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B. K. boy  
Columbia. N.M.

**COPPER STATE**



# FACTS ABOUT THE COPPER STRIKE

Arizona now has over 100,000 acres of copper-bearing land, valued at \$100,000,000.

At the present time, only 10,000 acres are being mined, and the world market for copper is \$100,000,000.

The copper industry has been in a slump since 1914, and the world market for copper is \$100,000,000.

The strike in Arizona copper mines in 1914 cost the world market for copper \$100,000,000.

The Arizona copper mines in 1914 cost the world market for copper \$100,000,000.

At present, only 10,000 acres are being mined, and the world market for copper is \$100,000,000.

Every one of these operations was at one time owned and operated by a single person. First came the pioneer prospector, then the individual promoter and then the financial administrator.

No business enterprise anywhere has more efficient management than the great copper mines of Arizona.

A hundred years ago the great copper mines of Arizona were discovered, and the world market for copper is \$100,000,000.

His production has been large. The Copper State has produced as much of the metal as England and Scotland have, and all kinds of Europe.

## ARIZONA COPPER OUTPUT ESTIMATED IN 1910

1881	10,000,000	1881	10,000,000
1882	10,000,000	1882	10,000,000
1883	10,000,000	1883	10,000,000
1884	10,000,000	1884	10,000,000
1885	10,000,000	1885	10,000,000
1886	10,000,000	1886	10,000,000
1887	10,000,000	1887	10,000,000
1888	10,000,000	1888	10,000,000
1889	10,000,000	1889	10,000,000
1890	10,000,000	1890	10,000,000
1891	10,000,000	1891	10,000,000
1892	10,000,000	1892	10,000,000
1893	10,000,000	1893	10,000,000
1894	10,000,000	1894	10,000,000
1895	10,000,000	1895	10,000,000
1896	10,000,000	1896	10,000,000
1897	10,000,000	1897	10,000,000
1898	10,000,000	1898	10,000,000
1899	10,000,000	1899	10,000,000
1900	10,000,000	1900	10,000,000

# The COPPER STATE MINING CO.

Mines in  
Pinal and Graham Counties, Arizona

Mill  
Pinal County, Arizona

Mine Address  
Copper Creek, Arizona

COMPANY'S GENERAL OFFICE  
411 METROPOLITAN LIFE BLDG.  
MINNEAPOLIS, MINN.

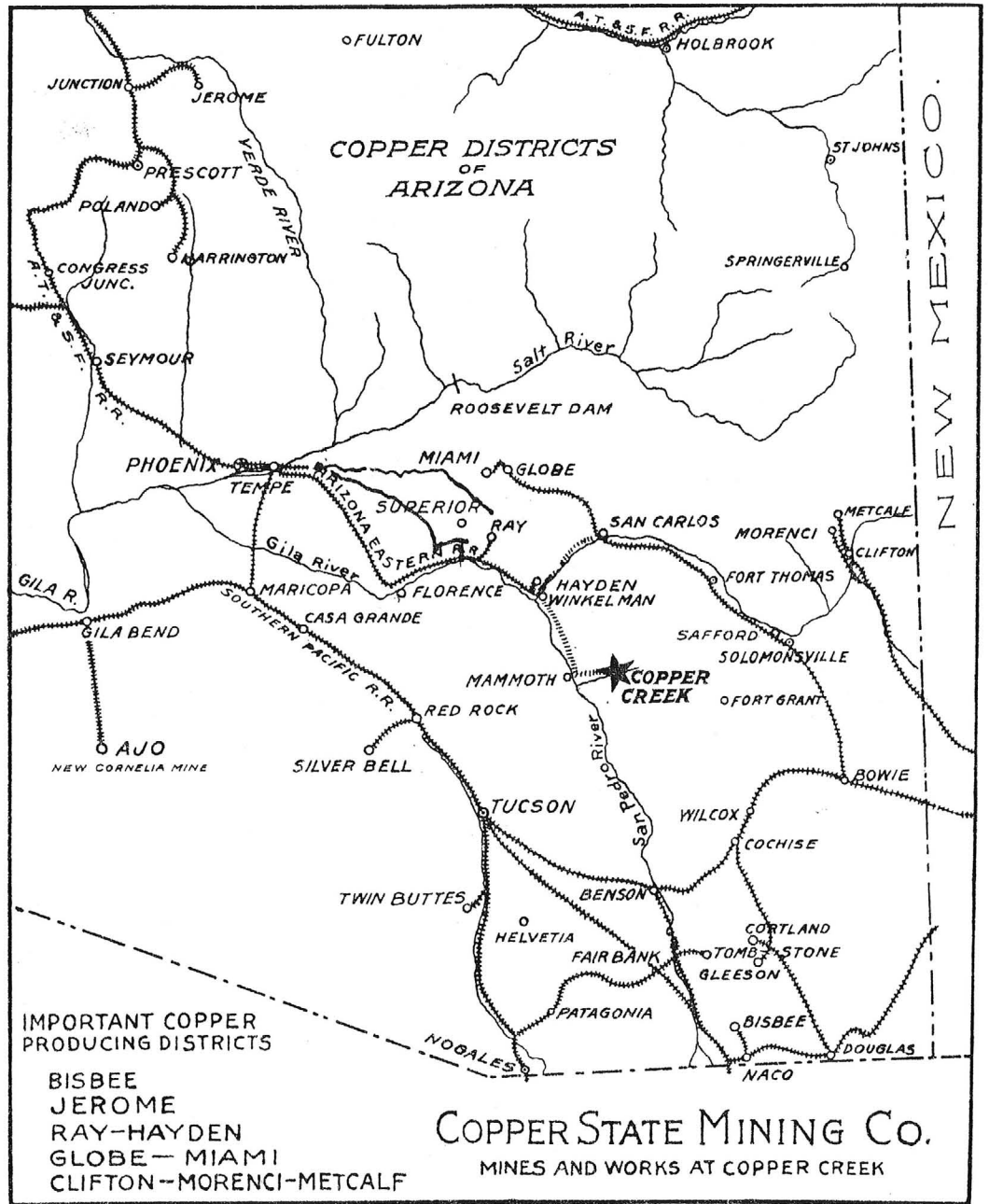
Incorporated Under the Laws of the State of Arizona

Shares \$10 Par

Issued Fully Paid and Non-Assessable

AUTHORIZED	. . .	750,000 SHARES
ISSUED	. . .	155,000 SHARES
IN TREASURY	. . .	595,000 SHARES





This Section of Arizona in 1915 produced 449,000,000 pounds of copper worth at 17 cents a pound \$76,130,000. The estimated production for 1916 is 500,000,000 pounds, worth at 25 cents a pound \$125,000,000. The properties of the Copper State Mining Company are near the geographical center of this copper region.





# Copper State Mining Company

THE Copper State Mining Company is incorporated under the laws of the State of Arizona, with a capital stock of \$7,500,000, divided into 750,000 shares each of a par value of \$10.00. Of this number, 155,000 shares have been issued, leaving in the Company's treasury 595,000 shares, of a total par value of \$5,950,000. All stock is issued fully paid and non-assessable, and each certificate so states on its face. By agreement with present stockholders, all certificates are held in trust until January 1, 1918, or until the financing of the property has been completed.

## LOCATION

THE Company's properties are in the Copper Creek Mining District in Pinal and Graham counties, southeastern Arizona, 65 miles northeast of Tucson and 31 miles southeast of Hayden, where the new \$3,000,000 smelter of the American Smelting & Refining Company was completed in 1913.

The Copper Creek District is midway between the Clifton, Morenci and Metcalf mining districts on the east, and the Silver Bell and Ajo districts on the west; and midway between the Bisbee, Cananea and Nacozari districts on the south, and the Ray, Superior, Globe, Miami and Jerome districts on the north. The mines of these districts produced 450,000,000 pounds of copper in 1915, or more than one-fifth of the world's production.

## PROPERTY

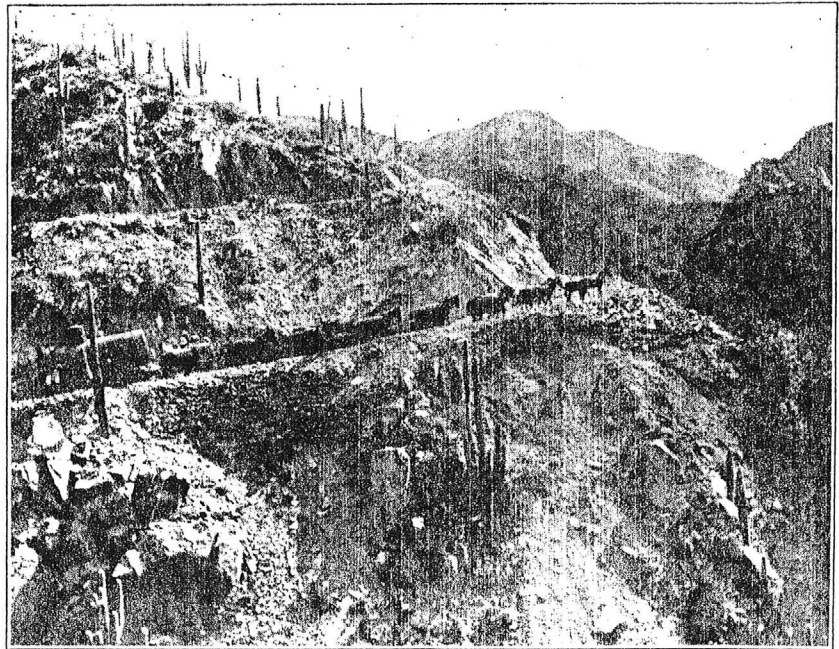
THE property of the Copper State Mining Company consists of practically all the valuable mineral lands in the Copper Creek District, embracing 175 claims, full or fractional. (An Arizona mining claim is 600 x 1500 feet—about 20 acres). The eastern boundary of the District, and of the Company's property, is the summit of the Galiuro range of mountains, 5200 feet above sea level. From this point the District extends westward five miles along the mountain slopes toward the San Pedro valley. Copper Creek, which has its source in numerous springs near the summit of the range, flows through the District from east to west, emptying into the San Pedro River 10 miles below the

western boundary of the Company's property. All the water rights, dam and reservoir sites of the District are owned by the Copper State Mining Company.

## HISTORY

**B**EFORE the advent of white men in Arizona Territory, the Copper Creek District was prospected by Mexicans and worked for the gold and silver ores near the surface. In the early eighties several American prospectors located and filed upon various groups of claims where the most prominent outcroppings of copper ore occurred. The nearest railroad was then hundreds of miles distant. Some years later the Southern Pacific came within 65 miles; but these mountain fastnesses were almost inaccessible and could be reached only on sure-footed horses or burros.

In 1903 a mining company was organized and the first attempt made to attract capital for the development of the district. In the years following, several other companies were formed and purchased from the pioneer prospectors various groups of mining claims in the District.



A Boiler for Power Plant at Copper Creek. Note Character of Roads.



From 1904 to 1914 a large amount of exploratory and development work was done by these various companies. Many ore bodies were opened up and blocked out, costly roads were built, machinery and mining equipments were installed, numerous buildings erected, dams, reservoirs, pipe lines, power plants, test mill, narrow gauge railroad, machine and blacksmith shops, and many other improvements provided. The underground work in the District--tunnels, shafts, drifts, crosscuts, upraises, winzes--now totals over 16,000 linear feet, or more than three miles. This exploratory work has been for the purpose of determining the size and quality of the ore bodies and to assure the proposed railroad and reduction plant a large daily tonnage for a long period of years.

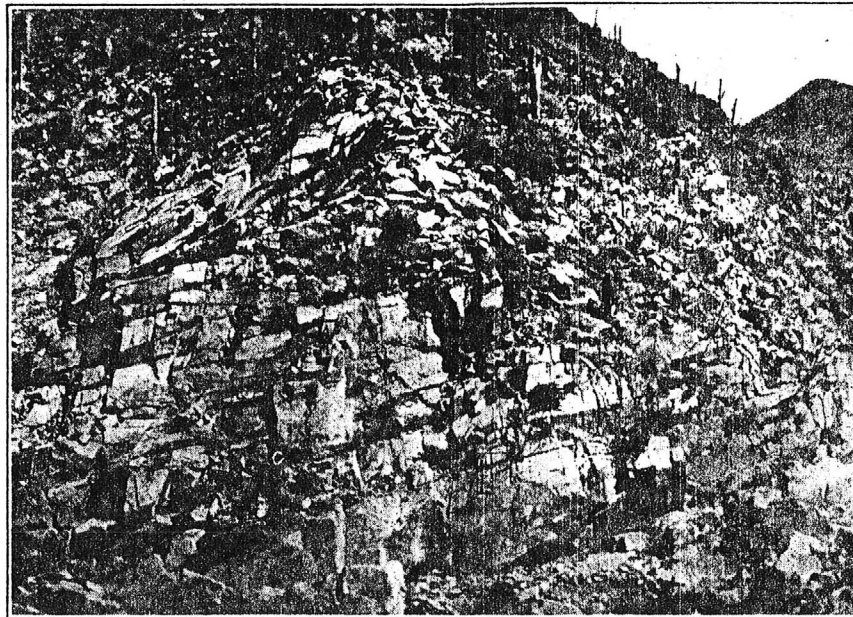
In 1915 the work of merging all the mines of the numerous companies operating in the district was undertaken, and in December was completed. The Copper State Mining Company, which was incorporated in September, 1915, for the specific purpose of effecting this consolidation or merger, now owns 150 claims (about 2000 acres) extending five miles east and west on both sides of Copper Creek, together with all surface improvements in the District. Very favorable options on 25 additional claims (about 450 acres including the Globe, Giant and Prince mines) are also held by the company.

The bringing of all these properties into one organization and under one management will result in the building of a railroad to the smelter at Hayden, 31 miles from Copper Creek, and the treatment of all the ores from the District in one large plant, thus reducing mining, milling, and smelting costs to a minimum.

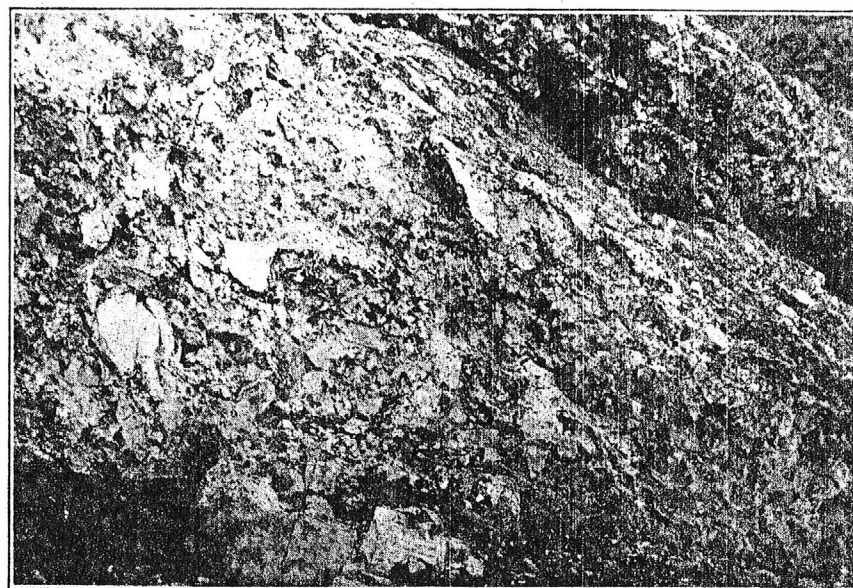
## ORE DEPOSITS

THE large bodies of ore which have thus been developed, and which assure the importance and permanence of the Copper Creek District as a producer of the red metal, occur in the lower basin, or the western portion of the District. In an area of diorite, or granitic rock about 3 miles long by 2 miles wide, there are 40 or 50 "blow-outs," or chimneys, where the "breccia," or copper ore, comes to the surface, outcropping as green-stained masses of rock which show evidence of having been broken and ground up, saturated with mineralizing solutions and cemented together, offering greater resistance to erosion than the unaltered and barren rock around them. Hence these "blow-outs" rise 25





Blocky, or Unaltered Diorite. Not Mineralized.



Brecciated, or Crushed and Broken Diorite. Mineralized Throughout with Copper

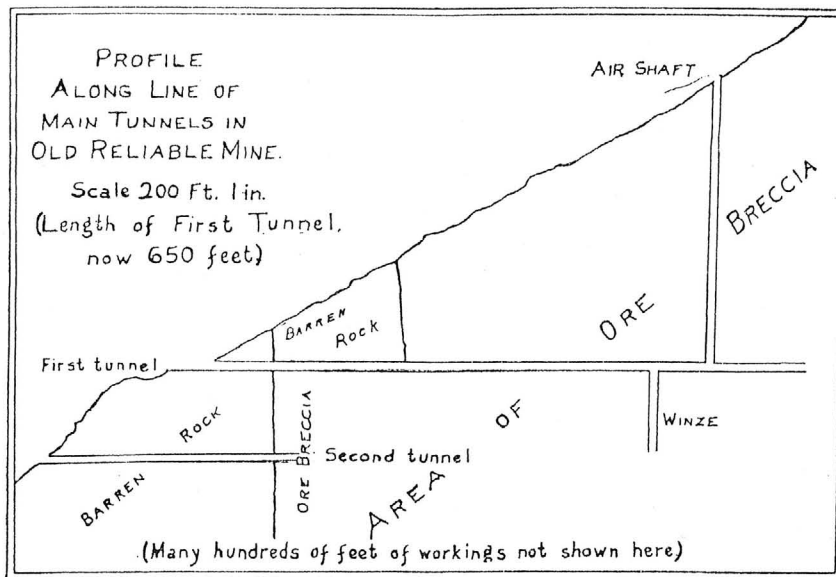
to 50 feet above the surrounding country rock, and are markedly stained with the "rust" of copper and iron.

These chimneys, or masses of breccia, wherever penetrated by shafts or other underground workings, have proven to be the cappings or outcrops of ore bodies beneath. Eight out of the 40 or 50 "blow-outs" of the District have been explored by more or less extensive underground workings, and ore of good commercial grade has been found in all, as deep as the workings have been extended. The deepest shaft in the District is in the Globe copper mine—650 feet. On the Copper Giant mine several diamond drill holes have been put down 600 feet. How far the ore extends below this depth is not known. Eminent geologists, however, like Dr. Walter Harvey Weed, and others, who have made a careful study of the genesis of these ore deposits, have expressed the belief that they will continue practically unchanged to great depths.

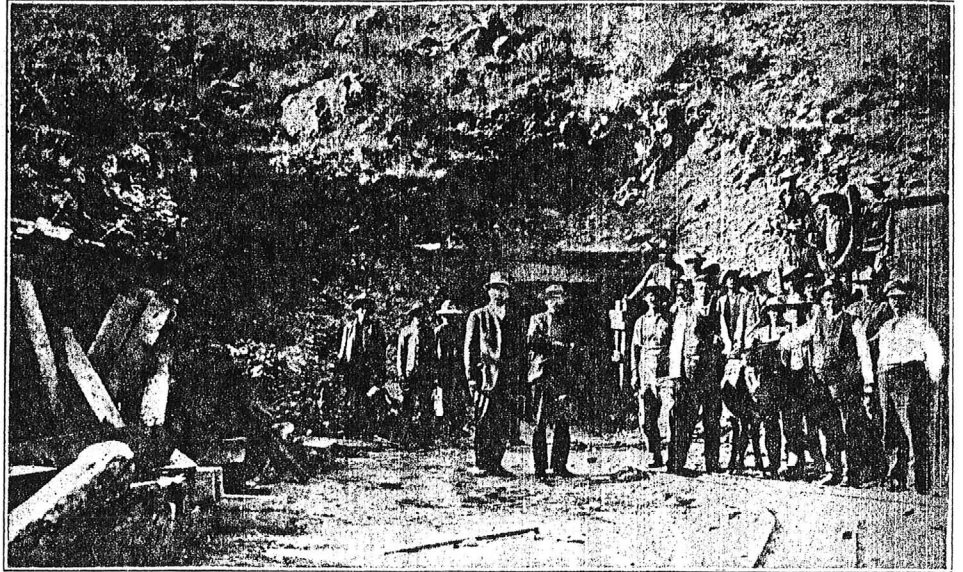
The size of these ore bodies varies from pipes, or chimneys, 50 feet in diameter to masses 350 to 650 feet in diameter, having a lateral area of three and one-half to four acres.

#### THE OLD RELIABLE COPPER MINE

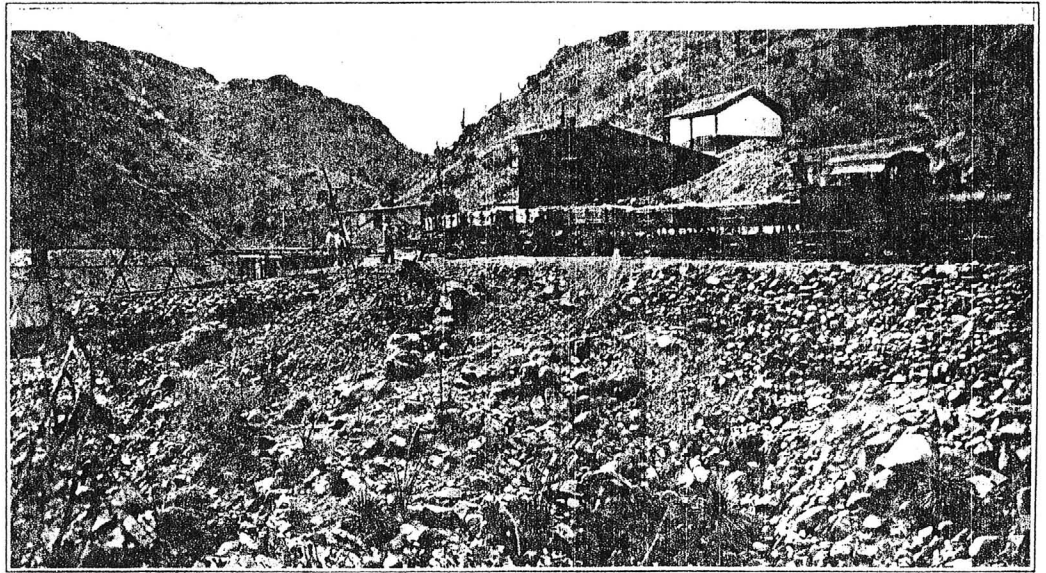
**T**HE Old Reliable mine, in the extreme western part of the Company's property, has an ore body which on the surface is about 350 by 420 feet, giving an area of 147,000 square feet, or







Entrance to Upper Tunnel of Old Reliable Mine. It Runs Straight Into the Mountain 640 feet, Penetrating an Orebody whose Surface Area is  $3\frac{1}{2}$  Acres.



Train of Copper Ore from Old Reliable Mine on Way to the Mill. Entrance to the Upper Main Tunnel is Directly Behind the Buildings. From this Point it Extends to the Right 640 Feet into the Mountain. In the Gulch (below the Chimney at Left) is Entrance of Lower Tunnel.



about three and one-half acres. In the mountain side, some 250 feet below the outcropping, a tunnel has been driven northward through the ore body. The first  $37\frac{1}{2}$  feet of this tunnel is in barren diorite; the next 90 feet is in leached ore breccia; the next 67 feet passes through another block of barren diorite; then it enters the main ore body and continues 445 feet in ore, the first 150 feet of which is more or less leached, being close to the surface. The total length of this tunnel is 640 feet. The face, or end, of the tunnel is still in ore.

That portion of the ore body lying west of this tunnel has been explored and blocked out by 13 drifts, or crosscuts, running at right angles to the main tunnel—all in ore. Several of these have been raised as stope-leads to a height of 40 to 80 feet, preparatory to actual mining. About 9,000 tons of ore from these workings have been treated in the test mill, and the concentrates shipped to the smelter at Hayden. The tunnel and the drifts are equipped with steel tracks, ore cars, chutes and bins. A shaft from the top of the hill, 258 feet deep, connects with the tunnel and gives an excellent circulation of air.

Preparations are now being made to drive drifts eastward to explore that portion of the ore body lying on that side of the main tunnel. As the most prominent part of the outcropping is in this direction, namely, east of the main tunnel, it is fair to assume that a large additional tonnage of ore will be opened in the eastern portion of the mine, not only on this level, but in all the levels to be opened below.

A second main tunnel, 100 feet below and parallel to the one just described, is now being driven. At a point directly under the mouth of the upper tunnel ore was encountered and has continued with but one break as far as the tunnel has been driven to date. From all present indications the ore body on this second level is over 600 feet long from north to south. A block of ore 600 feet long, 300 feet wide, and 100 feet deep would contain 18,000,000 cubic feet. Thirteen cubic feet of this ore make a ton. Allowing a liberal deduction for blocks of diorite, or boulders, in this ore body, there would still be more than 1,000,000 tons of ore for each 100 feet of depth below the leached zone in the Old Reliable mine.

Before the outbreak of the war in 1914, operating the mill one shift 164 days, 8,400 tons of ore from the Old Reliable were treated, resulting in 728 tons of concentrates averaging 28.26 percent copper and some gold and silver. Total copper marketed, 411,465 pounds.



Looking North over the Diorite Area, western part of Copper Creek District. Below center of picture is seen the "blow-out" and hoist frame of the American Eagle Mine. To right is outcrop of ore breccia on Velasquez claim. Kimbro and Kimbro Eastern mines, mill, dam and buildings of lower camp are in valley below center of picture. Blow-out of Old Reliable mine can be seen in center of upper left hand quarter of picture. To right of it are the Globe, Prince, Giant, and other mines.

#### THE GLOBE COPPER MINE

**H**ALF a mile to the north of the Old Reliable is the Globe mine, whose outcroppings of copper-stained rock rise high above the surrounding country. From the gulch a tunnel 290 feet in length has been driven into the ore body. This tunnel connects, 158 feet below the surface, with a shaft which has been sunk to a depth of 650 feet. This is the deepest of all workings in the District, and ore continues without a break to this depth. Extensive drifts and cross cuts on the tunnel level, on the 250-foot level and on the 450-foot level have blocked out in this mine 310,000 tons of ore averaging 3.08 percent copper. The ore on the 350-foot, on the 550-foot, and on the 650-foot levels yet remains to be blocked out for actual measurement and sampling.

#### THE COPPER PRINCE MINE

**I**N the west end of the Copper Prince claim are four outcroppings of ore breccia. On the edge of one of these a shaft has been sunk 300 feet, and ore blocked out on each of the levels, 100

feet apart. On the 200-foot and 300-foot levels tunnels have been driven into one of the nearby ore bodies, and the ore partly blocked out on one of these levels. The amount of ore put in sight by the workings in the Prince mine is 535,000 tons, and the average assay is 3.56 percent copper, or 71.2 pounds of copper per ton of ore. With the oil flotation process of concentration 63 pounds of copper from each ton of this ore can be recovered, making a total of 33,000,000 pounds of copper from the ore already blocked out in the Prince mine. The total value of this copper at 25 cents a pound would be \$8,250,000, or more than the capitalization of the Company owning all the mines in the District. And yet the ore bodies on the Copper Prince are small in comparison with those of the Old Reliable or Copper Giant mines.

#### THE COPPER GIANT MINE

ADJOINING the Copper Prince on the north is the Copper Giant claim, in the western portion of which is one of the largest surface showings of ore breccia in the District, same having an area of approximately four acres. Borings with diamond drills to a depth of 600 feet have proven that the ore continues to at least that depth. The amount of tunnel and shaft work in the Giant mine is small in proportion to the size of the ore body. A shaft starting in the highest part of the outcrop has been sunk to a depth of 200 feet. A tunnel from the gulch connects with this shaft at a point 124 feet below the surface. From the junction of the shaft and tunnel two drifts have been run in opposite directions several hundred feet into the ore body. These drifts, as well as the shaft, are in the ore breccia all the way. As the Copper Giant ore body has even a larger surface area than that of the Old Reliable the development of 1,000,000 tons of ore on each 100-foot level below the upper or leached zone can reasonably be expected.

#### THE AMERICAN EAGLE COPPER MINE

A MILE and a half southeast of the Old Reliable, and on the opposite side of the canyon, is the American Eagle mine. The outcropping is a prominent chimney or blow-out whose green copper-stain can be seen far away. A short distance outside of the ore body a shaft has been sunk to a depth of 300 feet, and the ore body opened by crosscuts and drifts on the 100-foot, 200-foot and 300-foot levels. The width of the ore body is about



50 feet on each level. A considerable amount of ore from this mine has been treated in the test mill, the average copper content of which was over three percent, with some gold and silver values. The American Eagle shaft has two compartments and manway, is exceedingly well timbered, and is equipped with gallow's frame, double drum electric hoist and all accessories. The other ore bodies, near by, have not yet been explored.

#### THE COMPANY'S OTHER MINES IN PINAL COUNTY

**T**HE Company owns sixteen other mines, some in Pinal and some in Graham County, which have been partly explored by underground workings, but in which the ore has not yet been blocked out for accurate measurement and sampling.

In the SILVER REEF mine there is a 100-foot tunnel and a 40-foot shaft, both in ore. From the shaft a carload of ore averaging 13½ percent copper and \$12 in gold and silver per ton was extracted and shipped to a smelter. The outcropping on this claim is large and the mineral strain most marked.

The LEAD CARBONATE mine is opened by a 130-foot tunnel and a 30-foot shaft which penetrate a body of galena (silver-lead) ore carrying some gold and copper. Shipments of this ore to the smelter at El Paso have given returns of 35% lead, 20 oz. silver and \$10 per ton copper and gold. The character of the ore gradually changes from silver-lead to copper sulphides as depth is attained. A large surface area of this claim bears a yellow stain—the "rust," or carbonate of lead.

On the COPPER REEF claim is a very prominent outcropping of copper-stained ore breccia which has been partly explored by a shaft and tunnel, both of which are in copper ore. The extent of this ore body has not yet been determined. From an ore body in another part of the Copper Reef claim leasers are now extracting ore containing 20 to 30 percent copper with gold and silver values. Shipments to the smelter at Hayden are being made regularly.

The VELASQUEZ claim, adjoining the American Eagle, has a large blow-out or chimney similar to many others above described. A 1026-foot tunnel from the mountain side in the south end of the Kimbro Eastern claim to the 200-foot level of the American Eagle mine cuts through the full width of the Velasquez claim—600 feet—exposing a body of low-grade ore

72 feet wide. The main Velasquez ore and following the and 75 feet respec

On the KIMBRO strongly marked ore cut into in gradings in 2 to 6 percent. Near this ore body in or cross-cutting

#### THE COMPANY'S OTHER MINES IN

**T**HE upper part of the Copper In this part of the in large masses of erous fissure vein basalt. These veins vein is traceable and traced 500 to 3000 50% copper and c

The ROUGE opened on one of the the nearest railroad hundreds of miles was packed on but From a shaft 250 feet a vein 15 feet in

Half a mile to vein is the SIOUX and some short d carrying 30% copper from this mine.

On the ROSS COPPER claims, posed ore of high these mountains

Besides the pages the Company claims, some of which little explored

72 feet wide. This tunnel is several hundred feet west of the main Velasquez outcrop, towards which two drifts 72 feet apart and following the walls of the ore body, have been driven 50 and 75 feet respectively.

On the KIMBRO and the KIMBRO EASTERN claims are strongly marked outcroppings of copper ore, both of which were cut into in grading for the railroad. The bed of this railroad is in 2 to 6 percent copper ore for 200 feet on the Kimbro claim. Near this ore body a shaft has been sunk 100 feet, but no drifting or cross-cutting has yet been done.

#### THE COMPANY'S MINES IN GRAHAM COUNTY

THE upper basin of Copper Creek—the eastern portion of the Copper Creek Mining District—is in Graham County. In this part of the Company's property the ore does not occur in large masses or breccias, as in the lower basin, but in numerous fissure veins, in a different rock, known as rhyolite, or basalt. These veins vary from a mere seam to 15 feet. One vein is traceable on the surface a mile in length. Others can be traced 500 to 3000 feet. The ore in these veins runs from 5 to 50% copper and carries gold and silver values.

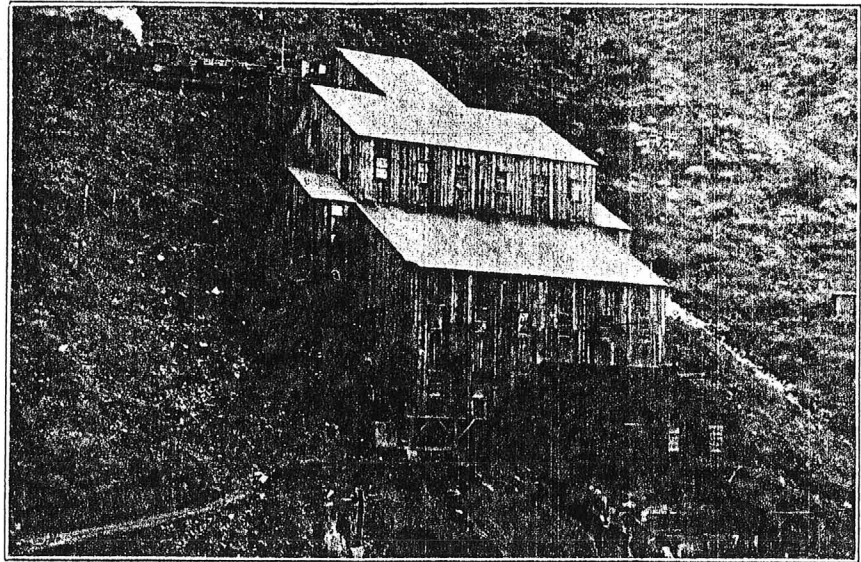
The ROUGH RIDER, or Ute Chief mine has been developed on one of these veins. Twelve and more years ago, when the nearest railroad was 65 miles distant and the nearest smelter hundreds of miles away, copper-gold-silver ore from this mine was packed on burros over rough mountain trails and marketed. From a shaft 250 feet deep drifts have been run on two levels and a vein 15 feet in width exposed.

Half a mile to the east of the Rough Rider and on the same vein is the SIOUX CHIEF mine, where a shaft 225 feet deep and some short drifts have opened a vein 2 to 3 feet wide. Ore carrying 30% copper and gold and silver values has been shipped from this mine.

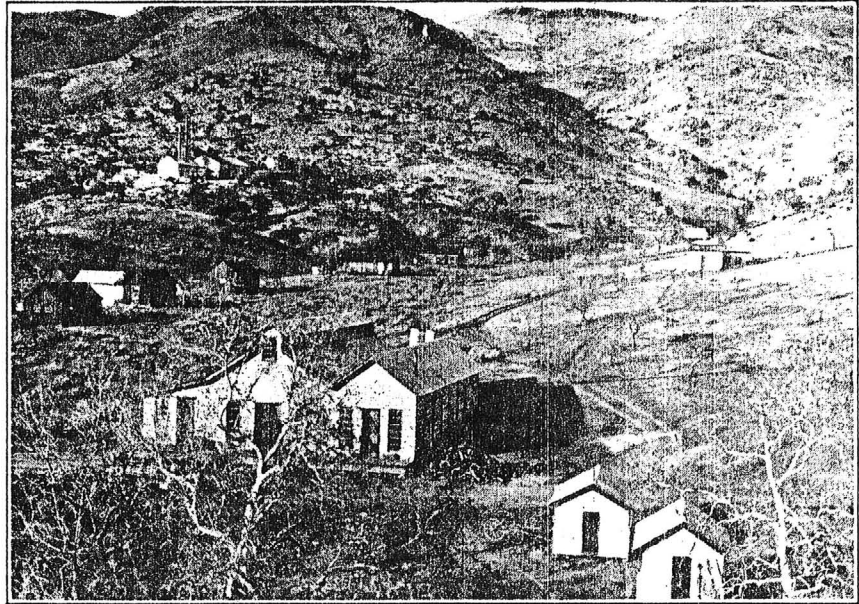
On the ROSSI, COPPER GLANCE, SUMMIT and GREY COPPER claims, short tunnels, pits and shallow shafts have exposed ore of high grade, some of which has been packed out of these mountains on horses or burros and shipped to smelters.

Besides the mines and claims enumerated in the foregoing pages the Company owns a large additional number of mining claims, some of which have promising surface showings, but on which little exploratory work has yet been done.





Concentrating Mill. Ore Train Unloading at Bins Above.



Looking North Over Sycamore Flat, Near Center of Company's Property. Store and Office Building in Foreground. Employees Dwellings and Power Plant in Distance.

## SURFACE IMPROVEMENTS AND EQUIPMENT

A WAGON ROAD, traversing the entire length of the District and connecting same with the San Pedro valley on the west, and the Sulphur Springs valley on the east, was constructed some years ago at a cost of \$40,000 or \$50,000. Several miles of this road is hewed into the rock walls of almost perpendicular mountain sides. Branch roads connect the developed mines with this main road.

A concentrating mill of 7 to 8 tons hourly capacity, near the center of the lower basin, has made it possible to conduct extensive tests to determine the best methods of treating the ores from the various mines of the Company. The treatment of more than 12,000 tons in this mill has demonstrated that the ores of the district are ideal milling ores, assuring high-grade concentrates and a high percentage of recovery.

The Company's main power plant consists of two 100-horse power boilers (coal and wood burners), a 200-horse power Corliss engine, with feed-water heater, a 160-Kilowatt, 2300-volt General Electric dynamo, switchboard and all accessories.

Power is carried to the mill, to the principal mines, to the machine shop, etc., over a three-phase transmission line, consisting of three heavy copper wires supported by steel towers. Transformers, lightning arrestors, 16 motors, a complete lighting system for mines, mill and all buildings are a part of this equipment.

A railroad two and three-quarters miles in length, of 30-inch gauge, with 40-lb. steel rails, connects several of the mines in the lower basin with the mill. Equipment consists of 18-ton H. K. Porter locomotive, 8 ore cars, locomotive shed, water tank, coal bins, loading bins, etc. The road is cut in the solid rock of the steep mountain sides.

A portable power plant consists of 60-horse power distillate engine and accessories. This is used for running air compressor when the large power plant is not in operation. The Company also has a number of smaller gasoline engines for various purposes.

A machine shop, two blacksmith shops, ice making plant, refrigerator plant and a 31-mile telephone line connecting the various mines and buildings of the District with Mammoth, Winkelman, and Hayden, are owned and operated by the Company.

The water supply system consists of 5 miles of pipe lines, carrying water from unfailing springs to the mill and other build-



ings. A concrete dam, 26½ feet high and 131 feet across the canyon, creates a reservoir holding 8,000,000 gallons of water. This water is of excellent quality, both for boilers and domestic use.

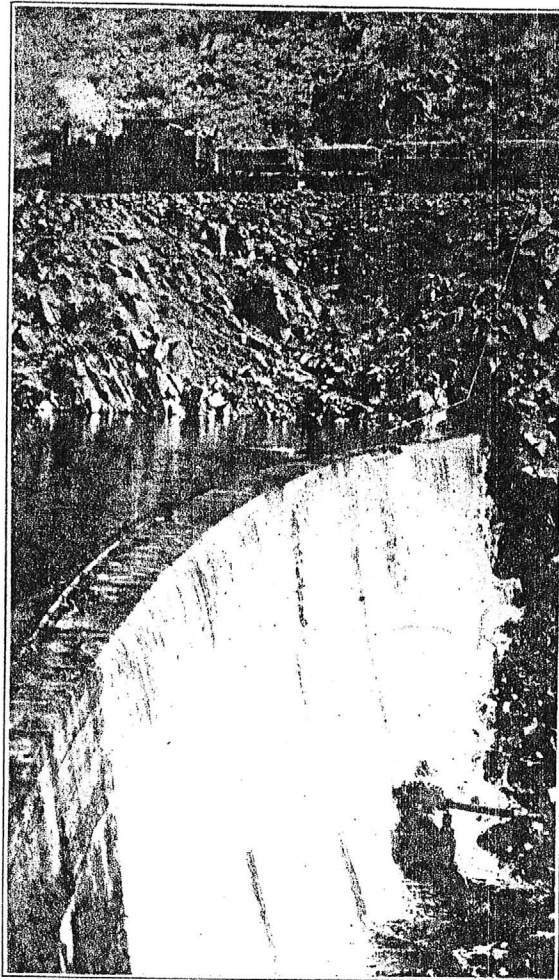
Included in the mining equipment are 24 air drills, several tons of steel for same, air compressors and receivers, several thousand feet of pipe, blowers, mine tracks, cars, cages, skips, hoists, cables, pumps, etc.

The Company conducts a general store, or commissary, which does a large and profitable business. Among the 30 buildings owned

by the Company are boarding houses, bunk houses, a butcher shop, a hospital, a complete assay office and dwellings.

Other minor properties are a 5-ton auto truck, wagons, horses, pastures, corrals, office fixtures and furniture, wagon scales and loading platforms at Winkelman, etc.

Climatic conditions are ideal all year round. Owing to high altitude the summer heat is never excessive. The rains and light snow falls in winter do not interfere with mining operations.



Concrete Dam Across Copper Creek Canyon.

## GOVERNMENT AND ENGINEERS' REPORTS

NO expert or layman who has visited the Company's properties has ever doubted that they contain large deposits of copper. Write to any banker or business man at Tucson, Winkelman, Hayden or Phoenix and he will answer that Copper Creek is universally spoken of among mining men as one of the coming big producers of Arizona.

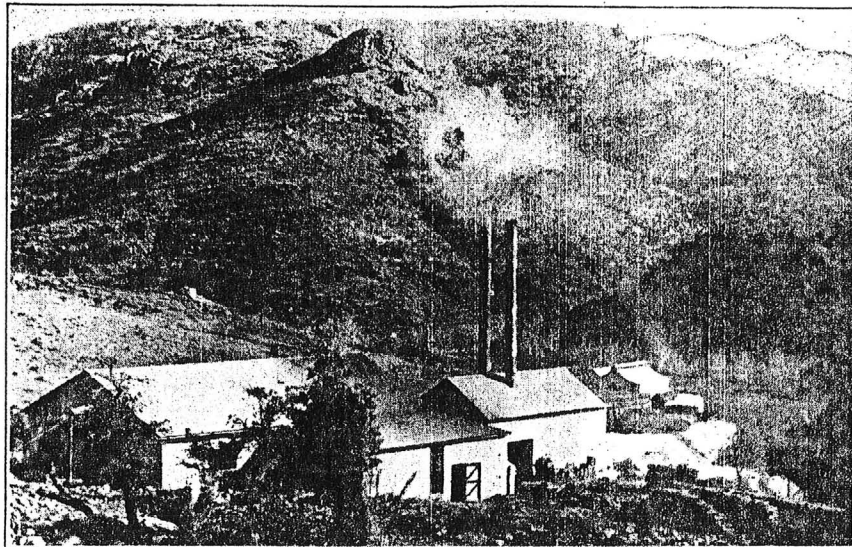
But the best authority is the United States Government. In various official publications of the U. S. Geological Survey the Copper Creek Mining District is prominently noted both in printed text and on maps as one containing deposits of copper, gold, silver and lead. It is the only locality thus featured in the entire range of the Galiuro mountains.

From the Company's properties can be supplied as great a variety of beautiful mineral specimens as one usually finds in an entire Mines Building at a western exposition. The merit of a mining property, however, is not to be measured by samples, but by the QUANTITY of ore. To supply even 500 tons a day for a long period of years very large bodies must be developed. It is because the disinterested geologists of the U. S. Government know that these large deposits exist at Copper Creek that the District is given as prominent a place on official maps and in printed documents as those districts which have already been fully financed and equipped and are now steadily producing millions of pounds of copper every year.

Many mining engineers of the highest standing have reported on various mines of the District, now owned by the Copper State Mining Company. The Copper Giant, Globe and Prince mines were purchased from the original owners after final examination by Dr. L. D. Ricketts, one of the best known engineers and mine managers of the Southwest.

In 1909 the Old Reliable mine, then owned by the Old Reliable Copper Co., and only slightly developed, was examined by Dr. Walter Harvey Weed, noted geologist, author of "The Copper Mines of the World" and publisher of the "Mines Handbook." His report was most favorable throughout. It concludes with the following statements: "In conclusion we are able to endorse the property." . . . . There is "reasonable assurance of the development at an early date of much larger bodies of commercial ore." . . . . "We consider it possible with the practice of economy and the latest mining and metalurgical methods to treat ore carrying 2 percent copper at a profit, producing the red metal at a cost of 9½ cents, maybe less."

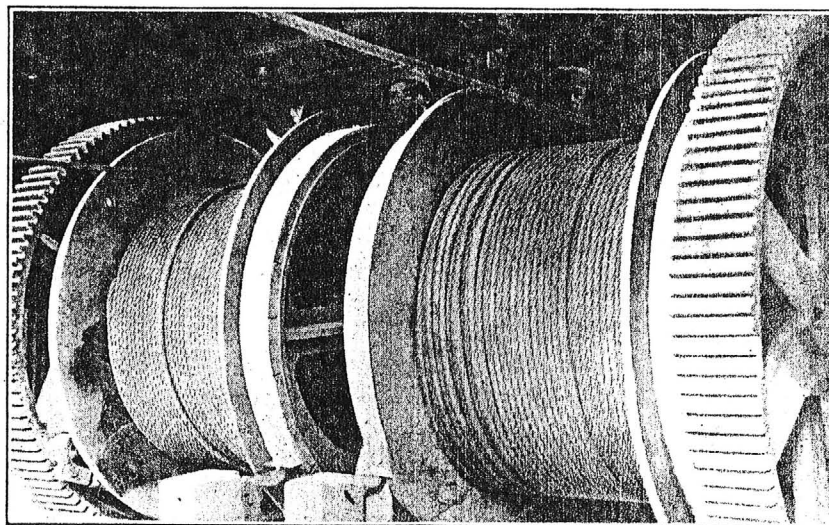




Looking South Over Sycamore Flat. Power Plant in Foreground, Store and Office Building in Distance.



An 18-ton Locomotive on Way to Copper Creek; 24 Animals Pulling & Pushing.



Double Drum Electric Hoist at the Company's American Eagle Mine.

## THE OWNERS OF THE PROPERTY

THE stockholders of the Company, about 500 in number, consist of bankers, professional men, merchants, farmers, contractors and tradesmen, a large number of whom have visited the property one or more times. The faith which first caused them to invest has grown as the developments in the District have uncovered more and more of its hidden wealth. The affairs of the company are administered by the following:

### OFFICERS AND DIRECTORS

#### President

MARTIN E. TEW, Mining Man and Lawyer, 411 Metropolitan Life Building, Minneapolis, Minn.

#### First Vice President

JOHN A. NELSON, President Nelson Brothers Paving & Construction Co., 939 Plymouth Building, Minneapolis, Minn.

#### Second Vice President and Treasurer

E. E. MCCARTHY, President McCarthy Produce Co., 227 North La Salle St., Chicago, Ill.

#### Secretary

S. H. HUDSON, Lawyer, Director Metropolitan National Bank, Minneapolis, Minn., Vice President Swift County Bank, Benson, Minn.

#### Assistant Treasurer

WALTER DE LA HUNT, Merchant, Real Estate, Willmar, Minnesota.

#### Director

GEORGE P. DOUGLAS, Lawyer, 826 First National-Soo Line Building, Minneapolis, Minn., Owner Iron Mines in Duluth District; President Minneapolis Athletic Club.

#### Director

A. M. ANDERSON, Farmer, Secretary New London Farmers' Elevator Co., Secretary Irving Creamery Company, Hawick, Minn.

#### Consulting Engineer

LEWIS A. DUNHAM, 61 Broadway, New York City.

#### Manager and Mining Engineer

W. C. STEUBING, Copper Creek, Arizona. References: Wm. A. Palne, Boston, Pres. Copper Range; Walter Harvey Weed, E. M., New York; Horace V. Winchell, E. M., Minneapolis, Minn.



## THE WORLD'S INCREASING CONSUMPTION OF COPPER

Year.	Long Tons
1800 •	8,000
1850 —	50,000
1880 —————	153,000
1892 —————	310,000
1904 —————	641,000
1915 —————	1,200,000

### DECREASE OF VIRGIN COPPER TERRITORY

While the consumption of copper has increased at this marvelous rate the new territory in which copper mines may be discovered is constantly growing smaller, about in the ratio of the above lines inverted.

In 1850 practically all the region west of Lake Michigan was virgin territory. This may be represented by a line across the entire page, as follows:



Between 1850 and 1880 the great Michigan copper field was developed, leaving the Rocky Mountain region virgin territory. This and the other unexplored copper districts may be represented by the following line:



From 1880 to 1890 the Butte district and three of the prominent Arizona copper districts were brought to the producing stage, leaving the remaining copper fields of the west yet to be developed. These may be represented by a line like this:



From 1890 to 1900 several new deposits in Arizona and Mexico were opened up, leaving still a number of undeveloped districts, which may be indicated by the following line:



Since 1900 and up to the present time the new developments have been chiefly in Arizona, Nevada, Utah, New Mexico, Alaska and South America, leaving only a few known copper districts undeveloped, mainly in Arizona, Alaska, Mexico, Africa, and South America. These may be represented by a line as follows:



Since the electrical age began (about 1880) the consumption of copper has doubled every 12 years. Production has kept pace with consumption up to the present time only because of the vast mineral deposits discovered and developed in the West. The age of electrification of railroads and power using industries has only fairly begun. The demand for copper is certain to increase from year to year. But the area in which undeveloped copper deposits are likely to exist is constantly growing smaller.

All known facts force the conclusion that prices for copper will go higher and higher.

MS  
DEPARTMENT OF MINERAL RESOURCES  
STATE OF ARIZONA  
FIELD ENGINEERS REPORT

Mine Old Reliable Mine ✓

Date May 24, 1957

District Bunker Hill District ---- Pinal Co.

Engineer Axel L. Johnson

Subject: Field Engineers Report. Personal Visit & Information from M. R. Biswell, Foreman.

Location Sec. 10 -- T 8 S -- R 18 E. About 11 miles east of Mammoth on Copper Creek.

Number of Claims 5 patented claims

Owners Copper Creek Consolidated Mining Co. Lewis W. Douglas largest stockholder. ✓

Option to Purchase ✓ Siskon Corporation, Box 889, Reno, Nev.  
✓ H. B. Chessher, President, Box 889, Reno, Nev.  
✓ M. R. Biswell, Mine Foreman, Box 58, Mammoth, Ariz.

Principal Minerals Copper ores, with a mixture of oxides, carbonates, and sulphides.  
Oxidized ores are malachite, azurite, chrysocolla and brochantite.  
Sulfide ores are chalcocite, chalcopyrite and bornite.

Present Mining Activity Exploration work, consisting mostly of diamond drilling.

Geology and Ore Values See Bureau of Mines Bulletin -- RI 4006.

At the time of field engineer's inspection on July 19, 1954, when mine was being operated and the ore milled, the mill feed was reported as averaging 2.2 % copper, and being about 1/2 sulfides and 1/2 oxides (See report of July 19, 1954).

M. R. Biswell, Mine Foreman reports that the average content of the ore, as found by the exploration work, is from 2.0 % to 2.5 %.

Country rock is grano-diorite porphyry. Mr. Biswell reports a pipe of ore approximately 250 x 250 ft. and about 200 ft. deep.

Milling and Marketing Facilities The old mill built in 1953 -54 by the Copper Creek Consolidated Mining Co., and operated March to August, 1954, is still standing. (See report of July 19, 1954) This is considered inadequate to meet the requirements of the mine, after production is started, and plans for a new mill will, no doubt be made.

Past History See Bureau of Mines Bulletin --- R I 4006.  
See report of July 19, 1954.

Mine Workings See Bureau of Mines Bulletin ---- R. I. 4006.

Present Operations , Company, at present, doing diamond drilling with 3 drill rigs, two underground in the Old Reliable, and one on the surface.

Proposed Plans Company expects to continue diamond drilling until sufficient ore has been developed in the Old Reliable and the Prince, Globe and American Eagle properties, which adjoin the Old Reliable, to warrant the construction of a mill to treat the ore. Mr. Biswell estimates that close to 1,000,000 tons of milling grade ore has been developed in the Old Reliable, Prince and Globe properties already. He also reports that consideration is being made to building this mill some where on the San Pedro River, near Mammoth, and the LPF system of leaching, precipitation, and flotation is being considered.

Work done to date Company started work on the Old Reliable and surrounding properties on March 1, 1956. Work done to date has been as follows:

- (1) On the Old Reliable ---- Cleaning out the old drifts in the Old Reliable and sampling. Diamond drilling underground and from the surface on the Old Reliable, as shown above.
- (2) On adjoining Properties ----- Repairing drifts and 200 ft. of drifting on the Globe. Dewatering the Prince shaft and sampling.



COPY

HARMON E. KEYES  
Chemical and Metallurgical Engineer  
508 East Culver Street  
Phoenix, Arizona

Telephone Alpine 3-5909

August 19, 1954

COOPER CREEK CONSOLIDATED MINING CO.

Mr. Lewis W. Douglas  
Southern Arizona Bank Building  
Tucson, Arizona

Dear Mr. Douglas:

As Mr. W. T. Elsing very kindly has offered to convey to you any further suggestions I might have on Old Reliable operations, the following points are offered for your consideration.

1. Due to the grade of the ore proving to be somewhat less than anticipated, small scale operations become more difficult to handle profitably. Therefore, to provide incentive to enlarge the scope of operations sufficient for ultimate maximum profit and attracting necessary capital, the entire tonnage in the area should be encompassed in the general plan. If not already arranged, some tangible tie in should be negotiated for definite terms on handling the Copper Prince and Globe properties, so that such terms could be relied upon in event that developments at the Old Reliable become profitable.

Some revised estimates would seem to be in order, on tonnage, grade and mining cost, for each property. It is understood, from information supplied by Mr. M. J. Elsing in 1951, that the Copper Prince and Globe properties may be reached by 3,000 feet of tunnel from the Old Reliable. Milling of sulphide ore from these two adjacent properties might later be done at the Copper Creek Mill.

2. Aside from the above suggested scope, planning for increased returns from a marginal operation divides itself logically into two categories, namely-

- A. Developing lowered mining costs
- B. Developing processes to produce forms of copper products to sell at a higher price level than usual mine shipments.

I have reviewed my former investigations dealing with the above categories and offer these suggestions-

A. There is some reasonable hope that the Old Reliable Mine might be leached in place without actually breaking all the ore. By suitable development of locations for solution entry and collection this method, if successful, would lower mine costs to a fraction of present figures. In view of the low gangue consumption of this ore a (\*\*

(\*\* Page torn at corner

collection tunnel already in at water level, and easy accessibility of solution distributing points both on the 100 level and the surface, and the development of reagents to increase penetrating qualities of water, this may be the proper time and situation to re-open the proposition of investigating further the leaching of unbroken ore in place.

B. A few years ago I developed an improvement for copper production of 99 plus percent purity, using shredded tin cans. The plan was to produce material suitable for copper powder metallurgy. My process also can produce crystalline, dense, flaky type material and which settles very rapidly in washing.

If there is a suitable market outlet in the West for such copper powder, it may provide opportunity for increased income in your operations. This treatment requires special precipitating equipment, such as a drum, whereby the iron scrap is cleaned and maintained free of rust. Special precautions also are taken to prevent precipitation of iron from solution, by hydrolysis.

Another process which I developed is production of red cuprous oxide,  $Cu_2O$ , using cement copper. This is accomplished by controlled oxidation and requires a special furnacing operation. Later, I located a progressive paint manufacturing company in the South that was interested in using such material.

There are advantages in producing cement copper as preliminary to the above finished products. Examples are possibility of using various types of scrap iron precipitant, as well as employing dilute copper solutions of variable composition as would be encountered in Old Reliable Mine Leaching operations. Other methods of producing pure copper powder require rather definite conditions of solution concentration and may not be applicable to the type under consideration.

Before the sulphidizing step is entirely abandoned in the flotation mill, it seems worthwhile to give further study to the specific conditions that existed in the laboratory testing, and to consider ways and means of establishing these conditions in the plant. For example, it is possible that fluctuations in the pH may have upset the flotation. If this is the case a large conditioning or surge tank in the circuit just ahead of oxide flotation, equipped with continuous pH meter, should aid stabilization as well as to give a possible improvement in conditioning. This last item is conjecture, but submitted for consideration. Thus, it might be possible to achieve sufficient improvement in oxide flotation to offset advantages of leaching the flotation tailings. If this improvement can be achieved feasibly, the mill could be operated as originally planned, and leaching ( plans centered on the mine and dumps.

Mr. Dick King called yesterday and gave a little more information on ( the copper powder process. The inventor has demonstrated a special leaching ( and electrolytic deposition method to produce copper powder of high purity ( and extreme fineness of particle size; also the process and product have been (

(Torn across side and not sure whether all words intact.



checked by different experts, according to Mr. King. A copper property has been acquired as source of ore. Evidently the group is looking for finances to handle this complete process and mining property. Other aspects of the proposition seem to be in common with copper powder processes in general. As Mr. King is arranging for me to meet the inventor, if any further information is received that seems pertinent I shall be glad to send it along in a supplemental letter to your Tucson office.

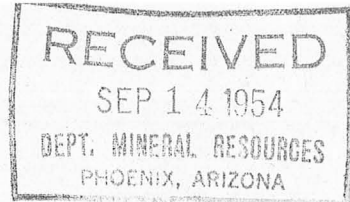
Trusting that the above discussion may be of some help to you at this time, and with my best wishes for your early return to good health, I remain,

Sincerely,

Harmon E. Keyes

COPY/hjl-1/6/57 (3) for Shattuck Denn Mining Corporation

DEPARTMENT OF MINERAL RESOURCES  
STATE OF ARIZONA  
FIELD ENGINEERS REPORT



Mine Old Reliable Mine

Date July 19, 1954, and Aug. 31, 1954.

District Bunker Hill # Dist., Pinal Co.

Engineer Axel L. Johnson

Subject: Field Engineers Report. Personal Visit on July 19. Inf. from Bob Ageton on 8/31.

Location Sec. 10 -- T 8 S -- R 18 E. About 11 miles east of Mammoth over a rough mountain road.

Number of Claims 5 patented claims --- Mineral Survey # 4059.

Owners Copper Creek Consolidated Mining Co. Lewis W. Douglas largest stockholder. *inspected 3-3-51*  
Morris J. Elsing, 95 Camino Espanol, Tucson, Ariz., Consulting Engineer.  
Bob Ageton, 1650 E. 1st. St., Tucson, Ariz. --- Mine Superintendent.  
(At present time (Aug. 31) Bob Ageton expects to finish up his work with the company in a few days, Morris Elsing is incapacitated on account of illness, and Mr. Douglas wishes to dispose of the property and relieve himself of the responsibility)

Operators Property closed down during the last week in August, 1954. Until that time, for the previous 6 months (approx), the mine was operated by the owners and officials as shown above.

Principal Minerals Copper ores---mixed sulfides and oxides.  
Sulfide ores are chalcocite, chalcopyrite and bornite.  
Oxidized ores are malachite, azurite, chrysocolla and brochantite.

Number of Men Employed Closed down on Aug. 31. None working.  
25 men working at the mine when it was in operation on July 19.

Production Rate No production now .  
140 tons per day of ore production, when it was operating on July 19.

Geology and Ore Values See Bureau of Mines Bulletin---R. I. 4006, (acc. this report)  
At time of inspection on July 19, the mill feed was reported as running between 2 & 2.5 %, averaging about 2.2 % copper, and being about 1/2 sulfides and 1/2 oxides.

Milling Facilities A mill was designed and built last fall and winter for the treating of from 200,000 to 300,000 tons of mixed sulfide and oxide ores, which the operators deemed ~~it~~ necessary to remove from the ore body in preparation for extensive leaching operations of ~~the~~ the remainder of the ore body in place. The removal of this ore was considered necessary in order to create voids into which the remainder of the ore body could be broken up and leached in place. The mill was designed by Leland Vought of the Mines Exploration and Development Co., 2000 S. Freeway, Tucson, Ariz., and assisted by George Roseveare of the Arizona Bureau of Mines, from the results of a mill test that was made on ore, which was considered to be representative of the ore to be milled.

Mill had a capacity of 150 tons, and the ores were treated by flotation with the ~~use~~ use of a sulphidizing agent. Mill consisted of a 50 ton coarse ore bin, a 150 ton fine ore bin, a Jaw Crusher, a Cone Crusher, a 64" Marcy Ball Mill, a 48" Classifier, 4 Denver sub A flotation cells for the sulphide unit, and 6 Denver sub A flotation cells for the oxide unit, attachments for adding sulphidizing agents, a 16'dia. x 10' Thickener, and an Oliver filter. Concentrates were trucked to Tucson, and then shipped by rail to Douglas.



DEPARTMENT OF MINERAL RESOURCES

STATE OF ARIZONA

FIELD ENGINEERS REPORT

Page 2.

Mine Old Reliable Mine

Date July 19, 1954 & Aug. 31, 1954.

District Bunker Hill District, Pinal Co.

Engineer Axel L. Johnson

Subject: Field Engineers Report. Personal Visit on July 19. Inf. from Bob Ageton on 8/31.

Present Mine Workings See Bureau of Mines Bulletin --- R. I. 4006.

Past History See Bureau of Mines Bulletin --- R. I. 4006.

Mine Operations of the Company ---- March to August 1954.

Mining operations of the company were conducted from the 100 ft. level of the mine. Operations consisted of stoping out certain sections of the ore body in order to create voids and provide room for the broken ore in the future planned "in place" leaching operations. ~~Broken~~ Mine was operated two shifts, 6 days per week with about 18 miners working in the mine. A mucking machine and a double drum slusher was used, the ore being trammed out from the 100 ft. level adit in ore cars and dumped in the crude ore bin of the mill. Operations closed down the last week in August, 1954.

Milling Operations of the Company ---- March to August 1954.

According to Bob Ageton, Mine Superintendent, the ore sample on which the mill test was made, from the results of which the mill and the milling operations were designed and planned, did not turn out to be a representative sample of the ore to be mined and milled. The ore sample tested was almost 2/3 sulphides, the remaining 1/3 consisting principally of malachite and azurite, which was to a certain degree amenable to flotation with the use of sulphidizing agents. As mining operations continued, however, the character of the ore changed to about 1/2 sulphides and 1/2 oxides. The oxides, moreover, also changed in character. Instead of being mostly malachite and azurite, more or less amenable to flotation with sulphidizing agents, they changed to a mixture of these oxides with brochantite and chrysocolla, the latter two not being amenable to concentration by these methods. As a result, less than 25 % of the oxides were recovered, and the overall recovery dropped below 60 %. Mill feed averaged about 2.2 %. Concentrates, at first, ran about 27 %, then later dropped to 22 %. Concentrates were hauled to Tucson, and then shipped by rail to Douglas. Operations closed down the last week in August, 1954.

Reasons for Closing

- (1) Company was losing money on their mining operations, due principally to the low mill recovery, and also to high overhead.
- (2) The illness of Morris J. Elsing prevented him from taking an active part in the planning and the administration of the mining operations.
- (3) Lewis Douglas is reported as not wishing to assume responsibility for ~~the~~ any future mining operations of the company, due to lack of time to devote to same.

Future Leaching Operations In Place

According to Bob Ageton, Mine Superintendent, the Old Reliable ore body was considered to be ideally suited for leaching broken ore in place. A small amount of sulphuric acid would be mixed with the water to start the leaching process. After the leaching process was under way, it would continue without the addition of any more acid.

Water Facilities Company had a lease from Phelps Dodge for the Globe shaft, 2,000ft. N., with a capacity of 30 g.p.m, and of the Copper Prince shaft, 2,000 ft. NE., with a capacity of 10 g.p.m. A reservoir on Copper Creek would also provide an additional supply of water. (Also see Bureau of Mines Bulletin R. I. 4006---p 8)

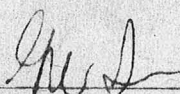
Future Plans Owners wish to sell or lease the property to some large operator.

ARIZONA DEPARTMENT OF MINERAL RESOURCES  
Mineral Building, Fairgrounds  
Phoenix, Arizona and visit

Ned Krier, Geologist OCCIDENTAL MINERALS CORP AND OTHERS.

1. Information from: \_\_\_\_\_  
Address: 6073 West 44th Ave. Wheatridge, Colo, 80033
2. Mine: OLD RELIABLE & SURROUND AREA 3. No. of Claims - Patented ##### 9.  
Unpatented Not informed.
4. Location: S10 ~~T7S~~ T8S R18E COPPER CREEK
5. Sec 10S Tp 8S Range 18E 6. Mining District COPPER CREEK
7. Owner: SISKON CORP
8. Address: RENO NEVADA
9. Operating Co.: OCCIDENTAL MINERALS CORPORATION.
10. Address: 6073 WEST 44th Ave. Wheatridge Colorado 80033
11. President: \_\_\_\_\_ 12. Gen. Mgr.: \_\_\_\_\_
13. Principal Metals: \_\_\_\_\_ 14. No. Employed: \_\_\_\_\_
15. Mill, Type & Capacity: \_\_\_\_\_
16. Present Operations: (a) Down  (b) Assessment work  (c) Exploration   
(d) Production  (e) Rate \_\_\_\_\_ tpd.
17. New Work Planned: Evaluation. One drill.
18. Misc. Notes: Have staked a large area mostly to the north and west of old reliable.  
Allen Jaejer in charge, but on vacation. Dave McGee of Little Hill Mines has 3 employees doing dozing etc for Occidental. Most of the geological work is being done by consultants as Holt & McPhar, and others.

Date: 1-30-69

  
(Signature)

(Field Engineer)



NOTES ON

OLD RELIABLE MINE

BUNKER HILL DISTRICT, PINAL COUNTY, ARIZONA

BY Ira B. Joralemon

November 2, 1951.

The Bunker Hill or Copper Creek District is 11 miles by steep road northeast of Mammoth, a village on the San Pedro River 22 miles by highway from the Hayden smelter. The properties are in high hills separated by deep, steep-walled gulches. While fair sized orebodies have been known for several years, the only successful operation was that of the Arizona Molybdenum Corporation, from 1933 to 1938. Attempts to mill copper ore many years ago were unprofitable.

Scarcity of water and transportation difficulties have been largely responsible for the difficulties. While there are large flash flows in the rainy season, the only stream that flows throughout the year is Copper Creek, which is hardly more than a trickle in dry years. The 200 ton mill of the molybdenum operation, on the Childs Aldwinkle group, was supplied with water from a small dam on Copper Creek and from pumping the old Prince Shaft, now owned by Phelps Dodge Corporation. It would not be safe to figure on any considerable local water supply without storage for more than three months of the year.

Geology and Orebodies

In the Copper Creek area, a large mass of metamorphosed andesite tuff, lava, and breccia is intruded by granodiorite. Shale and limestone are found in places, but do not enter into the present picture.

Mineralization is in a remarkable group of breccia pipes or chimneys, at fracture intersections or on andesite-diorite contacts. The Bureau of Mines reports that 125 of these pipes have been found. They vary from a few feet in diameter to 300 feet in longest dimension. Fragments in the pipes are altered andesite or diorite. The loose cementing material is quartz, sericite and sulphides of copper, iron and sometimes molybdenum. Only 10 or 12 of the pipes, most of them on Phelps Dodge ground, have been developed, with widely varying results. One, on the Childs-Aldwinkle Group, contained several hundred thousand tons of good copper-molybdenum ore. The Old Reliable, American Eagle, and five pipes in the Globe and Copper Prince claims contained copper ore of fair grade. The Superior, Michigan and Minnesota pipes had only iron sulphide, with practically no copper. There is therefore no general rule as to what will underlie the iron stained breccia outcrops.

At a depth of from 200 to 800 or more feet the pipes shrink into open fissures, partly filled with quartz and pyrite.

Developed and Possible Ore, Old Reliable Chimney

The Old Reliable has been developed and partly mined from two tunnels, the 100 Level, 150 to 260 feet below the surface, and 200 Level, 100 feet deeper. The upper tunnel developed an irregular breccia mass about 300 feet long by a maximum of 225 feet wide. The outcrop indicates a possible maximum length of 500 feet. The developed breccia on the 200 Level, as shown on maps, is 380 feet long by 235 feet maximum width. Assays shown on the maps in U. S. Bureau of Mines Report of Investigations 4006 average 2.06% copper on the 100 Level and 1.35% copper on the 200 Level. In obtaining these averages, high assays were thrown out, although lenses of rich ore are known to occur. The raise from the 100 foot level to surface was very uneven in grade, with a 0.31% band from 43 to 98 feet above the level. Including this band, the raise averaged 1.28% copper for 133 feet above the level, and 0.4% from 133 to 260 feet.

The upper, lean material was oxidized and leached. Ore down to or below the 100 level was partly enriched, with copper in chalcocopyrite, bornite, chalcocite and a little malachite. The 200 Level was largely in primary sulphide.

The richest part of the ore on both levels was partly mined 30 to 40 years ago in shrinkage stopes. A considerable tonnage of broken ore remains in the stopes.

An approximate estimate of ore in the Old Reliable Chimney follows:

## Total Ore, including that mined

Above 100 Level	540,000 tons	1.25%
100 to 200 Level	370,000 "	1.70%
Total	910,000 tons	1.44% av.

## Ore Broken (from stope maps and sections)

100 Level	58,000 tons	
200 Level	12,000 "	
Total	70,000 tons	Grade unknown

## Broken Ore remaining in stopes

100 Level	19,100 tons	2.77%
200 Level	2,900 "	1.67% ?
Total	22,000 tons	

(Assays are average of B. of M. chute and grab samples, omitting one 9.82% sample in 100 Level stope.)

## Remaining Unbroken Ore

100 Level	482,000 tons	1.2% ?
200 Level	358,000 "	1.7% ?
Total	840,000 tons	1.4% av. ?

While this estimate is approximate, it shows about what may be expected in the Old Reliable chimney.

### Treatment of Ore

There are two possible methods of recovering the copper from the Old Reliable ore. The first, which will be slow and comparatively inexpensive, would be to undercut and cave the ore above both levels; place the ore that is drawn on heaps for leaching; and later on to leach the remaining broken ore in the stopes. The second would be to mine all available ore by a cheap caving method, build a flotation mill in which a high recovery of the copper would be made in a rich concentrate, and ship the concentrates to the Hayden smelter. After mining is completed there would be some scavenging recovery by leaching the remaining lean broken material in place.

### Leaching in Heaps and Underground

If the first method of treatment is selected, the first step will be to mine a third to a quarter of the ore by the cheapest possible method, and to place the drawn ore on leach heaps on the hillside below the mine. At the same time the small dam across Copper Creek should be rebuilt, and if possible permission should be obtained from Phelps Dodge Corporation to pump water from the Prince Shaft. All available water should be distributed over the ore heaps, and water coming out at the lower end of the heaps should be run through launders for precipitation of the dissolved copper on scrap iron or tin cans and then pumped back to the dump.

There will probably be little solution of copper in the first year or two, until oxidation of the dump material has a good start. After two years, recovery of copper should be substantial, increasing to a maximum in three or four years. The oxidation of the dumps of the old tunnels proves that a large part of the copper sulphide is oxidized in a few years to sulphates that will be soluble in water or in ferric sulphate solution that is formed in the precipitation launders.

This process is substantially the same as that used at Rio Tinto in Spain for 75 years or more.

After production from the heaps begins to fall off, the solutions can be pumped to the caved outcrop and the remaining broken ore leached in place. Alternation of leaching between dumps and underground will give both materials a chance to oxidize. The eventual recovery, based on leaching operations at the Ohio Copper Company and elsewhere, should be at least 60% of contained copper.

The capital expenditure required for this leaching operation will depend on the desired scale of operation. If desired, it could be held to a low figure by starting on the upper level only and mining about 100,000 tons at \$2.00 or less per ton. Preparation of the lower level could come later. Leaching could start before all this tonnage is mined. The expense for a small dam, pumps, pipes, launders, etc.



should not exceed \$200,000. The small crew could live in Mammoth. The total cost of coming to moderate production is estimated at not to exceed \$400,000, and it might be \$300,000 or less.

If it is decided to come to full production more quickly, the amount of ore placed on the heaps would be doubled, and a larger dam would be built to provide a longer season. The initial expense might then be \$600,000.

If, as expected, water supply under the less costly plan will permit circulating an average of 350 gallons per minute for three months in the year, with a recovery of 4 lbs. copper per ton of water, the production would total about 900,000 lbs. copper per year. Total production from leaching down to the 200 Level, both on heaps and underground, may amount to more than 15,000,000 lbs. copper. The total cost exclusive of depreciation of the \$400,000 or less preparatory expense should not exceed 15 cents per pound of copper, which will include 5 cents for hauling, smelting and refining the copper precipitates.

### Flotation

The second plan will involve building a mill with a capacity of at least 500 tons of ore per day. Under present conditions this will cost at least \$1,000,000, and material will be very hard to obtain. It will be necessary to use all available water, which may involve an additional expenditure of \$100,000 or more. Mine preparation would cost at least \$100,000, and an expensive housing project may be necessary.

To offset the large initial expense of \$1,200,000 to \$1,500,000, recovery will be higher. Mr. E. V. Given, of St. Anthony Mining and Development Company, Ltd., obtained an average recovery in four laboratory tests of 81.15% of the total copper in a 25.89% concentrate. Recovery at the rate of nearly 3,000,000 lbs. copper per year could start in the third year, if materials for the mill are available. The cost, allowing \$3.00 per ton of ore for mining and development and \$3.25 for milling, and after allowing 6 cents per pound for treatment of concentrates and refining, should be in the neighborhood of 20 cents per pound of copper.

An added advantage of building a mill at the Old Reliable would come from the fact that the operators would be in an excellent position to take a lease on the adjoining Phelps Dodge property, which has developed nearly 400,000 tons of 2.67\* copper ore. The Old Reliable and the adjoining Phelps Dodge properties together contain about 35,000,000 lbs. of copper recoverable by flotation.

In view of the present acute shortage of miners and of construction materials, the plan of leaching a quarter of the ore on heaps and leaching the rest in place seems most feasible.

Ira B. Joralemon

R. I. 4006

DEPARTMENT OF MINERAL RESOURCES  
MINERAL BUILDING  
FAIR GROUNDS  
PHOENIX, ARIZONA

FEBRUARY 1947

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
J. A. KRUG, SECRETARY

BUREAU OF MINES  
R. R. SAYERS, DIRECTOR

REPORT OF INVESTIGATIONS

✓  
OLD RELIABLE COPPER MINE  
PINAL COUNTY, ARIZ.



BY

THOMAS C. DENTON

REPORT OF INVESTIGATIONS

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

OLD RELIABLE COPPER MINE, PINAL COUNTY, ARIZONA<sup>1/</sup>

By Thomas G. Denton<sup>2/</sup>

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INTRODUCTION

The Old Reliable copper mine was first examined by Harlow D. Phelps, an engineer of the Bureau of Mines, in October and November 1942, in compliance with a request from the War Production Board, which furnished copies of assay maps of the 100- and 200-foot levels and requested that they be check-sampled. The author and R. M. Grantham and W. D. Hughes, engineers of the Bureau, made a second and more detailed examination later, after a number of manways had been opened that were inaccessible when the first examination was made.

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<sup>1/</sup> The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Report of Investigations 4006."

<sup>2/</sup> Mining engineer, Bureau of Mines.



Accessible mine workings were sampled and mapped during this later examination. A third examination was made by Charles A. Kumke, Bureau of Mines engineer, from September 17 to November 6, 1943, when a vertical raise extending 260 feet from the 100-foot level to the surface and passing through the approximate center of the ore body was sampled.

#### ACKNOWLEDGMENTS

In its program of exploration of mineral deposits, the Bureau of Mines has its primary objective the more effective utilization of our mineral resources to the end that they make the greatest possible contribution to national security and economy. It is the policy of the Bureau to publish the facts developed by each exploratory project as soon as practicable after its conclusion. The Mining Branch, Lowell B. Moon, chief, conducts preliminary examinations, performs the actual exploratory work, and prepares the final report. The Metallurgical Branch, R. G. Knickerbocker, chief, analyzes samples and performs beneficiation tests.

Special acknowledgment is due J. H. Hedges, chief, Mining Branch, Tucson Division of the Bureau of Mines, who directed the function of the Mining Branch in carrying out the investigation reported in this paper. Sampling and surveying of the Old Reliable mine was done by the author, Harlow D. Phelps, Chas. A. Kumke, Robert Grantham, and W. D. Hughes, all mining engineers of the Tucson Division of the Bureau.

Chemical analyses of samples taken by the Bureau, included in this paper, were made at the Bureau's Laboratory, Reno, Nev., under the direction of A. C. Rice, acting supervising engineer. Metallurgical tests were performed in the Bureau's laboratory at Salt Lake City under the direction of H. G. Poole, engineer in charge of the ore-dressing unit.

#### LOCATION AND ACCESSIBILITY

The property is situated in sec. 10, T. 8 S., R. 18 E., Gila and Salt River meridian and base line, in the Copper Creek area of the Bunker Hill mining district, Pinal County, Arizona.

Access to the property is from Mammoth northeasterly by 11 miles of narrow, winding, unimproved road, which in a number of places has steep grades but is passable by automobile throughout. The town of Mammoth is in the San Pedro River Valley on State Highway 77. It has a population of about 500. Winkelman, 21 miles north of Mammoth by State Highway 77 and 35 miles northwest from the mine, is the nearest rail point. The Hayden copper smelter of the American Smelting & Refining Co. is 1 mile from Winkelman.

#### PHYSICAL FEATURES AND CLIMATE

The area in which the property lies is near the northwestern margin of the Galiuro Mountains, which are flanked on the west by the San Pedro River Valley and on the east by Aravaipa Creek. In the vicinity of the Old Reliable mine the topography is rugged. Altitudes range from 3,500 feet in the bed of Copper Creek to 5,650 feet at the top of a prominent lava flow.

Copper Creek is the main stream of the area. Ash Creek enters it about  $\frac{1}{4}$  mile downstream from the mine. Both creeks occupy narrow, steep, V-shaped canyons.

The climate of the region is semiarid. Rainfall is said to average 18 to 20 inches annually. Recorded temperatures range from  $110^{\circ}$  F. to  $8^{\circ}$  F. Snow falls occasionally during the winter. There are no climatic obstacles to year-around operation.

Vegetation is sparse and of a semidesert variety. There is no timber suitable for mine use in the area.

#### HISTORY AND PRODUCTION

Lode-mining claims were first located in the Copper Creek area about 1863, when rich lead-silver ore from the Blue Bird mine was shipped. In 1863 the region was recorded as the Bunker Hill mining district.

Little work was done until 1893, when the Copper Creek Mining Co. acquired claims along Copper Creek. Acquisition of claims north of the creek in 1907 by the Calumet & Arizona Mining Co. and completion of a wagon road from Mammoth in 1908 started a boom. This latter company explored the Copper Giant, Superior, Globe, Copper Prince, and other properties in the area by underground work and diamond drilling. From 1908 until about 1918, numerous other deposits, including the American Eagle, were worked. A survey for a railroad from Winkelman was made, but construction was not undertaken.

Except on the Childs-Aldwinkle claims, little or no work was done in the area after 1918. This property was exploited primarily for molybdenum, the first work done during World War I. The war ended before production began, but from 1933 to 1938, 329,000 tons of ore was milled and 7,000,000 pounds of  $\text{MoS}_2$  was recovered. From 1933 to 1935, the Old Reliable mill was used to treat the ore. Toward the end of 1935, a mill was built on the property, and from then to the end of 1938 a total of 296,652 tons was milled, an average of about 200 tons per day. Maximum production was reached in 1936, when 87,021 tons was milled.

The first corporate owner of the Old Reliable claims was the Copper Creek Mining Co., which by 1908 was controlled by the Minnesota-Arizona Mining Co. The latter company built a steam-electric power plant, a dam, and a mill on Copper Creek, about a mile from the Old Reliable mine, and about  $2\frac{1}{2}$  miles of a railroad from the mine to the mill. Ore from other mines in the area was treated in the mill.

In 1910, the Minnesota-Arizona Co. was reorganized under the name Copper State Mining Co., to which company the Old Reliable was transferred. In 1914, the new company replaced the steam plant with a Diesel-electric unit and revamped the mill. Ore from the American Eagle as well as from the Old Reliable was treated. The property operated until about 1919. Later, the mill was dismantled and the machinery was removed.

Production records are incomplete. The following table shows the approximate total metal produced from the Copper Creek area. Most of the 700,000 pounds of copper listed under Copper States Metals is believed to have been obtained from the Old Reliable from the treatment of about 30,000 tons of ore.

TABLE 1. - Production from Copper Creek area

Mineral	Childs- Aldwinkle <sup>1/</sup>	Twin S - Blue Bird, 1863-1920	Blue Bird, 1926-1939
Molybdenum sulfide, pounds.....	6,946,782	-	-
Copper, pounds.....	5,859,033	-	200,000
Lead, pounds.....	-	-	4,000,000
Gold, ounces.....	723	-	-
Silver, ounces.....	26,938	-	119,000
Estimated production, value.....	-	\$150,000	-

Mineral	Copper Prince 1937 <sup>1/</sup>	Clark Scanlon, <sup>2/</sup> 1905-1930	Copper States Metals 1903-1916
Molybdenum sulfide, pounds.....	-	-	-
Copper, pounds.....	1,227,667	200,000	700,000
Lead, pounds.....	-	-	-
Gold, ounces.....	-	-	-
Silver, ounces.....	-	15,000	3/55,000
Estimated production, value.....	-	-	-

<sup>1/</sup> According to W. C. Riggs.

<sup>2/</sup> Univ. of Ariz. Bull. 140, p. 99 (apparently leasers; mine not given).

<sup>3/</sup> Blue Bird.

PROPERTY AND OWNERSHIP

The Old Reliable property comprises five patented lode-mining claims covered by Mineral Survey No. 4059 and a number of adjacent claims. It is owned by the Copper States Metals Co., in which Martin E. Tew, of Copper Creek, Ariz., is said to be a majority shareholder.

DESCRIPTION OF THE DEPOSIT

Sediments in the area are believed to be of Cretaceous age. They consist of limestone, quartzite, conglomerate, shale, and sandstone, and are interbedded with and intruded by andesite, dacite and rhyolite. The sediments and an andesitic tuff are intruded by granodiorite. An extensive series of flat-lying basaltic flows overlies the complex. Mineralization is believed to be post-basalt. Several systems of faulting are in evidence in the area.

The Blue Bird ore occurred in a vein, and although many veins have been explored in the district, none except the Blue Bird have been productive.

With the exception noted, all production from the area has been from pipelike occurrences of breccia. About 125 of these pipes occur in the district, only a few of which have been productive.



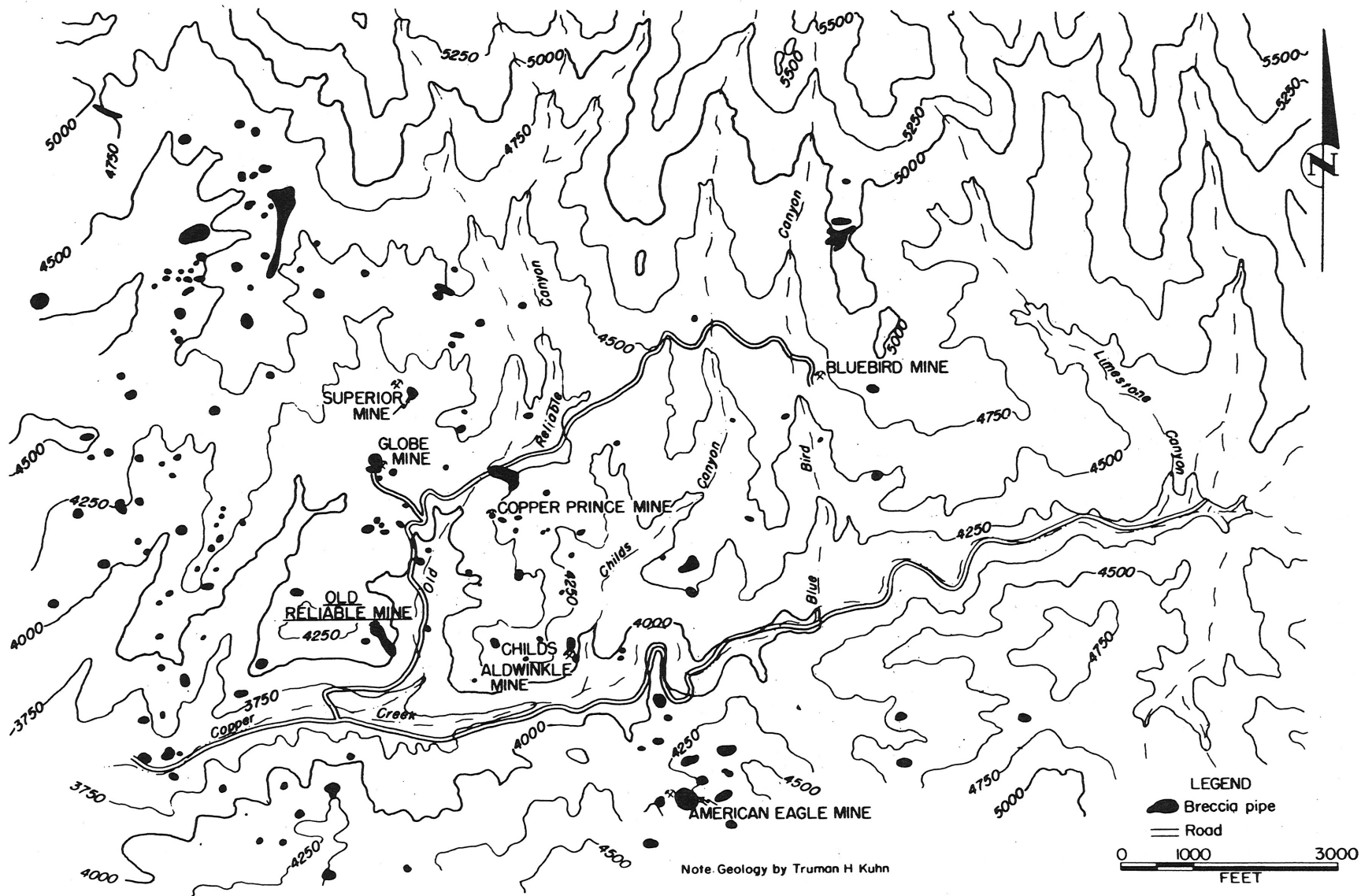


Figure 2.- General map of Copper Creek ore deposits, Pinal County, Arizona.

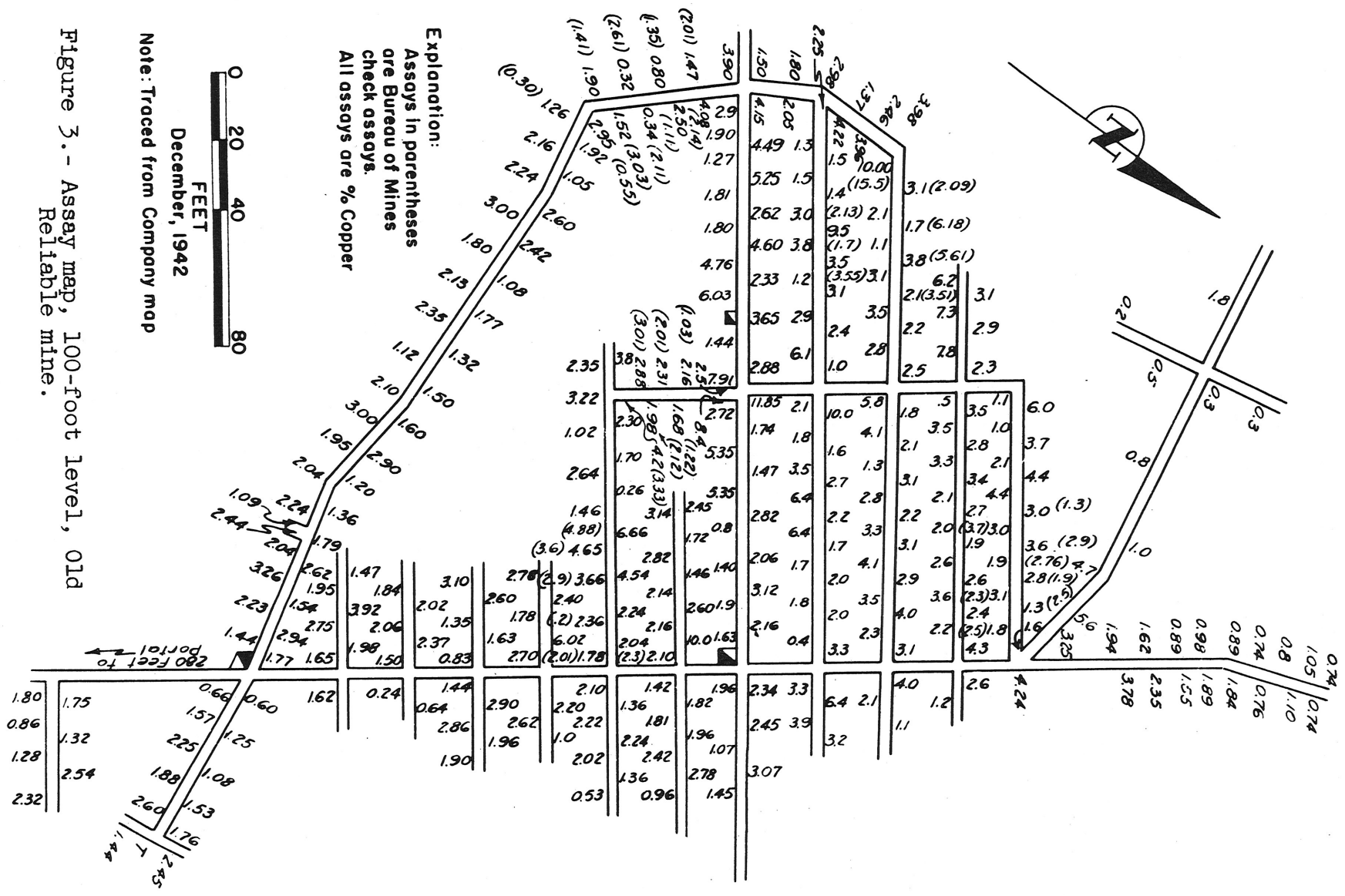
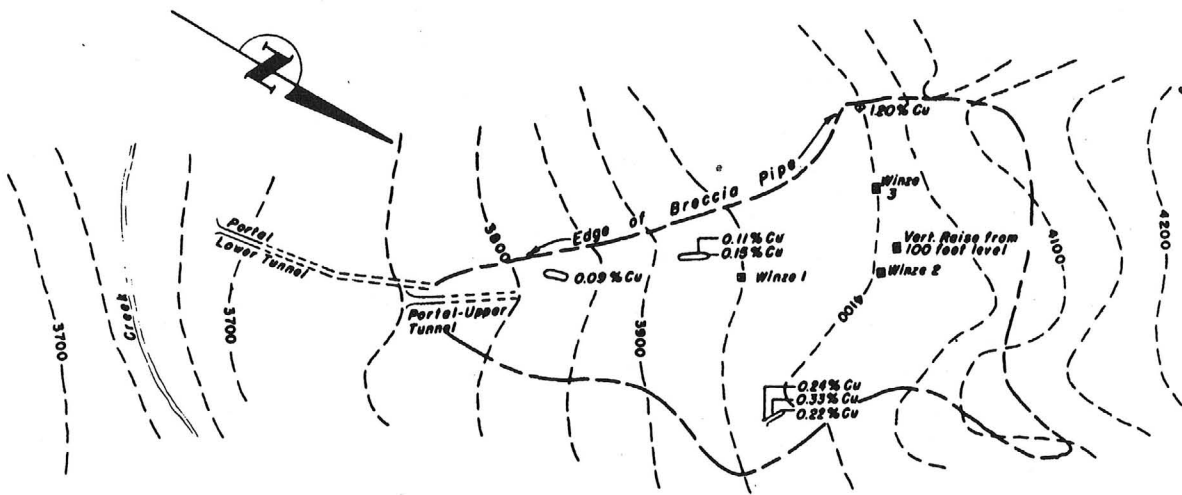
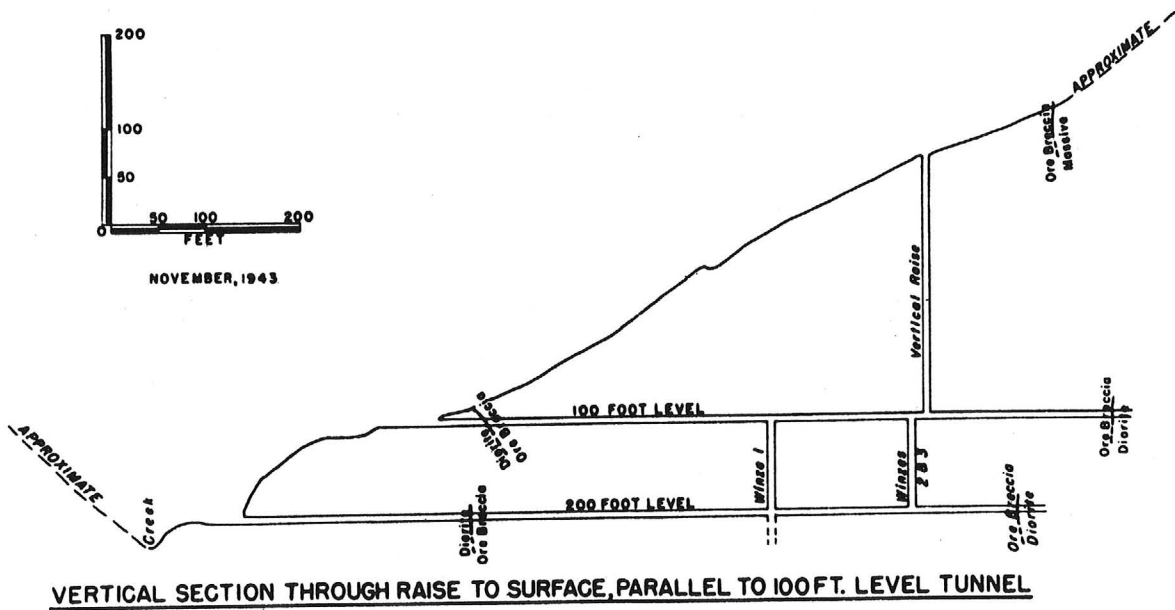


Figure 3. - Assay map, 100-foot level, Old Reliable mine.



**PLAN**

NOTE: - - - - 4000 - - - - APPROXIMATE ELEVATION



**VERTICAL SECTION THROUGH RAISE TO SURFACE, PARALLEL TO 100 FT. LEVEL TUNNEL**

Figure 5.- Surface workings and assays, Old Reliable mine.



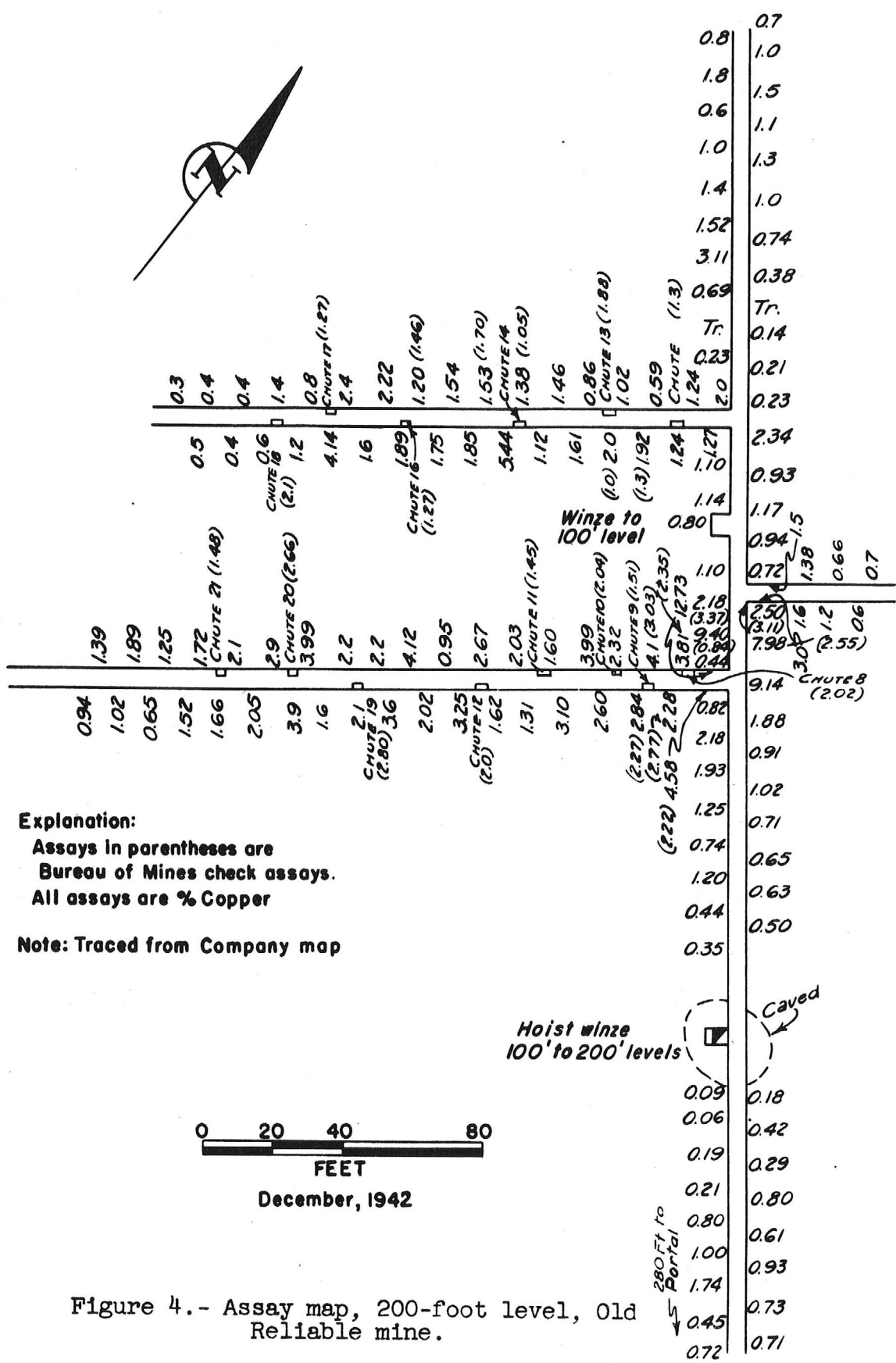
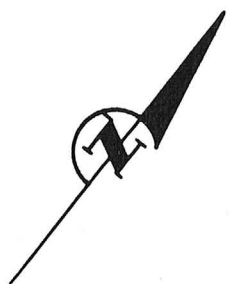


Figure 4.- Assay map, 200-foot level, Old Reliable mine.

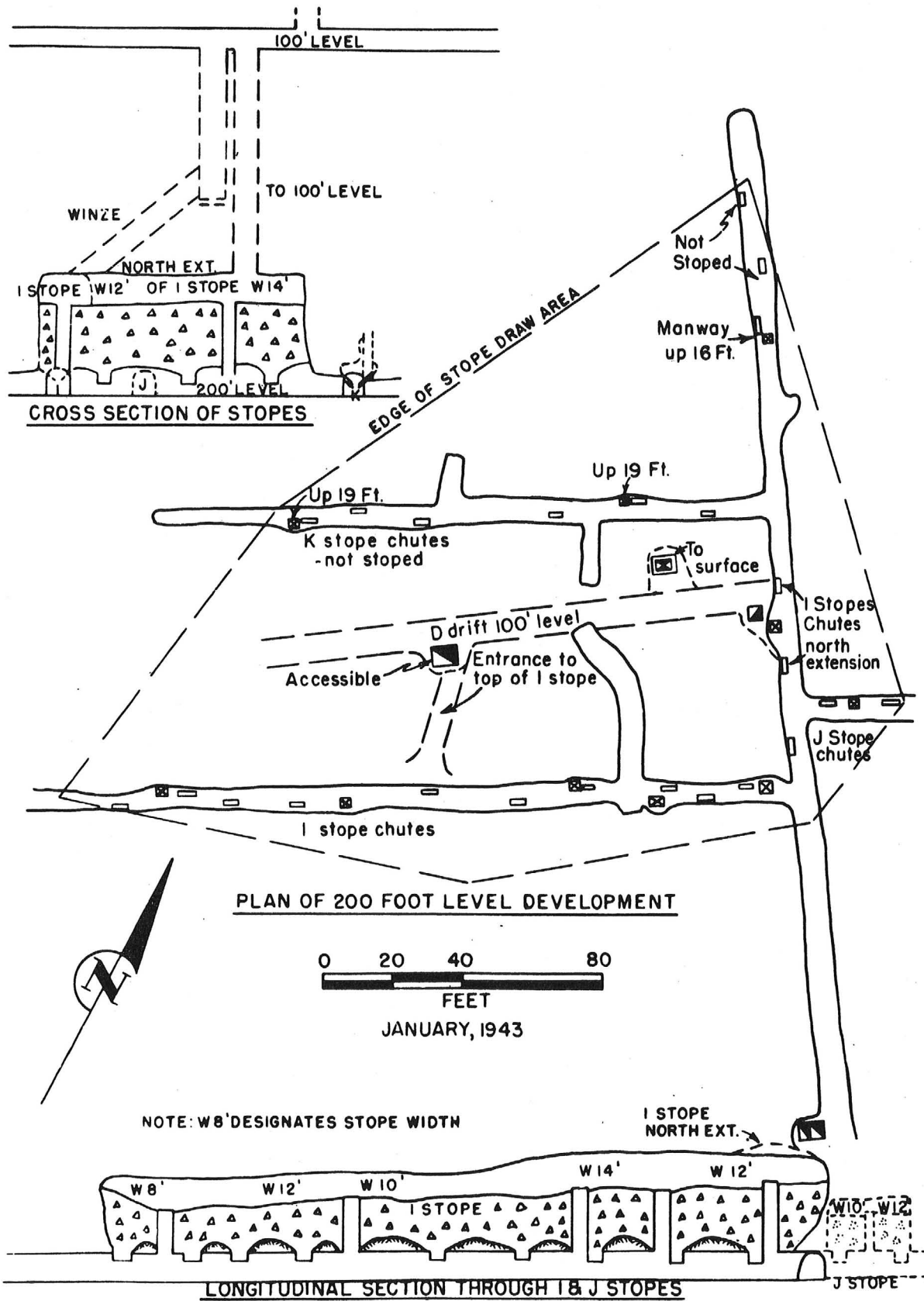
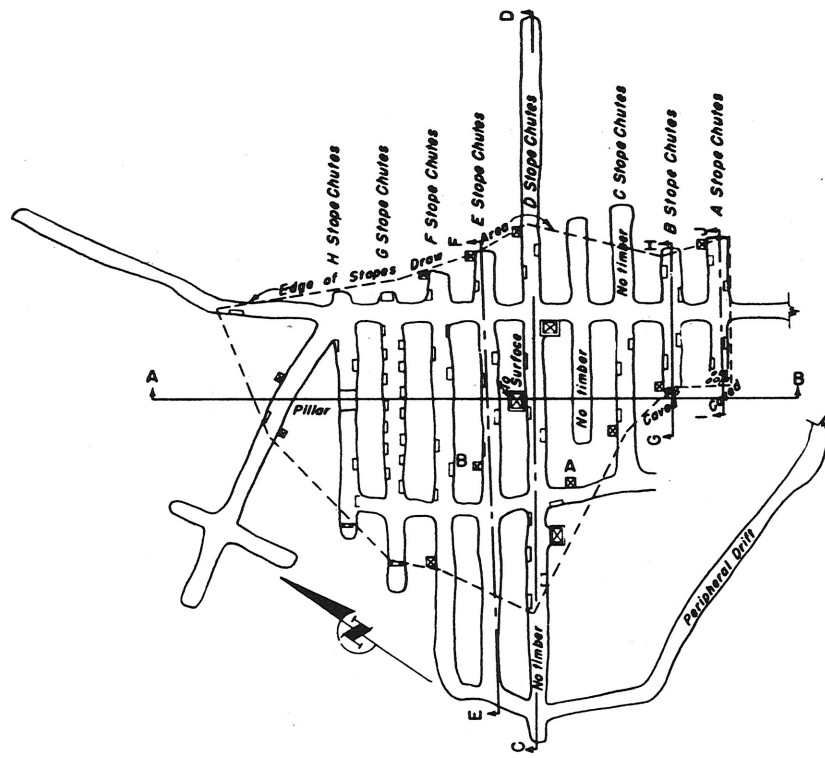
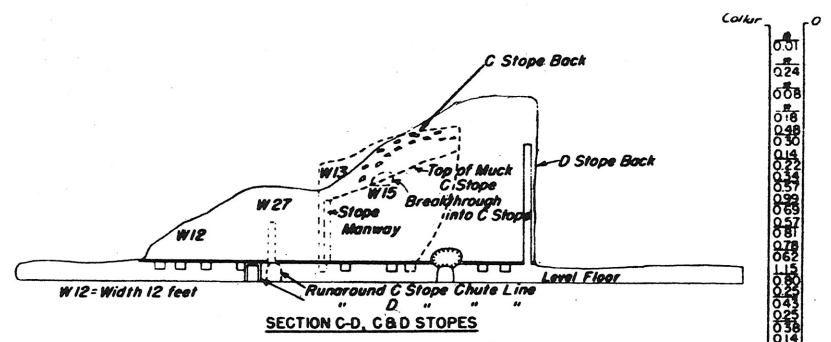


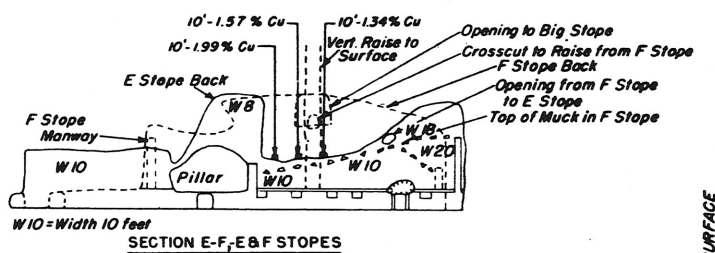
Figure 7.- Development on 200-foot level, Old Reliable mine.



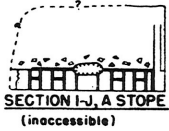
PLAN OF DEVELOPMENT - 100 FT. LEVEL



SECTION C-D, C&D STOPES



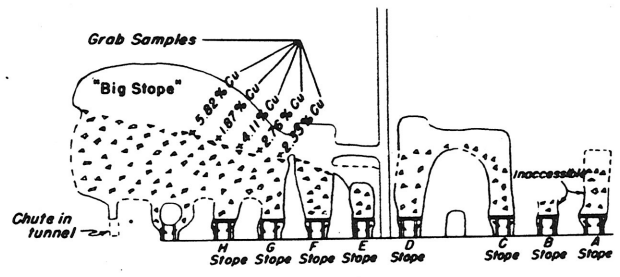
SECTION E-F, E&F STOPES



SECTION I-J, A STOPE (inaccessible)



SECTION G-H, B STOPE



SECTION A-B, THROUGH ALL STOPES



NOVEMBER, 1943

Notes:  
Samples in Vert. Raise were cut in East & West walls.  
Top figure is % Cu, East wall.  
Bottom figure is % Cu, West wall.  
\* Not sampled.  
All samples are 5ft. long.

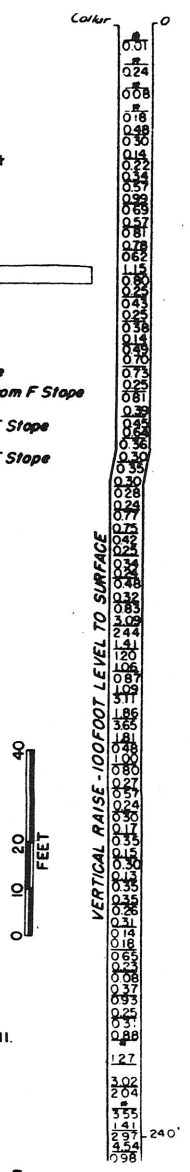


Figure 6.- Development on 100-foot level, stope assays and assays for vertical raise, Old Reliable copper mine, Pinal County, Arizona.



Although the pipes are found in all the igneous rocks, those that have been productive are in or near granodiorite. The chief producers have been the Childs-Aldwinkle, Copper Prince, Old Reliable, American Eagle, and Globe. The first two are in a large granodiorite mass. The second two, although chiefly in andesitic tuff, are at a granodiorite contact. The Globe is 1,000 feet from a granodiorite contact.

A typical pipe outcrops as a small but prominent pinnacle. In horizontal section, the pipes vary from circular to elliptical and stand vertically or have a steep pitch.

The pipe filling consists of angular, silicified rock fragments cemented chiefly by quartz, sericite and copper minerals.

The outcrops of some copper-bearing pipes, notably the Old Reliable, appear to be leached. Below the leached zone, oxidized copper minerals occur. The transition from oxidized copper minerals to copper sulfides, usually chalcopyrite and bornite, is gradual. Some chalcocite occurs at and near the water table. There is evidence of the occurrence of primary chalcocite. Molybdenum sulfide occurs at the Childs-Aldwinkle mine, and zinc and tungsten minerals have been found in the area.

Few data are available regarding the grade of the copper ore mined from the pipes or of the continuation of ore in depth. The Childs-Aldwinkle pipe was mined to a depth of about 800 feet, where it became small and the molybdenum content low. The copper content of the pipe, however, appears not to have decreased with depth and to have averaged about 2 percent.

The formation of the breccia pipes is believed to be due to intersecting fracture systems, solution of the rock along these fractures and subsequent slumping of unsupported masses.

The Old Reliable pipe is one from which production has been realized. Although molybdenite has been identified, copper is the only metal of consequence in the pipe.

Much of the outcrop is covered by talus. Parts exposed appear silicified and leached.

#### SAMPLING

##### Check-sampling 100- and 200-foot Levels

Detailed company assay maps of the 100- and 200-foot levels were furnished the Bureau by the War Production Board. All samples were horizontal channels 5 feet in length and taken at 5-foot intervals.

Five areas on the 100-foot and three on the 200-foot level were selected by the Bureau for check sampling. In all, 64 samples were taken; 37 were channel samples taken from the 100-foot level. Of the remaining 27, which were taken on the 200-foot level, 13 were grab samples of ore left in chutes

and 14 were channel samples. All channel samples taken by the Bureau are of 5-foot length. The location and analyses of these samples are shown on figures 3 and 4, together with the company assays.

#### Vertical Raise From 100-foot Level to the Surface

Beginning 2.5 feet below the collar, samples from opposite walls of the raise from the 100-foot level to the surface were taken at identical vertical, five-foot intervals. In a few places, however, conditions made it necessary to omit a sample from one wall or the other. Each sample was a horizontal channel 5 feet long. Ninety-one samples were taken in the raise. The results of this sampling are shown on figure 6. A summary of analyses is tabulated below:

TABLE 2. - Grade of ore in raise.

From, feet	To, feet	Vertical distance, feet	Average grade, percent Cu	Cumulative from the level	
				Feet	Average grade, percent Cu
0 (on level floor)	43	43	2.17	43	2.17
43	98	55	0.31	98	1.13
98	133	35	1.70	133	1.28
133	223	90	0.51	223	0.97
223 (at raise collar)	260	37	0.22	260	0.86

#### Sampling Stopes Above 100-foot Level

Sampling was done in two stopes. The maximum height to which stoping was carried above the 100-foot level was about 80 feet. This height was reached in a stope about 100 feet in diameter, the back of which could not be reached without special stage construction. However, the top of the broken ore appeared to be largely material that had fallen from the back of the stope, and five grab samples of this material were taken. The point at which these samples were taken was north about 95 feet horizontally from the vertical raise. Three 10-foot channel samples were taken across the back of the south stope at an average horizontal distance from the vertical raise of 45 feet. The analyses for these samples are shown on figure 6.

#### Surface Sampling

Eight channel samples were taken at five widely scattered surface pits and cuts of leached and oxidized breccia. The analyses for these samples are shown on figure 5.

#### MINE WORKINGS

The Old Reliable mine has been opened on two levels 100 feet apart vertically. They are known as the 100-foot and the 200-foot levels. Access to each is by tunnel. A vertical raise extends from the 100-foot level to

the surface. These levels are connected by three vertical raises. Ore mined from the 200-foot level was hoisted through one of these to the 100-foot level tunnel.

Horizontal development on the 100-foot level consists of parallel chute drifts, for the most part on 20-foot centers at right angles to the direction of the tunnel, and a peripheral drift. In addition, near the tunnel portal are exploratory drifts that make acute angles with the tunnel.

In a number of the chute drifts the backs have been raised, timber and chutes placed, and shrinkage stoping done. The maximum height to which stopes have been carried is 80 feet above the level floor.

Six pillars separating stopes have been broken through, making a stope about 100 feet in diameter at the north end of the mine about 40 feet above the 100-foot level. Farther south, the pillar between "C" and "D" stopes was broken through about 40 feet above the level, making a stope 50 feet wide.

The 200-foot level has not been developed or stoped as extensively as the 100-foot level. Pillars were left above the chute drifts. Only three narrow shrinkage stopes have been started. The maximum height reached in stoping is about 35 feet.

Timber on the 100-foot level is in good condition. Chute-drift sets are tied with girts. In many places these are supported by posts between sets. Most are on 5-foot centers. Posts are 8 feet high. Some round timber has been used, but most of it is 8 by 8 inches square.

Access to the 200-foot level is by either the tunnel or the raise to the 100-foot level. The bottom of the raise is in the back of stope 1. Where stoping has been done, a back pillar has been left over the chute drift. The level makes an insignificant quantity of water.

#### METALLURGICAL TESTS

##### Inspiration Copper Company Tests

Preliminary small-scale laboratory tests made by the Inspiration Copper Co. by their continuous, single-stage, leach-float method extracted 96 percent of the copper with a consumption of 98 pounds of 60° Be<sup>1</sup> sulfuric acid per ton of ore. The concentrate averaged 42.41 percent copper. The tests were made by W. G. Scott, leaching plant superintendent.

The sample tested assayed 4.42 percent copper, about twice the indicated average grade of the ore; 2.01 percent of the copper occurred as oxide and 2.41 percent as sulfide. A qualitative microscopic analysis showed the predominant sulfide mineral to be chalcocite. Some chalcopyrite and covellite and traces of bornite and tetrahedrite were found. The oxidized copper minerals were malachite and chrysocolla.



University of Arizona Tests

A small-scale laboratory test of a sample from the same source as that above was made by E. H. Crabtree, Jr. He obtained an indicated 90.5 percent of the total copper by the Inspiration single-stage, leach-float method in a concentrate assaying 34.0 percent copper; 73.6 pounds of sulfuric acid and 9.0 pounds of lime were required per ton of ore.

The sample tested assayed 3.0 percent copper, of which 1.70 percent was oxidized. The sulfide copper occurred chiefly as chalcocite with minor amounts of bornite and chalcopyrite. Oxidized copper appeared to occur chiefly as malachite. As received by Crabtree, the sample weighed about 100 pounds, and was virtually all minus 2-inch. The manner in which and the places from which it was taken are not known.

Bureau of Mines Tests

Small-scale laboratory tests were run on two samples from the 100-foot level, one having been taken by the Bureau as representative of mixed oxide-sulfide ore and the other of predominantly sulfide ore.

The mixed-ore sample weighed 328 pounds. It assayed 3.65 percent copper, of which 1.85 percent occurred as oxidized minerals and 1.80 percent as sulfide. By the single-stage, leach-float method, 89.7 percent of the total copper was recovered in a cleaner concentrate assaying 44.3 percent copper. Addition of a cleaner tailing raised recovery to 91.5 percent in a concentrate assaying 39.4 percent copper. A two-stage application of the leach-float method recovered 90.2 percent of the total copper in a concentrate assaying 39.9 percent copper. Acid consumption was 84 pounds per ton of ore.

The sulfide ore sample weighed 100 pounds. It assayed 1.20 percent copper, of which only 0.20 percent occurred as oxide. At minus 65 mesh, flotation recovered 78.0 percent of the copper in a 34.0 percent copper rougher concentrate. An additional 4.4 percent of the total copper was recovered in an oxide copper concentrate that was floated after removal of a pyrite concentrate. The combined concentrate assayed 24.4 percent copper and represented an over-all recovery of 82.4 percent.

OPERATING CONDITIONS

Water supply. - There are no perennial streams in the area, but between November 1 and June 1, Copper Creek has an appreciable, if unpredictable, flow. In Copper Creek Canyon, about 1 mile from and about 100 feet above the mine workings, is a debris-filled reservoir which is said to have a capacity of 784,000 cubic feet. Sufficiently above the mine to permit gravity flow, and about 1 mile distant, is a spring reported to have a minimum flow of about 40 gallons per minute. About 2,000 feet north of and above the mine is the Globe shaft, now filled with water. The Henderson ranch, on which are three wells each 200 feet deep, is about three-quarters of a mile distant and about 500 feet below the mine. The wells are said to have an aggregate flow of about 50 gallons per minute.

The Childs-Aldwinkle property, which is nearby, milled 200 to 250 tons of ore per day for several years by utilizing these sources of water. Although the mine appears to have made little water, it is now flooded and is itself a potential source of water.

A reliable source of unlimited water is the San Pedro River. About 10 miles of pipeline would be required, and a static head of approximately 1,400 feet would have to be overcome to utilize this source.

Power. - Power could be obtained by constructing a transmission line from a high-tension hydroelectric-transmission line at a point near Mammoth.

Equipment. - An old-model, 285-horsepower, McIntosh-Seymour full-Diesel engine direct-connected to a Crocker-Wheeler 200-kilowatt, 2,300-volt generator with switchboard is installed at the property. It is said to be in good condition. There are a few buildings at the property, which are in fair condition. Some rail remains at the mine.