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GEOLOGICAL SURVEY AND RE-SURVEY

OF THE

TONOPAH MINING DISTRICT OF NEVADA

(Dynamic Geology and Ore Deposition)

BY

LETSON BALLIET

Consulting Engineer and Geologist

Author of technical papers

Dynamic Geology of the Tonopah District, Genesis of Ore Deposits, Genesis of Petroleum, Deep Mining between the Wasatch and Sierra Nevada Mountains, Oxygen in the Steel Industry, Cutting Costs of Mine Operations, etc., etc.

Efficiency Engineer with the Shipbuilding Industry during the war.
Engineer of the first Hydroelectric Survey of the Colorado (1914).
Inventor of the "Balliet Counterbalance for Mine Hoists", etc.

Price $1.00

"AS OTHERS SEE US"

"Mr. Balliet is one of the highest paid technical writers in the United States." From the **Oil Age**, Los Angeles.

"Mr. Balliet is one of the able engineers of the country." Dr. Edward Allison Hill, Geologist and Petroleum Engineer of world-wide reputation.

"One of the best known engineers in the west, and frequent contributor to the scientific journals."—**Mining Review**, Salt Lake City.

Referring to Balliet's Genesis of Petroleum and Ores, Dr. George H. Hook, one of the best geological authorities in the country, and the man who was sent by big oil interests to investigate the mineral and oil deposits of South America, said, "It opens up many avenues of thought for the scientific geologist."

Many others could be quoted from the technical magazines of this country and abroad, and also personal endorsements from many of the best engineers of the country.

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LETSON BALLIET, Consulting Engineer

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INTRODUCTION

This report is published to correct errors and omissions of early geological investigations. The much faulted, broken up, condition, of the upheaval zone made it difficult for geologists to say positively what would be found when development opened up the ground beyond the area of disturbance. Tom Lockart's "Tonopah Extension" and Tom Bannerman's "Little Tonopah" were then pure wild cat stock selling prospect holes, outside the ore zone. Today they are both part of the Tonopah Extension Mine, over 2200 feet deep, "the greatest silver-gold mine in the world." Voorhees' "Buckeye" and Kieth & Kerns "Halifax" were both prospects beyond the ore belt. Today they are **mines** with great future possibilities before them, while the once big producers in the broken up zone have "bottomed" and are being abandoned for the better, bigger and deeper mines beyond the blow-out to make up the production of Tonopah for the years to come. (See drawing Figure 1)

No one has ever mined long enough nor deep enough, any where in the world, to bottom an ore deposit where it has been found in the permanent unbroken formations, and the depth to which the EAST and WEST SIDE mines of Tonopah will go, is limited only by the physical and mechanical ability of man to follow them to depth.

Lebbeus Balliet

Consulting Engineer and Geologist.

Review of the Geological Surveys of the Tonopah Mining District

The region between the Rocky Mountains and the Sierra Nevadas includes the State of Nevada. This state is larger than all six of the New England States and New York with several other little states like New Jersey and Delaware included for good measure. The distance across Nevada is more than half the distance from New York to Chicago.

This state has a total population of about 70,000 people, 25% of which live in one city, Reno. The builders of the railroad across the state naturally hunted out the levelest and easiest route for construction. Every mile of flat level desert was a saving in cost of building, consequently the passenger across the state sees miles and miles of uninviting desert, which is a great injustice to the state. The mapmaker labeled it "The Great American Desert,"—not a very inviting term to immigrants and tourists, particularly in view of what could be seen from the railroad to create an idea of what the mapmaker meant by "desert."

We who have spent years of our life upon the desert, trying to find its hidden treasures, fighting its sandstorms, its blizzards, its burning heat, its long distances without water, avoiding the springs of poison waters that are surrounded with the bleaching bones of animals that have lost their life for a drink, are rather proud of the term "desert" because we know its fertile valleys, its underground streams, and its mineral wealth.

Its sparce population, its long distances from habitation to habitation, has not permitted its hills and valleys to be half explored, and yet it has produced in gold, silver, copper, lead, quicksilver, and other metals, over **two billion of dollars.** It has great deposits of gypsum marble and limestone, a few of which are being used in manufacturing cement, lime, and lime-products. The "Twenty Mule Team Borax" originated on the Nevada "desert" and the greatest deposits of borax and rock salt in the world are here "on the desert". Iron and iron oxide ores in great quantities have been discovered, which will in time be a factor in the worlds supply. Clays for pottery and diatomaceous earth are attracting attention. Agriculture is increasing rapidly. Cattle, sheep, blooded horses, poultry, bees, and fruits are prominent factors in the state's wealth.

Its State funds are enormous, and are invested in interest bearing bonds of other states and eastern cities. It has been said that Nevada owns bonds issued in every other state in the Union, and that every state that has a bond issue, is paying interest to Nevada.

It makes no difference what state you live in, part of your money that is paid for taxes, or that you pay for meat and groceries, (the butcher and grocer pay taxes which are included in the price you pay) goes to Nevada as interest on money borrowed from Nevada. Nevada's great mines pay taxes on their property and on bullion production, while the state funds pile up, and are put out at interest. The Postal Telegraph, the Atlantic Cable, and the Pacific Cable were financed with money from the Comstock mines of Nevada. Part of the transcontinental railroads were financed with money from Nevada mines. Nevada money is helping states, cities and industries all over the country.

The greatest water power in the United States is the Colorado River on the boundary of Nevada and is yet unharnessed.

If you knew the state as we know it who have worked and fought to bring its natural wealth into production and to give it to the world, you'd be proud of the "desert" too. Two billion of dollars in mineral wealth have been taken out of the ground, and is now circulating in the world somewhere, being used by mankind, that would yet be buried under the desert surface, if the mapmaker and geographer had frightened all of us into believing the "desert" to be only a barren waste.

THE UPLIFT

Gilbert's Geology tells us that the territory between the Rocky Mountains and the Sierra Nevadas was once a great sea bottom which is called Lake Bonneville and that Great Salt Lake is the remnant of that once great mediterranean sea. Gilbert tells us that the earth in cooling off contracted on the surface until this sea bottom was lifted to its present elevation and that the water went out to the north by way of the Snake River. Manifestly, at some time, this region between the mountains was elevated, crushed together, folded up and wrinkled into mountain ridges with valleys between them, but this was not all done in one movement. A series of many little slips and folds occurred at intervals over many, many years until it reached its present condition.

The dynamic force that caused this great uplift was tremendous and is responsible for the folded condition of the strata as we find them today. Theoretically, if the crust of the earth wrinkled upwards in one place and downward in another the molten interior would follow the folding—

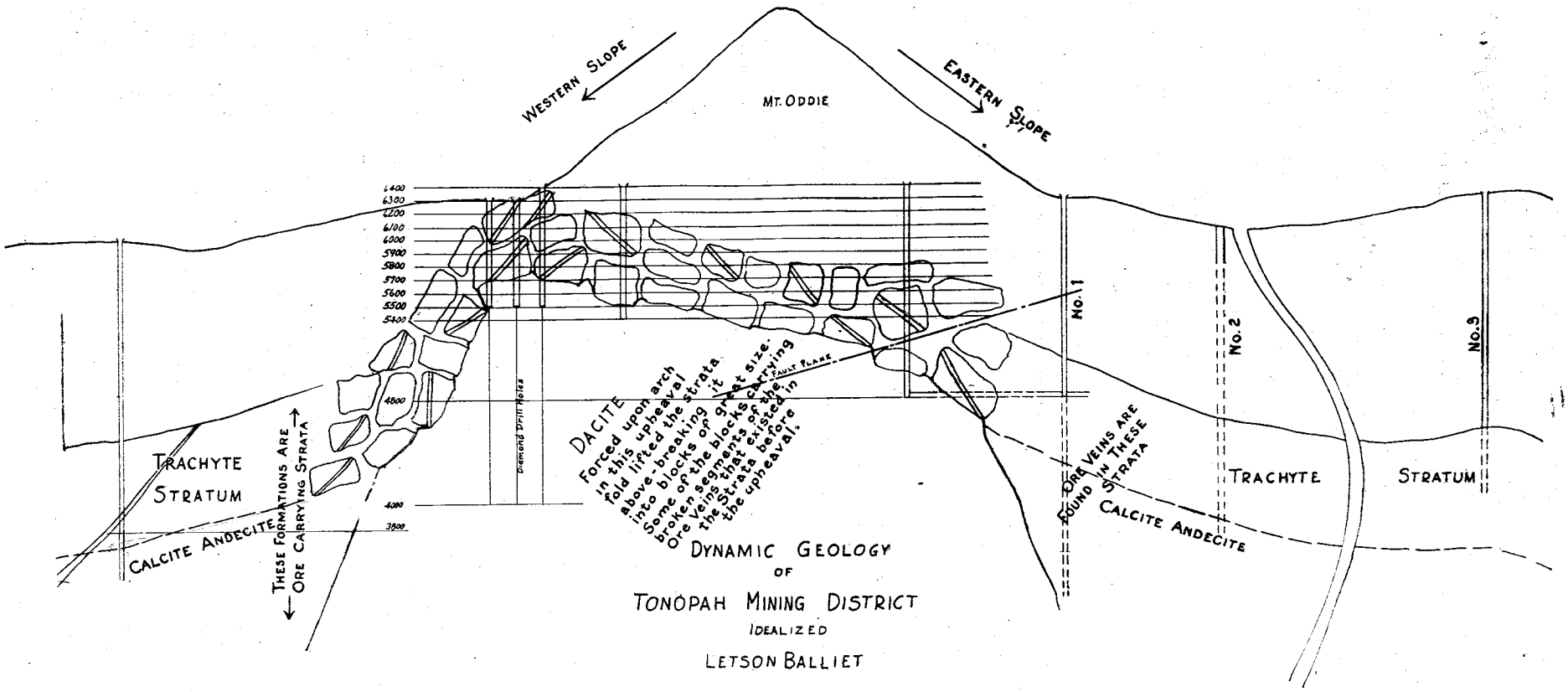


FIGURE 1.

This drawing will convey the idea of how the DACITE shoved itself up against the strata, broke it into blocks and followed it up as it folded. No commercial ore has been found in the dacite.

it would be forced into fissures and cracks and between strata. Great slips or faults would occur, causing the earth to tremble in what we call earthquakes. Within this area many mineralized districts have been discovered which have been heavy producers of both precious and useful metals. One of these mineralized zones is the Tonopah mining district, which as a producer of silver ore has become known the world over.

One of the folds, or wrinkles, in the earth crust that was made when the earth shrunk, squeezed itself together and uplifted the inter-mountain region, (Nevada) till the water all ran off to the sea, is known as the San Antone Range of mountains, of which Mt. Oddie is one of the peaks.

Tonopah mining district is situated right on top of this San Antone ridge. It is divided by the ridge, and lies on both sides of it. The first discovery of ore was made upon the western slope, about half way down from the peak. At this point the ore bearing blocks had been thrust up to the surface or so near the surface that rains and winds had eroded away the overlying rocks leaving the ore exposed. The story is told that Jim Butler picked up a rock to throw at his donkey (all donkey drivers throw rocks at them) and noticing it to be heavy like lead, he investigated and found it to be rich in silver. Had not the ore **outcropped** and been exposed by the donkey, $200,000,000 (two hundred million) in gold and silver that is now circulating around the world somewhere, would still be buried in the ground where no one would be getting the benefit of it. No doubt there are many other deposits of metal equally big, or bigger, that do not outcrop, and that have not yet been found. By digging into the ground and tracing the ore farther and farther away it led to greater depths and to the bodies (or "treasure vaults" as they are sometimes called) from which the outcrop originated before the upheaval shoved it to the surface. Jim Butler said, "It didn't rain down from the sky, it must have come up from below," and digging began. The ore was found in a rock that was called "trachite." A great block of the trachite stratum had been shoved up to the surface. The ore vein was found in this block. Digging in other places exposed other blocks of trachite and more veins of ore in them. **Trachite** is a flow stratum. It was evident that the flow had been broken by an upheaval, and that the great blocks had been shoved up into the mountain by the force of the upheaval. Geologists called this "a block faulted zone" (illustrated in drawing No. 1.)

Many geologists and engineers, including some of the ablest men in the profession, have written upon the stratagraphical or historical geology of Tonopah. Some of them have been quite general and wide in their scope; others have been merely a log of the ground through which some particular shaft or mine working extended. The logs of different shafts in the district have some variations, which in some cases are probably variations in nomenclature, but all geologists have agreed on one thing and that is that the trachite formation carries ore bodies. Some have said "without trachite in this district there is no ore", others have said that the trachite is the "mother formation" of ore. Although there are places in Tonopah where the ore seams and ore veins extend into other formations it has been well established that they have come from or come through the trachite.

Without disturbing any of the stratagraphical geology or nomenclature that has been written upon the district it will be found that the dynamic geology will fit very closely into the reports of some of the most prominent engineers.

As early as 1902 John Hayes Hammond made an examination of the prospect holes and lessees' shafts on the western slope of Mt. Oddie. At that time there was no development except in the immediate vicinity of the original discovery where the ore outcropped. Nothing but sage brush desert was visible in any direction from the mountain. Mr. Hammond is reported to have said: "It's mighty rich ore but it will not go down very deep." A local paper and some of the mining papers made comment upon Mr. Hammond's statement at the time, which, quite naturally, did not please the prospectors and promoters of mining property.

Mr. Hammond was right, within the limits of what he was able to see at that early date. He conveyed the idea that **ore in a flow sheet might not be any deeper than the flow sheet was thick** (unless it came through the flow sheet from some underlying strata, which is just what it did. Bear in mind that when Mr. Hammond made his examination there were no deep shafts in the district. The few shallow holes near the original discovery (where the three shafts are shown close together in the drawing) had not then penetrated beyond the first block near the surface. Hammond made no report on what might be found by subsequent development either east or west, but the fact remains that the original discovery bottomed the ore, and passed through the trachite at 600 feet depth. It was sunk a couple of hundred feet farther and then they put down a diamond drill hole 1500 feet deeper in DACITE and found no ore. Other mines in the upheaval zone had a similar experience. They were rich, and big producers while they lasted (about 20 years) but nevertheless they **bottomed,** and all that they produced came from above the 800 foot level, until the Belmont mine run through the mountain and put in its new shaft on the eastward slope. The ore dipped deeper on this side and the expression became common, "No ore **below** 800 on the west side and none **above 800 on** the east side." On the east side the Belmont practically bottomed the ore at 1200, though they sunk to 1500 feet without opening anything of importance in the lower levels. Practically all of their great production came from above the 1200 foot level. In 1923 the Belmont attempted to tunnel south-east-

ward from their bottom level to pick up the ore where it dipped deeper into the ground to the eastward, but the expense was too great to reach it after their own production had dwindled to what they could clean up here and there, in their own mine.

The bottom levels in all the mines located in the upheaval zone have been abandoned. The Tonopah Mining Co. can "glory hole" or steam shovel a great tonnage of low grade ore for many years because the ore comes to the surface and they have little or no overburden to handle. The Belmont is cleaning up some of the places where they left ore in small quantities during their days of strenuous production, and are sending it to custom mills. The Montana Tonopah Mining Co. has transferred their operations to the East side beyond the upheaval zone. The Midway sunk a new shaft and moved their operations outside the broken up zone. The West End Consolidated and the Tonopah Extension abandoned their first shafts and moved westward, where the ore veins are greater than anything ever found in the broken-up zone. It is a common expression to hear people say, "The Tonopah Extension has so much ore they never will be able to mine it out." The Rescue Eula's original shaft is inside the block faulted zone, but their property extends eastward, where good ore is proven to exist having been followed to the line of that company from the deep workings of the Buckeye mine.

The situation has changed. The once great mines whose production startled the world, are passing into history, while mines around the edges are coming into the lime light as the big producers. The mines in the upheaval zone were likened to the foam on a glass of beer or soda water, while the real solid matter is beyond the foam. The outside mines have to go deeper to reach the ore, hence the inside mines began production sooner, but the outside are taking their place, and will be producing for many years. It was but natural that the brokers and promoters could sell stock and keep up excitement easier with the "foam" of the rich ore that was actually producing millions for the time, than to sell stock in the mines that had to be sank 1500 to 2000 feet before they reached the ore. Even though the deeper mines may be longer lived, and production greater, it was but natural that the investor should regard a "bird in the hand worth a dozen in the bush", but now that the "bird in the hand" has been eaten, attention must be turned toward getting the "birds in the bush", or to getting out the greater tonnage that lies deeper.

The Tonopah Extension has reached a depth of nearly 2300 feet, and has found great ore bodies in **calcite-andesite** UNDERNEATH THE TRACHITE STRATUM. Hence it is now known that the trachite was only one stratum that happened to be laid down before the ore was put into the veins and that the ore came up from below, or was deposited in other and deeper strata. The trachite was therefore the top stratum that received the metal—and it was this formation that was shoved up to the outcrop.

THE TONOPAH EXTENSION ON THE WEST AND THE BUCKEYE ON THE EAST HAVE BOTH GONE THROUGH THE TRACHITE INTO CALSITE ANDESITE AND FOUND ORE. The **dacite** intrusion that came up under the mountain has not been encountered outside the upheaval zone.

The trend of the ore veins eastward is directly toward the Buckeye Eagle shaft (No. 2) indicated on the drawing, which points to the possibilities of making it a great producer.

A few years after Mr. Hammond's visit, Mr. J. E. Spurr made a report which, though more diplomatic than Mr. Hammond's, conveyed practically the same idea. Briefly we draw from Mr. Spurr's report that **the trachite came up from the west and terminated against a fault or slip.** He tied his theory of the ore deposition so strongly to **trachite,** that the impression became general "no trachite no ore." And anyway, if ore was in trachite, as the origin or mother formation of ore, it meant that it wouldn't go down any deeper than the trachite flow stratum. However, after the Belmont had run through under the mountain and found ore beyond the slip, Mr. Spurr is credited with amending his report, indicating that subsequent development had proven the ore beyond the fault and that if ore was found still eastward it would be at greater depth. That is just what was afterward found to be the case.

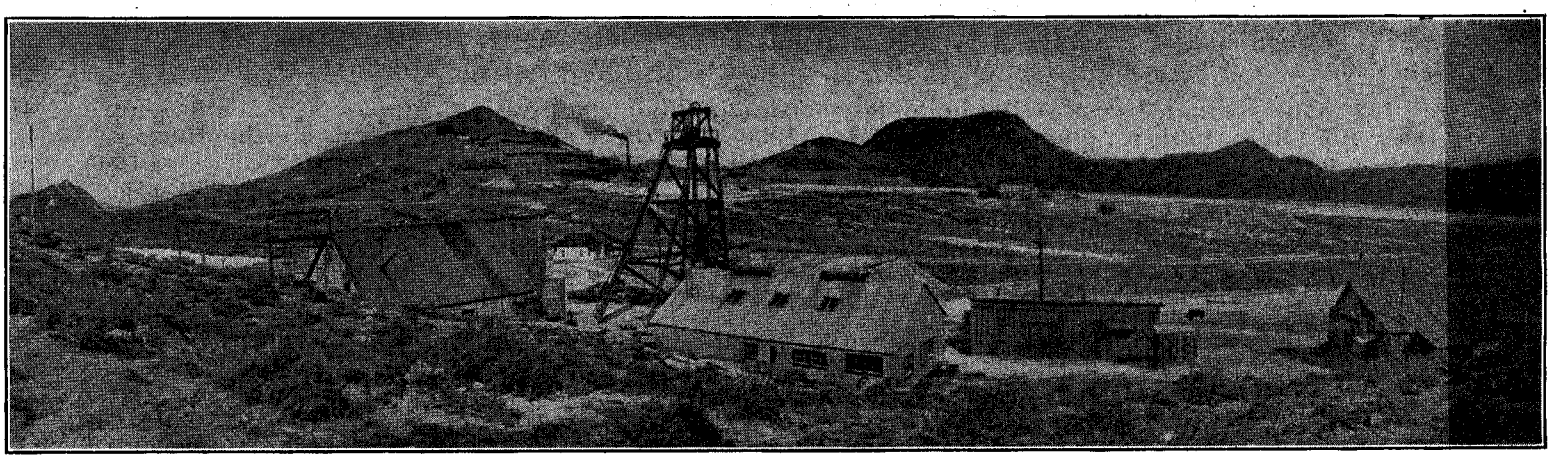
In 1906 the writer made a report in which he stated **"the ore bearing formations extend both east and west. The mines on the mountain are in a broken up zone, much faulted, and the deep permanent mines will be found east and west of Mt. Oddie."** In 1914 the MINING WORLD of Chicago published a paper prepared by the writer on the **dynamic geology of the eastern slope of Mt. Oddie,** conveying at some length the same idea briefly expressed above. In 1923 in the MINING REVIEW of Salt Lake City, the writer again published a series of articles on the same subject which present development has proven to be correct.

Burgess, Winchell, Lawson, Scott, Chandler, Brady, Lindgren, and others have written reports, and made geological surveys, for various clients and at different times. The verbiage differs and minor matters and localized conditions differ in their reports but in the main they differ but little.

The geologists for the mining companies in the upheaval zone had a hard nut to crack. The formations were block faulted and thrown into such irregular positions, and in the most unexpected contact with others, until a geological map laid off in colors looked like the side of a camouflaged ship.

For a long time the writer was alone in his theory that the ore came from greater depth than the trachite, and from the east and west to be thrown into the broken up zone by dynamic pressure. Some of them said, "Balliet is wrong," and, "There is no ore to the east," but I was so sure that I was right that I put my energies with the Buckeye Belmont Company to help them sink to 1500 feet to prove my theory. In fact I had to; otherwise no one would have ever known whether I was right or wrong. If no one had sunk to the ore I would have been the "poor geologist," and it was not until the Tonopah Extension found ore at depth, and below the trachite that some of them began to agree that "Balliet might be right". When the Buckeye shaft cut the trachite and found ore, and went on through the trachite into the calcite andesite, it proved that **I was right,** and opened great possibilities for other east side properties, as well as the Buckeye. It required some nerve to ask my friends to furnish the money to sink 1150 feet without an assay, to the 1200 foot to find any ore, and to the 1400 to prove it continuous and big enough to have commercial possibilities, but they made good, and some people seem to have the idea that I can see 1400 feet into the ground, which of course is impossible. I simply analyzed the formations, and figured what **ought to be** the condition, (illustrated in the drawing) and my analysis happened to be correct. The No. 1 shaft went down on top of the ore, and found the veins, or ore filled fissures, coursing eastward toward the No. 2 and No. 3. shafts.

The Tonopah Extension Mine is now said to be the "Greatest Silver Mine in the World" and a glance at the drawing will show you why. It's the deepest mine in Tonopah district and no sign of bottoming its ore is in evidence. That company plans to spend a million dollars in development and improvement this year, which will add many years of "ore reserves" ahead of what is now in sight. The Montana-Tonopah Mines Co. has reorganized and transferred their operations to the EAST SIDE of Mt. Oddie, on the Gypsey Queen, and will sink that shaft to 2200 feet depth or deeper, thus reaching



The Buckeye mine, which proved that the ore-bearing formations extended eastward by sinking the shaft into the trachite. View is looking westward to the Belmont Mill, swinging to the northward it shows the Halifax. Mt. Oddie, behind the Belmont Mill. The original discovery in Tonopah is on the western slope of the mountain. The Tonopah Extension's deep shaft is just beyond the base of the mountain westward. It's their No. 3 shaft. The Buckeye Eagle and Buckeye Tonopah shafts (No. 2 and 3), still eastward, will likely prove greater than this one.

a similar depth on the EAST SIDE that the Tonopah Extension has attained on the WEST SIDE. The Buckeye shaft on the EAST SIDE encountered the trachite at 1200 feet depth, and has since gone to the depth of over 1500 feet into calcite andesite. This shaft proved the great ore-bearing formations to exist eastward, and though not yet equipped with a mill of its own, as is the Tonopah Extension, nor so extensively developed, it will no doubt run a pretty close "50-50" race with the west side property, as it develops.

In 1923, The Montana-Tonopah Mines Co., in sending out their circular letters to their old stockholders, recommending the reorganization to finance the work of sinking a deep shaft on the East side, printed the following very conservative paragraph concerning the Tonopah Extension property.

"With the consent of the management of the Tonopah Extension Mining Company we submit a brief description of the bonanza ore-body which has been developed on the lower levels of that property during the past six months. The ore-shoot on the 1,880-foot level is approximately 700 feet in length. It is developed by drifts on the hanging and foot walls, which at the narrowest point are 40

feet apart and at the widest about 140 feet apart. The ore-body has been crosscut at frequent intervals from hanging wall to foot wall, so that it can safely be said that at least 400 feet of this shoot has been blocked out. Three hundred feet is at the present time being square-set and the average width of this 300 feet is 60-feet, and the values average $18 a ton. At about the center of the shoot a winze has been sunk to a depth of 115 feet, the values averaging $18 a ton. As this has proved the ore to within a very few feet of the 2,000-foot level it is demonstrated beyond doubt that good mining will be had on the 2,000-foot level and the tonnage that is now shown in the mine will be practically doubled. Crosscutting is now in progress from the shaft on the 2,000-foot level. The company is milling at the present time 425 tons a day and is adding 10 stamps to the mill which, when completed, about March 15, (1923), will increase the tonnage to 500 tons a day. It is estimated that the tonnage now exposed on the 1,880 and upper levels will furnish this mill for a period of four years. With the assurance that the ore-bodies extend to the 2,000-foot level the Tonopah Extension Company should continue to be a dividend-payer for the next eight years. Nor is there any reason to believe the 2,000-foot level is the limit, as the Murray vein has increased in width with depth, and there has been no diminution in value. Similar ore-bodies in the same formation, such as Pachuca, Mexico, and the Comstock at Virginia City, Nevada, are being mined to a depth of approximately 3,000 feet, and the ore-bodies have not been bottomed in this formation in any silver-gold mine in the world. Therefore, there is no predictable depth-limit to the Tonopah Extension." (This mine is now 2300 feet deep and going deeper.)

Zadig and Company's "Market Letter" mentioned many mines and gave their values from the stock market point of view, but contains the following words in the first paragraph:

"The new work in the Buckeye-Belmont property, which is in the eastern part of Tonopah, is of as great importance to the camp as the work the Tonopah Extension is doing in the western part."

Since the Buckeye (No. 1) has struck the ore and proven itself to have great possibilities for a long life and steady production, it appears evident that the Buckeye-Eagle (No. 2) will have the same chance to become a big producer, that the westward shafts of the Tonopah Extension had, and will find the continuation of the ore eastward. I have no hesitation, now, to back up my geological analysis in saying that the Buckeye Eagle should sink a three compartment shaft 1500 feet deep and that it will be justifiable to continue it to greater depths after the ore has been encountered, perhaps to 2000, and even 3000 or more feet of depth. THERE IS NO KNOWN DEPTH-LIMIT TO TONOPAH.

The estimated cost of the buildings, hoisting and air compressing equipment, machine shop, tools, pipe lines, timbers, pumps perhaps below 1500, and air connections through to the Buckeye Belmont (to make double outlet for safety as well as for ventilation) will be $200,000. There is little room for doubt but that its own ore production will carry the expense of further development after it has been equipped and developed. The Buckeye Belmont (No. 1) has a two compartment shaft, as it was cheaper to sink, while trying to prove that the ore did extend eastward, but the proof having been found the Buckeye Eagle (No. 2) shaft should be widened to three compartments. The trend of the veins is known, and tells just where the No. 2 shaft should be sunk to encounter them.

The second drawing (Figure II) is a north and south section through the Buckeye No. 1. A careful study of this drawing will tell the whole story. The view is looking at the ends of the vein, looking east. The development to the eastward cannot be shown on a north and south section. The 1200 foot level is extended eastward directly away from you as you look at the section for a distance of 1700 feet., westward (toward you) about 300 feet and to the S. E. obliquely from you to the right about 700 feet. The 1200 is connected with the Halifax mine on the north (to your left) for ventilation and safety. The upraise extends into the Halifax ground (to your left.) On the 900 foot level the drifts extend about 125 feet eastward and 70 feet westward. On the 1400 the drift follows the ore about 200 feet eastward, and about 100 feet westward to the Rescue-Eula Company's line. The 1450 is a crosscut to the vein, but no east and west drifting has been done on this level yet. The 1508 foot level is just a short crosscut, not yet to the main vein, but evidently close to it for a little water is coming into the level draining the levels above. The dotted lines indicate the proposed deeper sinking into the calcite andesite to reach greater ore bodies which I am satisfied will be encountered.

The dip of the formation eastward, indicates that this should be the case in relation to ore found in the mines to the westward, (see drawing through the upheaval zone). The ore "didn't come down in a rain storm", and greater depths must open bigger ore bodies. If this mine can be productive above its 1500 foot level the Buckeye Eagle should be made even greater, with development. This is practically assured as the No. 3 shaft (still beyond) is down 900 feet and has just reached the trachite contact, showing stringers of ore that assay well, some of them running into three figures. I cannot conceive of the formation being continuous between No. 1 and 3, and not being productive in No. 2 which is between the two.

The No. 1 now needs a much bigger hoist and another air compressor and more air drills, which will be immediately arranged for.

VALUE OF THE ORES

The 900 foot level in the present face shows $6 per ton, though this is only a low grade spot that should open out richer at any time. The 1200 shows conservatively cut samples from $18 to $36, and can be opened to average $25 to $26 per ton. The 1400 sent 20 tons to mill that yielded $10.50, which was taken out while cutting the station and was mixed with more than half waste rock, as we had no facilities for sorting. I draw the conclusion had the ore been mined free from the waste that it would undoubtedly return over $25 a ton. Assays have been taken from various places in the mine showing from $185 to $340 per ton, but all such assays I have discarded, fearing that if I averaged them in it would make the average appear too high. All such ore would be saved and milled, but every assay over $36 a ton, I discard so as to be sure I do not fool myself, and expect too much.

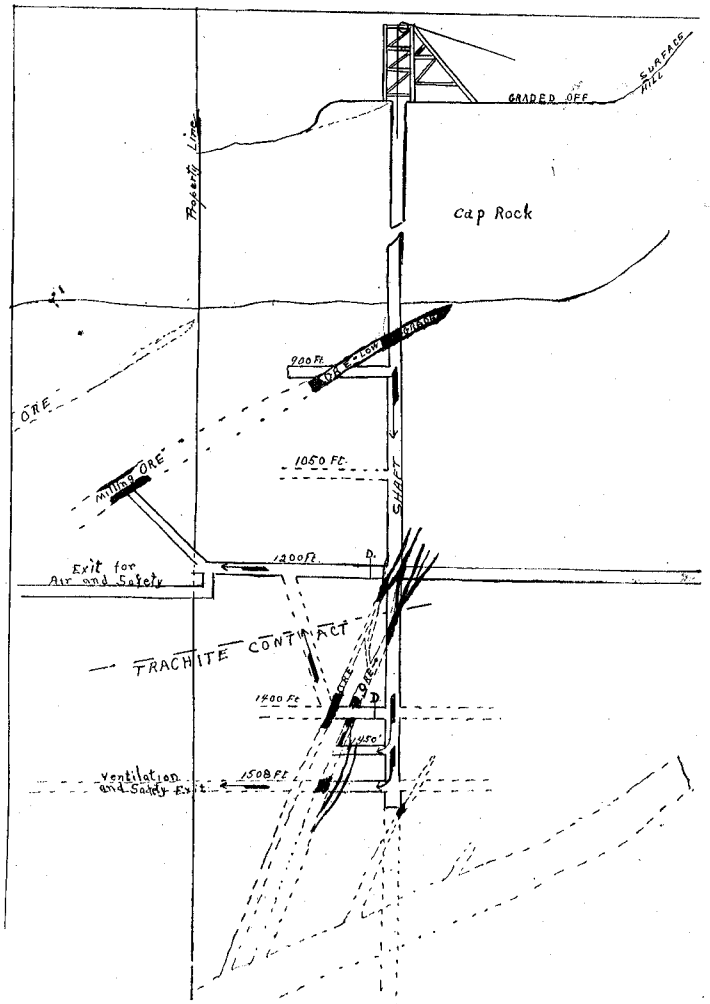


FIGURE 2

North and south section through the Buckeye Belmont Mine (No. 1 Shaft)

Notwithstanding that custom milling charges are $4 per ton, ore can be milled for $2.50 per ton or less in a mill owned by the mine, if handled in sufficient quantities. There is no reason why mining and milling cost should exceed $7 a ton. But at $10 a ton, ore yielding $20 a ton would net $10 a ton profit.

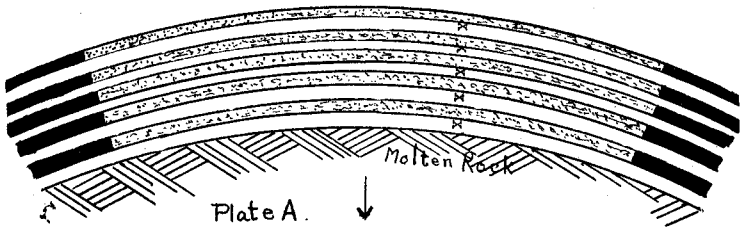
If this mine could be developed and equipped to produce 500 tons a day of $20 ore, it would mean 182,500 tons a year, on which $10 net profit would mean $1,825,000 a year, or more than $1500 a year in dividends on each 1000 shares.

Such a production means that a property must have development, equipment and facilities for handling the tonnage.

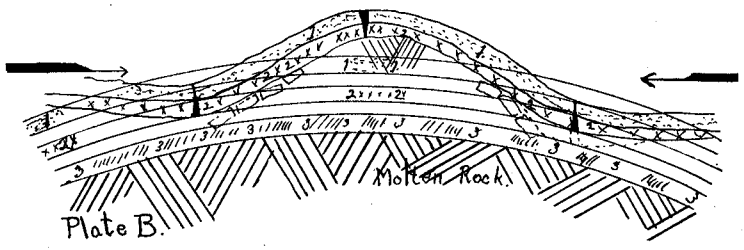
It might be well to state that practically all of the dividends that have ever been paid by any of the mines of Tonopah, came from ore averaging less than $18 per ton. Rich specimens and "pockets" have been found in places in all the mines that made high assays and fine specimens to

show off in cabinets, but the dividends come from large tonnage, of ore that yielded less than $18 and not from the specimens carried off to repose in cabinets of specimen hunters, who still have them.

In PLATE A, we see what a section of the earth might have looked like, if it had not wrinkled or folded itself by contracting the outer crusts. The molten interior would have contracted as it cooled—contracting away from the outer crust—and another crust would have been formed within the outer one, and so on. Imagine, if you can, that the black ends represent the location of the Rocky Mountains on the right and the Sierra Nevadas on the left, say 1000 miles apart. If in contracting, these ends are squeezed nearer and nearer each other they would wrinkle and fold the strata between into ridges or ranges of mountains. But do not think that this was all done at once. Inch by inch, little by little, through many, many years this squeezing, wrinkling, foldings and slipping occurred and **is still going on.**



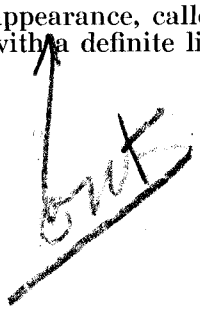
First the outer crust folded, and settled onto the molten interior, then the second crust was formed and it folded and yielded to the pressure somewhat as might be indicated by PLATE B. In places it cracked letting the molten interior be squeezed up into the cracks as indicated.

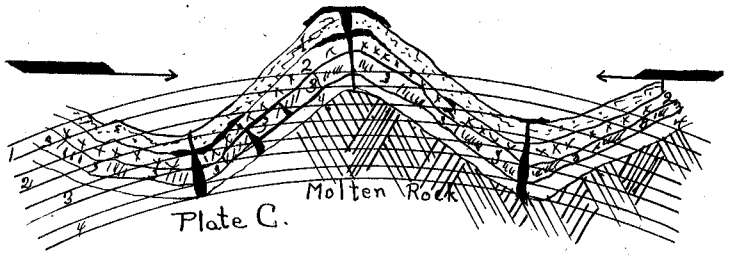


In PLATE C, we see how it might have looked after four successive crusts had been formed and folded, and how the next crust is being formed following the irregular contour of the outer ones. This action has continued until there are many strata similarly folded.

Often we find layers or strata that show no difference in chemical analysis, the composition being the same, but the stratification has occurred merely by cooling at different times and under different conditions.

Sometimes we find one formation shading into another with the only difference, its physical appearance, called by a different name, but evidently formed by a continuation of the cooling process with a definite line of demarkation.





In PLATE D we have a case where the upper crusts shrunk making a crack, along which one side slipped down to settle upon the molten interior. Such a crack is called a **"fault"** and the line of the crack is called **"a fault plane".** A fault or slip may be either a horizontal or vertical slip. In

following veins of ore we sometimes find where they have been cut off by a slip that has occurred after the vein was filled with the ore. We then have to find which way the vein slipped, and follow the slip to pick up the vein again on the other side of the fault.

(On the east slope of Mt. Oddie at Tonopah, some of the faults were **downward** slips dropping the ore formations about 600 feet in the aggregate, relative to their position in the upheaval zone in the mountain. That is why greater depth was required to reach the ore on the eastern slope of the mountain, and why it is more in place toward the origin.)

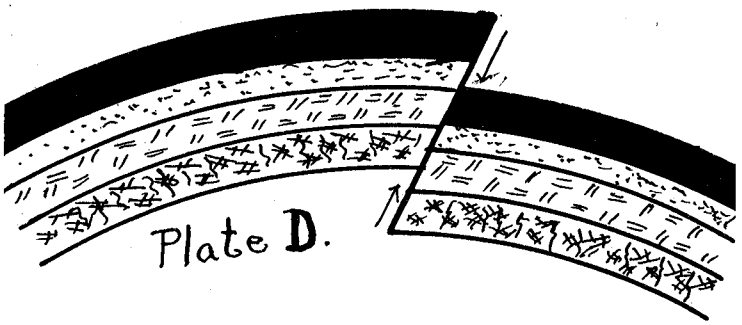
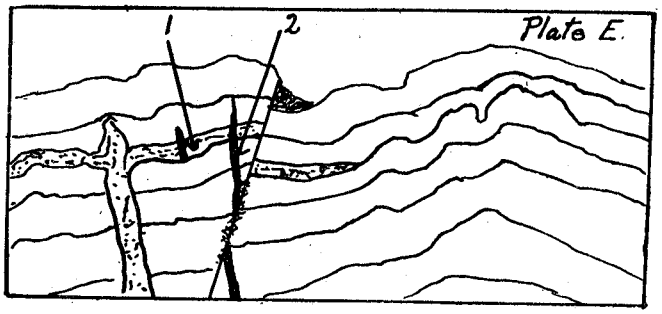


PLATE E again illustrates strata folds, shrinkage cracks and a fault slip through the strata, through a flow sheet and through a filled shrinkage crack. Many modifications of folding, faulting, cracking, settling occur in the ignious strata of the earth's crust. On top of all this the winds and the rains have laid down the eroded material as sedimentary strata in places. These in turn may be folded by later movements of the earth crust below it.



"In six days the Lord made the heavens and the earth * * " alright, and tossed it overboard to cool off. It has been cooling off and changing itself ever since as we know by the action of earthquakes, volcanoes, winds and rains, and it is still cooling and changing.

Ore veins, or ore deposits, have been made by depositing the metal in the cracks in the earth's crust, while the rocks and metals were liquid, or gaseous from the tremendous heat, or by solutions carrying the dissolved metals.

The business of mining is to find the cracks that carry the metals, follow them, and excavate the ore that fills the cracks. Cracks are not all the same width, they sometimes narrow down, and widen out, and sometimes the ore is richer in metal in one place than another. A rich vein is not all rich, there are places where it becomes low grade for a distance and then becomes rich again. If this were not a fact, a rich mine would never run out of rich ore, once it struck it. As a matter of fact any old vein, or crack may find spots where there has been a concentration of metals but it is the big cracks with hundreds of thousands of tons yielding a good profit right along year after year that pay the dividends. Any old prospect hole can get a few specimens out to lay on the desk, or to give to stockholders, but a pocket full of specimens, will never pay the grocery bill. It is tonnage, continuously produced, that makes the stockholders rich. None of the big dividend paying mines in the world today are averaging $20 a ton on all they take out. The Homestake is producing its millions on $5 ore, the Mercur mine produced its millions from ore yielding less than $4. There are no mines quoted on any stock exchange that average $20 on all they produce.

If you will now turn back and look at Figure 2, you will understand it, and also at the drawing of the Dynamic fold at Tonopah (Figure 1.)

When I advised W. B. Voorhees to sink his first shaft, marked shaft "No. 3" on the drawing, and later to sink the No. 1 shaft, this was the basis of that advice. It was hard for Mr. Voorhees to raise money enough to do it, but he did it by selling stock in small lots until he struck the ore forma-

tion in both places. Today the Buckeye is a proven property. Its ore veins are known, and its production can be arranged to **any tonnage per day** that is desired. Its production today is an INDUSTRIAL problem, just like a cement works, a brick yard, a coal mine, an iron mine, or a gravel yard, its production must be based on the tonnage that can be produced. And whatever they wish to develop and equip for is possible.

Including, power, labor, supplies, taxes, insurance, interest on invested capital, administration and overhead, ore in quantity can be mined and milled in Tonopah for $7 a ton, or less, with competent equipment. A production of 500 tons a day will aggregate over 180,000 tons a year. On this basis ore yielding $12.50 a ton can return $5.50 a ton net profit, or one million dollars a year. That would be 100% a year on a million shares of stock.

Surveying the geological structure and formation as now known, it is possible that the BUCKEYE EAGLE (No. 2) shaft can be sunk into the same ore formations that have been proven by the No. 1 shaft, and were just reached in the No 3.

The No. 1 shaft was equipped with machinery, piped for air, wired for power, timbered and sunk at a cost of $37 per foot. It is a **two compartment shaft.** The No. 2 shaft can be sunk as a **three compartment** shaft with the present higher price of naterial and labor for $66 per foot, including the heavier timbers for the larger shaft. By connecting them under ground a splendid natural ventilation of both No. 1 and No. 2 mines will be obtained.

In the No. 1 shaft the sinking was "going it blind" to find it. The No. 2 now has the knowledge of what the No. 1 found and is not the risk that the No. 1 was when it started.

THE BANKER AND THE ENGINEER

From the very nature of the Engineer's profession, he becomes the **defacto agent** of the investor and stockholder. They depend upon his knowledge and ability to bring their money safely back to them with its earning capacity. If this is not a fact the investor should secure the services of another engineer who is his agent in the matter. Obviously the only value any engineer's report can have upon any industry is based upon his skill, training, experience, superior judgment and knowledge of the business to answer the questions, "Will the money return safely?" and "What must be done," and, "How shall it be done to bring the money home with its greatest earning capacity?"

The engineer who reports favorably upon an industrial investment is in **reality** advising the investor to buy stock and put his money into it, with the implied statement that **it will return safely if you rely on his judgment,** and follow his advice. No honest engineer will report upon any property he has never seen, nor will he advise you to go into it unless he can see a way out. Ask your banker if this is not a fact?

Although your banker may never have seen a mine in his life, and knows nothing about the industry, he is **ultra-conservative**—HE WOULDN'T BE A SAFE BANKER IF HE WASN'T. He is the best advisor you could get on how to save what money you have, but he is not so good on advising you how to get more. He can't, he mustn't go beyond the boundaries of **absolute safety.** He cannot take the chances that all business takes, and is therefore—not a good business advisor. His whole business consists of telling you how to SAVE not how to GET money. It is this very fact that makes the banker a safe care taker of the depositors money. I wouldn't deposit my money with a banker, if I thought he was taking chances with it, and neither would you. If you want to go in business, or buy a farm, or other property, the banker will lend you about half its value and take a mortgage on the whole for his security. You have just as much in the business as the banker has, and perhaps more, but the banker has a mortgage on all you have as his security, and you are taking the chances with your money unsecured, except with your own judgment that the business or farm will yield enough to pay the banker his money and give you the balance. Bear in mind that the banker is handling depositor's money. If you are a depositor you wouldn't want him lending your money on worked out farms, or to ambitious business men without security. You'd want YOUR money secured, and let the business man or farmer take the chances on a good business or a good crop. Therefore a banker who took the chances that all business must take, would be an unsafe banker. Obviously no banker can be competent to advise on all business, from a peanut stand to a department store, from a button factory to automobiles, pianos, farm machinery, mines, railroads, bridge building, and shipbuilding and know it all. It can't be done. There are specialists in each line who are competent business advisors, hence the banker must PLAY SAFE and keep out of everything that he doesn't know to be absolutely safe for his part of the money. Therefore the banker is the best advisor on the safety of money you already have, and the engineer of each branch of industry is the best advisor on industrial progress and production of more money. Ask your banker. Don't be afraid of him. Any engineer's report that cannot be laid in front of your banker isn't worthy of any confidence at all.

The engineer looks ahead, plans, constructs and visualizes the results, while the banker looks only at the security as it is now. An engineer may take a contract for a million dollar bridge, or a great building on which he can make a hundred thousand dollars profit. The engineer's knowledge of costs and requirements can see the $100,000 profit because he KNOWS it can be made, but the banker who doesn't know, and cannot figure the costs of completing the structure, looks on it as a risk, or liability until it is completed. He cannot safely lend money, secured by something that doesn't exist till the job is completed, but only on what is the present value. If a banker backs a contractor it's done on his confidence in the personal ability of the contractor to complete the work, because the banker couldn't figure the contract to save his life. Ask your banker if this is not so.

I want you to go to your banker, or to all the bankers in your community if you wish, and ask them if these are not facts.

If I were a banker, (and I am a stockholder, and have been a director of a bank, and may be again) I wouldn't use the depositors money for buying mining stock, because it is not "bank paper" and again many people would lose confidence in the bank if I did. I might buy some with my own personal money knowing what I do.

In fact the biggest bankers we have made their money out of mining, and are personally interested in mines, Gugguenheim, D. O. Mills, Rockefellar, Hetty Green, Wingfield, W. A. Clark, Monette, and hundreds of others, for example. If you made a fortune in mining you'd likey buy some bank stock and be a director yourself.

The production of metals from known deposits of ore, is the safest business there is and the most profitable—that is the reason why there are so many imitators, and ambitious efforts to get up a mining company. You never heard of any one imitating a counterfeit nickel. People do not imitate the bad. It is the great flood of imitations, illy advised, incompetently directed and poorly financed that places a discredit upon metal production (mining) as an investment. Webster's Dictionary says, "A mine is an underground excavation from which ore and minerals ARE PRODUCED". My own opinion is that it should be unlawful to use "Mining Company", "mine," etc., in the name of a company or corporation, until the property is in shape so it CAN PRODUCE. If I were a blue sky commissioner, I wouldn't let a **prospecting company** that was hunting for ore call itself a "mining company" until it had sent at least ten tons to mill and could truthfully say **"We have produced."**

The same question of management arises in mining that does in every other business. You wouldn't put a tinsmith to damming Niagara, a horseshoer to making jewelry, a coal miner to making automobiles, a cigar clerk to building a bridge, then why expect them to make a success of mining. Good management will not monkey with a poor mine. If you have good management it's almost a cinch you have a good property. Ask your banker if it isn't a fact, that good, competent, experienced management is a pretty safe guarantee of value, because there are many good properties that want and need the good, skilled manager, and he wouldn't be wasting his time where he couldn't accomplish something.

Respectfully,

Lebon Balliet

Consulting Engineer.