nor would they sell the properties to larger companies, who could work the mines at a profit. Silver mining declined in 1892, when the price of silver went down.

Around 1917, an increase in the price of manganese directed the attention of the operators to the "black mag" gangue of silver lodes, a material which had been looked down upon as waste or fluxing material only, but now it became a possible source for manganese. Even then the mining of black manganese in this area was not of a high magnitude, because competition was great from ores of Butte and oxide ores from Phillipsburg, and scarcity of good ore on the Czarina claim.

Manganese in peace time is largely supplied by Russia. During the last Great War imports were greatly curtailed because of the lack of shipping facilities. The Defense Commision, looking for sources of manganese, learned that the Butte hill could be a substantial source in United States. A contract was negotiated to sell all manganese to the Government that could be produced, for a period of three years. This stimulated exploration of
all possible sources in the Butte hill. During this time the Czarina lode was leased to Mr. John Cole, who worked this mine for a short time.

The Czarina mine was opened by an adit and the lower level by a shaft east of the mine. There is another shaft in the western end of the claim. A third shaft which still contains the headframe, is located about 600 feet eastward from the adit. Its connection to this mine is doubtful.

GENERAL GEOLOGY OF THE REGION

The geology of the region is very complex. The ore-bodies occur in a granitic host rock, which is the Boulder Batholith, a great intrusive body of late Cretaceous or early Pæleocene age. The ore deposits are concentrated within an area of about 3-mile square on Anaconda hill. The minerals occur in wide veins which are continuous to a depth of several thousand feet.

The geology of the region has been determined to be the result of number of geologic events. A chronological order of events has been published by J. C. Ray,
(1) and are briefly as follows:

1. Late or Upper Cret. mountain growth; development of sharp folds; thrust faulting along northwest lines. Andesite flows, which in part became the roof of the Boulder Batholith.

2. Late Cret or Eocene? Intrusion of Boulder Batholith

3. Oligocene. Uplift of Rocky mountain province; development of greater intermontane trough; normal north-south faulting

4. Pleistocene, Faulting.

It is evident that the Butte district has been subjected to diastrophism at several periods, after the intrusion of Boulder Batholith.

The time from late Cretaceous or Eocene, when the intrusion of Boulder Batholith occurred, to the Oligocene, when regional diastrophism occurred, may be considered sufficient for magmatic differentiation, crystallization of the granite, and the concentration of mineralizers.

The next geologic event was the rhyolite flow which seems to have covered an extensive area. In certain localities rhyolite had intruded fissures forming dikes. Such a dike is located east of the mine extending in a north-south direction.

Pleistocene faulting shows wide ranges in strike and
dip. In detail many of the fractures are extremely complex.

Three main phases of faulting can be recognised in the mine, although there may be more phases of faulting present.

The mineral area at Butte has been divided into three concentric zones. The first two extend about a half a mile wide on the surface, and the third is extending outward indefinitely. They were recognized by Sales (2), and are as follows:

1. A main central copper zone.
2. An intermediate zone containing copper minerals, sphalerite and lead and galena, and manganese at the outer edge.
3. An outer zone extending indefinitely outward. The Czarina mine is located in this third zone.

Paragenesis of the ore minerals as has been studied by Walter H. Weed (8), and is as follows:

Quartz
Pyrite
Sphalerite
Copper minerals (Enargite, Tennetite, Chalcopyrite, Bornite)
Galena
Manganese Minerals
Chalcopyrite
Gangue minerals
Chalcocite

The rocks of the region are mainly two kinds, quartz monzonite or Butte "granite" and rhyolite. The mine is in granite, but close to the east a rhyolite dike was observed. It is difficult to trace the exact length or width of the dike, but certain characteristics of the rock seems to show its dike nature.

Czarina Mine

The Czarina mine is said to have been operated last around 1940-43 by Mr. John Cole, who leased the property from the Anaconda Copper Mining Company. Definite figure on production are not available.

Most conspicuous of the outcrop minerals in Butte is the black oxide of manganese, which is known as "black mag" to miners. To mineralogist this black oxide contains different kind of manganese oxides, all oxidation products of primary rhodochrosite or rhodonite, one of which is present in the mine.

The vein system, one of which crops out at the mine, is called Czarina. This vein system may be the continuation of the Black Chief lode, which is mined at the Emma
mine and the Travona mine. The manganese ore mineral in these mines is rhodochrosite. In the Czarina mine the orebody consists of both manganese oxide and carbonate depending upon the depth.

The vein is opened by an adit and by a shaft. The adit and the level below follow the trend of the outcrop. Several outcrops were driven in the adit, and from these crosscuts, shorter drifts were cut parallel to the main drift. A winze was sunk in one of these drifts, and may connect the lower level with the adit. There were also several crosscuts driven in the lower level but not much drifting was done there. The western shaft does not seem to be connected to either of these two levels.

There are number of pits (Plate No. IV), which may be observed both north and south of the outcrop of the lode. They were exploration work, for some of the veins that are not clearly exposed like the main vein. These pits are about 10 to 15 feet in diameter and about 6 to 10 feet deep. They show clearly the trend of two of the veins.

The mine is surveyed by the writer of this report and his observations in the adit with additional information provided in the map of the lower level, are given below.
Geology: - The outcrop of the main vein is about 30 feet wide on the surface, whereas in the adit the maximum width observed is about 6 feet. It appears that the vein is gradually decreasing in size downward as is shown in figure 2.

The mine workings show three from 4- to 6- ft. veins with minor veinlets, having a general easterly strike.
The fracture systems have general trends, one system of fractures has an east-west trend, and the other has a northwest-southeast trend. While investigating the adit, it appeared that at least two sets of fractures have been superimposed on the east-west fracture system.

The first produced a series of fractures having an east-west trend, along which the mineralization took place. Subsequent to this, a series of northwest-south-east fractures were formed. There are considerable displacements observed in the veins in the direction of these fractures. As the contacts of the veins and the granite are followed in the adit it is found that the movements in most cases were approximately in the north-south direction. The last period of fracturing did not result in any noticeable displacement, except along the strike of the vein. Brecciation with slickenside has been observed in the mine. Breccias have been cemented by oxidised manganese. The vein seems to have moved east along the strike of the fracture, the rake (pitch) is measured about 45°. The gouge material contains both granite as well as vein material. Oxidation of the veins continued after this diastrophism, as evidenced from the cementing of vein breccias by oxidised manganese.

The vein in the upper level is remarkably persistent
than in the lower level. They occur in granite, which is found to be altered in the adit. The vein fillings consist of oxide of manganese and quartz. On the map of the lower level it is observed that the vein material consists of rhodochrosite, pyrite, sphalerite, and galena.

Country Rock: The country rocks around the mine are of two kinds, granite and rhyolite. The mine workings show that the country rock in the mine is granite.

Granite: The granite is a part of the Boulder Batholith. It is a phaneritic rock characterized by predominance of alkali feldspar, which is almost all orthoclase. Plagioclase may be present, but cannot be determined in the hand specimen. The color of the granite is slightly pinkish. Much of the wallrock of the mine is considerably altered forming kaolinite, but in some places the granite is only slightly altered, and crystals of orthoclase can be traced in it. Granite is the only rock observed in the mine. This granite contains about 20% of quartz, 10 to 20% of femic minerals, and the rest is feldspar. Although the granite is altered, yet in one place some wallrock was observed containing relatively fresh femic minerals. The presence of this fresh granite against highly altered granite may be explained by block
faulting. This occurrence of fresh granite also seems to support a premise that this faulting was later than the mineralization of the fissures.

Rhyolite:—Intrusive rhyolite formed dikes in this district, and one, which may be observed in the east of the adit, is covered by wash. Its presence is recognised by floats only (Plate No. 111). The rhyolite is platy and uniform in character. It is a porphyritic felsitic igneous rock having the same composition of granite chemically and mineralogically. The groundmass is aphinitic, slightly brown color, with phenocrysts of feldspar, quartz and a liberal scattering of biotite. The dike seems to have cut the Czarina veins. The observation that the rhyolite intrusion was later than the mineralization is evident here.

Wallrock Alteration:—In some places the granite is much altered, especially along the veins. But where the wallrock is exposed without any vein close to it, the alteration is slight. It appears that the alteration is caused by hydrothermal solutions, and probably some meteoric water. It is difficult to distinguish between the two types of alteration, and the two types may have been superimposed. The physical and chemical changes brought about by the hydrothermal solutions may have been modified by the meteoric water close to the surface, and further changes
may have taken place when such altered rocks were brought by erosion or other causes into the oxidation zone.

The alteration products should be, as generally assumed, chlorite, sericite and little kaolinite. But surprisingly enough, except for kaolinite, no other alteration product has been observed. It is possible that these altered product were further altered by some other agent or agents. The effect of meteoric water appears to be slight as is indicated by some slightly altered granite not close enough to any vein to be effected by mineralizers. Abundant kaolinite observed in the adit may be due to meteoric action over already altered granite. The absence of chlorite and pyrite in the adit is probably oxidation. Oxidation is profound as can be seen by the vein material which is an oxidation product of the carbonate or silicate of manganese. Oxidation may have been caused by meteoric water in the presence of oxygen.

The lower level being inaccessible, the extent of alteration of the wallrock has not been determined.

**Vein System:** The oxidised vein system in Butte, including the Czarina veins, commonly form bold outcrops which may be traced across hundreds and thousands of feet. The Czarina vein system contains three prominent veins one of which is exposed as a prominent ridge. The ridge is
about 50 feet above the wash, about 30 feet wide on the surface, and 800 feet in length. The other two veins, that do not crop out on the surface, have been traced by exposures in the pits (Plate No. IV). The mineralization of the veins is in part fissure fillings, and in part a replacement type. The veins continued below the oxidised vein above.

Mineralogy:— Manganese oxides associated with quartz are the vein filling material in the adit, and rhodochrosite with galena, sphalerite, and pyrite in the lower level. Parent (5) has stated that rhodochrosite as the primary manganese mineral in the southern part of Butte. This is evident in this mine. The lower limit of oxidation could not be determined accurately. But from the nature of the vein in the adit it may be possible to state that the change from the oxidised to unoxidised material is abrupt. In the process of oxidation most of the vein materials have been removed except quartz, and the manganese has been transported and redeposited into the openings and cracks, cementing the loose brecciated materials.

It is probable that the process of oxidation might have enriched the veins, because considerable amount of materials from the primary veins have been removed such as the carbonate from rhodochrosite and primary sulphide minerals. At the same time however, this process of en-
richment may have been offset by the scattering of the oxide by transportation away from the veins by meteoric water.

In the lower level all the minerals present in Sales’ (2) third or peripheral zone, are shown in the map, but only rhodochrosite has been observed in dumps. The other minerals of sulphide may be present in very minor quantity, in the mine.

There are three oxidised minerals of manganese, pyrolusite, psilomelane, and wad, which may be definitely recognized; a fourth, magnite may be present, which is difficult to identify by physical tests alone. Rhodochrosite is the primary mineral found in the dump from the lower level.

Pyrolusite:— This is the most abundant oxide in the ore. In places it forms solid masses, but more often it is found scattered through out the veins, and as stain on quartz fragments. It occurs as radiating fibres or columns, in some cases its hardness which may be caused by quartz is much above the knife blade, otherwise it is less hard than the knife blade. And when scratched and rubbed between fingers it soils fingers. The luster is dull metallic, and has a iron streak. The chemical composition is MnO₂, and contains 63 percent of manganese and 36 percent of oxygen.
Psilomelane:- The common occurrence of this mineral is with pyrolusite, and its origin is same as that of pyrolusite. It is often found in cavities and is abundant in this oxidised zone. Though it is black in color it has a peculiar blue cast to the blackness. It has much greater hardness than pyrolusite, around 6 according to Moh's scale. It has a brownish streak and is not so abundant as pyrolusite in this mine. The chemical formula is $H_4R_2Mn_8O_{30}$, where $R$ is chiefly barium, but also includes manganese, magnesium, and calcium in traces.

Davis (10) observed from the chemical analysis of the psilomelane of the Butte district that it did not contain barium at all, but an appreciable amount of potassium. The variety of psilomelane was, as Davis pointed, called "true psilomelane" by early worker Ramsdell, and later changed to cryptomelane by recent workers Fleischer and Richmond. The formula given is $K_{\alpha}AO_{30}(?)R-Mn^{IV}$ chiefly, also $Mn^{II}$, $Zn$, $Co$ where $Mn^{IV}$ and $Mn^{II}$ are quadravalent, divalent manganese respectively. He concluded that "psilomelane type" mineral of the Butte district is cryptomelane.

Wad:- This is the name given to a black manganese ore composed of hydrous manganese oxides. It is commonly earthy, and crumples when rubbed. It also stains fingers. It is much softer than pyrolusite, and contains clay and
iron oxide impurities.

Manganite:— It is a minor mineral of manganese found with the ores of manganese. Its presence in the ore of the mine is difficult to determine.

Rhodochrosite:— It is one of the primary manganese mineral in the Butte mining district. It is found in the form of typical vein matter with quartz. It has a characteristic rose-red color, and slightly harder than the knife blade. It effervesces with warm hydrochloric acid, a characteristic which distinguishes it from rhodonite.

Sulphide minerals such as sphalerite, galena and pyrite are known to occur in the mine, but they are not found by the writer. The writer thinks the quantity of sulphides in the ore is not enough to call them ore mineral in this mine.

SUMMARY AND CONCLUSION

The mine workings show three phases of movements, the second and third being superimposed. The first produced a fracture system, having a east-west trend, and strongly mineralized. This movement seemed to occur after the intrusion and cooling of the batholith. Subsequent to this another movement caused the formation of
southeast-northwest fractures. This movement was much later than mineralization and seemed to cause cross faulting. These may be the lines of weaknesses along which rhyolite was injected during the next diastrophism. The last period of faulting occurred late, and the movement was confined along the strike of the first veins. The vein materials were broken by this movement, and the breccias became well cemented by the oxidised manganese minerals in the oxidised vein.

This was a simple investigation, and the lower level was inaccessible. The investigation of the primary minerals of the mine was limited to dump samples only.

The survey of the adit did not reveal any large high grade ore deposit. The primary rhodochrosite ore did not appear to be high grade. The vein is not continuous, and is broken by faulting.

The vein dips at a high angle to the south. The oxidation of veins is shallow, and this part of the veins would be cheaply minable. But the mining of this orebody will depend on two conditions: first, to develop an ore dressing process to concentrate the ore to sufficient high grade; and second, a national emergency when manganese will be in great demand, and low grade ores can be worked profitably.
BIBLIOGRAPHY


8. Weed, Walter Harvey, "Geology and Ore Deposits of the Butte District, Montana", 1912.


Plate No. 1

View showing a portion of the area. Czarina outcrop in the background. Looking west.

Close view of the portal and outcrop on the right. Looking northwest.
View showing the western shaft in the foreground and Czarina outcrop in the background. Looking east.

Czarina outcrop and the portal, on the left 150-ft. level shaft not seen in the picture. Looking west.
SURFACE GEOLOGY
OF
CZARINA MINE
BUTTE, MONTANA
Scale 1" = 40'

LEGEND

OUTCROPPED VEIN
TRACED VEIN
UNDERGROUND WORKINGS
PITS
WASTE DUMPS
TRACED DIKE

PLATE NO. IV
MAP OF
THE TZARINA
AND
ADJACENT CLAIMS
ADAPTED FROM
HARPER & MACDONALD

PLATE NO. V