

Chapter 1

THE COPPER ORES OF AJO, ARIZONA

Discovery to World War II

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Paint to Direct Shipping Ore:

Ajo, Arizona, sits in western Pima County, 128 miles by road west of Tucson and 37 miles north of the international boundary with Mexico. Today's Ajo must be distinguished from the original town ("Old Ajo") that is located where the open pit copper mine sits today. The name "Ajo" is Spanish for garlic, but the origin of the name actually came from the Tohono O'odham (Papago) word for paint: *au'auho*. The brightly colored oxides of copper ores had been used as part of O'odham custom for body paint. Col. Andrew B. Gray, leader of the boundary survey that defined the international boundary with Mexico after the Gadsden Purchase in 1854, reported that the Sierra de Aja derived its name from the copper oxides "which the Indians have made use of to paint (Ajo) themselves." The Indian origin was soon forgotten and the term transferred to both the local wild lily, the valley where it grows and the town. The bulb of the Ajo lily has a perceptible onion flavor and if it had a Spanish origin it would probably have been called *cebolla*, the word for onion.

The first prospecting of the area by Europeans had probably discovered the Old Ajo mineral deposit by the 1700s but it didn't attract much attention. The workings observed by American trapper Tom Childs, Sr., in 1847, described trenches that had been cut and some excavation had been started down the veins in the richest mineralized zones using notched mesquite tree logs for ladders and ore buckets made of rawhide. The real interest in the area came as a result of the Gadsden Purchase.

After the war with Mexico had been settled by the Treaty of Guadalupe Hidalgo in 1848, it was discovered that the boundary was described based on inaccurate maps leaving the Mesilla Valley of New Mexico in limbo. Probably more important, however, was that the United States needed more land to the south of the Gila River for a southern railroad line. Therefore, in July of 1853, James Gadsden, the United States Minister to Mexico, offered to purchase the land south of the Gila River within pre-

sent-day Arizona, westward to the Colorado River at a point about 20 miles below the junction of the Gila and Colorado Rivers. After the Gadsden Purchase (also called the Treaty of Mesilla) was ratified on April 25, 1854, the United States Congress added these new lands to the Territory of New Mexico.

Colonel Gray was appointed to survey both the new international boundary and a railroad route in the vicinity of the 32nd Parallel. In 1854, when the party was in Sonoita, Sonora, Peter R. Brady, Sr., a member of the survey party, was sent to Old Ajo to obtain mineral specimens, which were in turn taken to San Francisco. Following up in the summer of 1854, Edward E. Dunbar, a pioneer resident of San Francisco, asked a group of adventurers and some of his associates to organize a company, to be called the Arizona Mining and Trading Company, to prospect in northern Mexico and in the newly acquired lands of the United States. This group left San Francisco in early October, 1854, on a steamer to Los Angeles and then overland to Old Ajo. After an initial examination, some volunteers stayed at the deposit and the rest went into Mexico. The examination must have been encouraging as Dunbar quickly went back to San Francisco to incorporate the company leaving the mine in the hands of Brady and local workers (mostly Indians from local and Sonoran tribes).

Brady's first shipment of ore was in 1856, when ten tons was transported, probably by L.J.F. Jaeger's pack trains to Yuma Crossing, then by barge or small river boat to the mouth of the Colorado River at the Gulf of California, then onto a small sailing ship bound for San Francisco. At San Francisco, the ore was transferred to a clipper ship for the trek around Cape Horn to the nearest copper smelter at Swansea, Wales. With such an infrastructure, it can't be surprising that the Arizona Mining and Trading Company had failed by 1859 and the property was left in the hands of a caretaker.

The Ajo Mine is Born:

The real birth of the mines at Ajo came as a result of two major factors. First, the Southern Pacific Railroad, by April 1, 1879, had progressed eastward from Los Angeles to Gila Bend (only 42 miles to the north) eliminating the need for long hauls by wagon, and second, copper became a new commodity in the world's economy when the telephone was introduced in 1876 and by 1889 copper was necessary for copper wire to conduct electricity. As for the Ajo deposit, Tom Childs, Sr., returned to Ajo in 1884 with his son Tom Jr., and W.M. Jacobs to begin a cattle business. They staked their first mining claims in 1887 that constituted most of the Old Ajo group of mines.

By 1896, the potential mineral wealth of the Ajo area had been advertized in the money centers of the eastern United States and A. J. Shotwell, a promoter of a dubious reputation, decided to make Ajo the base of his operations. In 1896, Shotwell persuaded A. W. Hopper to organize the St. Louis Copper Company. Shotwell hoped that by leasing one claim to the St. Louis Copper Company that he would obtain enough money to purchase five claims. When the St. Louis Copper Company ceased operations, Shotwell was not discouraged and organized the Rescue Copper Company. The next "participant" was John R. Boddie, a trusted and respected traveling dry goods salesman. Based on Shotwell's representations, Boddie persuaded many of his customers and fellow clothing merchants to invest in the mine and a number went to the Old Ajo Camp in April, 1900. The camp at that time was in a little basin on the east side of the Little Ajo Mountains surrounded by the brilliant iron and copper stained rocks of Copper Mountain.

Boddie and associates purchased four claims from Childs, Jacobs and others and on May 1, 1890, organized the Cornelia Copper Company (named in memory of Boddie's first wife). The initial results from shaft sinking proved to be disappointing and instead of the "simple and easy" work that Boddie had anticipated, he was forced to admit that "it began to dawn upon us that we were out of our element in the mining game."

When the Cornelia Copper Company ceased operations, Shotwell proceeded to organize a fourth company, the Shotwell Tri-Mountain Copper Company and in 1906 associated with Prof. Fred L. McGahan to take advantage of his vacuum smelting process. McGahan's invention was supposed to melt the ore and then draw off pure gold, silver, copper, and

other metals through separate spigots. Shotwell, perhaps displaying the "insight" that drew him to McGahan, then began to play with spiritualism and succumbed to the devices of a notorious lady medium. As a result, his financial credit was ruined and both he and McGahan disappeared.

After an arbitration in 1906, what was left of the Cornelia Copper Company absorbed the Rescue Copper Company and bought all three of the iron and copper-stained Old Ajo hills owned by the Cornelia Copper Company. Further consolidation took place in June, 1907, when the seven claims of the Ajo Mountain Copper Mountain Mines Company were purchased by the Randall Ore Reduction Company which was then under the control of Sam Clark and M.G. Levy. The initial Randall operations were successful in producing 2,500 to 3,000 pounds of copper concentrates per day which assayed from 35 to 45% copper. The concentrates were hauled by freight teams to Gila Bend and then by railroad to the Phelps Dodge smelter at Douglas. The apparent Randall success spurred the Cornelia Copper Company to reorganize on September 10, 1909, as the New Cornelia Copper Company with 1,200,000 shares. Hope faded quickly however, after close examination of the properties by three separate optionees during the winter of 1909-1910. At the time, the greatest engineers in this country all joined in the verdict: there was no ore in Ajo except for a shallow deposit of copper carbonate. Boddie's directors gave him authority to dispose of their properties.

Not everyone was discouraged and in the fall of 1909, Sam Clark met Ira B. Joralemon, then the chief geologist of the Calumet and Arizona Mining Company, who had recently begun the bulk mining at Bisbee under John Campbell Greenway. Clark took Joralemon to Ajo where he became acquainted with the men doing the drilling for all three groups. In the end, however, Joralemon didn't follow up until two years later when Greenway told him that he was serious about a steam shovel copper mine. Joralemon thereupon returned to Ajo and was convinced that the possibility existed for a great mine. There were some drawbacks—the ores were very different from other porphyry ores, the copper near the surface had oxidized in place to a carbonate, and the sulphides below it were not a soft, enriched chalcocite ore, but were intensely hard. In April of 1911, Calumet and Arizona decided to attempt to acquire rights to the mineral lands around Old Ajo and obtained a two-year option from Boddie. The area optioned included the three hills and stock would be

issued as money was spent for development. At this same time, the Calumet and Arizona also took a six-month option on the adjoining claims of the Randall Ore Reduction Company.

In 1912, James P. Gaskill brought the Randall property to the attention of Walter M. Briggs. When Briggs approached Randall he was told about the Calumet and Arizona option. When the option expired, however, Gaskill purchased the claims for cash on behalf of his father-in-law, and the Ajo Copper Company took over on July 1, 1912.

The exploration by Calumet and Arizona was turned over to Joralemon and Gene Whitely. By 1913, new diamond drilling by E.J. Longyear Company on the east side of Copper Mountain together with test pitting to check the drilling results, showed that the silicified iron and copper stained hills were the outcrops of a great low-grade copper orebody. The oxide and the sulphide ores were remarkably uniform in grade and since the ore body outcropped at the surface, the usual high initial stripping costs were avoided. Calumet and Arizona was thus convinced to exercise its option to purchase the capital stock of the New Cornelia Copper Company, and at the annual meeting on December 19, 1913, the new Board of Directors of the New Cornelia became identical to that of the Calumet and Arizona.

The man behind the efforts at Calumet and Arizona's efforts, and who was destined to become the architect of Ajo's success was John C. Greenway, who provided the general direction from his office in Bisbee. Greenway, a veteran of the fabled "Cowboy Cavalry," the Rough Riders of the Spanish American War, was a 1895 graduate of Yale University's Sheffield Scientific School and was a member of the All America college baseball team. He first distinguished himself as the general superintendent of Oliver Iron Mining Company's Canisteo District in the western Mesabi Range and is credited with inventing the turbo log washer to concentrate low grade iron ores. In July, 1910, he traveled to Bisbee, Arizona, to become the general manager for Calumet and Arizona. At the time of Calumet and Arizona's takeover at Ajo he was 41 years old.

Another result of the 1912-13 drilling was the disclosure that the ore zone extended from the New Cornelia property into the ground controlled by the reorganized Ajo Consolidated Copper Company. On July 28, 1917, the Calumet and Arizona Board of Directors decided to purchase the mining claims

that were extensions of their ore bodies. The Ajo Consolidated ground was thought to contain 21 million tons of ore averaging 1.55% mainly sulphide copper. Ajo's initial asking price was considered outrageous, but the parties eventually arrived at an agreement (probably due in no small part to the fact that during the negotiations, Gaskill's attractive sister married Mike Curley, New Cornelia's general superintendent). The terms of the purchase included 200,000 shares of New Cornelia stock and notes for \$500,000 due in six to 12 months with 4% interest. As a part of this same effort, the New Cornelia Company also acquired the Childs group of claims and another block north of the original holdings upon which the existing townsite, plants, and tailings dumps are located.

During the process of this land acquisition, the Calumet and Arizona also began to tackle a technical problem. The carbonate ores would require the development of a new process for treatment. An experimental group was organized under Dr. Louis D. Ricketts. The first important laboratory tests were made in early July, 1912, at the Calumet and Arizona smelter at Douglas under the direction of Stuart Croasdale assisted by Henry A. Tobelmann and James A. Potter. The effort was to test the practicability of leaching oxidized ores with a weak solution of sulfuric acid. Croasdale's tests showed that more than 80% of the copper in carbonate ores, crushed to no finer than one-half inch, could be leached out in from 36 to 72 hours. Next, it was decided to try electrolytic deposition of copper from the leach solutions. After the lab work was completed, an experimental staff was transferred to Ajo in August, 1914, and a one-ton-per-day leaching plant erected. The testing continued with a 40-ton plant and a final report recommending a full-scale operation of 5,000 tons per day was submitted on January 4, 1916, signed by W. H. Morse, Tobelmann and Potter. The original leach solution was to contain 3% sulphuric acid and the copper content, after leaching, was not to be in excess of 3%. Greenway and Ricketts reported to the Calumet and Arizona Board of Directors in 1916 that copper could be produced at eight and one-half cents per pound against a current selling price of 14 cents and recommended an appropriation of \$4.2 million. The Board approved the operation and construction of the large leaching plant and related facilities were begun in March, 1916.

Ajo Enters a New Era:

The construction of the new facilities began the modern era for Ajo. Old Ajo would have to give way. It was never much of a town the few inhabitants had normally lived in tents or rude shacks made of rock and clay. The houses for single men (the Calumet and Arizona did not encourage wives because of the poor living conditions) were built of ocotillo branches tied together with bailing wire and plastered with adobe. General Superintendent Mike Curley used one of these huts until it was blown away in a dust storm prompting the construction of an adobe house for him. In 1915, for the five married men, "home" was two small tents linked together end to end with a small space between to serve as a bathroom (without any "modern" conveniences). Kerosene lamps were used for lighting and wood stoves were used for cooking and heating. Cooking was no small task; iced vegetables, fruits and some meat were shipped in twice monthly from Los Angeles, and normal fare consisted almost entirely of canned goods.

The "New" Ajo began in 1916 as a planned community. Greenway had earlier developed a model community while he was in Minnesota and the New Ajo presented him with the opportunity of developing a town and the related industrial plants at the same time. Greenway engaged the architectural firm he had known in Minnesota, William M. Kenyon and Maurice F. Maine, who spread the project around the entrance to the basin in whose center was Copper Mountain. A central plaza would form a core to include the railroad station and the commercial buildings. The company offices were to be situated on a low ridge midway between the processing plant and the center of the new town. The residential areas reflected the racial segregation of the times; the "American Townsite" was placed around the central plaza, while the "Mexican Townsite" was separated from it by low hills and a smaller "Indian Townsite" was further to the west. All of the houses were to be constructed of hollow tile, plastered on the inside and out and serviced by electricity, water and sewer systems.

By the end of 1916, ten houses had been completed in the Mexican Townsite and the central plaza was nearing completion around a grassy mall with palm trees that had already been planted. As originally conceived, the plaza was to be made up of arcaded structures on three sides of the plaza, measuring 360 by 200 feet, which was to be open on the west side (the planned commercial buildings on the north

side were not constructed). An impressive railroad depot made up the east side of the plaza and was completed in early 1917. The south side of the plaza was to be the business block which would house all of the basic business needs of the community and would provide some of the recreational facilities. By April of 1916, there were about 2,500 people living in the Ajo area.

The operation of the new camp also reflected a concern for the workers. Company stores had historically been a source of ill will in mining camps and the New Cornelia Copper Company decided that it would operate a general store on a cooperative basis. Employees who had made purchases at the store would receive a rebate on their purchases if the store made a profit. This co-op store, in the business block, opened in April, 1917, and when Christmas arrived in 1917, there was a disbursement of \$12,052.60. Employees became boosters of the co-op store but other competitive stores of all types could also be found in the area.

The "new" Ajo was not the only housing. Sam Clark laid out a townsite he called Clarkston southeast of the Ajo townsite and east of the leaching plant. By 1916, Clarkston developed into the trade center; it was also the center of amusement facilities that included gambling and frequent brawls. A fire destroyed much of Clarkston in 1917 and a population of perhaps 1,200 began to move elsewhere. In addition, Matthew E. Gibson laid out the townsite of Gibson northwest of Ajo. Gibson had its own utility company.

Water for both the mine facilities and the town was critical. It was originally decided that there might be a chance for the discovery of water under the lava beds that covered the desert so Greenway authorized the drilling of a deep well six miles north of Old Ajo. A large oil well drill rig was hauled in by mule train from Gila Bend and three wells were drilled in early 1913. The effort was successful and significant quantities of water were found in two holes. Well No. 1, where water was encountered at a depth of 645 feet, was test pumped at a rate of 197 gallons per minute for 17 days without any effect on the water table. A small oil-fired power plant was soon built near the water wells to provide electric power for water development, the town and the leaching plant.

As finally constructed, water was pumped from a sump pump, up an eight-inch column and delivered to a ten-inch water main that transported it to a 500,000 gallon steel reservoir. Water was then dis-

tributed by gravity to the plant area and for domestic use. When it was completed, the Ajo Power Plant supplied 6,600 volts of alternating current.

The next job was the construction of the railroad from the main line of the Southern Pacific at Gila Bend to the new mining operations. Construction began on July 29, 1915. Grading was done with mule-powered standard Fresno Scrapers under the supervision of William Skausen with a reported 500 men on the payroll. Scheduled operations of the new TC & GB Railroad began on February 20, 1916, with a trip of two hours and ten minutes required to travel from Gila Bend to Cornelia (the new depot at Ajo). Cornelia station became "Ajo" in December, 1916.

Mine construction began with the arrival, during 1916, of three 100-ton Osgood steam shovels, five 70-ton steam-operated switching locomotives and fifty 20-yard side dump railroad cars. First, an excavation was made through a hill close to the coarse crushing plant which was then connected to the mine by a standard gauge single railroad track. A double track of some 4,100 feet in length was installed to serve the steam shovels on each side of Copper Mountain. It was completed on December 31, 1916, two weeks after the first steam shovel used to strip the slight overburden had been placed in operation.

The New Cornelia Copper Company open pit copper mine became the first steam shovel enterprise in Arizona. It started in a large basin, which was about one mile wide by about one and a half miles long. The northeast part of the basin was a smoothly cut pediment which widened to the north to give an excellent townsite. The outstanding topographic features of the surface overlying the orebody at the beginning of the mining operations were the three hills which had very precipitous slopes. As materials and equipment became available during 1916, the building of the leaching plant and its related facilities was pushed. During 1916, the average number of men employed was 694 with a maximum of 1,268 working on November 22.

The first efforts at mining presented a number of problems caused mainly by the lack of experience in mining Ajo's rock formations. Some drilling was done with light churn drills while another method was to excavate short tunnels from the faces of the cuts made in the three hills by the steam shovels. The tunnels were loaded with explosives and blasted. Lumps of rock had to be broken by secondary blasting. Ore was loaded into the side dump railroad cars

by three steam shovels on their own set of tracks. The steam shovels were served by five steam locomotives, each of which pulled five side-dump railroad cars and hauled the ore approximately one mile.

For the actual construction of the leaching plant, Greenway and Curley turned to Hans A. Nelson, another trusted friend from the Oliver Iron Mining Company. Nelson had come to America from Norway in 1892 as a bricklayer and had found work with Greenway in Michigan. He had been the construction manager for Oliver Iron and the town Greenway had built for his employees. Nelson left for Ajo on January 1, 1916, to take up the new challenge.

The coarse crushing plant consisted of one large No. 24 gyratory crusher and four No. 8 gyratory crushers. From the railroad cars the ore was dumped directly into the bowl of the No. 24 crusher and its product discharged directly into the No. 8 crushers. The ore would be crushed to minus four inch and conveyed to the fine crushing plant ore storage bin. It was then drawn and conveyed on four conveyor belts to the fine crushing plant to four units of three Symons 48-inch vertical shaft disc crushers. This process first reduced the ore to minus one inch and then two other disc crushers, operating in parallel, crushed the ore to approximately 3 to 4 inch size. Finally, this oxide ore was sampled and conveyed to the leaching tanks. The leaching plant would have 11 lead-lined leaching tanks, each 88 feet square by 15 feet deep and holding 5,000 tons of ore. A million dollars worth of lead was used in lining these tanks.

Charging of the leaching tanks was done by a spreader bridge. A belt conveyor received the crushed ore and a tripper car spread the ore in even layers. The ore was then leached for eight days using a countercurrent solution flow system and upward percolation. The principal solvent used was dilute (2.86% to 3%) sulphuric acid leaching solution. From the tank with the newest charge the solution issued practically neutral and contained about 3% copper. When a newly charged leaching tank was put into the circuit, the solution that remained in the oldest tank (that is, after eight days) was drained and sent to the sulphur dioxide reduction towers. After the charge was washed, the tailings (the charged carbonate ore from which the copper had been dissolved) were removed from the tank by a Hulett unloader and dumped about one mile to the north and east of the leaching plant.

During the experimental work the control of the ferrous iron proved to be one of the hardest problems to

solve. In order to reduce ferric iron it was decided to make use of the cheaply mined, abundant iron pyrite from the Calumet and Arizona operations in Bisbee. The crushed pyrite ore was desulphurized to 7.7% sulphur in four Wedge roasters and the resulting calcine shipped to the Douglas smelter. The sulphur dioxide gas was first cleaned of dust in a Cottrell electrostatic precipitator and introduced into a large cooling chamber. The gas was then divided equally between two sulphur dioxide towers and a "neutral" advance solution distributed over the tops of the towers. At the bottom of the towers, the solution flowed into a sump and was then pumped to the next pair of towers and then to a settling tank before going to the tank house. The purpose of the tank was to settle out slimes and to obtain the benefit of the added reduction of ferric iron which was found to take place in the neutral or slightly acidic solution. It was important that the solution that entered the tank house be practically free of ferric iron because ferric iron was a solvent for freshly precipitated copper.

The tank house was a structural steel building (166 feet wide by 280 feet long) and was used for electrolytic deposition of copper. The 152 electrolytic tanks were lined with chemical lead. Each tank would have 84 lead anodes (about 215 pounds each) and 77 sheet copper cathode starting sheets (15 to 18 pounds each). The properly prepared solution from the leaching plant would then be circulated through the electrolytic cells. After the resulting electrostatic deposition of copper after 14 to 16 days, the finished cathodes weighed 130 to 140 pounds with a copper content that varied from 99.15 to 99.85%. The electric current for the deposition of the copper onto the cathodes was supplied by two of the three motor generator sets in the power house. A total capacity of 120,000 pounds of electrolytic copper could be deposited per day.

Approximately 109 gallons per minute of discarded solution, containing some copper along with the remaining dissolved impurities, was discharged into concrete precipitation launders which were loaded with scrap iron. The copper precipitated as "cement copper," part of which was absorbed into an acid solution and returned to the electrolytic plant. The cement copper that was not absorbed was dried and shipped to the smelter at Douglas. At the beginning of operations, the amount of "cement copper" produced was about 25 % of the total copper from the leaching operations. The discarded solution, from which the cement copper had been removed, was sent to the desert.

On May 1, 1917, the work of spreading carbonate ores in even layers in the leaching tanks began and gradually each part of the plant was successfully placed in operation. Five years of hope and anticipation were culminated on June 18, 1917, when the first shipment of electrolytic copper left Ajo. This product and related scrap, the first electrolytic copper ever made in Arizona, had required \$6 million to produce. It was shipped to the Raritan Copper Works at Perth Amboy, New Jersey.

The "new" Ajo was completed in July, 1917, when the New Cornelia Copper Company acquired the Ajo Consolidated Copper Company. Greenway's monumental task of opening the mine had been completed and in October he tendered his resignation to enter service with the United States Army in France. The company granted him an indefinite leave of absence and placed Dr. Ricketts in charge. Greenway's good friend, Irish-born Mike Curley, who had come to Arizona with Greenway from Michigan, oversaw the day-to-day operations.

The Mine Comes to Life; the Greenway Era

During 1918, the first dividend of 25 cents per share of issued stock was distributed. Wartime controls fixed copper prices at 23 cents per pound until July 1, 1918, but an increase to 26 cents was thereafter allowed to cover increased freight charges and other costs. The Armistice on November 11 brought both bad and good news. The peacetime demand for copper had dried up, requiring a reduction to 60% of capacity on February 1, 1919. On August, 12, 1919, now Major of Engineers John Greenway, having been released from active duty with a Distinguished Service Cross, returned to Bisbee and resumed his duties as general manager. Greenway joined the Army reserves and was appointed a brigadier general in December, 1922, a title by which he was most frequently known.

In the first year of operation, sulphide ores were uncovered in the open pit mine and an appropriation of \$160,000 was made for the construction of a 500-ton-per-day floatation test mill. The mill was completed in August of 1919.

Greenway went about continuing his efforts to civilize the remote desert location. A new hospital for the employees was built on the ridge that divided the American and Mexican Townsites. The company spent \$75,000 for the building and its equipment and although some fees were deducted from wages, the hospital was operated at a monetary loss.

Schools were also necessary. The first school, an elementary school, had been started in 1912 beginning in a one-room adobe building and then in a tent house with a tin roof. The school was moved in 1917. During 1918-19, a large school building was built at the end of Lomita Avenue that continued the long axis of the central plaza to the east on a site donated by the New Cornelia Copper Company. The building, now the Curley School, was designed by Leslie J. Mahoney of the Phoenix architectural firm of Leshner and Kibby. More than \$175,000 was spent on the building and its furnishing.

These efforts showed an extraordinary faith in the copper business; after the war, copper users bought copper for immediate requirements only. In November, 1919, however, some interest in purchasing copper returned resulting in record sales in December for 1920 delivery. The January, 1920, operating basis was three million pounds per month, but market conditions waned during the year and production was cut to two and a half million pounds for November and then to two million pounds in December. The 1920 production included 1.73 million tons of carbonate ore delivered to the coarse crushing plant and 4,566 tons were mined for the experimental flotation mill. During May, a record of 3,613,985 pounds of electrolytic copper was produced, over 400,000 pounds more than the previous high. Finally, another record of sorts was set in 1920, as the New Cornelia Copper Company paid 40% of the state and county taxes paid in Pima County, and the registered voters in the Ajo precinct was 2,336.

Curtailed production continued in 1921 at two million pounds per month, but by the end of the first quarter the general business conditions made it necessary to further curtail operations or shut down entirely. Shutting down was not an option because of potential damage to the processing plant and the difficulty in bringing back skilled employees to such a remote mining camp. It was thus decided to continue to operate on the smallest economic scale with the number of employees fixed at 305. This meant that 200 men would be laid off. The savings turned out to be more than expected as the smaller production rate made it possible to double the leaching time resulting in greater recoveries. Copper prices recovered in mid-1922 as surpluses were gradually reduced and Ajo's curtailed rate of 1.6 million pounds per month was doubled in August. Management determined that the carbonate ore reserves would permit the operation of the leaching plant for only 32 years and therefore plans were

developed for the construction of a flotation mill with a capacity of treating 5,000 tons of sulphide ores per day. The Board of Directors approved an appropriation of \$4 million to cover the cost of construction and work started in October.

It was also during 1922 that the water supply was improved. The water from the "Old Shaft" at Well No. 1 had been pumped for five years with no indication that the original water level had been lowered. The flotation mill would require additional water and the man way of the old shaft had no room. A new shaft was therefore started during May, 135 feet east of the original shaft. Underground pumping stations were cut in the lava formations to the north and south of the shaft along with two other stations on the centerline to the original shaft which were connected at the pump station level by a drift. The combined pumping capacity of the two wells was 74,600 gallons per minute which discharged into a common water column extending up the pipe compartment of the new shaft and delivered water to a 20-inch diameter water transmission line to the water cooling pond located near the power house. Two 1,800 gpm centrifugal pumps were installed to pump water from the cooling pond to the storage reservoir for the concentrator and two 600 gpm centrifugal pumps directed water directly from the weir box at the cooling pond to the clean water tank.

Demand for copper continued during the first three months of 1923 and the price for copper rose to 17.37 cents per pound in March. The result was another cycle of overproduction from U.S., South American and African mines and a price drop to 12.5 cents per pound in December. New Cornelia was undeterred and continued the construction of its concentrator. Five new steam boilers were installed in the extended powerhouse, and the water cooling pond was extended 388 feet. The big event of the year, however, occurred on November 4, when Greenway married Isabella Selmes Ferguson. Isabella was a widow with two small children and it must have been a major change of life for lifelong bachelor Greenway. The Greenway's home in Ajo, a modest sized Mexican hacienda style, designed by George Washington Smith of Montecito, California, continues today to be an Ajo landmark.

The first unit of the new concentrator would go on line on January 8, 1924, but the mine was getting a running start with a throughput of 6,417 tons per day during November and December of 1923, 28% in excess of the plant's rated capacity of 5,000 tons per day. The design of the new concentrator and its related facilities was complicated by the fact that

the open pit mine would be producing two distinct ores that would require approximately the same preliminary crushing steps. It was finally decided to keep the preliminary crushing plants separate. First, the sulphide ore was dumped into a receiving hopper at the coarse crushing plant 240 tons at a time. Under this hopper a pan conveyor, eight feet wide by 75 feet long, delivered the ore to a grizzly that diverted the larger pieces of ore into the bowl of a McCully 54-inch gyratory crusher. The undersize and the crusher product (approximately 6-inch material) dropped onto a conveyor belt to be delivered to the intermediate crushing plant's 5,000 ton bin.

The intermediate crushing plant consisted of four units, each consisting of pan feeders to feed ore to a single conveyor belt which delivered the ore to a grizzly and passing on the coarse pieces to the crusher. Each of the four units in this crushing plant had one Gates No. 8, Style K gyratory crusher, that reduced the ore to approximately three inches and delivered it (together with the undersize from the grizzly) to a corresponding unit in the fine crushing plant. The four units of the fine crushing plant consisted of one 48-inch Symons horizontal shaft disc crusher and one set of 78-inch by 25-inch Traylor rolls. Each conveyor belt from the intermediate crushing plant discharged its product to a grizzly. The oversize from this grizzly was the feed for the Symons disc crusher, which reduced the ore to approximately 12 inches. This product, together with the undersize from the grizzly, was delivered to another grizzly with the oversize to the Traylor rolls. Each set of rolls operated in closed circuit with its grizzly. The undersize from the grizzly was delivered to the mill storage bin at the concentrator.

The concentrator building proper covered an area of approximately 190 by 380 feet. The suspension-bunker mill storage bin was 300 feet long and had a capacity of 10,000 tons. The concentrator had five sections, each with an estimated capacity of 1,000 tons per 24 hours, and served by six hoppers and two conveyor belts which discharged into a common hopper. From here a conveyor belt (equipped with a weightometer) delivered the ore to rod mills. The equipment for each grinding section of the concentrator consisted of two primary Marcy rod mills (six feet in diameter by 12 feet long, nominal size) and two secondary Marcy rod mills. The rod mills were lined with hardened iron.

Each rod mill delivered its product to a six- by 23-foot Dorr duplex rake classifier. The oversize material was returned to the primary rod mills or sent to the secondary rod mills. The secondary rod mills

operated in closed circuit with the overflow from the classifiers proceeding to the flotation area. The equipment in the flotation section of each section of the concentrator consisted of Inspiration pneumatic flotation machines. Each set consisted of two cleaner and two rougher sections. Low pressure air was introduced to each machine by two De Laval turbo-compressors. The flotation method for the concentration of sulfide ore minerals consisted of mixing certain reagents with finely ground ore and water. Then, when low-pressure air was blown through the mixture, sulphide mineral particles would adhere to the air bubbles and be carried up to the surface of the mixture where the bubbles and their mineral particles could be skimmed off as a high-grade sulphide concentrate. Flotation reagents consisted of tar and pine oil which obtained excellent copper recoveries. As reagents became more sophisticated, changes were made to obtain better recoveries.

The flotation rougher cell concentrates were lifted to the cleaner cells by an air lift. The flotation cells were interconnected with launders so that the product of the first set of cleaner cells could be sent through the other set which could function as re-cleaner cells. The cleaner cell concentrates were carried by launders to the Dorr concentrate thickener tanks and settled to a sump from which they were pumped to an eleventh Dorr thickener. The thickened concentrates then flowed by gravity to the filter plant. The filter plant had four 14-foot long by 14-foot diameter Oliver continuous filters containing vacuum pumps and a compressor that could reduce the moisture in the concentrates to 9.9%. The concentrates, averaging more than 37% copper (when the sulphide ore averaged 1.53% total copper), then dropped to a conveyor belt that discharged directly into railroad cars for delivery to the Calumet & Arizona smelter in Douglas.

The tailings from the rougher flotation cells were conveyed in launders to a concrete tank where it was combined with other coarse material from the 200-foot diameter thickener tank and then sent to the tailing disposal area. The overflow (relatively clear water) went to the 200-foot thickener tank and then to a return water sump where it joined the overflow from the concentrate thickeners for reuse in the concentrator processes.

The tailings were carried by gravity through launders for about 4,400 feet to a pumping plant where sand pumps pumped them through woodstove pipe for about 5,000 feet for delivery to the overhead tailings distribution launder. As the level of the tailings dump (dam) rose, the distribution launders

were extended until they surrounded the selected area of about 250 acres. Water was recovered from this tailings dam and was pumped back to the Concentrator area.

The community life also advanced considerably during 1924. The streets surrounding the central plaza and the radial streets in the immediate vicinity were paved with Willite paving that contained 2% copper sulphate. The Board of Directors of New Cornelia also voted to donate \$30,000 toward the building of two churches; one half each to the Catholic and Protestant denominations. The Catholics in the Ajo area had been traditionally served by the Franciscan priests of San Solano Indian Missions and the Immaculate Conception Parish had been formally established on August 24, 1916. The first mass had been celebrated in a tent house in Clarkston, then in the old sheriff's office and jail in Ajo and finally in a private home that was purchased to serve the parish as a church and a rectory. The new Catholic church was designed by George Washington Smith and located to the west of the central plaza. Construction began in September, 1924, and the finished church was dedicated on November 26, 1925.

Adding to the community's joy was the birth, in October, 1924, of John (Jack) Selmes Greenway to General and Mrs. Greenway.

As 1925 began, copper consumption remained on the upswing, and the company's benefits provided to its workers continued with the creation of an Employees' Benefit Association in May to provide inexpensive life insurance as well as other benefits. Change was in the air, however, and on May 30, General Greenway tendered his resignation, effective June 30. As an expression of high esteem for Greenway, the communities of the Warren Mining District (Bisbee), set aside June 9, 1925, as "Greenway Day." Greenway then disclosed that he would be closing his home in Warren to establish residence in Ajo, the community that he, more than anyone else had molded. His retirement years were short, however, as Greenway died, at age 53, in New York City on January 19, 1926, of complications after an operation for gall stones. Services were held at the Greenway home in Ajo on January 26 and burial took place on a knoll a short distance south of the residence. Greenway's friends came from far and near in a special train of five Pullman cars. After the service, as the cortege moved along the path toward the grave site, an Army airplane circled and scattered flowers over the site. In a final tribute to Greenway's dedication to his employees,

his will contained a bequest of \$100,000 to the employees of the New Cornelia Copper Company. His employees responded by erecting a monumental cross on a hill overlooking Ajo. Greenway's contributions to the United States were also recognized as the United States government erected his statute in Statuary Hall in the U.S. Capitol Building on May 24, 1930.

The Post-Greenway Era at Ajo:

After Greenway's resignation, Harry Clark, the superintendent of the Douglas smelter became the manager of Calumet and Arizona and Michael Curley, the general superintendent of the New Cornelia Copper Company since 1912, was named the manager.

During 1926 the Federated Church, located to the west of the central plaza was completed. Protestant services had begun in March, 1915, when Rev. Henry Van Valkenburg held services in Old Ajo in a pool hall. At the beginning of 1916, Protestant religious services for the Ajo area were held about once a month in the grade school house in Clarkston, but in September, 1916, it was arranged for a resident minister, Rev. William Winans, to alternate weekly services between Clarkston and one of the school tent houses in Old Ajo. In 1918, a church was built in the developing townsite of Ajo and a parsonage was also built sometime before 1925. For the new building, Leslie J. Mahoney, the same architect that had designed the Curley School, would prepare the plans for the new church. The cost was \$20,000, \$15,000 being provided by the New Cornelia Copper Company with the remaining funds provided by the parishioners. The new Federated Church was completed in July, 1926, and the opening service was held by Rev. Thomas H. Dodd on September 26, 1926. The church was dedicated to the memory of General Greenway in services held on January 11, 1927.

Improvement of life in Ajo also continued with the creation of the Ajo Improvement Company. On November 5, 1927, the remaining property owners were notified that a sewer had been completed, and everyone was expected to connect the line to their properties. Up until this time, everyone who had a tent house or other small house had an outdoor toilet or privy at the foot of the yard. Three to four times a week, the galvanized pails from privies were cleaned by men who would come up the alley. This service would be discontinued 60 days after the notice.

As for the mining operations, the market conditions did not justify maximum production in 1927, and in early April, a substantial curtailment took place. It was also during 1927, that company records make the first mention of separate low-grade ore dumps, when 123,212 tons of sulphide ore assaying 0.525% total copper and 845,912 tons of carbonate ore measuring 0.385% total copper were stockpiled. As the open pit mine matured, the levels were generally 30 vertical feet apart and railroad tracks were placed on all working levels. Holes for blasting were drilled two feet below the elevation of the next lower level and shot with three kinds of blasting powder. Boulders and hard areas ahead of the steam shovel were drilled with hand held jackhammers. Sampling for ore control was accomplished by collecting cutting from the drill holes as they were being drilled and all moving of the railroad tracks was done by hand labor. The average haul distance from the various orebodies to the coarse crushing plants was about 1½ miles.

During 1928, improvements began at the mine as a newly developed seven-foot Symons Standard Cone Crusher was installed in April to replace one of the No. 8 gyratory crushers in the intermediate crushing plant. Its related Symons horizontal disc crusher was also installed in the fine crushing plant. One set of roll crushers was equipped with Hummer electrically vibrated screens to provide feed for the rod mills while the oversize material passed to the rolls. In the concentrator two rod mills were extended to a length of 15 feet allowing larger tonnages of ore to be treated.

The never-ending effort to supplement the water supply also continued as the Board appropriated \$200,000 for the development of an additional water supply at the reliable Well No. 1. In September, a fifth pumping unit, a 1,300 gpm horizontal duplex pump was installed in the east pump station and two 3,500 gpm deep-well turbine pumps were installed in the sump of the "Old Shaft" to handle the water developed.

The Depression, Merger and Sale:

In the later part of 1928 and early 1929, an actual shortage of copper occurred and fabricators began to cover their positions for future deliveries. This extraordinary buying movement forced the price of copper to a record 23.775 cents per pound. The demand, however, collapsed with the stock market on October 29, 1929. The corporate reaction was to consolidate the Calumet and Arizona Mining Company and the New Cornelia Copper Company,

at the time representing one of the largest mining mergers on record. The new Calumet and Arizona, the surviving corporation, was capitalized with one million shares of capital stock, of which 842,857 shares represented one share for each share held by Calumet and Arizona shareholders and one share for each 2.85 shares of New Cornelia stock. The Ajo operations became Calumet and Arizona Mining Company, New Cornelia Mines.

The collapse of the nation's economy was not immediately felt in Ajo as the company made plans to increase its capacity to treat sulphide ores as the oxide ore reserves were nearly exhausted. Three additional Symons Standard Cone Crushers were installed in the intermediate crushing plant and all the six-foot wide classifiers for the rod mills were given eight-foot wide replacements. The Inspiration flotation cells were replaced with McIntosh flotation cells and more than \$3 million was to be expended in increasing the capacity of the concentrator with a goal of 1,875 tons per day per unit.

As stocks of refined copper increased during 1930, the price declined, first to 18 cents per pound, then to 14 cents in mid-April, and finally slid to 9.2 cents, the lowest price since 1894. The precipitous fall in prices brought a reduction in production at New Cornelia to a minimum. All stripping in the open pit mine was suspended, the leaching plant and the electrolytic plant were closed. The water development that had begun in November of 1928 was stopped on June 30, 1930. The worst was yet to come: in 1931, prices ranged from 10.5 cents to a record low of 6.25 cents.

The company's position now made it attractive to its friendly rival in Bisbee, the Phelps Dodge Corporation. In 1930, Phelps Dodge had seen its ore reserves depleted resulting in an excess smelting and refining capacity. It was also in excellent financial shape compared to the Calumet and Arizona which year after year had poured out their treasure of high-grade copper ores to its shareholders through dividends. The Calumet and Arizona thus found themselves with huge copper reserves, but without the necessary monetary reserves to develop and operate their holdings. A purchase by Phelps Dodge thus made sense and negotiations began in April, 1930, in the face of active opposition by a determined minority of Calumet and Arizona stockholders. The opposition did not prevail and on October 31, 1931, the Calumet and Arizona Mining Company was merged with Phelps Dodge and the Ajo operations became the New Cornelia Branch of Phelps Dodge. The merger

resulted in an exchange of 3.25 shares of Phelps Dodge stock for each share of Calumet and Arizona stock and the company would also pay its stockholders a special dividend of \$2.50 per share (a total of \$2,093,850).

Under Phelps Dodge, the first effect was a reduction, then a complete shutdown, of the New Cornelia branch on April 24, 1932. A total of 495 men were out of work. The price of copper continued to drop to new lows in 1932, first to 5.75 cents in March, then to 4.775 cents on December 8. This price continued until March, 1933, then gradually rose to nine cents before falling to eight cents. The work force at Ajo reflected the times and only 28 men were employed. In 1934, copper prices began to recover slightly and from June to the end of the year it remained at nine cents per pound. The New Cornelia Branch, in part encouraged by the "Code of Fair Competition for the Copper Industry," scheduled the resumption of operations giving preference to the hiring of former employees. The mid-June payroll practically wiped out the "relief" load in the Ajo area and operations began on July 1, 1934. By the end of the year, approximately 900 men were employed in five-day-per-week operations.

During 1935, Caterpillar mounts were substituted for the former railroad mounts for ten of the 12 steam shovels in the open pit mine. A new launder was built to handle tailings from the concentrator and a re-grind unit was installed. Two full revolving electric shovels were placed in service and new electric powered churn drills (with Caterpillar traction treads) were adopted for blast hole drilling. Changes were also made to the screening plant in the sulphide fine crushing plant by the installation of two Symons Short Head Cone Crushers. In the concentrator, the Callow-McIntosh equipment was replaced by Hunt-Dunn pneumatic flotation machines that introduced air by means of a series of submerged jets. There were two units for rougher flotation; each unit had five 62-foot Hunt-Dunn cells. All rougher cell concentrates were sent to be retreated in a 12-foot cell to produce a finished concentrate. Tailings were classified and were re-ground in a ballmill and two stage cleaner cells produced a final concentrate.

With a workforce now totaling 1,089, the renovated concentrator operated virtually at capacity to produce about eight million pounds of copper per month; even with a price of ten cents per pound, Phelps Dodge's cost of seven cents per pound made the company a tidy profit. More good news came in August, 1936. Western Gas Company, an El Paso Natural Gas

Company subsidiary, announced that it would spend more than \$1 million to extend a natural gas pipeline to Ajo. The use of natural gas would result in substantial additional economies in operations.

On the southwest side of the open pit mine, exploratory drilling developed additional ore that could be made accessible by moving the face of a hill (locally called Arkansas Mountain) 400 feet to the southwest. To do the job, four 222-ton trucks were put into operation on April 1, 1937. The haulage ramps were as steep as 28% and tire wear was a major problem due to the hard, rocky material. The exploration program, by the time it was completed in September, consisted of 270 diamond drilled holes for a total of 141,300 feet.

Improvement of the concentrator continued as three sets of Ajo type 78-inch diameter roll crushers were replaced by the final three Symons units and to classify the product of the ballmill, an experimental spiral classifier was installed.

The final close of the old guard came in October, 1939, when Mike Curley, announced that he would retire on December 31, 1939. Phelps Dodge announced that J. H. Davis, the general manager at Douglas, would take over the management of the New Cornelia properties. As the dark clouds of World War II gathered, the urgent copper requirements for the defense program resulted in the omission of the usual short summer shutdown. As war mobilization cut into the available workforce, a serious labor shortage developed in the Arizona mining camps and the War Department furloughed a number of men with mining experience to return to work in Arizona's mines.

The politics of 1942 placed Ajo in an important position within Pima County. Local positions included a justice of the peace and constable, and one of the three members of the Pima County Board of Supervisors. The area elected one member of the Arizona House of Representatives and the sheriff appointed two deputies to serve the area. One judge of the superior court was designed to hold sessions in Ajo from time to time. Voter registration was overwhelmingly Democrat and party officials frequently conducted their meetings in Ajo.

Epilogue:

After construction of the leaching plant in 1917, Hans Nelson became the assistant plant superintendent and later the assistant concentrator superintendent until he retired in January, 1945. After Michael Curley retired he left Ajo to live in California where

he died on July 13, 1945. After World War II, the New Cornelia Branch at Ajo continued to expand and play a major role in domestic copper production until it was finally closed on August 12, 1984. The smelter operated until April 4, 1985, when it was also closed. The company housing has been sold primarily to retirees and Ajo is today primarily a retirement community. Phelps Dodge Corporation still maintains a presence to monitor the mine and plants and to provide water and electricity to the housing previously served by the New Cornelia Branch.

During the period covered by this article, the capital expenditures for the mine, plant and townsite amounted to more than \$19 million; from 1916 to 1939 the wages by the company and the TC & GB Railroad was \$30.6 million and the cooperative store rebated \$953,222.94 to employees of the company.

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Selected Bibliography:

- Allen, A. W., "Ajo Enterprise of the New Cornelia Copper Company - I," *Engineering and Mining Journal-Press*, Vol. 113 No. 22, June 3, 1922, pp. 952-56; Vol. 113, No. 23, June 10, 1922, pp. 1003-08; Vol. 113 No. 24, June 17, 1922, pp. 1051-53; Vol. 114, No. 5, July 29, 1922, pp. 184-90.
- Angst, Harry H., "Trucking Operations at New Cornelia Mine," *Transactions, American Institute of Mining and Metallurgical Engineers*, Vol. 153, Metal Mining and Milling, AIME, New York, 1943, pp. 137-142.
- Ajo Copper News, Vol. 39 No. 1, October 21, 1954, "1854 Ajo Centennial 1954," "Awakening The Copper Giant," 14 pp., and various other sources.
- Austin, Leonard S., *The Metallurgy of the Common Metals*, John Wiley and Sons, Inc., New York, 1926, 658 pages, Chapter V, "Crushing and Sizing," pp. 52-61; Chapter XXXI, "The Hydrometallurgy of Copper, The Ajo Process of the New Cornelia Copper Company," pp. 438-44.
- Bailey, L. R. (ed.), *The A. B. Gray Report - Survey of a Route on the 32nd Parallel for the Texas Western Railroad, 1854, and Including the Reminiscences of Peter R. Brady, Who Accompanied the Expedition*, Westernlore Press, Los Angeles, California, 1963, pp. 158, 166, 215, 216, 227.
- Bell, George A., "Leaching Practice and Costs at the New Cornelia Mines of the Calumet and Arizona Mining Company, Ajo, Arizona," IC 6303, July, 1930, Department of Commerce, U. S. Bureau of Mines.
- Brady, Francis P., "Portrait of a Pioneer, Peter R. Brady, 1825-1902," *Journal of Arizona History*, Vol. 16 No. 2, Summer, 1975, pp. 171-94.
- Burch, H. Kenyon, "New Cornelia Concentrating Mill at Ajo, Arizona," *E&MJ-Press*, Vol. 118 No. 21, November 22, 1924, pp. 806-21.
- Calumet and Arizona Mining Company, Annual Reports, 1910 through 1930 (includes New Cornelia Copper Company beginning with 1914).
- Clark, Sam, "Papers and Business Records of . . .," University of Arizona, Special Collections Library.
- Curley, Michael, "The Story of Ajo's Development," *The Mining Journal*, Vol. 23 No. 12, November 15, 1939, pp. 3 and 4.
- Croasdale, Stuart, "Leaching Experiments on the Ajo Ores," *Transactions, American Institute of Mining Engineers*, Vol. XLIX, AIME, New York, 1914, pp. 610-58.
- Diehl, T. E., "History of the New Cornelia Mine, Phelps Dodge Corporation," Arizona Conference of AIME, Open Pit Division, Ajo, Arizona, April 24, 1981.
- Dobyns, Henry F., "Southwestern Chronicle - The Case of Paint vs. Garlic," *Arizona Quarterly*, Vol. 11, No. 2, Summer, 1955, pp. 156-60.

Conference of AIME, Open Pit Division, Ajo, Arizona, April 24, 1981.

Dillard, Gary, "Mining Will Always Bear the Mark of Dr. Louis Ricketts," *Pay Dirt*, March, 1992, pp. 8B-10B.

Du Moulin, W. L., "Water Development at New Cornelia Copper Company," *Mining Journal*, Vol. 8, No. 24, May 15, 1925, pp. 5-8.

Du Moulin, W. L., "New Cornelia Copper Company - Crushing Plants," *Mining Journal*, Vol. 11 No. 23, April 30, 1928, pp. 7-9, 14-18.

Dunning, Charles H., *Rock to Riches*, Southwest Publishing, Phoenix, Arizona, 1959, pp. 46, 217-18.

Gilluly, James, "The Ajo Mining District, Arizona," U. S. Department of the Interior, Geological Survey, Professional Paper 209, 1946.

Joralemon, Ira B., "The Ajo Copper Mining District," *Transactions, American Institute of Mining Engineers*, Vol. XLIX, AIME, New York, 1914, pp. 593-609.

Joralemon, Ira B., *Copper - The Encompassing Story of Mankind's First Metal*, Howell-North Books, Berkeley, California, 1973, pp. 170-98, 319.

Joralemon, Ira B., "Adventure Beacons," *Society of Mining Engineers of AIME*, New York, 1976, pp. 42-47, 63-66, 68, 88, 133, 134, 136, 149, 181-183, 187, 193, 195, 248.

Lakes, Arthur, "Copper Deposits of the Ajo Basin, Gila Basin, Arizona - The Large Amount of Mineral and Difficulties of Exploiting," *Mines and Minerals*, August, 1900, pp. 12-15.

Myrick, David F., *Railroads of Arizona*, Vol. 1, The Southern Roads, Howell-North Books, Berkeley, California, 1975 ("Tucson, Cornelia and Gila Bend Railroad," pp. 395- 418).

Phelps Dodge Corporation, Annual Reports, 1930 through 1942.

Rees, David I., "Again The Ancient Mines of Ajo," A Gloree Publications, June, 1973 (Revised July, 1977), pp. 10 and 17, University of Arizona, Special Collections Library.

Rickard, T. A., "The Story of the New Cornelia," *Engineering and Mining Journal-Press*, Vol. 115, No.1, January 6, 1923, pp. 7-10.

Rickard, T. A., "The Later Story of the New Cornelia Enterprise," *Engineering and Mining Journal-Press*, Vol. 119 No. 7, February 14, 1925, pp. 285-89.

Rose, Dan, *The Ancient Mines of Ajo*, 1936.

TeMey, James Brand, "History of Mining in Arizona," Vol. I, unpublished, Tucson, Arizona, 1927-29, 514 pages (Introduction, pp. 1 and 2; Chapter 1, "General History of Mining In Arizona," pp. 3-26; Chapter 7, "History of the Ajo District," pp. 116-24), manuscript at Arizona Geological Survey, Tucson, Arizona.

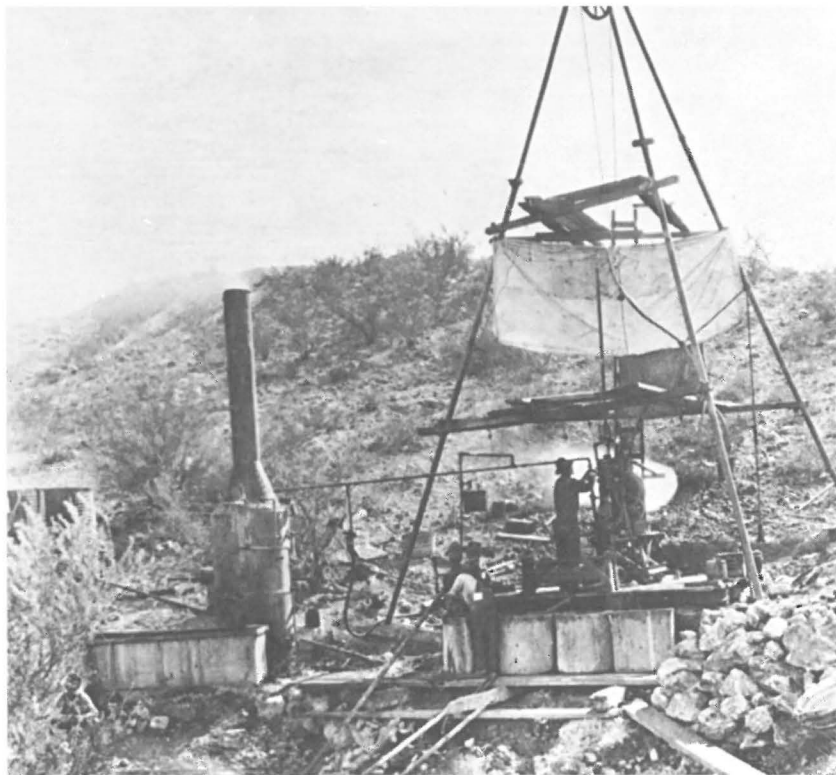
Therrien, Corinne Rentfrow, "The Historical Background of the Ajo, Arizona, School System," Thesis, University of Arizona, 1945.



Statue of John Campbell Greenway (1872-1926). "Rough Rider, Mining Engineer, Developer of the Ajo Copper Mines and Designer of the Town of Ajo for Calumet and Arizona Mining Company. Brigadier General, Army Reserve, and Regent, University of Arizona." Sculptor: Gutzon Borglum. Original in National Hall of Statuary, The Capitol, Washington, D.C. To represent the state of Arizona. Dedicated May, 24, 1930. The other original is near east entrance to Arizona Historical Society (Tucson). Courtesy of the Arizona Historical Society/Tucson, Buehman Collection B#27664.



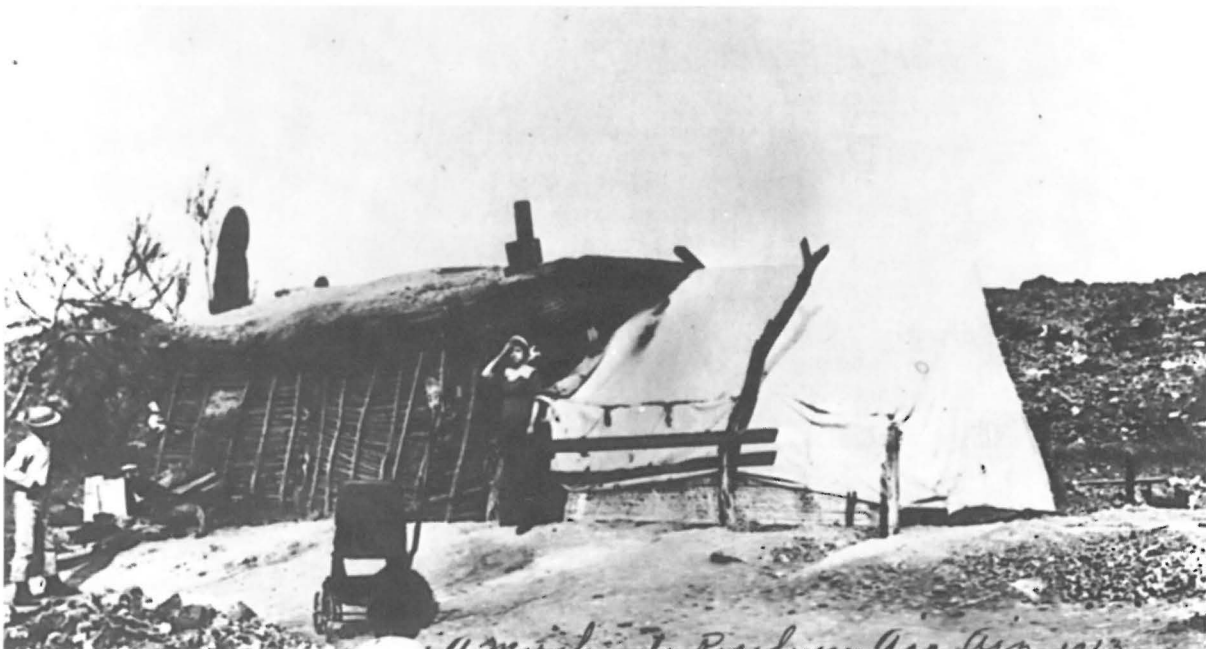
Foreground: some of "old Ajo;" background: the dark-colored hills were the outcrops of the richest orebody as of 1915. Note building in left foreground: compare this photo with no. 18. Courtesy of Ajo Historical Society Museum.



Prospect drilling with a diamond drill (operated by steam). Started December, 1911, in the three green hills. Courtesy of Phelps Dodge Corporation.



Home in "Old Ajo" in 1912, of Michael Curley (in picture) and John P. Furnstahl. Constructed of ocotillo branches tied together; roof was thatched with limbs of desert growth and "tin." Arkansas Mountain in left background. Courtesy of Ajo Historical Society Museum.



Merchant's residence in "old Ajo" in 1913. A combination of construction with local materials and purchased tent. Courtesy of the Arizona Historical Society/Tucson, Bevin Gordon Granville Collection #14460.



Well No. 1, six plus miles north of Ajo. Tower at right was the large oil-well drill rig that started to drill the water prospect hole in the Spring of 1913. To its left was the sinking headframe for the development shaft (100 feet south of the drill hole); started April 26, 1914. Courtesy of the Arizona Historical Society/Tucson, Buehman Collection #64221



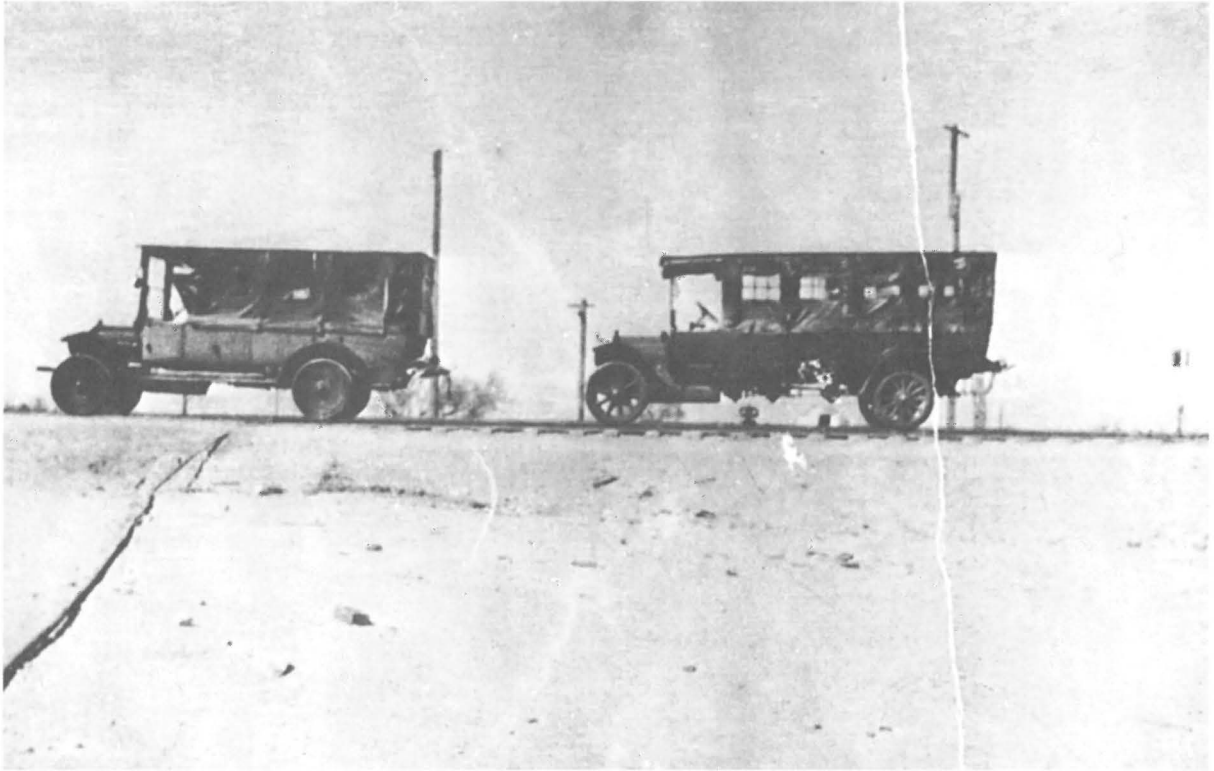
Freight wagons in "old Ajo" in 1914. These hauled necessities from Gila Bend or Tucson before the TC & GB Railroad. Courtesy of Ajo Historical Society Museum.



40-ton oxide-ore pilot plant under construction in "Old Ajo;" completed January 31, 1915. Courtesy of Ajo Historical Society/Tucson, Tobelmann Album #70267.



Tent houses for single men in "Old Ajo" in 1915. These were close to the orebodies. In the upper right are the remains of the McGahan Vacuum Smelter. Courtesy of the Arizona Historical Society/Tucson, Tobelmann Album #70267.



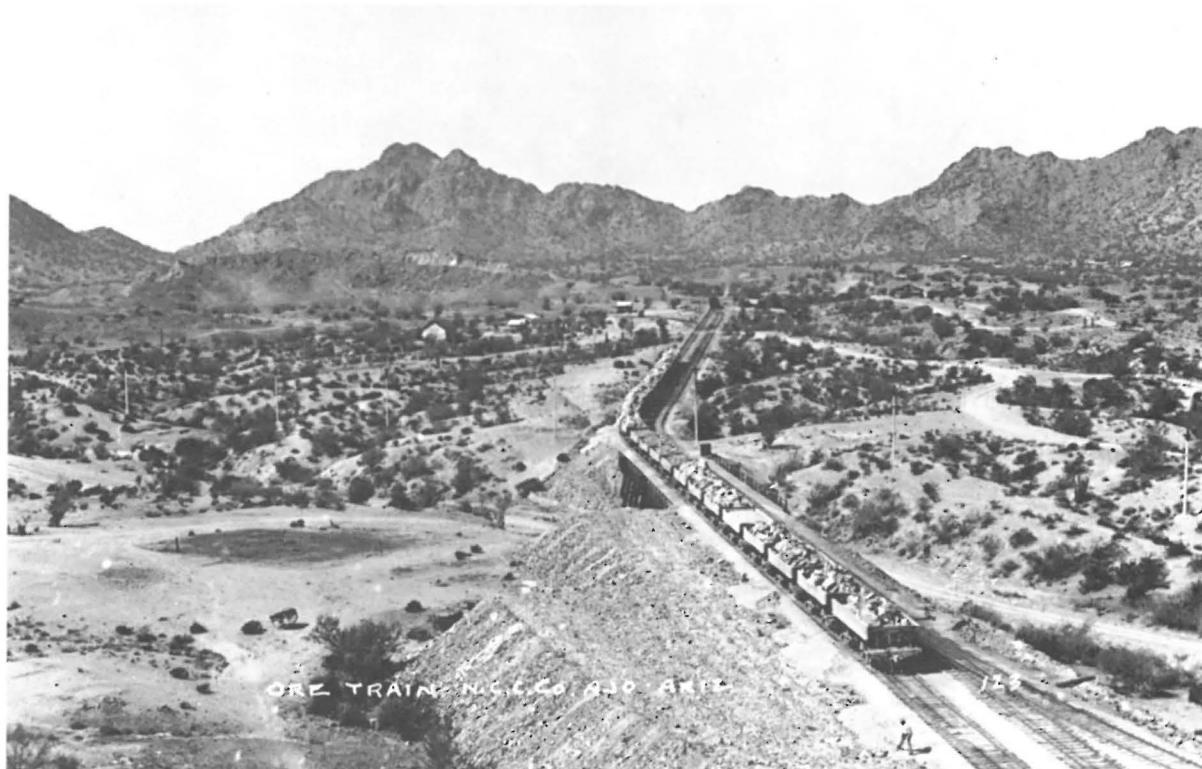
The two (gasoline) motor cars used to haul passengers to and from Gila Bend on the TC & GB Railroad; first one in use in 1916. Note the side curtains for weather protection. Courtesy of Georgia Nardelli.



"Employees Cottage." The nearest house was at 200 Morondo Avenue; these houses were of hollow tile plastered on the inside and outside. Depot in right center (sometime after March 1916). Courtesy of the Arizona Historical Society/Tucson, Hadsell collection #64203



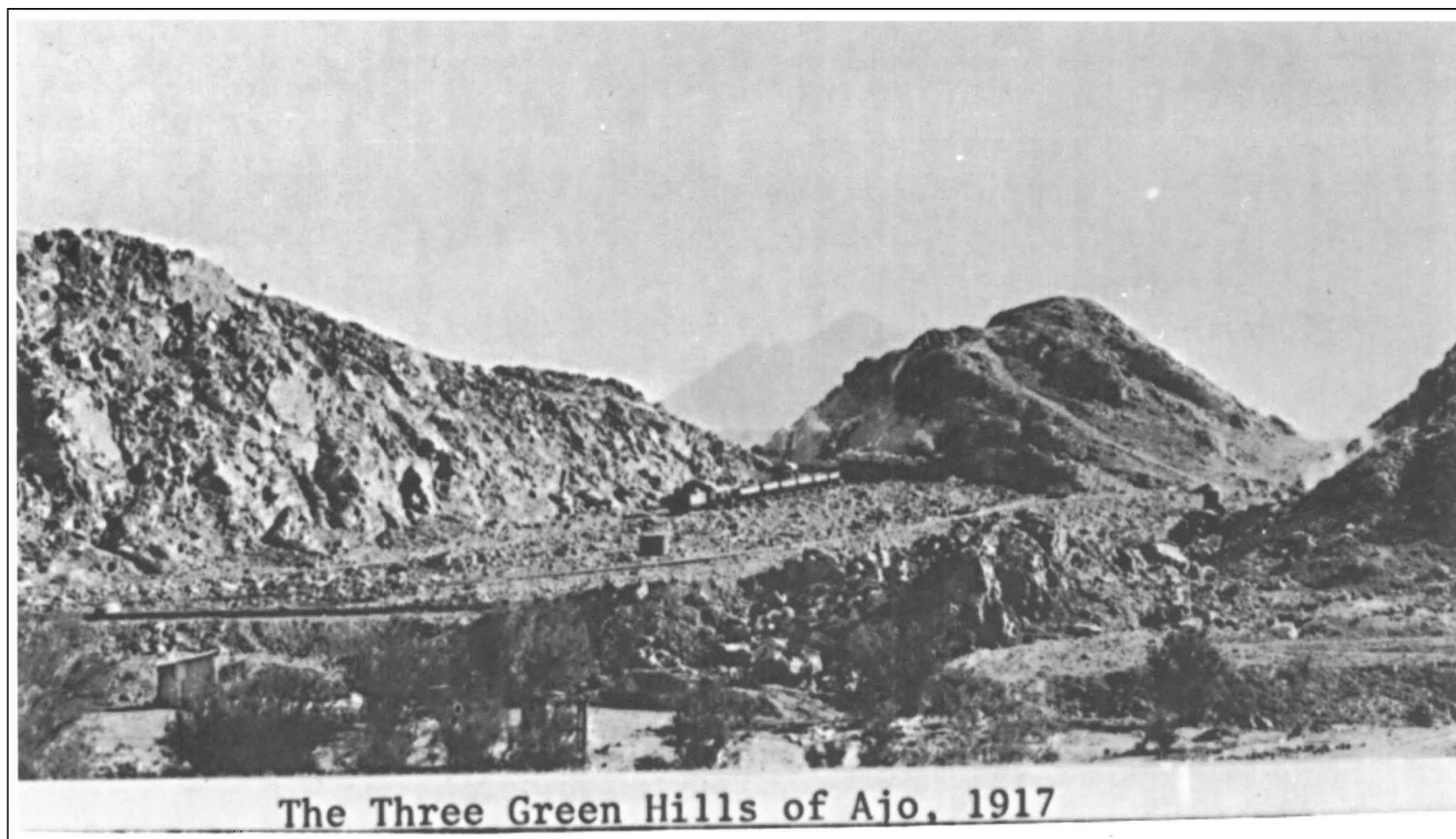
First school in Ajo in a tent house. School moved from "Old Ajo," probably in 1917. Courtesy of the Arizona Historical Society/Tucson, Tobelmann Album #70267



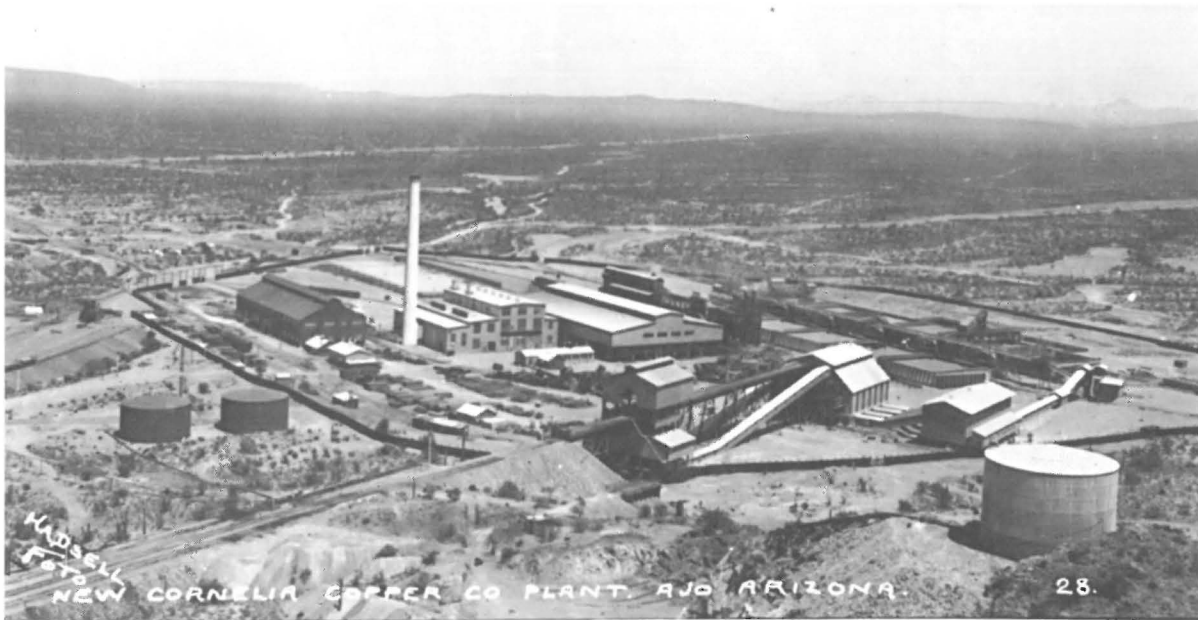
Railroad tracks from oxide Coarse Crushing Plant to area where Hills No. 1 and No. 2 were being mined (to the left of the steam locomotive) sometime in 1917, looking west. Ore cars in the foreground. Courtesy of the Arizona Historical Society/Tucson, Hadsell Collection #64123A.



Steam shovels ining Hill No. 1 (on right) and Hill No. 2 (on left). There are two trains of ore cars. Left middle are single tent houses; above center are two larger tent houses. On the horizon are the four Department-Head Residences and the hospital (finished in 1919). Courtesy of the Arizona Historical Society/Tucson, Hadsell Collection #64141.



"The Three Green Hills of Ajo, 1917." Looking southeast toward Black Mountain (faint outline in center). Probably Hills No. 2, 1, and 3 from left to right. Courtesy Phelps Dodge Corporation.



Leaching Plant and related facilities (oxide ore first spread in leaching tank May 1, 1917). Lower right is the tank that received water from Well No. 1; above and to left are the crushing plants and the leaching tanks; center is Tank House, above it is the sulfur dioxide plant; to the left of the Tank House is the Power House, beyond is the cooling pond; to the left of the Power House are the machine shop and the warehouse; oil and acid storage tanks are above the railroad; the "American" and the "Mexican" Townsites are to the left of the photo. Courtesy of the Arizona Historical Society/Tucson, Hadsell Collection #64028.



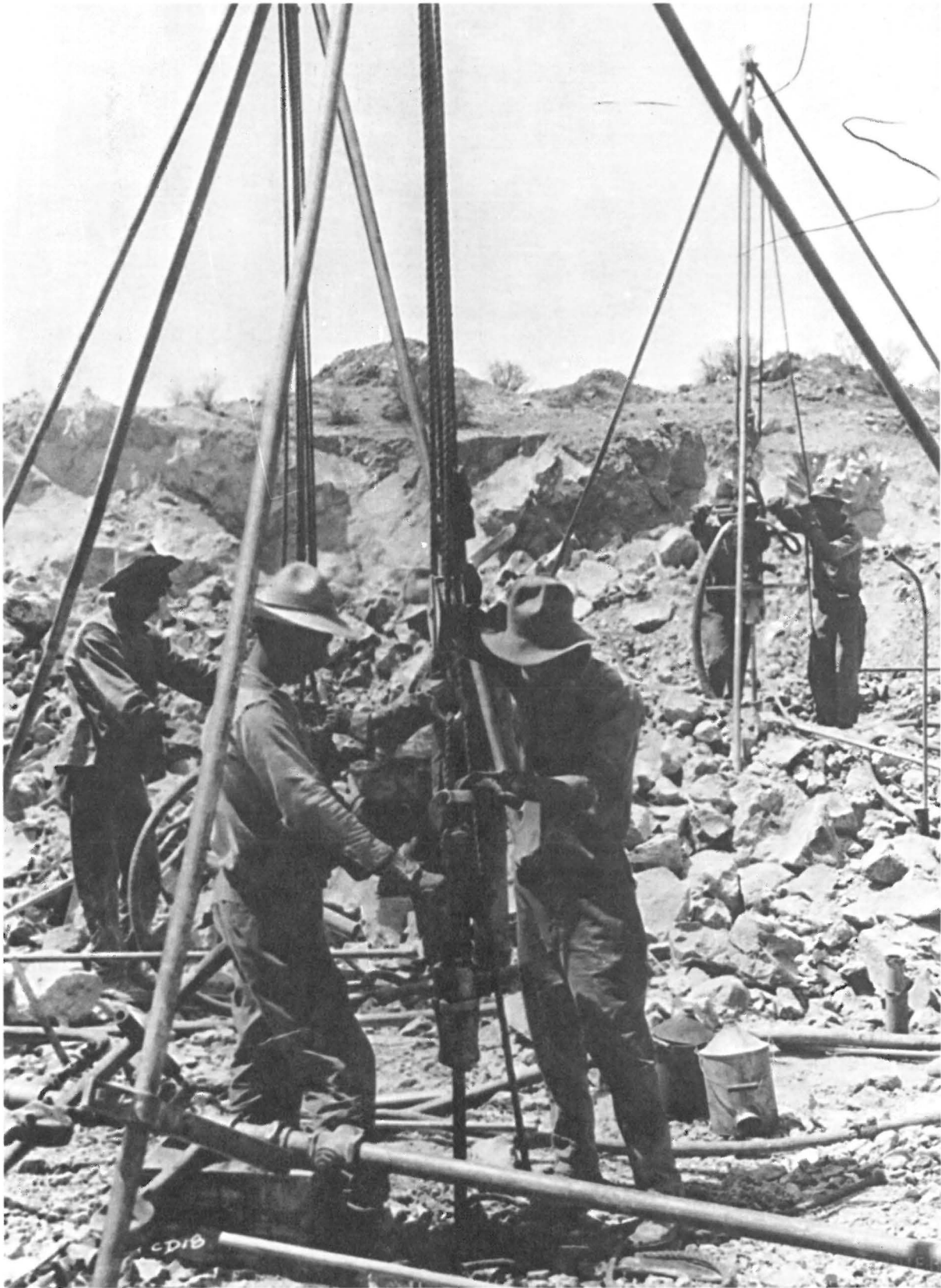
In the foreground is a leaching tank that has oxide ore and sulfuric acid leaching solution in it; beyond is the Hulett unloader which removed the leached tailings from the leaching tanks, beyond it is the town of Clarkston. Courtesy of the Arizona Historical Society/Tucson, Bevil Gordon Granville Collection #30485.



Compare with photo 2. Mining on Hill NO. 3 (October 1918). Ajo Shaft (center) was developed to check prospect drilling and to mine sulfide ore for the flotation process pilot plant; other shafts at left center were also for checking and to remove high-grade oxide ore mined in the glory hole. Courtesy of the Arizona Historical Society/Tucson, Hadsell Collection #64215.



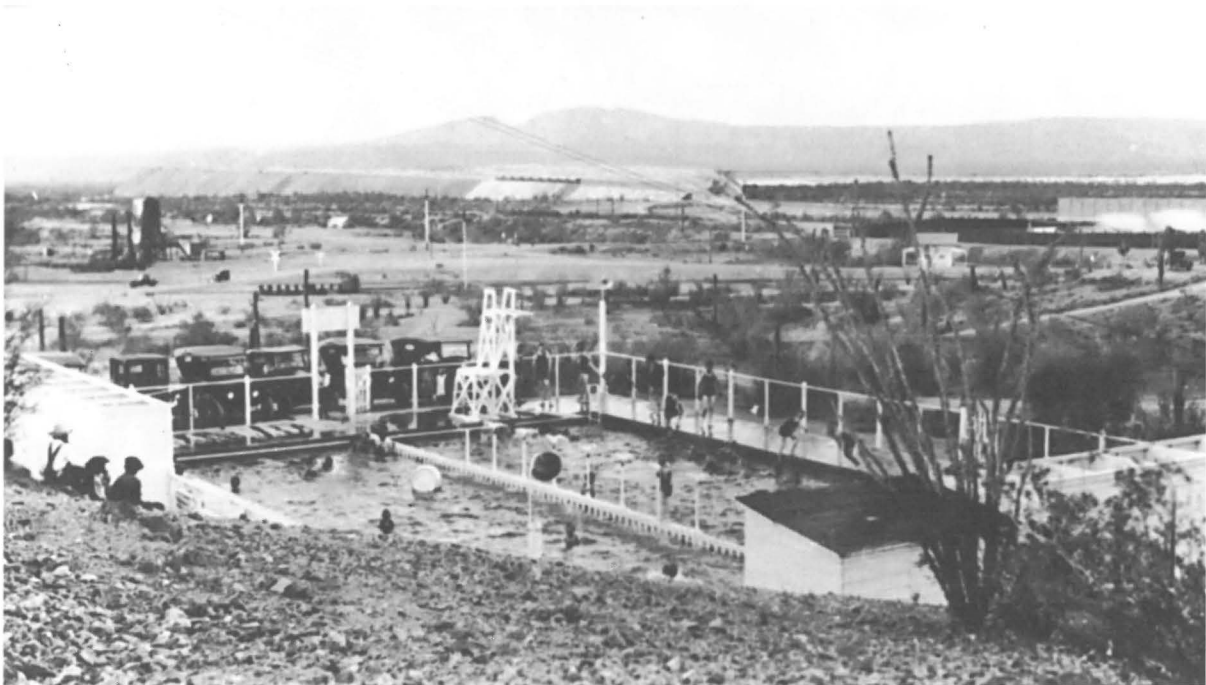
The Plaza. The business block is to the left. Houses beyond the Plaza (the churches and school had not yet been built); above these houses is the General Superintendent's House—later the Manager's House (built in 1918). To its left are the four Department Head residences and the hospital (hidden by the corner of the business block). Courtesy of the Arizona Historical Society/Tucson, Hadsell Collection #64052B.



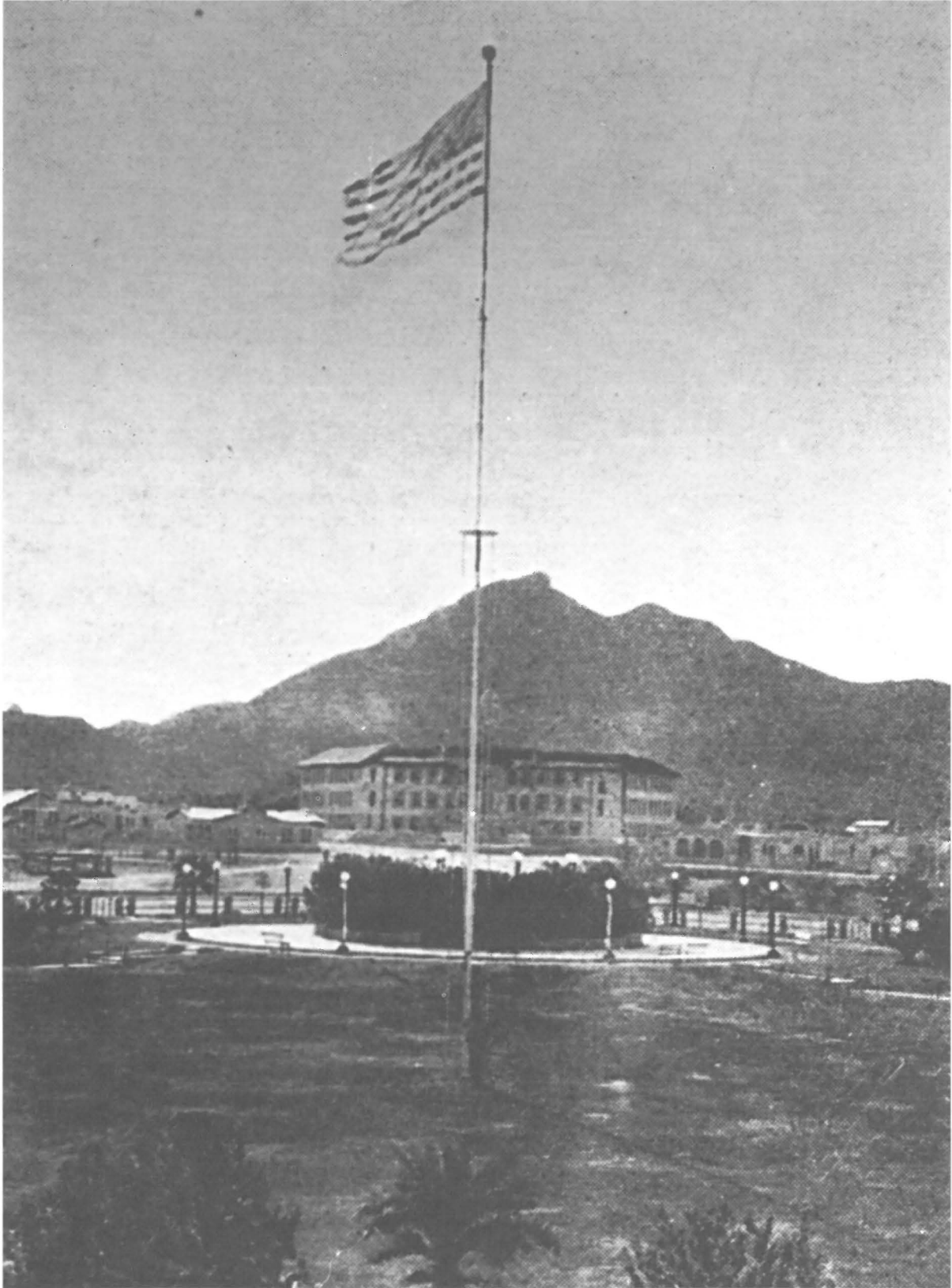
Drilling holes 35 feet deep for blasting on normal height operating benches. Ingersoll-Rand rock drills (operated by compressed air) were suspended by rope and rope blocks from tripods. Courtesy of Phelps Dodge.



"Mexican Townsite" looking northwest to "A" Mountain (highest one toward the left). Well constructed housing along the center was built by the company, other housing built on leased lots. Starting at right center and going to the left are: the hospital (1919), four Department Head Residences, and the General Superintendent's House (1918); on the hill to the left of this house appears to be a tent house (John C. Greenway lived there when he was in Ajo). Courtesy of the Ajo Historical Society Museum.



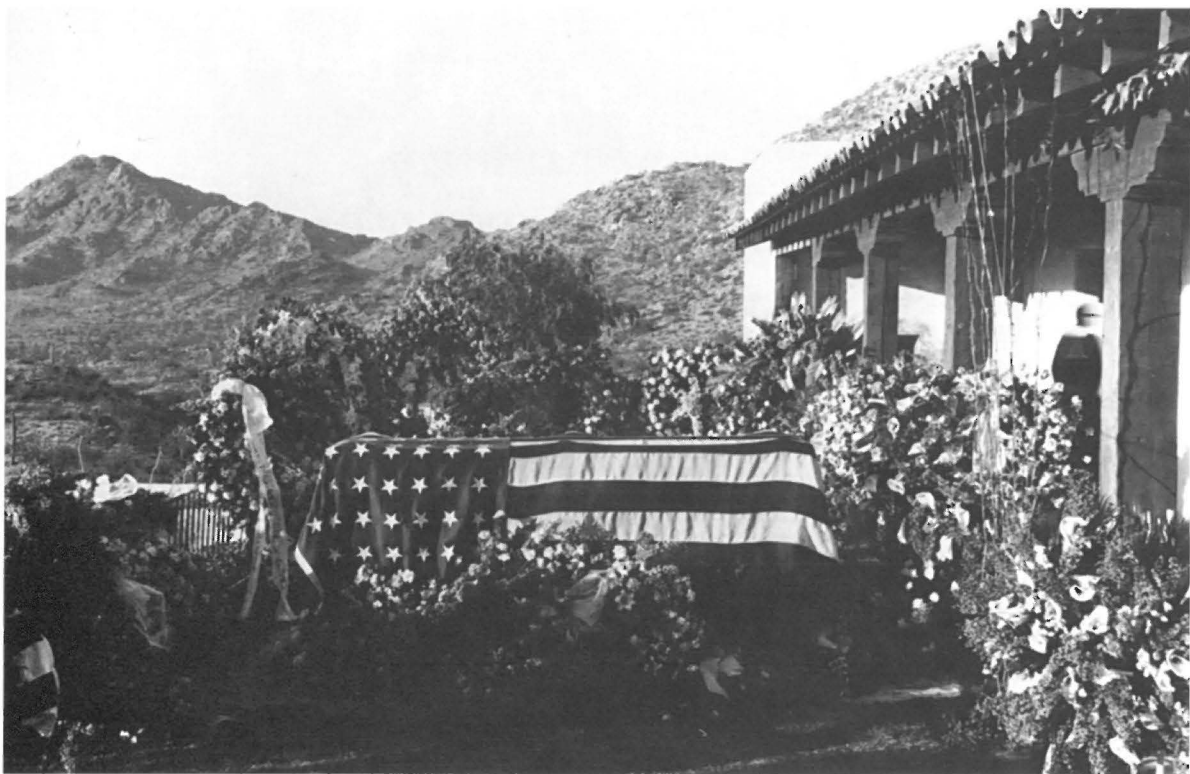
Swimming pool (northwest of General Office), in service September 1, 1920. Leached tailings beyond swimming pool. Courtesy of the University of Arizona Library - Special Collections.



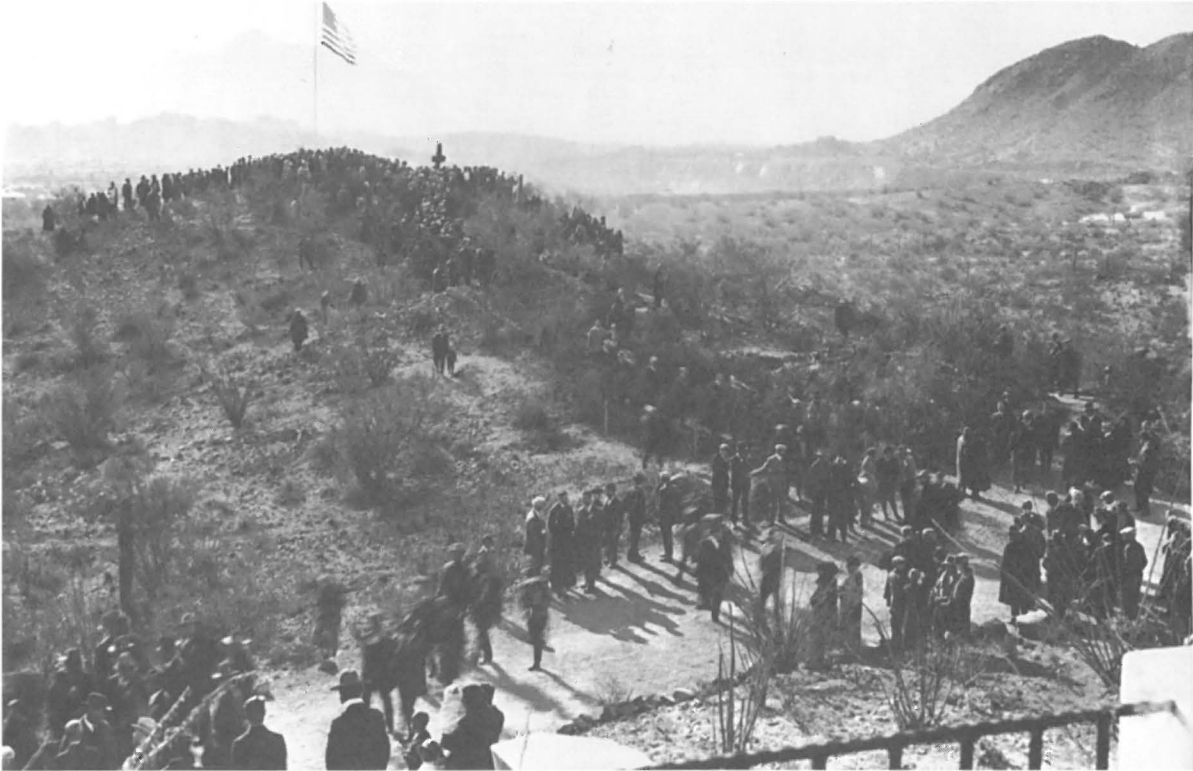
Looking west from depot along axis from depot to school; the Plaza, bandstand, Curley School (dedicated January 5, 1920) with houses to either side, "A" Mountain. Churches had not yet been built. Courtesy of University of Arizona Library - Special Collections.



Home of John C. and Isabella Greenway, built 1924-1926. Courtesy of the Arizona Historical Society/Tucson, Buehman Collection B#38858.



Funeral of John C. Greenway (January 26, 1926), casket at Greenway home. Courtesy of the Arizona Historical Society/Tucson, Buehman Collection B#38882.



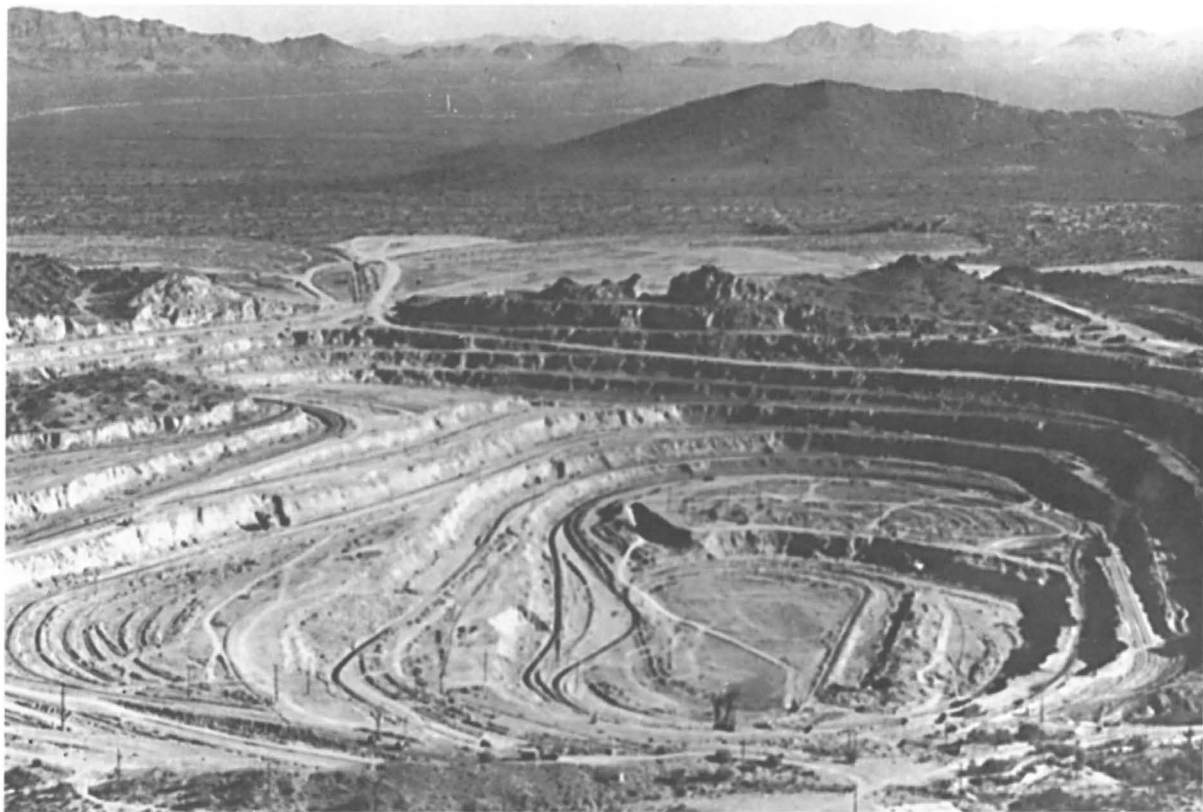
Funeral of John C. Greenway, walkway from home to grave site on knoll south of home. Open pit mine in background, Arkansas Mountain to right, Black Mountain in distance at left. Courtesy of the Arizona Historical Society/Tucson, Buehmann Collection B#38875.



Photo taken November 27, 1939. In left background is the concentrator. To its right are the crushing plants and ore bins; in front of them are the leaching tanks. Wood-stave pipes coming from the concentrator are carrying sulfide ore tailings to the tailings disposal area. Courtesy of the Phelps Dodge Corporation.



New Cornelia Copper Company open pit mine (early 1930), looking southeast: Arkansas Mountain on right, Black Mountain in right background. Steam shovels, railroad tracks, and railroad cars are visible. Courtesy of Phelps Dodge Corporation.



Phelps Dodge Corporation, New Cornelia Branch open pit mine (December 7, 1942), looking more to east than southeast. Waste dumps are to the east beyond the open pit mine. Courtesy of Ed Powell.

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Editors
J. Michael Canty
H. Mason Coggin
Michael N. Greeley

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