

STORY OF THE UNITED VERDE

According to the Phelps Dodge Corporation's Annual Report for 1951 there were then only a few months more life in the United Verde Mine which, at the time it was owned by Senator Clark was probably the richest mine that was ever worked under individual ownership. From the date of its purchase by William A. Clark in 1888 to the end of 1935, the mine had yielded 20,346,000 tons of ore, from which 1,979,105,400 pounds of copper have been extracted, together with 971,735 ounces of gold and 34,358,390 ounces of silver. The gross value of this output, after transportation, refining and marketing, was slightly more than \$350,000,000. This indicates an average grade of better than 17 dollar ore, and the United Verde Mine ranks among the "bonanza" mines of the State, as distinguished from the "low-grade porphyry" mines.

History*

The United Verde Mine, the chief mine of the Jerome or Verde Mining District, is at Jerome, in Yavapai County in north-central Arizona. Jerome is on the northeasterly slope of the Black Hills. The mean altitude is about 5,200 feet, and the smelter towns of Clarkdale and Clemenceau are in the valley about 2,000 feet lower. The Verde Tunnel and Smelter Railroad connects Jerome with Clarkdale, which is on a branch of the Santa Fe.

The first mining claim to be located in the Jerome District was that of Albert Sieber, a noted Scout, in 1877; he named it the Verde because of the green carbonate stain. However, Al Sieber located none of the original United Verde claims. The first claims in the original United Verde group were located on Feb. 17, 1876 as follows: Venture No. 1 North by John O'Dougherty, John P. Kelly and Josiah Riley; Venture No. 1 South by Edward O'Dougherty, John D. Boyd and A. B. O'Dougherty. By 1880 the district had acquired fame enough so that the Phelps Dodge Company sent Mr. Douglas to examine it. He reported that there was a little copper ore, but the long 175-mile wagon haul to the Santa Fe Railroad discouraged him from recommending exploitation. During these early days the United Verde Mine was worked on a small scale and shipments of high-grade gold-silver ore were made from the surface workings.

In the summer of 1882, Fred Thomas, a San Francisco engineer, obtained an option on the Wade Hampton and nine other claims and two millsites which comprised the original United Verde grant. The Wade Hampton had been located in 1877 by M. A. Ruffner and Angus McKennon. With the help of George Treadwell (who later developed the Great Treadwell Gold Mine in Alaska) Thomas organized the United Verde Copper Company. Its secretary was Eugene Jerome, for whom the growing town was named. The Governor of the Territory, F. A. Tritle, maintained an active interest in the company until Clark took over in 1889. Thomas built a fifty-ton furnace and turned out nearly \$800,000 worth of copper in the first year, and paid \$62,000 in dividends. Then the price of copper dropped and the mine had to shut down. Even 20 or 30 percent

* Rickard's "A History of American Mining"

Paper by Louis E. Reber Jr. in Arizona Bureau of Mines, Bull. # 145

Joralemon's "Romantic Copper"

H. V. Young, longtime employee of the old United Verde Copper Company and Phelps Dodge Corporation.

ore was of no value in such a remote camp when copper sold for less than 10 cents a pound.

Dr. Douglas visited the United Verde a second time in 1887, after the first little smelter had been in production and the railroad was then only 45 miles away. He was sufficiently impressed with it to enter into negotiations for an option. The terms he offered were opposed by Charles Lennig, the principal creditor of the United Verde, and in January 1888, the deal went on the rocks. In the same month W. A. Clark took his option.

In 1888, W. A. Clark came down from Butte with his smelter man Joe Giroux. Clark took a lease on the United Verde and bought it the following year. The development work he carried on soon proved that the 10 to 20 percent copper glance ore was two hundred feet wide and six or eight hundred feet long.

In 1894 Clark built a twenty-seven mile narrow-gage railway to connect with the new Santa Fe running south from Ash Fork to Prescott. With a new smelter and roast heaps like those at Rio Tinto to burn the sulphur out of the ore, the United Verde was soon one of the great copper mines. As the grade of ore dropped with increasing depth of the mine, new equipment and larger tonnage kept up the yield of copper and the profits. In the thirty years before he died, Senator Clark made \$60,000,000 out of the mine that Thomas had bought with so much difficulty for \$50,000.

The smelter which Clark built was unfortunately placed over the mine workings, and became endangered by the settling of the ground; moreover, the site was inadequate for the desired expansion of the plant. In 1912, the building of a new smelter was started in the valley, at Clarkdale. It was completed in 1915. At this time the Santa Fe built a branch of standard gage to this point. 1919 marked the beginning of open-pit operation. In 1931 the United Verde purchased the Verde Central and in 1935 the Phelps Dodge Corporation purchased the United Verde.

The development of the United Verde Extension Mine, beginning in 1899, makes a story in itself, and it has been very interestingly told by T. A. Rickard in his "History of American Mining". The data for this story was obtained from Ira Joralemon's "Romantic Copper". Joralemon was given credit by Rickard for having recommended the venture to Mr. James Douglas (the son of James Douglas of Copper Queen fame), and Major A. J. Pickrell.

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Just below the "Big Hole" (United Verde Mine) is a great fault. The rock east of this Jerome fault has slid down toward the Verde Canyon for half a mile. As a result, the limestone and lava that were laid down on an ancient erosion surface long after the orebody was formed are high up on top of the mountain west of the fault and of the United Verde, and far down toward the canyon east of them. Under these comparatively recent rocks east of the fault, the older schist that contains the ore is buried six hundred feet deep. The fault cut off the greatly enriched top of the United Verde orebody, together with the enclosing rock, and slid it two thousand feet down an equal amount to the east. Erosion then exposed the roots of the ore west of the fault. The former top of the orebody, now east of the fault, remained safely covered and hidden by the limestone and lava. The dip of the fault was to the east, under claims owned by George Hull, a Jerome Pioneer. In 1899, he formed the United Verde Extension Mining Co., and induced a New York broker, named Louis Whicher, to sell a lot of stock and to sink a shaft through the lava on the Little Daisy claim.

* Joralemon's "Romantic Copper".

In the next twelve years Whicher and his associates raised and spent nearly half a million dollars on the Verde Extension. Only a few streaks of ore resulted from the investment and the Little Daisy was finally shut down.

Among Verde Extension's stockholders was a fine old southern gentleman, Major Andrew Jackson Pickrell, who still had faith in the property, and persuaded his friend James S. Douglas to become interested in it. The latter, with his friend Geo. Tiner of Pittsburg, sent an engineer to examine the Verde Extension. It was recommended as a good gamble, and Douglas and Tiner started development. \$200,000 went into the ground with no results. They decided to risk another hundred thousand. Two years after they started work, a crosscut on the 1200 foot level found five feet of 45 percent copper glance, and they started to sink again.

In 1916, after a four-year campaign of development, the fourteen hundred level electrified the mining world by cutting 300 feet of 15 percent ore. It was the faulted top of the Great United Verde orebody and its richest spot. A vertical side-line agreement with the old company prevented a complicated apex suit that might have ruined the Verde Extension. Under Clark's very nose, Jim Douglas and his friends took out over 42 million dollars in dividends. The ore-body was finally exhausted in 1938.

Rickard paid the following glowing tribute to James S. Douglas for the part he played in this successful venture:

- * "Many of the richest mines in the world have been the cause of great financial loss to the public because they were over-valued on the stock exchange and their shares were bought at inflated prices. The "bonanzas" have been as much a source of regret as the "borrascas"; the genuine enterprises, by being grossly exaggerated, have done as much harm to the pockets of innocent folk as the calculated frauds. The U.V.X. has been free from anything of the kind; not much stock was sold at the high quotations, because the principal holders retained their stock even when, in 1916, it went up to \$52 per share. Mr. Douglas, I may add, sold none of his stock until 1928, when he sold some, most of which he bought back later. The whole business has been clean from start to finish; it has justified the claim of Agricola that "mining is a calling of peculiar dignity."

Ore Mineralization **

*** "The United Verde ore zone, as developed in the United Verde Mine, consisted of a very irregular pipelike body of massive sulphide and rock. In plan the mineralized zone ranged from more than 500,000 square feet to less than 300,000 square feet, with an average of near 400,000 square feet. The massive sulphide itself had an average cross section of approximately 250,000 square feet. Pyrite, quartz, carbonate minerals, and some sphalerite (locally in significant quantity) formed the sulphide gangue. Black chlorite rock (black schist), with some quartz porphyry, is the predominant rock gangue. The mineralization is very clearly of the replacement type. Although

* Rickard's "History of American Mining", p. 379.

** L. E. Reber's Article in Arizona Bureau of Mines Bull. # 145.

*** Paul Yates

other sulphides were present, the copper content of the ore as a rule depended on the abundance of chalcopyrite with about one-seventh of the volume of the mineralized zone as commercial copper ore."

The ore zone in the U.V.X. Mine probably represents a segment from over 2,000 feet above the top of that exposed in the United Verde Mine. Probably a large part of the chalcocite ore was a fairly good grade before enrichment. As in the highest levels in the United Verde, there was probably a smaller-than-average area of mineralization, with a higher-than-average proportion of chalcopyrite. The intensity and extent of the secondary enrichment in the U. V. X. Mine formed an almost unique deposit of chalcocite that placed the mine in the front rank of high-grade copper mines.

Mining, Milling* and Smelting

Several methods of underground stoping have been employed in the United Verde mine: horizontal cut-and-fill, incline cut-and-fill; square-set and fill, shrinkage and fill, and glory hole. In 1918, open-pit operation was started, and was completed in 1940. Since then, underground mining was employed chiefly in removing the pillars left in the mine.

The system of ventilation was complete and modern and has been fully described by Tally in his paper on mine fires. Owing to several expensive mine fires it was found necessary to devote much attention to this subject. One fire, on the 400-foot level, burned for over twenty years. Mining in the fire zone was conducted under the plenum system, by which air under pressure is introduced into the workings. As far as possible the fires were isolated by bulkheads. In order to reach the burning sulphides, steam shovels were introduced in 1918 to remove 15,977,807 cubic yards of overburden, which permitted the mining down to the 600-foot level of some 9,708,923 tons of ore said to average 3.47 percent copper, 2.07 ounces silver and .07 ounces gold.

Most of the copper-bearing mine water was formed during the progress of natural surface drainage through the oxidized zone and through old filled stopes above the 500-foot level. Before and during early Pit operations these waters were the source of profitable copper precipitate. All ore hoisted through the No. 5 shaft was dumped into storage bins above the 1000-foot level. Trains of 40-ton ore cars were hauled an average distance of 8,900 feet through the Hopewell tunnel to a crushing plant which was originally at the tunnel's mouth but later moved to Clarkdale near the new smelter.

A concentrator, designed by H. Kenyon Burch and United Verde's chief engineer J. E. Lanning, was constructed near the crushing plant, and began operations in 1927, handling 1000 tons of ore per day. The general location of the concentrating plant was such that tailings could be delivered by gravity through a pipeline to a very desirable location for tailings disposal. The plant was also located favorably with respect to all services such as railroad, water, power and the like. The Verde Tunnel & Smelter Railroad, owned by the corporation, hauled the ore from the Hopewell Tunnel, a distance of six miles to the crushing plant. The water supply had its source in springs, artesian wells, and a tunnel under the Verde River. Power was available from the smelter power plant, the generators therein being operated on waste-heat steam from reverberatory furnaces. The smelter power system, however, is interconnected with the Arizona Power Co.

* Milling method described by Kuzell & Barker in U.S.B.M. Information Circular 6343.

The primary breaking was done by 48" x 36" jaw crushers, followed by 48" vertical disk crushers and 56" x 24" rolls crushing to minus $\frac{1}{4}$ " size. The maximum size piece of ore received at the crushing plant was about 17 inches. The product of the Jaw crushers was minus 4-inch size, and of the disk crushers minus 1-inch size. Conveyors and elevators were used throughout the plant for transporting the ore to each machine.

As initially constructed, the mill consisted of two units consisting of 8' x 12' ball mills and mechanical flotation machines. Hunt flotation machines were also used experimentally. Auxiliary thickeners, classifiers and pumps were employed in each unit of the plant, and the capacity of the plant varied from 1,000 to 1,600 tons per day, depending upon the degree of grinding required.

The ore treated usually contained about three percent copper, and consisted chiefly of the schist ore, and at times the massive. Lime was used in the mill to neutralize deleterious soluble ore salts and for pyrite depression. Although an extraction of over 91 percent of the copper was obtained, constant experimenting and research were carried on by a competent metallurgical staff.

The concentrate, after filtering, and containing about 15 per cent copper, 5 percent silica and 30 percent iron, was conveyed to the roaster-charging conveyor system of the smelter. The latter, built at Clarkdale in 1915, had a capacity of 5,000 tons of ore a day. It consisted of a crushing plant and sampler; a calcining plant of 21½ foot Wedge furnaces with dust chambers and a Cottrell precipitating plant, six 100 foot reverberatory furnaces; four 48 x 320 inch blast furnaces; seven stands with eight shells of Great Falls converters; and necessary pumps and compressors. The smelter has been described by L. A. Parsons in Mining & Scientific Press Oct. 16, 1920 and June 25, 1921.

Conclusion

The United Verde Mine has produced over two and three quarter billion pounds of copper, which with gold and silver values, was worth about 475 millions of dollars. The U.V.X. Mine has produced over three-quarters of a billion pounds of copper, which, with gold and silver values, was worth over 125 millions of dollars. Of course, most of this grand total of six hundred million dollars was turned back to the state and nation in the form of wages, supplies and taxes. However, probably one hundred and twenty-five million dollars was the profit returned to the investors, or a little over 3½ cents per pound of copper produced. For the seventy years of production, this was a return of less than two million dollars per year. With a probable capital expenditure of twenty million dollars for plant and development, the average return for the investment was less than ten percent, which can be considered only a fair return on what at many times must have been a hazardous proposition.

Arizona Department of Mineral Resources

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