History and Minerals of the San Manuel Mine, Pinal Co., Arizona

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45th New Mexico Mineral Symposium
November 7-9, 2025,Macey Center, Socorro, NM
pp.18-21

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Introduction and History

The San Manuel mine is located in south-central Arizona in Pinal County about 45 miles northeast of Tucson. It is near the towns of San Manuel and Mammoth and only about a mile from the famous specimen mines at Tiger. However, even though it is so close to Tiger it could not be more different in almost every respect – history, geology, mineralogy and specimen production.

The first claims were staked at what was to become the San Manuel Mine in the early 1870s but due to its low-grade it would not become a viable mine for almost 70 years. In the late 1930s and early 1940s as hostilities were increasing overseas, the United States was looking for additional sources of strategic metals. In 1939 Congress passed the Strategic Materials Act and directed the US Geological Survey (USGS) and US Bureau of Mines (USBM) to locate additional domestic sources. The USGS identified the San Manuel property as having the potential to be a major, untapped copper deposit.

The USBM initiated a drilling program in late 1943 and by May 1944 results suggested a deposit of at least 30 million tons averaging 0.8% copper. Based on this, the Magma Copper Company optioned the property and began their own drilling program. The results were so encouraging they bought the property in May 1945. By 1951 Magma had proven 479 million tons of ore averaging 0.77% copper. They decided to move forward with mine development and the San Manuel Mine was brought on line in November 1955.

San Manuel became the largest underground mine in North America. Over its 44 year history it produced over 4.6 million tons of copper and 73 tons of molybdenum. At its peak, it provided high paying jobs for 3,400 people and made a significant economic contribution to Arizona. Mining ended in January of 2002 and by 2007 all surface facilities had been removed and the site reclaimed.

Historical “Firsts”

San Manuel played a significant role in several varied and unexpected firsts. One was the town itself which became a prototype of advanced urban design. There was no actual town of San Manuel before the mine. As the mine would be Magma’s new flagship operation, they wanted an equally impressive and efficient community to go with it and they wanted it quickly. To accomplish this, they selected a contractor with extensive, recent experience building new bases for the military. The entire town including homes, stores, schools, parks, recreational and medical facilities plus streets and other infrastructure was completed in 1954. The contractor was Del E. Webb and San Manuel was his first master planned *residential* community. But it was certainly not his last. He went on to repeat and refine his master planned communities with spectacular success all across the American sunbelt from Florida to California.

San Manuel was also the inspiration for a new geologic understanding of porphyry copper deposits. A large, low-angle fault had cut the San Manuel orebody into two pieces and no one knew the location of the upper portion. However, an independent geologist in Tucson, J. David Lowell, believed that he could find it. He had been underground at San Manuel and observed alteration patterns and mineral assemblages in the rocks around the orebody.

He thought he recognized the same patterns in surface rocks he had mapped about a mile west of the mine. Using this information, he led a drilling program that accurately located the missing orebody at a depth of 2,500 feet. It identified an additional 560 million tons of ore averaging 0.72% copper. Lowell went on to work with University of Arizona professor J. M. Guilbert to develop a new geologic model for locating buried porphyry copper deposits (Lowell and Guilbert, 1970). Today, over 50 years later, their model is still used for exploration and research into porphyry deposits worldwide.

Mining Methods

Several methods were employed to mine the San Manuel orebodies: underground block caving for the deeper sulfide ores and open pit and heap leaching for the shallower oxide ores. In-situ leaching was also used for some of the deeper oxides later in its history. One of these, block caving, is of particular interest for mineral collectors because it prevented access to much of the orebody and made specimen recovery almost impossible. For that reason, a brief explanation of the process is warranted.

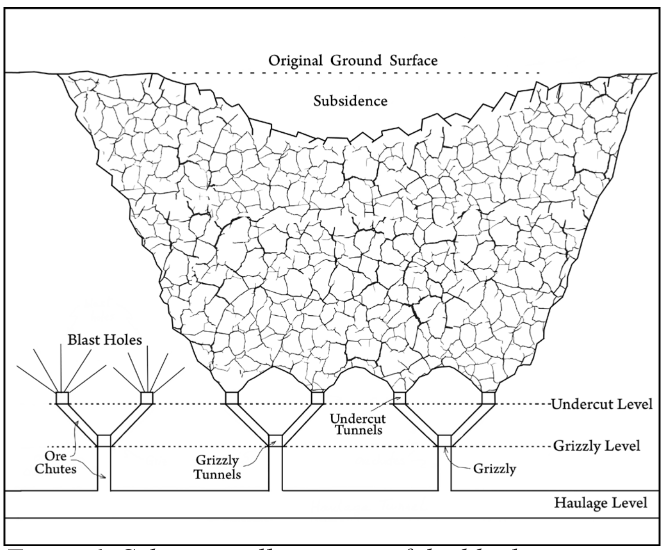

Figure 1. Schematic illustration of the block caving mining method used at the San Manuel Mine.

The block caving mining method is highly complex to implement but its basic concept is simple: undercut the orebody by using explosives to shatter an entire layer of rock at its base. Remove the shattered rock and the rock immediately above it is destabilized and collapses. As long as the shattered rock is removed, the overlying rock will continue to destabilize and collapse progressing upward through the overlying orebody. The process may progress to the point that it results in land subsidence at the surface.

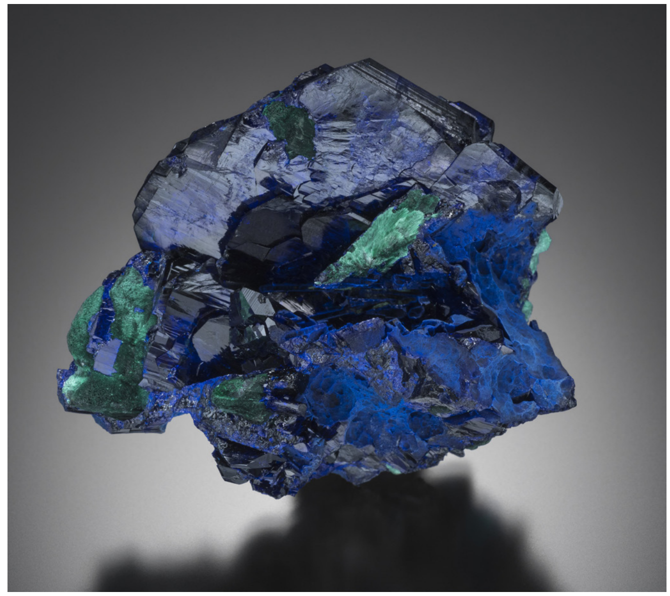

Figure 2. Azurite overgrowth on malachite pseudomorph after azurite, 5.2 cm. San Manuel Mine, Pinal Co., AZ. Private collection. Jeff Scovil photo.

Figure 3. Calcite crystals to 7 mm with cuprite inclusions. San Manuel Mine, Pinal Co., AZ. Garry Alexander collection. Jeff Scovil photo.

Minerals

Forty-nine species have been identified from the San Manuel mine (Table 1) and at least twenty of them occur in sufficient quality to be of interest to collectors. As might be expected, the open-pit excavation in the oxide zone produced many of the mine's best specimens but many were recovered from the underground as well. Most of these came from areas worked by conventional methods including the numerous tunnels, raises, work rooms and other areas where people were in close proximity to freshly exposed rock and could collect specimens. Surprisingly, though the block cave mining was definitely not favorable to specimen recovery, some did indeed survive.

Figure 4. Copper crystals,11.1 cm. San Manuel Mine, Pinal Co., AZ. Les and Paula Presmyk collection. Jeff Scovil photo.

Conclusion

San Manuel was the source of several innovative and historical firsts. The town was the first master planned residential community designed by Del E. Webb. Its success led him to build other residential communities throughout the American sunbelt. Additionally, characteristics and challenges specific to the San Manuel orebody inspired J. David Lowell to develop a new geologic model of porphyry copper deposits that significantly advanced the science of economic geology and is still the basis for the exploration for porphyry deposits.

Figure 5. Gypsum crystals with azurite and chrysocolla inclusions,7.6 cm. San Manuel Mine, Pinal Co., AZ. Evan Jones collection. Jeff Scovil photo.

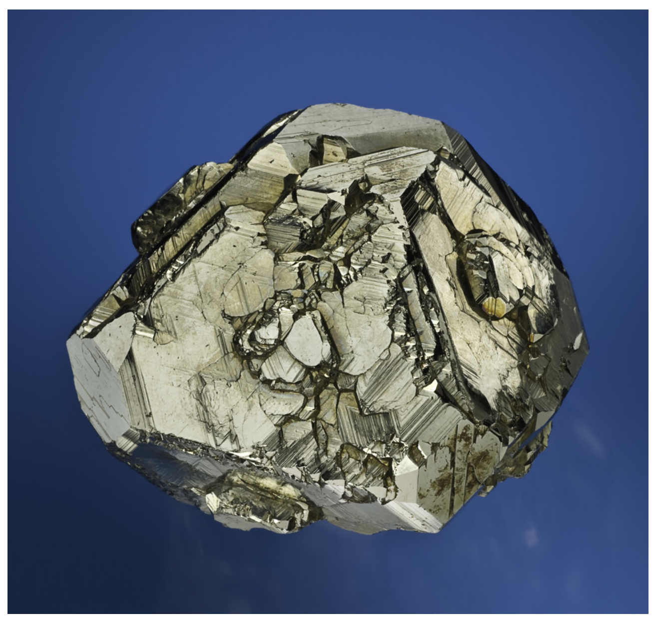

Figure 6. Cuboctahedral pyrite crystal,10.4 cm. San Manuel Mine, Pinal Co., AZ. Garry Alexander collection. Jeff Scovil photo.

Albite*	Allophane	Alunite	Anhydrite
Atacamite	Azurite*	Barite*	Beidellite
Bornite	Calcite*	Chalcocite	Chalcopyrite*
Chrysocolla*	Clinozoisite	Conichalcite	Copper*
Covellite	Cuprite*	Dickite	Dioptase*
Enargite	Endellite	Epidote	Epsomite
Fluorapatite	Galena (?)	Goethite	Gold
Gypsum*	Hematite	Hexahydrite	Jarosite*
Jurbanite (type locality)	Kaolinite	Libethenite*	Malachite*
Molybdenite*	Muscovite	Plancheite*	Pyrite*
Pyrophyllite	Quartz*	Rutile	Shattuckite
Siderite*	Sphalerite*	Starkeyite	Tenorite*
Zunyite			

Table 1 – Species identified from the San Manuel Mine (an asterisk indicates the mineral occurs in collector quality material).

For the mineral collector, the San Manuel mine was not extraordinarily productive of specimens, mainly because the primary mining method prevented access to so much of the orebody. But the parts of the mine outside the block cave areas produced a wide variety of beautiful and interesting collector-grade specimens.

References

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