

# **MINING AT BISBEE**

**CHAPTER 3**

## **A HISTORICAL OVERVIEW**

**MINING HISTORY**

**1900 - 1930**

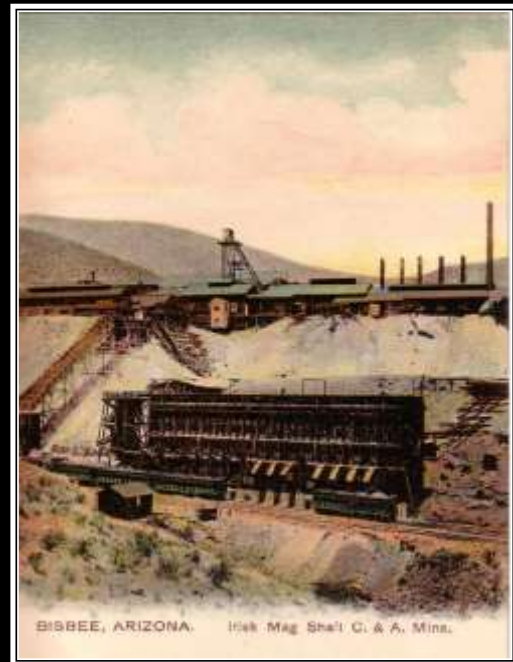
SLIDE 1

# MINING AT BISBEE

**A HISTORICAL  
OVERVIEW**  
MINING HISTORY  
1900 - 1930

**IRISH MAG SHAFT  
CALUMET AND ARIZONA MINING COMPANY  
C - 1905**

PART 3



BISBEE, ARIZONA. Irish Mag Shaft C. & A. Mins.

GRAEME LARKIN COLLECTION

**SLIDE 2**

**OTHERS COME TO BISBEE LOOKING FOR OPPORTUNITY**

**BY THE END OF THE 1890s, THE COPPER QUEEN WAS THE ONLY PRODUCER IN THE WARREN MINING DISTRICT, BUT IT DID NOT HOLD ALL OF THE PROPERTY, NOT EVEN ALL OF THE PROMISING GROUND, INCLUDING A GROUP OF CLAIMS QUITE NEAR ITS OWN, VERY PRODUCTIVE SPRAY MINE. THIS WAS BOUGHT BY A THE C&A A NEWCOMER TO THE DISTRICT**



GRAEME LARKIN COLLECTION

IRISH MAG MINE C- 1907



GRAEME LARKIN COLLECTION

IRISH MAG MINE (C&A) 1902 SPRAY MINE (CQCMCo)

**THE CALUMET & ARIZONA MINING CO. WAS SUCCESSFUL QUICKLY AS IT DEVELOPED THE RICH “IRISH MAG” MINE JUST A FEW HUNDRED FEET FROM THE SPRAY MINE. THE C&A THEN WENT ON TO BECOME A HUGE PRODUCER AT BISBEE AND BEYOND, WITH A NUMBER OF VERY GOOD MINES**

~~~~~

While Dr. Douglas had always been a proponent of an aggressive acquisition policy in the district, there was one opportunity that was lost. Lost not because Douglas did not want to buy the property but because of a series of peculiar circumstances. A group of unpatented mining claims including the Irish Mag were owned by one James Daly, whom Dr. Douglas characterized as “not being of sound mind.” Daly offered the claims to James Douglas, but his close friend and superintendent; Ben Williams said he would resign if Douglas made the purchase, as Daly had threatened his life. Douglas, out of respect for his superintendent declined the purchase. Soon thereafter, in the spring of 1890, Daly shot and killed a deputy sheriff who was seeking to arrest him for assault. Daly fled, never to be seen again, at least in Bisbee, thus ended the chance for Dr. Douglas to buy the claims.

With Daly safely out of sight and unlikely to return to a hangman’s noose, a host of claimants began to appear with all manner of documents allegedly signed by Daly transferring ownership to them. The increasingly valuable properties were in legal limbo. After a string of court battles, in 1899, the United States Supreme Court vested title to the properties to Angela Diaz, Day’s common law wife as she had advanced the necessary funds to complete the required annual assessment work. In the interim, Diaz had sold her rights to Tombstone saloon keeper, Martin

Castillo, who financed the protracted legal battle. He was to be rewarded mightily for his faith and efforts.

In 1898, one John Graham, a former resident of Bisbee, arrived in Calumet, Michigan with beautiful malachite and azurite specimens he wished to sell. Graham looked up his old friend and fellow miner, Captain Jim Hoatson, who was very much interested in the beautiful rocks. When Captain Jim asked John about the potential for acquiring good mining ground at Bisbee, Graham assured Hoatson that “there was just as good as the Copper Queen at Bisbee” (Bisbee Daily Review, 1906).

Thus, Captain Jim Hoatson came to the district looking for property to purchase on behalf of the Lake Superior and Western Development Company. After some investigation, nothing looked as good to him as the barren, hard limestone knob called "Mag Hill" which was owned by a Tombstone saloon keeper, Martin Costello. The Irish Mag claim, named for a woman of the red-light district in upper Brewery Gulch, lay far to the east of any known ore and was generally considered to be of little value. However, Hoatson's 26 years of experience had taught him many things not the least of which was that surface showings in a copper camp were not so important. He quickly reached a deal with Costello and returned to Calumet to raise money for the development.

**SLIDE 3**

**THE CALUMET & ARIZONA GOES ON TO DEVELOP MORE MINES**

**THE SUCCESS AT THE IRISH MAG MINE LED THE C&A TO ACQUIRE MORE AND MORE PROPERTY AND DEVELOP MORE MINES. SUCCESS FOLLOWED SUCCESS FOR THE C&A AND SOON IT WAS ONE OF THE LARGER COPPER COMPANIES IN THE US AND EXPANDED BEYOND BISBEE.**

**THE C&A WAS AN INDUSTRY LEADER IN MANY TECHNICAL ASPECT AND PROSPERED THROUGH INNOVATIVE APPROACHES IN AN OLD INDUSTRY.**



GRAEME LARKIN COLLECTION

COLE SHAFT C-1908

**AFTER THE “MAG” CAME THE OLIVER MINE, THEN THE COLE, HOATSON, JUNCTION AND BRIGGS MINES, ALL OF WHICH BECAME GREAT PRODUCERS.**

**THE COPPER QUEEN WAS LOSING THE GAME AND BEGAN TO PAY HUGE SUMS FOR PROPERTY IT COULD HAVE HAD FOR VERY LITTLE, IF ONLY THE FAITH HAD BEEN STRONGER. ~~~~~**



GRAEME LARKIN COLLECTION

HOATSON SHAFT C-1910

**SLIDE 4**

**SEVERAL SMALL COMPANIES WERE SUCCESSFUL AS WELL**

**A SMALL GROUP OF CLAIMS FORMED THE PROPERTY OF THE SHATTUCK & ARIZONA MINING CO. WITH THE SHATTUCK MINE CALLED "THE RICHEST LITTLE MINE IN ARIZONA," AND FOR GOOD REASON. HIGH GRADE ORE WAS HIT JUST 100' DOWN**

~~~~~



GRAEME LARKIN COLLECTION



GRAEME LARKIN COLLECTION

DENN MINE C - 1907

**SHATTUCK MINE C - 1908  
THE DENN & ARIZONA DEVELOPED THE RICH DENN MINE WHICH PROVED HUGELY CHALLENGING BECAUSE OF WATER PROBLEMS AS WELL AS THE FACT THAT THE ORES WERE DEEP, VERY DEEP — SOME 1,700' TO THE FIRST ORE**

~~~~~

~~~~~

SLIDE 5

**MOST OF THE SMALL COMPANIES FAILED**

BY 1900, MORE THAN 1,000 MINING CLAIMS COVERING NEARLY 20,000 ACRES HAD BEEN FILED. SOME 400 WERE PATENTED WHILE THE REMAINDER WERE UNPATENTED. THE QUICK SUCCESS OF THE C&A AND THE SHATTUCK INSPIRED A RUSH TO INVEST IN THESE COPPER FIELDS. DOZENS OF SMALL MINING COMPANIES FORMED, EACH CONVINCED THAT THE NEXT COPPER QUEEN MINE WAS ON THEIR CLAIMS, BUT YOUR MONEY WAS NEEDED TO FIND IT. INVEST IN US, THEY SAID. THE EARLY YEARS OF THE 20<sup>TH</sup> CENTURY WERE TO BE BUSY ONES FOR MANY OF THESE SMALL COMPANIES.

SOME WERE HONEST EFFORTS, WITH SEEMINGLY GOOD GROUND. OTHERS WITH LESS PROMISING PROPERTY WERE HIGHLY SPECULATIVE AND STILL OTHERS WERE ABSOLUTE FRAUDS, SEEKING ONLY TO SWINDLE MONEY FROM INVESTORS.



GRAEME LARKIN COLLECTION

BISBEE EXTENSION MINING CO.  
STOCK CERTIFICATE - 1911

**MORE THAN 40 MINING COMPANIES CLAIMED TO BE DEVELOPING OR EXPLORING GROUND AT BISBEE AT ONE TIME OR ANOTHER, BUT VERY FEW WERE TO BE SUCCESSFUL.**

~~~~~

**SLIDE 6**

**SOME FAILED BECAUSE THERE WAS NO ORE TO BE FOUND**

**THE COPPER GLANCE MINING COMPANY EXPLORED AN AREA FAR TO THE EAST OF THE KNOWN ORE. IT WAS FOLLOWING GOOD SURFACE INDICATIONS IN THE POST-ORE GLANCE FORMATION WHICH CONTAINED SCATTERED PIECES OF ORE, ERODED FROM DEPOSITS FAR AWAY. NOTHING OF CONSEQUENCE WAS EVER FOUND IN SPITE OF DILIGENT WORK**



GRAEME LARKIN COLLECTION  
COPPER GLANCE MINING CO.  
STOCK CERTIFICATE - 1902



GRAEME LARKIN COLLECTION  
COCHISE DEVELOPMENT CO.  
STOCK CERTIFICATE - 1906  
~~~~~

**THE COCHISE DEVELOPMENT COMPANY SANK A SHAFT IN THE MINERALIZED PORPHYRY/SCHIST NORTH OF THE DIVIDEND FAULT AND NEAR SACRAMENTO HILL, FINDING ONLY VERY LOW-GRADE MINERALIZATION**

**IN BOTH CASES, THE STOCKHOLDERS LOST WHAT THEY HAD INVESTED, BUT THESE COMPANIES HAD MADE HONEST EFFORTS**



Early shaft sinking at the Cochise Mine C-1902.

Note the use of a horse whim to hoist broken rock and the simple tripod headframe in use

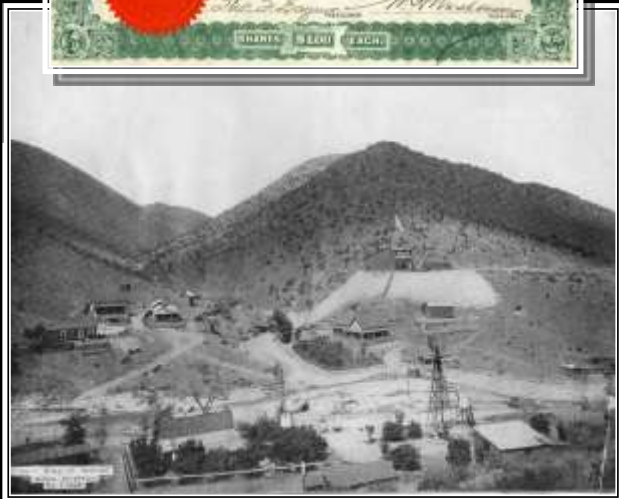


**A FEW COMPANIES CAME HERE TO SWINDLE, NOT TO MINE**

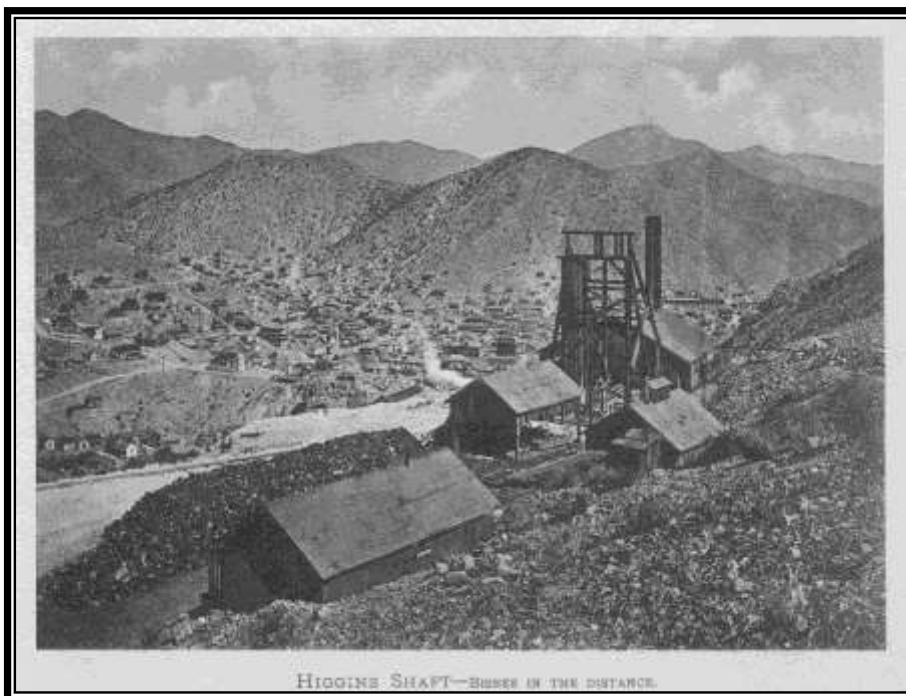


**THE COPPER KING OF ARIZONA MADE MUCH OF ITS PROXIMITY TO THE COPPER QUEEN MINES, SUGGESTING IT COULD BE OF EQUAL VALUE. HOWEVER, THE DIVIDEND FAULT CUT OFF ANY ORE EXTENSIONS. MOST OF THE MONEY RAISED IN THE STOCK MARKET WAS USED BY TO PAY THE DIRECTORS HANDSOMELY , NOT LOOK FOR ORE**

~~~~~



GRAEME LARKIN COLLECTION  
EXCERPTS FROM COPPER KING PROSPECTUS AND STOCK CERTIFICATE - 1900



Higgins Shaft C-1905.

The Higgins was one of the few small, independent mines which was successful. It was the west-most of the successful mines as well.

Graeme Larkin Collection

SLIDE 8

**THE INDEPENDENT MINE OPERATORS AT BISBEE 1880 - 1930**



GRAEME LARKIN COLLECTION  
 NIGHT HAWK LEASING COMPANY  
 STOCK CERTIFICATE - 1926

**THE LARGER OF THE  
 INDEPENDENT  
 COMPANIES AND THE  
 MINES THEY DEVELOPED  
 AT BISBEE. THE  
 SUCCESSFUL MINES ARE  
 NOTED BY UNDERLINING**

~~~~~

MINE	OPERATING COMPANY
ABC	ARIZONA BISBEE COPPER Co.
BISBEE EXTENSION	BISBEE EXTENSION MINING Co
BISBEE QUEEN	BISBEE QUEEN DEVELOPMENT Co.
BISBEE WEST	BISBEE WEST COPPER MINING Co.
CALUMET & BISBEE	CALUMET & BISBEE DEVELOPMENT Co.
COCHISE	COCHISE DEVELOPMENT Co.
<u>COPPER PRINCE</u>	ARIZONA PRINCE COPPER Co.
COPPER KING	COPPER KING OF ARIZONA Co.
<u>DENN</u>	DENN ARIZONA COPPER Co.
EASTER SUNDAY	EASTER SUNDAY MINING Co.
GLANCE	COPPER GLANCE MINING Co.
<u>HIGGINS</u>	HIGGINS DEVELOPMENT Co.
HOUGHTON	HOUGHTON DEVELOPMENT Co.
IVANHOE	IVANHOE COPPER Co.
<u>LOWELL</u>	LOWELL AND ARIZONA MINING Co.
NEPTUNE	NEPTUNE MINING Co.
<u>NIGHT HAWK</u>	NIGHT HAWK LEASING Co.
PORTAGE LAKE	PORTAGE LAKE & BISBEE DEVELOPMENT Co.
RED JACKET	RED JACKET & BISBEE DEVELOPMENT Co.
<u>SHATTUCK</u>	SHATTUCK & ARIZONA COPPER Co.
SAGINAW	AMERICAN-SAGINAW DEVELOPMENT Co.
WARREN (OLD)	WARREN DISTRICT DEVELOPMENT Co.
WOLVERINE # 1	WOLVERINE & ARIZONA MINING Co.
<u>WOLVERINE #2</u>	WOLVERINE & ARIZONA MINING Co.

The number of companies attempting to develop mines at Bisbee was cyclical and largely a function of available capital in the stock market. Thus during periods of high metal prices, more speculators were in the market with more money available for these junior type companies. This remains much the same today, except that those intent on swindling the investors have a more difficult time. The periodic stock market panics/crashes/depressions typically cleaned out the market place by forcing many into bankruptcy. The panics of 1893, 1907 and 1929 had the most impact on the small mines at Bisbee. Even the smaller successful mines such as the Denn, Shattuck and Wolverine mines were closed during 1907/08 and the depression of post WWI years forced the merger of the Denn and Shattuck companies and caused the Higgins to be sold to Phelps Dodge while the unprecedented market crash of 1929 forced the merger of the C&A with PD.

**SLIDE 9**

**THE COPPER QUEEN TRIES TO CATCH UP**

**FACED WITH THE VERY REAL POSSIBILITY OF BEING LEFT BEHIND, THE COPPER QUEEN BOUGHT ALL OF THE CLAIMS IT COULD. IT PAID HUGE SUMS FOR PROPERTY THAT COULD HAVE BEEN HAD FOR A TRIFLE A FEW YEARS EARLIER, YET MOST OF IT WAS TO BE BARREN OF ORE. THE QUEEN HAD WAITED TOO LONG TO ACT ~~~~~**



**GRAEME LARKIN COLLECTION**

**MINERS AT THE LOWELL SHAFT 1905**

**OF THE MANY CLAIMS BOUGHT DURING THE RUSH, ONLY THE PROPERTY WITH THE LOWELL MINE AND NEARBY DALLAS MINE WERE EVER OF VALUE AND IT TOOK THE DALLAS SEVERAL DECADES TO PROVE ITS TRUE WORTH ~~~~~**



**GRAEME LARKIN COLLECTION**

**DALLAS MINE 1898**

## SLIDE 10

### **A HUGE PROBLEM IS AVERTED THROUGH COOPERATION**

- **THE SUCCESS OF THE NEW MINES IN THE DISTRICT HAD THE POTENTIAL TO CREATE ENDLESS LITIGATION AND ENRICH AN ARMY OF LAWYERS THROUGH THE MUCH HATED “LAW OF THE APEX”**
- **JUST AS THE COPPER PRINCE CLAIMED ORE IN THE COPPER QUEEN, THE QUEEN COULD HAVE CLAIMED THE NEW FINDS AS THEIR OWN, AS THE “APEX” WAS CLEARLY ON QUEEN GROUND, BUT ONLY AFTER YEARS OF BITTER LITIGATION**
- **DR DOUGLAS WOULD HAVE NONE OF IT AND SAID “WE MUST DECIDE WHICH INDUSTRY IS TO PROSPER HERE - THAT OF MINING OR THAT OF LAWYERS”**
- **HE CHOSE WISELY AND BECAUSE OF THIS, THE DISTRICT WAS TO BE ONE OF THE VERY FEW SPARED THE VICIOUS FIGHTING BETWEEN COMPANIES OVER THE OWNERSHIP OF ORES .**
- **ALL PARTIES MADE THE “VERTICAL SIDELINE” OF A CLAIM THE BOUNDARY TO WHICH ORE COULD BE MINED AND FREE ACCESS WAS GIVE TO EACH OTHERS MINES SO THAT ANY INFORMATION GAINED BY ONE WOULD BE SHARED WITH THE OTHER.**
- **MINING PROSPERED MIGHTILY IN THE WARREN MINING DISTRICT TO THE BENEFIT OF ALL ~~~~~**

Douglas was a man well ahead of his times in many ways. He spoke and wrote extensively on the preservation of natural resources (1909b), (1913b), often taking his own industry to task for their less than efficient practices (Douglas, 1904). Douglas argued against the “law of the apex as an inhibitor to productive commerce and as an endless source of income for predatory lawyers (Douglas, 1907). To the very real benefit of the district he abolished this practice at Bisbee. The Copper Queen could have claimed all of the ore found by the Calumet & Arizona had it chosen to wage the battle, but that would have been fundamentally wrong and against the cherished beliefs of both himself and the partners of Phelps Dodge & Co.

With the abolition of the “Apex” rights came free access to the mines of the other companies so that each could profit from the success of the other in the discovery of ore near the property boundary. There was also the sharing of technical information which allowed the companies to take full advantage of the experiences, both good and bad, of their neighbor. This was open sharing of such knowledge and information was absolutely unprecedented.

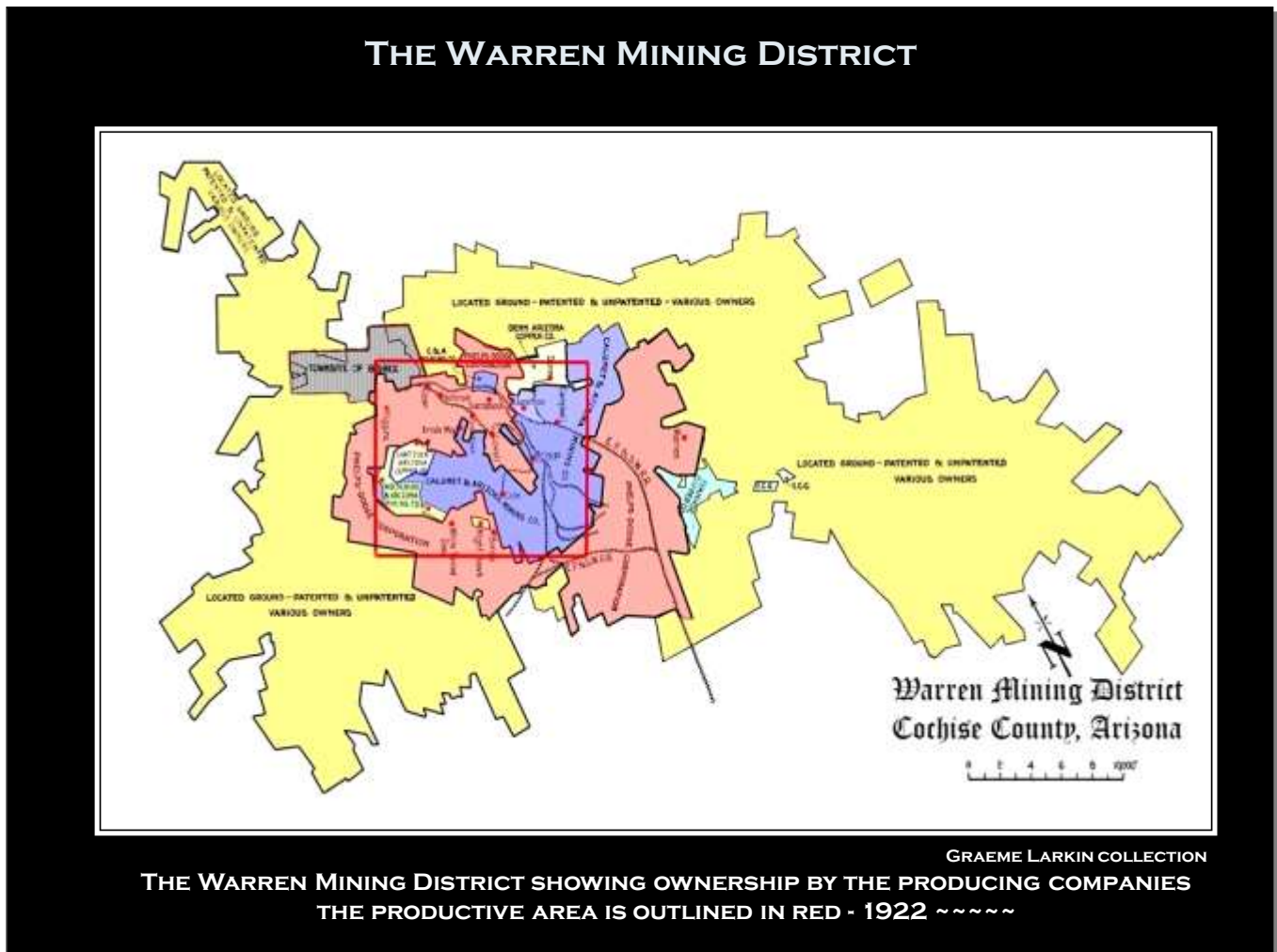
Perhaps this was the most significant contribution Dr. James Douglas made to his industry, and thereby benefiting society as a whole, was to bring an end to the long held practices of keeping

every improvement or discovery secret. In tribute to him after his death in 1918, the Engineering & Mining Journal said:

*“It was he who led in tearing away the veil of secrecy that formally shrouded and hampered mining technology. Our marvelous progress during the last 20 years has been based on the general and generous exchange of knowledge and information more than upon anything else. In permitting that great philosophy Dr. Douglas led the way and exhibited a spirit that spread widely and prevailingly.”*

We in the industry today still greatly benefit from this selfless effort.

**SLIDE 11**



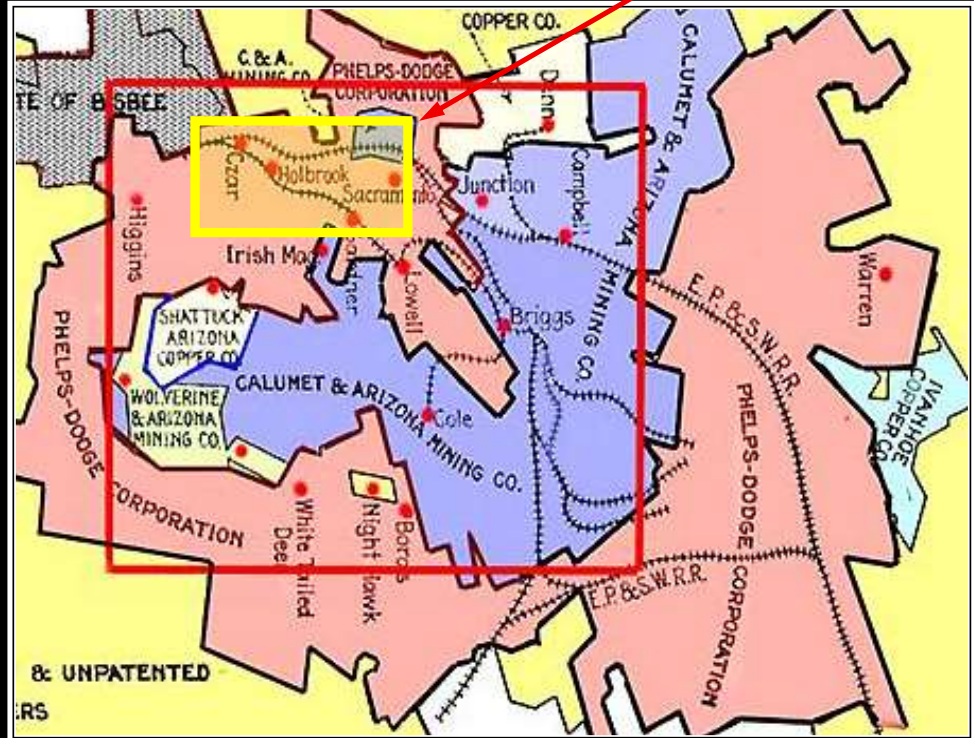
SLIDE 12

THE COPPER QUEEN IS CUT OFF

COPPER QUEEN AREA PER -1900

THE COPPER QUEEN'S HISTORIC MINING AREA WAS LIMITED. NOW THE C&A AND OTHERS HAD ALL OF THE GROUND WHERE NEW ORE WAS MOST LIKELY TO BE FOUND. THE QUEEN WAS IN TROUBLE. IT COULD NOT EXPAND INTO NEW AREAS, BUT IT COULD OPTIMIZE WHAT IT HAD IF IT MODERNIZE.

~~~~~



GRAEME LARKIN COLLECTION

RELATIVE POSITIONS OF THE PROPERTIES HELD BY THE PRINCIPAL MINING COMPANIES 1922

SLIDE 13

## THE CHANGING FACE OF THE COPPER QUEEN

- **THE COPPER QUEEN COULD NOT OPEN UP NEW AREAS TO EXPLORE FOR ADDITIONAL RESERVES, THEY WERE BLOCKED BY OTHER MINING COMPANIES, PARTICULARLY, THE C & A**
- **THE QUEEN HAD TO GET SMARTER ABOUT HOW TO USE WHAT IT HAD, AND IT HAD HUGE AMOUNTS OF LOW GRADE ORE**
- **MOST OF THE VERY HIGH GRADE ORE WAS GONE. FEED TO THE SMELTER, AFTER HAND SORTING THE ORE IN THE STOPES, WAS NOW BELOW 7% COPPER**
- **IT BEGAN WITH A CHANGE OF MANAGEMENT AT BISBEE**

**THE YOUNG  
BUSINESSMAN,  
WALTER DOUGLAS,  
REPLACED THE VERY  
EXPERIENCED MINER,  
BEN WILLIAMS, IN  
LATE 1899 ~~~~~**



GRAEME LARKIN COLLECTION

**BEN WILLIAMS**

**IN ONE OF THE COPPER QUEEN MINES  
C - 1895**



GRAEME LARKIN COLLECTION

**WALTER DOUGLAS C - 1910**

In December 1899, Ben and Lewis Williams left the Copper Queen and Bisbee, but the reasons for their departures have always been unclear. Both were capable men in their 50s with a lot of time left to work. Indeed, both continued working in mining elsewhere for a number of years. Why did they leave?

Ben Williams was clearly responsible for the loss of opportunity to acquire the Irish Mag claim when he threatened to resign if Dr. Douglas purchased it from the apparently demented owner, Daly. By the time it was purchased by the C&A, its potential value was well understood from development in the nearby Spray mine. There can be little doubt that the owners of the Copper Queen were unhappy about this loss, but was this what caused the change?

Lewis Williams as smelter superintendent performed marvelously with the relatively primitive furnaces he installed in the early 1880s, so much so, that he insisted the same small and somewhat inefficient furnaces be installed in the new smelter at the Czar in 1887. However, Dr. Douglas was less impressed with the old units and while he allowed three to be installed, he insisted that the next furnaces added be of a different and larger type. As the smelter expanded, in the confined space, it was not the most efficient of plants and surely only developed this way

under the guidance of Lewis Williams. Perhaps he was reluctant to change in general. Perhaps he wanted to save the owners the costs associated with the construction of a new and modern plant. If either of these were true, he was costing the owners more by keeping a plant that was inefficient and wasteful.

Over the years that the Copper Queen was in operation, a number of important advances had been made in mining technology. Most importantly were the advent of pneumatic drills and motorized ore haulage. Why did the Queen not adopt these technologies? They were largely proven by the mid-1890s.

Were the Williams brothers replaced because they could not adapt to the changes? This very problem still plagues the mining industry today with many otherwise capable managers are replaced because they are unable to take the next step toward becoming efficient through the effective use of new technology. Or was it simply old fashioned nepotism? Ben Williams was, after all, replaced by Walter Douglas, the son of Dr. Douglas. To this point Walter Douglas was somewhat inexperienced. Whatever his shortcomings may have been, it must be said, and without reservation, that Walter Douglas became an extraordinary manager and led the Copper Queen and Phelps Dodge to the forefront of the industry at the time. He did not waste any time getting started either.

In any event, during November 1899, the news of their resignations was received by the town with sadness (Tombstone Epitaph, 1899). Thus the mine workers and town's people joined with the Copper Queen to give an appropriate token of their collective affection and esteem to the Williams brothers. For this, the people of Bisbee turned to Shreve & Co., the noted San Francisco silversmiths, when it came to honoring Ben and Lewis.



Two large, sterling silver trophy-like loving cups adorned with gold decoration were presented to these fine gentlemen by a grateful populous on December 20, 1899. Together, they moved on to California two days later (Arizona Orb, 1899), but they returned often and were always warmly welcomed by their many friends.



The loving cups presented to the Williams brothers. Top: back side of Ben's. Roger Becksted collection; Lower: two views of the cup given Lewis, Bisbee Mining and Historical Museum Collection

## THE DRIVE TO BECOME MORE EFFICIENT

THE MOTTLE COLLECTION OF FACILITIES AT THE BASE OF QUEEN HILL WHICH MADE UP THE COPPER QUEEN SMELTER WERE MORE THAN AN EYESORE; THEY WERE HORRIBLY INEFFICIENT. ON AVERAGE, THE SLAG WASTE FROM THE BISBEE SMELTER AVERAGED 2.5% COPPER. TOO MUCH OF THE METAL WAS BEING LOST, ESPECIALLY NOW, WITH THE LOWER ORE GRADES BEING MINED

~~~~~



GRAEME LARKIN COLLECTION

COPPER QUEEN SMELTER 1898

- THE YEARS FROM 1900 TO 1920 WERE TO BE TWO DECADES OF SIGNIFICANT CHANGE IN THE WAY THE COPPER QUEEN DEVELOPED AND MANAGED ITS MINES AND SMELTER
- MILLIONS OF DOLLARS WERE TO BE INVESTED IN THE MINES, AND A MORE EFFICIENT AND LARGER SMELTER HAD TO BE BUILT AT A COST OF MILLIONS MORE

~~~~~

The old smelter at the Czar shaft was ugly beyond description. Photographs of the time look more akin to a junkyard than an industrial complex, much less a profitable one. On writer of the time said” *The old smelting plant was crowded and inadequate, notwithstanding which it earned many millions of dollars for the Copper Queen Company, in the past, doing much better work than its appearance promised.*”

**SLIDE 15**

**IT BEGAN WITH A NEW SMELTER IN A NEW TOWN**

**A NEW SITE WITH AN ABUNDANCE OF BOTH SPACE AND WATER WAS SELECTED SOME 24 MILES AWAY ON THE MEXICAN BORDER AND NAMED "DOUGLAS" FOR DR. JAMES DOUGLAS. INTERESTINGLY, THIS SITE WAS NOT THE FIRST CHOICE. ONE NEAR NACO WAS PREFERRED, BUT LAND SPECULATORS BOUGHT THE DESIRED PROPERTY FIRST AND DR. DOUGLAS REFUSED TO BE ROBBED AND CHANGED LOCATIONS.**

**A STATE OF THE ART PLANT WITH THREE TIMES THE CAPACITY WAS BUILT AND BROUGHT INTO PRODUCTION IN 1904. SLAG FROM THE NEW PLANT CONTAINED LESS THAN 1% COPPER AND OFTEN LESS THAN 0.5%. THE TWIN EFFICIENCIES OF INCREASED SCALE AND MODERNIZATION CAME WITH THE NEW SMELTER. NOW THE MINES HAD TO KEEP UP WITH THE HUGE, HUNGRY SMELTER AND THEY DID BY MINING LOWER GRADE.**

**PRODUCTION FROM THE COPPER QUEEN JUMPED FROM 3 MILLION POUNDS PER MONTH TO JUST OVER 5 MILLION POUNDS THEN TO 6 MILLION THEN TO 7 MILLION POUNDS PER MONTH AS MORE THAN TWICE AS MUCH ORE FROM BISBEE WAS TREATED. THIS PLANT ALSO SMELTED ORES FROM THE MINES AT NACOSARI, MEXICO, ALSO OWNED BY PD.**

~~~~~



GRAEME LARKIN COLLECTION  
COPPER QUEEN SMELTER, DOUGLAS, ARIZONA  
C- 1905

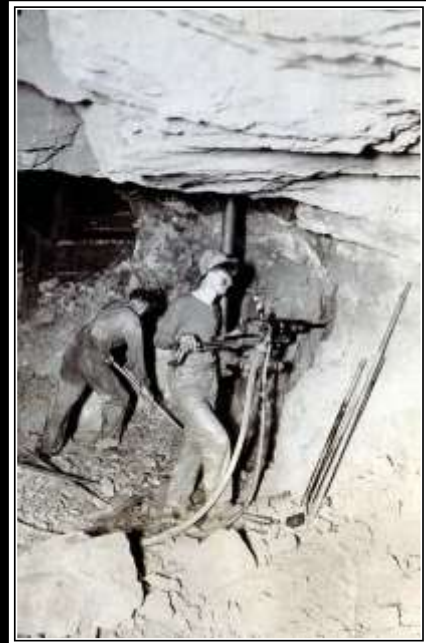
**SLIDE 16**

**THE MINES HAD TO KEEP THE HUGE, NEW SMELTER FULL MORE ORE HAD TO BE MINED AND FASTER — MORE MINERS WERE NEEDED, BUT SKILLED MINERS WERE SCARES AND HAND DRILLING WAS A HIGH SKILL TASK. A CHANGE MADE IN THIS ALONE COULD HAVE A HUGE IMPACT.**

**IMPROVED DRILLING WAS AN IMPORTANT FIRST STEP. PNEUMATIC ROCK DRILLS REPLACED HAND DRILLING, REDUCING THE TIME TO DRILL A BLAST FROM TWO SHIFTS WITH TWO MEN TO THREE HOURS WITH ONE MINER AND A HELPER.**



GRAEME LARKIN COLLECTION  
SINGLE JACK, HAND DRILLING IN A STOPE C - 1903



GRAEME LARKIN COLLECTION  
PNEUMATIC DRILLING IN A STOPE C - 1920

**COMPRESSED AIR DRILLS WERE NOT INTRODUCED AT BISBEE UNTIL 1905 EVEN TOUGH THEY HAD BEEN AVAILABLE FOR A NUMBER OF YEARS**

~~~~~

There is little doubt that the introduction of pneumatic drills in the mines of the Copper Queen was delayed by the need to develop the infrastructure required just to get sufficient volumes of compressed air to the working faces. First power was needed to run the huge compressors which were required and electricity was not readily available, thus steam power plants had to be built to run the compressors. Then there was the huge task of installing the miles of pipe in the shafts and other workings as well as the placement of air receivers to provide the essential surge capacity when demand was high. These projects obviously took years to complete.

## SLIDE 17

### JUST GETTING THE ORE FROM THE STOPES TO THE SHAFT WAS HARD

ALL OF THE ORE WAS PUSHED, BY HAND TO THE SHAFT, ONE CAR AT A TIME, JUST AS IT ALWAYS HAD BEEN DONE. THIS SLOW AND VERY LABOR INTENSIVE APPROACH COULD NOT BE DEPENDDED UPON. THESE CARS HELD ONLY 1/2 TON OF ORE AND THE SMELTER NEED, 3, 200 SUCH CARS EVERY WORKDAY. THIS COULD NOT BE DONE BY HAND ALONE, EVEN WORKING THREE SHIFTS PER DAY.



GRAEME LARKIN COLLECTION  
HAND TRAMMING LOADED MINE CAR  
C - 1915

MULES WERE INTRODUCED IN 1907, AND WHILE THEY COULD PULL 3 OR 4 SUCH CARS AT A TIME, A MULE NEED MORE HEAD CLEARANCE THAN A MAN. THUS THE WORKINGS HAD TO BE ENLARGED WHERE THEY WERE TO BE USED. THIS WAS A GREAT IMPROVEMENT, BUT STILL INSUFFICIENT TO MEET THE SMELTER'S GROWING DEMAND.

UNDERGROUND  
MULE BARN  
C - 1908  
GRAEME LARKIN  
COLLECTION



~~~~~

Introducing mules into the mine for haulage was not a simple matter. A number of changes had to be made to accommodate these special beasts. First, it was not easy to get a mule down the shaft. Not one of the cages at any of the mines was nearly big enough to allow hold a mule (this changed with the Sunrise shaft in 1920 which had a cage built to accommodate mules). To lower one, it had to be securely tied, indeed bundled to keep it from catching on the shaft timber. They are powerful animals and are not easily trussed in a manner that would allow them to be suspended under the cage and lowered down the shaft, so they were sedated. Now a +1,000 pound, sedated mule is still not easy to handle as every effort was taken not to injure these expensive creatures.

When a man pushes a loaded mine car, he is in a stooped position and needed only a little head room. Mules required a good deal more space, thus many of the drifts and crosscuts had to be raised, not a simple matter where the ground was heavy and timber was already in place. In un-timbered areas, it was easy to drill a few holes in the back (ceiling) and blast to make more head room, but timbered areas had to be treated carefully as they were raised to make the necessary head room.

Bisbee's mines were wet, often very wet. Mules must have the ability to have their feet dry out. They cannot work in mud or water all day, thus drainage was important to keep the track as dry as possible, a little water or mud was OK, but not a lot.

Then there was the matter of caring for them. Dry, well ventilated areas were chosen for their "barns" and they were well fed and watered. More than one miner was fired for stealing the oats used to mix with the other forage they received. Because of this and the many changes, indeed improvements made to bring in and feed the mules, it was common lore that the mules were cared for better than the men. To be sure the mules were very well cared for, just as any expensive tool or animal should be treated, but in no way were they viewed superior to the men, at least not at Bisbee.

A well trussed mule about to be unloaded from a cage C-1915.

Note the sand placed on the flooring to help protect the mule from injury when unloaded.



**SLIDE 18**

**ELECTRIC TROLLEY HAULAGE MEETS THE CHALLENGE**

**IN 1908 ELECTRIC TROLLEY “MOTORS” (LOCOMOTIVES) WERE BROUGHT IN TO SOLVE THE PROBLEM OF HAULAGE OF ORE TO THE SHAFTS AND WASTE ROCK TO WHERE EVER IT WAS NEEDED. BRINGING IN TROLLEY MOTORS WAS A HUGE TASK. ONE WHICH REQUIRED AN ENORMOUS INVESTMENT.**



**GRAEME LARKIN COLLECTION**

**TROLLEY MOTOR WITH 1 1/2 TON GABLE BOTTOM CARS C - 1910**

~~~~~

**HISTORICALLY, THE SIZE OF MOST OF THE OPENINGS CUT IN THE ROCK FOR ACCESS WAS KEPT AT A MINIMUM. EVERY INCH OF HEIGHT OR WIDTH REQUIRED MORE HAND DRILLING AS WELL AS HAND MUCKING. ALSO, THE MINE OPENINGS WENT WHERE THE ORE WAS AND THIS WAS WHERE THE ROCK WAS THE MOST UNSTABLE. SMALL OPENINGS, BAD GROUND, NOT A GOOD MIX FOR MODERN, MOTORIZED HAULAGE. ALL THIS HAD TO BE CHANGED BEFORE MOTORS COULD BE SAFELY AND EFFECTIVELY USED.**

~~~~~

**THE WHOLE MINE COULD NOT BE CHANGED, SO STARTING WITH THE 400 LEVEL, EVERY EVEN NUMBERED LEVEL WAS MADE READY FOR THE TROLLEY. MILES OF NEW CROSSCUTS WERE DRIVEN IN GOOD ROCK, WHILE EXISTING WORKINGS WERE WIDENED TO ACCEPT THE NEW, BIGGER CARS AND THE BACK WAS RAISED TO PLACE THE 240 VOLT DC BARE TROLLEY WIRE SAFELY ABOVE THE HEADS OF BOTH MEN AND MULES.**

~~~~~

Men and mules continued to be the principal method of moving rock on the odd numbered levels as well as all levels above the 400, but by using closely spaced raises for dump points, the distance was kept to a minimum. Hand tramming averaged 260 feet in 1910 while mule haulage was 770 feet. Motors on the other hand averaged 2,650 feet per tram that same year. It was not until 1930 that mules and most hand tramming was totally replaced by motor haulage.

**SLIDE 19**

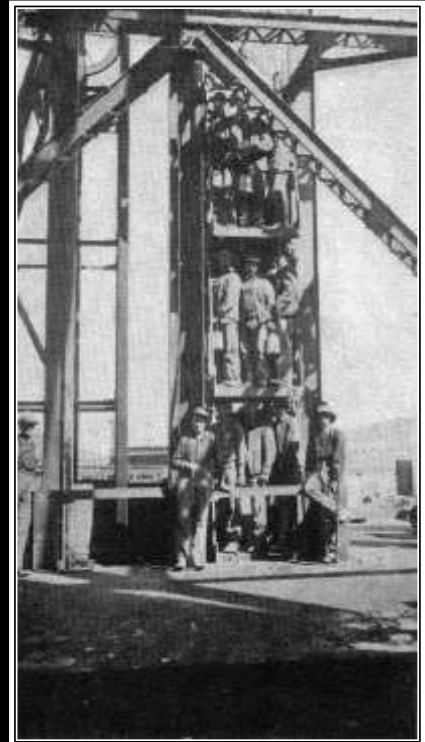
**THE SHAFT IS THE NEXT POTENTIAL BOTTLENECK**

**EVERY CAR OF ORE BROUGHT TO THE SHAFT WAS PUSHED ONTO A CAGE DECK FOR HOISTING TO THE SURFACE , HUNDREDS OF CARS WERE HOISTED DAILY, WORKING 24 HOURS JUST TO MEET THE DEMAND OF THE SMELTER.**

**THE INDIVIDUAL MINE SHAFTS AT BISBEE WERE CLOSELY SPACED TO OPTIMIZE THE DISTANCE THE ORE CARS WERE HAND TRAMMED. THERE WERE MANY SHAFTS WITH LOTS OF CARS TO BE HOISTED EVERY DAY. THE CAGES TYPICALLY HAD 3 DECKS SO 3 CARS COULD BE HOISTED AT ONE TIME. STILL, A SLOW, LABOR INTENSIVE PROCESS.**



GRAEME LARKIN COLLECTION  
CAGE LOADING ORE CARS AT A SHAFT STATION C - 1908



GRAEME LARKIN COLLECTION  
MINERS ON A THREE DECK CAGE  
GARDNER MINE C - 1915

~~~~~

Each loaded car was pushed onto a cage (elevator) deck, then hoisted to the surface where it was then hand trammed and dumped into bins for loading into railroad cars. The empty cars were then pushed back to the shaft to be placed on the cage deck and returned underground. Many men were required in this process which involved nearly two thousand cars a day from all of the shafts.

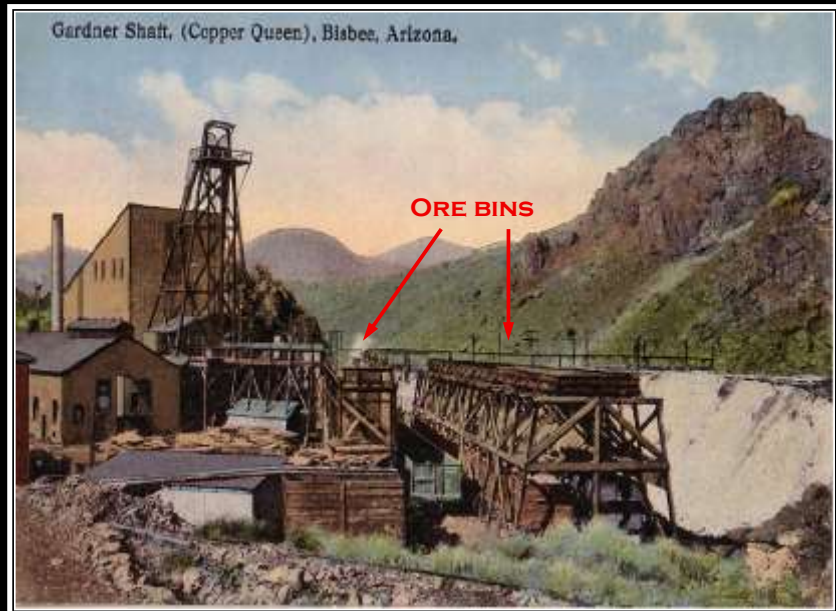


**HANDLING THE ORE ON THE SURFACE WAS ALSO LABORIOUS**

- **EVERY LOADED CAR HOISTED TO THE SURFACE WAS TRAMMED BY HAND TO ORE BINS AND MANUALLY DUMPED FOR LOADING INTO RAILCARS FOR TRANSPORT TO THE SMELTER. THE EMPTY CARS WERE RETURNED TO THE SHAFT TO BE LOWERED AND BEGIN THE CYCLE ALL OVER.**

**THE SURFACE TRAMMING AND DUMPING OF SEVERAL HUNDRED CARS PER DAY AT EACH OF THE SHAFTS INVOLVED A LARGE NUMBER OF MEN, A SIGNIFICANT EXPENSE**

~~~~~



GRAEME LARKIN COLLECTION

ORE BINS AND RAILCARS AT THE GARDNER MINE C - 1908



Left, removing a loaded car of ore from a cage. Note empty on the top deck, which has been dumped into the ore bin and is to be returned underground.

Right, dumping a car of ore into the ore bins.

Both photos from 1904 and at the Gardner Mine. Graeme-Larkin collection.

**SLIDE 21**

**ORE HANDLING IS SLOW, LABOR INTENSIVE AND EXPENSIVE**

- **WITH EVERY EVEN NUMBERED LEVEL EQUIPPED WITH TROLLEY HAULAGE AND ALL OF THE ORE FROM THE ODD LEVELS TRANSFERRED TO A TROLLEY LEVEL, THE HAULAGE DISTANCE TO THE HOISTING SHAFT COULD BE GREATLY INCREASED**
- **A SINGLE, CENTRALLY LOCATED SHAFT COULD BE DEDICATED TO HOIST ALL OF THE ORE WITH MEN AND MATERIALS HANDLED AT THE OTHER SHAFTS ACCORDING TO THEIR INDIVIDUAL NEEDS.**
- **THE SACRAMENTO SHAFT WAS DEVELOPED FOR THIS USE AS ITS LOCATION WAS IDEAL WITH GOOD RAILROAD ACCESS**
- **THE SHAFT WAS EQUIPPED WITH A LARGE STEEL HEAD FRAME AND POWERFUL STEAM HOIST WITH THE STEAM PROVIDED BY A LARGE AND NEW POWER PLANT NEARBY**
- **THE SHAFT DESIGN INCLUDED ORE POCKETS FROM WHICH THREE TON SKIPS COULD BE LOADED**
- **NO LONGER WAS IT NECESSARY TO HANDLE A MULTITUDE OF SMALL ORE CARS SEVERAL TIMES TO GET THE ORE TO THE SURFACE AND INTO RAILCARS**

~~~~~

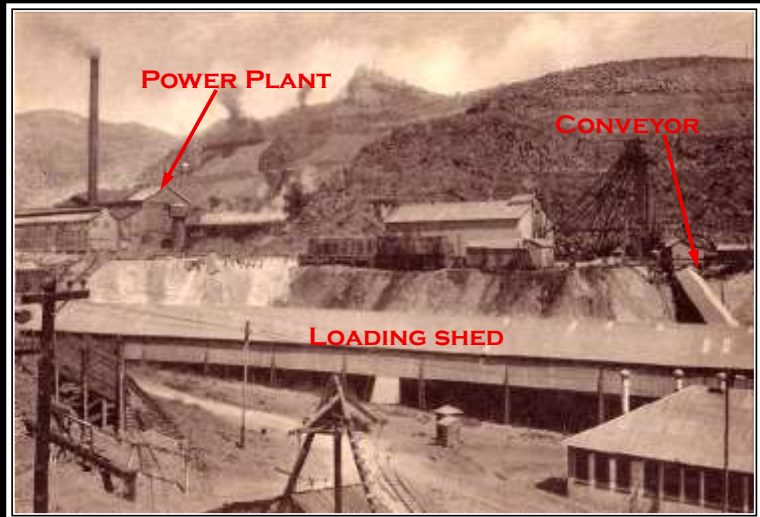
**SLIDE 22**

**THE SACRAMENTO IS THE CENTRAL HOISTING SHAFT**

**THE NEW UNDERGROUND HAULAGE SYSTEM DEVELOPED WAS CONNECTED TO THE SACRAMENTO SHAFT ON EVERY LEVEL FROM THE 400 DOWN. ORE FROM ALL OF THE MINES WAS TAKEN TO THE "SAC" WHERE IT WAS DUMPED INTO STORAGE POCKETS NEAR THE SHAFT. THE POCKETS WERE CONNECTED TO THE SHAFT AND THE ORE LOADED INTO THREE TON CAPACITY SKIPS FOR HOISTING TO THE SURFACE ~~~~~**

**ONCE AT THE SURFACE, THE SKIPS SELF-DUMPED INTO A BIN WHICH FED A CONVEYOR BELT THAT LOADED THE RAIL CARS DIRECTLY. ~~~~~**

**THE LOADING AREA FOR THE RAIL CARS WAS A COVERED SHED WITH THE CAPACITY FOR 21 CARS AT A TIME, WITH AN ADDITIONAL SEVEN CAR TRACK AT THE SIDE. ~~~~~**



**GRAEME LARKIN COLLECTION  
SACRAMENTO SHAFT & LOADING FACILITY C - 1920**

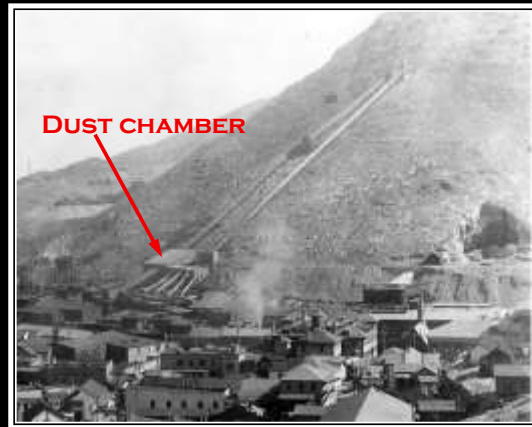
### OTHER SOURCES OF COPPER LOOKED FOR

- THE MANY TENS OF THOUSANDS OF TONS OF SLAG PRODUCED BY THE SMELTER IN BISBEE AVERAGED 2.5% COPPER AND WERE REPROCESSED IN THE NEW PLANT OVER SOME FIVE YEARS, RECOVERING MORE THAN 4 MILLION POUNDS FROM THIS ONCE WASTE MATERIAL
- THE SMOKE STACKS FROM THE OLD SMELTER CLIMBED UP QUEEN HILL FOR SOME DISTANCE WHICH COOLED THE SMOKE SUBSTANTIALLY. THIS CAUSED LARGE AMOUNTS OF VERY HIGH COPPER FLUE DUST TO DROP OUT OF SUSPENSION. THIS WAS COLLECTED IN A "DUST CHAMBER" AT THE BOTTOM. IT WAS DIFFICULT FOR THE OLD PLANT TO RETREAT THIS EXTREMELY FINE BUT RICH MATERIAL. THE NEW PLANT HANDLED IT JUST FINE AND SEVERAL MILLION MORE POUNDS OF COPPER WERE RECOVERED FROM ANOTHER WASTE
- RESOURCE CONSERVATION WAS AN IMPORTANT ISSUE FOR DR DOUGLAS

~~~~~



GRAEME LARKIN COLLECTION  
SLAG DUMPS 1897

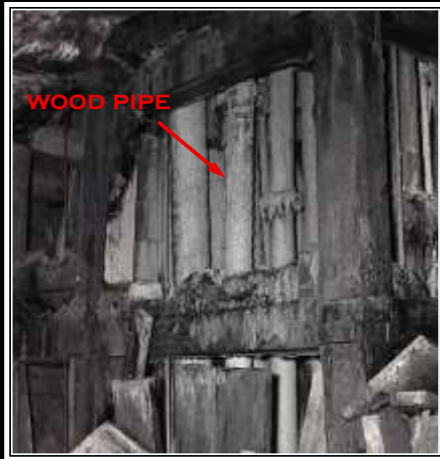


GRAEME LARKIN COLLECTION  
SMELTER STACKS & DUST CHAMBER 1900

Dr. Douglas was a visionary, a man well ahead of his times in so many ways ---labor relations, industrial safety and the conservation of natural resources. He believed in the optimization of recovery system to extract the most out of what he saw as limited, nonrenewable resources 70 years before most others expressed such a concern.

SLIDE 24

HIGHLY CORROSIVE MINE WATERS YIELD COPPER



GRAEME LARKIN COLLECTION

CZAR SHAFT PIPE COMPARTMENT 1961



BISBEE MINING MUSEUM COLLECTION

TRACK HAMMER REPLACED BY COPPER

- **SINCE THE SULFIDE ORES WERE FIRST MINED, HIGH COPPER, ACID WATERS WERE A REAL PROBLEM IN THE MINES, LITERALLY REPLACING ANYTHING IRON WITH SOFT COPPER RENDERING THE ITEM INTERESTING, BUT USELESS. AT THE CZAR MINE, SPECIAL CERAMIC LINED PUMPS CARRIED THIS TROUBLESOME WATER TO THE SURFACE IN PIPES MADE OF WOOD AND WRAPPED WITH STAINLESS STEEL WIRE TO RESIST THE ACID ~~~~~**
- **COPPER RECOVERY FROM THIS WATER BEGAN IN 1904 VERY NEAR THE SITE OF THE QUEEN MINE TOURS BUILDING**
- **THIS FORMER NUISANCE BECAME A VALUED SOURCE OF COPPER, ONE WHICH WOULD BE EXPLOITED FOR MANY YEARS TO COME**

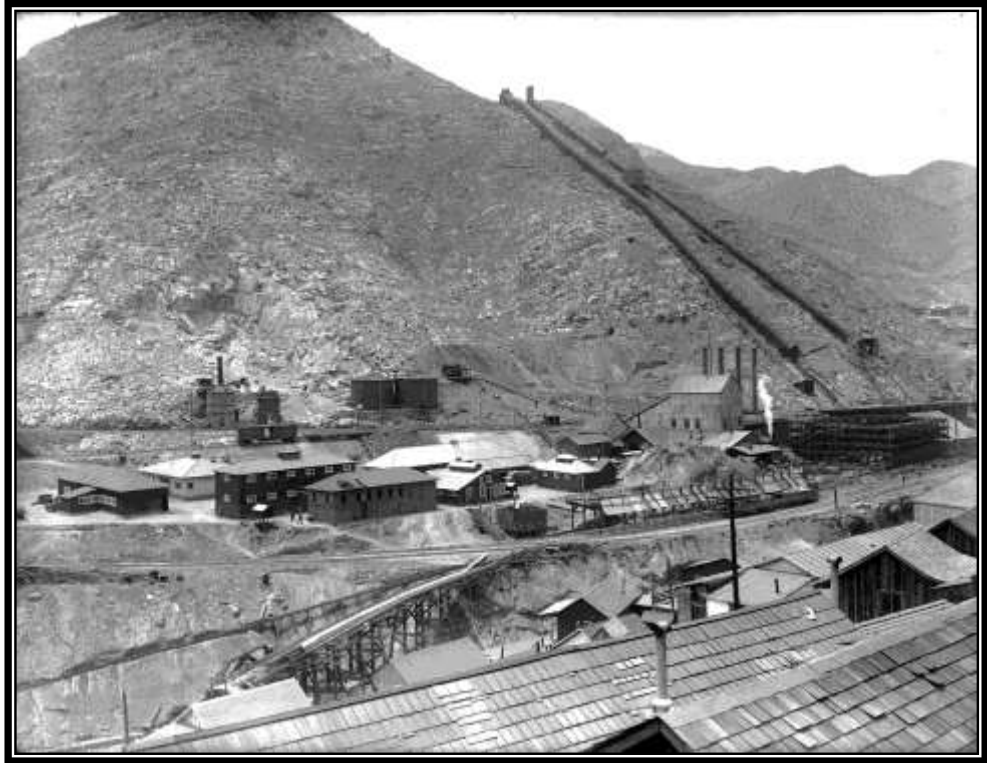
~~~~~

From 1904 until the present time, copper has been recovered from the acidic mine waters at Bisbee. The plants for this have been in several locations with the first near the Czar shaft which collapsed in 1909 and was rebuilt. A second plant replaced this and was located at the base of Sacramento hill.

When low-grade waste was removed from the Sacramento pit, it was placed in piles near the concentrator site and irrigated to produce the copper rich acid waters. This the first effort at dump leaching at Bisbee and the plant was very successful and operated for most of 10 years.

The C&A had a plant on the 1500 level of the junction for many years then, as the mines deepened, it was moved it to 1800 level of the Junction mine where all acid mine waters were collected for pumping to the surface following copper recovery.

The last such plant was constructed near the Campbell shaft to recover copper from both the acid waters collected underground, which were pumped from the 1800 level of the Junction mine by a stainless steel pump through stainless steel pipe, and the waters recovered from the irrigation of the number 7 dump.



Multi-story copper precipitation plant to the right of the Czar Shaft headframe C-1905

The process of dump irrigation to mobilize the copper and recover it from solution is

called leaching as the copper is leached from the sulfides (sulfur + metal, copper and iron in this case) as they breakdown in the moist environment with the aid of sulfur fixing bacteria. A weak sulfuric acid based solution results from this breakdown with both the copper and iron placed in solution. This is the same process which takes place underground, but typically without the intentional irrigation.

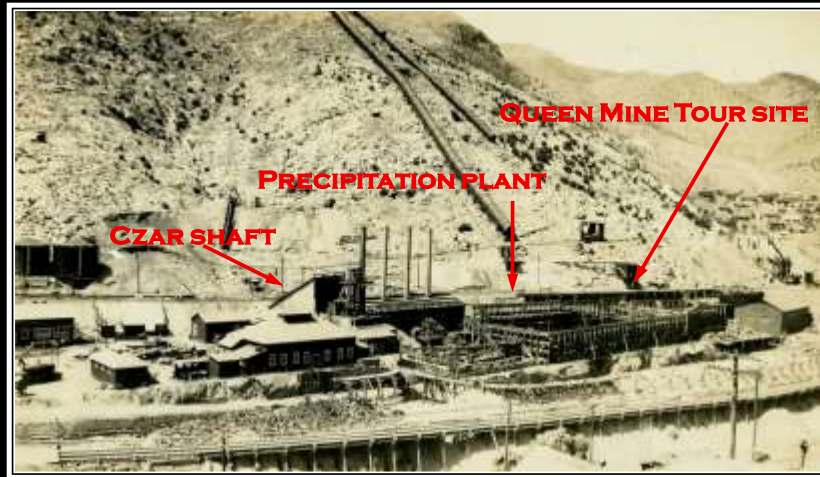
After leaching has removed the copper from the ore and dissolved it into a sulfuric acid-water solution, the recovered solution is passed over pieces of iron, such as cans, car bodies and other scrap. Some of the iron dissolves and replaces the copper in the solution. The copper, meanwhile, is deposited on the remaining pieces of iron. The resulting copper concentrate is called precipitate copper and is from 60 to 90 percent pure copper. From this point, usually it must be smelted or refined to remove the rest of the impurities.

**SLIDE 25**

**COPPER PRECIPITATION PLANTS BECOME A PART OF PRODUCTION**

**COPPER RECOVERY FROM THE ACIDIC, COPPER RICH, MINE WATERS AT BISBEE PRODUCED MANY MILLIONS OF POUNDS OF THE RED METAL IN THE MORE THAN 100 YEARS THAT THE PROCESS WAS EMPLOYED. THIS PROCESS LATTERLY TURNED MILLIONS OF TONS OF WHAT WOULD OTHERWISE HAVE BEEN WASTE, INTO SOMETHING OF TRUE VALUE.**

**THE FIRST SUCH PLANT WAS BUILT ON THE OLD SMELTER SITE, BUT COLLAPSED IN 1910 AND WAS MOVED TO SAC HILL. LATER PLANTS WERE LOCATED NEAR OPEN PIT LEACH DUMPS TO TAKE ADVANTAGE OF WATER RECOVERED FROM LEACHING THESE LOW GRADE MATERIALS**



GRAEME LARKIN COLLECTION

**PRECIPITATION PLANT NEAR THE CZAR SHAFT - 1910**

~~~~~

## SCRAP IRON IS USED TO PRODUCE COPPER

- **THE PROCESS WAS SIMPLE: PUT IRON IN COPPER WATER, THE IRON IS SLOWLY REPLACED BY A HIGH-GRADE, COPPER SLUDGE, OR PRECIPITATE IS LEFT BEHIND WHICH IS COLLECTED, DRIED AND THEN SMELTED.**
- **ANY SCRAP IRON NEAR BISBEE ENDED UP IN THE “PERCIP” PLANT TO MAKE COPPER. THIS INCLUDED TIN CANS, OLD CAR BODIES AND ANY INDUSTRIAL SCRAP IRON. THIN MATERIAL LIKE CANS WORKED BEST AND OVER THE YEARS, MANY THOUSANDS OF TONS OF SCRAP TIN CANS CAME TO BISBEE BY THE RAILCAR FULL.**

**BISBEE WAS HOME TO A NUMBER OF PRECIPITATION PLANTS, BOTH ON THE SURFACE AND UNDERGROUND, ALL OF WHICH WERE A MATERIAL PART OF ITS COPPER PRODUCTION OVER THE YEARS**

~~~~~



GRAEME LARKIN COLLECTION  
PRECIPITATION PLANT FOR WATERS FROM THE CZAR AND  
HOLBROOK MINES AT THE BASE OF SAC HILL C - 1927



**OTHER SOURCES OF REVENUE WERE SOUGHT**

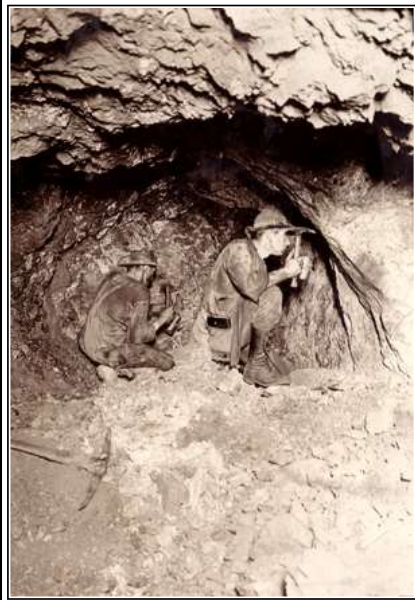
- **IN AN EFFORT TO MAXIMIZE THE AVAILABLE RESOURCES, DIFFERENT SOURCES OF COPPER AND OTHER METALS WERE EXPLOITED**
  - **THE OLD WASTE DUMPS AT THE COPPER QUEEN, CZAR AND HOLBROOK MINES AVERAGED 2½% COPPER. THEY WERE REMOVED AND SENT TO THE SMELTER**
    - MUCH OF THIS WAS DONE DURING A STRIKE IN 1907 TO SUPPLEMENT PRODUCTION LOST DUE TO THE PARTIAL WORK STOPPAGE.
  - **LEASES WERE GRANTED TO A NUMBER OF SMALL MINERS TO EXPLOIT THE FRINGE AREAS OF OLD STOPES STARTING IN 1904**
    - THESE SMALL MINERS COULD MINE CHEAPER THAN THE LARGER COMPANY, THEREBY MINING METAL WHICH WOULD OTHERWISE BE LEFT BEHIND
    - ALL ORE MINED UNDER THE LEASE SYSTEM WAS SENT TO THE COPPER QUEEN SMELTER TO HELP FEED THE FURNACES
    - THE LEASE APPROACH TO MINING SMALL AREAS CONTINUED UNTIL 1944
  - **LEAD HAD BEEN A COMMON METAL IN SEVERAL OF THE MINES AND BECAME ECONOMICALLY IMPORTANT IN 1908 AND CONTINUED TO BE SO FOR 40 YEARS MORE**
    - THE QUEEN TUNNEL WAS DRIVEN IN 1915, PRIMARILY TO FACILITATE THE HANDLING OF LEAD ORES FOUND IN THE SOUTHWEST MINE
    - THESE ORES WERE SENT TO EL PASO FOR SMELTING
  - **MANGANESE WAS MINED FROM A NUMBER OF NEAR-SURFACE DEPOSITS DURING SEVERAL HIGH-DEMAND PERIODS**
    - MOST OF THE MANGANESE ORE MINED WAS SENT TO BESSEMER, ALABAMA TO BE USE IN STEEL MANUFACTURING

~~~~~

From 1904 until 1944, a number of leases were granted to small miners to mine materials deemed uneconomical by the larger Copper Queen. Each lease granted had a defined area and the mining was restricted to those areas. Over the 40 years, many millions of tons of copper, lead, and manganese were mined by these industrious, small companies.

## NEW AREAS ARE EXPLORED WITH A NEW APPROACH

A GEOLOGY DEPARTMENT WAS ESTABLISHED IN 1909 TO LEAD THE SEARCH FOR NEW SOURCES OF ORE IN AREAS PREVIOUSLY UNTESTED AS WELL AS TO LOOK ANEW AT AREAS WITHIN THE OPERATING MINES.



GRAEME LARKIN COLLECTION  
GEOLOGIST AND ASSISTANT SAMPLING  
WORKING FACE C - 1915

FOLLOWING THE SUCCESS OF THE SHATTUCK MINE AND DISCOVERIES IN THE NEARBY UNCLE SAM MINE, THE PROSPECTING OF QUEEN HILL BEGAN WITH NEW AND IMPORTANT OREBODIES FOUND WHICH LED TO THE DEVELOPMENT OF THE WONDERFULLY RICH SOUTHWEST MINE

THE PORPHYRY/ BRECCIA HOSTED DEPOSIT IN SAC HILL WAS IDENTIFIED AS A POTENTIAL SOURCE OF ORE USING STEAM SHOVEL MINING TECHNIQUES AND FLOTATION FOR CONCENTRATING

SACRAMENTO HILL  
1902  
GRAEME LARKIN  
COLLECTION



~~~~~

The creation of a geology department by the Copper Queen was an important, but controversial, step forward in understanding the nature of the complex depositional environment at Bisbee. Dr. James Douglas, a visionary in most respects, was quick to point out that it was not prudent to place too much faith in the science of geology and its application to ore exploration. He placed more faith in the ability of an experienced miner to find ore. In this aspect, Dr. Douglas was wrong.

As suggested, to this point, most exploitation was based on the, often very good, instincts of the miners and/or foremen, but at best these instincts were subjective and less than perfect. This is not to say that the geologist were perfect, this was never the case, but the introduction of a systematic, science-based approach brought about a much higher degree of success in exploration.

SLIDE 29

**NEW ORE IS FOUND IN OLD PLACES**

**GEOLOGIC WORK COUPLED WITH THE SUCCESS OF THE SHATTUCK MINE SUGGESTED THAT ORE COULD BE PRESENT IN THE LIMESTONES ABOVE THE ORIGINAL COPPER QUEEN MINE. TO THIS POINT, LITTLE HAD BEEN DONE ABOVE THE 5,300 ELEVATION AND NOTHING FOUND. WITH NEW GEOLOGIC INFORMATION AND EXPLORATION WORK, MANY IMPORTANT OREBODIES WERE FOUND.**



GRAEME LARKIN COLLECTION  
SITE OF THE SOUTHWEST MINE - 1909

**THE RICH SOUTHWEST MINE WAS DEVELOPED ON THESE ORES BEGINNING IN 1911. BY 1915, IT WAS ONE OF THE MOST IMPORTANT MINES ~ ~ ~ ~**

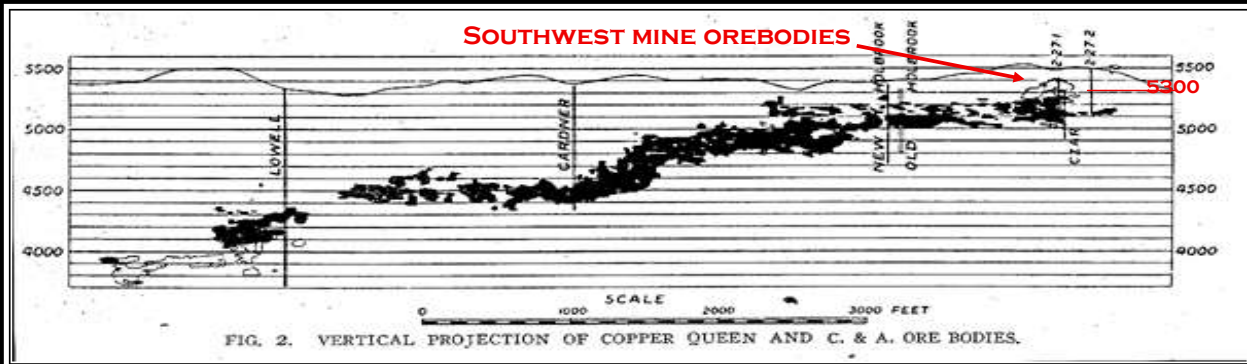


FIG. 2. VERTICAL PROJECTION OF COPPER QUEEN AND C. & A. ORE BODIES.  
GRAEME LARKIN COLLECTION  
CROSS SECTION, LOOKING SOUTH, WITH ORES MINED PROJECTED TO THE SECTION LINE - 1913

The areas above the 5,300 elevation had been largely ignored as the little work done above this level had been disappointing. The Higgins Development Company was exploring above this level and to the west of the Copper Queen property, but they too had little luck. It was the success of the Shattuck mine and subsequent discoveries in the Uncle Sam mine of the Copper Queen coupled with good geologic work that pointed the way to the orebodies in what became the Southwest Mine.

## THE CQCMCo. BECOMES THE CQ BRANCH OF PHELPS DODGE

- THE COPPER QUEEN CONSOLIDATED MINING Co. AND PHELPS DODGE HAD ALWAYS BEEN VERY CLOSELY HELD COMPANIES WITH FEWER THAN 20 SHAREHOLDERS, LARGELY DECEDENTS OF THE PHELPS AND DOGE FAMILIES.
- TO THIS POINT, THE SUBSTANTIAL INVESTMENTS MADE IN MODERNIZING BISBEE HAD, IN EFFECT, COME DIRECTLY FROM THEIR POCKETS AS THE MONEY COULD HAVE BEEN DISTRIBUTED AMONG THE FEW SHARE HOLDERS INSTEAD.
- THE DECISION TO PROCEED WITH THE SACRAMENTO PIT WAS A MONUMENTAL ONE, HUGELY EXPENSIVE LIKE NOTHING BEFORE AND RISKY, VERY RISKY. A DECISION WAS TAKEN TO SHARE THE RISK BY GOING PUBLIC.



GRAEME LARKIN COLLECTION  
PHELPS DODGE CORP. STOCK CERTIFICATE - 1952

~~~~~

IN 1917, PHELPS DODGE & Co. SELLS ITS SHARES PUBLICLY AND BECOMES A LISTED COMPANY. ALL OF THE RISKS AND REWARDS WERE NOW SHARED BY THE MANY SHAREHOLDERS AND NOT JUST THE ORIGINAL OWNERS. TO BE SURE, THE ORIGINAL OWNERS WERE HANDSOMELY REWARDED THROUGH THE SALE, BUT IT WAS ONLY APPROPRIATE GIVEN THEIR NEVER FAILING SUPPORT AT BISBEE AS WELL AS THE DEVELOPMENT OF OPERATIONS AT MORENCI, ARIZONA, TYRONE AND DAWSON, NEW MEXICO AND NACCOZARI, SONORA, MEXICO, ALL NOW PART OF PD CORP. DR. DOUGLAS IS ELECTED PRESIDENT OF PD BY THE DIRECTORS

## SACRAMENTO HILL IS DEVELOPED – 1917 –1929



GRAEME LARKIN COLLECTION  
INITIAL BLAST ON SACRAMENTO HILL – JANUARY 1917



GRAEME LARKIN COLLECTION  
SACRAMENTO PIT - 1926



GRAEME LARKIN COLLECTION  
STEAM SHOVEL MINING IN THE "SAC" PIT - 1923

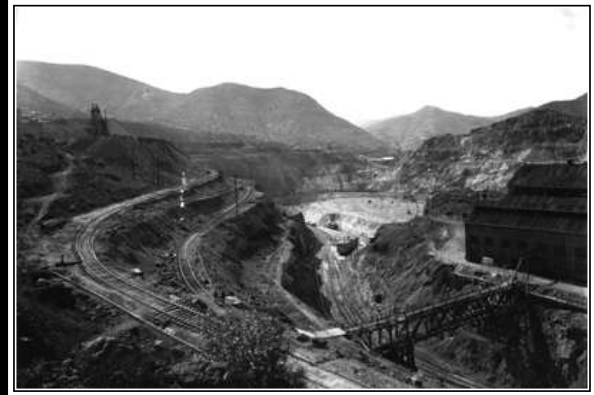
THE "SAC" PIT WAS ONE OF THE EARLIER OPEN-PIT, STEAM SHOVEL, COPPER MINES IN THE WORLD WITH WASTE REMOVAL STARTING IN 1917 AND ORE PRODUCTION BEGINNING IN 1923. IN ALL, SOME 7.8 MILLION TONS OF 2.02% COPPER ORE WERE MINED ALONG WITH 24 MILLION TONS OF WASTE AND LEACH MATERIAL. IT CLOSED IN LATE 1929

~~~~~

## THE SACRAMENTO PIT WAS AN ENGINEERING MARVEL



GRAEME LARKIN COLLECTION  
SACRAMENTO PIT - 1928



GRAEME LARKIN COLLECTION  
SAC PIT, LOOKING WEST - 1926



GRAEME LARKIN COLLECTION  
SACRAMENTO PIT - 1929

**THE LAST ORE IN  
THE PIT BOTTOM  
WAS BLASTED  
INTO OR PUSHED  
INTO OPENINGS  
IN THE PIT  
CALLED "GLORY  
HOLES"**



GRAEME LARKIN COLLECTION  
GLORY HOLE IN PIT BOTTOM - 1933

~~~~~

After the railroad in the Sac pit could not be advanced any deeper because of space constraints and steep grades, raises were driven into the pit bottom from the 500 level of the Sacramento mine. The ore was then blasted into these raises, or glory holes, and the broken ore collected in the raises below and hauled to the Sacramento shaft for hoisting. A modest amount of ore beyond the reach of the raises was loaded by a steam shovel into small mine cars (3 ½ ton) which were then pulled by a tractor to the glory holes for dumping. In all, some 498,000 tons of 2.40% copper were recovered in this process. A depression in the pit bottom was the result of this final effort to recover the last bit of ore.

## WATER IS NEEDED TO PROCESS THE ORE FROM THE SAC PIT

- **COPPER FLOATION MILLS REQUIRE LARGE VOLUMES OF WATER TO OPERATE, BOTH FOR THE COPPER RECOVERY AND THE DISPOSAL OF THE WASTE TAILINGS**
- **THE MINES OF THE COPPER QUEEN DID NOT PRODUCE SUFFICIENT WATER TO OPERATE SUCH A PLANT**
- **THE C&A HAD WATER IN ABUNDANCE, BUT WAS NOT INCLINED TO ALLOW IS USE BY THE QUEEN IN THE NEW CONCENTRATOR**
- **A SHAFT, THE CALUMET AND COCHISE (C&C) ABOVE THE WARREN TOWN SITE WAS DEVELOPED JUST TO FIND WATER. IT WAS, IN EFFECT, A "WATER MINE"**
- **SUFFICIENT WATER WAS HIT ON THE 1800 LEVEL IN 1920, AFTER SEVERAL YEARS OF NERVOUS EXPLORATION**



GRAEME LARKIN COLLECTION  
CALUMET & COCHISE MINE - 1961

**CONTINUED DEVELOPMENT IN THIS "WATER MINE" FOUND ENOUGH WATER TO NOT ONLY SUPPLY THE CONCENTRATOR, BUT ALSO TO ALLOW FOR THE LEACHING OF LOW GRADE MATERIALS FROM THE SAC PIT WHICH HAD BEEN PLACED NEAR THE CONCENTRATOR**

~~~~~

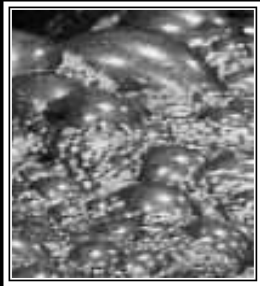
In hopes of finding ore to the east of the Junction and Campbell mines, Phelps Dodge had purchased the holdings of the Warren Reality & Development Company in 1916, which included the long-abandoned Calumet and Cochise shaft. The shaft was deepened and crosscuts drive toward major fault zones to find water. Over time and with much effort, adequate water was found on the 1800 level. Pumps were installed and the water supply secured.

Latter additional development work, also on the 1800 level, succeeded in finding even more water, which allowed the leaching of the low grade materials.

**SLIDE 34**

**A CONCENTRATOR IS BUILT TO HANDLE THE SAC ORE**

**THE RECOVERY OF COPPER FROM LOW-GRADE SULFIDE ORES BY FLOATATION WAS A PROVEN TECHNOLOGY BY THE TIME THE COPPER QUEEN CONCENTRATOR BEGAN OPERATION IN 1923. BULK SAMPLES RECOVERED FROM EXPLORATION DRIFTS HAD BEEN TESTED AND THE RESULTS WERE POSITIVE. MUCH OF THE COPPER IN THE LOW-GRADE MATERIAL OF SAC HILL COULD BE RECOVERED BY FROTH FLOATATION. THIS PROCESS TURNED MILLIONS OF TONS OF WASTE MATERIAL INTO PROFITABLE ORE.**



**COPPER FLOATATION FROTH**

**COPPER QUEEN  
CONCENTRATOR  
C - 1928  
GRAEME LARKIN  
COLLECTION**



**THE 5,000 TON PER DAY PLANT TREATED MORE THAN 7 MILLION TONS OF ORE FROM THE SAC PIT AND OPERATED FOR SEVERAL YEARS AFTER THE PIT CLOSED, TREATING ORE MINED FROM BELOW THE PIT LIMIT BY "GLORY HOLE" METHODS AND LATER BLOCK CAVING OF THE EASTERN PART OF THE OREBODY~~~~~**

Flotation is a separation process for concentrating the copper sulfide -bearing mineral in a low-grade material. Crude ore is ground to a fine powder and mixed with water, frothing reagents, and collecting reagents. The technique relies upon differences in the surface properties of different particles to separate them. The particles that are to be floated are rendered hydrophobic by the addition of the appropriate chemicals. Air is then bubbled through the mixture and the desired particles become attached to the small air bubbles and move to the surface where they accumulate as froth and are collected by skimming off the froth. The waste material settles to the bottom of the cells and is removed by pumping for disposal as tailings.



**SLIDE 35**

**DUMP LEACHING BECOMES IMPORTANT IN THE RECOVERY OF COPPER**

**RECOVERY OF COPPER FROM PILES OF COPPER SULFIDE ORE WITH THE ADDITION OF WATER HAS BEEN CARRIED ON FOR MORE THAN 1,000 YEARS IN OTHER PLACES. AT BISBEE, DR. DOUGLAS FIRST BECAME INTERESTED IN THE APPLICATION OF THIS PROCESS IN ABOUT 1900, HOWEVER EARLY TEST ON LOW-GRADE ORE FROM UNDERGROUND WERE DISCOURAGING AND THE WORK STOPPED.**

**DRILLING FOR THE SAC PIT OUTLINED SEVERAL MILLION TONS OF LOW GRADE MATERIAL WHICH PRODUCED SATISFACTORY TEST RESULTS. THIS MATERIAL WAS PLACED ON A LINED AREA NEAR DON LUIS AND SUCCESSFULLY LEACHED FOR SEVERAL YEARS. THUS BEGAN A PROCESS WHICH WOULD PRODUCE MILLIONS OF POUNDS OF COPPER OVER THE NEXT 75 + YEARS**



**GRAEME LARKIN COLLECTION  
No. 1 LEACH DUMP NEAR DON LUIS -1929**



**GRAEME LARKIN COLLECTION  
No. 7 LEACH DUMP NEAR WARREN -1929**

**IN 1929, THE VERY LOW GRADE WASTE IN THE No. 7 DUMP NEAR WARREN WAS PLACED UNDER IRRIGATION WITH GOOD RESULTS AS WELL. ~~~~~**

The process of leaching low grade mine waste had been successfully employed at several locations prior to the effort at Bisbee. The addition of water, sometimes with added sulfuric acid, to copper/iron sulfides causes the sulfides to decompose and to put both copper and iron into solution. It was an old process dating back to the Roman occupation of Spain, but with a difference in how the copper was recovered.

In the earliest of times, the copper rich solutions were evaporated and the residual muds/salts were smelted and the copper recovered. By the early 20<sup>th</sup> century the use of scrap iron to recover the metal from solution was commonly employed just as it was for the recovery of copper from acidic mine waters. This procedure was employed at Bisbee for a great many years.

### A LAST EFFORT TO FIND ORE IN NEW GROUND

- IN 1926, THE C&A MADE A FABULOUS DISCOVERY IN THE CAMPBELL MINE
- THIS PUSHED THE KNOWN EXTENT OF ORE MUCH FARTHER EAST THEN EVER EXPECTED. WHERE DID THE ORE END?
- THE COPPER QUEEN HELD THE GROUND JUST EAST OF THE CAMPBELL AND THERE WAS EVERY REASON TO HOPE THE ORE WOULD CONTINUE EVEN FURTHER
- HOWEVER, IT WAS NOT TO BE. ONLY A FEW WEAKLY MINERALIZED STRUCTURES AND ABUNDANT WATER WERE EVER FOUND. THE ORE DID NOT EXTEND ONTO THE QUEEN GROUND
- THIS LAST HOPE, THIS LAST EFFORT BROUGHT NOTHING BUT DISAPPOINTMENT

THE WARREN SHAFT WAS SUNK TO A DEPTH OF 2,200 FEET WITH EXPLORATION DRIFTS DRIVEN TOWARD THE CAMPBELL AND EXTENSIVE DIAMOND DRILLING WAS UNDERTAKE, BUT WITHOUT ANY SUCCESS. HOWEVER, THE WATER IT DID DEVELOP WOULD BECOME IMPORTANT 25 YEARS LATER WHEN THE LAVENDER PIT OPENED



GRAEME LARKIN COLLECTION

WARREN SHAFT - 1928

~~~~~

During the late 1930s, Phelps Dodge made a second effort to find extensions of the ore in the direction of the Warren shaft. This time, it was from the 2700 level of the Campbell mine. Drifts were run to the east, actually right under the Warren shaft and even a bit beyond. No ore was ever found, but, again water was hit. At the time, the huge volumes of water were a real problem as the lower part of the mine was flooded, in spite of reasonable precautions. Ultimately, the water was controlled and a four inch drill hole put in the bottom of the Warren shaft to drain into the drift below.

This water, which had proved so troublesome, would be important with the development of the Lavender Pit, as it was all needed for the mill.

### THE WORKER IS NOT FORGOTTEN

WITH THE INCREASED NUMBERS OF INEXPERIENCED MINERS CAME AN UNACCEPTABLE NUMBER OF INJURIES, OFTEN SERIOUS.

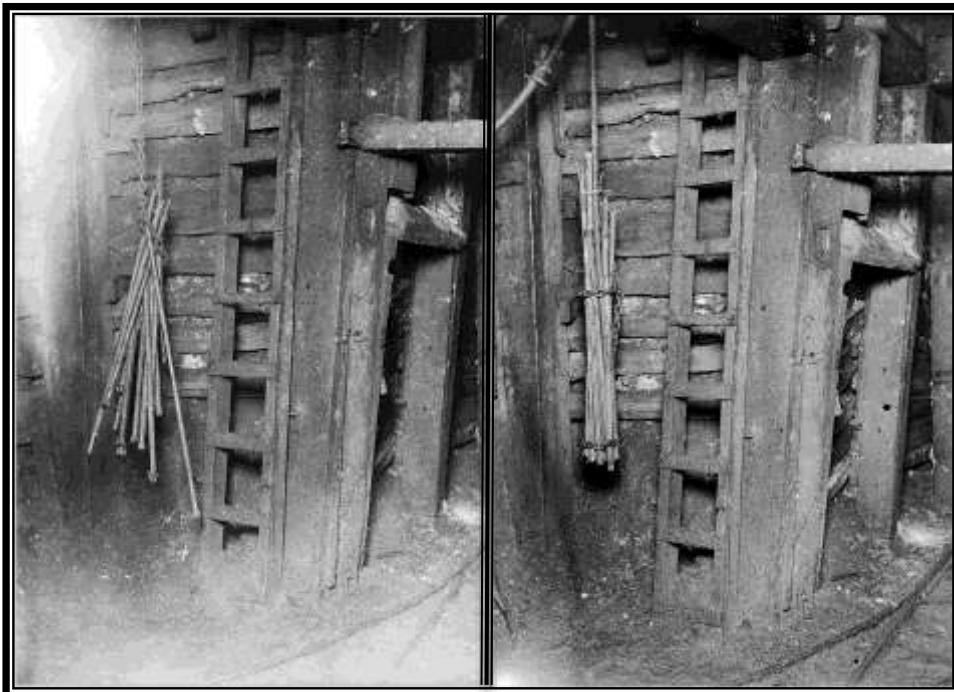


A SAFETY DEPARTMENT WAS ESTABLISHED IN 1913. WHILE IT TOOK A FEW YEARS TO BECOME FULLY EFFECTIVE, THE RESULTS WERE IMPRESSIVE. SAFETY BECAME EVERYONE'S BUSINESS, EVERYDAY



PHOTOS USED DURING SAFETY TRAINING C - 1915  
GRAEME LARKIN COLLECTION

~~~~~



Safety illustration demonstrating the wrong way (left) and the right way to hoist drill steels. C-1915 Copper Queen Consolidated Mining Co.  
Graeme Larkin Collection

**ACCIDENT PREVENTION IS RECOGNIZED AND AWARDED**

**AS AN INTEGRAL PART OF THE  
COPPER QUEEN SAFETY PROGRAM,  
EXCEPTIONAL SAFETY PERFORMANCE  
WAS RECOGNIZED ON A CREW BASIS  
AND REWARDED ON AN INDIVIDUAL  
LEVEL ~~~~~**

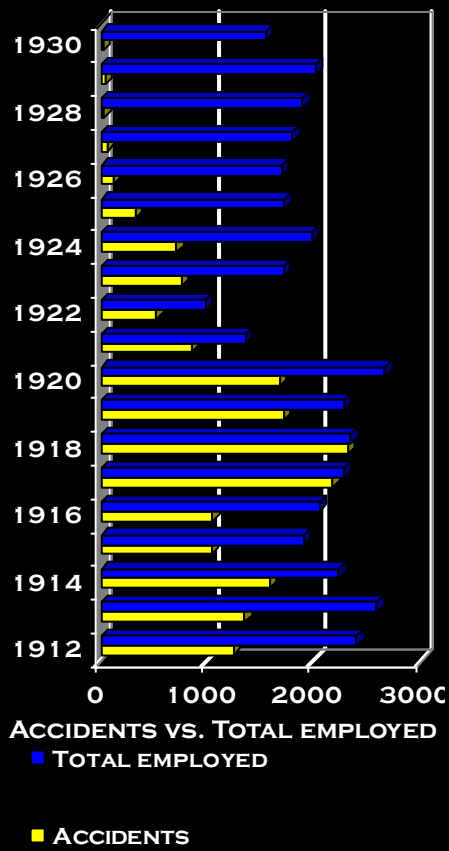


**COPPER QUEEN SAFETY  
AWARDS 1926 – 1930  
GRAEME LARKIN COLLECTION**



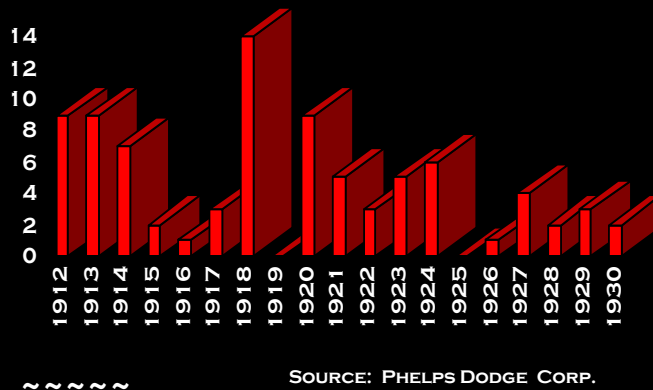
**GRAEME LARKIN COLLECTION  
DAYSHIFT CREW AT THE SOUTHWEST MINE RECOGNIZED  
FOR AN EXCEPTIONAL SAFETY RECORD - 1926**

## SAFETY BECOMES AN EVERYDAY EFFORT



WHILE BISBEE WAS SPARED ANY OF THE CATASTROPHIC EVENTS FOR WHICH MINES ARE KNOWN, ACCIDENTS, PARTICULARLY FATALITIES, WERE FAR TOO FREQUENT. THE YEAR 1918 WAS THE WORST WHEN A LOADED BLAST IN THE SACRAMENTO PIT EXPLODED PREMATURELY, KILLING FOUR AND INJURING SIX ~~~~~

### FATAL ACCIDENTS



SOURCE: PHELPS DODGE CORP.

**SLIDE 40**

**IMPROVING THE WORK ENVIRONMENT WAS IMPORTANT**

**MANY SECTIONS OF THE MINES WERE HOT, OFTEN VERY HOT WITH TEMPERATURES IN EXCESS OF 100° NOT RARE. WHEN THE SULFIDE ORES WERE HIT THE TEMPERATURE CLIMBED EVEN FURTHER. WORKING IN THESE ENVIRONMENTS WAS DIFFICULT AT BEST. ONCE WORKING PLACES WERE CONNECTED BY MORE THAN ONE OPENING, NATURAL VENTILATION WAS USED TO COOL THE MINES AS WELL AS REMOVE BLASTING SMOKE AND DUST. WHILE THIS HELPED, IN SOME AREAS OF THE MINE, IT WAS NOT ADEQUATE IN OTHERS, PARTICULARLY THE DEEPER MINES. COMPRESSED AIR WAS USED TO COOL AREAS WHEN IT BECAME AVAILABLE, BUT THIS WAS INEFFICIENT. ELECTRICITY ALLOWED THE INTRODUCTION OF FORCED AIR VENTILATION WITH IMMEDIATE BENEFITS. THIS TYPE OF CONTROL OF AIR MOVEMENT BECAME EVER MORE CRITICAL WHEN SULFIDE MINE FIRES STARTED OCCURRING ~~~~~**

**FORCED AIR VENTILATION  
MAKES WORK SAFER AND  
MORE PRODUCTIVE**



**GRAEME LARKIN COLLECTION  
INSTALLING A LARGE VENTILATION  
BLOWER IN THE GARDNER MINE - 1912**

From the very beginning, sections of the Copper Queen mine were hot and the high humidity that accompanied the heat was an added burden to the men working below the water level. This difficulty was recognized by the company through additional pay to those in these areas. This additional pay was equal to 28.5% more, a significant difference, but it came at the cost of working in a very difficult, if not unhealthy environment. The company was keenly aware of the problems and always tried to open more access to an area, thereby allowing the natural flow of air currents to ventilate the mine. However, it was very often many months before such openings were possible. Meanwhile, the men labored in the heat and humidity.

In 1908, sulfide mine fires began and with them came more than heat. Deadly carbon monoxide gas was generated which had to be controlled and forced air ventilation was the best way to do so.

## MINE FIRES PLAGUE THE COPPER QUEEN

- WITH THE MINING OF SULFIDE ORES CAME MINE FIRES. SULFIDES NATURALLY DECOMPOSE ON EXPOSURE TO OXYGEN, A PROCESS WHICH GENERATES HEAT, LOTS OF HEAT, ENOUGH TO IGNITE THE MINE TIMBERS AND THE SULFIDE ORES THEMSELVES. THIS WAS HARD TO CONTROL, BUT COULD BE MONITORED
- MINERS CANDLES, IF CARELESSLY PLACED AND LEFT UNATTENDED, ALSO CAUSED FIRES. THIS SOURCE OF FIRE WAS CONTROLLABLE WITH TRAINING AND CARE
- CARBON MONOXIDE GAS, A NATURAL COMBUSTION PRODUCT, WAS THE REAL DANGER IN CASE OF FIRE. AIR FLOW MUST BE CONTROLLED TO STOP THE SPREAD
- EVERY PRECAUTION WAS TAKEN TO PREVENT THESE VERY DANGEROUS EVENTS, BUT STILL, DOZENS OCCURRED AND SOME OF THE SULFIDE MINE FIRES WERE NEVER EXTINGUISHED

FIREPROOF DOORS WERE SET IN ALL OF THE DRIFTS LEAVING A SHAFT STATION TO CONTROL AIR FLOW IN THE EVENT OF A FIRE. THEY COULD BE CLOSED FROM REMOTE POINTS



AUTOMATIC CLOSING,  
CONCRETE FRAME AND  
STEEL FIRE DOOR

C - 1915

GRAEME LARKIN  
COLLECTION



CAST IRON SCONCES WERE MADE TO HOLD THE CANDLES WHILE NOT ALLOWING THEM TO SET FIRE TO THE TIMBER

~~~~~

CAST IRON, CANDLE  
SCONCE ON MINE TIMBER

C - 1909

GRAEME LARKIN  
COLLECTION

## THE COPPER QUEEN AFTER 50 YEARS

BY 1930, THE COPPER QUEEN HAD BEEN MINING AT BISBEE FOR 50 YEARS. THE FEW REMAINING RESERVES IN THE SEVERAL MINES WERE SCATTERED AS WELL AS BOTH LOW GRADE, UNDER 5%, AND EXPENSIVE TO MINE. FOR PD, THE TIMING COULD HARDLY HAVE BEEN WORSE WITH THE DEPRESSION AND ITS LOW COPPER PRICES. HARD CHOICES CONCERNING WHAT TO DO WITH ITS MINES WERE AT HAND

- THE SACRAMENTO PIT HAD BEEN CLOSED DUE TO THE EXHAUSTION OF MINABLE ORE
- WALTER DOUGLAS, WHO HAD RESCUED BISBEE ONCE BEFORE, RETIRED AS PRESIDENT OF PHELPS DODGE CORP.
- THE FULL WEIGHT OF THE DEPRESSION WAS ON THE MINES AND SMELTER. THERE WAS LITTLE MARKET FOR COPPER EVEN AT THE UNPRECEDENTED LOW PRICES
- MANY MINERS WERE LAID OFF. MEN LUCKY ENOUGH TO HAVE A JOB WERE WORKING HALF TIME
- THERE SEEMED TO BE LITTLE FUTURE HERE. THE END WAS SURELY AT HAND FOR THE COPPER QUEEN AT BISBEE, BUT FATE HAD OTHER PLANS. THE QUEEN WAS NOT TO DIE, NOT JUST YET ~~~~~



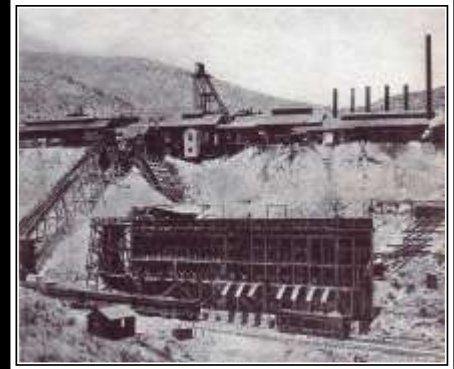
GRAEME LARKIN COLLECTION  
WALTER DOUGLAS C - 1925



**SLIDE 43**

**THE C & A GROWS IN TO A MAJOR FORCE IN THE INDUSTRY**

- **THE C & A DEVELOPED THE VERY RICH IRISH MAG MINE QUICKLY AND LEVERAGED THIS WEALTH INTO WHAT BECAME ONE OF THE PRIMER COPPER COMPANIES OF THE ERA**
- **IT ALSO DEVELOPED THE NEARBY OLIVER MINE AS SOON AS IT BECAME EVIDENT THAT THE ORE CONTINUED IN THAT DIRECTION**
- **BOTH OF THESE MINES CAME ON LINE RELATIVELY EASY, ONCE THE INITIAL ORE WAS DISCOVERED**
- **THE SYNERGISTIC VALUE OF THE TWO PROXIMAL MINES SOON PAID OFF HANDSOMELY AS SURFACE FACILITIES COULD BE SHARED AND UNDERGROUND CONNECTIONS MADE**
- **THE INCREASED PRODUCTION COULD PROVIDED THE NEWLY BUILT SMELTER NEAR DOUGLAS WITH A SECURE SOURCE OF ORE**
- **THE C&A THEN WENT ON TO DEVELOP OTHER MINES, BUT UNDER THE ASEPSSES OF OTHER, YET RELATED COMPANIES ~~~~~**



GRAEME LARKIN COLLECTION  
IRISH MAG MINE C-1905



GRAEME LARKIN COLLECTION  
OLIVER MINE C - 1905

The Oliver mine was named for Henry W. Oliver a steel produce of importance in the Pittsburgh area as well as an early, significant investor in the C & A. In his estate, he established a scholarship for graduates of Bisbee or Ajo High schools who majored in geology or mining engineering at the University of Arizona. Many who entered the mining industry did so with the help of this fund, including the author.

**THE LAKE SUPERIOR & PITTSBURG MINING CO.**

- **THIS WAS ONE OF THE SEVERAL RELATED COMPANIES THE C&A USED TO DEVELOP OTHER MINES. WHILE THE SHAREHOLDING OF THE COMPANY VARIED SOMEWHAT, THE MANAGEMENT WAS THE SAME AS C&A IN VIRTUALLY EVERY RESPECT**
- **THE INTENT OF THIS WAS TO ESTABLISH A CORPORATE VALE TO PROTECT THE ASSETS OF THE C&A IN THE CASE OF FAILURE OR COMPLICATIONS RELATED TO THE MINES BEING DEVELOPED**
- **THE FIRST MINE IT DEVELOPED WAS THE HOATSON, NAMED FOR THE MAN THAT BROUGHT THE C&A TO BISBEE. IT PROVED TO BE A VERY GOOD PRODUCER**
- **WATER WAS HIT IN THE LOWER LEVELS OF THE MINE, BUT NOT IN UNMANAGEABLE AMOUNTS**
- **THIS WATER WAS TO PORTEND THE FUTURE PROBLEMS THAT WOULD COME WITH FURTHER DEVELOPMENT IN THIS PART OF THE DISTRICT**

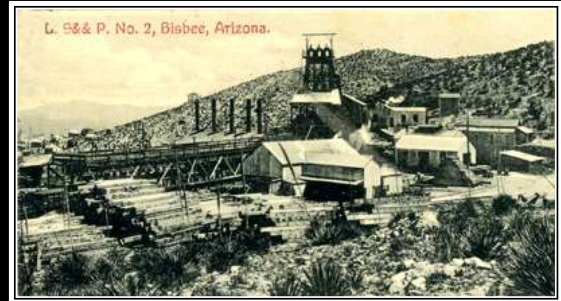


GRAEME LARKIN COLLECTION  
HOATSON MINE C - 1908

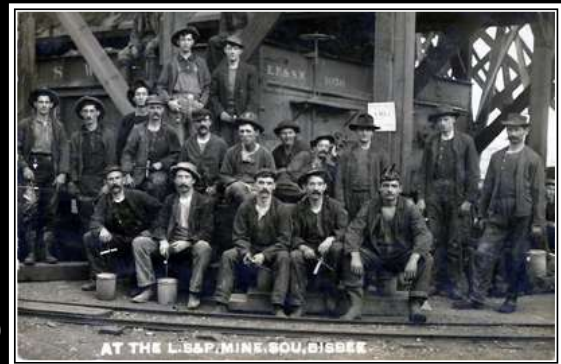
~~~~~

## THE LAKE SUPERIOR & PITTSBURG MINING CO.

- THE SECOND MINE DEVELOPED BY THE LAKE SUPERIOR AND PITTSBURG (L.S. & P.) WAS ONE PURCHASED FROM THE SOUTH BISBEE MINING COMPANY.
- INITIALLY CALLED THE L.S.&P. No. 2. LATER IT WAS RENAMED THE "COLE" TO HONOR THOMAS COLE, THE PRESIDENT OF BOTH THE C&A AND L.S.&P. AS WELL AS THE OTHER RELATED COMPANIES
- THE COLE WAS THE SOUTHERNMOST MINE AT THE TIME, WELL OUTSIDE OF THE KNOWN ORE AREAS AND AS SUCH, VERY SPECULATIVE
- GOOD ORE WAS HIT EARLY IN THE DEVELOPMENT OF THE MINE AND IT BECAME AN IMPORTANT SOURCE OF COPPER FOR MOST OF THE NEXT 70 YEARS



GRAEME LARKIN COLLECTION  
L.S. & P. No. 2 MINE C - 1910



GRAEME LARKIN COLLECTION  
MINERS AT THE L.S. & P. MINE C - 1908

~~~~~

The Cole had been purchased from the South Bisbee Mining Company, which had started work on this area when it was well outside of the known ore zone. While the South Bisbee Mining Co. never found the hoped for copper, others did and in substantial quantities. In this regard they were visionaries who lacked the funding to continue prospecting until sufficient ore was found, a common fate of undercapitalized mining companies to this day.

## THE JUNCTION DEVELOPMENT CO AND THE L.S. & P.

- THE JUNCTION MINE WAS STARTED BY THE CLOSELY RELATED JUNCTION DEVELOPMENT Co. AND SOON FOLDED INTO THE L.S.&P.
  - ITS LOCATION WAS BASED ON A SURFACE DIAMOND DRILL HOLE THAT SHOWED PROMISING MINERALIZATION
  - THE ORE WAS THERE AS PROMISED BY THE DRILL HOLE, BUT WHAT THE HOLE DID NOT SHOW WAS THE INCREDIBLE AMOUNTS OF WATER WHICH FILLED THIS BASIN AND WHICH WOULD LATER IMPEDE THE DEVELOPMENT OF THIS MINE
  - IN THE FINAL ANALYSIS, THE JUNCTION MAY WELL HAVE BEEN THE MOST PRODUCTIVE OF ALL OF BISBEE'S MINES
- ITS LARGELY SULFIDE OREBODIES WERE OFTEN OF GOOD SIZE AND GRADE. THE ROCK WAS GENERALLY STRONG WHICH BROUGHT LOWER MINING COSTS
  - FROM 1905 UNTIL ITS CLOSURE IN 1958, THIS INCREDIBLE MINE WAS THE MAINSTAY OF COPPER PRODUCTION AT BISBEE



GRAEME LARKIN COLLECTION  
JUNCTION MINE C - 1910



The Junction Shaft, shown here in 1906, was sunk on the results of a diamond drill hole that indicated ore was to be found at a depth of 700 feet under the thick cover of post-mineral Glance Conglomerate



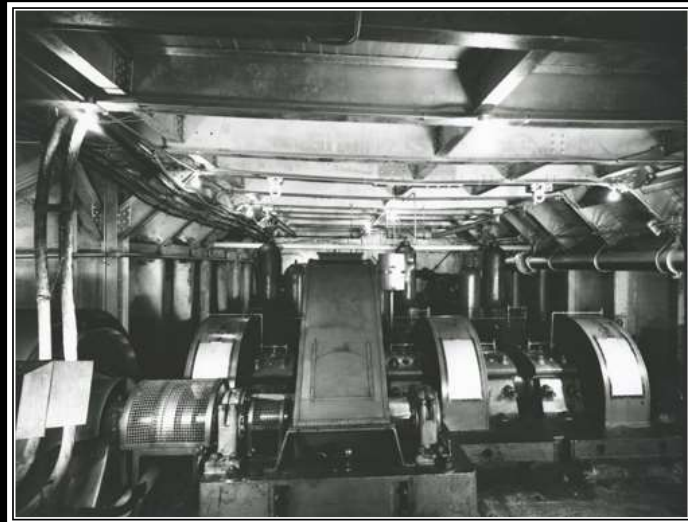
A shift of men posed for this group portrait before going underground at the Junction Mine C – 1925. At the time, and for some 30 years after, the Junction was the largest mine at Bisbee, thus the large number of men. Graeme Larkin collection

## WATER WAS AN EVER-PRESENT PROBLEM AT THE JUNCTION

- WATER WAS AN ISSUE IN THIS MINE TO THE VERY END WITH PUMPING RATES VARYING FROM HIGHS OF 5,800 GALLONS PER MINUTE TO A STEADY STATE AVERAGE OF 2,700 GALLONS PER MINUTE
- BY 1925, THE JUNCTION WAS HANDLING ALL WATER FROM THE COPPER QUEEN AND DENN MINES UNDER CONTRACTS AS WELL AS ALL OF THE WATER DEVELOPED BY THE C&A MINES. IT REMAINED THE PRINCIPAL PUMPING SHAFT TO THE VERY END

~~~~~

LARGER AND LARGER PUMPS WERE PLACED IN THE JUNCTION UNTIL THE MASSIVE PUMP STATION ON THE 2200 LEVEL WAS COMPLETED IN 1924 WITH SIX LARGE PUMPS CAPABLE OF PUMPING MORE THAN 7,000 GALLON PER MINUTE



GRAEME LARKIN COLLECTION

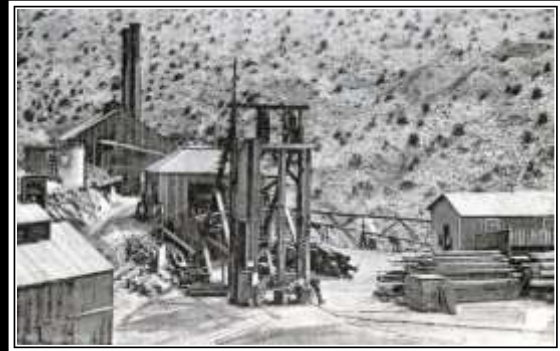
THE 2,250 GPM, # 6 PUMP, 2200 LEVEL JUNCTION MINE  
C - 1928



2200 level Junction pump station showing the number two pump capable of pumping 1,000 gallon per min. to the surface. It was one of five, positive displacement piston types in this massive pump station and augmented by a single 2,250 GPM, centrifugal pump. Graeme Larkin collection

## THE C&A HAS A FEW MISSES AS WELL

- GOOD ORE HAD BEEN FOUND AT THE COLE AND THE OREBODIES IN THE COPPER QUEEN HAD BEEN RICH BEYOND DESCRIPTION. IT SEEM ONLY LOGICAL THAT A SHAFT PLACED BETWEEN THE TWO WOULD DEVELOP ORE AS WELL. IT DID NOT
- THE CONGDON SHAFT, WAS DEVELOPED BY THE RELATED PITTSBURG & DULUTH MINING CO. AND NAMED FOR ONE OF THE C&A DIRECTORS, CHESTER A. CONGDON. IT WAS FULLY EXPECTED TO HIT ORE QUICKLY. WHILE IT WAS MORE THAN 1250 FEET DEEP, AND CONTAINED NUMEROUS PROSPECTING DRIFTS, LITTLE MORE THAN A FEW SMALL PODS OF ORE WERE EVER HIT
- BUT THEN, THE SILVER BEAR SHAFT OF THE COPPER QUEEN WAS IN ALIGN WITH THIS SAME SUGGESTED TREND AND IT TOO WAS BARREN. WAS THE GEOLOGIC THEORY SIMPLY WRONG?
- EXPLORATION WORK FROM THE COLE MINE 50 YEARS LATER WOULD DISCOVER THE EXPECTED ORE. HOWEVER, IT WAS IN A COMPLETELY DIFFERENT LIMESTONE UNIT, ONE WHICH HAD NEVER CONTAINED MUCH ORE BEFORE AND 300 FEET DEEPER. THE GEOLOGIC THEORY WAS REASONABLE, BUT CONGDON HAD SIMPLE NOT BEEN DEVELOPED DEEP ENOUGH ~~~~~



GRAEME LARKIN COLLECTION  
CONGDON MINE C - 1906

## THE C&A MISSES AGAIN WITH THE POWELL SHAFT

- THE FINE OREBODIES DISCOVERED IN THE SHATTUCK MINE HAD LED TO DISCOVERIES IN THE ADJACENT PROPERTIES OF OTHERS
- AT THE UNCLE SAM MINE OF THE COPPER QUEEN, EXTENSIONS OF THE SHATTUCK ORES TO BOTH THE NORTH AND WEST HAD BEEN FOUND
- A SOUTHERN EXTENSIONS OF THESE ORES WAS BEING MINED BY THE WOLVERINE AND ARIZONA
- THE LIKELY EASTERN EXTENSION WAS TO BE FOUND BY THE POWELL SHAFT, NAMED FOR LOUIS POWELL A VICE PRESIDENT OF THE C&A AND MANAGER AT BISBEE. HOWEVER, THE SHATTUCK ORES DID NOT EXTEND VERY FAR TO THE EAST. THE 900 FOOT DEEP SHAFT AND ASSOCIATED DRIFTS HIT NOTHING



GRAEME LARKIN COLLECTION  
400 LEVEL STATION, POWELL SHAFT - 1961

~~~~~



## THE CALUMET & PITTSBURGH DEVELOPS THE BRIGGS MINE

- CHARLES BRIGGS WAS ONE OF THE FOUNDING DIRECTORS OF THE C&A GROUP OF COMPANIES AND THE EAST MOST MINE DEVELOPED BY THE GROUP WAS NAMED FOR HIM
- THE TREND OF THE ORES IN BOTH THE HOATSON AND JUNCTION MINES SUGGESTED THE SITE CHOSEN FOR THE BRIGGS MINE SHOULD BE GOOD, AND IT WAS. HOWEVER, NO ONE EXPECTED THE FLOW OF WATER IN THE AREA TO BE ANYTHING LIKE IT WAS - SEEMINGLY ENDLESS AND HUGE
- TIME AFTER TIME, THE WORK OF SINKING THE SHAFT HAD TO BE SUSPENDED UNTIL NEW, LARGE PUMPS COULD BE INSTALLED. EVEN WHEN WORK COULD BE PURSUED, IT WAS IN WAIST-DEEP WATER. HARDLY, A PRODUCTIVE ENVIRONMENT

---

*IRONICALLY, IN LATER YEARS, THE BRIGGS BECAME BETTER KNOWN FOR ITS SULFIDE MINE FIRES THAN ITS WATER PROBLEM*

~~~~~

A DRIFT WAS DRIVEN BELOW THE BRIGGS FROM THE 1300 LEVEL HOATSON AND A DRILL HOLE PUT IN THE SHAFT BOTTOM, THIS BROUGHT VERY LITTLE RELIEF. WORK WAS THEN SUSPENDED UNTIL A DRIFT FROM THE 1500 LEVEL OF THE JUNCTION COULD REACH THE AREA AND HOPEFULLY DRAIN IT. THIS EFFORT SUCCEEDED AFTER TWO YEARS



GRAEME LARKIN COLLECTION  
BRIGGS MINE - 1906

## THE C&A BECOME A FORCE IN THE INDUSTRY



GRAEME LARKIN COLLECTION  
CALUMET AND ARIZONA STOCK CERTIFICATE -1909

**IN MID-1910, JOHN GREENWAY IS APPOINTED GENERAL MANAGER OF THE C&A, REPLACING LUIS POWELL. THEN, IN 1911, ALL OF THE SEVERAL RELATED COMPANIES AT BISBEE ARE MERGED INTO THE C&A. ITS RICH AND EFFICIENT MINES ARE MAKING THE INVESTORS MONEY, LOTS OF MONEY. THE UNHEARD OF AMOUNT OF \$80,000,000 WAS PAID IN DIVIDENDS FROM 1904 TO 1920. THE C&A EXPANDS BEYOND BISBEE AND INTO THE COURTLAND-GLEASON AREA WITH NO LUCK, BUT THEN TO AJO WITH GREAT SUCCESS**



GRAEME LARKIN COLLECTION  
JOHN C. GREENWAY C - 1910

~~~~~

John Campbell Greenway was born in Huntsville, Alabama, on July 6, 1872. He attended the University of Virginia and was graduated in 1895 from the Sheffield Scientific School of Yale University where he excelled in the sport of football and was one of the 35 Ivy League players feature on early trading cards by a tobacco company.

His early employment as a furnace helper for the Carnegie Steel Company was both humble and brief, as he joined Roosevelt's Rough Riders in the Spanish-American War. After earning a Silver Star for his courageous service at the Battle of San Juan Hill, he was recommended for brevet captain by Colonel Roosevelt.

Beginning in 1899, Greenway held executive positions in a number of mine, steel, and railroad companies then in July of 1910 he joined the Calumet and Arizona Mining Company as its General Manager based in Bisbee. He took an already good mining company and made it better, much better through his innovative leadership and visionary approach to the industry.

His visionary approach to mining led the C&A to Ajo, Arizona where acid based dump leaching and copper cementation brought an otherwise unless mine to account for the great benefit of the

company. He employed well know architects to build the town of Ajo. Greenway served for one year as a regent of the University of Arizona before the United States entered World War I. During the war, he took leave from the C&A to serve as a combat officer in the US Expeditionary Force in France. He was especially praised for his heroic conduct in battle and was cited for bravery at Cambrai. France awarded him the Croix de Guerre, the Legion of Honor, and the Croix de l'Etoile. He also received a Distinguished Service Cross.

Following the War, he returned to Arizona and the management of the C&A however, he remained active in the US Army reserve. In 1919 Greenway became a colonel of the infantry, and three years later he was promoted to brigadier general. Full of stamina, John Greenway continued to be active in business and politics in Arizona where he was considered as potential US presidential candidate and was often mentioned as a candidate for governor of Arizona.

### THE C&A MINES WERE AMONG THE MOST EFFICIENT

- THE C&A MINES WERE JUST BEING DEVELOPED WHEN THE COPPER QUEEN BEGAN ITS MODERNIZATION PROGRAM. THUS, THEY DID NOT HAVE TO REDO EVERYTHING
- IT COPIED THE CQ IN SOME THINGS AND SHOWED THE WAY IN OTHERS
- ELECTRICITY WAS INTRODUCED UNDERGROUND IN 1906 WITH TROLLEY HAULAGE STARTING IN 1907
- COMPRESSED AIR DRILLS WERE INTRODUCED AT THE VERY BEGINNING OF MINING, THOUGH HAND DRILLING WAS USED AS WELL
- DIAMOND DRILLING WAS USED AS A PROSPECTING TOOL VERY EARLY ON
- IT BUILT A MODERN SMELTER NEAR DOUGLAS IN 1903 AND KEPT EXPANDING ~~~~~



GRAEME LARKIN COLLECTION  
C&A SMELTER DOUGLAS C - 1925



GRAEME LARKIN COLLECTION  
DIAMOND DRILL PROSPECTING IN THE C&A MINE - 1905

SLIDE 52

SLIDE 53

## THE C&A CONTINUES IT SUCCESS AT BISBEE

THE CAMPBELL SHAFT WAS DEVELOPED PRIMARILY AS A VENTILATION OPENING TO COOL THE AREAS BEING MINED EAST OF THE JUNCTION. IT WAS NAMED FOR GORDON R. CAMPBELL, THEN SECRETARY OF THE C&A. WORK WAS STARTED IN 1918 WITH SINKING FROM THE SURFACE AND RAISING FROM THE 1300 LEVEL OF THE JUNCTION. THE TIE IN WAS FLAWLESSLY COMPLETED IN VERY LATE 1919. SOON THEREAFTER, GOOD ORE WAS FOUND NEARBY, BUT THIS WAS JUST TO BE THE BEGINNING OF GREAT THINGS TO COME AS EXPLORATION WORK CONTINUED.

THE LARGEST AND RICHEST SULFIDE OREBODY EVER FOUND AT BISBEE WAS DISCOVERED IN THE CAMPBELL MINE IN 1926. IT EXTENDED FROM ABOVE THE 1200 LEVEL TO BELOW THE 2566 LEVEL AND CONTAINED MORE THAN 1,000,000 TONS OF ORE. IT WAS MINED FROM THE TIME OF DISCOVERY UNTIL 1955 AND DID MUCH TO KEEP BISBEE OPEN DURING THE DEPRESSION OF THE 1930s



GRAEME LARKIN COLLECTION

CAMPBELL MINE WITH THE INITIAL SINKING HOIST  
IN PLACE C - 1920

~~~~~

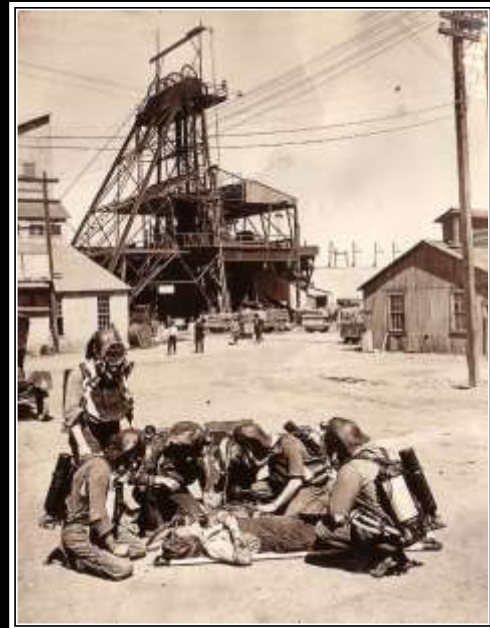
## THE C&A LOOKS AFTER ITS EMPLOYEES AS WELL

LIKE THE C.Q.C.M.Co., THE C&A WAS PROGRESSIVE, FOR THE TIME, IN HOW IT TREATED ITS EMPLOYEES, THOUGH NOT QUITE AS QUICK AS THE CQ TO RESPOND TO CHANGE.

IT STOPPED SUNDAY WORK FOR ITS MEN IN 1912, SOMETHING THE COPPER QUEEN HAD DONE IN 1887. THE C&A IMPLEMENTED THE EIGHT HOUR DAY IN 1903 WHEN LEGISLATED. THE QUEEN HAD DONE THIS BY 1895.

A FINE SAFETY DEPARTMENT WAS ESTABLISHED IN 1915 WITH IMPRESSIVE EFFECT. FATALITIES DECREASED FROM 6 IN 1915 TO 1 IN 1920.

TO THE GREAT BENEFIT OF THE MINERS, FORCED AIR VENTILATION WAS INTRODUCED IN 1915. THE WORK AREAS WERE NOW MUCH COOLER



GRAEME LARKIN COLLECTION  
FIRE RESCUE TEAM DRILL IN THE YARD OF  
THE JUNCTION MINE C - 1920

~~~~~

The eight hour law:

23-282. Underground mine employees and hoisting engineers; eight hour day; exceptions; violation; classification

A. Employment in mining activities in underground mines and underground workings is declared injurious to health and dangerous to life and limb of those employed therein.

B. The period of employment for all persons employed or engaged in mining activities in underground mines or underground workings or as hoisting engineers at underground mines shall not exceed eight hours within any twenty-four hour period and the eight hours shall include the time used in descending to and ascending from the point or place of work in an underground mine or underground workings place of work.

C. The period of employment prescribed in subsection B may be deviated from in the following instances:

1. In an emergency, where life or property is in imminent danger, the period of labor prescribed in subsection B may be prolonged during the continuance of the emergency.

2. The hours of employment may be changed from one part of the day to another at stated periods, the change not to occur more than once in any two weeks, and the employment may be for more than eight hours during the day in which the change is made.

3. If the employer has adopted a policy of longer periods of employment based on a collective bargaining agreement between the employer and one or more labor organizations representing one or more affected employees that expressly authorizes longer periods of employment, but in no event longer than twelve hours in any twenty-four hour period, subject to compliance with the terms and conditions for implementing periods of employment in excess of eight hours as set forth in the collective bargaining agreement. For purposes of this paragraph, "affected employees" means all or any group of employees of the employer, regardless of whether or not the employees are members of a labor organization, whose periods of employment are limited pursuant to subsection B of this section.

D. Any person violating any provision of this section, and any person who, as foreman, manager, superintendent, director, or officer of a corporation, or as employer or superior officer of any person, knowingly commands, persuades, or allows any person to violate any provision of this section is guilty of a class 2 misdemeanor.

E. Each day this section is violated constitutes a separate offense.

**1926 – THE BEST OF TIMES AND THE WORST OF TIMES FOR THE C&A**



GRAEME LARKIN COLLECTION  
CONSTRUCTION OF THE CAMPBELL MINE  
FACILITY -1926

**1926 - THE WONDERFULLY RICH  
CAMPBELL OREBODY IS FOUND**



STATUE IN THE STATUARY  
HALL OF THE US CAPITAL  
WASHINGTON, DC - 1930



FOOTBALL AT YALE  
1894

~~~~~

**1926 - JOHN GREENWAY DIES**  
*THE C&A NEVER QUITE RECOVERS FROM  
THE LOSS OF THIS EXTRAORDINARY MAN  
AND EXCEPTIONAL LEADER. IT STARTS TO  
FALTER AT A MOST INOPPORTUNE TIME*

John Greenway had actually resigned as General Manger in June of 1925 following a dispute with Gordon Campbell, the president of the company. The dispute was over the obligation of a “handshake” deal Greenway had made and which was no longer economically advantages to the company, but Greenway insisted in honoring as it was his word. The C&A lawyers said the agreement was not binding as it was never committed to paper and signed. Greenway refused to back down and Campbell took the side of the lawyers. Greenway continued to serve as a consultant however.

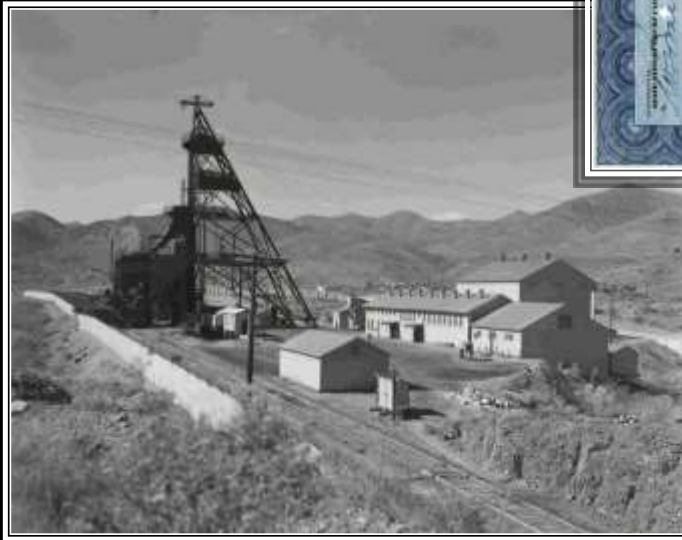
This incredible career came to a very premature end with his death in New York City on January 19, 1926 following an illness of several months. Arizona honored John Campbell Greenway in death by choosing him as one of the two personages to honor with a statue in the US Capital Building. A life sized bronze by Gutzon Borglum was placed in the National Statuary Hall in 1930.

### 1930 - THE C&A NEARS ITS END

**THE RICH OREBODIES IN THE CAMPBELL AND THE OTHER FINE MINES COULD NOT SAVE THE C&A WHEN THE GREAT DEPRESSION HIT IN 1929 AND COPPER PRICES FELL TO LOWS NEVER BEFORE SEEN**



GRAEME LARKIN COLLECTION  
C&A STOCK CERTIFICATE - 1921



GRAEME LARKIN COLLECTION  
CAMPBELL MINE C - 1930

**THERE IS NO PROFIT TO BE MADE. WORSE YET, THERE IS TOO LITTLE MONEY IN THE BANK TO CARRY THE COMPANY. IT HAD ALL BEEN INVESTED IN EXPANDING THE MINES OR PAID OUT TO INVESTORS AS DIVIDENDS**

~~~~~



**SLIDE 57**

**THE 1920S ARE DIFFICULT FOR OTHER COMPANIES AS WELL**

**THE EARLY 1920S WERE A TIME OF LOW COPPER PRICES WHICH PUT A GREAT DEAL OF ECONOMIC PRESSURE ON THE MINES AT BISBEE. IN 1920, THE DENN MINE HAD CLOSED BECAUSE OF HUGE INFLOWS OF WATER WHICH IT SIMPLE COULD NOT AFFORD TO PUMP. THE SHATTUCK WAS STILL OPERATING, BUT IN OLD AND INEFFICIENT WAYS. WORST OF ALL, IT WAS RUNNING OUT OF HIGH GRADE ORE**



GRAEME LARKIN COLLECTION  
SHATTUCK DENN MINING CO. STOCK CERTIFICATE  
1925



GRAEME LARKIN COLLECTION  
DENN & ARIZONA MINE & MILL C - 1922

**IN 1925, AFTER SEVERAL MONTHS OF OFTEN BITTER DISPUTE, THE SHATTUCK & ARIZONA MERGED WITH THE DENN & ARIZONA TO FORM THE SHATTUCK DENN MINING COMPANY. IT THEN WENT ON TO EXPLOIT THE FINE OREBODIES IN THE DENN MINE AS WELL AS EXPAND BEYOND BISBEE. THE SHATTUCK MINE WAS LEASED TO OTHERS ~~~~~**

**1930 FINDS THE THREE REMAINING COMPANIES IN VERY DIFFERENT POSITIONS**

- **IN THE FIRST YEAR OF THE “GREAT DEPRESSION” PD WAS ALMOST OUT OF MINABLE ORE, BUT HAD A SUBSTANTIAL CASH RESERVE**
- **C&A HAD HUGE ORE RESERVES, BUT HAD LARGELY DEPLETED ITS AVAILABLE CASH**
- **THE SHATTUCK DENN HAD REASONABLE ORE RESERVES FOR ITS SIZE, AND SUFFICIENT CASH TO SEE IT THROUGH THE HARD TIMES – WITH PRUDENT MANAGEMENT**
- **CASH MADE THE DIFFERENCE, THE C&A HAD NONE, IT WAS TO DISAPPEAR ~~~~~**

|                   |                |
|-------------------|----------------|
| ATLANTA           | HOLBROOK       |
| BAXTER            | LOWELL         |
| BORAS             | SACRAMENTO     |
| COCHISE & CALUMET | SACRAMENTO PIT |
| CONTACT           | SILVER BEAR    |
| COPPER QUEEN      | SOUTHWEST      |
| CUPRITE           | SPRAY          |
| CZAR              | UNCLE SAM      |
| DALLAS            | WADE HAMPTON   |
| GARDNER           | WARREN (NEW)   |

MINES DEVELOPED BY PHELPS DODGE PRIOR TO 1930

|          |               |
|----------|---------------|
| BRIGGS   | IRISH MAG     |
| CAMPBELL | JUNCTION      |
| COLE     | L.S.&P. No. 3 |
| CONGDON  | OLIVER        |
| HOATSON  | POWELL        |

MINES DEVELOPED BY CALUMET & ARIZONA PRIOR TO 1930

|          |      |
|----------|------|
| SHATTUCK | DENN |
|----------|------|

MINES DEVELOPED BY SHATTUCK DENN PRIOR TO 1930