

TO THE
American Institute of Mining
Engineers

Arizona Meeting
September, 1916

With Compliments of the
Calumet and Arizona Mining Co.
Warren, Arizona



Calumet & Arizona Mining Co.

EARLY HISTORY

Until the fall of 1900, the Copper Queen Consolidated Mining Co. was the only company of any importance in the Warren District. While hopeful prospectors had located many claims south of Sacramento Hill, these claims were generally looked upon as worthless. Even when ore had been developed from the Spray Shaft of the Copper Queen Company to within a short distance of the "Irish Mag" sideline, the old belief that ore would end at Sacramento Hill prevented the development of the "Irish Mag" and of claims further south.

In 1898 Capt. James Hoatson of Calumet, Michigan, visited the Warren District. After becoming familiar with the occurrence of ore in the district, and learning the general location of ore bodies near the Spray Shaft, he became convinced that a large orebody would be found in the Irish Mag claim. He interested friends in Calumet in

his idea, with the result that the Lake Superior and Western Development Co., with Charles Briggs as President, was formed to develop the Irish Mag and other claims. In March, 1901, the company was reorganized as the Calumet and Arizona Mining Co.

The Irish Mag Shaft was started in November, 1900, and was sunk to the 750 level before any drifting was done. Mr. I. L. Merrill was the first Superintendent. The first work was disappointing, and it became necessary to raise more money before continuing the development. At this time Mr. Thomas F. Cole, of Duluth, Minnesota, became interested in the prospect. He secured money with which to continue the work from Mr. Henry W. Oliver and others of Pittsburg and Duluth.

A little ore was found on the 850 and 950 levels, and a small smelter was started in Douglas. In the spring of 1902 the Northeast Drift on the 1050 level cut the main Irish Mag orebody. For 325 feet the ore developed by this drift averaged over 9 per cent copper. From this time the success of the Company was assured. Shipments to the Douglas smelter were commenced in November, 1902, and the first dividend of \$400,000

was paid in December, 1903. Early in 1903 the Oliver Shaft was started to develop the Senator group of claims, and the following year large ore-bodies were found on the 1050 level of this mine.

DEVELOPMENT COMPANIES

In 1902 and 1903 the success of the Calumet and Arizona Mining Co. led several of the men who had been responsible for this success to explore other ground lying still further south and east of the productive area. The "Junction Development Co." "Pittsburg and Duluth Development Co.," "Lake Superior and Pittsburg Development Co.," and "Calumet and Pittsburg Development Co." were formed to develop various groups of claims. The officers and management of these companies were the same as of the Calumet and Arizona Mining Co.

Exploration was carried on under the most discouraging conditions. Shafts had to be sunk 1000 feet or more before there was any likelihood of finding ore. Usually the surface gave no idea of where orebodies might lie, and thousands of feet of development work in barren ground had to be done before orebearing horizons were lo-

cated. In the Junction Shaft and the Briggs Shaft great flows of water were encountered, which at times stopped all progress for many months, until the ground could be drained. Although the volume of water pumped from the Junction Shaft has exceeded 4000 gallons per minute and the Briggs has pumped over 2500 gallons per minute, during 13 years of fighting these heavy flows of water, the pumps have never been lost.

Many million dollars were spent before any of the shafts became self supporting. Although in one case eight years elapsed before commercial ore was found, great mines were finally developed on all four properties.

In 1906 the four smaller companies were combined to form the Superior and Pittsburg Copper Co., which was absorbed by the Calumet and Arizona Mining Co. in 1910. In 1913 the American Saginaw Development Co. was also absorbed by the Calumet and Arizona Mining Co.

LATER HISTORY

In 1910 and 1911 the development of wonderful sulphide orebodies in the Junction and Briggs Mines made these mines the greatest in the en-

larged Calumet and Arizona property. The increasing proportion of sulphide to oxide ore caused by these large orebodies in the lower mines was the principal reason for building the new and larger smelter in 1912 and 1913.

In 1913 the Irish Mag Mine, the beginning and cause of the success of the Calumet and Arizona Mining Co., was practically worked out and closed down. The bottom of the limestone was reached on the 1350 level of this mine. The Oliver, Cole, Hoatson, Briggs and Junction Mines are all producing.

The present monthly shipments to the Douglas smelter average about 68,000 dry tons of ore, from which 5,800,000 lbs. of copper are recovered. In addition about 300 tons per day of low grade pyritic fluxing ore are shipped to other smelters.

To prevent depletion of ore reserves by this large production, it is necessary to do an enormous amount of underground prospecting. The extreme irregularity in distribution and shape of orebodies makes the footage of drifting and raising necessary to develop a ton of ore far greater in Bisbee than in any other large copper district. At present the drifting and raising per month

carried on by the Calumet and Arizona company alone averages over 9000 feet. In the most productive part of the district, in order to find all the ore it is necessary to do over a mile of development work per acre. This work finds from 60,000 to 80,000 tons of ore per acre. The great amount of drifting and raising per ton of ore makes it impossible to develop in advance the ten or twenty years' life which is considered necessary in the case of the great low grade copper mines. Yet the fact that the ore reserves show a constant, though small increase makes it certain that the life of the property will be long.

The Calumet and Arizona Mining Co. now owns about 2005 acres of mining claims in the Warren District. Nearly three quarters of this area is absolutely undeveloped, and only the fifteen acres of the Irish Mag claim are considered to be worked out.

OUTSIDE EXPLORATION

In addition to work in the Warren District, the Calumet and Arizona Mining Co. has spent several million dollars in exploration and equipment of prospects and mines outside of Bisbee. Con-

siderable work was done in seven districts. Four of these proved failures, and properties there were abandoned or options given up. In two districts ore enough was discovered to pay part or all of the cost of exploration. The seventh district is the Ajo District. In this camp the Calumet and Arizona Mining Co. under the management of John C. Greenway, has bought over 75 per cent of the stock of the New Cornelia Copper Co., and has developed during the past 5 years 40,000,000 tons of 1.5 per cent ore. Within a year the New Cornelia Company should be mining 5000 tons of ore per day.

SUMMARY OF PRODUCTION

In less than 14 years, from the time shipments started from the Irish Mag Shaft to July 1, 1916, the present Calumet and Arizona mines produced 5,763,226 dry tons of ore, from which 634,694,594 pounds of copper were recovered. The gold and silver values in this period amounted to \$6,913,072. The dividends paid before July 1, 1916, reached a total of \$25,726,661.75.

MANAGEMENT

Since the Calumet and Arizona Mining Co. was formed, the work has been in charge of the following men:

1900—December, 1903

I. L. MERRILL

January, 1904—January, 1906

S. A. PARNALL

February, 1906—June, 1910

L. W. POWELL

July, 1910 to Date

JOHN C. GREENWAY



WORKING MINES

IRISH MAG MINE

Sinking startedNovember, 1900
First ore shippedNovember, 1902
Depth of Shaft1393 feet

Levels—450, 550, 650, 750, 850, 950, 1050, 1150, 1250 and 1350. Ore was shipped from all levels. The large orebody extended from the 750 to the 1150 level.

The greater part of the Irish Mag ore was rich carbonate, oxide, and native copper ore. In the north end there was a body of enriched chalcocite ore, and on the lower levels, some primary pyrite and chalcopyrite ore was mined.

The Irish Mag was practically exhausted and closed down in 1913, after yielding a profit of nearly \$10,000,000 from 15 acres. Since 1913 a little ore has been shipped from the upper levels by leasers.

EQUIPMENT

70 ft. steel headframe.

92 H. P. double drum geared electric hoist. Allis-Chalmers hoist motor.

20x60 inch Nordberg double reel Corliss hoist. Dismantled)

OLIVER MINE

Sinking started	1903
First ore shipped	November, 1904
Number of men employed	150
Depth of shaft	1375.5 ft.

Levels—(Taken from Irish Mag)—750, 850, 950, 1050, 1150, 1250, 1350, 1450. Also 1600, run from Hoatson Shaft. Ore has been shipped from all levels from the 850 to the 1600, inclusive.

The Oliver orebodies have been of all sorts, from soft oxide and carbonate orebodies in large masses of leached material to hard, primary pyrite and chalcopyrite bodies in equally hard Cambrian limestone. Hence many systems of mining have been used. At present, square setting and cut-and-fill are the only systems in use.

The Oliver has shipped over 900 tons of ore per day for long periods. The present shipments average about 250 wet tons per day.

Water from the Oliver and Irish Mag Mines is taken on the 1600 level to the Hoatson Mine, from where it flows to the Junction.

EQUIPMENT

75 ft. steel headframe.

Six 250 H. P. Marine boilers, dry back type. Feed water treatment tanks, fuel oil tanks, etc.

4 cylinder double reel Nordberg Corliss hoist, cylinders 16x42. Non-condensing

Allis-Chalmers geared dinky hoist, 12x4 inch, slide valve engines.

Sullivan Machinery Co. cross compound Corliss 2-stage compressor, capacity 3500 cu. ft. Runs condensing.

OLIVER MINE—Continued

Sullivan Machinery Co. straight line compressor. 950 cu. ft. capacity.

1000 K. W., 2200 volt, 60 cycle, 3-phase, 3600 r. p. m. Westinghouse Turbo-generator.

500 K. W. turbo-generator, same type.

14 panel switch board.

300 K. W. 600 volt motor generator, for street railway.

300 K. W. 600 volt split phase rotary converter for street railway.

Nordberg jet condenser and dry vacuum pump, steam cylinder 10x24 inches, vacuum pump 18x24 inches. Three double acting plunger pump sets maintaining very low vacuum.

Cooling tower 20 ft. wide, 132 ft. long.

COLE MINE

Sinking started1902
First ore shipped October, 1905
Number of men employed350
Depth of shaft 1480 ft.

Levels—600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400. Ore has been shipped from all levels from the 800 to the 1400, inclusive. The 900, 1000 and 1100 have been the big levels up to date.

The Cole orebodies have been chiefly soft oxidized ore, requiring square set mining. Top slicing and the Mitchell slicing system are used wherever possible. There are also bodies of harder sulphide ore, which can sometimes be mined by shrinkage, cut-and-fill, or one of the Mitchell slicing systems.

Present shipments from the Cole Mine average about 500 tons per day.

About 500 gallons of water per minute are pumped from the Cole Shaft.

EQUIPMENT

Steel headframe.
One 250 H. P. marine boiler.
Five 150 H. P. tubular boilers.
Four-cylinder Nordberg Corliss double reel hoist, cylinders 16x42 in.
12x36 inch Hendrie and Bolthoff dinky hoist.
Direct connected double drum electric hoist, motor generator flywheel set. Idle.
Sawmill.
Two 14 and 26 and 7x18 Prescott duplex pot form compound pumps, 500 gal. per min. each, on 1100 level.
Independent jet condenser.

HOATSON MINE

Sinking started March, 1905
First ore shipped November, 1906
Number of men employed 50
Depth of shaft 1680 ft.

Levels—(Taken from Junction Mine)—1000, 1100, 1200, 1300, 1400, 1500. Ore has been shipped from all of these levels. The great Hoatson orebody extended from above the 1200 to below the 1400 level.

The main Hoatson orebody consisted of soft oxidized ore, which was mined chiefly by the square set system. The Mitchell Slicing System was also used. In smaller hard sulphide orebodies shrinkage and cut-and-fill systems were used. At present practically all the mining is square set.

Present production averages about 200 tons of ore per day. This ore is hauled to the Junction on the 1400 level by electric locomotives. For several years the Hoatson shipped over 500 tons per day. The Del Norte Claim, in which the Hoatson Shaft was sunk, has yielded nearly as much copper per acre as the Irish Mag.

The water from the Hoatson workings runs on the 1500 level to the Junction Shaft.

EQUIPMENT

Steel headframe.

Six 72x18 tubular boilers. 750 H. P.

17x48 inch Wellman-Scaver-Morgan double reel hoist.

Idle.

Double drum Allis-Chalmers geared electric hoist, 100 H. P.

JUNCTION MINE

Sinking started	July, 1903
First ore shipped.....	June, 1907
Number of men employed	640
Depth of shaft	1837.5 ft.

Levels—770, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800. Ore has been shipped from about the 700 level to the 1800. The 1000 and 1100 levels have as yet produced almost no ore. The great orebodies are on the 1300, 1400 and 1500 levels. Development has only commenced on deeper levels, but much ore has already been found. In the shaft itself there is ore at 880 ft. depth and again at 1830 ft., by far the greatest vertical thickness of orebearing ground yet developed in the District. Since there is over 1000 feet of limestone which may be orebearing below the present bottom of the Junction, this thickness of the ore zone is sure to be greatly increased.

Above the 1200 level, the Junction ore was soft and oxidized, and was mined by square sets. Little work is now being done on the upper levels. From the 1200 down, ore has been almost all sulphide. The character of ore varies greatly. Hard primary chalcopyrite, bornite and pryrite ore occurs above the 1200, while soft, enriched chalcocite ore occurs on the 1800. The Gilman cut-and-fill method of mining is used wherever possible, with modified cut-and-fill systems as required by the shape and character of orebodies. In the softer portions of orebodies square set mining is still used.

Present production averages about 1350 tons of ore per day. Most of the Briggs and Hoatson ore is also hoisted at the Junction Shaft, making the total ore hoisted over 2000 tons per day.

Water from all of the Calumet and Arizona mines except

JUNCTION MINE—Continued

the Cole, and from the lower Copper Queen mines is pumped from the Junction Shaft. The maximum flow for a short time was about 4600 gallons per minute. At present the flow averages about 3500 gallons per minute.

EQUIPMENT

SURFACE

Thirteen 250 H. P. marine boilers, with feed water treatment plant, heaters, etc. The fuel is California crude oil averaging 18,350 B. T. U. per lb., with 14° Be gravity, weighing 342 lbs. per bbl.

4-cylinder Nordberg Corliss double reel hoist, non-condensing, cylinders 16x42 inches.

Single drum, 2-cylinder Sullivan dinky hoist, cylinders 18x42 inches.

Nordberg 4-cylinder triple exp. Corliss two-stage compressor, 18½ & 36 & 2—36 & 40 & 23x42 inches, capacity 5080 cubic feet per minute, has attached condenser and spray intercooler.

Nordberg cross compound Corliss two-stage compressor, 18 & 36 & 32 & 19x44, capacity 3500 cu. ft. per min. Surface intercooler, independent jet condenser.

Ingersoll belted compressor, 19 & 12x16, capacity 888 cu. ft. 135 H. P. motor.

75 ft. steel headframe, with skips dumping into gyratory coarse crusher. Conveyor belt to cars.

Steel enginehouse, sawmill, change house.

Wooden cooling tower.

C. & A. general machine shop, blacksmith and plate shop, rope house and warehouse. All steel buildings.

JUNCTION MINE—Continued

UNDERGROUND EQUIPMENT

Eight 3½-ton Westinghouse-Baldwin electric locomotives, 18-inch guage, on 1400 and 1600 levels. These haul up to 20 saddleback dump cars of 38 cubic feet capacity.

PUMPS—1800 LEVEL

One 18 & 23 & 47 & 12x24 Prescott Duplex pot form slide valve triple exp. capacity 1500 gal. per min.

One 15 & 23 & 39 & 10x24, same type, capacity 1000 gal.

One 15 & 23 & 39 & 12½x24 Prescott duplex pot form rolling valve triple exp., capacity 1500 gal. These three pumps all have independent jet condensers. They throw 800 ft. to the 1000 level sump.

There is also ordered one 6¾x24 Prescott duplex power pump with direct connected 100 r. p. m. motor, capacity 1488 g. p. m. against 2200 ft. head.

1500 LEVEL

One 15 & 23 & 39 & 14½x24 Prescott Messabe type, rolling valve, triple exp., 2245 g. p. m., independent jet condenser.

One 18 & 34 & 8x36 Prescott cross compound Corliss Messabe type, 1500 gal. per min., attached condenser.

One 16 & 30 & 14½x24 Prescott Messabe type slide valve compound, independent jet condenser.

These pumps all throw 500 ft. to the 1000 level sump.

JUNCTION MINE—Continued

1000 LEVEL

Three 15 & 23 & 39 & 10x24 Prescott pot form, slide valve, triple exp., 1000 g. p. m. each. Independent jet condensers.

Two 20 & 38 & 6½x36 Prescott cross compound, Corliss, pot form, capacity 1000 g. p. m. each. Attached condensers. These pumps all throw to the surface.

VENTILATION

The Junction Shaft is the upcast for all the mines. The air is forced to the Junction by two Sturtevant multivane blowers, driven by 75 H. P. motors, with a capacity of 100,000 ft. of air each against 1¾ inches water pressure; and by two Stine disk fans, driven by 50 H. P. motors, with a capacity of 80,000 ft. of air each against 1½ inches water pressure. The two large blowers are on the 1400 Briggs and 1400 Hoatson; the smaller ones on the 1200 Briggs and 1200 Hoatson.

BRIGGS MINE

Sinking started January, 1902
First ore shipped December, 1910
Number of men employed 340
Depth of shaft 1630 ft.

Levels—770, 900, 1000, 1100, 1200, 1300, 1400, 1500. Ore has been mined from just below the 900 level to below the 1400.

The largest Briggs orebodies have been rather soft and crumbly sulphide ore. Square sets or the Mitchell slicing system are usually employed in this ore. There are many smaller oxide orebodies, which are mined by square sets. At the south end of the mine there is a steep vein of oxidized ore, developed for over 400 feet vertically, with very little expansion on the bedding of the limestone. This vein is mined by overhand stoping with stulls or square sets.

Early work at the Briggs was greatly delayed by water. The mine was closed down during nearly all of the years 1908 and 1909, while drainage drifts were run from the Junction.

Present production averages about 650 tons of ore per day. Most of this ore is hauled to the Junction on the 1400 level by electric locomotives.

Water is taken from the Briggs to the Junction Mine on the 1500 level.

EQUIPMENT

Timber headframe.

Two 250 H. P. marine boilers.

18x42 inch Sullivan double drum Corliss hoist.

PROSPECTING SHAFTS

There are in outlying portions of the Calumet and Arizona ground several prospecting shafts from which little or no ore has yet been found. Among these are the Congdon Shaft, 1266 ft. deep; the Powell Shaft, 646 ft. deep; the Cole No. 3 Shaft, 917 ft. deep; and the Saginaw Shaft, 1006 ft. deep. No work is being done at present from these shafts.

