at 135 degrees. With six machines this still leaves the problem of furnishing 600 g.p.m. from 400 g.p.m.

To solve this problem a five-stage spray pond was built on the 3,600 level near No. 8 shaft in the exhaust air. This cooling pond cools 200 g.p.m. from 135 to 92 degrees. The spray pond consists of separate ponds, each 8 by 20 feet, and 936 spray nozzles (3/16-in.), divided among the five stages. Condensing water from one condenser enters the first stage at 135 degrees and is sprayed. It is then picked up from this stage and sprayed into the next by a 10-h.p. Byron Jackson "Bilton" pump. This is repeated in the other stages, and the water flows from the last stage back to the original condenser water-gathering sump.

The present arrangement of the machines is two units, one Type A and one Type B on the 3,600 level, with cooling coils and fans placed to serve the 3,600 and 3,800 levels; two units, one of each type on the 4,000 level, to serve two locations on this level; and two, one of each type on the 4,400 level, to serve two different locations on this level.

The circulation of the condenser water is as follows: From the storage sump, 600 g.p.m. is pumped through the three Type A machines on the three different levels and then on through the three Type B machines, on the same levels. The condenser water from the units on 3,600 and 4,400 is returned to the 3,600 level where it is pumped out of the mine by the main mine pumps. The water from the 4,000 level units returns to the 3,600 level and goes through the spray pond for recooling.

The main mine pumps are two horizontal duplex Prescott pumps, 600 g.p.m. capacity against a 3,300-foot head, which are powered with 600-h.p. motors. One is used for pumping, while the other is a stand-by.

MINING METHODS USED AT THE MAGMA MINE

The mining methods used at the Magma mine prior to about 1929 have been described in several articles. Only the methods now being used are outlined in the following brief description.

Recent changes in the mining methods have related chiefly to stoping. The modifications resulted from a change in the type of wall rock, more variation in the vein width on the lower levels, and the desire for more selective mining.

Most of the Magma ore bodies occur as shoots in a strong east-west fault zone which has an average dip of about 75 degrees south. A few ore bodies occur on branches of this fault and on adjacent parallel breaks. The ore shoots range from a few feet

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to more than 2,000 in length and have a maximum width of about 30 feet.

A change to the present development and stoping method was made after the 2,800 level was reached. A level interval of 200 feet has been used from the 2,800 level to the present bottom of the mine, the 4,800 level.

The main copper ore body is developed by sinking the No. 3, 5, and 8 shafts and the West No. 14 winze. These shafts are sunk at least 100 feet below the level to be developed to make the necessary shaft length for the shaft pockets, spill pockets, and sump. At a point 60 feet below the proposed level, loading-pocket stations are cut on both sides of the shaft opposite the hoisting compartments. At the top, and back from these loading stations, raises of 55 degrees incline, pointed away from the shaft, are driven to the elevation and position of the proposed level tail drift. The shaft crew then cuts the shaft stations and drives the tail drift from 50 to 100 feet both ways from the shaft. The pocket raises are widened to about 10 by 10 feet and become the shaft pockets. The tops of these pockets are covered with grizzlies made of 70-pound rails spaced 9 inches apart. If the ground will permit the pockets are not timbered, but if the ground is soft or heavy they are cribbed and lined. The loading baskets and air-operated pocket doors are then installed in the shaft-loading pocket stations, completing the shaft-sinking program.

A five-man drift crew drives an 8- by 8-foot crosscut from the shaft tail drift to intersect the vein. A drift of this same size is then started on the vein by working toward each other from opposite shafts. Channel samples of the faces of these extraction drifts are taken at 10-foot intervals for assay records. In addition to the extraction drift, a parallel drift, also 8 by 8 feet, is driven in the footwall on every second level. These two drifts are from 75 to 125 feet apart and are connected by crosscuts at intervals of about 300 feet.

Upon completion of drift work on the level, double-compartment cribbed raises from the extraction drift are driven into the footwall of the vein. These raises are spaced at 105-foot centers along the vein. Drilling is done by self-rotating stopers, using detachable bits, and the rounds are fired by electricity.

At the completion of a stope raise two stopes may be started, because each raise is used as a waste passage, timber passage, manway, and ventilation opening for two stopes. Each stope is laid off nine sets, or 45 feet, measured from the center of the raise along the vein. This arrangement permits a length of 90 feet along the vein to be mined by the two stopes served by the one raise.

The ore is stope by the standard square-set cut-and-fill method. The stope timber is sawed 10- by 10-inch Oregon pine. The sets measure 6 feet 8 inches high and are spaced 5 feet from center to center. As stoping progresses above the sill floor, an arch or
THE SUPERIOR MINING AREA

incline of about 35 degrees, with the high end at the stope raise, is maintained throughout the mining life of the stope. This arch conforms to the angle of repose of the waste fill. In the two lines of sets at the low end of the arch (the two lines farthest away from the stope raise) the manway and chute are carried upward as the mining progresses. At the completion of a cut in the stope all broken ore is cleaned out, the flooring is removed, and waste fill is dropped from the level above through the stope raise. When the stope is filled the flooring is again laid over the fill, and the stope is ready for another cut.

The waste fill is mined from a surface glory hole connected to the levels of the mine by raises. All waste produced by development work can be dumped into this raise on each of the levels.

A pillar of ore 15 feet wide is left between each of the stope raises. When adjoining stopes have been mined out and completely filled, the pillar is mined either by a modified Mitchell System and timbered with stringers or by the square-set method of the cut-and-fill upward from the bottom. The manway and chute left open by the two adjoining stopes are used when mining these pillars.

LAKE SUPERIOR AND ARIZONA MINE

HISTORY

The Lake Superior and Arizona mine, locally known as the L. S. and A., is on the east edge of Superior (see Pl. I). It extends from Queen Creek northward for 2,300 feet. The property, now owned by the Magma Copper Company and operated intermittently by lessees, comprises the Golden Eagle and five adjacent claims. In the early days of the camp it was known as the Golden Eagle mine and was worked for gold by the Gem Mining Company. This company, after driving short tunnels and shallow pits and paying some dividends, ceased operations in 1885. The existence of copper in the mine was recognized but not considered economic at that time.

In 1902 the Lake Superior and Arizona Mining Company was organized at Calumet, Michigan, to acquire the property and work it for copper. First officers of the company were John D. Cuddihy, of Calumet, President; Dr. W. A. Holt, of Globe, Arizona, Vice-President; A. E. Petermann, of Calumet, Secretary; Wm. B. Anderson, of Calumet, Treasurer; Alfred C. Sieboth, Superintendent; and Henry Richardson, Engineer. Final payment of $31,000 on lands was made November 30, 1903. During 1904 the vertical Vivian shaft, 279 feet deep, was sunk, and three tunnels, the Anderson, Carlton, and Holt, 200, 250, and 500 feet long, were driven. During 1904 several hundred tons of oxidized copper ore were hauled to Florence and shipped to the Val Verde smelter, near Humboldt. At that time the company had thirty employees.
In 1904 the title was changed to Lake Superior and Arizona Mining and Smelting Company. Total mine openings at the beginning of 1905 were approximately 5,000 feet, of which 4,000 feet were of the earlier, random type and the rest systematic development of the L. S. and A. Company. Three ore bodies were developed in Martin limestone at intersections of east-west fractures with the Troy-Martin contact. The principal ore body was 6 feet wide by about 20 thick and followed the eastward dip of the limestone downward at an angle of 26°. The ores were siliceous carbonates and oxides associated with iron and manganese oxides, quartz, and a little free gold.

By the end of 1905 the L. S. and A. Company had driven a total of 9,497 feet of workings. The Holt inclined shaft, 460 feet deep, was sunk on a slope of 26° from the end of the Holt tunnel, 500 feet east of the portal.

Shipments in 1905 were 13 carloads, which assayed 31.6 per cent copper, 2.2 oz. silver, and $2.67 gold, with a net yield of $24,650.

In 1906 no ore was produced, but about $100,000 was spent on development. Assessments totaling $1.00 per share on about 120,000 shares were levied in 1906, 1907, and 1908. By the end of 1908 the Holt shaft had been deepened to 630 feet below the collar, or 850 feet below the surface. A crosscut from the bottom of the shaft was reported to show high values in both copper and gold. The Carlton tunnel, 100 feet vertically below the Holt tunnel, was connected with it by a winze 165 feet long driven on the dip of the ore body. The Carlton tunnel was extended to its portal on Queen Creek, a total length of about 2,000 feet from the Holt shaft. Power was derived from a steam plant on Queen Creek. Supplies were hauled from Florence by wagon at rather high cost, and the company considered building a branch railroad from Florence to the mine. Operations were suspended about November, 1907, and resumed July, 1908, with a force of about sixty men. Production in 1907 was 92,120 lbs. copper, 1,040 oz. silver, and 188 oz. gold. By the end of 1908 the Holt shaft was deepened to 1,800 feet on the incline from the Holt tunnel. Operations were suspended in 1909. Capital paid in by the end of that year totaled $1,680,000.

On August 1, 1910, an option on the property was taken by the Magma Copper Company. The price was set at $500,000, of which, at the option of the L. S. and A. Co., $300,000 was to be paid in Magma Copper Company stock at par value of $1.00 per share. Some development of the property was carried on by the Magma Copper Company in 1910, but work again ceased in 1911. The option was not exercised, and the property remained idle until 1916.

In 1916 the company was reorganized as the Superior Arizona Copper Company with a capital stock of $250,000, par value $1.00 per share, of which $180,000 was issued. Some dump ore was shipped in 1916, and some development was carried on in 1917. Officers of the company were: H. F. J. Knobloch, President; D. E.
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<th>Year</th>
<th>Tons</th>
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<th>Value</th>
<th>Oz. silver</th>
<th>Value</th>
<th>Oz. gold</th>
<th>Value</th>
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Thomas, Vice-President; F. V. Munster, Secretary-Treasurer; and D. E. Thomas, F. V. Munster, F. W. Holmes, and A. E. Petermann, Directors.

During 1917-18, 4,130 tons of ore averaging 10.08 per cent copper and yielding 768,673 pounds of copper were shipped, mainly by lessees. Ninety tons containing 43.78 per cent manganese were produced.

In October, 1920, the property and assets of the Superior Arizona Copper Company were acquired by the Magma Copper Company. Shareholders of the Superior Company were entitled to receive $2.00 per share in cash, or within 90 days they could exchange on the basis of 20 shares of Superior for one of Magma. The mine was idle between 1918 and 1925.

During 1925-27 lessees mined and shipped to the Magma smelter a small tonnage of oxidized ores.

In 1932, after discovering gold-quartz ore in the old workings, Sam Herron and Con Laster leased the L. S. and A. mine from the Magma Copper Company and subsequently opened important bodies of gold ore.

GEOLOGY AND ORE

The Lake Superior and Arizona mine is in Cambrian Troy quartzite and Devonian Martin limestone, which strike northward and dip about 30° eastward. According to Ransome, the quartzite-limestone beds above the contact were brecciated by strike faulting. A later examination by Kuhn failed to recognize extensive brecciation at this horizon.

The ore bodies occur as small lenticular replacements along seven east-west faults. The most productive gold horizon along the faults is within Martin limestone, 10-20 feet stratigraphically above the Troy quartzite.

The principal values are in gold, with lesser amounts of silver and copper. The gold ore consists mainly of oxides of iron and manganese, together with fine-grained yellow to gray quartz. Malachite and chrysocolla are found generally below the gold at the quartzite-limestone contact. Silver is associated with both the gold and copper.

All the ore mined has been oxidized. Pyrite and some chalcocite have been found in the lowest working of the mine, 800 feet vertically below the Holt tunnel level. Considerable limonite is associated with the pyrite. These sulfides may have escaped oxidation because of an irregularity in the water table. On the

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Other hand, their presence may indicate that oxidation took place before the beds were tilted.

Six shoots of gold ore within a horizontal distance of 1,600 feet have been found on the Carlton tunnel level. All bodies of ore on this level are associated with one or more east-west faults, and very few such faults were found between the ore bodies. Evidently east-west faults acted as channelways for the ore solutions.

In the lower levels only one ore shoot has been found. It is a continuation of the general zone, 100-300 feet broad, mined near the collar of the inclined shaft and cropping out northeast of the Holt tunnel portal. East-west faults were found near this shoot on most levels, but at many places within it mineralization has obscured the faulting.

SILVER KING MINE

EARLY HISTORY

The three published accounts of the discovery of the Silver King mine essentially agree. The following is based upon material published by Wm. P. Blake who, as Territorial Geologist, examined the property at various times.

In the middle of the nineteenth century, while settlements along the Gila River were slowly growing and spreading, the mountainous areas in Pinal and Gila counties were still in possession of the Apaches. These marauding savages dominated the whole region and made it almost inaccessible to prospectors who began to press outward from frontier settlements into the mountains. The country is rugged. One of the trails most frequented by the Apaches led over the steep limestone cliffs about 2 miles north of the site of Superior.

In 1873, General George Stoneman, later Governor of California, was commander of the military department of Arizona Territory. In a campaign to stop Apache raids, he established a camp at the base of the mountains close to the Apache trail and constructed a road, the Stoneman Grade, over the cliffs. It became the main route of travel between the Globe mining districts and the valleys of the Salt and Gila rivers.

A soldier named Sullivan, engaged in construction of the grade, was attracted by some heavy, black lumps of metallic material which flattened when hammered. He gathered a few specimens but said nothing of his find. When his term of service expired soon afterward he went to the Charles G. Mason ranch, near the site of Superior.

Raymond, R. W., Eighth ann. rept. of the mineral resources west of the Rocky Mts., 1876.
Plate XXIX.—A, Silver King in 1880's; B, Silver King and King's Crown, 1935.
of Florence, where he frequently showed the black ore. This ore has since been known as nugget silver. Sullivan suddenly disappeared, supposedly killed by Apaches while returning to his discovery.

In 1874 Mason and some fellow ranchers organized prospecting trips to locate Sullivan’s find. Their first discovery of importance was the Silver Queen, now known as the Magma mine. Soon afterward the Globe mine, from which the Globe mining district derived its name, was located.

In 1875 Mason, Benjamin W. Reagan, William H. Long, and Isaac Copeland, returning from the Globe district with a pack train of samples, camped near the base of the Stoneman Grade and found more of the black nuggets. This float was followed up a small conical hill near by to the outcrop of ore at its top. On March 22, 1875, the initial location was made, and the Pioneer mining district laid out. Assays by Tom Price, of San Francisco, established the value of the ore, and active mining began.

DEVELOPMENT AND PRODUCTION

In a report on the mineral resources of the Rocky Mountains, Raymond states that by the end of 1875 the shaft was down 42 feet and a 12-foot drift had been driven at the bottom. The shaft started in ore and was sunk along a network of stringers ranging from 3 to 18 inches wide in “granite.” The gangue material in the stringers was quartz, and the ore minerals were cerargyrite, argentite, and native silver. This ore, when sorted, ran $2,000 a ton. To treat the ore a small furnace of cupel type was erected at Florence by Cury and Hughes. Pig lead for collecting the silver was obtained from the Mowry mine in the Patagonia Mountains 150 miles south. Five hundred pounds of selected ore from the first 14 feet of the shaft yielded over $5 a pound. The total production from the shaft and drift was estimated at $50,000.

When the news of the discovery reached San Francisco, mining experts representing the Comstock interests were sent to negotiate purchase of the property, and in 1876 the mine was sold to the Silver King Mining Company. Further development was begun, and a small stamp mill and amalgamation plant were erected at Pinal, on Queen Creek, to treat the lower-grade ore. Most of the ore was shipped without milling.

In 1879 Arthur Macy was appointed Superintendent. Exhaustion of the free milling ore necessitated a change in method of treatment in 1882. The ore was crushed at the mine in a Blake crusher and sent to Pinal where it was further crushed by a battery of 20 stamps and concentrated over 12 Frue vanners. The concentrates were sent to the Dome Mining and Smelting Company, Melrose, California, the Selby Works at San Francisco, and the

*Abstracted from unpublished manuscript by J. B. Tenney.*
Omaha Smelting Works. In 1883 the mill treated 50 to 57 tons a day, with a concentration ratio of about 2 to 1. The average grade of the heads was $61.08 in silver, and the reported extraction was 92.31 per cent. In addition to silver, the concentrates assayed 21.5 per cent lead and 18 per cent zinc.

Active prospecting of adjacent ground closely followed the success of the Silver King mine. In 1883 fourteen groups were worked and three mills, of which the largest was the amalgamation plant of the Windsor Consolidated Company, had been erected. In 1884 this mill was leased by the Silver King Company to treat ore not amenable to concentration. In the same year the mine was developed to a depth of more than 800 feet, and most of the ore was obtained from the 700 and 800 levels. The grade had fallen to $43.00 for concentrating ore and $46.40 for amalgamation ore.

The last year of profitable operation was 1887. The grade had fallen to 21.08 ounces per ton for concentrating ore and 32.47 ounces for amalgamation ore. Lixiviation was tried on some ore high in copper from the 800 level, and some old tailings were reconcentrated. Costs reported by the Superintendent for 1887 were as follows:

<p>| | |</p>
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<td>Mining, per ton</td>
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<tr>
<td>Milling and roasting, per ton</td>
<td>9.69</td>
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<tr>
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During the first half of 1888 the company operated at a loss, and the President, H. H. Noble, reported a debt of $75,000. An assessment was levied, and operating costs were lowered from $40,000 to $5,000 a month. By December the indebtedness had been paid, the company had a balance of $74,000, and sufficient ore was in sight to run until January 1, 1889.

As prospecting in 1889-90 failed to find commercial ore, the mine was closed in January, 1891. It was reopened in September of that year after 44,000 delinquent shares had been called in. In October a strike was made in a new shaft east of the old workings. This ore was developed in 1892, but the company was again in debt. Ten stamps were moved from Pinal to the mine, and a small production of concentrates was made during the remainder of the year. With the decline of the price of silver early in 1893, the mine was again closed.

In the fall of 1895 the Superintendent, W. S. Champion, resumed work in the new shaft. He reported finding a pocket of ore at a depth of 75 feet worth $40,000. The mine was again closed in 1896.

From 1876 to 1896 the company declared $1,950,000 in dividends, of which the last was paid in 1887. A total of $300,000 in assessments was levied from 1888 to 1895, making the net profit $1,650,000. The dividends were paid on 100,000 issued shares, and assessments were collected on 56,000 shares.
In 1916, after successful exploitation of the neighboring Silver Queen mine by the Magma Copper Company, the property was acquired by the Silver King of Arizona Mining Company, a Delaware corporation, with A. W. Hildebrand, of New York, as President, and John Fowle as Manager. In 1917 the old main shaft, 987 feet deep, was unwatered and repaired. Small high-grade ore bodies, overlooked by the former operators, were mined on the 120 level. A small flotation mill was completed in 1918 to treat this ore and low-grade dump material. About 35 tons a day were treated, with a reported extraction of 90 per cent. A small vein on the 400 level yielded some rich ore that was shipped to the smelter, and shipments of concentrates continued intermittently to July, 1919. At that time the management claimed to have developed 10,000 tons of ore averaging over $20 per ton.

In July, 1919, a new shaft, financed by a $500,000 bond issue, was started 150 feet northwest of the ore chimney. The old shaft was kept unwatered, and ore from the 120 and 400 levels was treated at the mill. In October a crosscut from the old shaft on the 400 level connected with the 415 level of the new shaft.

In January, 1920, the capitalization was reduced to allow further financing. Shaft sinking continued until June, 1920, when a depth of 635 feet was reached. A crosscut on the 615 level extended to the old workings. The company went into bankruptcy shortly afterward, and a reorganization as the Silver King Mine, Incorporated, was effected, but no further work was done. The total ore treated from 1916 to 1920 amounted to 12,546 tons, averaging approximately $20 a ton in silver. The concentrates contained 1,000 to 1,980 ounces of silver, 20 per cent lead, and 7 to 8 per cent copper.

The Bilk shaft (Pl. XXIX A, left) is 450 feet northwest of the new Silver King shaft. It is reported to be over 1,000 feet deep and connects with the lower levels of the Silver King mine. The shaft was sunk during the early days by interests outside of the Silver King Mining Company. Observing the westward pitch of the Silver King ore body, owners of the Bilk assertedly hoped to intersect the Silver King pipe in depth where it passed beyond the side line of the Silver King claim. No mention was made of the apex law.

In 1940 a pipe line was laid from the Bilk shaft to provide an auxiliary water supply for the Magma mine.

In 1941 the Silver King property was owned by Mr. Bat Gays, of Superior, Arizona.

Pinal, on Queen Creek at the base of Picket Post Mountain, was first settled in 1877 during construction of the Silver King mill. As Silver King Wash had insufficient water for milling, the site chosen for the mill was on the north bank of Queen Creek, near

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"Hamilton, Patrick. The resources of Arizona, 1884."
its junction with Silver King Wash, about 5 miles west of Silver King. The settlement first was called Picket Post but was named Pinal upon establishment of its post office.

Pinal grew rapidly and by 1884 had a population of about 600, with several stores, a bank, two hotels, several saloons, a church, and a school. The newspaper *Pinal Drill* was established by J. DeNoon Reymert, a lawyer, and was maintained for several years prior to 1884. In 1887 the population was about 400.

A telephone, one of the earliest in the territory, connected Pinal with Silver King, and a telegraph connected Pinal with Florence, the county seat.

The settlement of Silver King, around the mine, had during the late eighties a population of about 500, with three stores, two hotels, a post office, a school, and several saloons. Present local tradition gives for both camps a much greater population.

### PRODUCTION OF SILVER KING MINE
(Compiled by J. B. Tenney)

<table>
<thead>
<tr>
<th>Year</th>
<th>Price of silver</th>
<th>Silver (oz.)</th>
<th>Gross value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1875</td>
<td>$1.24</td>
<td>40,323</td>
<td>$ 50,000</td>
</tr>
<tr>
<td>1877-79</td>
<td>1.16</td>
<td>706,157</td>
<td>819,142</td>
</tr>
<tr>
<td>1880</td>
<td>1.15</td>
<td>439,689</td>
<td>505,642</td>
</tr>
<tr>
<td>1881</td>
<td>1.13</td>
<td>574,049</td>
<td>648,675</td>
</tr>
<tr>
<td>1882</td>
<td>1.14</td>
<td>714,912</td>
<td>815,000</td>
</tr>
<tr>
<td>1883</td>
<td>1.11</td>
<td>533,787</td>
<td>592,503</td>
</tr>
<tr>
<td>1884</td>
<td>1.11</td>
<td>429,559</td>
<td>476,811</td>
</tr>
<tr>
<td>1885</td>
<td>1.07</td>
<td>764,832</td>
<td>818,370</td>
</tr>
<tr>
<td>1886</td>
<td>.99</td>
<td>656,566</td>
<td>650,000</td>
</tr>
<tr>
<td>1887</td>
<td>.98</td>
<td>708,134</td>
<td>694,951</td>
</tr>
<tr>
<td>1888</td>
<td>.94</td>
<td>319,149</td>
<td>300,000</td>
</tr>
<tr>
<td>1889</td>
<td>1.00</td>
<td>55,000</td>
<td>55,000</td>
</tr>
<tr>
<td>Total (1875-89)</td>
<td></td>
<td>5,943,157</td>
<td>$6,526,094</td>
</tr>
<tr>
<td>1918</td>
<td>1.00</td>
<td>37,000</td>
<td>37,000</td>
</tr>
<tr>
<td>1919</td>
<td>1.12</td>
<td>126,892</td>
<td>142,119</td>
</tr>
<tr>
<td>1920</td>
<td>1.09</td>
<td>65,872</td>
<td>71,800</td>
</tr>
<tr>
<td>1928</td>
<td>.58</td>
<td>3,000</td>
<td>1,755</td>
</tr>
<tr>
<td>Total (1918-28)</td>
<td></td>
<td>232,764</td>
<td>$252,674</td>
</tr>
<tr>
<td>Grand total</td>
<td></td>
<td>6,175,921</td>
<td>$6,778,768</td>
</tr>
</tbody>
</table>

### SILVER KING ORE BODY

The Silver King mine is filled with water and therefore is inaccessible for examination. Blake's article contains the only original description of the ore body, although Ransome has given

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*Hamilton, Patrick, op. cit.*
*Bancroft, H. H., History of Arizona and New Mexico, 1889.*
*Bancroft, op. cit.*
*Blake, Wm. P., op. cit.*
a concise summary of Blake’s description in addition to data collected by himself. Quoting from Ransome:

The ore body formerly cropped out at the top of a little hill about 75 feet high, composed of much-altered yellowish brown to greenish gray porphyry. Stoping was carried to the surface and a crater-like pit from 100 to 125 feet in diameter marks the site of the former outcrop. Here and there in the porphyry walls of the pit may be found small veinlets of rich, partly oxidized silver ore, but, so far as can be seen from the surface, the ore body was determined by the intersection of two or more persistent fissures. It apparently was a compact plexus of veinlets inclosed in comparatively unfissured porphyry. Blake’s description and the maps of underground workings show that the ore body was a stockwork about 130 feet in maximum diameter, with a general dip of 70° W. The stockwork was disposed about an irregular core or axis of milk-white quartz, containing some bunches of rich ore but as a whole comparatively barren. This material is abundant and conspicuous in the mine dump and evidently constituted at times the bulk of the waste.

The following description is from Blake:

The portion removed from the open pit consisted largely of rock, the porphyry, so-called, penetrated and seamed with interlacing veinlets of quartz, reticulating and crossing in every direction. These veinlets varied from the thickness of a sheet of paper to \( \frac{1}{4} \) inch or an inch in thickness, and were generally accompanied with ore in a medial position, having quartz on each side of it next to the rock. The same conditions may be seen in the lower levels at the present time. In addition to these veinlets, there are masses and bunches of ore, and apparently (at least in the upper levels) a central mass of quartz, a large and compact body, toward which the system of veinlets converged, or from which they may be said to radiate. This mass of quartz, of irregular dimensions, still exists in the region opened by the lowest levels of the mine, but it has not yet been thoroughly explored. This quartz appears to hold some direct relation to the deposition of the ore: The heavier bodies of ore, so far, having been cut below, or on the foot-wall side of the quartz body. It may be regarded as holding the relation of the chief veinstone to the ore, and as presenting within itself, and together with the branching veinlets, the characters of a true fissure-filling, although it has not the usual sheet-like or tabular form. It is, instead, a columnar or chimney-like mass, some 80 feet in diameter in places, but irregular and without longitudinal extension. In other words, this quartz-vein, instead of having a width much greater than its breadth, is approx-
imately cylindrical or columnar in its form, filling a nearly vertical, spirally-formed cavity.

If we examine the structure of the veinlets in detail, we find them presenting the characteristics of fissure-veins. They extend for long distances through the rocks, and with parallel walls. They have regular veinstone and vein structure. The quartz forms on the opposite walls of the fissures in regular sheets, with "combs" or quartz crystals pointing inward and holding the ore in bunches and sheets. Such inclusions of ore are still to be seen in the small veins at the summit of the croppings and in the levels below.

The ore occurs also in bunches in the rock with but little veinstone. A tendency to triangular forms is observable, and in several places I have noted veins joining together nearly at right angles.

It will be inferred from the preceding descriptions that the richest and most important accumulations of ore are not found in the main body of the quartz veinstone. Although the massive quartz does hold bunches of rich ore, it is not, as a rule, so rich and profitable to work as the rock adjoining it. The ore is more abundant in connection with the small branching veins in the outside rock than in the mass of the quartz itself. It must, however, be stated that the quartz body has not yet been fully explored, being merely cross-cut in the upper levels. It is my opinion, however, based upon what has already been shown that, contrary to the usual conditions in the mines, the chief body of quartz veinstone does not carry the best part of the ore. It appears rather to have been the main channel of the mineralization: the main artery or feeder to the thousands of veinlets branching from it into the wall-rock following the clefts and penetrating the substances of the rock, depositing and diffusing native silver and the sulfides throughout the whole mass of rock for an indeterminate distance on each side.

Through the courtesy of Mr. Bat Gays, owner of the Silver King mine, level maps made by Mr. Starbird, resident engineer for the Silver King of Arizona Mining Company, were examined by the writers. These maps show the stoped area of the ore body to have the following dimensions:

<table>
<thead>
<tr>
<th>Level</th>
<th>North-South (ft.)</th>
<th>East-West (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>400</td>
<td>80</td>
<td>50</td>
</tr>
<tr>
<td>500</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>600</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>800</td>
<td>180</td>
<td>100</td>
</tr>
</tbody>
</table>

MINERALOGY

General statement: Although the Silver King mine was worked exclusively for silver, the most abundant minerals are those of lead, copper, and zinc. The most important of the base metal minerals are sphalerite, chalcopyrite, tetrahedrite, galena, and bornite. Much of the tetrahedrite contains a small amount of silver, but with this exception stromeyerite and native silver were the valuable constituents of the ore. Chalcocite, covellite, cuprite, azurite, and malachite are present in smaller amounts.

Hypogene minerals: Pyrite: Pyrite occurs in only a few of the specimens studied, generally as small, rounded remnants in chalcopyrite, by which it has been replaced most extensively. In sections where pyrite is in contact with sphalerite, the two minerals exhibit smooth boundaries with no marginal relations which
can be interpreted. In the Magma mine pyrite is the earliest sulfide and is followed by sphalerite. By analogy, the same condition is believed to exist in the Silver King area.

**Sphalerite:** Sphalerite is the most abundant sulfide mineral. In hand specimen much of it is light colored and translucent; in polished section it is medium gray and gives a weak reaction for iron. Sphalerite, like the other hypogene minerals of the ores, is present largely as open-space filling. However, it replaces quartz to a much greater degree than any of the other sulfides. It is in turn replaced by the other sulfides, particularly galena, with which it is almost invariably associated.

**Galena:** Next to sphalerite, galena is the most abundant sulfide. It is intimately associated with sphalerite, which it replaces along cleavage cracks. The galena in many places shows mutual boundaries with chalcopyrite and tetrahedrite, but it is later than these minerals. It selectively replaces tetrahedrite, as shown by its numerous tiny tongue-like projections into tetrahedrite and a multitude of small residual masses surrounding the larger areas of that mineral. Microchemical tests of the galena showed no silver.

**Chalcopyrite and tetrahedrite:** Chalcopyrite and tetrahedrite, the most abundant copper minerals, are present in about equal proportions.
quantity and intimately associated. Their marginal relations are of mutual boundary type, and no definite evidence of replacement of one by the other was seen. They are believed to be essentially contemporaneous. They generally occur as open-space filling in quartz gangue but also replace sphalerite, and the tetrahedrite is extensively replaced by galena. Microchemical tests indicate that the tetrahedrite contains 1 per cent or more of silver.
**Bornite:** Although less abundant than chalcopyrite, bornite was observed in nearly all the specimens which contained chalcopyrite. It occurs chiefly as a replacement of chalcopyrite but has also replaced tetrahedrite. The most striking occurrence of bornite is the formation of halos around residual grains of chalcopyrite. These halos occur most commonly between chalcopyrite and stromeyerite but also between chalcopyrite and tetrahedrite. Bornite also forms advance islands and minute veinlets in areas of chalcopyrite. These veinlets probably follow grain boundaries but apparently not open fractures. In several sections the bornite consistently occupies gangue boundaries surrounding areas of stromeyerite, which suggest supergene origin and indicate it to be later than the stromeyerite. Other evidence described later leaves no doubt that the stromeyerite is later than the bornite. It seems probable that the bornite is hypogene, that it replaced chalcopyrite and possibly some tetrahedrite along grain and gangue boundaries, leaving only residual remnants of the chalcopyrite. When supergene solutions attacked these minerals, the tetrahedrite was broken down to form stromeyerite, bornite was slightly replaced, and chalcopyrite was unaffected—a process which should produce the present texture.

**Argentite:** This mineral was found in only one specimen and in small quantity. It forms graphic structure with tetrahedrite (Pl. XXXIII B), which it replaced. The argentite in turn is replaced by galena.

**Supergene minerals: Stromeyerite:** By far the larger part of the stromeyerite in the Silver King ore is believed to be supergene. The stromeyerite has formed by replacement, particularly of tetrahedrite and also of bornite. A supergene origin for the stromeyerite is suggested by reticulated veinlets of it along fractures in tetrahedrite and by residual islands of tetrahedrite in stromeyerite. Microtextures indicate that tetrahedrite was more susceptible than bornite to the replacement process.

A bladed structure in the stromeyerite has been described and explained by Guild. This structure is caused by mixture of stromeyerite and chalcocite, the stromeyerite forming the blades and the chalcocite forming the matrix. Well-formed blades are exceptional, and in most specimens the stromeyerite and chalcocite formed a mixture of small, irregular grains. The structure is rarely visible in plain light on a freshly polished surface but is revealed by etching with nitric acid.

The formation of this mixture was explained by Guild as follows:

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67Guild, op. cit.
In the breakdown of the tetrahedrite molecule the sulphide of antimony has been removed leaving the sulphides of copper and silver, some of which appear as the double salt Cu₃S·Ag·S (stromeyerite).

Guild recognized that this structure might also be formed by replacement of chalcocite by solutions rich in silver or replacement of stromeyerite by solutions rich in copper.

Textural evidence of supergene origin for the stromeyerite has already been mentioned. In addition, blue chalcocite, believed to be supergene, occurs abundantly in the stromeyerite-chalcocite mixture, and veinlets of this mineral are associated with the replacement of bornite by stromeyerite. Many specimens of fine-grained stromeyerite contain supergene covellite, and only in these specimens were malachite and azurite observed.

**Massive chalcocite:** Although supergene massive chalcocite was observed in only three of the polished sections studied, its mode of occurrence indicates that it was an important constituent of the sulfide ores in upper levels of the mine. Where seen, it constitutes a large portion or all of the sulfides in the specimen. Microscopically, it is distinctly lighter blue than the supergene massive chalcocite from the Magma mine previously described by Short. The mottled character of the Magma ore is present to a slight degree only, but the rounded gray patches described by Short and believed to represent "ghosts" of replaced bornite are readily seen; the difference in color is probably due to incomplete removal of iron. The chalcocite is fine grained, and nitric acid does not bring out the cleavage structure of individual grains as it does on coarse-grained hypogene chalcocite from other localities. This chalcocite has been derived, in large part at least, from hypogene copper sulfides. It replaces chalcopyrite and tetrahedrite, both of which appear as remnants throughout the chalcocite, and tetrahedrite has been replaced by the chalcocite along fractures. Bornite has been almost entirely replaced by chalcocite. It is present as halos surrounding remnants of chalcopyrite (Pl. XXXIII A), but rarely tiny areas of bornite alone may be seen. The bornite might be considered an evanescent transitional phase in the replacement of chalcopyrite, but a similar relationship between bornite and stromeyerite, already described, suggests that the bornite is hypogene and a remnant rather than a product of replacement. Furthermore, in many specimens chalcocite replaces chalcopyrite without bornite halos, and the bornite presents an exceedingly hazy or fuzzy boundary toward the chalcocite but a clear, sharp boundary toward the chalcopyrite. Inclusions of bornite in the chalcopyrite contain no chalcocite.

**Blue chalcocite:** This mineral, determined by Posnjak, Allen, and Merwin to be chalcocite containing a small proportion of

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Covellite in solution, is observed sparingly in several specimens. It is derived from both chalcopyrite and bornite, which it frequently replaces along minute fractures (Pl. XXVIII C). By analogy with covellite, it is believed to be later than the massive chalcocite.

**Covellite:** Covellite is less common than blue chalcocite. The mode of occurrence of the covellite is identical with that of blue chalcocite, replacing chalcopyrite and bornite along minute fractures. Nowhere in the specimens studied was covellite observed as a product of oxidation of massive chalcocite, and therefore the sequence of formation of massive chalcocite, blue chalcocite, and covellite is not illustrated. In the Magma mine, however, covellite is later than massive supergene chalcocite, and as blue chalcocite is believed to be incipient covellite, the minerals are believed to have been formed in the order described. Supergene covellite also replaces hypogene stromeyerite.

**Chalcopyrite:** A second generation of chalcopyrite is supergene, but it is not abundant. It is intimately associated with supergene covellite and appears as tiny veinlets in bornite, which it has replaced along open fractures and in tongues branching outward from such fractures.

**Native silver:** Native silver is intimately associated with massive chalcocite and in places makes up about 30 per cent of the specimen (Pl. XXXIII A). Guild has described the relationship as follows:

The silver is arranged in beautiful filiform structure, the branches of which envelope individual chalcocite grains, some of the finer filaments even extending into fracture and cleavage cracks of the chalcocite. In places the whole design is roughly oriented with reference to cleavage directions of chalcocite. All of these features are well brought out by etching with potassium cyanide solution. The areas showing the structure described grade into stromeyerite, where the native silver disappears altogether, or is confined to borders, veinlets or clumps of more or less rounded outline. The causes responsible for the filiform structure now become clear. Stromeyerite has been broken down into chalcocite and native silver. The chalcocite has crystallized into definite grains of varying size. The silver in recrystallizing has formed around these grains, extending everywhere into the minutest cracks. The silver is also recrystallizing in cracks and along borders of other minerals, both gangue and ore.

**Cuprite:** Cuprite was observed in only one specimen, but there is no doubt that its supergene origin is later than that of chalcocite and native silver. It replaces these minerals as tongues extending into the residual areas, and at one place it has filled an open fracture extending through chalcocite and native silver.

**Azurite and malachite:** Azurite and malachite occur as pockets of small, well-formed crystals in the walls of the open pit. In

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7Guild, F. N., A microscopic study of the silver ores and their associated minerals: Econ. Geol., vol. 12, pp. 323-4, 1917.
Plate XXXI.—Photomicrographs of Silver King ore.

A.—Minute veinlets and advanced islands of bornite (dark) replacing chalcopyrite (light). These minerals exhibit smooth mutual boundary relations in other parts of the same section. (x 30)

B.—Open space filling beside euhedral quartz crystal by chalcopyrite (white) which is replaced by hypogene bornite (dark gray), in turn replaced by supergene stromeyerite (light gray). (x 106)

C.—Hypogene stromeyerite (light gray) replacing bornite (dark gray). The stromeyerite does not cut through the chalcopyrite (white). Supergene covellite is younger than the stromeyerite. (x 184)

D.—Supergene mottled stromeyerite (light) replacing bornite along fractures. The bornite is also replaced by supergene blue chalcocite. (x 425)
Plate XXXIII.—Photomicrographs of Silver King ore.

A.—Hypogene chalcopyrite (medium gray) replaced by hypogene bornite (dark gray). The bornite has been replaced by supergene massive chalcocite (light gray). Supergene native silver (white) has extensively replaced the chalcocite and to a lesser extent the bornite. (x 84)

B.—Hypogene argentite (light gray) replacing tetrahedrite (dark gray) in a graphic texture. Both tetrahedrite and argentite have been replaced by supergene native silver (white). (x 156)

C.—Hypogene chalcopyrite (white) and bornite (dark gray) replaced by supergene blue chalcocite (light gray) along fractures. (x 190)

td:—tetrahedrite

bcc:—blue chalcocite
polished sections, the minerals occur as stains along minute fractures in quartz gangue.

**Anglesite**: In one specimen anglesite replaces galena, forming a network of tiny veinlets in open fractures.

**Gangue minerals**: **Quartz**: At least 95 per cent of the gangue is quartz. It occurs in two forms, one a rather fine-grained crystalline variety and the other as euhedral crystals extending from walls of the fine-grained gangue (Pl. XXXII B). Hand specimens as well as thin sections show both varieties of quartz to be later than the Silver King porphyry in which the ore body was formed. Open spaces left after deposition of the quartz were the most favorable locations for deposition of ore minerals.

**Barite**: In the specimens studied, small amounts of barite occur in two generations—
1. Earlier than the ores, as open-space filling in the quartz.
2. Later than ores, numerous narrow veinlets cutting through the sulfides. The later generation is much less common than the earlier.

**Calcite**: Calcite was infrequently observed as narrow veinlets in the quartz gangue. Its age relative to the barite was not determined, but it is assumed to be younger, since in other districts most calcite is generally considered to be later than the latest barite.

**MINES IN THE BELMONT SUBAREA**

**EARLY HISTORY**

Some mining, largely of manganese-stained vein outcrops, was done in the Belmont-Queen Creek area before 1900. This ore, mined for its silver and gold, was treated in a custom stamp mill near Pinal. After construction of the Silver King Mining Company's mill, this older mill was closed, for at the new one provision was made for roasting the ore, a process which aided materially in recovery of the precious metals.

Most of the present claims were located shortly after 1900 by Henry Thomson, C. H. Smith, A. C. Norris, A. J. Daggs, John Sandal, and many others. Organized prospecting, begun in 1912, has been carried on intermittently.

**MINERALIZATION**

Two favorable horizons for ore deposition, the Troy-Martin contact and the upper portion of the Escabrosa, have been recognized.

**Troy-Martin contact**: The Troy-Martin contact is known as the L. S. and A. contact, from the Lake Superior and Arizona mine
which developed it north of Queen Creek. Considerable breccia occurs throughout along the contact but particularly in the northern part of the Belmont subarea. This breccia is particularly well developed in the quartzite, and in some places it is 15 to 20 feet thick. It indicates a strong bedding fault. The movement on this fault was not determined, but it must have been considerable.

The brecciated quartzite of this zone formed a porous channel along which solutions could ascend, and the limestone was a reactive rock by which solutions might be neutralized.

The Queen Creek mine has prospected this contact to a depth of 800 feet on the dip of the vein.

In the central and southern parts of the area, mineralization, if present, is weak at the surface.

**Escabrosa ore horizon:** The second and most important ore horizon in the area is the top 20 to 25 feet of the Escabrosa limestone. As no structural evidence was found to explain why this horizon should be favorable to ore deposition, the limestone was host to mineralization presumably because of its chemical composition. This favorable zone, locally known as the “Big Ledge,” is continuous from the northern to the southern part of the area.

The ore occurs as shoots along intersections of the stronger east-west faults with the chemically favorable beds. The ore bodies are irregular, in places pinching to mere seams and elsewhere widening to 20 or 25 feet. Their outcrops are characterized by iron and manganese oxides. The Black, West, North, and Main leases are in this horizon.

Apparently the mineralizing solutions rose along the east-west faults through the underlying, chemically unfavorable quartzite and limestone. Upon reaching the favorable beds at the top of the Escabrosa limestone they spread laterally, forming the ore deposits. Because of the eastward regional dip of the beds, these ore bodies dip eastward, which makes mining difficult. Postore faulting of small magnitude has displaced them and made systematic mining almost impossible.

**Oxidation and enrichment:** The ore in these near-surface mines is completely oxidized. Ore minerals are cerargyrite, silver, gold, malachite, and azurite. Wulfenite and sparse vanadinite are present in most of the ore. Cerussite and calcite are common. Fine-grained sandy quartz and massive vein quartz occur as gangue.

Microscopic examination of ore from the mine dumps showed supergene argentite in galena and sphalerite. The amount of enrichment which has occurred is speculative, as an unknown amount of erosion has taken place since the hypogene mineralization.

Chemically, sufficient pyrite was present to yield sulfuric acid and ferric sulfate upon oxidation. This acid in the presence of ferric sulfate attacked argentite, producing silver sulfate. It
also attacked galena and sphalerite, producing lead and zinc sulfate. In a reactive gangue such as limestone, the acid solutions were soon neutralized and the metals precipitated as carbonate. Chlorine, which is present in most arid regions, would precipitate the silver as the chloride, cerargyrite.

The wulfenite and vanadinite are thought to have been derived by oxidation of minute amounts of molybdenum and vanadium contained in the primary ore.

BELMONT MINE

History: In 1913 the Calumet and Arizona Mining Company obtained an option on many of the claims in the Belmont area. With John C. Greenway in charge, the Belmont shaft was sunk to the 700 level and about 6,000 feet of work was done on the 140, 500, and 700 levels. In 1914 the option was released.

Early in 1923 F. S. Stephen obtained an option on the various claims, which he then turned over to the North Butte Mining Company. This company began exploration in May, 1923. New equipment was installed, the shaft was retimbered to the 700 level, and several thousand feet of drifts and crosscuts were driven on the 140 and 700 levels. Because of disagreement on company policies, the option reverted to Mr. Stephen.

In November, 1924, Stephen organized the South Syndicate, supported by A. Mackay, Captain Thomas Hoatson, and others. This company did some work on the 500 and 700 levels but found only highly oxidized ore of low grade.

In February, 1925, the Belmont Copper Mining Company was formed and obtained the option held by the South Syndicate. The Belmont company first worked on the 700 level, then deepened the shaft to the 1,600 level. Work was done on the 1,000, 1,150, 1,450, and 1,600 levels. Development by this company totaled 16,000 feet of drifts and crosscuts, 1,000 feet of raises and winzes, 922 feet of shaft, and about 50,000 feet of diamond drilling. The three companies did about 30,000 feet of development in addition to the diamond drilling.

In 1928 a small flotation mill was constructed on the Belmont property. It treated about 4,000 tons of galena and gold-silver ore. As the known ore bodies were small, it was soon closed.

The present holdings of the Belmont Copper Mining Company include one hundred twenty claims, of which twelve are patented. No development is being done at the Belmont mine below the 140 level. The shaft is flooded to the 700 level, and the 500 level station is caved. Present production is by lessees, principally from the Main, North, and West leases. Intermittently, some work is done on the 140 level by the Belmont Copper Mining Company.

Production: During 1926 and 1927, 200 tons of ore, averaging 50 oz. Ag, 0.35 oz. Au, 2% Pb, and 3% Zn, were mined on the 1,150 level. In 1928 the small mill near the Belmont shaft treated
3,327 tons of ore which averaged 4 oz. Ag and 0.04 oz. Au. In 1931 C. H. Smith, lessee, shipped 270 tons of ore, averaging 6% Cu and 1 oz. Ag from the 165 sublevel. In the same year he also mined and shipped from the 140 level 30 tons which assayed 38% Pb, 2% Cu, 11 oz. of Ag, and 0.06 oz. of Au.

Lessees have been actively mining on the property only since 1934. Total production from 1934 to 1938, inclusive, was recorded by the Belmont Copper Mining Company as follows:

<table>
<thead>
<tr>
<th>Lease</th>
<th>Tons</th>
<th>Gross value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main</td>
<td>9,637</td>
<td>$101,048</td>
</tr>
<tr>
<td>North</td>
<td>3,388</td>
<td>43,639</td>
</tr>
<tr>
<td>West</td>
<td>3,033</td>
<td>22,890</td>
</tr>
<tr>
<td>Others (6)</td>
<td>2,000</td>
<td>17,147</td>
</tr>
<tr>
<td>Total</td>
<td>18,058</td>
<td>$184,714</td>
</tr>
</tbody>
</table>

Production by metals for the period was 211,909 pounds of copper, 217,255 ounces of silver, and 3,422 ounces of gold.

**Ore deposit**: As the deeper workings of the Belmont mine are flooded, the following description is taken from private reports by I. A. Ettlinger.72

Most of the development in the Belmont mine has been along a strong fissure vein, the Eureka. Its outcrop, highly stained with iron and manganese oxides, is just north of the Belmont shaft. Some near-surface gold-silver ore was mined from it, mostly during the early 1900's.

The ores were formed chiefly by replacement of the shattered walls of the Eureka fault zone. Open space filling was not common. On the 1,150 and 1,450 levels the wall rock is shattered diabase, but on the 1,000 and 1,600 levels Mescal limestone blocks occur in the diabase. On the 1,000 and 1,150 levels the vein is developed for several hundred feet along its strike. It ranges from 2 to 5 feet in width and is mineralized by pyrite, chalcopyrite, galena, sphalerite, and argentite. It was from this area that the lead-silver ore previously mentioned was mined. On the 1,450 level the vein was developed for 730 feet along its strike. Here the silver content is lower, but the copper content is higher than on the upper levels. From the 1,450 level of the Belmont mine, the Sandal vein of the Grand Pacific mine is developed for 1,300 feet along its strike. It is a fissure vein from 1 to 5 feet wide. Weak mineralization by base metal sulfides and strong silicification of the diabase walls characterize this structure. On the 1,600 level the Eureka vein is developed for over 2,000 feet along its strike. Mineralization on this level is weaker than on those above. The wall rocks are highly silicified, and the vein contains minor

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72Ettlinger, I. A., Private reports to the Belmont Copper Mining Company, 1927 and 1929.
amounts of pyrite, chalcopyrite, and sphalerite. Mineralization is strongest where both walls are diabase. Westward the vein feathers out and becomes very indefinite; at a point 900 feet west of the shaft it could not be definitely located.

From the above description it is apparent that the Eureka vein shows remarkable zoning, passing from a barren pyrite-quartz vein on the 1,600 level to a galena-silver vein on the 1,150 level within a distance of only 350 feet.

GRAND PACIFIC MINE

**History:** The Grand Pacific claims were located in the early 1900's, and major prospecting began about 1910. Work continued intermittently until shortly after the first World War. Since 1920 little work has been done on the property.

The Grand Pacific Mining Company holds thirty-five claims of which seven are patented. The only available record of production of the Grand Pacific shows that 1,000 tons of ore with a gross value of $50,000 were shipped in 1918. It is believed to have been essentially the total production of the property.

QUEEN CREEK MINE

**History and production:** The claims of the Queen Creek property were located in the early 1900's. Prospecting began in 1916 when the Queen Creek Copper Company was organized by A. Mackay and F. Stephen. The first work, diamond drilling of fissures in diabase, showed mineralization in these fissures to be weak. The main shaft, on the L. S. and A. contact, was started in the summer of 1917 and a year later reached water level at an inclined depth of 800 feet. During 1918-20 drifting was done on the 600 level. Since 1920 the mine has been worked by lessees.
The Queen Creek Copper Company now holds forty-six claims and fractions, five of which are patented. Recent work has been limited to prospecting on the lower levels of the Queen Creek mine and at the Black lease.

Records in the office of the Queen Creek Copper Company give the following production for 1934-38:

<table>
<thead>
<tr>
<th>Location</th>
<th>Tons</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main workings</td>
<td>1,815</td>
<td>$17,340</td>
</tr>
<tr>
<td>Various leases</td>
<td>986</td>
<td>5,074</td>
</tr>
<tr>
<td>Total</td>
<td>2,801</td>
<td>$22,414</td>
</tr>
</tbody>
</table>

Production by metals for the period was 746 ounces of gold, 11,819 ounces of silver, and 7,140 pounds of copper.

Ore deposit: The ore consists of limonite, hematite, quartz, and free gold and silver. The vein outcrop carries considerable iron and manganese oxide. In general the ore occurs in shoots along fissures which cut the Troy-Martin contact transversely. Some ore has been found in the footwall part of the vein, but the best and largest ore shoots are in the hanging wall. This vein has been prospected for a distance of ¼ mile south of Queen Creek, but commercial ore was taken only from the Queen Creek mine and the Baer tunnel.

OTHER PROPERTIES

Three other groups of claims, The Arizona Hancock (four patented claims), the Lobb group (four claims), and the Consolidated Holding Trust (twenty-six claims), lie within the boundaries of the area described in this report. No data were available on their past history, and no work was being done on them at the time of the visit to them.
SERVICES OFFERED BY THE ARIZONA BUREAU OF MINES

(Continued from inside front cover)

5. Semitechnical meetings with miners and prospectors are held throughout the state.

6. The collection and dissemination of statistics relating to the mineral industries of the state.

7. The collecting and filing of all items relating to Arizona mines and minerals that appear in Arizona newspapers and in many technical periodicals.

MAPS OF ARIZONA

The Arizona Bureau of Mines now has available for distribution the following maps of the state:

1. Base map of Arizona in two sheets on a scale of about 8 miles to the inch. This map is strictly geographic, with the positions of towns, railroads, rivers, surveyed lands, national forests, national parks and monuments, etc., indicated in black, and the location of mountains and other topographic features shown in brown. It was issued in 1919 and is sold unmounted for 25 cents.

2. Topographic and highway map of Arizona in one sheet, on the same scale as the base map. It conveys all the information given by the base map and, in addition, shows the highways and carries 100-meter contours. There is a meter-foot conversion table on the map. It was issued in 1933 and is the most complete and up-to-date map of Arizona in print. It is sold, unmounted, for $1.00, or mounted on cloth with rollers at top and bottom for $3.25.

3. Geologic map of Arizona on the same scale as the base map, printed in many colors. It does not show the positions of mines or mineral deposits. It was issued in 1924 and is sold unmounted for $2.50, or mounted on cloth with rollers at top and bottom for $4.75.

4. Base map of Arizona similar to No. 1 but printed entirely in black on one sheet 21 by 26 inches. It was issued in 1940 and sells for 20 cents unmounted.

5. Mineral map of Arizona, 25 by 26 inches. This map consists of a red overprint made on map No. 4 and shows the chief mineral deposits by means of representative symbols. The production figures of the major metals in each district are given, and the total production of each metal for the state is also shown. Roads are also indicated. The map was issued in June, 1941, and sells for 35 cents.

The following unmounted Arizona map may be obtained from the U.S. Geological Survey, Washington, D.C., for $1.00:

Relief map of Arizona on the same scale as the base map, printed in various shades of brown, black, and blue. It was issued in 1925 and looks exactly like a photograph of a relief model of the state.

The Arizona Bureau of Mines is also an agent for the sale of available U.S. Geological Survey Arizona quadrangle sheets. Most of these sell for 10 cents.

Postage prepaid on all maps.

All communications should be addressed and remittances made payable to the Arizona Bureau of Mines, University Station, Tucson, Arizona.
The Arizona Bureau of Mines still has the following bulletins available for free distribution to residents of Arizona. Bulletins not listed herein are out of stock and cannot be procured from the Bureau.

Because of the very heavy demand for bulletins from nonresidents of Arizona, which quickly exhausted stocks, it has become necessary to discontinue sending free bulletins out of the state. Nonresidents may purchase bulletins at the prices quoted, which include mailing charges.

123. Geology and Ore Deposits of the Courtland-Gleeson Region, Arizona, by Eldred D. Wilson. 1927................................................................. .15
125. The Mineral Industries of Arizona, by J. B. Tenney. 1928............. .25
126. Asbestos Deposits of Arizona, by Eldred D. Wilson. 1928............. .25
130. Petroleum, by G. M. Butler and J. B. Tenney. 1931..................... .15
131. Geology and Ore Deposits of the Oatman and Katherine Districts, Arizona, by Carl Lausen. 1931........................................................... .25
134. Geology and Mineral Deposits of Southern Yuma County, by Eldred D. Wilson. 1933................................................................. .50
137. Arizona Lode Gold Mines and Mining, by E. D. Wilson, J. B. Cunningham, and G. M. Butler. 1934......................................................... .50
139. Some Facts About Ore Deposits, by G. M. Butler. 1935.................. .15
140. Arizona Metal Production, by Morris J. Elsing and Robert E. S. Heineman. 1936................................................................. .25
141. Geology and Ore Deposits of the Ajo Quadrangle, Arizona, by James Gilluly. 1937................................................................. .25
143. Geology and Ore Deposits of the Tombstone District, Arizona, by B. S. Butler, E. D. Wilson, and C. A. Rasor. 1938............................ .50
144. Geology and Ore Deposits of the Mammoth Mining Camp Area, Pinal County, Arizona, by Nels Paul Peterson. 1938......................... .25
145. Some Arizona Ore Deposits, by numerous authors. 1938.............. .35
146. Bibliography of the Geology and Mineral Resources of Arizona, by Eldred D. Wilson................................................................. .35
148. Tungsten Deposits of Arizona, by Eldred D. Wilson..................... .25
150. Field Tests for the Common Metals (Eighth Edition), by G. R. Fansett.. .20