MINERALS OF ARIZONA

Twentieth Annual Symposium

Sponsored By
Flagg Mineral Foundation
Saturday April 14, 2012

Co-Chairpersons
Phil Richardson - Chair, Flagg Mineral Foundation
Ray Grant - President, Mineralogical Society of Arizona

Minerals of Arizona

Twentieth Annual Symposium

Sponsored by the Flagg Mineral Foundation

Friday, Saturday, and Sunday
April 13, 14, and 15, 2012

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Celebrating
One Hundred Years of Arizona Statehood
Fifty Years for the Flagg Foundation
Twentieth Minerals of Arizona Symposium

Clarion Hotel at Phoenix Tech Center
5121 E. La Puente Ave, NW corner of Elliot Rd and Interstate 10.

Friday, April 13 – Dealers selling at the Clarion 5 to 10 PM

Saturday, April 14 – Symposium Program

8:00 - 8:45 -	**Coffee Hour**
8:45 - 8:50 -	**Welcoming Remarks and Introductions**
	Arizona Localities
8:50 – 9:30–	Minerals of Washington Camp and the Patagonia Mountains – Barbara Muntyan
9:30 – 10:10 -	Geology, Mines, and Minerals of the Tombstone Area– Jan Rasmussen
10:10 – 10:40 -	**Break**
10:40 – 11:20 -	Gemstones of Arizona – Wolfgang Mueller
	Arizona Mineral History
11:20 – 11:50 -	The Mineralogy of Arizona: Past, Present, and Future – Raymond Grant and Marcus Origlieri
11:50 – 1:10 -	**Lunch and silent auction**
1:10 – 1:50 –	History and Development of Mining in Arizona before Statehood (1912) – Jim McGlasson
1:50 – 2:30 -	Arizona - 100 years of Collecting - Les Presmyk
2:30 – 3:00 -	**Break**
3:00 – 3:40 –	Celebrating 40 years of Mineralogy at the Arizona - Sonora Desert Museum - Anna Domitrovic
3:40	Arizona Territory mineral treasures and "mysteries" in the Vaults of the Yale Peabody Museum – Stefan Nicolescu
4:30 - 5:30	Dealers selling in rooms
5:30 - 6:30	Social Hour

Saturday, April 14

6:30 **Evening Buffet** Keynote Speaker – Bob Jones, topic "Formation of Mexico's Giant Selenites."

Auction to support the Earth Science Museum.

Sunday, April 15

Field trip to Reymert mine, Superior, Arizona

Appendices:
Symposium History and Index
Flagg Foundation History

Cover Design: Harvey Jong

Cover photo captions and credits

Upper left photo: Quartz, Japan-law Twin, Holland mine,
Washington Camp, Santa Cruz County, Arizona
Flagg Mineral Collection specimen
Jeff Scovil photo

Upper right photo: Turquoise nugget, Bisbee, Cochise County, Arizona
Brent Weller specimen
Roger Weller/Cochise College photo

Lower left photo: Dugganite, Empire mine, Tombstone District,
Tombstone, Cochise County, Arizona
Peter Megaw specimen
Sugar White photo

Lower right photo: From postcard picture in public domain
Morenci, Arizona circa 1910
Real Photo postcard
Downloaded from commons.wikimedia.org

THE MINES AND MINERALS OF WASHINGTON CAMP

Barbara L. Muntyan
Tucson, Arizona

The Washinton Camp/Duquesne mining area, located in the Patagonia Mountain range in Santa Cruz County, is noted for unusually large, very well-formed crystals formed by a number of species including quartz, pyrite, chalcopyrite, galena, sphalerite, calcite, rutile and andradite garnet. Some crystals have been reported as much as 10" in length. Crystals of 2" – 3" on edge are not uncommon.

The Patagonia mountains are encompassed by four mining districts; the two on the north and east side of the range – the Harshaw and Patagonia mining districts – are home to big mines like the Flux, the Trench, the Hardshell, and those of Washington Camp-Duquesne (Holland, Empire, North Belmont, South Belmont, Kansas, and Santo Nino). Originally mined during the nineteenth century as lead-silver deposits, some of these mines also contained copper mineralization at depth. The last of the mines of the area closed down in the 1960s.

This area is well-known to mineral collectors for the many beautiful examples of fine crystals, especially Japan law twinned quartz from Washington Camp, big amethyst sceptered crystals from the Santo Nino and Duquesne, fine pseudomorphs of hissingerite after pyrite, clusters of chlorite-included quartz crystal sprays, and pseudomorphs of quartz after calcite. Specimens of azurite are also known. ↳ iron silicate (HF to clean)

For the most part, the mines of Washington Camp/Duquesne have been easily accessible by graded dirt roads within the Coronado National Forest. From the 1970s until quite recently, mineral collectors were able to extract fine specimens from surface outcrops and infrequent forays into some of the underground workings. However, border problems, deteriorating roads and gating-off of previously accessible areas has reduced collecting to a mere trickle. The minerals specimens are still there; they have unfortunately become much more difficult and dangerous to obtain.

HOLLAND, EMPIRE, BELMONT, DUQUESNE, BONANZA
KANSAS, SANTO NINO

References:

Schrader, F.C. USGS Bulletin 582. Mineral Deposits of the Santa Rita and Patagonia Mountains.

Geology, Mines, and Minerals of Tombstone

Numerous episodes of mountain building and sedimentation have left a record in the rocks of the Tombstone Hills. The oldest rocks there are the phyllites and metarhyolites of the Pinal Schist, which was dated at 1,695 Ma in the nearby Little Dragoon Mountains (Silver, 1967). It is intruded by granite, which may be similar to the granite dated at 1,420 Ma in the nearby Little Dragoon Mountains (Silver, 1978). The Precambrian rocks are unconformably overlain in the Tombstone Hills by a thick sequence of Paleozoic quartzite, limestone, and siltstone ranging in age from Cambrian (about 500 Ma) through Permian (about 250 Ma). These sedimentary rocks generally are excellent hosts to mineralization, as the limestones are reactive and the more resistant quartzites fracture easily under tectonic stress and provide pathways for veins and mineralization.

The Laramide orogeny (85-43 Ma) is represented in the Tombstone Hills by three structural and two igneous-mineralization types. The east-west faulting that uplifted Government Butte was emplaced early in the Laramide and may be related to early movement on the Prompter fault. The silver mineralization in the main district was emplaced in association with northeast structures and caldera volcanism and intrusive rocks (74 Ma). A later intrusion of quartz monzonite porphyry and rhyolite (63 Ma) in the northern and eastern Tombstone Hills is of the same age and style as porphyry copper mineralization elsewhere in southern Arizona (Wilt, 1993).

The principal past production from the Tombstone mining district has been silver (Ag) from high grade veins associated with the intersection of north-northeast-striking fissures and andesite dikes with the fractured crests of northwest-trending anticlines (Butler and others, 1938). Silver mineralization has been dated at 74.5 million years ago (Ma) and alteration at 72 Ma (Newell, 1974). It is probably related to the intrusion of the Schieffelin Granodiorite and associated tuff, the Uncle Sam Tuff, which have been dated at 76 Ma and 73.5 Ma (Creasey and Kistler, 1962; Marvin and others, 1973). A later period of mineralization could be associated with the Tombstone rhyolite, dated at 66.6 Ma (Marvin and Cole, 1978) or 63 Ma (Newell, 1974) and the associated Extension/Comstock quartz monzonite porphyry in the eastern part of the Tombstone district, dated at 62.8 ± 2.6 Ma (Drewes and others, 1985).

The first mining claim in the Tombstone district was located in 1857 (Butler and others, 1938), but mining did not commence until prospector Ed Schieffelin located rich Ag deposits at Tombstone in 1877. Development and mining in the Tombstone district then boomed (Tenney, 1929), with approximately 167 mine names in the district (MinDat.org, 2011). Oxide ores were mined from above the water table in the early years, but water plagued the district from the beginning. A lack of sufficient water in the early years meant the first mills at Tombstone were built along the San Pedro River, 9 miles to the west, which incurred high transportation costs. The situation reversed in March 1881 when water was encountered in the Sulphuret mine at a depth of 520 ft. Pumping was initiated in 1884 to dewater the mines and was successful for 3 years until fire destroyed the pumps. Coupled with low Ag prices at that time, many mines were forced to close. In 1900, the larger mines in the eastern part of the district were consolidated into the Tombstone Consolidated Mining Company. With new, larger pumps, mining operations below the water table resumed. In 1911, the pumps failed once more, the lower levels were allowed to flood, and mining by the Tombstone Consolidated Mining Company ceased. The smaller mines continued mining above the water table for several years, but by 1918 most of the mines were operated by lessees. By 1911, the rich deposits above the water table were depleted and Ag prices had declined to $0.50 per oz.

The price of Ag had the greatest effect on the success and failure of the Tombstone mines (Devere, 1978; 2010; Bailey, 2004). Most of the ore was produced during the 38-year period from 1877 to 1915, during which silver prices declined, financial panics ensued, and the United States currency was removed from the silver standard. In 1911, the silver price of $0.55 per ounce was less than half that in effect when Schieffelin discovered Tombstone. In 1914, the Phelps Dodge Corp. began mining under the name of Bunker Hill Mines Company, concentrating on the lower grade Mn-Ag ores at shallower depth above the

water table until 1933. With the repeal of the Pittman Act in 1923, the price of Ag plummeted and the mines closed (Table 1).

Between 1980 and 1985, Tombstone Exploration, Inc. operated an open pit mine on the Contention vein, and produced up to 3,000 tons per day of ore averaging approximately 1.25 ounces Ag and 0.02 ounces Au, recovered by cyanide leaching. Graves (1985) reported that 2 million ounces of Ag and 10,000 ounces of Au were produced in the period from 1970 to 1985, mostly from the TEI open pit operation, and in a small part by the Partnership mine dump consolidation (Greeley, 1984).

Stanton Keith (1973) concluded that through 1970 the total value of Tombstone production exceeded $38.8 million. Keith stated that through 1970, the Tombstone mining district produced not less than 1.5 million tons of Ag-bearing ore, either with Pb or Mn. He calculated that the yield between 1879 and 1970 was approximately 1.5 thousand tons of Cu, 22.5 thousand tons of Pb, 9,000 tons of Mn ore shipped during war years, 590 tons of Zn, 240 thousand ounces of Au, and 30 million ounces of Ag. He estimated that by 1890 over one-half the total Tombstone district Ag production had been extracted. A more recent production history was summarized by Stanley B. Keith (2002) (Table 2).

Museum quality specimens of minerals from Tombstone are rare, but the unusual telluride and chloride minerals are interesting. The Tombstone ores were mainly silver chloride varieties, with a little Pb and some telluride ore. Hypogene silver-bearing minerals included hessite, tetrahedrite, and galena (Rasor, 1937). Tellurates were described by Williams (1978). Alabandite was found to be the only definitely hypogene manganese mineral, although hollandite, psilomelane, and cryptomelane also occur. Bromargyrite, embolite, cerargyrite, argentite (acanthite), stromeyerite, native silver, native gold (Butler and others, 1938), and argentojarosite were identified as supergene ore minerals. The zone of oxidation was thought to be at least 600 ft deep (Rasor, 1937; 1939), and bromargyrite was believed to be the most abundant supergene silver mineral. High concentrations of manganese were associated with the Prompter fault, and the principal Mn production was derived from the Oregon, Prompter, Lucky Cuss, Luck Sure, Bunker Hill, and Comet mines (Wilson and Butler, 1930). Psilomelane, the major manganese mineral, typically occurred in pipes and chimneys in limestone horizons. Principal minerals are listed in Table 3.

Table 1 Production history, Tombstone mining district

Period	Price of Silver (USD)	Production	Remarks
1877–80	1.15 – 1.20	$2,318,567	Discovery and early development. Mills built on San Pedro River.
1881–86	0.99 – 1.14	16,877,175	Active development and large production. Water encountered in mines in 1882, and mills built at Tombstone.
1887–96	0.63 – 1.05	4,564,650	Decreased production due to depletion of many of the large ore bodies above water level.
1897–1911	0.52 – 0.68	5,575,900	Consolidation of principal properties and attempted de-watering of district by a 1,000-foot pump shaft.
1912–14	0.553 – 0.615	379,917	Lessee operations.
1915–17	0.507 – 0.824	1,117,687	War period. Considerable production of manganiferous silver ore and concentrates.
1918–32	0.282 – 1.12	5,150,789	Mainly lessee operations. Production of silver during 1918 –22 stimulated by Pittman Act.
1933–36	0.35 – 0.77	1,118,325	Production stimulated by increased price of gold and silver.

Source: Butler and others, 1938, p. 39; Note: USD = United States dollars

Table 2 Estimated mine production, Tombstone district

Mineral System/ Synonym (Mineral Zone)	Production Period (years)	Ore (short tons)	Au (oz)	Ag (oz)	Cu (lb)	Pb (lb)	Zn (lb)
Argenta	1922-1924	184	10	3,539	1,225	206	
Bunker Hill	1889-1931	382,330	32,404	4,407,706	2,963,902	7,461,919	45,192
Contention	1880-1885	98,252		5,240,721			
Contention/ Grand Central	1881-1950	306,090	7,815	5,377,798	286,771	6,345,686	
Galvez	1910-1924	295	81	4,382	2,149	1,796,733	
Good Enough	1884-1913	174,603	7,560	5,367,114	21,109	1,560,100	
Herschel	1905-1935	11,430	2,060	320,085	48,068	1,167,270	
Ingersol	1922-1932	1,359	378	39,273	11,689	227,393	
Lucksure	1905-1918	2,324		24,817	1,445		
Old Guard	1905-1935	2,644	383	59,516	61,574	186,887	
Rocky Bar	1920-1924	510	7	17,954	2,497	91	
Soltice	1914-1940	475	107	20,761	841	133,865	
State of Maine	1921-1950	30,343	9	104,696		2,667	
Sunset	1919-1927	419	3	11,443	5,644	10,458	
Tombstone Extension	1930-1954	26,680	1,308	222,106	90,930	14,304,882	
Tombstone Group	1903-1957	451,927	64,302	4,907,169	3,879,915	13,566,470	214,517
Toughnut-Empire	1879-1936	108,697	4,006	4,260,112	32,850	1,222,400	
Vizina	1880-1891	12,726		517,079			
Tombstone (combined)[1]		2,677,138	240,844	25,926,156	5,354,277	107,085,538	2,141,711
Tombstone (combined)[2]	1879-1981	2,953,296	131,468	32,076,966	7,763,447	49,854,350	555,527

Source: [1]Singer (1993); [2]Keith (2002)

Table 3 Principal minerals of the Tombstone mining district

Native elements	Sulfides	Haloids	Oxides	Carbonates	Sulfates
sulfur	galena	cerargyrite	quartz	calcite	barite
tellurium	argentite	bromargyrite	cuprite	rhodochrosite	anglesite
gold	chalcocite	embolite	tenorite	cerussite	jarosite
silver	sphalerite	fluorite	hematite		plumbojarosite
copper	alabandite		magnetite		
	covellite		hetaerolite		
	bornite		polianite & pyrolusite		
	chalcopyrite		manganite		
	pyrite		psilomelane		

Source: www.mindat.org (accessed 2011)

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The Gemstones of Arizona, from A to Z

Wolfgang HT Mueller
DiWolf—Fine Stone Emporium
Oracle, Arizona

With the 100th anniversary of Arizona statehood on February 14, 2012 almost everything Arizona is being celebrated, including its very abundant gemstones. Natural materials have been used for personal adornment for at least 10,000 years, and include shell, bone, and stone (argillite, claystone, copper and sandstone). The use of turquoise goes back about 1500 years.

Arizona is one of the major producers of gemstone materials in the US. This is in large part due to the proliferation of Arizona's mines, especially its world-class copper mines. Gem minerals have formed both from primary emplacement and from the weathering and alteration of orebodies.

The most famous and/or abundant gemstones include: quartz, agate, jasper, azurite, "campbellite" (a mixture of copper minerals), chrysocolla, copper, fire agate, garnet, gem-grade chrysocolla, magnesite, malachite, obsidian ("apache tears"), peridot, petrified wood, shattuckite and turquoise. For discussion purposes the gemstones can be divided into six groups: (1) the quartz family, (2) the metals, (3) the "classics," (4) the leftovers, (5) the manmade materials, and (6) those to beware and be aware of. This introduction to the great variety of Arizona gemstones will touch on the highlights, the major or famous locations as well as a cross section of the lesser known gemstones.

There are literally hundreds of gemstone locations throughout Arizona, from large to almost unrecognizable. Gemstones can be found almost anywhere in the state. Ten locations throughout the state are highlighted. The largest quartz group region is in the Petrified Forest area around Winslow, Holbrook, and the Petrified Forest National Park. Don't even think of collecting in the park; it is illegal. The second largest is the Burro Creek area west of Bagdad. The remaining eight are copper mining camps: Ajo, Bagdad,

Bisbee, Clifton/Morenci, Globe/Miami, Jerome, Kingman-Mineral Park, and Ray.

Arizona's major economic gemstones are fire agate, gem-grade chrysocolla, peridot, petrified wood, and turquoise, "the big five." Of these, turquoise is undoubtedly the best known, made famous by its extensive use in Native American jewelry. There is an Arizona Gemstone list online at www.diwolf.com, listing gemstones, gem materials, and brief location information.

Mineralogy of Arizona, Past, Present and Future

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In the last 143 years there have been twelve efforts to compile a complete list of Arizona minerals. In that time the list of minerals found in Arizona has grown from 18 minerals to about 890 minerals. The first published list was made by William P. Blake (1866) and was part of a report for California and Arizona. In 1909, Blake published the first complete work on Arizona minerals titled Minerals of Arizona. From 1895 to 1910 he was a professor of geology and mining and the Director of the School of Mines at the University of Arizona. In 1898 he also became the territorial geologist of Arizona. A year later, in 1910, Frank N. Guild authored The Mineralogy of Arizona. Guild was a professor of chemistry and mineralogy at the University of Arizona. In 1941, Frederic W. Galbraith, chairman of the Department of Geology at the University of Arizona and curator of the Mineral Museum, authored Minerals of Arizona as Arizona Bureau of Mines Bulletin 149. He wrote a revised edition six years later. A third edition of Minerals of Arizona was published in 1959 in which Daniel J. Brennan, was coauthor with Galbraith. The next series of mineralogies for Arizona were the three editions of the Mineralogy of Arizona by Anthony, Williams, and Bideaux with Grant added on the third edition. The first edition was published in 1977, the second in 1981 and the third in 1995. In this publication, the total number of mineral species found in Arizona was 808. Over eighty additional species have been reported from Arizona since the 1995 edition.

There are seventy-three type or co-type minerals (they were first found in Arizona). For the type minerals of Arizona, forty-nine are named for people, and seventeen are named for the locality where they were found. The other seven are named for their chemistry, a physical property, or some combination of

names. Here are some examples of the origins of the Arizona type mineral names. The ones named after localities are mostly after cities, counties, or the mines where they were found. Wickenburgite, ajoite, and flagstaffite are examples of minerals named after cities. Maricopaite, yavapaiite, pinalite, gilalite, and coconinoite are named after the counties in which they were found. Grandreefite, antlerite, and coronadite were named after mines. Wupatkiite, one of Arizona's newer minerals was named after the National Monument. Most of the people who had minerals named after them were geologists, mineralogists, mineral collectors, or miners. Some minerals named after people are andersonite, artroeite, bermanite, bideauxite, coesite, graemite, henryite, junitoite, luddenite, ruizite, and shannonite. Apachite, papagoite, and navajoite were named after indian tribes. Chalcoalumite and cuprotungstite are named for their chemistry and the names hemihedrite, cryptomelane and paramelaconite are related to something about their physical appearance. Calcioaravaipaite is named for chemistry and the locality in the Aravaipa mining district. There are several additional type minerals from Arizona approved by the IMA, but not published at present.

At present we are working on a new edition of the Mineralogy of Arizona. Our plan is to have it published in the next few years. This is a request for information about minerals and localities in Arizona that should be included in the Mineralogy of Arizona.

Blake's 1909 list of Arizona Minerals, present species name in brackets .

Agate (=quartz)
Alabandite
Alum (=alum-K?)
Alunite
Amphibole
Aurichalcite
Azurite
Anglesite
Antimony Glance (=stibnite)
Argentite
Asbestos (=chrysotile)
Barite
Bismutheninte (=bismuthinite)
Bismuth
Bournonite
Barnhardite (=chalcopyrite and chalcocite mixture)
Bornite
Brochantite
Calamine (=hemimorphite)
Calcite
Caliche (=calcite)
Ceraryrite (=chlorargyrite)
Cerussite
Chalcanthite
Chalcedony (=quartz)
Chalcocite
Chalchuite (=turquoise)
Chalcopyrite
Chrysocolla
Chrisolite (=olivine)
Chrysotile
Cinnabar
Coal (not a mineral)
Copper-pitch ore (mixture)
Cobalt (=erythrite)
Copiapite
Copper
Coronadite
Cuprite
Cuprotungstite
Cyanite (=kyanite)
Derbyshire Spar (=fluorite)
Des Cloizite (=descloizite)
Diamond
Diaspore
Diatomite (=quartz)
Diopside
Dioptase
Dumortierite
Electrum (=gold)
Endlichite (=vanadinite)
Epidote
Erythrite
Felsite (=volcanic rock)
Fluorite
Footeite (=connellite)
Galenite (=galena)
Garnet (=pyrope and andradite)
Glauberite
Gerhardite
Gold
Grossularite (=grossular)
Halite-Rock Salt
Hematite
Hubnerite
Hyalite (=opal)
Ilmenite
Infusorial Earth (=quartz)
Iodobromite (=bromargyrite)
Iodyrite (=iodargyrite)
Iron
Jarosite
Kaolin (=kaolinite)
Libethenite
Limonite (=goethite)
Linarite
Magnetite
Malachite
Manganese (=various Mn-oxides)
Marble (=calcite)
Melanochalcite (mixture tenorite and other copper minerals)
Melanterite
Melanochalcite (listed twice)
Mirabilite-Glauber Salt (=mirabilite)
Molybenite
Molybdite
Morencite (=nontronite)
Muscovite
Nitre
Onxy Marble (=calcite)
Opal
Peridote (=forsterite)
Polybasite
Pyrite
Pyrolusite
Pyrrhotite
Pyromorphite
Quartz
Quicksilver (=mercury)
Salt (=halite)
Scheelite
Selenite (=gypsum)
Sericite (=muscovite)
Siderite
Silicified Wood (=quartz)
Silver
Silver Glance (=argentite)
Smithsonite
Sphalerite
Spangolite
Specular Iron (=hematite)
Stibnite
Stromeyerite
Tenorite
Tetradymite
Tetrahedrite
Thenardite
Topaz
Tourmaline
Troilite
Tremolite
Trona
Tungstite
Turquois (=turquoise)
Vanadinite
Vermillion (=cinnabar)
Willemite
Wolframite
Wulfenite
Zinc (=zinc bearing minerals)
Zinkenite

Guild's 1910 list of Arizona Minerals, present species names in brackets.

Actinolite
Agate (=quartz)
Alabandite
Alunite
Amethyst (=quartz)
Amphibole
Andalusite
Anglesite
Apatite
Aragonite
Argentite
Arizonite (mixture)
Arsenic
Asbestos
(=chrysotile)
Atacamite
Augite
Aurichalcite
Azurite
Antimony Glance
(=stibnite)
Barite
Biotite
Bornite
Bournonite
Brochantite
Calamine
(=hemimorphite)
Calcite
Caliche (=calcite)
Cement Clay
(unknown clay)
Ceraryrite
(=chlorargyrite)
Cerussite
Chalcanthite
Chalcedony
(=quartz)
Chalcocite
Chalcophyllite
Chalcopyrite
Chalcotrichite
(=cuprite)
Chrysocolla
Chrisolite
Chrysoprase
(=quartz)
Chrisotile (=olivine)
Cinnabar
Clay

Cobalt Bloom
(=erythrite)
Cobaltite
Cohenite
Colmanite
Connellite
Copiapite
Copper
Copper Glance
(=chalcocite)
Copper Pitch Ore
(mixture)
Coronadite
Covellite
Crocoite
Cuprite
Cuprodescloizite
(=mottramite)
Cyanite (=kyanite)
Dannemorite
(=amphibole)
Descloizite
Diamond
Diatomaceous
Earth (=quartz)
Dolomite
Domeykite
Dioptase
Dumortierite
Ecdemite
Embolite
(=bromargyrite)
Emmonsite
Epidote
Epsomite
Erythrite
Ettringite
Feldspar
Flint (=quartz)
Fluorite
Footeite
(=connellite)
Gadolinite
Galenite (=galena)
Garnet (=andradite,
pyrope, and
spessartine)
Gerhardite
Glauberite
Gold

Groslarite
Graphite
Graphitic Clay
(=unknown clay)
Gypsum
Halite
Heavy Spar
(=barite)
Hematite
Hessite
Hornblende
Hubnerite
Hyalite (=opal)
Ice
Iodobromite
(bromargyrite)
Iodyrite (=iodgyrite)
Iron
Iron Pyrites
(=pyrite)
Jasper (=quartz)
Jarosite
Kaolin (=kaolinite)
Leadhillite
Lettsomite
(=cyanotrichite)
Libethenite
Limestone (=calcite)
Limonite
(=goethite)
Linarite
Magnetite
Malachite
Marble (=calcite)
Meteoritic Iron
Mexican Onyx
(=calcite)
Mica
Microcline
Mimetite
Mirabilite
Molybdenite
Molybdite
Morencite
(=nontronite)
Muscovite
Nitre
Nitrocalcite
Olivine
Onxy Mexican

(=calcite)
Opal
Orthoclase
Peridote (=fosterite)
Petrified Wood
(=quartz)
Plagioclase
Platinum
Polybasite
Proustite
Pyrargyrite
Pyrite
Pyrolusite
Pyrope
Pyroxene
Quartz
Rhodochrosite
Scheelite
Schreibersite
Semi-opal (=opal)
Sericite
(=muscovite)
Serpentine
Siderite
Silver
Silver Glance
(=argentite)
Spangolite
Specular Iron
(=hematite)
Sphalerite
Stromeyerite
Sulfur
Talc
Tenorite
Tetradymite
Tetrahedrite
Thenardite
Topaz
Tourmaline
Tremolite
Turquoise
Vanadinite
Vauquelinite
Vesuvianite
Willemite
Wolframite
Wollastonite
Wulfenite
Zircon

Preliminary list of mineral species added to the Arizona list since 1995.

Abernathyite
Alum(Na)
Anilite
Annabergite
Arsendescloizite
Ashburtonite
Babingtonite
Bandylite
Bechererite
Bonattite
Boothite
Brushite
Bustamite
Calcioaravaipaite
Calderonite
Carmichaelite
Clinoatacamite
Coloradoite
Crichtonite
Cumengite
Cuprocopiapite
Eriochalcite
Ferrohexahydrite
Ferrohornblende
Ferroselite
Ganomalite
Georgerobinsonite
Glaucocerinite
Glushinskite
Glaucodot
Gordaite
Grandviewite
Herbertsmithite
Hopeite
Hydroglauberite
Hydrohonessite
Jacobsite
Jokokuite
Kamitugaite
Kentrolite
Kieserite
Kinoshitalite
Lansfordite
Likasite
Liroconite
Loveringite
Markascherite
Mcgunnessite
Meionite
Milarite
Molybdite
Monohydrocalcite
Montanite
Montroydite
Munakataite
Namibite
Natrodufrenite
Nesquehonite
Nickel-Boussingaulite
Nordstrandite
Orthoserpierite
Paracoquimbite
Pentahydrite
Petersite(Y)
Pharmacolite
Phosphohedyphane
Pyrochlore
Ramsbeckite
Rectorite
Reichenbachite
Rongibbsite
Scotlandite
Shannonite
Soddyite
Srilankite
Straczekite
Surite
Szenicsite
Uranopilite
Utahite
Wagnerite
Weddellite
Wupatkiite
Zincocopiapite

A Brief History of Mining in Arizona – pre-1912

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Mining has been an integral part of the history and development of the area we currently know as the State of Arizona since pre-history. From the name of the State to the construction of the Capitol building, mining has played a critical role. Miners were the first explorers and settlers in the new land. They charted locations of mountain ranges and rivers because of their importance in exploration of mineral wealth. Arizona leads the nation in copper production, an essential element in maintaining the high standard of living we all enjoy. "Civilization follows the flag, but the flag follows the pick" (T. A. Rickard). Arizona has seen many flags in its history, and all were associated in some way with mining and the quest for metals.

Pre-Historic Period – 1520

There is documentation of the use of naturally occurring materials by man as early as 200 B.C. This early exploitation of natural resources by ancestral Native American peoples consisted of taking stones from formations exposed at the surface. In time, these people acquired skills and tools sufficient to excavate shallow pits, following the surface exposures to depth. These "workings" became the first mining operations in the desert southwest. Products of these operations were salt, pigments, clay, quartz, turquoise and other items that had trade value. The earliest of these was most likely obsidian and chert (for weapons and tools) followed by clay (for pottery) and pigments (malachite – green, hematite- yellow and red). Turquoise is associated with copper mineralization, occurring in the upper few feet of these deposits and was readily available to the inhabitants. The colorful material was valued for ornamentation as well as for trade with neighboring peoples. The main turquoise mining was located in the Cerbat Mountains and on Turquoise Mountain in the Courtland-Gleeson area. In addition to turquoise, there are surface occurrences of a variety of silica minerals (agates, clear and amethystine quartz crystals) in varying colors and patterns which also fit the needs of these people. Salt was reportedly

mined in the Camp Verde area from 900 A.D. The aboriginal people were exploiting coal for use as a fuel, possibly before it was used extensively in Europe.

Spanish Colonial Period 1520 – 1848

1535 – The remains of the Cabeza de Vaca exploration expedition to Florida may have crossed into eastern Arizona on the walk back to Mexico. Four men (Cabeza de Vaca, Estebanico, Dorantes, and Castillo) walked for 8 years from the coast of Eastern Texas to arrive at the Spanish outpost in Sinaloa in 1536. Many scholars think that the party crossed the western portion of New Mexico and Southern Arizona. This party spread stories of "cities 4-5 stories high".

1538 – The Viceroy of New Spain (Mendoza) sent a second party out to scout the northern portions of the territory. The party was lead by Fray Marcos and included Estebanico as a guide. It wandered up the San Pedro Valley and told tales of "seven great cities, all under one land" (the famed Seven cities of Cibola). Marcos reported seeing one of the seven cities (probably the Zuni pueblo of Hawikuh). He said that the inhabitants had killed Estebanico who was leading a scouting party. Marcos returned to New Spain.

1540 - Francisco Vasquez Coronado was appointed governor of New Galicia and took on the expedition to conquer the seven cities of Cibola. His expedition consisted of 300 Spanish volunteers, and 1,000 Indians. The expedition conquered several Zuni pueblos and explored much of northern Arizona.

1563 - Francisco de Ibara established the town of Durango as the capitol of the new frontier province – Nueva Vizcaya. Nueva Vizcaya included Arizona and Sonora for two centuries.

1593 – An expedition into the Jerome area by Antonio de Espejo was financed by a wealthy mine owner.

1598 - In a Spanish report, Marcos Farfan de los Godos described mineralization in the Jerome area which included a shaft 16 -17 feet deep.

Based on the ore specimens returned by Godos there was much contention for a land patent in the Jerome area. The ultimate winner of the patent was Juan de Onate, from the city of Zacatecas. Onate's father had "struck it rich" in the silver mines at Zacatecas. In 1604 Onate was the first expedition to explore central part of Arizona seeking mining properties.

1629 – The first of 5 missions was established in northern Arizona by Franciscan missionaries from Santa Fe. These five missions were near the Hopi Pueblos between 1629 and 1675. These missionaries were not well received (Hopi were resistive to conversion) and several missionaries in this area earned martyrdom.

1680 - Things turned very bad for the Spanish in Northern Arizona and New Mexico when the Pueblo people revolted against the Spanish.

1691 - Southern Arizona was explored by the famous Jesuit Missionary, Padre Eusebio Francisco Kino. Padre Kino first entered Arizona along the Santa Cruz valley to the Tucson area. During the following nine years Kino made several additional expeditions into the southern portion of Arizona. More than a simple ecclesiastical missionary, Kino is responsible for the introduction of: cattle, sheep, goats, horses, and mules, varieties of fruits, vegetables, grain and sugar cane. The influence of Kino resulted in settlement by Spanish as well as a political shift in which Arizona became aligned with Sonora and separated from New Mexico. Following Kino's death in 1711 there was a period of 25 years the Arizona area was essentially forgotten by both the Spanish government and missionaries. Kino recognized the importance of mining (especially silver) as he wrote.

"In these new nations and new lands there are many good veins and mineral lands bearing gold and silver; in the neighborhood and even in the sight of the missions some very good new mining camps of very rich silver ores are now being established." (Greeley, p14)

1697 - Spanish explorers Christobal Bernal and Juan Mateo Manje reported conversations with the Apaches where they described the use of cinnabar and native mercury (used as body paint). This deposit is thought to be in the Dome Rock Mountains.

1737 – At the Spanish presidio of Fronteras in Sonora a letter was penned to Bishop Benito Crespo of Durango by Juan Butista de Anza. In this report Anza first uses the name Arizona in relation to a report of a silver discovery in the area (planchas de plata).

"Late in the past month of October, between the mission of Guevavi and the Rancheria of Arissons, there was discovered more balls and chunks of silver, one containing more than a hundred arrobas (2,500 pounds), proof of which I am sending to your illustrious lordship. Other lumps were ... altogether more than two hundred arrobas." (Wyllys, p46)

Word of this discovery in Arizona spread and hundreds of prospectors flocked into the area, establishing the first "boom town" in the area – Real de Arizona. By the time Anza had heard about the discovery much of the metal had been spirited away by miners and the government failed to receive the "Quinto Real" tax on silver production. Because of the problem with the taxes, the rights to work these deposits were tied up in the courts in Mexico City until 1741. At which time the mines were closed by royal order.

Even with the closing of the mines at Real de Arizona, the impetus had begun and prospectors, settlers, merchants, and the military soon flooded the region. The Spanish government had to construct presidios to protect the prospectors and collect the Quinto Real from the miners.

1776 – Expeditions by Escalante and Garces from the Tusayan Mission at the Hopi villages explored the area north of the Grand Canyon, south of the Grand Canyon, and along the Colorado River. These expeditions resulted in trails being marked to connect to California. The main importance of these trails was that San Francisco had been established as a major Spanish port.

1776 – 1820 - Mining was sporadic. When there was a peace with the Native Americans, prospecting and mining operations proceeded at a normal pace. However, there were many instances when local hostilities were rampant. Other times the Spanish military was called away from the frontier for more pressing war efforts in the Spanish Empire, including the Mexican Revolution. By 1820 at least one fourth of the mines, ranchos, and settlements in Arizona and Northern Sonora had been abandoned. With

the end of the revolution and independence in 1821, Sonora and Arizona became the Mexican frontier. The presidio at Tucson was re-occupied, and this gave some protection from Indian attacks and outlaws. However, mining and prospecting in areas away from the presidios did not take place. Maps of the time show the area west of the continental divide, east of the Sierra Nevada, and north of the Gila River as "Land of the Heathen Indian" (Wyllys, p. 70).

1848 - The Mexican-American War (1846-1848) ended with the treaty of Guadalupe Hidalgo signed on February 2. The United States paid Mexico $15,000,000 for California, Nevada, Utah, New Mexico and portions of Colorado, Wyoming and Arizona.

Unknown to both governments, the gold strike at Sutter's Mill in California had occurred just 9 days earlier. In the first year of mining, California produced $45 million in gold (1849).

1854 - The Gadsden Treaty finalized the southern boundary of Arizona and Mexico for $10 million. The Mexican people were so outraged at Santa Anna (dictator) that he was thrown out and went into exile 2 years after signing the treaty. This ended the Spanish-Mexican rule of Arizona.

United States Territorial Period 1850 – 1912

New Mexico Territory 1850 – 1863

With Arizona becoming the western part of the New Mexico Territory, and ruled by the laws of the United States, mining and exploration efforts expanded. Much was due to the influence of mining in California. Miners passed through Arizona on the way to California. The disheartened returned from California. Within the first year of the gold discovery in California (February 1848 – February 1849) approximately 80,000 people had migrated to California in search of the riches in the gold rush.

The first areas to have located mining claims were along the Colorado River. This was an area with easy access. The first organized Mining Districts in

the Arizona portion of the New Mexico Territory were Castle Dome and La Paz.

Tucson was a favorite stop along the trail from the Southern Rio Grande (El Paso) to Southern California. It was out of Tucson in 1850 that Tom Child met a fellow 49'er, Peter Brady. Childs told Brady of the copper outcroppings at Ajo and said that he was planning to return. Brady took a job with the survey party lead by Andrew Grey. They surveyed the 32nd parallel for the Texas Western Railroad. When in Sonoita, he talked a Seri Indian into taking him to see the green outcroppings at Ajo. The Arizona Mining and Trading Company was organized in August 1854 with the mines at Ajo as the principal asset. This was the first mining company to operate in Arizona. Ore mined at Ajo was shipped across the desert to San Diego, then by ship to a smelter in Swansea, Wales. In an attempt to reduce costs, a smelter was constructed at Ajo in 1856 at a cost of $30,000. The lack of coke and charcoal as well as suitable flux resulted in the furnace being unsuccessful. By 1859 the remote location, scarcity of water, and low grades caused the operations to close.

During 1854-1855, Charles D. Poston and German mining engineer, Herman Ehrenberg, were searching for "planches de plata", near Nogales. They never found this deposit, but they did find rich veins of silver in the Santa Rita and Cerro Colorado Mountains. They formed an association that included Samuel Heintzelman. On Feb 1, 1857 they located the Salero, Heintzelman , and Arenia mines in the area south of Tucson and north of Nogales. By 1856 the Sonora Exploring and Mining Company had been formed with offices in Tubac. The company purchased the 17,000 acre Arivaca Ranch and acquired several additional mines in the area. The company was financed by investors from the Cincinnati, Ohio area. Samuel Colt was also a prominent investor and by 1859 had replaced Hintzelman as president of the Company. In 1858 mines in the Santa Rita Mountains were spun off into a new company - Santa Rita Company. The Santa Rita Company established headquarters at Tumacacori. The two companies controlled most of the mining activity in the area. William Wrightson, brought a printing press from Ohio to Tubac and published the first newspaper in Arizona (Weekly Arizonian) March 3, 1859.

In 1857 Fredrick Brunckow was working for the Sonora Exploring and Mining Company as a mining Engineer. Brunckow left this company in 1859 to operate the San Pedro Silver Mine which he had found near the San Pedro River west of Tombstone. Brunckow was found murdered the following year on the property. Brunckow's discovery influenced Ed Schieffelin and brought him into the area. Schieffelin and his partners used the Brunckow cabin as a headquarters and assay facility while staking claims in Tombstone.

As prospectors and miners moved into the Western New Mexico Territory, they were followed by farmers, traders and teamsters. Several forts were established to protect the immigrants. By the time of the census of 1860 the population of the territory of New Mexico, County of Arizona, was 1541, of which 643 were living in Tucson. This census showed several mining camps as having significant population centers (Gila City – 58, Arivaca Mines - 27, and Ajo – 18).

In 1861 the Civil War started. Most of the military garrisons were withdrawn from the western territories. As a result, the Mexican Nationals and the Apaches thought they had pushed the Americans out of Arizona. Chaos broke out and the Butterfield stage line discontinued service to Arizona. Operations in all but a few of the mining camps in southern Arizona ceased. One operation that continued to operate was the Mowery Mine near Patagonia, which produced silver and lead. This ended when William Mowery was arrested by Union troops as a confederate sympathizer and imprisoned in Yuma for 6 months. The mine was operated by Union agents unsuccessfully and finally returned to Mowery with $40,000 worth of damages. Mowery died in London trying to raise sufficient funds for repairs.

In central and western Arizona, however, prospecting and mining flourished under the protection of General Carleton (Ft. Yuma). Carleton recognized the value of gold to finance the war. The result of this attitude was the finding of rich gold placers on the western flanks of the Dome Rock Mountains. La Paz City had a population of 1,500 by the end of 1862. This gold rush moved eastward into the Bradshaw Mountains, near Wickenburg.

During this time period the Planet Mine was discovered and produced copper. The Oatman District was discovered and produced metal.

Arizona Territory 1863 – 1912

Arizona was declared an independent territory from New Mexico on December 29, 1863 at Navajo Springs. In January 1864, the new governor of the Arizona Territory, John Goodwin, and his party arrived at Ft. Whipple near Prescott. A new census was ordered to properly represent the people in the new legislature. The results of this census indicated that the population of Arizona had risen to 4,573, and Tucson remained the most populous city with 1,568 . Population centers in central and western Arizona reflected growth based on additional mining activity. There were 2,404 working males, of which 1,080 listed "miner" as their occupation. Essentially one of every four people in the Territory was a miner or prospector. By the end of the first year of Territorial Government, there were 25 organized mining districts in Arizona.

During the territorial era, business and transportation was very closely associated with mining and mine development. Tucson remained the mining center of the territory. In 1880, the American and Mexican Mining Exchange was established there to promote mining and collect pertinent information for engineers and potential investors. Newspaper names reflected the strong influence of mining on the economy of the territory. Some of those names included *Arizona Miner*, Ft. Whipple; *Nugget*, and *Daily Prospector*, Tombstone; *Copper Belt*, Jerome; etc.

Beginning in 1877 infrastructure increased with the construction of the railroad from Yuma. The number of miners and prospectors was ever increasing. This afforded protection from Native Americans and bandits as they traveled in groups. The opening of the Territory by the railroad increased the ability to ship machinery in and ore out. This resulted in the increase of investment from Eastern States and Europe. By 1886 Geronimo had surrendered and raids by the Apache decreased.

During the Territorial period many of the mining districts were discovered and some persist in production today. Mining was a profession with much

uncertainty, resulting in many boom and bust cycles for towns that supported the mines. As shallow deposits were exploited and the ores became lower grade, miners would move on to the next camp, leaving store owners and the other suppliers to find another source of income or move on as well.

In the census of 1880, records show that 21% of working males (4,678) were employed as miners. At this time there were 7 copper mines, 232 precious metal lode mines, 2 placer mines, 24 amalgamating mills, 5 arrastras, and one smelter operating in the Territory. Substantial population was centered in the mining and milling centers throughout the Territory.

Tombstone was operating at peak capacity from 1882 to 1884, with a population of about 10,000. At this time Tombstone was larger than San Francisco and offered more cultural activities. Tombstone is the largest primary silver producer in Arizona, with combined production in excess of $30 million. However, in the late 1880's the mines at Tombstone flooded and, not having the technology to handle the high inflow of water, the mines were abandoned. In 1890 there were only 1875 people living in Tombstone, and the support communities of Charleston and Contention were deserted.

By 1890 the population centers in the Territory were essentially mining camps. They included Bisbee, Clifton, Arivaca, Harshaw, Reymert, Morenci, Congress, and Jerome. Mining supported the Territory by supplying employment, payrolls, and taxes. The total payroll for mining was the largest of any industrial / agricultural segment of the economy in the Territory. It has been estimated that in the 50 years of mining in Arizona from 1860 to 1910, there was $600 million in metal production.

In 1901 the territorial legislature moved the Territorial capitol from Prescott to Phoenix. The new capitol building was constructed from materials mines within the Territory. Mining companies continued to play a greater and greater role in community development, building hospitals, schools, and recreational facilities. The generosity of the mining companies is often overlooked. For example, Phelps Dodge supplied 75% of the funds to construct the first gymnasium on the University of Arizona Campus. In

Jerome, the United Verde Copper Company built a hospital for the community, where miners got free treatment and their families paid a small fee. The Phelps Dodge Company financed the first natural gas pipeline from El Paso to the smelter in Douglas at a cost of $2 million. Eventually the company providing the gas (El Paso Natural Gas) built a distribution network throughout the state.

In the census of 1910, there were 204,354 persons living in the Territory, of which more than 18,000 were employed as miners. Tucson was still the largest city, followed by Phoenix. Other important cities were: Bisbee – 9,019; Globe-Miami – 8,473; Douglas 6,437; Morenci – 5,010; Clifton – 4,874; Jerome – 2,393; and Silver Bell – 1,721.

On Valentines Day, February 14, 1912 Arizona Territory became the 48th state of The United States of America. When Arizona became a state it had documented 445 active mines, 72 concentrating facilities, and 11 smelters. Metal production in that year amounted to $67 million.

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Arizona—100 Years of Collecting Minerals

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Arizona became the 48th state of the United States of America on February 14, 1912. Its mining history was already 60 years old, beginning in the early 1850s as unsuccessful adventurers began returning from the California Gold Rush of 1849. The western side of the Arizona Territory was the least inviting for settlement because of its arid nature and the various hostile native tribes, especially the Apaches. Other lawless individuals also roamed the Arizona deserts and mountains until the mid-1870s, when the re-establishment of Army forts after the Civil War subdued these unfriendly elements. Army soldiers also became some of the first prospectors in these areas. But soldiers were not the only ones interested in locating undiscovered mineral treasures. The western and central portions of Arizona had a growing population of ranchers and farmers, some with an interest in looking for mineral deposits.

The collecting of mineral specimens was entirely mine and ore related until the early 1880s. Heintzleman and others had specimens shipped east and displayed in St. Louis, Chicago and points further on, not solely for their aesthetic appeal but to entice capital investment in this last American frontier. The early interest was in silver and gold. Silver mining began to take hold prior to the Civil War, at the Ruby and the Mowry mines. In fact, silver from the Ruby mine was fashioned into an inkwell set presented to President Lincoln. The Red Cloud mine, very near the Colorado River, was located in the 1860s, so named for a nearby Indian trail near the Colorado River; mining started there in 1880. This silver mine would become more famous for its wulfenite crystals, even attracting the attention of the Territorial Governor and mention in one of his reports to Congress.

Towards the middle of the Territory, several rich but short-lived silver deposits, all in the Superior to Globe area, were discovered

and mined in the late 1870s and early 1880s. The Silver King mine was located on the west side of the mountains near the Town of Superior, and the Stonewall Jackson mine was located east of Globe. Both were rich enough that crystallized specimens were saved and found their way into the inventories of mineral dealers of the time. Most of these early mines and mining camps were short-lived, usually less than ten years. It was the copper mines that finally brought stability and longevity to Arizona's towns and economy, but these required that railroads be built, providing cheap and reliable transportation. With this new prosperity, more specimens began to be saved. Once people no longer feared for their lives, and (more importantly) mineral dealers from the east began to travel out west in search of specimens, the normal economic drivers took hold The beauty of some of these mineral finds, such as the caverns at Bisbee and the rich copper oxide orebodies at Morenci, inspired both miners and management to preserve specimens. Ben Williams and Dr. James Douglas of the Copper Queen Mining Company both had an eye for specimens, even employing miners to collect for them and the company account. Bisbee remained Arizona's premier producer of specimens for 90 years, until 1975 when the mines closed. Phelps-Dodge Corporation's legacy of saving specimens lives on today through the efforts of Freeport McMoran Copper and Gold, mainly at Morenci; they also continue to maintain the corporate mineral collection in Phoenix, Arizona, started back in 1885.

Other mines like the Live Oak and Old Dominion were produc-ing specimens and gem materials recognized for their beauty and value as early as 1900. The Mammoth and Collins mines produced enough wulfenite to qualify as an ore of molybdenum prior to and during World War I. While it is fun to speculate how many great specimens might have gone to the crusher, it is probable that most of the wulfenite was so tightly crystallized as to have value only as ore. In its final mining phase, mine management recognized the value of its mineral suite and employed one or two full-time miners to collect specimens for sale.

Arizona's mineral collecting legacy began its rise in the 1940s and continues today. Amateur and professional collectors have scoured and rescoured its abandoned mines and surface deposits for the past seven decades, bringing to light hundreds of discover-

ies of specimens for collectors and museums throughout the world. Minerals from aurichalcite to zunyite and every letter in between have been found, including world-class and type specimens. Arizona's mineralogy is as diverse as that of any state or country. Mine names like the Glove, the Magma, the Old Yuma, the 79, the Rowley, the Red Cloud, the New Cornelia, the Portland, the Western Union, the Grandview, the Apache, the Defiance, the Silver Bill, the Silver Bell and the Silver Hill all form part of Arizona's mineral heritage and legacy.

While the next century will probably not be as exciting as its first 100 years, new deposits and finds still await those who are willing to put in the time and sweat necessary to hike the hills, explore the old mines and then dig out those treasures still awaiting discovery.

CELEBRATING 40 YEARS OF MINERALOGY AT THE ARIZONA - SONORA DESERT MUSEUM

Anna M. Domitrovic
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Arizona - Sonora Desert Museum
Tucson, Arizona

Arizona marks its Centennial Anniversary in 2012. The year is also a milestone for the Arizona-Sonora Desert Museum (ASDM). The Museum was opened to the public on Labor Day, 1952. And its Earth Sciences Center (ESC) was conceived in 1972. So, that means 2012 is the 60th anniversary for the Museum and the 40th anniversary for the Stephen House Congdon Earth Sciences Center (ESC).

The Desert Museum interprets the Sonoran Desert which includes southern Arizona, Sonora, Mexico, and most of the Baja Peninsula. The ESC expanded that interpretation to the Sonoran Desert region includes all of Arizona and the Baja Peninsula. The Desert Museum innovated artificial rockwork when it built two manmade limestone caves, similar to those found within the Sonoran Desert region, opened in 1977, followed five years later with the dedication and opening of the exhibit halls - the Earth History Room, the Mineral Hall and Mine Tunnel and the Mine Dump collecting site. The Mineral Hall provided the opportunity to display specimens from classic . mineral localities in Arizona, as well as the Baja Peninsula and Sonora, Mexico. The Permanent Mineral Collection (PMC) continues the Museum's reputation for maintaining the finest mineral collection in any regional museum. The PMC ranks right up there with the likes of the Smithsonian and the American museums.

There was a limited exhibit of rocks and minerals in the Museum's original Orientation Room just inside the entrance. With the completion of Phases I and II of the ESC, mineral exhibits were moved to the exhibit halls. But in 2002, the Birth of the Blues, an exhibit on turquoise and its importance to the southwestern desert and culture, made its debut in Phoebe's Coffee Bar, followed by a display of large mineral specimens, which added to the ambiance of the Ocotillo Café, the Museum's formal dining room. In the fall of 2003, a new display case was added to the Mineral Hall to allow for rotating mineral exhibits and provided space for showing off new acquisitions to the Permanent Mineral Collection and mineral-related topics.

The most valuable, non-renewable asset that the ASDM maintains has to be the PMC. The core of the collection was donated by well known mineralogists and collectors like Richard Bideaux, Richard Graeme, Rukin Jelks and John Sinkankas. Readily recognized specimens attributed to the ASDM's ownership include one of two known specimens of graemite (named after Richard Graeme) from its Bisbee type locality; the largest know crystal of matlockite from the Mammoth-St. Anthony Mine at the historical site of Tiger near San Manual; and a specimen that bears the PMC's catalog number "1", bideauxite, also from Tiger and named in honor of Richard Bideaux. These are just a few of the specimens that serve as anchors for the PMC's Bisbee and Tiger sub-collections.

Also, and probably most important for researchers, is the extensive micromount collection included in the 16,000 + catalogued mineral specimens in the PMC. Donated in their entirety, hundreds of specimens make up each collection. Noted micromounters like Marvin Deshler, Dan Helm, Bob Massey and Arthur Roe each spent hours through their lifetimes preparing these microscopic gems of the mineral world. They now have a permanent and prominent home in the ASDM's PMC.

The Desert Museum has always been involved in taking Sonoran Desert studies off the Museum grounds and into public view. With a mineral collection that surpasses any regional exhibit at museums worldwide, it, also, needed to be recognized off the Desert Museum grounds. The ESC joined the practice of taking the Desert Museum to the public in 1996 when the first long term mineral loan went to Tucson's Arizona Historical Society (AHS) Museum. The AHS exhibit loan was followed in 1998 with a collection of Bisbee minerals to Old Tucson Studios and were returned to the Museum in 2011. Loew's Ventana Canyon Resort in the Santa Catalina Mts foothills next benefitted from the ESC's long term loans in 2003. Cases and mineral mounts were specially designed for large mineral specimens that can be seen from the resort's spacious lobby. And finally, in 2005, the Tucson International Airport provided space in a series of wall cases for a display designed to rotate mineral specimens from the Permanent Collection. This display is currently in its third rotation. The ESC also loaned single specimens of gold to the Mesa Southwest Museum for their mineral exhibit and an iridescent calcite from Bisbee's Southwest Mine to the Bisbee Mining & Historical Museum.

To further the Desert Museum's mission of interpreting the Sonoran Desert to those who can't visit regularly, the ESC has participated in mineral shows in the Southwest by providing short term loans to enhance a show's exhibit space. The first off grounds mineral display went to the annual Bisbee Show in the fall of 1974. Since then, mineral displays have always appeared at the annual Tucson Gem & Mineral Show, as well as shows in Bisbee, Cottonwood, Phoenix, Sedona and Sierra Vista; and out of state to Denver and Las Vegas.

The ESC is not only involved in exhibiting and interpreting the earth sciences as they relate to the Sonoran Desert. Every year since 1975, we've assembled and organized an annual fund raising event for the Desert Museum. Donations of minerals, fossils and rocks have always been accepted. While acquisitions to the Permanent Mineral Collection are the top priority, other donations go into educational or sales stock. It's the sales stock that comes out at Mineral Madness once a year in January. It started with a few tables set up in the Museum's parking lot in 1975. The operation moved to classrooms in the Education Building in 1977. In the late 1980's, the sale was renamed Mineral Madness Showcase & Sale and moved to the Ironwood Galllery, the first Museum event to be held in the facility. Mineral Madness's current venue in the new Baldwin Building. Mineral Madness continues to be the first of the public sales in Tucson during February, culminating in the Tucson Gem & Mineral Show at the TCC.

Bill Panczner was hired as the ESC's first curator in 1972, followed by Dave Thayer in 1982. Anna Domitrovic assumed responsibilities for the ESC and the PMC in 1982. Anna retired from the Desert Museum in 2005, but continues on in the capacity of Earth Sciences Curator *Emeritus*. The ESC and the PMC are cureently under the umbrella of the Center for Sonoran Desert Studies and maintained by Debbie Colodner, Director of Education, hired in 2006.

Arizona Territory mineral treasures and "mysteries"
from the vaults of the Yale Peabody Museum of Natural History

Stefan Nicolescu
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In 1801, when Benjamin Silliman senior was offered the first Yale professorship in "chymistry" and natural history, the college did not have much in terms of mineral or rock collections. By 1825, through the labors of Silliman and with the support of Yale president Timothy Dwight (the Elder) and his successor, Jeremiah Day, Yale College had one of the best mineral collections in the United States. The quality of this collection, combined with Silliman's pedagogical gift and mastery of the subjects he taught were crucial in attracting brilliant students to Yale. As stated in 1946 by Wilmarth Lewis, one of the friends of the Yale Peabody Museum: "... fine collections attract great scholars, great scholars attract brilliant disciples, the quality of the institution's teaching is improved, and the students are the gainers thereby. Everyone is benefited by collections, whether they know it or not." (Narendra, 1979). Among the 19th century geology Yale graduates were such towering scientific personalities like James D. Dana, Benjamin Silliman, Jr., George J. Brush, Othniel C. Marsh, Edward S. Dana and Samuel L. Penfield. Marsh also had another lasting contribution to Yale's legacy: he played an instrumental role in persuading his uncle, George Peabody, to contribute the funds for the creation of what since 1866 is known as the Yale Peabody Museum. Eventually, the mineral collections of Yale College and those of the Yale Scientific School (established in 1854, renamed in 1860 the Sheffield Scientific School and incorporated in 1956 into Yale College) became part of the Yale Peabody Museum.

Once the scientific fame of the school was established, mineral specimens from across the country and from across the world started being sent to Yale for both research and preservation. With its world class mineral deposits starting to be discovered, mineral specimens from the Arizona Territory began making their way to Yale too. The earliest Arizona Territory mineral still in the Yale Peabody Museum mineralogy collection is a small, unassuming fluorite specimen acquired by George J. Brush from Benjamin Silliman, Jr. in 1865 (Fig. 1).

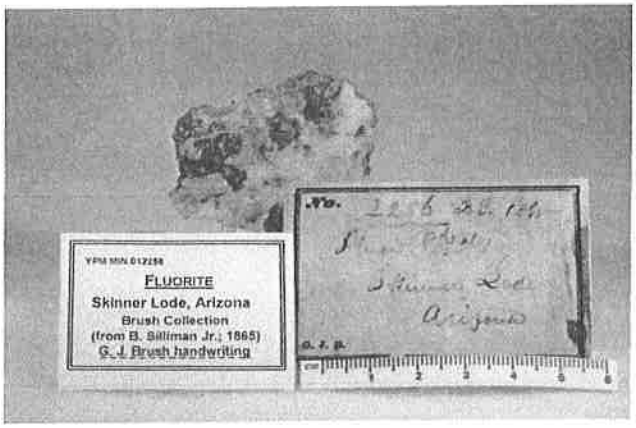

Figure 1. Fluorite (YPM MIN. 012256) from the Skinner Lode, Mohave Co; earliest Arizona Territory specimen preserved in the collections of the Yale Peabody Museum. © 2012 YPM.

Over the next 40 plus years Arizona Territory mineral specimens where sent to Yale by scholars, scientists, collectors and dealers like: William P. Blake, James Douglas, George L. English, Albert E. Foote, William F. Hillebrand, George Kunz, Waldemar Lindgren, to name but a few (Table 1).

Gerhardtite, $Cu_2(NO_3)(OH)_3$ (orthorhombic), the first new mineral described from Arizona, was published by Horace L. Wells and Samuel L. Penfield of the Yale Sheffield Scientific School (or simply "Sheff") in 1885. The specimen (Fig. 2), from the United Verde Mine in Jerome, Yavapai County, was left at Sheff by the mine assayer, G. W. Stewart. Wells and Penfield credit George J. Brush with recognizing it as a new mineral species. Another new mineral from Arizona, spangolite, $Cu_6Al(SO_4)Cl(OH)_{12} \cdot 3H_2O$ (hexagonal) (Fig. 3), was described in 1890 by Samuel L. Penfield. The precise locality of the holotype, although very likely Bisbee, Cochise County, will probably remain a mystery, because the Tombstone resident Norman Spang acquired it from could not remember the exact locality where it was found. Spang lent Penfield the specimen for study in 1889, and eventually presented it to him.

Figure 2. Gerhardtite type specimen (YPM MIN. 033269); scale bar in centimeters. © 2012 YPM.

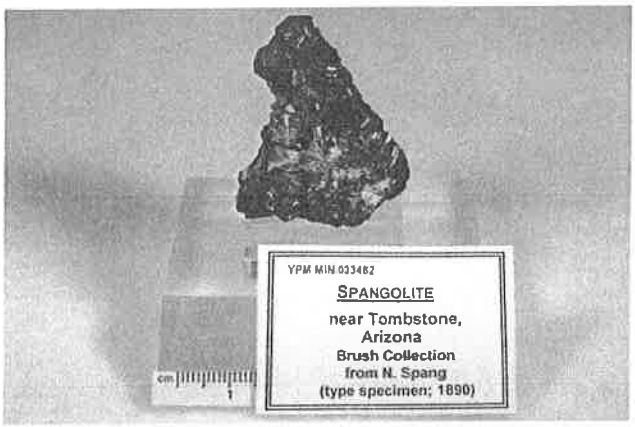

Figure 3. Spangolite type specimen (YPM MIN. 033482). © 2012 YPM.

Table 1 lists the 199 specimens belonging to 38 mineral species from the Arizona Territory preserved in the Yale Peabody Museum's mineralogy collection. The top five species in terms of number of specimens are: azurite (39), vanadinite (32), cuprite (23), wulfenite (19) and malachite (16). Many of them have been the object of detailed studies, a selected list of which is appended. All pre-1912 scientific work on Arizona Territory minerals done by Yale scientists was published in the in-house *American Journal of Science* (http://www.ajsonline.org/), the oldest scientific journal in the United States that has been published continuously. Its beginnings are again tied to the protean Benjamin Silliman senior, who established it in 1818; during the first decades of its existence, it was known simply as "Silliman's journal".

The presence in the mineral list of skutterudite from Tombstone needs some explanation. There is no mention of this mineral (or of its Ni-dominated equivalent) from Tombstone in the scientific literature; the only confirmed Arizona skutterudite occurrence is at the Blue Bird Mine in the Santa Teresa Mountains, Graham County (Anthony *et al.*, 1995). On the other hand, the genetic type of the Tombstone ore deposit does not necessarily preclude the presence of Co and Ni arsenides (P. Megaw, 2012 personal communication). Raman analyses of several small chips from the specimen in discussion, recently performed at Yale, confirm the mineral is skutterudite. As this result puts to rest the speculation that the mineral species might have been misidentified, either the mineral's presence in the paragenesis was overlooked or the specimen originates from somewhere else. To solve "the mystery", a reexamination of specimens from the Lucky Cuss Mine, and from Tombstone in general, seems to be in order.

Vauquelinite from the Chromate Mine in Maricopa County is another elusive member of the old Arizona mineral collection at Yale. As stated by Benjamin Silliman, Jr. (1881), the specimen was sent to Yale by George A. Treadwell of Vulture, Arizona. In a 1999 written personal communication of Sidney. A. Williams to Richard A. Bideaux, a copy of which is filed with the mineralogy division at the Yale Peabody Museum, it is stated that anglesite, brochantite, phoenicochroite, mottramite and vanadinite have been identified in the Silliman/Treadwell specimen, with no mention of vauquelinite, or of the investigative method(s) used. In the same document Williams briefly mentions that not much can be found nowadays at the old Chromate Mine.

The Yale Peabody Museum mineralogy collection holds today over 31,000 cataloged specimens; less than 2 % of these (568 specimens) come from Arizona, with 35 % of them being acquired before 1912. The number of mineral specimens (199) from pre-statehood times is an extremely conservative estimate. Only specimens for whom documented evidence of pre-1912 acquisition exists have been included in the current review; one hundred or so more, for which only circumstantial evidence exists for having been acquired before 1912, could be added to the list.

List of selected publications on Arizona Territory minerals from the collections of the Yale Peabody Museum

Dana, E. S. (1892) – *The system of mineralogy*. 6th ed. Wiley, New York. 1134 pp.

Farrington, O. C. (1891) – Crystallized azurite from Arizona. *American Journal of Science*, series 3, 41, 300 – 307.

Ford, W. E. (1902) – On the chemical composition of dumortierite. *American Journal of Science*, series 4, 14, 426 – 430.

Hillebrand, W. F., Penfield, S. L. (1902) – Some additions to the alunite-jarosite group of minerals. *American Journal of Science*, series 4, 14, 211 – 220.

Penfield, S. L. (1886) – Crystallized vanadinite from Arizona and New Mexico. *American Journal of Science*, series 3, 32, 441 – 443.

Penfield, S. L. (1890) – On spangolite, a new copper mineral. *American Journal of Science*, 39, 370 – 378.

Pirsson, L. V. (1891) – Mineralogical notes. *American Journal of Science*, series 3, 42, 405 – 409.

Silliman, B., Jr. (1866) – On some of the mining districts of Arizona near the Rio Colorado, with remarks on the climate, &c. *American Journal of Science*, series 2, 41, 289 – 308.

Silliman, B., Jr. (1881) – Mineralogical notes. *American Journal of Science*, series 3, 22, 198 – 205.

Wells, H. L., Penfield, S. L. (1885) – Gerhardtite and artificial basic copper nitrates. *American Journal of Science*, 30, 50 – 57.

References

Anthony, J., W., Williams, S. A., Bideaux, R. A., Grant, R. W. (1995) – *Mineralogy of Arizona*. 3rd ed. University of Arizona Press, Tucson. 508 pp.

Narendra, B. L. (1979) – Benjamin Silliman and the Peabody Museum. *Discovery*, 14/2, 12 – 29.

TABLE 1. ARIZONA TERRITORY MINERALS PRESERVED IN THE COLLECTIONS OF THE YALE PEABODY MUSEUM OF NATURAL HISTORY

(number of specimens in parantheses)

Mineral	Chemistry	Locality	Source	Acquisition year
ALABANDITE (2)	MnS	Lucky Cuss Mine, Tombstone, Cochise Co.	A. J. Moses	1893
ANGLESITE (2)	$PbSO_4$	Castle Dome, Yuma Co.	J. C. Trautwein	1872
ARAGONITE (2)	$CaCO_3$	Copper Queen Mine, Bisbee, Cochise Co.	G. L. English	1891 - 1892
ATACAMITE (1)	$Cu_2Cl(OH)_3$	United Verde Mine, Jerome, Yavapai Co.	[F. F.] Thomas	1884
AURICHALCITE (2)	$(Zn, Cu)_5(CO_3)_2(OH)_6$	Longfellow Mine, Morenci, Graham [Greenlee] Co. (1)	G. Talcott (1)	1907
		Metcalf Mine, near Clifton, Graham [Greenlee] Co. (1)	G. L. English (1)	1893 - 1899
AZURITE (39)	$Cu_3(CO_3)_2(OH)_2$	Copper Queen Mine, Bisbee, Cochise Co. (26)	G. L. English (12)	1893 - 1899
			J. Douglas (5)	no date
			A. E. Foote (8)	1877 - 1890 (5)
				no date (3)
			G. L. English (1)	1887 - 1888
		Morenci, Graham [Greenlee] Co. (5)	A. E. Foote (2)	1877 - 1890
			G. L. English (2)	1893 - 1899
				no date
			A. H. Petereit (1)	no date
		Bisbee, Cochise Co. (1)	J. Douglas	no date
		Clifton, Graham [Greenlee] Co. (1)	G. L. English	1888 - 1891
		Longfellow Mine, Morenci, Graham [Greenlee] Co. (1)	J. Douglas	no date
		United Verde Mine, Jerome, Yavapai Co. (1)	F. F. Thomas	1884
		Yavapai Mine, near Clifton, Graham [Greenlee] Co. (1)	G. L. English	1887 - 1888
		Arizona [no further details] (3)	G. L. English	no date
BORNITE (1)	Cu_5FeS_4	San Carlos Mine	G. L. English	1887 - 1888
BROCHANTITE (1)	$Cu_4(SO_4)(OH)_6$	Arizona [no further details]	L. Stadtmüller	1886
CALCITE (4)	$CaCO_3$	Copper Queen Mine, Bisbee, Cochise Co.	G. L. English	1891 - 1892
CALEDONITE (1)	$Pb_2Cu_5(SO_4)_3(CO_3)(OH)_6$	Arizona [no further details]	A. E. Foote	no date
CERUSSITE (4)	$PbCO_3$	Red Cloud Mine, Yuma [La Paz] Co. (2)	G. L. English	1887 -1888
		Castle Dome, Yuma Co. (1)	W. P. Blake	no date
		Flux Mine, Santa Cruz Co. (1)	A. E. Foote	no date
CHLORARGYRITE (1)	Ag(Cl, Br)	Red Cloud Mine, Yuma [La Paz] Co.	G. L. English	1893 - 1899
CHRYSOCOLLA (6)	$(Cu,Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O$	Bisbee, Cochise Co. (1)	N. L. Wilson	no date
		Gila Co. (1)	Foote Mineral Co.	1908
		Globe, Gila Co. (1)	W. F. Hillebrand	1902
		Morenci, Graham [Greenlee] Co. (1)	A. E. Foote	no date
		Punta del Cobre, Williams Fork, Mohave Co. (1)	B. Silliman, Jr.	1866
		United Verde Mine, Jerome, Yavapai Co. (1)	F. F. Thomas	1885
CHRYSOTILE (4)	$Mg_3Si_2O_5(OH)_4$	Grand Canyon, Coconino Co. (3)	J. H. Pratt	1904 - 1905
		Shinumo Area, Grand Canyon, Coconino Co.(1)	L. F. Noble	1909
CONNELLITE (1)	$Cu_{19}(SO_4)_2Cl_6(OH)_{62} \cdot 6–12H_2O$	Arizona [no further details]	L. C. Bierwirth	no date
COPPER (3)	Cu	Bisbee, Cochise Co. (3)	L. Cahn (1)	1908
			A. H. Peterell (2)	1907
CUPRITE (23)	Cu_2O	Copper Queen Mine, Bisbee, Cochise Co. (12)	G. L. English (7)	1893 - 1899 (2)
				1894 (3)
				no date (2)
			A. E. Foote (2)	1877 - 1890
			C. S. Bement (1)	1908
			L. Cahn (1)	1910
			E. C. Wood (1)	1909
		Copper Mtn. Mine, Graham [Greenlee] Co. (5)	G. L. English	1891 - 1892 (3)
				1887 - 1888
				1888 - 1891
		Bisbee, Cochise Co. (2)	G. L. English (1)	no date
			A. E. Foote (1)	1884
		Clifton, Graham [Greenlee] Co. (1)	N. L. Wilson	no date
		Ryerson Mine, Morenci, Graham [Greenlee] Co. (1)	D. Irwin	1910
		United Verde Mine, Jerome, Yavapai Co. (1)	[F. F.] Thomas	1883
		Arizona [no further details] (1)	G. Kunz	1910
DIOPTASE (2)	$CuSiO_2(OH)_2$	near Florence, Pinal Co. (1)	C. S. Bement	1908
		Stevens Mine, Metcalf, Graham [Greenlee] Co. (1)	W. Lindgren	1903
DUMORTIERITE (5)	$Al_7(BO_3)(SiO_4)_3O_3$	near Clip, Yuma Co. (3)	G. L. English	1893 - 1899
		Yuma Co. (2)	A. E. Foote	1877 - 1890
FLUORITE (3)	CaF_2	Castle Dome District, Yuma Co. (1)	Foote Mineral Co.	1900 - 1904
		Skinner Lode, Mohave Co. (2)	B. Silliman, Jr.	1865; 1880
GERHARDTITE (1)*	$Cu_2(NO_3)(OH)_3$	United Verde Mine, Jerome, Yavapai Co.	G. W. Stewart	~ 1885
GLAUBERITE (1)	$Na_2Ca(SO_4)_2$	Rio Verde, Yavapai Co.	W. P. Blake	1889

*) - type specimen

TABLE 1 (continued)

Mineral	Chemistry	Locality	Source	Acquisition year
GOLD (1)	Au	Moss Lode, Mohave Co.	Yale College	no date
HUBNERITE (2)	$Mn^{2+}WO_4$	Russelville, near Dragoon, Cochise Co.	W. Niven	1898
JAROSITE (2)	$KFe^{3+}_3(SO_4)_2(OH)_6$	Vulture Mine, Maricopa Co.	B. Silliman, Jr.	no date
LEADHILLITE (2)	$Pb_4(SO_4)(CO_3)_2(OH)_2$	Shultz District, Pinal Co. (1)	M. Bixby	1899
		Shultz Gold Mine, Pinal Co. (1)	N.Spang	no date
LIBETHENITE (1)	$Cu_2(PO_4)(OH)$	Coronado Mine, Clifton, Graham [Greenlee] Co.	W. Lindgren	1903
MALACHITE (16)	$Cu_2(CO_3)(OH)_2$	Copper Queen Mine, Bisbee, Cochise Co. (11)	A. E. Foote (4)	1887 (2)
				1877 - 1890 (2)
			E. Reilly (4)	no date
			G. L. English (2)	1893 - 1899
				no date
			J. Douglas (1)	no date
		near Tucson, Pima Co. (2)	J. E. Pope	1882
		Bisbee, Cochise Co. (1)	T. van K. Swift	1909
		Morenci, Graham [Greenlee] Co. (1)	G. L. English	1893 - 1899
		United Verde Mine, Jerome, Yavapai Co. (1)	F. F. Thomas	1885
PHOENICOCHROITE (1)	$Pb_2O(CrO_4)$	Chromate Mine, Maricopa Co.	B. Silliman, Jr.	no date
SCHEELITE (1)	$CaWO_4$	Russelville, near Dragoon, Cochise Co.	W. Niven	1898
SILVER (2)	Ag	Stonewall Jackson Mine, Gila Co. (2)	L. Stadtmüller	1881
			B. Silliman, Jr.	no date
SKUTTERUDITE (1)	$CoAs_{2-3}$	Lucky Cuss Mine, Tombstone, Cochise Co.	L. Cahn	1897
SPANGOLITE (1)*	$Cu_6Al(SO_4)Cl(OH)_{12} \cdot 3H_2O$	near Tombstone, Cochise Co.	N. Spang	~ 1890
STROMEYERITE (7)	AgCuS	Heintzelman Mine, Pima Co.(6)	E. Hartley (4)	no date
			Unknown (2)	no date
		Silver King Mine, Pinal Co. (1)	W. P. Blake (1)	no date
TENORITE (1)	CuO	Bisbee, Cochise Co.	[P.] Hamilton	1910
VANADINITE (32)	$Pb_5(VO_4)_3Cl$	Yuma Co. (10)	A. E. Foote (7)	1877 - 1890 (1)
				no date (6)
			G. L. English (2)	1887 - 1888
			A. H. Petereit (1)	1906 - 1909
		Black Prince Mine, Pinal Co. (5)	L. Stadtmüller (5)	1883 (2)
				no date (3)
		Hamburg Mine, Yuma [La Paz] Co. (5)	E. S. Dana (3)	1881
			B. Silliman, Jr. (2)	no date
		Silver District, Yuma [La Paz] Co. (3)	G. L. English (2)	1887 - 1888
				no date
			A. E. Foote (1)	no date
		Prescott, Yavapai Co. (2)	L. Stadtmüller (2)	1884
				no date
		Farley's Mine, Maricopa Co. (2)	B. Silliman, Jr.	no date
		Chromate Mine, Maricopa Co. (1)	B. Silliman, Jr.	no date
		Collateral Mine, Maricopa Co. (1)	B. Silliman, Jr.	no date
		Phoenix Mine, Maricopa Co. (1)	B. Silliman, Jr.	no date
		Princess Mine, Yuma [La Paz] Co. (1)	B. Silliman, Jr.	no date
		Red Cloud Mine, Yuma [La Paz] Co. (1)	B. Silliman, Jr.	no date
VAUQUELINITE (1)	$Pb_2Cu(PO_4)(CrO_4)(OH)$	Chromate Mine, Maricopa Co.	B. Silliman, Jr.	no date
WULFENITE (19)	$PbMoO_4$	Melissa Mine, Yuma [La Paz] Co. (6)	G. L. English (3)	1887 - 1888
			B. Silliman, Jr. (3)	no date
		Red Cloud Mine, Yuma [La Paz] Co. (6)	E. S. Dana (3)	1881
			B. Silliman, Jr. (1)	no date
			G. J. Brush (1)	no date
			Unknown (1)	no date
		Silver District, Yuma [La Paz] Co. (3)	E. S. Dana (1)	1881
			B. Silliman, Jr. (1)	no date
			G. J. Brush (1)	no date
		Yuma Co. (2)	A. E. Foote	no date
		Vulture Mine, Maricopa Co. (1)	B. Silliman, Jr.	no date
		Arizona [no further details] (1)	H. E. Wood	1894

(*) - type specimen

Saturday Evening Speaker

Bob Jones

On various trips into Mexico I was able to visit four different selenite caves, including the famous caves at Naica, the Cave of Swords and the Big Crystal Cave featured in National Geographic. My talk will include photos taken in all these caves and there will be discussion of how such large crystals may have formed.

Bob Jones
(In part from The Mineralogical Record Biographical Archive, copyright 2012)

Over the years Bob has been a prolific author and mineral photographer, writing a column for Rocks & Minerals magazine from 1960 to 1972, and publishing over 700 articles (usually illustrated by his photos) in Rocks & Minerals, Lapidary Journal, Monde et Mineraux, and Rock and Gem magazine, where he has also served as Senior Consulting Editor since 1993. His articles for the Mineralogical Record include "The Mark Chance Bandy Collection," "The Grand Reef mine, Graham County, Arizona," "The Gunnell Crystal collection," "Famous mineral localities: The Ray Mine, Arizona" (with Wendell Wilson), "Red Grossular from the Sierra de Cruces, Coahuila, Mexico" (with Virgil Leuth), "Famous Mineral Localities: The Bristol Copper Mine, Connecticut" and "Philip Rashleigh and his Specimens of British Minerals."

He is also the author of several books including Fluorescent Minerals of Connecticut (based on his Master's Thesis) and Nature's Hidden Rainbows (Franklin/Sterling Hill) (1964), and worked on three chapters for the 2008 book America's Mineral Treasures. Bob first visited the Tucson Show 1960, and has attended every one since then—a remarkable record. This long experience helped him write a special book-length tribute entitled A Fifty-Year History of the Tucson Show in 2004. He has also assisted with writing the script for the Smithsonian sponsored video "Gemstones of America," wrote script for and hosted the "Russian Gem Treasures" video and the "Collecting Earth's Natural Treasures" video, and helped produce the "Treasures of Tucson" video.

His latest book is The Frugal Collector, volume 1. It is about a host of popular collector minerals that will fit the average collector's budget and their classic sources, and enjoy anecdotes about Bob's personal experiences over his 70+ years of collecting.

Minerals of Arizona Symposium

The following is a summary of the twenty years of the Minerals of Arizona Symposium. For each symposium the year, co-chair, and location are given.

First – 1993 – Glenn Miller – Arizona Mining and Mineral Museum
Second – 1994 – Glenn Miller – Arizona Mining and Mineral Museum
Third – 1995 – Glenn Miller – Arizona Mining and Mineral Museum
Fourth – 1996 – Susan Celestian – Arizona Mining and Mineral Museum
Fifth – 1997 – Susan Celestian – Arizona Mining and Mineral Museum
Sixth – 1998 – Susan Celestian – Arizona Mining and Mineral Museum
Seventh – 1999 – Susan Celestian – Arizona Mining and Mineral Museum
Eighth – 2000 – Susan Celestian – Arizona Mining and Mineral Museum
Ninth – 2001 – Kristen Cecchi – Mesa Southwest Museum
Tenth – 2002 – Susan Celestian – Arizona Mining and Mineral Museum
Eleventh – 2003 – Anna Domitrovic – Arizona Sonora Desert museum
Twelfth – 2004 – Susan Celestian – Arizona Mining and Mineral Museum
Thirteenth – 2005 - Susan Celestian – Arizona Mining and Mineral Museum
Fourteenth – 2006 – Susan Celestian – Arizona Mining and Mineral Museum
Fifteenth – 2007 – Susan Celestian – Arizona Mining and Mineral Museum
Sixteenth – 2008 – Jan Rasmussen – Arizona Mining and Mineral Museum
Seventeenth – 2009 – Jan Rasmussen – Arizona Mining and Mineral Museum
Eighteenth – 2010 – Jan Rasmussen – Arizona Mining and Mineral Museum
Nineteenth – 2011 – Anna Domitrovic – Arizona Sonora Desert museum
Twentieth – 2012 – Phil Richardson – Clarion Hotel, Phoenix

During the twenty years there were seventy-seven different speakers plus several coauthors. These speakers gave a total of 172 talks. The record is held by Anna Domitrovic with twenty talks, one each year. Les Presmyk comes in second with seventeen talks. Jim McGlasson is next with eight talks and Dick Bideaux also gave eight talks before he passed away. The speakers and their topics are listed on the following pages.

Many thanks are due the co-chairs and the speakers. Also, thanks to all the other people who contributed to the symposiums by being sure the facilities were set up and there was food and drink for the breaks and lunch. Harvey Jong has designed the last eleven really great proceedings covers. Thanks to all.

Ray Grant

Twenty-Year Speaker Index for Minerals of Arizona Symposium

This index is for the first twenty years of the Minerals of Arizona Symposium. It includes the current year (2012). For the 2001 Symposium on Arizona type localities, the titles are given as Type Localities followed by the locality name. Multiple authors are listed with the speaker first followed by the names of the other authors.

Beck, Brian (2010) Crown King ore deposits
(2011) The Forgotten Silver District – Peck Mining District

Bideaux, Richard (1993) Minerals of Mammoth-St. Anthony Mine
(1994) History of the Study of Arizona Minerals
(1996) The Glove Mine
(1997) Arizona's Lost Minerals –Arizonite and Bisbeeite
(1999) The Saddle Mountain Topaz – Bixbyite - Spessartine Locality
(2000) The Old Yuma Mine, Pima County, Arizona: a Premier Vanadinite and Wulfenite Locality
(2001) Type Localities – Mammoth St.-Anthony, United Verde, and Ajo
(2002) A Lost Arizona Chromate Locality

Burt, Donald (1993) Topaz Rhyolites in Arizona and the Southwest
(1999) Mn-rich Metamorphic Minerals from Squaw Peak, Phoenix, Arizona

Callahan, John (2005) Minerals of the 79 mine, Gila County, Arizona

Carter, Mark (2009) Solar Wind, Searles Canyon, and Maynard Claims, Utah

Celestian, Stan (2003) An Earth Science Image Archive
(2004) Quartz from Date Creek, Yavapai County

Celestian, Stan and Richard Zimmerman (2007) Amethyst Hill

Coggins, Mason (1994) History of Gold Mining in Arizona
(1995) The Flagg Photograph Collection

Connel, Charlie (2004) Restoration of the Swallow Mine Stamp Mill

Davis, Ed (2000) The Four Peaks Amethyst Mine

DeMark, Ramon (2003) Minerals of the Blanchard Mine, Bingham, New Mexico

Dodd, Darrel (1999) Myths and Facts about Metals

Domitrovic, Anna (1993) Arizona-Sonora Desert Museum Mineral Collection
(1994) Wulfenite: a Distinguished Arizona Mineral
(1995) Arizona Psuedomorphs
(1996) The Castle Dome District
(1997) The Care and Feeding of a Mineral Collection
(1998) Taking Care of the Little Things – the Micromount Collection at the Arizona-Sonora Desert Museum
(1999) A Geological Traverse of the Baja Peninsula, Mexico
(2000) Mines and Minerals of the Patagonia Mountains and Santa Cruz County, Arizona
(2001) Type Localities – Bisbee
(2002) Ten More Years of Collecting in the Arizona Sonoran Desert
(2003) A look at the Minerals and Mines of Helvetia, Pima County
(2004) Minerals of the Silver Bell Mine, Pima County, Part 1
(2005) Richard Bideaux's Mineral Collection
(2006) Twenty-eight years at the Arizona-Sonora Desert Museum
(2007) Mineral Park District, Mohave County
(2008) Mines and Minerals of the Pima Mining District, Pima County, Arizona
(2009) Mines and Minerals of the Turquoise District (Courtland, Gleeson), Cochise County, Arizona
(2010) The Eureka Mining District and Vicinity (T13.5-15.5N, R9W
(2011) Mines and Minerals of the Amole District, Tucson Mountains, Pima County
(2012) Celebrating 40 years of Mineralogy at the Sonora Desert Museum

Duffy, Doug (1996) Lapidary Materials

Eastman, Kyle (2008) Inclusions in Quartz crystals from Crown King, Arizona

Everson, Beverley (2011) Rosemont Copper Project, Coronado National Forest

Garvie, Laurence (1999) Cactus Minerals

Gibbs, Ron (1994) Collecting Micro-minerals in the Big Lue Mountains, Greenlee County, Arizona
(2003) A New Creasyite Locality in Arizona?
(2004) Minerals of the Silver Bell Mine, Pima County –Part 2
(2011) Microminerals of the Evening Star mine

Gibbs, Ron and Turzi, Urban (2007) Minerals in the Mirolitic Cavities of the Belmont Mountains, Maricopa County

Godas, George and Ray Grant (1996) The Silver District

Graeme, Richard (1993) Supergene Minerals of Bisbee

Grant, Raymond (1993) Pegmatite Minerals of Arizona
(1994) Some Unusual Arizona Mineral Localities
(1998) An Unusual Arizona Type Locality
(2001) Type Localities – 7U7 Ranch and Hilltop Mine
(2002) Minerals added to the Arizona List Since 1995
(2006) Minerals replacing fossils

Grant, Raymond, Malcolm Alter, and Peter Williams (2010) Mineralogy of the Grandview mine, Grand Canyon

Harris, Samantha, Zach Freeman, and Erik Melchiorre (2004) Why is some cerussite yellow, and why do we keep blaming chrome?

Harter, Paul (2007) A glimpse at life in a mining camp through postal history

Harvey, Sharleen (2006) Arizona Minerals at the Rice Museum

Hay, Mark and Dick Morris (2007) Fluorite from the Oatman District

Heath, Randall (2004) The Arizona Wulfenite Project

Houhoulis, Marty (2007) Discovery and exploration of the Resolution copper deposit, Superior

Hunt, Bill (1996) Micromount Video

Jones, Evan (2005) Red Beryl from the Wah Wah Mountains, Utah
(2009) Paramelaconite from Bisbee Arizona – The Type Locality

Jones, Robert (1993) Private Mineral Collections in Arizona
(1994) Gems of Arizona
(2000) The Creations of Carl Faberge
(2003) Turquoise in the Southwest United States

Jong, Harvey (2000) Virtual Reality Photography, a New Way of Sharing Mineralogical Knowledge and Experience
(2005) A Virtual Tour of the 79 mine

Jong, Harvey and Ray Grant (2008) What's new in Arizona Minerals
(2009) What's new in Arizona Minerals

Jong, Harvey and Joe Ruiz (2010) Rare Minerals from Tiger, Arizona

Kazal, Louis (1994) Lithograms

Kepper, Jack (1995) Goodsprings, Nevada

Kimbler, Frank (2008) Uranium in Arizona

Lauretta, Dante (2001) Type Localities – Meteorites and Meteor Crater

Leicht, Wayne (1999) Minerals of the Grandview Mine

Liken, Paula (2000) New Mineral Exhibits at the Mesa Southwest Museum

Lowery, Ron (2007) Phelps Dodge's new mine at Safford

Lueth, Virgil (1996) New Mexico Bureau of Mines – New Mineral Museum

Lueth, Virgil, Joan Beyer, and Ron Gibbs (1996) Geology and Tellurium Minerals of the Lone Pine Area, Wilcox District, Catron County, New Mexico

Marty, Joe (2005) Minerals of the Ophir District, highlighting the Hidden Treasure Mine
(2006) Wulfenites of Western United States

McGlasson, Jim (1998) Chromate Minerals in Arizona
(2001) Type Localities – Chromates and the Belmont Mountains
(2002) Tellurium Minerals
(2005) Richard Bideaux, An American Mineralogist
(2006) Vanadium mineral occurrences in Arizona, a brief review
(2007) Remembrance of Sidney A. Williams
(2008) Historical Mining, Minerals and Recent collecting, Batopilas, Chihuahua, Mexico
(2012) History and Development of Mining in Arizona before Statehood (1912)

Megaw, Peter (1997) Mineralogy of Santa Eulalia
(2001) Type Localities – Tombstone

Meiran, Eugene (2007) "Best of America" the 2008 project

Melchiorre, Erik (2004) Rich Hill: Arizona's Most Amazing Gold district
(2006) The origin of Malachite and Malachite

Miller, Glenn (1993) Arizona Mining and Mineral Museum Mineral Collection

Mooney, P., R.T. Downs, and H. Yang (2006) Ramon Spectroscopy and the future of handheld instruments

Moore, Carleton (2010) How to find a meteorite in Arizona

Mueller, Wolfgang (2012) Gemstones of Arizona

Muntyan, Barbara (2008) Minerals from the lessor mines, San Juan Mountains, Colorado
(2009) Quartz from the Santa Nino mine area, Santa Cruz County, Arizona
(2010) Aquamarine from Sierrita Mountains, Pima County, Arizona
(2011) Oracle Granite Tourmaline
(2012) Minerals of Washington Camp and the Patagonia Mountains

Nasser, Sam (1995) The Museum Foundation's Collection
(1997) The Perils of Pauline - Collecting Minerals in the Desert

Stefan Nicolescu (2012) Arizona Territory Mineral Treasures in the Vaults of the Yale Peabody Museum

Niemuth, Nyal (1993) Minerals and Metallogenic Provinces of Arizona
(1998) Collecting on Public and State Land
(2004) Arizona Department of Mines and Mineral Resources Historic Photograph Collection

North, Robert (1995) Mineralogy of Morenci
(2004) Gem Materials of Southwestern New Mexico

Oliglieri, Marcus (2009) How new minerals are recognized and characterized
(2012) The Mineralogy of Arizona: Past, Present, and Future

Oligieri, Marcus, Harvey Jong, and Ray Grant (2010) What's new in Arizona Minerals
(2011) What's new in Arizona Minerals

Polman, George (1994) Fluorescent Minerals of Arizona

Posser, Ed (1998) Reflecting on Bill Hunt and his Micromounts

Potucek, Tony (2003) Epidote in the Santa Theresa Mountains
(2010) Smithsonite in Arizona
(2011) Arizona Mineral Treasures

Presmyk, Les (1994) History and Minerals of the Pioneer Mining District
(1995) Arizona Silver
(1996) Arizona Calcite
(1997) The Red Cloud Mine: an Update
(1998) Diamond Point, a Case History in Mining Mineral Specimens
(1999) History and Minerals of the Old Dominion Mine, Globe, Arizona
(2000) Mines and Minerals of the Globe-Miami Area of Arizona
(2001) Type Localities- Grand Reef Mine
(2002) Specimens Added to the Foundation Collections in Recent Years
(2003) Twenty-five years of Collecting at Morenci, Arizona
(2004) Bisbee – Queen of the Copper Camps
(2006) "You might be a mineral collector if ....."
(2008) The Mammoth-St. Anthony Mine, Tiger, Arizona
(2009) Mineral preparation and cleaning – 101

(2010) Arizona's Mineral Heritage – a new book project
(2012) 100 years of Statehood, 50 years of Collecting Arizona

Presmyk, Les and Raymond Grant (2005) Rhodochrosite and other manganese minerals in Arizona

Rasmussen, Jan (2008) Vision for the Arizona Mineral and Mining Museum
(2009) Wulfenite in Arizona
(2012) Mines and Minerals of the Tombstone Area, Arizona

Richardson, Phil (2005) Known as "old reliable: the Bingham Canyon Copper Mine, Utah

Rosenfeld, Alice (1995) Arizona Miners and Mineral Collectors an Oral History Project

Ruiz, Joe and Jim McGlasson (2001) Type Localities – Christmas and Rosemont

Schuh, Curtis (2003) Collectors and Collections in Arizona

Scovil, Jeff (1994) Vanadinites of Arizona
(1995) Photographing Arizona Minerals
(2002) Ten Years of Photographing Arizona Minerals

Smith, Kyle David (1993) Minerals of the Kullman-McCool Group

Stevens, George (1997) Minerals of the 79 Mine
(2003) Wulfenite Localities in the Lost Basin District, Mohave County

Thompson, Bob (2000) Camp Verde Evaporites

Wallace, Terry (1993) University of Arizona Mineral Collection
(1997) The Romero Collection

Weide, John (1999) Quartz, a Mineral with Many Forms

Wenrich, Karen (2002) Mineralogy of the Breccia Pipes in Northern Arizona

White, Sugar (2002) Collecting in Southern Arizona

Williams, Bill (2011) Minerals of the Mission Complex

Williams, Sid (1996) Petrography

Wilson, Wendell (1996) Arizona Wulfenite Project

Vacek, Jimmy (2002) Copper Gems of Arizona

Vozza, Vince (1998) Zeolites, the Misunderstood Minerals

Zimmerman, Richard (2005) Minerals of the Midnight Owl Mine, White Pichacho District, Arizona
(2006) Pseudomorphs

The Flagg Mineral Foundation 50th Anniversary

The Flagg Mineral Foundation, an all-volunteer, non-profit corporation, was formed in 1962 by members of the Mineralogical Society of Arizona as a memorial to honor the late Arthur Leonard Flagg. The original vision of the Flagg Mineral Foundation, an organization began as the A.L. Flagg Foundation for the Advancement of Earth Sciences and in the early 1990's as the Arizona Mineral and Mining Museum Foundation (A Memorial to A.L. Flagg), was to pursue the establishment of an Earth Science Museum in the Phoenix area. Early on a fortuitous turn of events led the Foundation to acquire a large and well-known collection of minerals: the Colleen and Loris P. Woolery collection, out of Bisbee, Arizona. The expanded goal, beyond the promotion of the earth sciences, was now to become the curator and guardian of this important collection.

Arthur Leonard Flagg, the man that we honor, spent his entire adulthood promoting the identification, collection, and study of minerals. He immersed himself in Arizona geology, became a prominent figure within the local mining industry, and as you will see, was a catalyst for a number of earth science related organizations focused on the study of minerals. As Arizona's "Mr. Rockhound", Arthur led the way for the collection and preservation of Arizona's rich mineralogical heritage.

Mr. Flagg was born in 1883 in Rhode Island, and moved out west to Arizona in 1906 after graduating from Brown University with a bachelor's degree in geology. Mr. Flagg spent his last 55 years in mining, geology, and particularly mineralogy holding an assortment of positions from assayer, surveyor, mining engineer, to Superintendent of the Mineral Department of the Arizona State Fair. Finally, in 1949, he was hired as the curator of the Arizona State Mineral Museum. Throughout his varied career, he also founded the Mineralogical Society of Arizona, was very active in the Small Mine Operators Association, and was cofounder of the Rocky Mountain Federation of Mineralogical Societies. Mr. Flagg became known as an expert on Arizona mineral resources. Among many of his mineral and mining publications, he authored two locality books: Rockhounds and Arizona Minerals and Mineralogical Journeys in Arizona. It is only fitting that his legacy was to have a foundation named in his honor.

Shortly after the A.L. Flagg Foundation for the Advancement of Earth Sciences was formed, one year after Arthur's death, the foundation learned

of the impending sale of the Woolery mineral collection. An ambitious fund-raising plan was implemented by then Flagg board chairman Floyd R. Getsinger, who was assisted by an Arizona specialty collector, Mr. Carl E. Stentz, for its potential purchase. During a presentation by Floyd to the Small Mine Operators Association, Arizona businessman and 79 mine operator, Mr. Charles E. Goetz, donated $12,000 to keep the Woolery collection in Arizona. The Foundation now had a collection and money enough to build cases.

Bolstering the Woolery collection, a number of fine acquisitions came to the Foundation over the years through a series of donations and purchases. The Flagg Mineral Foundation Collection Committee has refined the collection's holdings and focus, and has established a priority list, with our main emphasis on Arizona, and peripheral attention shown to Mexico and the southwest in general.

Today, the Flagg Mineral Foundation boasts a fine collection of Arizona, Mexican, and worldwide minerals which numbers approximately 800 specimens. Over the years, duplicates either have been donated to the Arizona Mining and Mineral Museum, (AMMM), or sold to support functions and displays within the AMMM. The pride of the Flagg collection remain those early Woolery specimens, particularly the Bisbee suite.

As its prime fundraiser, the Foundation has hosted the annual A.L. Flagg show since 1971, now the third longest running mineral show in Arizona. It began at the Dons Club base camp in the Superstition Mountains, moved to the Pioneer Historical Museum north of Phoenix, then to the Arizona State Fairgrounds in front of the original Mineral Museum. Every year since 1987 it has called the southwest parking lot of Mesa Community College home on the second weekend in January. The most recent Flagg show featured over 120 dealers and a number of earth science exhibits for the general public.

The Foundation has also maintained its focus on its educational mission. An annual one-day, Saturday, symposium has been held since 1983 highlighting the minerals, mineralogy, and localities of Arizona. The 10th and the 19th Symposiums were held at the Arizona-Sonora Desert Museum, partially in recognition of the support of Anna Domitrovic, curator emeritus of that museum. Field trips are arranged the following day, Sunday, for those intrepid collectors who wanted to get out and enjoy an Arizona spring day. This year a Friday night dealer 'tailgating' session has been added offering

the attendees, and the general public, an opportunity to acquire mineral, gem, and fossil material.

From 1991 until April 30th, 2011, the Flagg collection has been on public view, housed within the AMMM located at 1502 West Washington Street, in Phoenix, Arizona, near the state capitol building. Through a plan by Arizona's Governor, Jan Brewer, the AMMM has been placed under the responsibility of the Arizona Historical Society, and separated once again from the Department of Mines and Mineral Resources. The original goal was to rename it the Arizona Centennial Museum, celebrating the five C's of Arizona; copper, cattle, cotton, citrus, and climate. The resulting planned exhibits would severely-reduce the current emphasis for the display of Arizona's rich history of geology, mining, and mineral specimens. The direction of the museum has changed at least one more time, shows no signs of being able to open during the centennial year, or for that matter within the foreseeable future, and at this point the collection of the Flagg Mineral Foundation has been packed and is in storage. Approximately 250 of the Flagg Mineral Foundation's best specimens are on temporary loan to the University of Arizona, in Tucson. They can be found on exhibit in a bank of cabinets in the basement mineral section of the UA Flandrau Science Center, on the UA campus.

A rich heritage of Arizona mining and minerals has been obfuscated by politics. The Flagg Mineral Foundation will remain conscious of the mineral traditions of Arizona and the importance of mining to our history and economy. We will continue to vigorously promote the earth science as we look for future permanent display opportunities and the possible establishment and support of a similarly aligned museum.

Phil Richardson, April 5, 2012

Arthur Leonard Flagg

June 29, 1883 – April 27, 1961

Education: **Friends' School in Providence, Rhode Island**
BS Geology from Brown University in 1906.

As a young mining engineer, Arthur Flagg followed Horace Greeleys' advice and went west. His work included assaying, surveying, and mining in Yavapai County, Arizona in 1906 and 1907. From 1908 to 1912 he held a position as Mine Examiner in Durango, Mexico. This was just the beginning of a colorful, diverse, and adventurous career in minerals and mining.

- 1912 Entered private practice as a consulting mining engineer in Washington and Idaho.
- 1913 Became the manager of the Kelvin Sultana Copper Company, he worked for the company until 1919.
  1919 Resumed private practice as a mining engineer and officer of several mining companies.
- 1946 Appointed Superintendent of the Mineral Department of the Arizona State Fair.
- 1949 Hired by the State of Arizona Department of Mineral Resources to be the curator of the State Mineral Museum.

In 1953 the mining companies respected Mr. Flagg's knowledge and dedication so much that they worked to keep him in the position of Curator of the State Mineral Museum even though he could no longer be a state employee at the age of 70.

Mr. Flagg was a co-founder of the Mineralogical Society of Arizona and the Rocky Mountain Federation of Mineralogical Societies. He served as president of both societies and as president of the American Federation of Mineralogical Societies and the American Association for the Advancement of Science.

Mr. Flagg was the author of many mineral and mining publications and two books: *Rockhounds and Arizona Minerals* and *Mineralogical Journeys in Arizona*. Mr. Flagg is said to have personally known more about the mineral areas of Arizona than any other individual. If a person needed information about Arizona minerals, the rule was "ask Mr. Flagg".

The Flagg Mineral Foundation Mineral Collection

The Flagg Mineral Foundation (FMF), an all-volunteer, non-profit corporation, was formed in 1962 by members of the Mineralogical Society of Arizona as a memorial to honor the late Arthur Leonard Flagg-a well-known Arizona mining engineer, prolific mineralogy author, and an expert on Arizona mineral resources. The original vision of the FMF, which began as the A.L. Flagg Foundation for the Advancement of Earth Sciences, became in the early 1990s the Arizona Mineral and Mining Museum Foundation (A Memorial to A.L. Flagg), was to pursue the establishment of an earth science museum in the Phoenix area. Early, the fledgling Foundation acquired several large and well-known mineral collections which included the Colleen and Loris P. Woolery collection, of Bisbee, Arizona. With this acquisition as its core, the Flagg Mineral Collection has grown in importance and focus over the years thanks to a number of generous donations and select purchases. The expanded goal, beyond the promotion of the earth sciences, was now to become the curator and guardian of this important collection.

The collection was originally housed in the Mineral Museum building at the Arizona State Fairgrounds in Phoenix. From 1992 until its closing on April 30, 2011, the Flagg collection was on public display within the Arizona Mining and Mineral Museum on West Washington Street, in Phoenix, Arizona, near the state capitol building.

The FMF and the State of Arizona's mineral collections were packed and removed from display at the Arizona Mining and Mineral Museum after the closure. Thanks to a generous offer by the University of Arizona Mineral Museum, approximately 265 of the Foundation's select specimens were placed on display there.

Current efforts are underway to create a new privately-owned and funded Earth Science Museum in the Phoenix metropolitan area where once again the entire FMF collection will be on display.

January 2012