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GEOLOGY and EXPLORATION
of the
MOUNTAIN CITY CONSOLIDATED PROPERTY
MOUNTAIN CITY, NEVADA

INTRODUCTION

The following report is based upon a recent short examination of the Mountain City Consolidated property, Cope Mining District, northern Elko County, Nevada. In 1933, the writer spent six months studying the surface geology of the district, and in more recent years he has visited the underground workings of the Mountain City mine. A few months ago a detailed examination was made of recent exploration in the Rio Grande property.

The general information given here regarding the Rio Tinto ore body of the Mountain City mine was gained from conversations and hurried observations several years ago. It is presented merely to give a general picture of the only commercial copper ore body discovered in the district to date.

GENERAL GEOLOGY OF THE DISTRICT

Rock Formations

Along the area in the general vicinity of Mill Creek (see the accompanying sketch map) the sedimentary rocks strike from east to west with generally steep dips to the north. Local and somewhat pronounced variations in strike may be noted and reversals in the direction of dip are not uncommon.

From north to south (presumably from younger to older) the following formations are exposed in the eastern section.

Limestone Series	1. A thick series of clean, thin-bedded limestone.
	2. A mixture of interbedded shaly limestone, sandy limestone, impure shale, and shaly quartzite. Not less than 230 feet thick.
Shale Series	3. Black, carbonaceous shale, finely bedded and somewhat schistose, 375 feet thick.
	4. Light-gray to medium-gray impure shale. Somewhat limy in zones and less finely bedded. 150 feet thick.
	5. Black, carbonaceous shale, somewhat schistose, with probably some interbedded quartzite. Approximately 1000 feet thick.
South of the area considered	6. Quartzite.
	7. Shale
	8. Quartzite.

The contact between the Limestone series and the Shale series has been reported to be an unconformity, and from the writer's observations in the Rio Grande mine he agrees with this interpretation.

On Mountain City Consolidated ground the clean limestone series is poorly developed. Shale is more abundant than limestone, suggesting a lateral gradation in the sediments or complications due to the unconformity.

Because of poor surface exposures, complications by faulting, and lack of much precise underground data, the thicknesses of many sedimentary units are not known accurately.

Well to the north of the Mill Creek area the limestone series is intruded by a large body of granite.

The north slope of the Rio Grande ground, leading down toward Mill Creek, is covered by a group of volcanic rocks (not shown on sketch) that rest upon the eroded edges of the upturned sediments. This erosion surface slopes gently to the north. These volcanics are mostly rhyolite tuffs associated with some obsidian. They are interpreted as post-mineral and relatively recent in age.

North of Mill Creek there is an extensive area of volcanic rocks of basaltic and andesitic composition. These are believed to be young surface flows and dikes of the same general age as the rhyolite tuffs. Their southern contact is shown approximately on the accompanying sketch, and their relation to Mountain City Consolidated ground is indicated.

Of particular interest is an igneous rock body between the Limestone series and the Shale series along the zone of the suspected unconformity. This appears to be an amygdaloidal basalt, and its texture suggests that it might be a volcanic surface flow on the ancient erosion surface marking the unconformity. However, it appears so closely similar to the young volcanics north of Mill Creek that it is believed to represent a dike-like feeder to these flows. The basalt is lightly mineralized by quartz, calcite, pyrite, and chalcopyrite and oxidation has developed sporadic tiny spots of malachite and cuprite. This mineralization has caused much interest, and a

fair amount of exploration has followed the margins of the basalt in Rio Grande ground. No important body of copper ore was found. The basalt varies in thickness from 15 to 200 feet and shows considerable irregularity. Locally it may be missing.

Faulting

The Mill Creek area is cut by numerous north-south faults. Only a few of these are shown on the accompanying sketch. Exact data on the behavior of the faults and their relation to the mineralization are difficult to obtain from the surface. Only in areas where mining operations have exposed abundant information that can be studied in great detail is it possible to interpret them correctly. Faulting will be discussed further along with the Rio Tinto ore body.

MINERALIZATION

General

The Mountain City District was discovered in 1859 and a production of about $1,000,000 in silver was credited to the camp prior to 1861. These early mined ore deposits were from small fissure veins in granite and metamorphosed limestone well to the north of the present area of interest where copper is being mined.

An important body of copper ore was discovered in 1952 by S. F. Hunt, and his discovery has developed into the present Rio Tinto ore body of the Mountain City mine.

Rio Tinto Ore Body

At its best development, the Rio Tinto ore body is about

1000 feet long on the 200 and 300 levels with an average width of about 50 feet. On the 200 level the average grade is about 40% copper. On the 200 and 300 levels important additions to the copper content have been caused by secondary enrichment. On the 400 level and below, mineralization is primary. The principal copper minerals in the enriched zone are chalcocite and chalcopyrite. Fine-grained chalcopyrite is the only prominent copper mineral of the primary zone.

The ore body is better described as an irregular lens-like body in shale than as a vein. The ore zone strikes about N 55 E, apparently with the bedding of the sediments and dips about 65 degrees north with the beds. Stratigraphically, it is reported to follow a "favorable" shale zone with black carbonaceous shale on the hanging wall and lighter colored shale on the footwall. The stratigraphic position of this favorable zone with respect to the limestone contact is not known accurately by the writer. Available information is complicated by poor outcrops, faulting, and the unconformity. The writer has suspected that the favorable beds were about 400 feet south of the limestone, but no reliable estimate really can be made.

When the Mountain City mine was hurriedly visited no dikes were seen along the mineralized zone. None were pointed out to the writer and none were noted on their very carefully made geologic maps. However, where thin, the dike so closely resembles the shale in appearance that it can readily escape attention. The dike zone along the unconformity is believed

to lie to the north of the favorable beds.

The Rio Tinto ore body going east is cut by a north-south west-dipping fault that projects to the surface just east of the new shaft. This is a post-mineral thrust fault with a flat westerly dip of about 30 degrees. Measured in the plane of the fault, the hanging wall is said to have moved up some 900 feet. The horizontal component gives a displacement of about 150 feet to the north, going east. See accompanying sections.

In the hanging wall of the fault is the larger and richer body of ore. It shows the normal sequence of gossan, secondary enrichment, and primary ore. Going west the ore zone in the hanging wall of the fault fades out into stringers. The writer is not informed as to how far recent exploration has continued out westerly on upper levels.

According to the writer's information, ore found in the footwall of the thrust fault is primary, and the primary upper edge fades out between the 300 and 400 levels with little or no ore on the 400 level. It is his impression that the ore dies out going east along a steep rake. That is to say, the east end dies out going east before it is cut by another fault.

It has been rumored that a more complicated interpretation of faulting may be considered, but no accurate information is available regarding the theory and its consequences.

On the 600 level, the ore body appeared strong. It is currently known, however, that 700 level mineralization has

been very disappointing. The ore body is badly faulted, and apparently mineralization is also weaker. It is rumored in the district that deeper exploration is now under way with a winze having been put down to the 1000 level from which a drift has been carried 2800 feet to the west. It is said that drifting is now going to east and west. No discovery of ore in these deeper workings has been reported or rumored.

A body of low-grade cuprite is said to have been discovered in recent years. The writer has no reliable data about this occurrence.

RIO GRANDE GROUND

The Rio Grande Group has been more extensively explored than any property adjacent to the Mountain City mine. Something in the neighborhood of $150,000 has been spent in this ground during the last six years without finding ore. The Golden Copper group of the Rio Grande Company will be discussed along with Mountain City Consolidated ground.

Earlier Explorations

In 1933 a geologic study of the surface was made, and the belief resulted that the Rio Tinto favorable shale beds were faulted to near or within the south side-lines of the westernmost claims of the Rio Grande group. Additional offsets were noted going east, but the favorable zone was believed to stay in Rio Grande property.

Five diamond drill holes were put down, but no ore was found. Minor copper mineralization was cut in Hole No. 1 near

the south side-line of Rio Grande Extension No. 1 claim (the claim nearest the Rio Tinto ore body). This small showing was at the edge of the basalt dike on the unconformity. Mineralization was weak, and there was danger of complications under the apex law even if it improved nearby.

All of this work was done for the Congdon interests of Duluth. Results in this and the Warhorse property well to the southwest were disappointing, and all work was abandoned in the spring of 1934.

Recent Exploration

Since 1934 the Rio Grande Company has driven the Davidson tunnel, sunk the Rio Grande shaft to the 265 level, and driven some lateral workings on the 265 level. During the last 15 months the Sunshine Mining Company has continued exploration by sinking the shaft to the 500 level and by driving an 800-foot crosscut on that level.

The edge of the Limestone series adjacent to the basalt dike was cut on both levels and some weak mineralization was found. Light and erratic iron-staining was found on the 265 level and a small amount of cuprite was noted near the dike. The dike was cut on both levels and was found to be lightly mineralized by quartz, calcite, pyrite, and chalcopyrite. Oxidation had locally developed a few specks of cuprite.

Driving across the dike into the shale consistently showed heavy ground and strong flows of water and added greatly to the expense and difficulty of the work. Considerable trouble

was experienced in handling the water due to the insufficient amount of electric power available in the district. Heavy timbering and spiling were needed for much of the crosscutting.

Due to these difficulties the supposedly favorable shale beds received very little exploration except for the earlier diamond drilling. Additional crosscutting of these beds was deemed advisable last summer and work was commenced on the 500 level in the central portion of the Rio Grande group where the shale series could be explored with less danger of apex trouble. Considerable trouble was experienced with water at the contact, but 300 feet of shale beds were crosscut before another flow of water drove them off the level and caused the abandonment of the property by the Sunshine people. Not all the favorable series was cut, but the remaining chances, considered in conjunction with the early drill hole data, did not warrant further expensive work with the low amount of power available. It is reported that a thin zone of weak oxidized lead and zinc was cut. Other than that, no mineralization was noted.

The Davidson tunnel was driven about 1000 feet at a maximum elevation of only 140 feet below the surface. For the first half of the distance it cuts volcanic rocks, and no bedrock is exposed except in a winze. The remainder of the tunnel cuts shale, and two zones of rather weak mineralization were exposed. These appear as zones of irregular quartz stringers accompanied by a variable amount of iron oxide. Much of the latter has been washed into fractures and joints and appears to have been

transported into place.

MOUNTAIN CITY CONSOLIDATED AND ADJACENT GROUND.

General

The Mountain City Consolidated Copper Company controls the Combine group of 11 unpatented claims and fractions in the western part of the area. Adjoining them to the west is the Fourth of July group of 4 unpatented claims. To the southeast is the Golden Copper group of the Rio Grande Company, consisting of 4 unpatented claims. The ground is about 1½ miles west of the Mountain City Copper Company's shaft.

Geology

The area is cut by several prominent cross-faults. The determination of their throws would require detailed mapping and difficulty would be experienced because of the covering of young volcanic flows. The eastern half of the Combine group shows the limestone series - Shale series contact in its southern portion striking to the northwest. A north-dipping basalt dike of variable thickness is intruded along the contact and appears to be the same contact (unconformity?) and dike that was cut in the Rio Grande workings. About 500 feet to the north is another, thicker dike. North of this north dike the sediments are shale and quartzite; farther to the east they are limestone. The Golden Copper fault cuts through the center of the Combine group. West of it limestone and young volcanics are exposed. The fault has apparently moved the west side to the south, possibly 1000 feet.

The writer's earlier mapping covered very little of this area, and the sketch map is only intended to give the approximate relations.

Exploration

The Mountain City Consolidated Copper Company has explored the southeast corner of their ground by an upper tunnel, a winze down from the tunnel, and a lower level off the winze.

The upper tunnel is located about 500 feet northwest of the southeast corner of Combine No. 4 claim and about 125 feet above the level of Mill Creek. It follows a crooked line toward the west and cuts the hanging wall (north side) of the southern dike at a distance of 170 feet in from the portal. The hanging wall formations exposed are shale with a central limestone zone. The basalt dike and its margin show minor mineralization by quartz and calcite stringers that carry sporadic spots of pyrite and chalcopyrite.

The winze starts down at the hanging wall contact of the dike at an inclination of 65 degrees. The dike dips at 55 degrees, and the winze cuts into it. Minor mineralization is reported in the dike. The winze continues down on the incline for 185 feet and is now tightly timbered.

The lower level cuts northerly across the dike (here 60 feet thick) and 90 feet out across the hanging wall sediments. These workings are now caved and could not be examined by the writer to check the report of goodness here discovered. A drift follows the footwall sediments about 50 feet easterly out of the

shaft. These show minor, irregular mineralization adjacent to the dike.

An assessment tunnel has been driven a length of 255 feet in the eastern portion of the Golden Copper group. This cuts the Limestone series - Shale series contact and dike and extends 145 feet into the footwall shales. The Shale series here shows abundant interbedded quartzite, and the dike is only 10 feet thick. It is reported that a 1% copper assay was obtained at the face, although the writer could see very little mineralization.

RELATION OF DIKES TO MINERALIZATION.

Exploration in Rio Grande ground by underground workings and diamond drilling and workings in the Combine ground show that the basalt dike along the contact and the sedimentary wall rock are lightly mineralized with copper. Rather extensive work has shown this to be very low in grade (well under 1% Cu.) and irregular. The dikes are apparently related to the young volcanics that rest on an erosion surface carved across the Rio Tinto ore body. Hence their mineralization is younger in age and distinct from known commercial mineralization.

The writer believes the known favorable zone to lie south of the southern dike an unknown distance (possibly 400 feet).

It appears that the dikes are not offset by the cross-faults to as great an extent as are the sediments, although detailed mapping might not support this view. This suggests

that the dikes are later in age than some of the fault movement.

SUMMARY OF EXPLORATION TO DATE

The writer believes the basalt dike and the sediments on its immediate walls to be sufficiently explored. Results have not been encouraging, and no more work is warranted.

The footwall shales have been explored by diamond drilling on the Rio Grande group without finding ore. Core recovery in this drilling was very poor, and the Sunshine Mining Company drove 300 feet into this series on the 300 level for additional information. No important mineralization was found. However, they were driven out by water before their objective was reached, and there remains about 400 feet of shale beds that could have been cut. Of these, only about 150 feet are in what the writer believes to be the favorable series.

The Golden Copper assessment tunnel could have been driven another 250 feet in favorable beds without fear of open complications, but work was concentrated in the Rio Grande group at greater depth.

Mountain City Consolidated has not explored the footwall shales on Combine ground partly because of the nearby Golden Copper property line and partly because of the fear of water on the lower level (some 50 feet below Mill Creek).

POSSIBLE FUTURE EXPLORATION.

The favorable beds should be found near the common property line between the Golden Copper and Combine groups. They

can best be reached by a 500-foot tunnel just above the level of Mill Creek leading northerly through the north half of Golden Copper No. 2 claim and into the Combine group. This should avoid water trouble and at the same time cut any mineralization near the base of oxidation. (The top of the sulphide zone in the Rio Tinto ore body was near the level of Mill Creek.)

Just north of the north dike there is a 25-foot bed of black shale that shows 10 feet of strong bleaching with iron oxide streaks. It is exposed in a pit, and on the hanging wall edge is about 6 inches of excellent gossan from which chalcopyrite has apparently been removed by oxidation and which is reported to give low assays in gold and copper. North of this there is about 300 feet of quartzite, all dipping steeply north. This showing is worthy of exploration.

RECOMMENDATIONS

The tunnel suggested above on the Golden Copper and Combine ground is warranted to cut the favorable beds. These beds, to the best of the writer's knowledge, are productive in the Mountain City mine. They were not productive in the Rio Grande ground where cut by drilling and crosscutting. Their full thickness, however, was not explored. Their first 145 feet was not productive in the Golden Copper tunnel, but a low assay is reported in the face. These beds can be thoroughly explored by the tunnel just above water level under a surface on which gossan float is said to have been found. They can also be cut by the less expensive expedient of extending the Golden

Copper tunnel, but the nearby property line might cause spur trouble and no great amount of back would be developed.

The tunnel above proposed into Combine ground is a sound prospect. The writer recommends the work but points out that the beds were not found productive to the east. In view of the strong Rio Tinto ore body; they should be well explored to the west.

The gossan showing just north of the north dike deserves some work. It should be followed by trenching and a few shallow shafts. If this proves it to be persistent, then a tunnel site should be located to cut it at depth.

PROPERTY CONTROL

The Golden Copper group of the Rio Grande Company and the Combine group of the Mountain City Consolidated Copper Company are necessary for carrying out the above work. Due to its position west of the Golden Copper fault, the Fourth of July group is not so necessary but it would be well to control until the fault structure is better known.

The writer does not recommend any further work on the Rio Grande group proper and does not believe that any commitments should be made to do work on this ground in order to obtain control of the Golden Copper group.

GEOLOGY

Prior to accurately locating the tunnel, the geology should be carefully plotted on the Combine group. This will make it possible to more accurately estimate the amount of

driving necessary and will indicate the best location. This report is based on rapid sketching, and contacts have not been closely enough placed to serve for a precise location.

R. N. Pennebaker

Kimberly, Nevada
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