
John C. Greenway, The Ajo Experience

H. Mason Coggin

A vandalized monument on a small hill in the Sonoran Desert marks the burial of John C. Greenway. It splits the distance between his desert home and the vastness of the New Cornelia open-pit copper mine at Ajo, Arizona. The plants died long ago and the surrounding wrought-iron fence is largely gone. His bronze name plate has been removed from its copper stone, but the largest monument to John C. Greenway is his open-pit mine. Spanning the horizon for nearly a mile, it shows a million colors in bright pastels along deliberately sculptured contours. Viewers stand in awe of this engineering and industrial marvel. This the largest man-made feature in western Pima County can be seen from space. The copper from this mine electrified the world by bringing light and power to homes, schools, hospitals, factories and businesses.

Greenway's vision and creative genius organized and bootstrapped this mine through the first copper leaching operation in North America to a successful copper sulfide mining operation. The mine made a major company of the Calumet & Arizona Mining Company and, after the merger of 1931, it made an even greater company, the Phelps Dodge Corporation.

The Ajo operation outlived Greenway by fifty-seven years, until the operations were suspended in 1983. Unlike the man, however, the mine may live again in the next century. A large reserve of unmined copper still lies in the bottom and in the walls of this pit. Uneconomical to extract in 1983, this resource will be reworked with new methods and new technology when the world needs the copper.

Greenway's only physical problem was a troublesome gall bladder and after the New Year's holiday of 1926, he decided to have it removed. Soliciting the

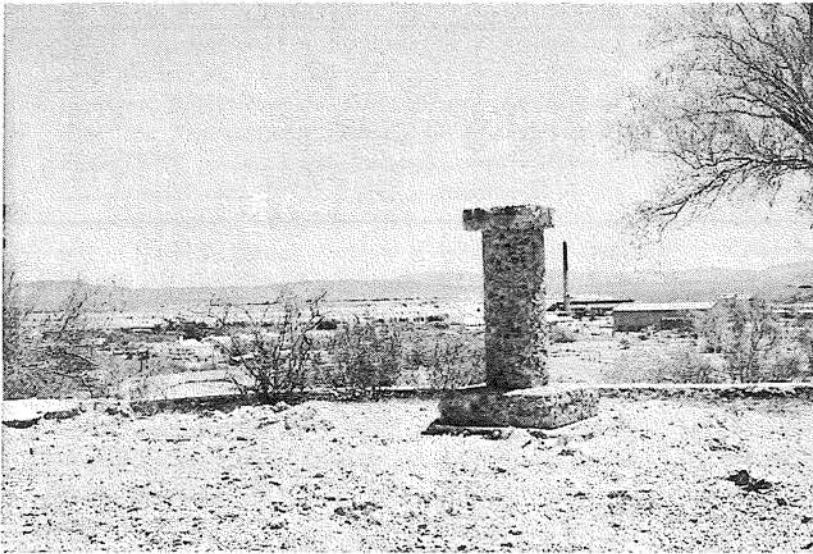
top medical technology available at the time he underwent surgery in New York's Theodore Roosevelt Hospital. After a successful operation a blood clot developed, and he died a few days later. He was fifty-four years old. Survivors included his wife, Isabella, an infant son, John, and two stepchildren from Isabella's first marriage to Robert H. Munro Fergusson.

His special funeral train to Ajo was followed by the general's friends and acquaintances. Even in death he commanded the respect of those who knew him. Some of the wealthiest and most politically powerful people in the United States sent condolences to his widow and children. Statesmen, executives, soldiers, and fellow officers from the Rough Riders' campaign in Cuba and his command in France marched in his funeral procession with miners from his industrial developments in Michigan, Mesabi, Bisbee, Ajo and Mexico sending their sympathies. Greenway would have appreciated the dropping of social status for this solemn occasion.

He wanted a "miner's funeral," to be buried in rock on the top of a hill, surrounded by friends, family and in full view of the mine he had created and the desert home he had designed. The excavation for his tomb penetrated solid rock. A concrete vault was constructed and clad in a half-inch thickness of copper armor to protect his body.

At the burial a flowering tribute from his many admirers was laid over the seal. People spoke elegantly of his many virtues, generals and soldiers told of his military honors, giants of industry recounted his achievements, and politicians told of his dedication to policy and his many supporters.

Eight members of Arizona's 158th National Guard infantry fired a "soldier's farewell." A poem, written in tribute by Richard Howard Whiteside to



GREENWAY COLUMN, C. 1994, The unfinished column represents Greenway's untimely death. The smelter stack in the background was abandoned in 1982 when Phelps Dodge refused to bow down to the Union during a strike. The Copper depression that followed in the mid 1980's insured the death knell for the operation. Displaced employees left the town that had provided a home and employment to their families for several generations. The mine was the only available employment in the area. Photo by author.

his former boss and benefactor, was read at grave side.

JOHN C. GREENWAY

They say he built five towns and wrote his name
 In letters big on scrolls of fame.
 His was the measure of a man, they say,
 As cortege train with garlands hung
 Southwestward wends its way.
 Of hero's mould, as silvery taps
 In silvery noted pain,
 Now loud and clear, now sweet and low
 Is sobbing its refrain.
 I only knew he was my friend
 And stumble blind through byways home
 A whimpering child again.

— Richard Howard Whiteside¹

A circular concrete wall to support a wrought-iron fence was built around the hill top. A flag pole was erected in the center and an oleander hedge was planted inside the fence. A broken marble column

indicating Greenway's early death and his unfinished life was placed beside a large copper stained rock that provided a mount for a bronze name plate. A galvanized steel pipe brought water to the well groomed hedge and the rare small plot of grass in the vastness of the Sonoran Desert.

His straight-lipped statue in future years would represent Arizona in the Congress' Statuary Hall in Washington, D.C. American Legion posts, schools, roads, and even buildings across the country bear his name.

Politically, Greenway was following a path aimed at the presidency of the United States. He had joined the Rough Riders as a private and emerged at the end of the Spanish-American War with a commission. He was promoted for bravery on the battlefield by Teddy Roosevelt. After the charge on San Juan Hill Roosevelt said of Greenway:

Greenway was the second man to the top of San Juan Hill and the first behind enemy lines . . . I only envy Greenway. I wanted to be the first there myself, but he outran me!² . . . He was a 200-pounder, slightly over six feet tall, who thrived on embalmed beef and regarded the entire Cuban campaign through intense heat and jungle as nothing but an enjoyable outing, the chance of fight on the morrow simply adding the needed spice of excitement.³

Roosevelt recommended Greenway for the rank of breveted captain and awarded him the Silver Star Citation for gallantry in action. Twelve years after the Rough Rider experience Teddy Roosevelt wrote a letter to Greenway following an incident when Mr. Roosevelt was shot while making a speech in Oyster Bay on November 2, 1912:

My Dear Jack: You'll probably never know how much your unflinching loyalty to me for the past fourteen years has meant-I believe in



GREENWAY HOME IN AJO, When this picture was taken the new owners of the home were planning on turning it into a bed and breakfast for tourists. Photo by author 1994.

you, I'm very proud of you and while I cannot help laughing a little at the absurd overestimate you made of my conduct in the talk of the shooting, still I am glad that you do overestimate it.⁴

Roosevelt asked him to become the Commissioner of the General Land Office in 1906. Greenway declined. He led Arizona's Bull Moose Party in Roosevelt's bid to upset Taft as a third-party Republican they lost to Woodrow Wilson, a Democrat, in the general election. Roosevelt, however, carried Arizona,⁵ and Greenway received the ballots of eight states in a 1924 bid for the vice-presidency.⁶ Had Greenway survived the gall-bladder operation, he might have been a candidate for the 1928 election.

He won recognition as a Yale athlete in football and baseball. His World War I service won him honors and decorations from the French and American armies. The citation reads:

Near Verdun, France, October 23, 1918,
lieutenant colonel, One hundred and first In-

fantry, Twenty-sixth Division. During a terrific enemy shelling on two of his battalions, and after both his battalion commanders had been wounded, Colonel Greenway personally directed the activities and greatly encouraged his forces by his presence. Leading them in attack, he demonstrated the utmost valor at the most critical moments, and he was the first of his command to enter the German trench which marked the objective for the day's attack. In the War Department files with his military record is a communication to General Greenway from Brig. Gen. George Van Horn Moseley attesting the valor Greenway displayed in action on the Toule, Cantigny, Chateau-Thierry, St. Mihiel, Menses and Douamont fronts. For good work and gallantry in action he was promoted to the rank of lieutenant colonel.

Greenway was to earn his colonelcy on the field of battle. He sought service as soon as we entered the war and came to France in the autumn of 1917 as a major of Engineers. Re-

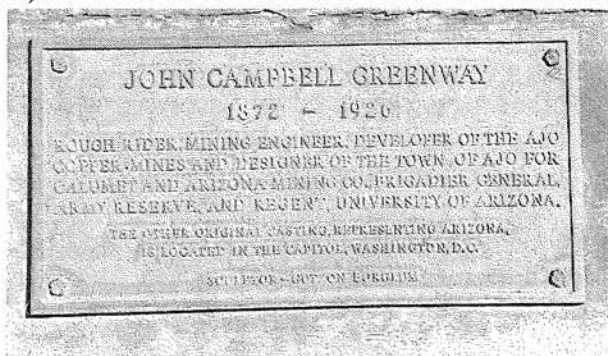


John Campbell Greenway Statue at the Arizona Historical Society in Tucson. Photo by Author 1994.

porting at General Pershing's headquarters at Chaumont, his marked ability and outstanding personality indicated him at once as an extremely desirable officer for staff duty. But he was so essentially an outdoor man that he was restless on the staff and longed for line duty. He was soon sent to the front and saw service with the First and Twenty-sixth Divisions, first as an engineer, and later as a field officer of Infantry, commanding his regiment in the principal battles of 1918. He participated in the actions of Cantigny, Champagne-Warns, Aisne-Marne, St. Michiel, and the Meuse-Argonne. He was severely gassed in action. My last memory of him in France was when, just before sailing for Lyons in December, 1918, he came to see me at Tours, wearing the eagles of a colonel which he had so gallantly won. His bravery in battle had been outstanding in an army of brave men. To the silver star won at Santiago in his splendid

youth he now added the French Croix de Guerre, the Legion of Honor, and the Etoile Noire. From his own country he received the distinguished-service cross, given only for the most extraordinary heroism in action, beyond the call of duty, and to win which one must descend into the very valley of the shadow of death. We of the old Army have always held the faith that the highest reward that can come to him who wears the uniform is the approbation of those with whom he has served. No man ever had this in more generous measure than John Campbell Greenway. In another age than ours he would have been a Richard the Lion-Hearted, a Philip Sidney, or a Chevalier Bayard, for his was the dauntless soul and the tender heart, without fear and without reproach.⁷

In both his athletic and professional careers, he played every game to win. He had the courage of a champion and he never accepted second place. He was just as competitive in his professional life. When he entered the field with a bachelors of science in engineering, he started as a furnace helper, a lowly position, with Carnegie Steel Company in Duquesne,⁸ where he earned \$1.32 per day. He rapidly advanced through the position of foreman of the Mechanical Department at Duquesne to assistant superintendent of mines for the U.S. Steel Corporation in Michigan. He was assigned the title of general superintendent of the Oliver Mining Company in Minnesota's Mesabi Range, where he started the mining operations.⁹ In 1910 he was named manager of the Calumet & Arizona Mining Company (C&A). It was while in this position that he developed the New Cornelia Mine at Ajo that allowed him to reach the zenith of his career.



Greenway's Brass Plate Arizona Historical Society in Tucson. Photo by Author 1994.

AJO

Mineralization at Ajo had been known for thousands of years. Native Americans crushed and ground the iron and copper minerals and mixed them with animal fat to decorate their bodies. Local Pimans called this paint *au'auho*. The Spanish apparently corrupted this term as *ajo*, their word for garlic.¹⁰ Their stone tools and grinding pits can still be found in the area.

After the Gadsden Purchase in 1853, American explorers tried to develop the area. Although highly mineralized, it defied development. Its remote, desert location and low copper content eventually discouraged all attempts at profitable operation. Shipments of the richest ores were hauled to the Gulf of California by mule train and shipped to Swansea, Wales for treatment. The tenor of the ores, however, could not long support the extensive freighting costs, and this venture quickly failed. Several attempts to smelt the ores failed, because the copper content was too low and Ajo lacked a convenient source of water and cheap fuel.

One of the most infamous attempts, the McGahan Vacuum Furnace,¹¹ was executed by Fred L. McGahan, a slick-tongued Irishman who was able to court influential investors out of their holdings. He convinced the two leading companies in Ajo in 1900 that his furnace would solve their metallurgical problems. He claimed that his furnace, by not allowing nitrogen to contact the ores in the smelting process, would allow the constituents of the ores to separate into their natural elements. Once separated, they could be tapped off at various levels and sold at market purity. After receiving nearly \$100,000 from the principals of the companies, McGahan started construction on the furnace.

The furnace was a brick-lined structure, twenty-five feet high and six feet in diameter. Cylinders for oxygen and hydrogen gases surrounded the furnace and a massive pump to maintain the vacuum was mounted above all else. Spigots placed up the side of the furnace would allow the operator to extract the elements at their appropriate level. The spigot at the bottom tapped off the gold, a little further up one tapped silver, above it was one for copper, then calcium, sodium, silicon--and at the top were spigots for oxygen and hydrogen. It was convincing to all but those knowledgeable in metallurgy. To them it was delirious nonsense. The smelter could not and would not work.

On the day that the furnace was to be blown in, McGahan called for an additional \$200,000 payment before he would proceed further. The investors realizing, at last, that they had been bilked by McGahan, had him arrested and taken to court for obtaining money on false pretenses. He countered that he was being victimized by the investors. They eventually dropped their charges and McGahan got off with most of the money they had given him.

Unfortunately, the furnace is no longer in existence. It would have made a great monument to investor's greed, a promoter's promise, and fraudulent investments in mining.

The oxide nature of the near-surface ores prevented concentration of the low-grade ores. This is still a problem and although oxide ores produce about 50% of Arizona's copper; they are treated using some of the process principles pioneered by Greenway and his staff at the New Cornelia Mine.

Greenway first heard about the Ajo copper deposit from a driller friend who had just finished drilling for the New Cornelia Copper Company (NCCC) in 1910. After listening to the driller he knew that the district should be examined by a professional. For this work he first recruited Ira B. Joralemon, a young mining engineer,¹² who was already acquainted with the property.

Joralemon, who later wrote of his involvement in Ajo, said of Greenway:

John C. Greenway was responsible for much of my success in the seven years from what I called the end of my apprenticeship in exploration until I entered the Army in World War I. I first met Greenway on my return from the Promontorio and, as he was replacing Powell, he was to be my boss. Even at first glance you couldn't help liking and trusting him. He was tall, well built, and erect - an old Yale athlete. . . . He became the best manager among those who ran the big copper mines. He was open-minded in encouraging discussion and even opposition - until he made up his mind. Then, in military fashion, everyone must follow his decision without question. I think this is an essential of good management. Unfortunately a few did not feel this way and they had to leave.¹³

Joralemon recognized the deposit as belonging to

the copper bearing quartz monzonite porphyry model that was then being described by geologists from such diverse camps as Butte, Montana; Bingham Canyon, Utah; and Ray, Arizona. Among the older and younger formations of the district he mapped the six-square-mile outcrop of the Cornelia Quartz Monzonite. Noting the areas of intense alteration and the areas where copper oxides were most plentiful, he outlined an area of interest. In accordance with the current theories of the day, he anticipated that this copper oxide area represented a large deposit of copper sulfide mineralization that had been eroded and the original sulfide minerals leached to leave these oxide minerals. Still working within the geologic model, and estimating the amount of oxidized and leached copper minerals, he estimated that about 50 percent of the copper had been leached from the surface and would be redeposited as a sulfide at the water table. From the elevation of ground water in the sparse seeps and wells in the area, he would have been able to estimate the depth to the water table and from this calculate the thickness and grade of the enriched sulfide blanket. His report to Greenway stated his findings.¹⁴

After reviewing Joralemon's report, Greenway was convinced that the deposit was a large one and made note of its many problems. Greenway then convinced the C&A to acquire an option on the New Cornelia Copper Company.¹⁵ This option, for 70 percent of the NCCC's 1,200,000 shares of stock, called for the stock to be issued to the C&A as it spent money in developing the property. The remaining 30 percent of the stock was delivered to its original investors.

Greenway based his faith in the property on his conviction that the great masses of oxidized ores would be amenable to a new technology which he would develop. He immediately consulted metallurgist, Dr. L. D. Ricketts, an acquaintance from Bisbee. Together they devised a complicated leaching process that included sulfur recovery from smelting the Bisbee ores at C&A's Douglas smelter. As sulfuric acid, it could be used to leach the copper from the surface oxides. The copper could then be recovered by precipitation on iron or perhaps through electrowinning.

Greenway expressed his optimism in a letter to his close personal friend George A. Newett on Feb. 11, 1913:

When I came west three years ago to take charge of the Calumet & Arizona properties, I

formed the belief that the future of rich Bonanza properties, like those owned by the Calumet & Arizona Mining Company in Bisbee, should be coupled with their natural complement, a low grade steam shovel property, where the tonnage and characteristics of the ore could be fully developed by drills prior to the mining and beneficiating of the ore. I found this property at Ajo. I do not care to give you the figures at this time, but will tell you something of interest when you come out to see us later.¹⁶

Greenway's optimism found immediate opposition from several noted professional engineers and metallurgists, who immediately recorded their belief that a process could not be developed to render the Ajo ores commercial.¹⁷ The C&A showed caution in 1912, when the *Annual Report* described the New Cornelia as "an outcrop of copper-stained monzonite . . . being developed for disseminated ores by a systematic drilling program to find an open-pit minable deposit."¹⁸ No mention was made of the metallurgical problems, the remoteness of the site, or the drastic lack of water.

Diamond drilling and test pitting began as soon as the agreement with New Cornelia was signed. Greenway personally directed the drilling. But, before this reserve could be classified as ore, the bench scale leach tests had to be corroborated by a pilot plant operation. If this program would upscale and Ajo's oxides could be leached economically, ore reserves would stand at 30 million tons of 1.5 percent copper. Infeasible results would mean these reserves would be as worthless as its detractors predicted. The pilot work started at Douglas was followed the next year by a larger program at Ajo. If there were any doubts about the feasibility of the process, they would be worked out in a still larger pilot plant.

In his letter to George A. Newett of December 1, 1914, Greenway describes the progress at Ajo:

Ajo is coming on fine. No. 1 well is down to the water and I believe we have plenty of it. We will know in the next month.

On the leaching we are making very satisfactory progress with the process I originated. I should say we will be ready to make final recommendations in this matter within three months, perhaps sooner.

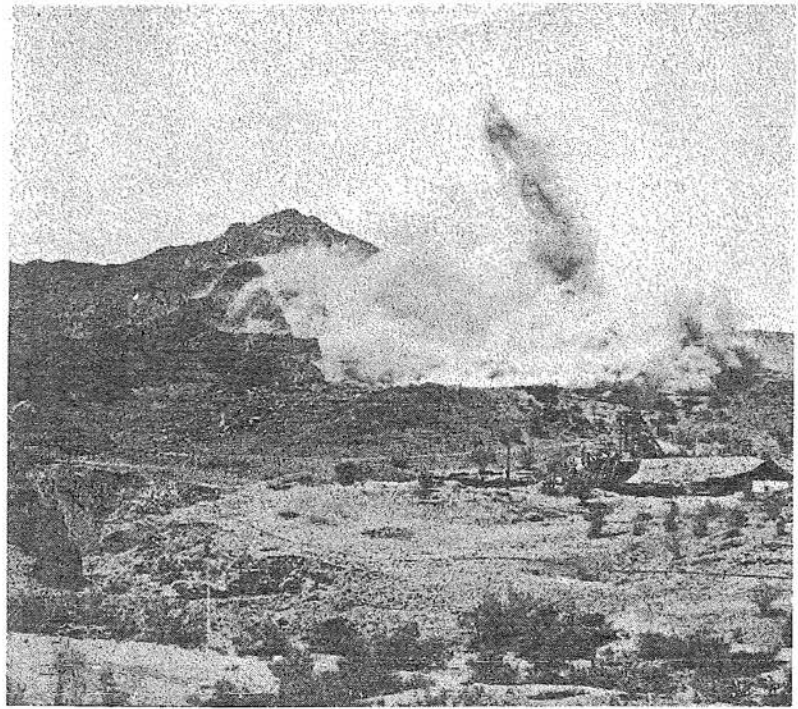
Getting patents through the Government Office will probably be the last thing we have to clean up. I expect this information will be sufficient for the present, so with kind regards, I will close.¹⁹

Greenway, Ricketts and the Calumet & Arizona's research staff quickly developed a pilot plant flow sheet for the Ajo ores. This system involved crushing and leaching the ores with dilute sulfuric acid in lead-lined vats. From the start the plan leaned toward electrowinning copper directly from solution. This would produce cathode grade copper which could be marketed directly and within a month of mining. Precipitation and conventional smelting required six months from the time the ores were mined until a copper product could be sold. This quickened cash flow was a large plus for the electrowinning process. Greenway's direct involvement in this work would later be recognized by two of his chemists when they referred to his approach as the "Greenway Process."²⁰

The pilot plant allowed the observation and resolution of many problems before the plant was built. Among these problems, how to handle increasing amounts of dissolved iron in the solution and how to insure the purity of the resulting copper cathodes required innovative solutions and resulted in a net savings of about 2.5 cents per pound of copper.²¹ As a result, the NCCC cathodes from the final plant assayed within the required 99.9 percent copper.

Finding an adequate water source at Ajo was a challenge that has followed the camp to the present time. Greenway tackled this problem in his typical technical manner. He and one of the C&A's geologists theorized that some of the later volcanic formations in the area had flowed over a large alluvial basin. They suspected that the trapped gravel was a confined aquifer filled with water. They were right, but the gravels were not as open as they might have wished.

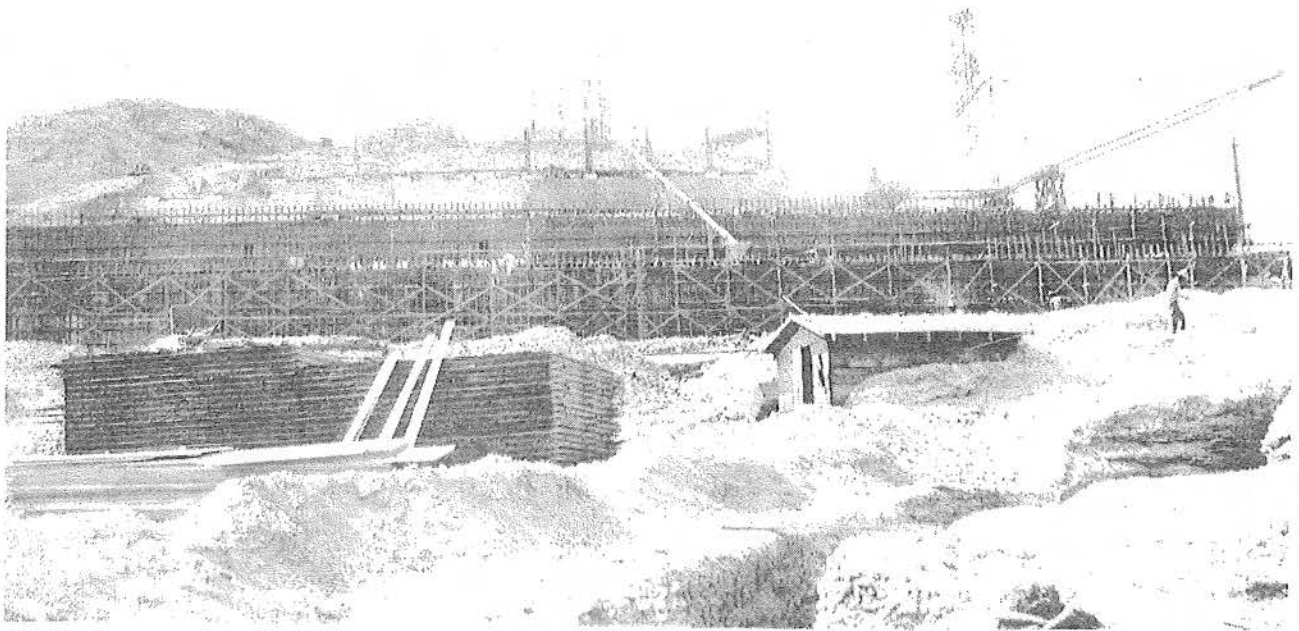
The first well was drilled in 1913 and tested at 197 gallons per minute. A mine shaft into this formation was planned for a location about 100 feet south. They



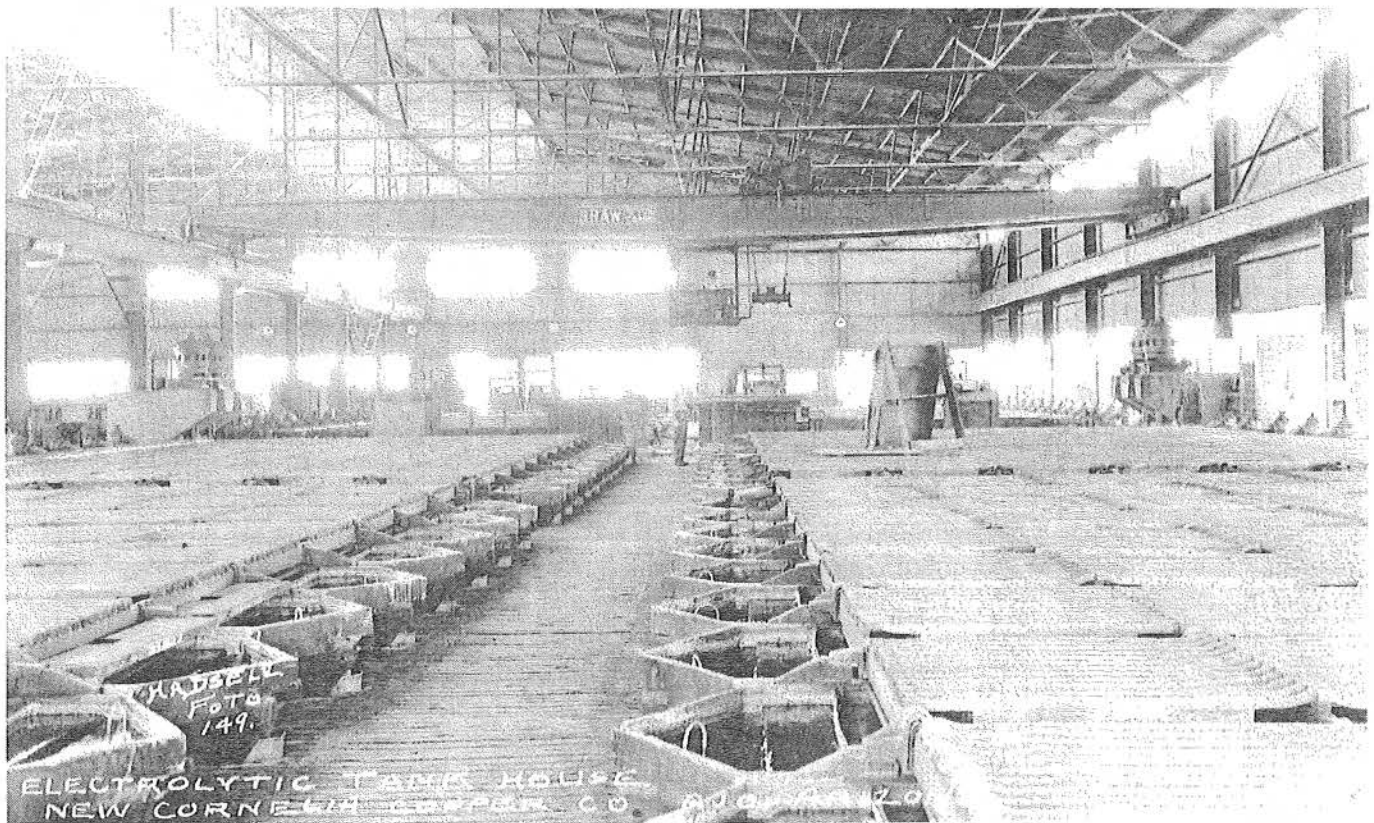
THE FIRST BLAST, c. 1916, This was the first blast on Arkansas Mountain and depicts the start of the open-pit mining operations at Ajo. Photo from George A. Newett.

were located about thirteen miles northwest of the Ajo open pit, where the well and the shaft were completed to a depth of 665 feet. Together they produced a little over 500 gallons per minute. This flow was considered adequate for the planned townsite and 4000-ton-per-day leaching plant.

Meanwhile, testing of the Ajo leaching system continued at C&A's Douglas Smelter. At this pilot leaching plant, a recovery of 80 percent was easily demonstrated.²² The smelter demonstrated its ability to make surplus sulfuric acid. The anticipated iron build-up was solved by aerating some of the high-iron solutions with sulfur dioxide. In this operation, the iron was precipitated out of solution. Operation of the pilot plant also indicated that some of the pregnant solution would have to be bled off and sent to iron launders to further check the ferric iron build-up. Now the company decided to move the pilot plant to Ajo for additional testing. After an entire year of operation, they expanded the capacity to 40 tons per day, and on January 31, 1915, they put this larger plant into operation. During its first year, it treated 12,000 tons of ore containing 1.25 percent copper and achieved a re-



VAT LEACHING, c. 1917 This is the vat leaching tanks that the NCCC constructed to hold the broken oxide ores while they were being leached. Photo from George A. Newett.



ELECTROLYTIC TANK HOUSE, NEW CORNELIA COPPER CO. AJO, ARIZONA, C. 1920. Photo by Harsell. This photo show the surprising amount of automation that the NCCC achieved at this early date. Photo from George A. Newett.



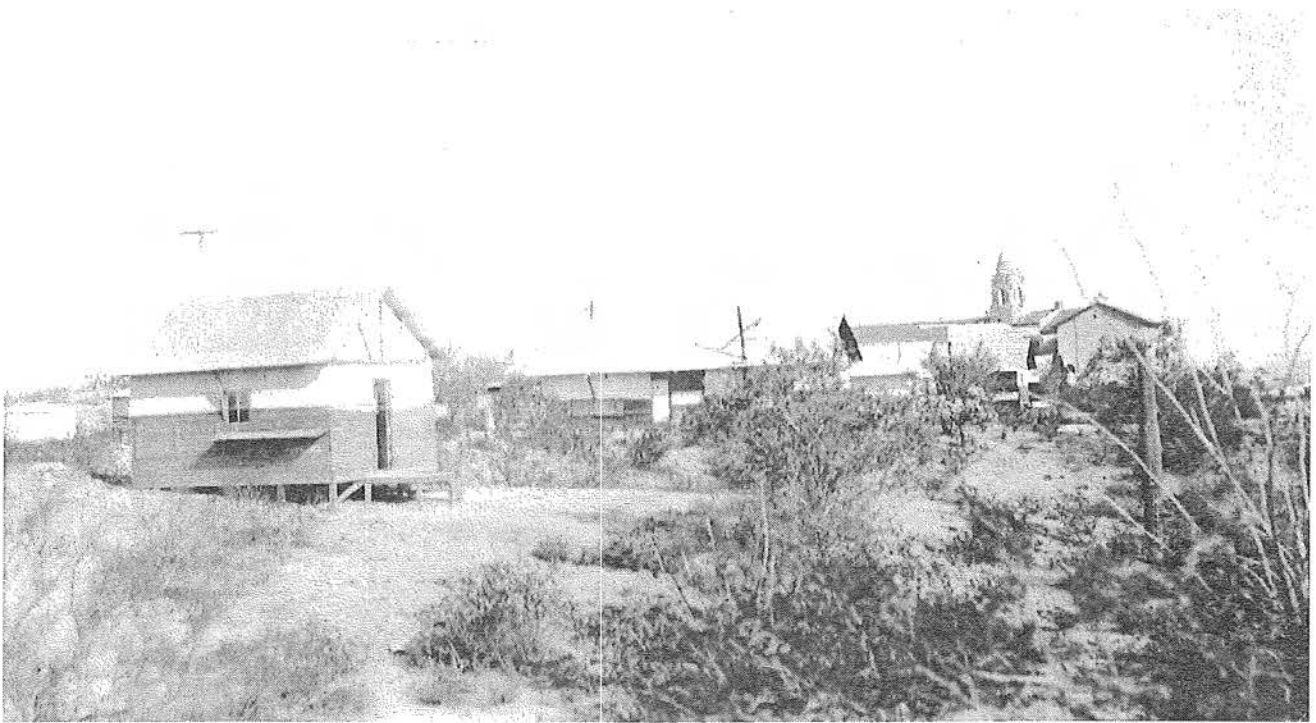
START OF MINING C. 1917. As soon as the railroad started bringing in the equipment the mining operation started. Photo from George A. Newett.



STEAM SHOVEL C. 1917. The steam shovel and rail haulage was a mining system that John C. Greenway brought with him to Ajo. Photo from George A. Newett.



AJO HOUSES, c. 1920. This image of the Ajo housing was made by George A. Newett during a New Cornelia Copper Company Board of Directors meeting at the mine some time in the early 1920's. Apparently these are duplex houses in what was called Mexican Town. Photo from George A. Newett.



EARLY AJO HOUSING C. 1917. The tent house on the left was typical of about 50% of the housing in Arizona at the turn of the century. One of the NCCC's first activities was to provide adequate housing for all of its employees. In spite of the best efforts of the company some of these tent houses remained in Ajo until the late 1940's. M. Curley School in the Background. Photo from George A. Newett.

covery of over 70 percent.

Based on the continued success of the pilot plant, the company directors committed to a \$4 million investment for a production plant at Ajo. The plant would produce 36 million pounds of copper annually and could be completed by July 1, 1917. This thirty-six million pounds of copper was sufficient to electrify a community of about one million people at that time. George Newett in a letter to Greenway quoted Mr. T. F. Cole, another director of the C&A and the NCCC: "Greenway has dug up a most valuable property in New Cornelia, and is doing good work for all our interests in the southwest."²³

Greenway argued with the C&A management that good housing and a town with churches and schools would attract the stable labor force that the operation required. He won over the objection of several C&A officers and directors.²⁴ Although they agreed with Greenway's approach, they argued over how much and when. He had just come from a similar environment, where he had built the town of Colaraine, and must have been convincing in his arguments. He hired reliable architects and started building a model company

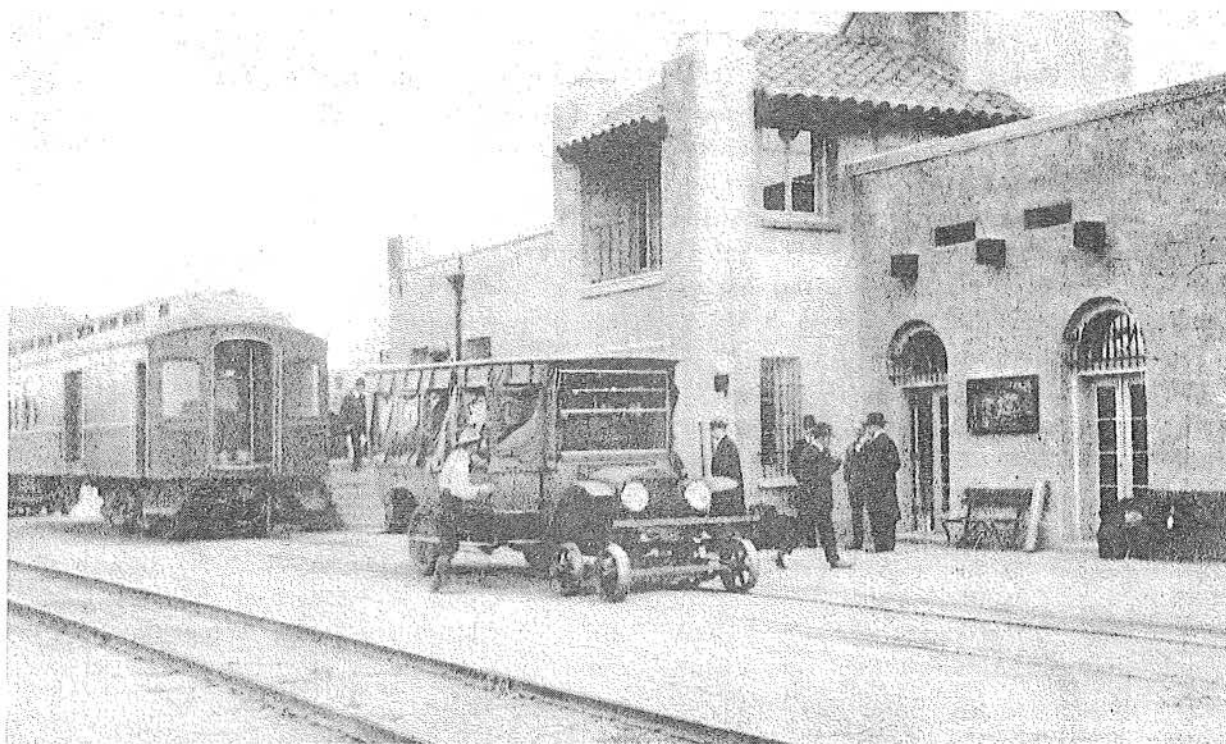
town in the Southwest. The townsite was nearing completion by the end of 1916 and included a plaza, business block, schools, and the best hospital in Pima County.

To manage the day-to-day operation of the mine, Greenway invited his old friend and former employee, Mike Curley, from the Measbi to join him in Ajo. Curley arrived in Ajo in 1913. He would have received a written offer from Greenway that would have been very business like and short of words. If his letter to Harry Clark was typical of his offering, it tendered a reasonable wage, moving expenses, a short description of the job situation and little else. There were no promises, but a general tone of great appreciation.²⁵ Curley stayed with the New Cornelia through all its mergers, retiring as manager of the New Cornelia Branch of the Phelps Dodge Corporation in 1939. From 1913 on, Curley supervised all the day-to-day operations at Ajo.

The initial mine design called for three 100-ton steam-shovels and a system of rail haulage that dumped directly into a gyratory crusher where the ore would be crushed to 1/4 inch. The crushed ores were



NCCC DIRECTORS IN ROUTE TO AJO, C. 1923 From left to right James E Fisher - Secretary and Assistant Treasurer, William H. Newett - visitor, William B. Mershon - Director, M. Curley - Superintendent, Thomas H. Collins - Director, Charles Briggs - Director, Thomas H. Collins - Director, Walter B. Congdon - Director, Thomas F. Cole - Director, Frank J. Kohlhaas - Director. Photo from George A. Newett - Director.



AJO STATION C. 1917. Rail transportation was the best way to transport materials and supplies when the Tucson, Cornelia, and Gila Bend Railroad established this essential link between Ajo and the Southern Pacific Railroad at Gila Bend. Photo from George A. Newett

conveyed to one of twelve 5,000-ton lead-lined concrete tanks. Four sulphur dioxide adsorption towers reduced the ferric iron to an insoluble ferrous compound, which was precipitated out of the solution. Electrical power for the entire operation was provided by a power plant, brought on in July, 1917.²⁶

Connecting Ajo to the outside world, the Tucson Cornelia and Gila Bend railroad (TC&GB) tied into the Southern Pacific at Gila Bend. This short line started from Gila Bend, a stop on the Southern Pacific,²⁷ and began making daily service to Ajo when completed in 1915. The entire 35 miles was lined with 70-pound rail. During its first year of operation, it hauled 64,000 tons of freight.²⁸ Ownership was held by the El Paso & Southwestern Railroad and the Calumet & Arizona Mining Company. The El Paso and Southwestern was a wholly owned subsidiary of Phelps Dodge Corporation and Copper Queen Mining Company, C&A's principal rival in Bisbee. This railroad ownership is another curious aspect of the strange courtship between the Calumet & Arizona and its friendly competitor, the Phelps Dodge Corporation, which ended in the merger of 1931.

Again writing to George A. Newett, Greenway describes the progress of the railroad:

The Ajo work is developing finely. Rate agreements with the Southern Pacific and El Paso & Southwestern Companies have been signed up. Permanent location of the railroad has been made and the work is now open for examination by contractors and we expect to award the contract about the middle of June. The road will cost approximately \$700,000.00 to complete. There is no gradient in the line from Gila Bend out 36 miles that is over 1/2 of 1% and no curves over 3 degrees. From this point back to Gila there are no adverse grades, all grades being either level or minus. From the 35 mile post into Ajo, there is a gradient of approximately 1.25 percent. Rail heads should reach Ajo, if our plans carry, sometime in January.

I also hope to be able to have material for construction of the plant ready for delivery into Ajo when the road is ready for transportation in order that there should be no break between the completion of the road and starting of construction work.

We have not been able to develop the results in the 40-ton plant that we have gotten in the 1-ton plant, but the work is improving right along and Ricketts and I consider the process is in satisfactory shape.²⁹

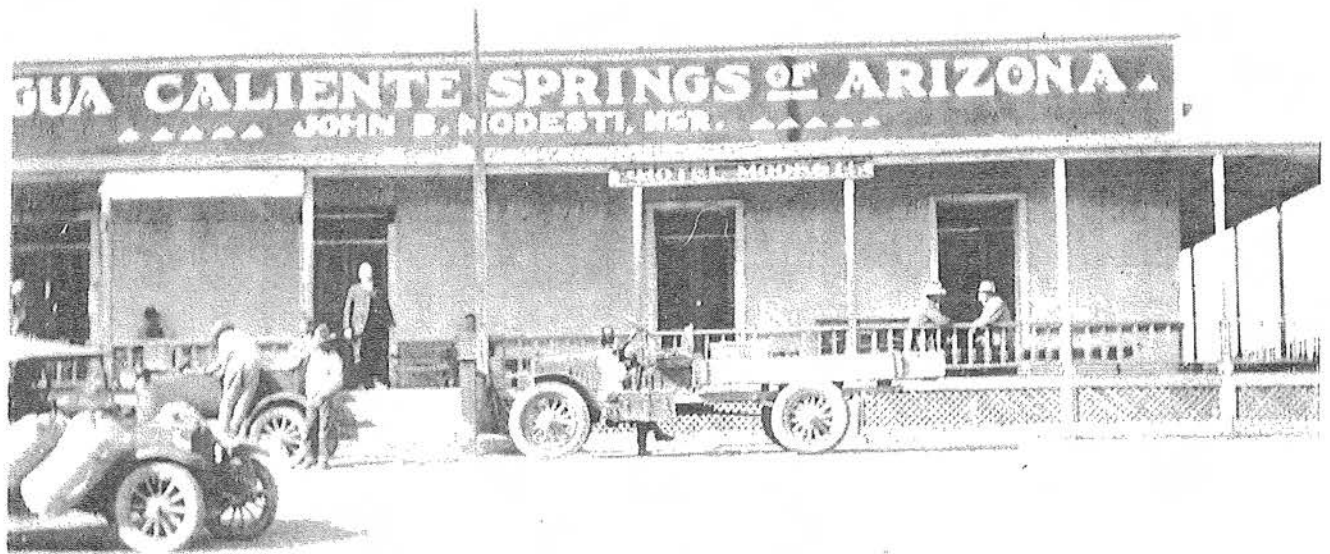
Including the town, the railroad, and the extensive water development plant, the overall cost of the development was estimated at \$7 million. Opposition to this large sum among the directors of the NCCC continued. They felt that it was too much to spend on a property that still seemed unproven. Some of the directors felt the townsite was an unnecessary luxury. Their reluctance forced Greenway to secure every dollar under criticism. Earlier opinions that the Ajo ores could not be profitably handled were brought up and rehashed at the board meetings.³⁰ In a letter to Greenway, Newett wrote, "I was very glad C&A directors decided on \$1.25 (dividend) as it is saving a lot of criticism. Most holders of the stock do not realize just what is being done for them at New Cornelia and other places."³¹

Although beset with these difficulties, Greenway

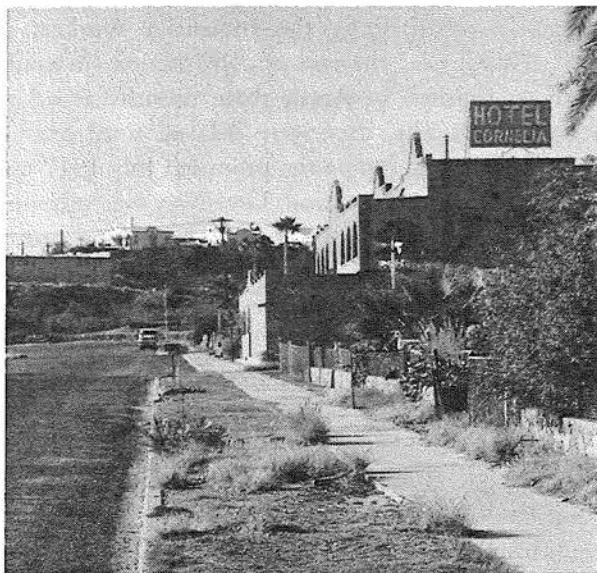
allowed no pause in his planning, and if the project had not been struck by the Industrial Workers of World (IWW) near the end of construction, it would have been finished in April, three months ahead of schedule. As it was, they were delayed until May 1 leaving two months before the promised July 1917 target date.³² During this period, Greenway was traveling around the country inspecting and purchasing equipment for the project.³³

One of the financing techniques used by the C&A to fund this operation was the issue of \$4 million of sinking fund gold bonds at 6 percent convertible for \$10.00 per share. The C&A bought \$3.1 million of these bonds as soon as they were issued.³⁴ The remaining bonds were immediately picked up by the directors and officers of the C&A and the NCCC. The El Paso & Southwestern, which provided at least some of the funding and a great deal of expertise, helped out with the costs and construction of the railroad.

During the middle of construction, and again at the end, the C&A Board of Directors toured Ajo to view the progress. Several photographs taken by George A. Newett, a director of the company, are featured in this essay.



AGUA CALIENTE SPRINGS OF ARIZONA, c. 1920. This is the stop on the Southern Pacific Railroad where the passengers to Ajo left the railroad to travel by motor car or wagon to Ajo. This photograph taken in the early 1920 shows the motorcars being readied for the two day trip. Photo from George A. Newett.



HOTEL CORNELIA Was deserted and windows boarded over when the author took this picture in January of 1994.

Three Osgood steam shovels and 36 twenty-cubic-yard side dump railroad cars were delivered to Ajo as soon as the rail was completed. The equipment for crushing, leaching, acid storage, the electrolytic tank house, power plant and other facilities were soon delivered to the camp.³⁵ With the new equipment on hand the plant was quickly completed.

From the May 1, 1917 start-up until the end of the year, net profit from operations reached \$760,000. The first 53,000 tons of ore averaged 1.58 percent copper. Reserves at year-end stood at 30 million tons of oxide carrying 1.83 percent copper. Thirty-nine million tons of sulfides grading 1.75 percent copper had also been developed. The company began testing a flotation process for these ores the following year.

In 1917, just as the plant was starting, the U.S. declared war with Germany. Fiercely patriotic, Greenway joined the Army, where his record during the next year was exemplary. He entered into service as a major in the Army Corps of Engineers.

A large gathering of his friends organized a departure party in Bisbee before he left for Europe. At that all-day community celebration, Greenway described the vital need for copper in the war efforts of the U. S. and its allies.³⁶ During his service he was honored and decorated several times for heroic episodes by both the U.S. and the French governments. After the

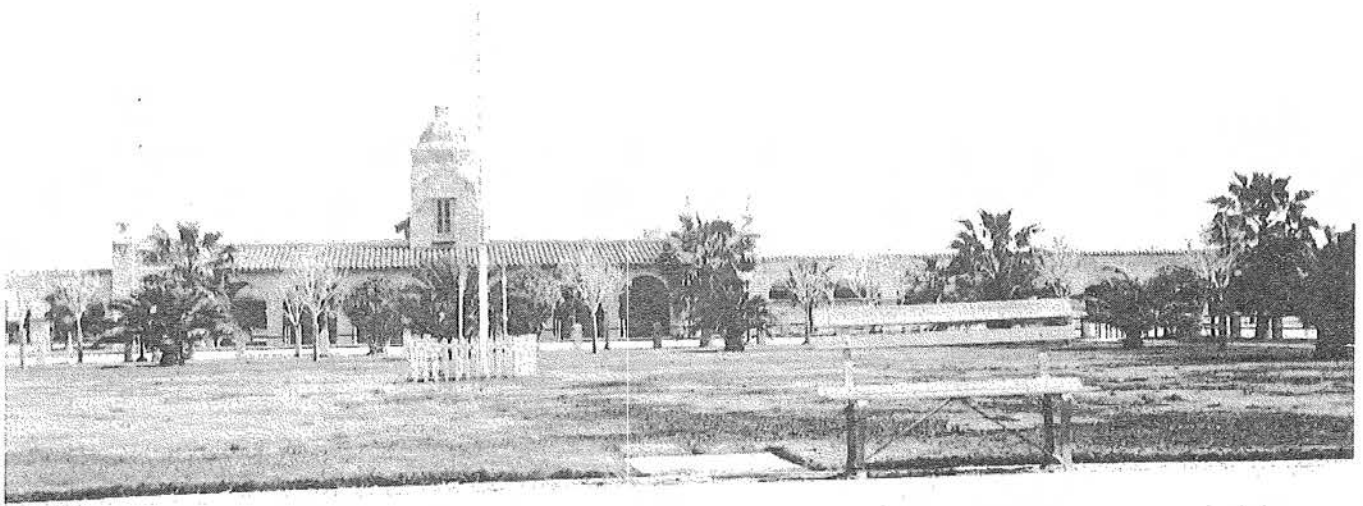
Treaty of Versailles he left France a breveted general.

The Armistice created a copper glut and during the next year a large surplus of copper was stockpiled by producers. In the face of this surplus, Greenway was still able to convince the NCCC to install a second pump and start a 500-ton-per-day flotation pilot plant to test the sulfide ores.³⁷

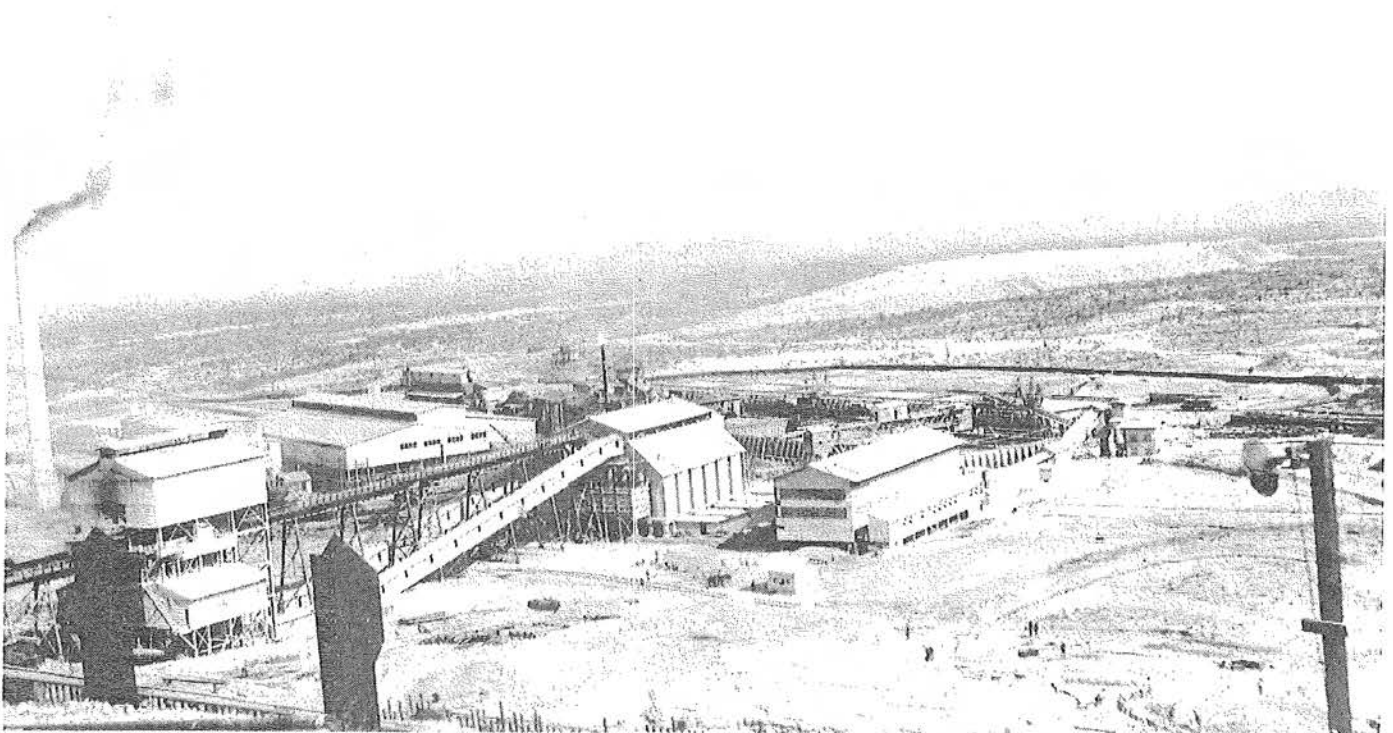
The flotation process at that time had become the most accepted form of copper sulfide concentration from low-grade sulfide ores. It was developed after Carey Everson who washed miners, clothes noticed that the soap bubbles would attract and hold the copper sulfide minerals. In this process the ore is crushed and ground to the consistency of corn meal, mixed with water, oil and soap, and then subjected to a bubbling action. The sulfide minerals attach themselves to the bubbles and are brought to the top of the solution where they are skimmed off and the minerals collected. Thickened and filtered, this sulfide pulp is sent to the smelter where the sulfur is burned off and other impurities removed by fluxing. The resulting copper matt is first reduced to an oxide by introducing oxygen, and then the oxygen is removed by poling the mixture with green logs.

In spite of the recession and depressed copper market, the NCCC continued to build and improve the townsite and the community of Ajo. In 1918, the company built sixteen new houses for employees, installed a ten-ton-per-day ice plant, and operated the New Cornelia Mercantile Company store on a competitive basis. The community, like most southwestern towns, was segregated with Mexicans living in "Mexican Town," Indians living in "Indian Town," and Anglos living in Ajo proper. The squalid conditions of Mexican Town were so bad that the company made this the first segment of the population to receive new housing. Most of these homes were of the duplex type and housed two families. The Anglo community in Ajo was the last to be rebuilt. Ajo families still lived in tent houses through World War II.

The NCCC encouraged alternative stores to the co-operative and even provided them with incentives to enter the community. These incentives included reasonable rental rates and cheap utilities. The biggest advantage of the co-operative was a 15 percent profit refund made to employee customers in time for Christmas shopping.³⁸ Studies by the company



THE PLAZA, c. 1923 Complete with Flag pole it was the only grassy plot of ground in the 300 miles between Tucson and Yuma. Photo from George A. Newett.



THE MILL AT AJO C. 1923. An overall view of the mill. The smoke stack at the left was from the sulfide roasting plant which roasted ores from Bisbee to provide sulfur gasses for the leaching operation. Photo from George A. Newett.

showed that 76 percent of the employees shopped at the cooperative, and, although prices were slightly higher, the quality was above standard.

Early in the development of the town, the company planned a plaza surrounded by trees, a gazebo, and grass. A virtual oasis in the desert, it provided a well-shaded area for picnics and parties. Stores, a theatre, the TC&GB terminal, and churches lined the plaza. To make life more enjoyable, the company built a large swimming pool for all of its employees as soon as the mine was on a stable and paying platform. During the summer of 1921, this pool served 11,647 customers, but only 48 people learned to swim.³⁹ The paved streets of Ajo radiated from the plaza. In the first blocks they planned a Protestant church and a Catholic mission. Partially completed in 1921, the church and mission served a community of 747 employees, including 442 of European or American extraction, 297 Mexican or Indians and eight blacks. Ajo was on par socially with other southwestern towns and mining camps.⁴⁰

Ajo was first and alone in developing a leaching operation for its oxide copper ores, and first to resolve the electrowinning problems in recovering a directly marketable product. Economically, this mine made a substantial impact on Pima County. In 1919 it paid about 40 percent of the Pima County taxes, or about \$1.85 per man-shift. The average wage paid to workers at the mine was about \$5.90 per day.⁴¹

Greenway began pushing the company to build a sulphide mill in 1920 to accommodate the increasing sulphide ores. He received approval in 1922 and began to design a mill with a flotation capacity of 5,000 tons per day. The new mill would require additional water, and the company immediately started its second water shaft, with a planned depth of 656 feet. Drifts into the aquifer would be driven horizontally from the bottom of the shaft to provide additional water flow to the pumping plant. The water requirement for the new mill was anticipated at 4,000 gallons per minute. Although this volume would not be considered large by Salt River Valley farmers' standards, it was a large volume to extract from the gravels that the NCCC had located several years earlier.

Additional locomotives, dump cars, and steam shovel equipment would be required to move the planned 5,000 tons of ore per day to the new sulfide

mill. The deepening mine needed more track to reach the ore faces and more time per trip to spiral the ore from the mine to the mill on the 4 percent grades that still restrict rail traffic.

At year-end 1922, the NCCC was back to being a healthy cash-winning subsidiary of the C&A due to the continued production of copper from oxide operation.⁴²

As the sulphide concentrator neared completion in 1923, the attention to planning for corporate success continued, as only three years of leach reserves remained and a smooth transition would be required to keep this subsidiary solidly in the black.

Two new shovels, three locomotives, and 20 railroad cars were prepared for assault on the sulfide ores. As a part of the scheme to switch over to sulfide ores, the mine planned to start roasting their own ores for the sulfur gas that it used to reduce the iron in its now famous process.

After a slow start, the Ajo flotation mill operated at 50 percent capacity during 1924, when it treated 1.8 million tons of sulfide ore and leached 1.2 million tons of oxides. The expansion was completed and Ajo increased production to nearly 64 million pounds of copper.⁴³

With this increase in copper production, NCCC got a substantial boost in earnings and income. On assets of \$33 million and through sales of nearly \$9 million, the company was able to hold an operating profit of just under \$3 million dollars. They paid out \$675,000 in dividends and produced nearly 64 million pounds of copper. As a bonus, the flotation of the sulfide minerals also recovered 106,000 ounces of silver and 10,675 ounces of gold. This precious metals extraction at Ajo remained an important contributor to Ajo's production throughout its operating lifetime.

The NCCC continued to improve the condition in the townsite. Through generous donations which were matched by contributions from the community, the Ajo Federated Church was completed early in 1926. The Catholic Mission already erected was dedicated on Thanksgiving Day, 1925, in an all-day ceremony of prayer and thanksgiving.⁴⁴

The NCCC organized, funded, and then transferred title to their utility to the Ajo Improvement Company in 1925 to provide lights and water to the community.

Continued exploration and blocking out of new reserves was successful, and at the end of 1925, reserves stood at 54 million tons, with an average grade of 1.41 percent copper as sulfides. The oxides dwindled to just slightly over three million tons averaging 1.25 percent copper.

John C. Greenway resigned as general manager of the Calumet & Arizona Mining Company on June 30, 1925. For years a rift had been developing between Greenway, the president of the C&A, and several of the directors over a commitment that Greenway made regarding a small mine in New Mexico. The C&A acquired the 85 Mine, located about five miles south of Lordsburg, New Mexico, to provide flux for the Douglas smelter. Greenway made a verbal commitment during the negotiations to provide the former owner with 9,000 tons of ore from the mine. After reviewing the contract, the C&A attorney observed that the contract was not binding and they did not need to honor Greenway's commitment. Greenway claimed that it was a moral obligation and that the company should deliver the 9,000 tons to Doer and his Kansas City Smelting and Refining Company. After several letters and telegrams, Greenway submitted his resignation.⁴⁵ The other officers and directors apparently convinced Greenway to stay on board, but the rift had already started and Greenway had his own programs, including politics, dam building and developing new mines. His untimely

demise ended these plans.

Perhaps the real reason for Greenway's resignation can be found in a letter from Gordon R. Campbell's letter to Harry A. Clark of May 23, 1925:

My dear Harry:

When I arrived at Arizona early in April, Mr. Greenway handed me a letter which, much to my surprise, proved to be a tender of his resignation as general manager of Calumet & Arizona Mining Company and of New Cornelia Copper Company. He asked that it be presented to the directors immediately and this was done at our meeting at Ajo. It was considered advisable to defer action for the reasons that several directors were not present and that we might have opportunity to consider and formulate our policy as the result of his resignation.

After very careful consideration and after canvassing the whole situation, it was the opinion of every member of the board of directors and it was therefore unanimously agreed that the resignation of the general manager should be accepted, effective June 30 next, and that no general manager should be appointed to succeed him for the present.



AJO HOSPITAL, c. 1920. Many of the early mining companies took great pride in having the best hospital for its employees. The large building on the left is the hospital. One of the large houses on the top of the hill was assigned to the companies Chief Surgeon. The other two houses belong to the General Manager and the General Superintendent. Photo from George A. Newett.

By the same unanimous judgment it was agreed that you should be made "manager"? of Calumet & Arizona Mining Company proper; that E.E. Whiteley should be made "assistant manager;" and that M. Curley should be named as manager of New Cornelia Copper Company.⁴⁶

Interpretation of this letter at this late date is difficult. In the preceding years Greenway had been elected to the board of directors for the corporation but was not made its president. There had been other recent changes in the corporate structure, and perhaps he was disappointed in not being promoted. At any rate they did not replace him as general manager but created other positions that were subordinate to the president and the board.

Greenway alone was responsible for the C&A's involvement in Ajo. He had pushed a reluctant corporation into acquiring the property and he had succeeded where other noted mine operators had failed. He made the mine a technical and financial success in the face of their stated doubts. It was his imagination, his leadership, and most of all his perseverance that made Ajo successful. This success can best be seen by graphing Ajo's copper production from 1917 to 1928.

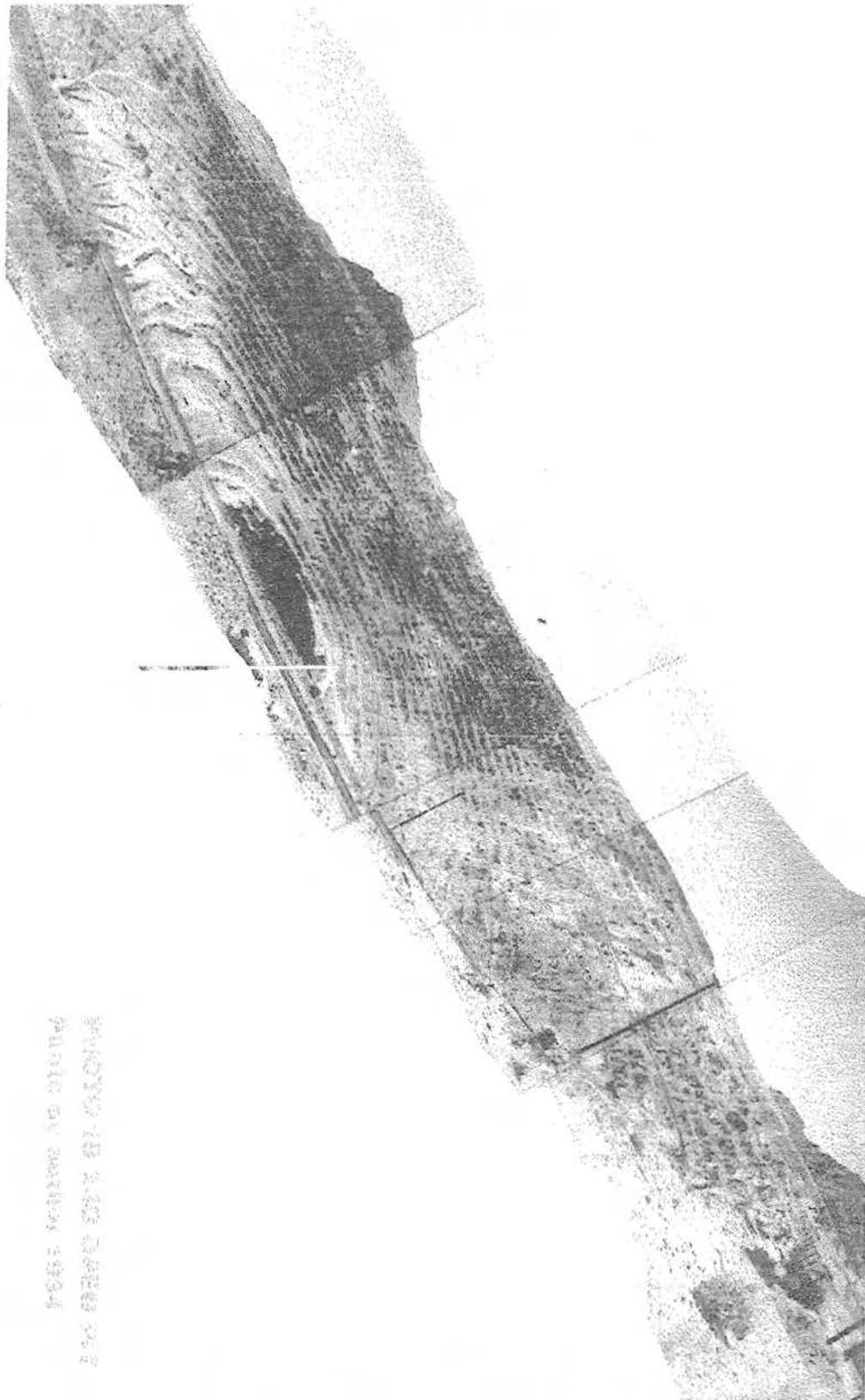
In spite of Greenway's early demise, Ajo continued to produce great quantities of copper for the New Cornelia Copper Company and the Calumet &

Arizona until that company's merger with Phelps Dodge during the Great Depression. Operations were suspended for a few short years in the mid-30's, only to be restarted, rebuilt, and revamped to be one of the primary sources of revenue for Phelps Dodge and one of the all time great copper producers for the U.S.

EXHUMATION AND REINTERMENT

Jack Greenway, who was born two years before the general's death, and was raised by his mother at the Arizona Inn in Tucson had provisions in his will to be buried with his mother in the family vault near Burlington in Boone County, Kentucky. He also had provided that his father be removed from his Ajo vault to join them there. Jack died in October 1995. On November 5, 1995, after hallowing their Ajo location for 74 years the Douglas Funeral Home removed the last remains of an Arizona pioneer and mining magnate for reinterment in a state where his wife once lived.

It is doubtful that any monument to General Greenway could be built over his grave in Kentucky that would be as meaningful, dramatic, or as appropriate as his Ajo open-pit copper mine. Perhaps some future generation will recognize his contribution to the development of Arizona and build a great monument to John C. Greenway at the open-pit overlook.⁴⁷



AJO OPEN-PIT MINE Photo by author 1994.

Notes

1. Funeral Papers, Greenway Collection at the Arizona Historical Society in Tucson.
2. Clippings from the Greenway Collection at the Arizona Historical Foundation in Tucson.
3. Clippings from the Greenway Collection at the Arizona Historical Foundation in Tucson.
4. Roosevelt Correspondence in the Greenway Collection at the Arizona Historical Foundation in Tucson.
5. Hunter, George S. "The Bull Moose Movement in Arizona" *Arizona and the West*, U of A Press, Tucson, Vol. 10, No. 4, Winter 1968, p 343-362.
6. Spence, Clark C., *Mining Engineers & the American West, The Lace-Boot Brigade, 1849-1933*, Yale University Press, 1970, New Haven, p. 352.
7. Address by Major General Harbord *Acceptance and Unveiling of the Statue of Gen. John Campbell Greenway*, 71st Congress, 2d Session-Senate Document No. 167, U.S. Government Printing Office, Washington, 1931.
8. Boese, Donald L., *John C. Greenway and the Opening of the Western Mesabi*, Itasca Community College, Grand Rapids, Minnesota, 1975.
9. Narrated by Tom Jay of Tucson, Arizona February 21, 1975.
10. Hoy, Bill, "Hardscrabble Days at the Ajo Mines George Kippen's Diary, 1855-1858," *The Journal of Arizona History*, V36, No. 3 Autumn, 1995, p 233.
11. Joralemon, Ira B., Copper, *The Encompassing Story of Mankind's First Metal*, Howell North Books, Berkeley, CA p. 185.
12. Joralemon, Ira B., op cit., p. 189. Joralemon claims that he was in the district in 1909 and already working for the C&A. The original publisher of the book insisted that it be titled Romantic Copper for good reason.
13. Joralemon, Ira B., *Adventure Beacons*, SME, NY, NY, 1967, p62.
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15. "John C. Greenway," *Arizona Mining Journal*, Phoenix, Arizona, October 1917
16. Greenway, John C. Letter to George A. Newett, Feb. 11, 1913.
17. Joralemon, Ira B., *Adventure Beacons*, op cit., p.63; Joralemon, Copper, *The Encompassing Story of Mankind's First Metal*, op. cit., 194.
18. *C & A Report to Stockholders 1911*. The term monzonite describes a certain type of igneous intrusive rock that is slightly different than the rock type recognized as bearer of most of the world's low grade copper deposits. Greenway's break with the popular preachments of the geological pundits of the time was yet another perceived blunder.
19. Greenway, John C. Letter to George A. Newett, December 1, 1914.
20. Morse, H. W. And H. A. Tobelmann, "Leaching Tests at New Cornelia", *AIME Transactions*, AIME, NY, NY, vol. 50, p. 830-955.
21. Dr. T. C. Chapman, U of A lecture notes April, 11, 1960, Metallurgy 220.
22. *C & A Annual Report to Stockholders 1914*.
23. Newett, George A., Letter to John C. Greenway, Feb. 11, 1915, copy in author's possession.
24. Narrated by Tom Jay, Bisbee, Arizona February 21, 1975.
25. John C. Greenway, Letter to Harry Clark, Calumet and Arizona Mining Company, Warren, AZ, August 19, 1910.
26. *C & A Annual Report to Stockholders 1915*.
27. *C & A Annual Report to Stockholders 1913*.
28. *C & A Annual Report to Stockholders 1916*.
29. Greenway, John C. Letter to George A. Newett, June 2, 1915.
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31. Newett, George A., Letter to John C. Greenway, Dec. 13, 1915, in author's possession.
32. Watkins, Robert A., John C. Greenway, *Arizona Mining Journal*, Oct. 1917 p1-3.
33. Greenway, John C., Letter to George A. Newett, March 25, 1916, in author's possession.
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39. *New Cornelia, Annual Report to Stockholders, 1921*.
40. *New Cornelia, Annual Report to Stockholders, 1924*.
41. *New Cornelia, Annual Report to Stockholders, 1920*.
42. *New Cornelia, Annual Report to Stockholders, 1922*.
43. *New Cornelia, Annual Report to Stockholders, 1924*.
44. *New Cornelia, Annual Report to Stockholders, 1925*.
45. John C. Greenway, letter to Mr. Kuno Doerr, July 12, 1920, The Greenway Collection Arizona Historical Society, Tucson, Arizona, 85 Mine folder; Mr. Charles Briggs, letter to John C. Greenway, July 12, 1920, The Greenway Collection Arizona Historical Society, Tucson, Arizona, 85 Mine folder; John C. Greenway, letter to Mr. Charles Briggs, August 7, 1920, The Greenway Collection Arizona Historical Society, Tucson, Arizona, 85 Mine folder; John C. Greenway, letter to Mr. Charles Briggs, August 13, 1920, The Greenway Collection Arizona Historical Society, Tucson, Arizona, 85 Mine folder;
46. Gordon R. Campbell, president of the C&A, letter to Mr. Harry Clark, about to be manager of the C&A, May 23, 1925, copy of letter in author's possession.
47. John Campbell Greenway has left Ajo for the last time, *Ajo Copper News*, Ajo, AZ, Nov. 8, 1995.