PHELPS DODGE CORPORATION

PRODUCERS, REFINERS AND FABRICATORS OF COPPER

Subsidiary Companies:

PHELPS DODGE REFINING CORPORATION

PHELPS DODGE COPPER PRODUCTS CORPORATION

General Offices:

300 PARK AVENUE • NEW YORK, N. Y. 10022

December 9, 1963

MINE TO MARKET

P D

PHELPS DODGE CORPORATION

300 PARK AVENUE

New York, December 9, 1963

To the Shareholders:

We enclose our check in payment of the dividend of seventy-five cents ($.75) per share payable December 10, 1963 on the capital stock of this Corporation standing in your name. Please deposit your dividend check promptly.

Dividends aggregating $3.00 per share were declared and paid during the year 1963 and, in the opinion of the Corporation, constitute taxable dividends for purposes of the United States income tax. They qualify, however, for use in determining the $50 dividends-received exclusion and 4% dividends-received credit provided under the Internal Revenue Code.

It will not be necessary to acknowledge the enclosed check, as your endorsement thereon is sufficient for that purpose.

Please notify Manufacturers Hanover Trust Company, our Transfer Agent, of any change in your post office address by completing the enclosed form and mailing it as directed thereon.

R. D. Barnhart, *Treasurer*

See: Arizona Mining Journal Jan 1918 p. 19,
July 1919 p. 24; June, 1918, p. 36

Phelps Dodge Corporation New Cornelia Branch (Active Mine file)

FIREFLY GROUP

PIMA COUNTY
AJO DIST.

A group of patented mining claims in the Ajo district of Arizona has been purchased by Phelps Dodge Corporation from the New Little Ajo Mining Company. The claims are known as Firefly and Firefly Nos. 1 and 2. A sales value of $186,000 was indicated by revenue stamps on the mining deed filed in the Pima County recorder's office.

Taken from MINING WORLD, Dec. 1960, p 35.

Knox, who recently sold 3 of his "Firefly" claims to Phelps Dodge, plans to patent the remaining 7 claims. They have been surveyed. He also holds 91 claims at Copper Mountain, which was drilled by Phelps Dodge. These holes disclosed low-grade copper mineralization. Phelps Dodge withdrew early in 1961.

LEWIS A. SMITH - Ajo Meeting - 9-5-61

Reference: AMJ, 1/18, p. 19; 7/19, p. 24; 6/18, p. 36

DEPARTMENT OF MINERAL RESOURCES

STATE OF ARIZONA

FIELD ENGINEERS REPORT

Mine: Firefly Group | Date: September 6, 1960

District: Ajo District, Pima County | Engineer: Lewis A. Smith

Subject: Conference with R. E. West, Chief Engineer, Phelps Dodge Corp.

Owner: New Cornelia Branch, Phelps Dodge Corp., Ajo

Previous Owner: William A. Knox, 8967 Lodue Rd., St. Louis, Mo.

Location: Sec. 33-35, T. 12 S., R. 6 W.

Three of these claims were sold to New Cornelia, recently. They adjoin the New Cornelia Pit on the southwest, and are in an area which consists of New Cornelia monzonite covered by fanglomerate of variable thickness. The Pit ore zone extends over into the Firefly to some extent, but claims at present are valuable for strip-clearance.

LITTLE AJO MINING COMPANY'S PROPOSITION

Mr. W. A. Knox formerly owned three mining claims that end in the **GREAT AJO COPPER BASIN** at Ajo, Pima Co., Ariz. He showed the **faith** that was in him by refusing a **BIG SPOT CASH OFFER.** He deeded his three FIRE FLY CLAIMS to the LITTLE AJO MINING COMPANY for a **STOCK CONSIDERATION** to the **END** that this exceptional ground should be **DEVELOPED. MARK YOU** he voluntarily stands to lose a **fortune** if the ground **DOES NOT MAKE GOOD.**

He was the original locator; a pioneer of the Ajo District; has sold many claims but he did not sell **THE FIRE FLY GROUP.**

Mr. Knox has associated with him several of Tucson's prominent business and professional men and they have incorporated the LITTLE AJO COPPER MINING COMPANY. These men are successful in their several lines and are eminently capable.

THERE IS ONLY ONE WAY TO MAKE A MINE AND THAT IS—DIG. The money raised from the sale of stock will be the **LITTLE AJO DIGGING FUND.**

Excerpts from Engineer
Chas. W. Carpenter's Report:

LITTLE AJO TECHNICALLY

——"The geology of the Fire Fly claims is typical of the Ajo District. Monzonite Porphry, diabase and rhyolite being the predominate rocks. The greater portion of your ground is covered by a flow of conglomerate. That this is superficial and does not extend to any great depth is proven by your 50 ft. shaft. In the bottom of this shaft you have a true, although slightly altered porphry."——

——"As to your possibilities of ore—I can see no reason why you should not strike ore at moderate depth. This statement is warranted by the successful development near you."——

——"With the proximity of the Big Ore Bodies, so thoroughly proven, to your property; considering their strike and dip the Fire Fly claims are deserving of comprehensive and scientific prospecting. In my opinion this prospecting could best be done by diamond drilling. It is cheaper, quicker and peculiarly adapted to determining the ores of the Ajo District.

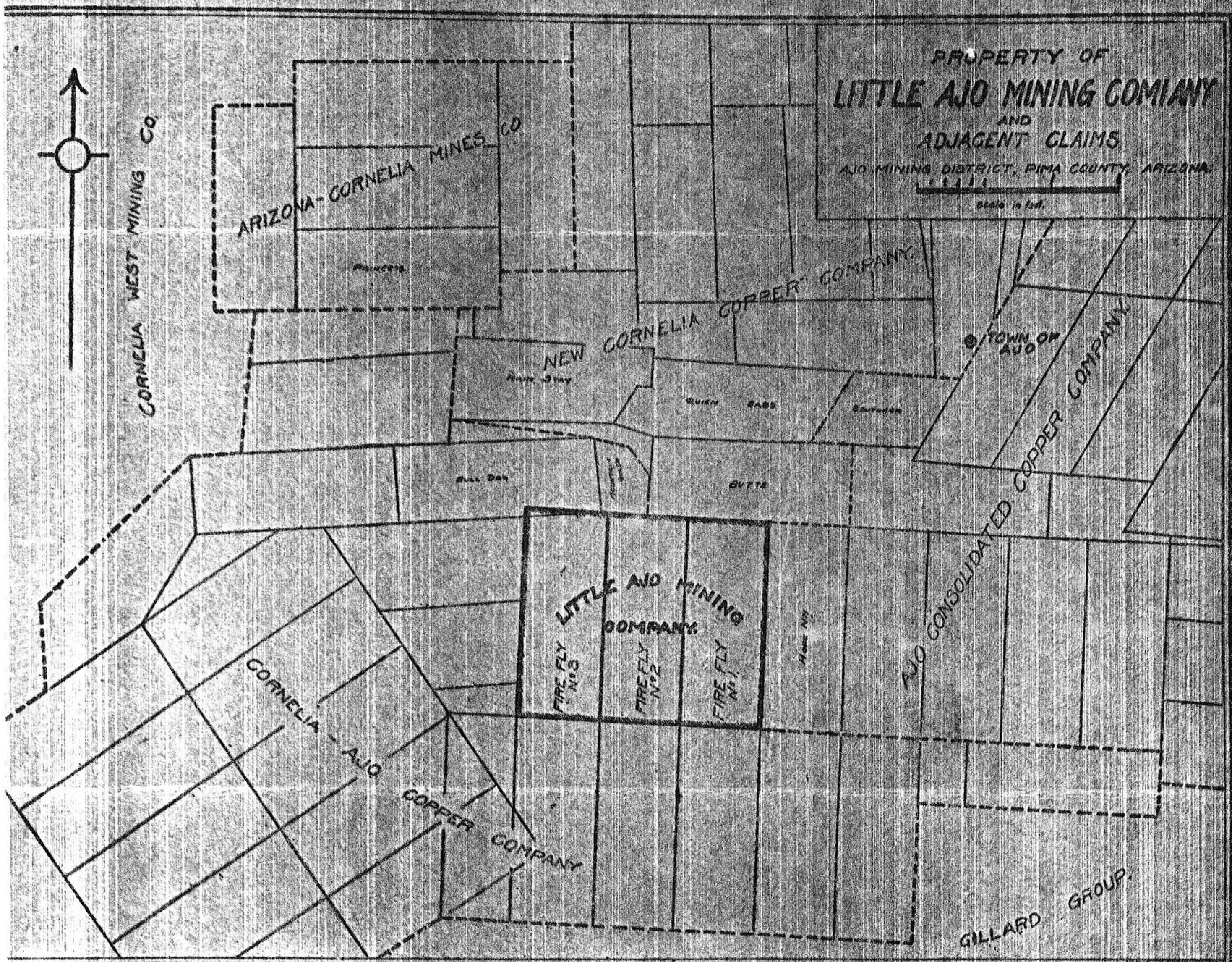
LITTLE AJO LOCATION

THE THREE FIRE FLY CLAIMS are located in the very heart of the Ajo Mining District.

They are entirely surrounded by the properties of the **NEW CORNELIA, AJO CONSOLIDATED** and **CORNELIA-AJO COPPER COMPANIES.**

A parallelogram 2250 by 1200 feet with its South Center placed on the end center monument of the Fire Fly No. 1 would take in the BULK of the 70,000,000 tons of the **DEVELOPED COMMERCIAL ORE** of the AJO COPPER BASIN.

With **STRIKE** and **PITCH** favorable does it seem reasonable that this **TREMENDOUS ORE BODY** will stop—cease to exist—when it reaches the MAN made LINE that marks the boundary between the **LITTLE AJO** and the above mentioned Companies? The Ajo Basin's richest ore lies less than 750 feet from FIRE FLY NO 1. To thoroughly appreciate the LITTLE AJO LOCATION—Carefully study **MAP.**



PROPERTY OF
LITTLE AJO MINING COMIANY
AND
ADJAGENT CLAIMS
AJO MINING DISTRICT, PIMA COUNTY, ARIZONA.
Scale in feet.
CORNELIA WEST MINING CO.
ARIZONA-CORNELIA MINES CO
NEW CORNELIA COPPER COMPANY.
TOWN OF AJO
AJO CONSOLIDATED COPPER COMPANY.
Bull Dog
Butte
LITTLE AJO MINING COMPANY.
FIRE FLY No 3
FIRE FLY No 2
FIRE FLY No 1
CORNELIA - AJO COPPER COMPANY
GILLARD GROUP.

LITTLE AJO DIRECTORATE

BOARD OF DIRECTORS AND OFFICERS OF THE LITTLE AJO MINING COMPANY

W. A. KNOX, President
Apex, Mo.
Business—Mining.

C. C. WHEELER, Vice-President.
Tucson, Arizona.
Business—Merchant.

CHAS. E. WALKER, Treasurer.
Tucson, Arizona.
Business — Vice-President Consolidated National Bank of Tucson.

O. T. RICHEY, Secretary.
Tucson, Arizona.
Business—Attorney at Law.

R. K. SHELTON,
Tucson, Arizona.
Business—Manager of Albert Steinfeld & Co.'s Hardware and Mining Machinery Department.

BUSINESS ADDRESS OF COMPANY,
52 W. Pennington St., Tucson.
Pima County, Ariz.

LITTLE AJO POLICY

Stock will be sold for development purposes only.

Only legal commissions on stock sales will be paid.

No money-eating publicity campaign is contemplated.

No heavy overhead expense.

All officers serve without pay.

Make every dollar work a dollar shift in the mine.

LITTLE AJO CAPITALIZATION

1,000,000 shares par value $1.00.

Promotion Stock, None.

Mr. Knox accepted payment for his property in STOCK.

100,000 shares have been placed on sale at 25 cents.

LITTLE AJO GUARANTEE

EVERY DOLLAR, LESS LEGAL COMMISSION AND ACTUAL EXPENSE, WILL BE SPENT FOR DEVELOPMENT.

THIS DEVELOPMENT WILL BE PROSECUTED WITH ALL EXPEDIENCE UNDER THE DIRECTION OF THE BEST ENGINEERING TALENT AVAILABLE.

IF THE LITTLE AJO IS A MINE IT WILL BE PROVEN QUICKLY AND CHEAPLY. IF IT IS A BLANK NO UNNECESSARY MONEY OR TIME WILL BE WASTED.

EVERY STATEMENT MADE BY THE LITTLE AJO IS TO THE BEST OF THE KNOWLEDGE AND BELIEF OF THE DIRECTORS—A FACT.

ALL FIGURES WERE SECURED FROM AN AUTHORITATIVE SOURCE AND WHEN POSSIBLE CAREFULLY VERIFIED.

THE AJO CAMP

Ajo is in the making—but making fast.

70,000,000 tons of Commercial ore definitely developed.

Ajo has the largest Leaching Plant in the World. Cost over $4,000,000.00. Capacity 5,000 tons daily. Plans are made for a large Flotation Plant.

A standard guage railway with two trains daily. Good auto roads.

The best planned, the best built, the best [illegible]red, the best sewered Camp in Arizona.

[illegible] live Newspaper, Four Schools, Two [illegible]rches, Two Banks, Two Picture Shows. No Saloons.

Ajo has developed more ore tonnage at less cost than any other Mining Camp in the World.

Copper outcrops over the GREATEST AREA ON RECORD.

UNITED STATES
DEPARTMENT OF THE INTERIOR
MINING ENFORCEMENT AND SAFETY ADMINISTRATION

UNITED STATES DEPARTMENT OF THE INTERIOR
mesa
Mining Enforcement and Safety Administration

HEALTH AND SAFETY REPORT

REPORT OF NONFATAL MACHINERY ACCIDENT
NEW CORNELIA
PHELPS DODGE CORPORATION, NEW CORNELIA BRANCH
AJO, PIMA COUNTY, ARIZONA

January 28, 1978

by

Chester A. Pascoe
Metal and Nonmetal Mine Inspector

Vernon R. Gomez
Metal and Nonmetal Mine Inspector

METAL AND NONMETAL MINE HEALTH AND SAFETY
WESTERN DISTRICT

Thomas C. Lukins
District Manager

Originating Office
Suite 900, 2721 North Central Avenue
Phoenix, Arizona 85004
Robert E. Riley
Subdistrict Manager

INTRODUCTION

This report is based on an investigation made pursuant to clause (1) of Section 4 of the Federal Metal and Nonmetallic Mine Safety Act (80 Stat. 772).

A State Plan Agreement was in effect in Arizona during this investigation.

Jose O. Dorame, shovel repairman, age 36, Social Security Number 526-56-4869, was seriously injured at approximately 9:15 a.m., January 28, 1978, when he became entangled in a shovel drive mechanism. Dorame had been employed by the Phelps Dodge Corporation, New Cornelia Branch, for 9 years. He had worked as a shovel repairman for the last 7 years. An investigation was started on January 30, 1978. The accident scene had been preserved.

Information contained in the report was obtained by interviewing company employees and officials and visiting the accident site.

GENERAL INFORMATION

The New Cornelia open pit copper mine, owned and operated by the Phelps Dodge Corporation, New Cornelia Branch, was located near Ajo, Pima County, Arizona. Total employment in the mine division was 360. The mine operated 11 days on, 3 days off, 3 shifts a day. Mechanical repair and maintenance crews worked on the equipment during the 3 down days.

Operating officials were: D. H. Orr, manager; A. L. Alexander, general superintendent; Charles V. Troutman, mine superintendent; and Thomas E. Diehl, safety supervisor.

Participating in the investigation were:

Phelps Dodge Corporation

Charles V. Troutman, mine superintendent
Edward Hare, pit mechanical foreman
Floyd Coody, shovel and drill repair foreman
Thomas E. Diehl, safety director
Art Fullager, assistant safety supervisor
James Hightower, shovel repairman, leadman
Richard A. Daniels, shovel repairman, helper
Miguel L. Perez, shovel repairman, helper

Arizona State Mine Inspector's Office

Willie J. Davis, deputy State mine inspector

Mining Enforcement and Safety Administration

Chester A. Pascoe, metal and nonmetal mine inspector
Vernon R. Gomez, metal and nonmetal mine inspector

The last regular inspection of this operation under P.L. 89-577 was completed January 20, 1978.

PHYSICAL FACTORS INVOLVED

The machine involved in the accident was a P&H model 1800, 9-yard electric crawler mounted shovel. The meshing teeth on the horizontal propel pinion gear and the crawler drive gear were 2-1/2 to 2-3/4 inches high, 2 to 2-1/4 inches thick at the base and 1-1/2 to 1-3/4 thick at the top. The horizontal propel pinion gear was 19 inches in diameter and 10 inches wide. The crawler drive gear was 36 inches in diameter and 7-1/2 inches wide. The protective casing was not in place over the gears. The shovel working weight was approximately 560,000 pounds. There were 22 inches of clearance between the top of the crawler unit and the bottom of the shovel hoist house where the victim was located when the shovel was put into motion.

DESCRIPTION OF THE ACCIDENT

Jose O. Dorame (injured), shovel repairman, reported for duty January 28, 1978 at 7 a.m., his regular starting time after picking up the equipment needed to finish the repair job that had been started 2 days earlier. Leadman James Hightower, Dorame and two shovel repairmen helpers, Richard Daniels and Miguel Perez, drove to the No. 28 shovel on the 980 level of the pit. Work proceeded normally until the new hydraulic steering unit had been installed and the crew had started checkout procedures. At this time, Hightower was standing in the operator's cab moving the shovel back and forth while attempting to activate the steering clutch. He was watching Dorame through the rear window for signals. The shovel house and dipper were positioned at an acute angle (approximately 50^{o} to the right) to the crawler frame. Dorame was standing several feet behind the left crawler. Perez was positioned in a safe location to the right of the shovel and Daniels had walked out in front of the shovel, as instructed by Dorame. Hightower had been propelling the shovel back and forth for 3 or 4 minutes when Daniels signaled that the clutch was not operating. Dorame relayed the signal to Hightower. Upon receiving the signal, Hightower turned and sat in the operator's seat, out of visual contact with Dorame. He started swinging the shovel to the left as he again propelled the unit ahead in an attempt to cause the low voltage rings to make electrical contact and energize the hydraulic motor. The shovel was moving forward when Daniels spotted Dorame on the crawler unit under the shovel house and heard him shout. Daniels started throwing rocks at the shovel cab to get Hightower's attention. Hightower, hearing someone shouting but not understanding what was being said, shut off the power and dismounted from the shovel. When he saw that Dorame's leg was caught between the horizontal propel pinion gear and the crawler drive gear, he immediately returned to the controls and backed the shovel up to release him. Perez signaled when Dorame was free of the pinch point. Hightower shut down the unit and returned to Dorame. A preliminary check showed that Dorame's leg had been crushed and severed at about mid-calf. A tourniquet was not applied as the bleeding was minimal. Hightower lowered Dorame from the crawler unit and placed him in the service truck. Daniels used the service truck's two-way radio to notify a company official. The shovel repair crew transported Dorame to the company hospital, arriving at 9:35 a.m. After receiving medical assistance, he was taken by ambulance to the St. Joseph's Hospital in Phoenix, Arizona. While being transported, Dorame stated that he had climbed onto the unit to check the hydraulic pump to see if it was running. He also stated to the inspection party during the interview at the hospital that he had given Hightower a "thumbs up" stop or spot signal before climbing onto the crawler unit. Hightower, at a later interview, stated he had not seen or received a stop signal prior to the time of the accident.

It could not be determined by the inspection party if Hightower had missed or misinterpreted the stop signal. Reportedly, Dorame was wearing a heavy pair of leather welding gloves that may have made his signals less clear.

It was determined that during the period of time that it took Hightower to position himself in the operator's seat and put the shovel into motion, Dorame climbed over the left crawler into a leaning position towards the center of the shovel. He had placed his weight on the left foot which was positioned at or near the pinch point between the two gears, and the downward motion of the gears drew his leg between the meshed gears.

CAUSE OF THE ACCIDENT

The direct cause of the accident was the failure to lockout the electrical equipment or take other measures to assure that the equipment would not be energized without the knowledge of the individual working on it. A contributing factor was the failure to replace the gear case (rock guard and gear cover) that had been knocked off during loading operations prior to the hydraulic motor failure.

RECOMMENDATIONS

55.12-16(M) Electrically-powered equipment shall be deenergized before work is done on such equipment. Power switches shall be locked out or other effective measures taken which will prevent the equipment from being energized without the knowledge of the individual working on it.

55.9-5(M) Operators shall be certain that all persons are in a safe position before starting or moving equipment.

55.14-6(M) Guards and covers shall be kept in place when equipment is being operated, including moving parts that would normally be guarded by location.

ACKNOWLEDGMENT

The cooperation and courtesies extended by company officials and employees during the course of this investigation are gratefully acknowledged.

/s/ Chester A. Pascoe

Chester A. Pascoe
Metal and Nonmetal Mine Inspector

/s/ Vernon R. Gomez

Vernon R. Gomez
Metal and Nonmetal Mine Inspector

Approved: for Robert E. Riley
Subdistrict Manager

phelps dodge Corporation

New Cornelia Branch / Ajo, Arizona

Phelps Dodge Corporation

New Cornelia Mine, Plant and Townsite

Front Cover: New Cornelia Mine

New Cornelia Branch

Phelps Dodge Corporation is the second largest copper producer in the United States. The Company's activities include the mining, concentrating, smelting, refining and sale of copper, and the manufacture and marketing of copper products.

This booklet tells the story of one of Phelps Dodge's western operations, the New Cornelia Branch at Ajo, Arizona.

The New Cornelia Branch mines copper ore and treats it metallurgically by concentrating and smelting. The copper it produces is shipped by rail to Phelps Dodge's refinery in El Paso, Texas, for further refining before it is sold or converted into manufactured products. It produces about 60,000 tons of copper annually.

Ajo, a community of about 7,000 persons, is located in the western part of Pima County in Southern Arizona. Tucson, the county seat, is 130 miles to the east, and Phoenix, the state capitol, is 110 miles northeast. Ajo is 40 miles north of the Mexican border and 105 miles northeast of Rocky Point on the Gulf of California.

Ajo's elevation is approximately 1,800 feet. Average annual rainfall is about 9 inches. Maximum summer temperatures range from 110° to 115° F., and minimum winter temperatures range from 35° to 17° F.

PHOENIX
10
GILA BEND
110 MI.
160 MI.
CASA GRANDE
YUMA
8
LUKE WILLIAMS
AIR FORCE RANGE
CABEZA PRIETA
NAT.
WILDLIFE
REFUGE
AJO
130 MI.
TUCSON
ARIZONA
SONORA
PAPAGO INDIAN RESERVATION
ORGAN
PIPE
CACTUS
NAT.
MON.
10
SELLS
SONOYTA
105 MI.
U.S.
MEXICO
LAND ENTRY
RESTRICTED BY FEDERAL
AGENCIES
ROCKY POINT
GULF OF CALIFORNIA

Geology

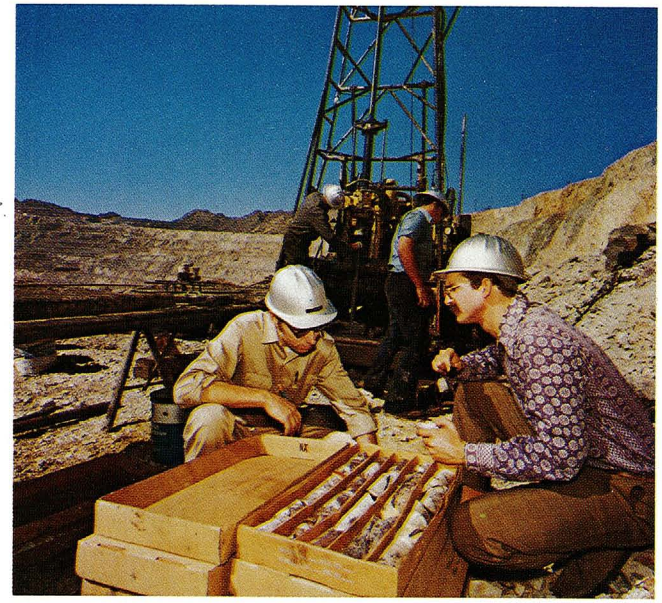
The New Cornelia Mine is located at the eastern end of the Little Ajo Mountains. These mountains are maturely dissected sierra-type with sharp ridges and peaks, surrounded at the base by well-developed pediments. Other mountains in the Ajo district are youthful mesas composed of gently inclined blocks of massive lavas separated by broad detritus-filled alluvial valleys. The rocks range in age from the Pre-Cambrian basement gneiss in the Little Ajo Mountains to the late Tertiary lavas of Black Mountain and recent alluvial deposits in the valleys.

The New Cornelia ore body was formed early in Tertiary time at the beginning of the Cenozoic era, or about 50,000,000 years ago. It was during this period that North America assumed approximately its present outline and relief.

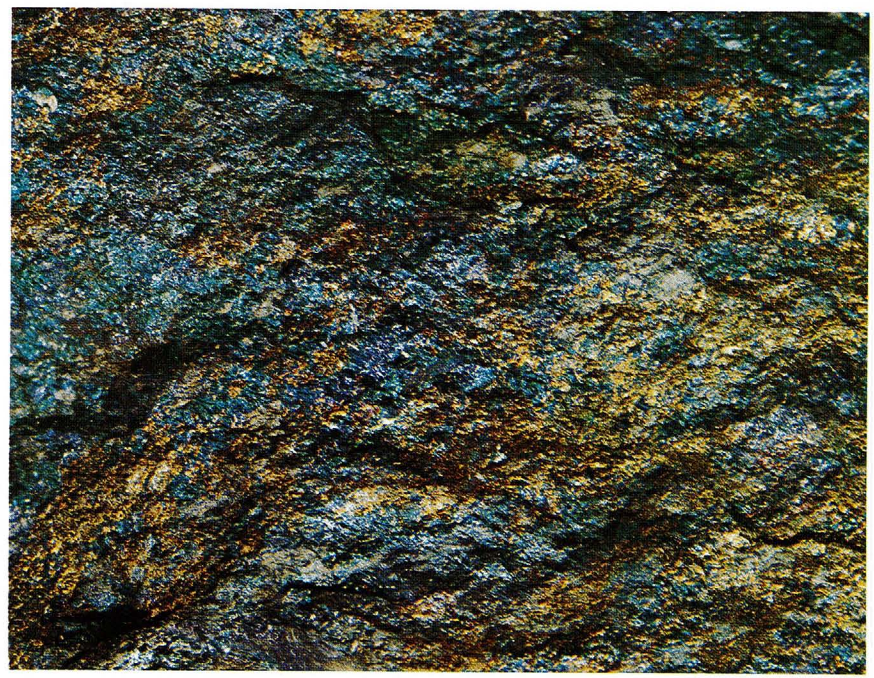
The ore body is in the apex of an offshoot from the Cornelia quartz monzonite stock which forms the north end of the Little Ajo Mountains. The mineralized part of the apex is about three-fourths of a mile wide and one and one-fourth miles long with the long axis trending northwest. The primary copper-bearing minerals, bornite and chalcopyrite, are disseminated through the quartz monzonite and to a lesser extent in the volcanics as veinlets. Overlying the ore body on its south end is an alluvial conglomerate, termed Locomotive fanglomerate, which rests on the erosion surface of the older rocks, and is many hundreds of feet thick.

There were two widely separated periods of oxidation and enrichment at Ajo. Oxidation of the sulfides in the rhyolite to a depth of 600 feet was the first event in the enrichment process. Only a minor amount of secondary copper mineral was formed in the rhyolite during this period as a result of very weak primary mineralization. After faulting displaced the rhyolite capping, the primary copper minerals were again exposed at the end of the apex.

Oxidation following the faulting resulted in the formation of abundant hematite and minor amounts of cuprite, chrysocolla, shattuckite and malachite. The chrysocolla and malachite gave the color to The Three Green Hills of Ajo that attracted the Indians and Spaniards as early as 1750.

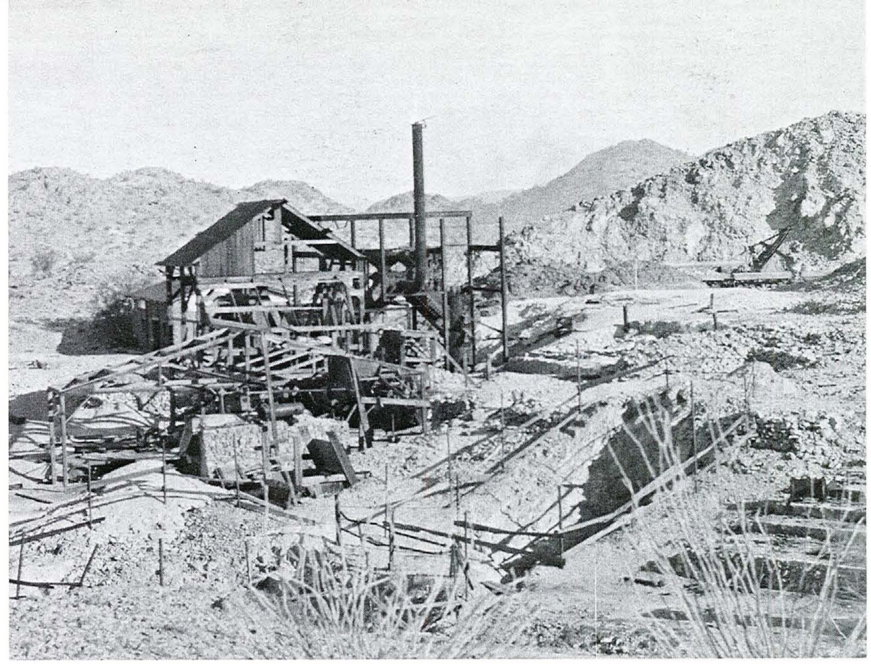


Diamond Drill Core



History

McGahan Smelter



The first American company to mine in Arizona, the Arizona Mining and Trading Company, arrived in Ajo in October 1854. This company found abandoned workings, rawhide ore buckets and crude tools as mute evidence of earlier attempts to mine the small veins of native copper, cuprite and chalcocite occurring in the three small hills that then stood where the huge open pit mine is today. The Arizona Mining and Trading Company failed in 1859 due to the high cost of hauling the ore to the ports of Yuma and San Diego and then shipping it around Cape Horn to Swansea, Wales.

Intermittent attempts to exploit the ore deposits followed, but the lack of water and the difficulties of transportation prevented success.

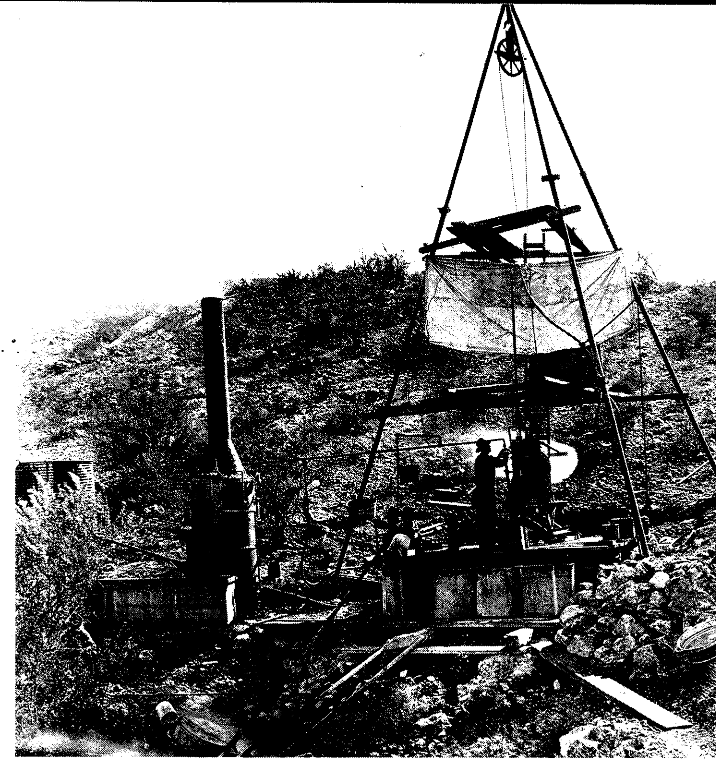
The activities at Ajo in the 1890's and early 1900's can best be described as strange and mysterious. A. J. Shotwell, a mine promoter, interested John P. Boddie, a successful drygoods salesman from St. Louis, Missouri, in the mines at Ajo. These two men organized the St. Louis Copper Company. This company failed, and Shotwell organized the Rescue Copper Company "to rescue" the St. Louis Copper Company. The Rescue Company also failed, and Shotwell and Boddie with others formed the Cornelia Company, so named in honor of Boddie's first wife. The Ajo ore was found to be too lean to work with the then conventional methods. Shortly thereafter several self-styled metallurgists undertook to meet this need with some of the weirdest inventions ever to have been tried in the history of American mining.

The first was the Rendall Process. This process, it was claimed, would treat "all classes of copper ores including oxides, carbonates, sulfides, chlorides, silicates and arsenides with equal facility." As it turned out, the plant treated all ores with equal difficulty and was a complete failure.

The second was the vacuum smelter designed and invented by Professor Fred L. McGahan. The mystifying McGahan Smelter was built at Ajo at a cost of $34,000. This invention "would melt the ore, and pure gold, silver, copper, etc. would then be drawn off in separate spigots. After the furnace was once started, the oxygen and hydrogen gases which escaped from the ore would be used to fire the furnace, and the purchase of any additional fuel would be unnecessary." The McGahan Smelter produced nothing but a vacuum in the pockets of the investors.

After this failure Boddie and his stockholders invested $30,000 in a hydrofluoric-acid leaching process almost as fantastic as the vacuum smelter. This leaching plant did produce a few pounds of copper, at a cost of over a dollar a pound.

Success of the Utah Copper Company at Bingham Canyon, Utah, Prospect Drilling



put an entirely new aspect on low-grade copper deposits. From 1908 to 1910 the desert was alive with engineers hunting for the new "porphyries." The big copper companies were actually bidding against each other for a chance to develop "Boddie's folly." The General Development Company, headed by Mr. J. Parke Channing, secured an option on a majority of stock of the reorganized New Cornelia Copper Company. Mr. Seeley W. Mudd and associates optioned the Rendall Ore Reduction Company's claims on the south edge of the Ajo basin. A group of English capitalists took an option on some outlying claims in the Ajo basin. The engineers representing the General Development Company, Mr. Mudd and the group of English capitalists were recognized as among the greatest in the world. All three groups based their planning development on different theories, but they all agreed that the three hills of the New Cornelia property contained a fair amount of copper but the rock was far too hard to allow for the necessary enrichment. None of the groups drilled in the hills, and all three failed to find the ore body.

In 1910 Captain John C. Greenway became the manager of the Calumet and Arizona Mining Company in Bisbee, Arizona, and he directed the company's geologist, Ira B. Joralemon, to find an ore body suitable for mining by the new open pit methods. Joralemon, who had passed through Ajo in 1909, decided it might be worth a try to return to Ajo to see what was under the Three Hills which the big companies had bypassed in their drilling. A few days of study and sampling convinced Joralemon that there might be a great mine at Ajo.

Calumet and Arizona, on the advice of Greenway, then optioned 70 percent of the New Cornelia Copper Company's stock from John P. Boddie. Within two years 25,000 feet of drilling proved that the Ajo hills were underlain by millions of tons of 1.5 percent ore with carbonate ores on top and sulfide ores below.

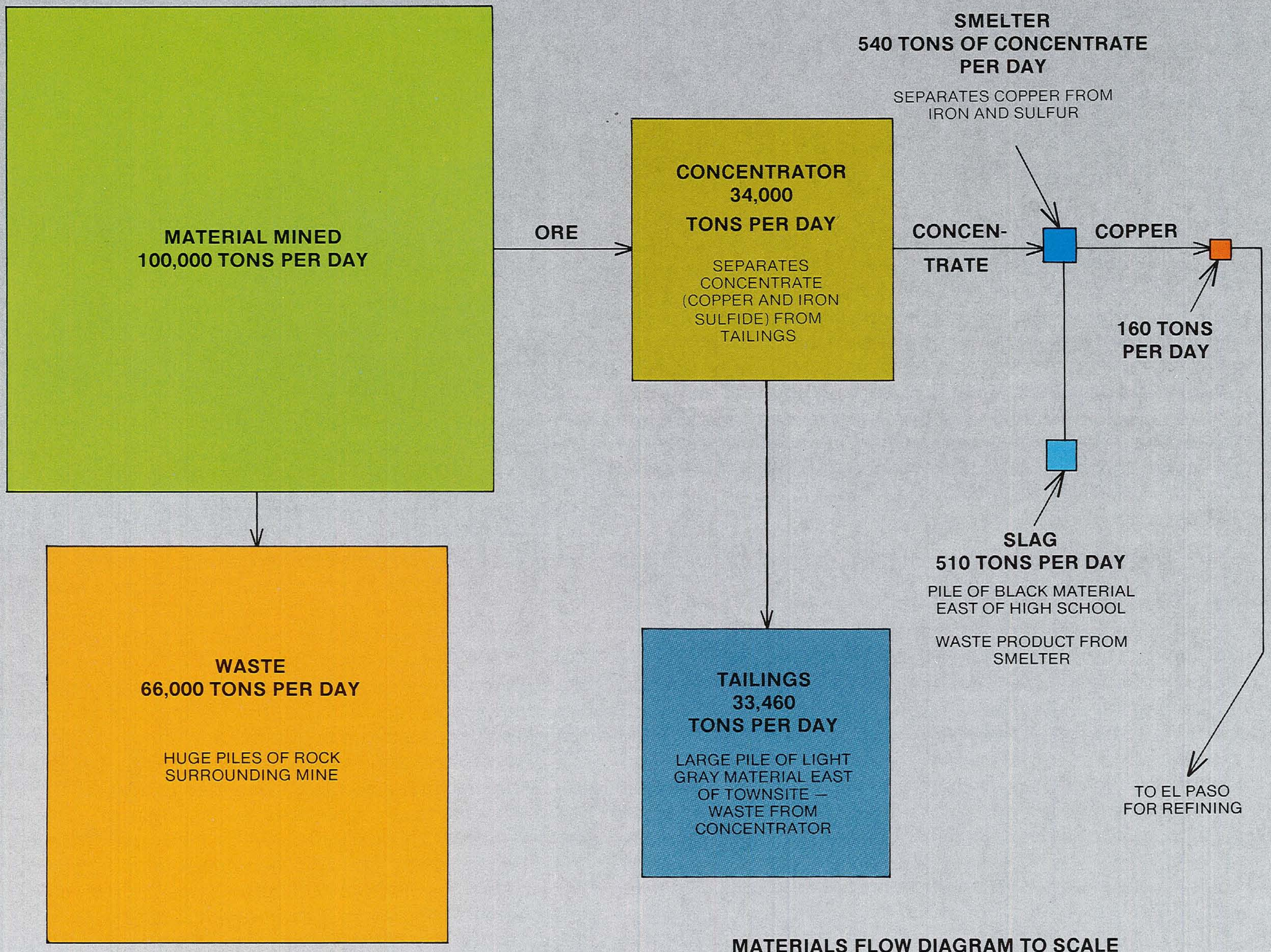
There was as yet no known method for treating the carbonate ores. Greenway employed Dr. Louis D. Ricketts to help solve the problem. After three years of experimentation, Greenway, Ricketts and dozens of chemists and metallurgists developed a successful miniature one-ton leaching plant at Douglas, Arizona. Subsequently a 40-ton pilot leaching plant was built at Ajo and operated successfully.

By drilling a well six miles north of Ajo, sufficient water was found to conduct a large-scale operation. A railroad from Ajo to Gila Bend was completed in 1916.

In April 1917 the big 5,000-ton-per-day leaching plant to process the carbonate ore was ready to operate. The first electrolytic copper was shipped on May 1, 1917.

Construction of a 5,000-ton flotation concentrator to treat the sulfide ore was begun in 1922, and ore dressing operations started on January 8, 1924. Ore production was increased to 8,000 tons per day in 1929. The New Cornelia Copper Company was consolidated with the Calumet and Arizona Mining Company in 1929. The leaching plant ceased operations in 1930 after all the carbonate ores had been mined, and a total of 16 million tons of carbonate ore had been treated. The Calumet and Arizona Mining Company merged with the Phelps Dodge Corporation in 1931. Further alterations in the concentrator over the years have increased production to 34,000 tons per day. A smelter was built and placed in operation in 1950.

The Three Green Hills of Ajo, 1917



MATERIALS FLOW DIAGRAM TO SCALE

Mining

The New Cornelia ore body is a low-grade, disseminated copper deposit occurring in a formation classified as quartz monzonite porphyry. Its principal ore minerals are chalcopyrite and bornite. The ore body has been developed by open pit methods, which require the additional removal of large tonnages of associated rock having no economic value. The mine covers an area of approximately 600 acres. Its bottom level is more than 900 feet below the average rim elevation. Mining operations are conducted on levels or benches which are normally established at vertical intervals of 40 feet. Present production is at a rate of 34,000 tons of ore and 34,000 tons of waste per day by train haulage. Additional tonnage is hauled by trucks.

As all material within the scope of the pit operations must be broken by blasting, the mining cycle begins with drilling a series of blast holes. These holes are located near the edge of the bank and are drilled somewhat deeper than the height of the bank to be blasted. The New Cornelia ore body of quartz monzonite is overlain in the south portion by a tough fanglomerate, which constitutes a drilling problem separate from that of the ore body. In this area 7-inch diameter holes, inclined 20 degrees from the vertical, are drilled by heavy percussion "down-the-hole" drills in which the hammer-type drill follows the bit into the hole. Heavy rotary drill machines are used for drilling 12¼-inch diameter holes in areas other than the fanglomerate. These primary blast holes are each loaded with 300 to 1,500 pounds of explosives. All holes in a series are connected with a detonating fuse and are blasted as a unit. A typical rotary drill hole blast will break about 60,000 tons of rock. After primary blasting, some portions of the broken rock may still be too large to handle in subsequent operations. The further reduction of such material is accomplished by different methods, depending upon its nature and accessibility.

The material broken by blasting is loaded into haulage trains by electric-powered shovels equipped with dippers of 6 to 9 cubic yards capacity. Power, at 4,000 volts, is brought from nearby power lines to the shovels via insulated power cables.

Rail haulage units are made up of 125-ton or 140-ton diesel electric locomotives pulling seven- and eight-car trains, respectively. Each car carries 60 to 80 tons, depending on the size of the car.

The engineer operates his locomotive by means of a portable radio transmitter pack strapped to his back. A receiver on the locomotive activates various controls which operate the train.

Tracks in the loading areas are built in sections which can be moved with a crane, and are moved each time a shovel has made a cut through the material broken by blasting. Mainline tracks connecting the various levels of the pit with the crushers and waste dumps are laid on maximum grade of 3 percent. Approximately 50 miles of standard gauge track is in use. The haul from the bottom level of the pit is 8½ miles to the waste dumps and 7 miles to the ore crushers. A system of signals and power switches for controlling rail traffic in the mine makes it possible for one man at a control board to control train movements through remote operation of track switches and signal lights. The dispatcher keeps informed of train locations by watching indicator lights on the control panel and by direct observation from the lookout building located on the rim of the pit. An electrical interlocking system prevents setting up conflicting train movements. The dispatcher also serves as a communications center for all operations through radio, telephone, and whistle signals.

Load


25

Milling

In extracting the copper from the ore the copper-bearing minerals are first concentrated into a product which is small enough in bulk and high enough in copper content to treat economically in the smelting operation. In the first steps of the process, the ore is crushed and finely-ground to a size that will free most of the mineral particles.

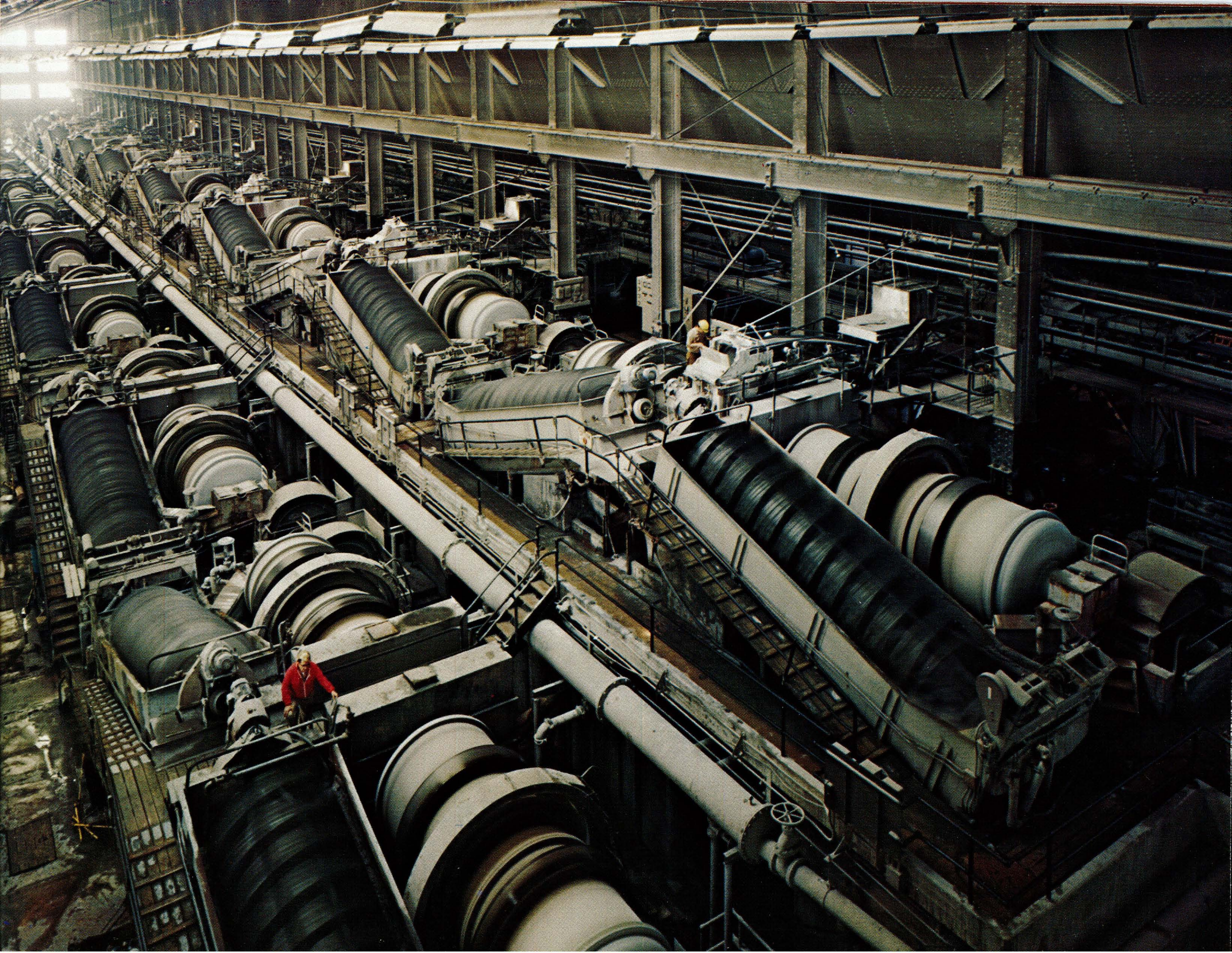
The coarse crushers receive the ore as it comes from the mine and reduce it to about a 6-inch maximum size. In two additional stages of crushing, the ore is further reduced to a final crusher product of 5/8-inch maximum size.

Belt conveyors carry the ore from the crushing plant to the concentrator storage bins, from which it is later withdrawn and fed, along with water, into ball mills. The ball mills are long steel cylinders each containing about 30 tons of steel balls. Grinding action takes place as the mills revolve, and the balls within tumble, roll and grind the ore between the balls themselves and between the balls and sides of the mill. Extra amounts of water are added as the ore-water mixture (called "pulp") flows from the mills to the classifiers, which are sizing devices. The fineness of the ground product depends upon the dilution in the classifiers. Rotating spirals in the classifier tanks return the coarse material to the ball mills for further grinding. Ore which has been ground to the desired size overflows from the classifiers in a more dilute pulp and goes to the flotation machines.

Flotation is a process to separate the copper-bearing minerals from the barren material in the ore. Frothing agents and other reagents are added to the pulp before it flows to the flotation cells. The frothing agents are used to produce a stable bubble, and the main function of the chemicals is to form a water-repellant, air-adhesive surface on the copper mineral particles. The surface of the waste particles does not become water-repellent. In the flotation machine the copper-bearing minerals adhere to the air bubbles formed by aeration, and they rise to the surface of the pulp. A mineral-laden froth forms and overflows at the sides of the flotation cell. This froth contains primary, or rougher, concentrate, of about 15 percent copper. The pulp, containing the barren material with only a small amount of copper, emerges from the tail end of the cells. This waste, or tailing, is directed to the settling tanks, and the thickened product is pumped to the tailing dam for disposal. The thickening procedure is important from the standpoint of conserving water.

Since the chief copper mineral at Ajo, chalcopyrite, contains approximately 35 percent copper, appreciable waste material is still included in the rougher concentrate. To remove more of this waste material, the rougher concentrate is ground to a smaller particle size in ball mills until it will pass through a 200-mesh screen, and then is refloated. The final concentrate, now about 30 percent copper, is dried by suction filters and a gas-fired rotary dryer. This dried product is delivered to the smelter by a conveyor belt.

The efficiency of the process is such that about 85 percent of the copper and only about one-third of 1 percent of the unwanted rock is contained in the final concentrate.



Smelting

The concentrate, which contains copper together with sulfur, iron, and some insoluble material (primarily silica and alumina), is received from the concentrator and is loaded into containers, which are carried by overhead cranes to the charging stations at the reverberatory furnace.

Concentrate is charged into the reverberatory furnace through the sidewalls, with machines called slingers. The furnace is about 100 feet long, 30 feet wide and 11 feet high. Its main purpose is to melt the concentrate. This is done by firing the furnace with a large amount of natural gas. In the furnace the melting concentrate makes a pool or bath about 4 feet deep. The lighter components of the bath rise to the top making a slag which is periodically skimmed off as a waste product. The heavier (copper-bearing) part of the bath sinks to the bottom and is withdrawn into ladles for further treatment. This product is composed almost entirely of copper, iron and sulfur, and is called "matte." As slag and matte are withdrawn from the furnace, more concentrate is added, and the melting process proceeds. Gases from the reverberatory furnace pass through a set of boilers, making steam for generating electricity, then through a precipitator to the gas treatment plant.

The ladles of matte taken from the reverberatory furnace are transported by overhead cranes to converting vessels. Air is blown through the liquid matte in the converters. Oxygen in the air unites with the sulfur, making sulfur dioxide gas which goes through a flue system to the gas treatment plant. The iron in the matte is also oxidized, and when silica material is introduced into the converter, the iron oxide and silica combine to form a component in the matte which is lighter than the copper. This material rises to the surface to make slag, which is skimmed off and returned to the reverberatory furnace. This process is repeated until a charge (about 50 tons) of blister copper is left in the converter.

The blister copper, which contains a small amount of sulfur, is then poured into an oxidizing furnace. All the remaining sulfur is removed by blowing more air through the liquid copper, leaving a slight excess of oxygen. Now the copper is practically free of impurities.

The copper is then transferred to the anode furnace, where it is accumulated for a 24-hour period and then refined by blowing a reducing gas (reformed mixture of natural gas and air) through the molten charge. The carbon monoxide and hydrogen in the reducing gas unite with the oxygen in the copper, forming carbon dioxide and water which leave the furnace as gases. When nearly all of the oxygen has been eliminated, the copper is cast into 750-pound slabs called anodes.

The anodes are loaded on railroad flat cars and shipped to the Phelps Dodge refinery at El Paso, Texas. There they are put through the electrolytic process for further refining of the copper and recovery of the small amount of by-product gold and silver which has remained in the copper through the smelter.

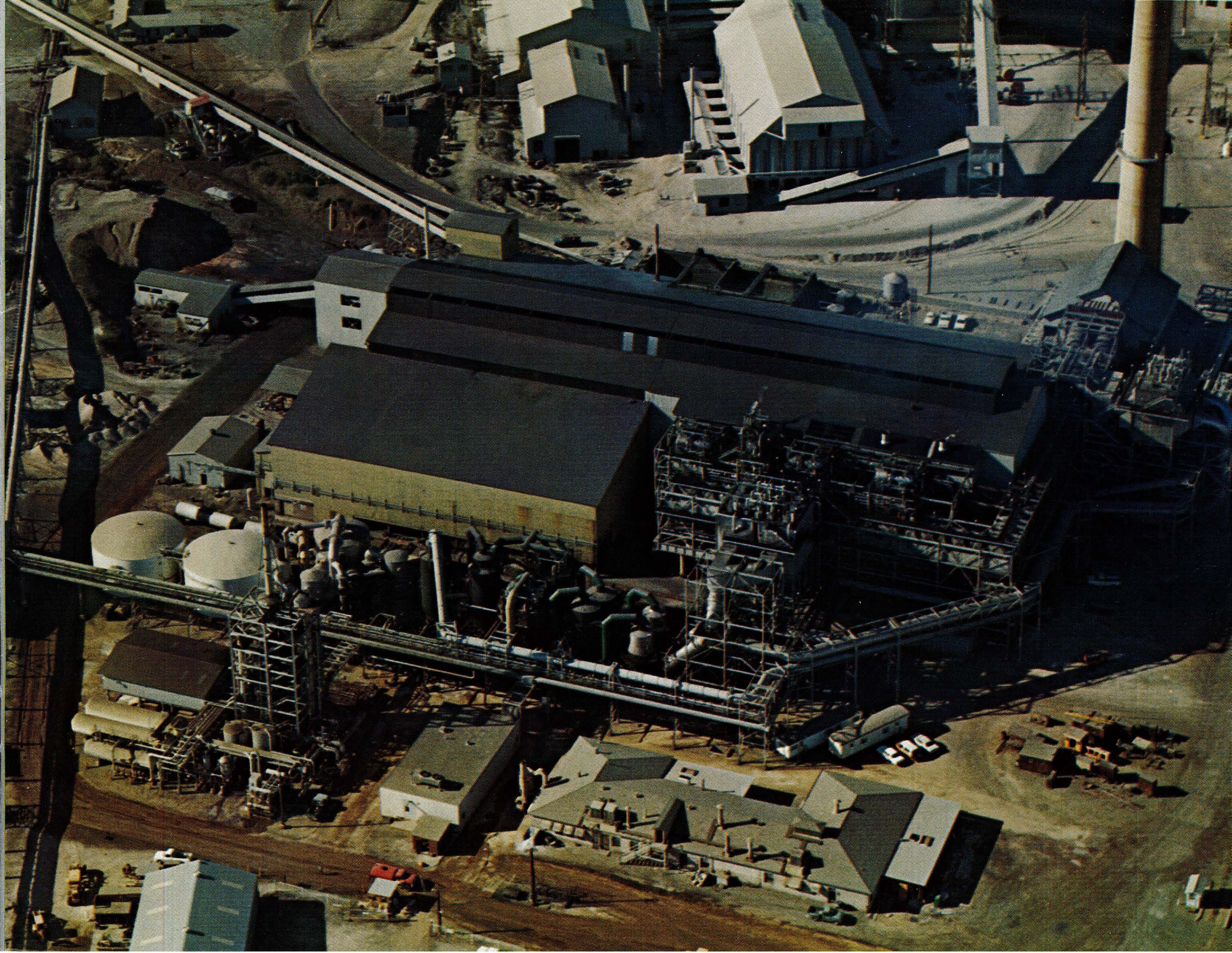
Gas Treatment Plant

The Gas Treatment Plant consists of a sulfuric acid plant and a sulfur dioxide absorption plant. The former is designed to produce 600 tons of acid per day, and the latter can produce approximately 50 tons of liquid sulfur dioxide per day. The sulfur dioxide from the converters can be routed to either plant to make sulfuric acid or liquid sulfur dioxide, but the gas from the reverberatory furnace, which is too dilute to be treated in the sulfuric acid plant, flows only to the absorption plant. The purpose of both plants is to eliminate sulfur dioxide from the off-gases generated by the smelting operation.

The hot sulfur dioxide gas from the converters, containing dust particles, passes through gas coolers where its temperature is lowered to approximately 600° F, and some of the dust particles are removed. The heat removed from the gas generates steam for subsequent uses. The gas then passes through an electrostatic precipitator, where the majority of the dust is recovered, and then on to the gas scrubbing section of the sulfuric acid plant. The scrubbing section consists of a humidifying tower, a cooling tower, and a mist precipitator. The first two towers cool the gases further and remove the remaining dust particles. The mist precipitator is designed to remove sulfuric acid mists from the gas stream to avoid corrosion of equipment down stream. From the mist precipitator the gas passes through a drying tower, where moisture is removed. The sulfur dioxide gas then passes through two blowers into the shell side of a series of heat exchangers, where it is heated by hot sulfur trioxide gas, and then passes on to a catalyst chamber. Sulfur dioxide gas is converted to sulfur trioxide in the catalyst chamber at an elevated temperature. The sulfur trioxide gas passes through the tube side of the heat exchangers and loses much of its heat before entering the absorbing tower. The circulating acid in the absorbing tower absorbs the incoming sulfur trioxide. Sulfuric acid is produced during the process of absorption. Additional water is required at times to maintain a desired acid strength. The acid is pumped to storage, whence it is shipped by railroad cars or tank trucks to purchasers.

The sulfuric dioxide absorption plant is built to supplement the acid plant with additional sulfur dioxide gas. Reverberatory gas entering the absorption plant is first cleaned by an electrostatic precipitator and gas scrubbers, then absorbed by dimethylaniline solution. The gas is then dried by sulfuric acid, is compressed and is condensed to a liquid form. Liquid sulfur dioxide is stored under pressure and is vaporized to supplement the acid plant operation whenever necessary.

Both plants are equipped with the most modern instruments and automatic controls.



Service Operations

The operation of a large mining, concentrating and smelting complex requires numerous service operations. They include a power plant, where all required electrical power is generated, and a well field for the production of domestic and process water. Many shops — electrical, machine, boiler, sheet metal, carpenter, paint, etc. — are required for the maintenance and construction of equipment and facilities. Departments for accounting, engineering, medical, house rental, employment, safety, supply and security are also necessary for efficient operation.

The power plant produces electric power for the Branch operations and for purchase by the Ajo Improvement Company, a Phelps Dodge subsidiary, for distribution in the town of Ajo. The Ajo Improvement Company also distributes water and natural gas to the community. Another subsidiary, the New Cornelia Co-Operative Mercantile Company, operates a mercantile store in Ajo. Still another subsidiary, the Tucson, Cornelia and Gila Bend Railroad Company, provides rail transportation between Ajo and Gila Bend.

The Community

The New Cornelia Branch operations and the associated companies dominate the economy of the community. These activities provide employment for about 1,400 people at a wide variety of skills and professions. Employees enjoy high wages, excellent working conditions and generous fringe benefits.

Many small independent enterprises such as barber and beauty shops, garages and service stations, lodging places, stores, food services, a laundry and dry cleaners, and various repair shops serve the needs of the population.

Ajo has an excellent public school system. Approximately 1,200 students attend the elementary school and 550 are in the high school.

The Company provides modern houses at low rent, mainly for Company employees. Some private housing is available, but the selection is limited, with the larger, more desirable units always in short supply. A hotel and several motels are also available.

A 33-bed hospital offers the usual hospital facilities and offices for the doctors who provide medical services to Company employees and their dependents under the Company's Hospital-Medical-Surgical Plan. This facility also serves others on a private patient basis.

Churches of many denominations fulfill the religious needs, and a large number of fraternal and service organizations provide "activity" interests for the community.

Ajo has a library, movie theaters, bowling alleys, a swimming pool, tennis courts and a golf course. The high school has an active athletic program which includes football, basketball, baseball, and track as spectator sports.

One hundred miles away is the Gulf of California, which has been called the biggest fish trap in the world. The abundance and almost unlimited variety of fish attract anglers from Ajo and all parts of the country. The surfcaster tries for sea trout, pompano and sierra, while the deep-water fisherman is likely to hook anything from the deep-water pinto, grouper, and white sea bass to the fabulous marlin or sailfish.

Ajo fishermen also frequent the canals in the Gila Bend, Mohawk-Wellton and Yuma districts, as well as the Colorado River and the warm-water lakes of southern Arizona's White Mountain and Mogollon Rim country.

Dove and quail hunting is good near town. In the farming area near Buckeye, Arizona (70 miles distant), the heaviest concentration of white wing and mourning dove in the nation can be found. White-tail and mule deer as well as javelina have been bagged near Ajo.

Because Ajo is situated on the northern extremity of the Sonoran Desert, interest and enjoyment is had in picknicking, camping, hiking, exploring, photography, rock hunting, and other recreations that are associated with this vast, little-known region.

Inside Back Cover: TC & GB Railroad Co. Station

Back Cover: Ajo Plaza


WESTERN UNION