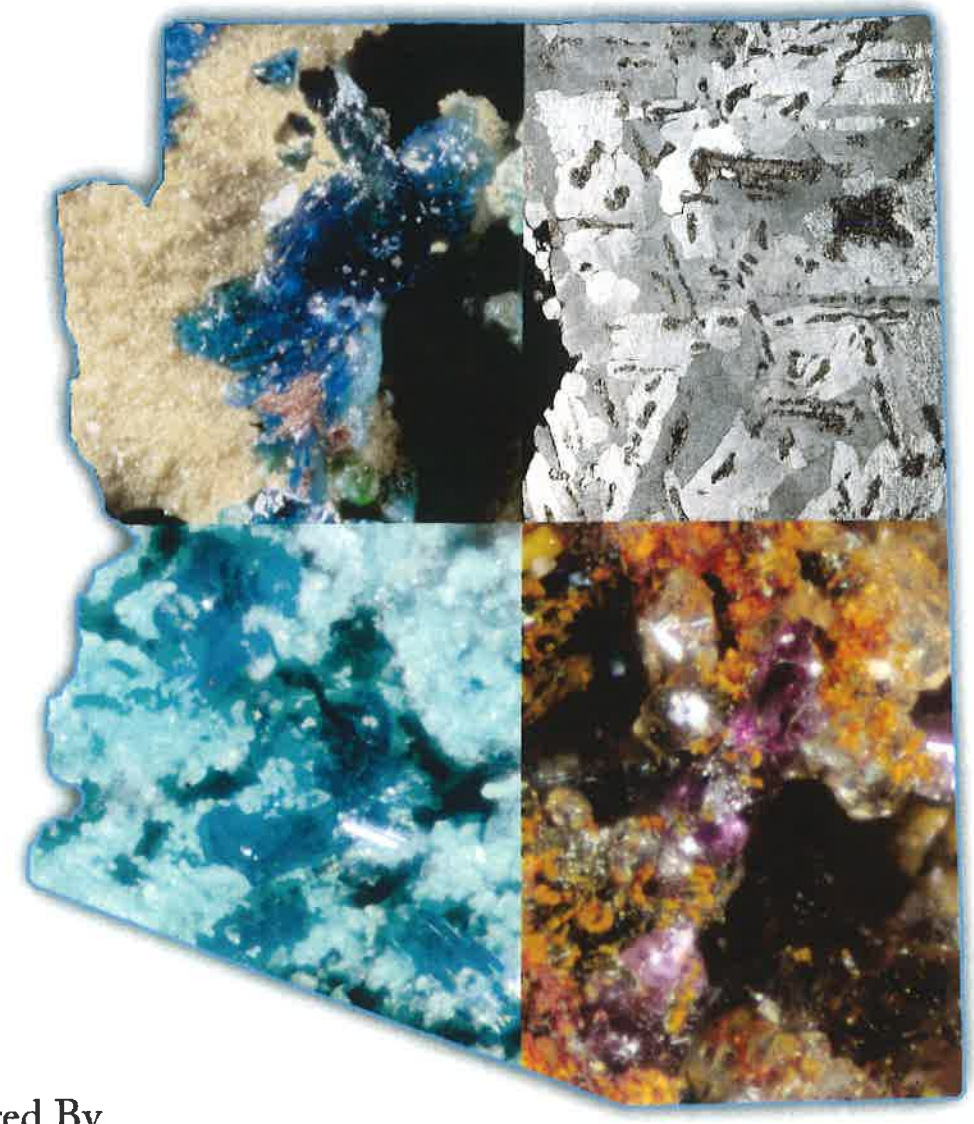
MINERALS OF ARIZONA

Eighteenth Annual Symposium



Sponsored By
Arizona Mineral and Mining Museum Foundation &
Arizona Department of Mines and Mineral Resources

Saturday March 20, 2010

Co-Chairpersons
Jan Rasmussen - Curator, Arizona Mining and Mineral Musuem
Ray Grant - Chair, Arizona Mineral and Mining Museum Foundation

Minerals of Arizona

Eighteenth Annual Symposium

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Saturday March 20, 2010
8 AM. to 5 PM.

Arizona Mining and Mineral Museum
15th Avenue and Washington
Phoenix, Arizona

Co-chairpersons:
Jan Rasmussen – Curator, Arizona Mining and Mineral Museum
Ray Grant – Chair, Arizona Mineral and Mining Museum Foundation

Cover Design by Harvey Jong

Photo credits:

Upper left corner: Osarizawaite, Grandview mine, Grand Canyon, Coconino County, Arizona – Harvey Jong specimen and photograph, field of view: ~ 1.5mm.

Upper right corner: Canyon Diablo meteorite, Coconino County, Arizona – Harvey Jong specimen and photograph, field of view: 4cm.

Lower left corner: Mammothite on atacamite, Rowley mine, Maricopa County, Arizona – Joe Ruiz specimen, Harvey Jong photograph, field of view: ~ 0.5mm.

Lower right corner: Yedlinite, Mammoth-St. Anthony mine, Pinal County, Arizona – Joe Ruiz specimen, Harvey Jong photograph, field of view: ~ 1.5mm.

Program

8:00 - 9:00 -	**Coffee Hour**
9:00 - 9:10 -	**Welcoming Remarks and Introductions**
9:10 – 9:40–	Arizona's Mineral Heritage – a new book project – Les Presmyk
9:40 – 10:10 -	Smithsonite in Arizona – Tony Potucek
10:10 – 10:50 -	**Break, Mineral Silent Auction**
10:50 – 11:20 -	Aquamarine from Sierrita Mountains, Pima County, Arizona – Barbara Muntyan
11:20 – 11:50 -	The Eureka Mining District and Vicinity (T13.5-15.5N, R9W), Yavapai County, Arizona –Anna Domitrovic
11:50 – 1:20 -	**Lunch, Mineral Silent Auction**
1:20 – 1:50 –	How to find a meteorite in Arizona – Carleton Moore
1:50 – 2:20 -	Crown King Ore Deposits - Brian Beck
2:20 – 2:50 -	**Break, Mineral Silent Auction**
2:50 – 3:20 -	Rare minerals from Tiger, Arizona– Harvey Jong and Joe Ruiz
3:20 – 3:50 -	Mineralogy of the Grandview mine, Grand Canyon – Ray Grant, Malcolm Alter, and Peter Williams
3:50 – 4:20 -	What's New in Arizona Minerals – Marcus Origlieri, Harvey Jong and Ray Grant
4:20 -	Field Trip Information, Minerals from Belmont Granite – Ron Gibbs

Insert – Reprint of Minerals in Miarolitic Cavities of the Belmont Granite, Belmont Mountains by Ron Gibbs and Urban Turzi, Minerals of Arizona Fifteenth Annual Symposium, March 10, 2007.

"Arizona's Mineral Specimen Heritage---The Specimens, Localities and Personalitites"

By Les Presmyk and Tony Potucek

Published by Gloria Staebler, Lithographie, LLC.

There have been numerous articles written and numerous books published on the mines, the mineral localities and the mineralogy of Arizona. Mineralogy of Arizona by Anthony, Williams, Bideaux, and Grant is one fine example as are the articles that have appeared over the years in Rocks and Minerals and Mineralogical Record. There is not a book that covers the collectors' side of Arizona minerals; those intrepid individuals who because of where they worked or how they spent their recreational hours collecting the specimens that now adorn private and public collections.

So, to celebrate all of us who have decided it is worth collecting Arizona minerals, both with a silver pick and a three pound sledge, and to celebrate Arizona's centennial, this book will be written, published and presented for sale at the 2012 Tucson Show. Gloria Staebler, who publishes the extra Lapis issues, most recently Smithsonite, and also American Mineral Treasures, among other projects, has graciously agreed to publish and market the book. To allay Paula's concerns about what Tony and I might write, Ray Grant has graciously consented to be our technical editor, although some of the back and forth between Tony and me already probably has Gloria wondering what she has gotten herself into.

The book's chapters will be arranged by periods of time rather than specific localities, mining districts, or mineral species. So, there will not be Bisbee or Morenci or Globe-Miami chapters but rather sections within each chapter highlighting the collectors and mineral specimens coming from the producing localities during that time period. Bisbee will probably be in most of the chapters but mines like the Silver King or the Stonewall Jackson will only be heard from in one or possibly two chapters or the Red Cloud and Morenci will have specimen production early in the history of Arizona, possibly in a middle period and then in the last 20 or so years.

Yes, we will deal with the gemstones of Arizona, as well, including turquoise, gem chrysocolla, peridot, and fire agate. Before Tony gets any further involved, and to get equal billing as co-author, he has to write the sections on fire agate and the Camp Verde evaporate minerals, to my satisfaction. Okay, I will do the Camp Verde collecting areas but Tony still has to think about fire agate.

We want to highlight the localities that have produced great specimens, the collectors and their stories; why they were drawn to a particular locality or the story about the pocket they found, who was involved and where the specimens are now. We want to show why Arizona is certainly one of the greatest mineral specimen producing regions in the country and probably the world. It is the characters who brought the specimens out who are as important as the specimen legacy they left behind. Ed Over, Arthur Montgomery, Dick Jones, Roy Jones, Arthur Flagg, Dick Bideaux, Gene Schlepp, Wayne Thompson, Mark Hay, Bob Jones, Evan Jones, Fred and Sammy Jones, Dick Morris, Ray Grant, Dick Graeme, Richard Graeme and Douglas Graeme,

George and Archie Griffith, Harold Talbot, Roy Jones, Dan Caudle, Clayton Gibson, George Godas, Graham Sutton and Bill Hawes, Jim and Joyce Vacek and the list goes on. The institution collections will be featured including the University of Arizona, Arizona Mining and Mineral Museum, the Arizona-Sonora Desert Museum, Arizona State University and others. Organization histories that will be captured include the Tucson Gem and Mineral Society, the Maricopa Lapidary Society, the Mineralogical Society of Arizona and the Arizona Mineral and Mining Museum Foundation.

We have divided the history of collecting in Arizona into seven periods, pre-1875, 1875 to 1900, 1901 to 1930, 1931 to 1955, 1956 to 1975, 1976 to 1995, and 1996 to present. These may change as we compile the stories and information that will make this book happen. These will include your collecting stories and photos, of the localities and the great specimens that came from there. It is not our intent to document every locality but we do want to capture those localities whose specimens would grace any Arizona collection and preferably even a world-wide collection. We need to have all of the stories submitted by September 2010.

Information and photos can be submitted to either Tony Potucek or me at the following addresses:

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Please realize that any photos you submit will have to remain with us until at least September, 2011. I would suggest not submitting the original photo until early next year. However, if you can send up a pdf or similar electronic file, at least we can start the preliminary sorting for the various localities. Tony and I will have some input into the photo selection but Gloria will have the final say. We would also like to know about specimens that you know about, who owns them and how we can get photographs. Gloria can be reached at:

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MINERALOGICAL JOURNEYS IN AZ - A.L. FLAGG
ROCK TO RICHES CHARLES H. DUNNING

Collecting Arizona's Premier Smithsonite Localities

Tony Potucek

Show Low, Arizona

Arizona arid conditions, extreme groundwater depths, and deep oxidation zones provide near optimum conditions for sulfide ores to produce many colorful and well crystallized secondary minerals. With an abundance of base metal mines, the state has its share of collector-quality smithsonite localities. During the 1970s, while based in Tucson, Arizona, many of these localities were collected by the author and a number of collecting partners. Much of the information of these favorite Arizona smithsonite localities are based on underground experiences.

Located about a kilometer north of Gleeson, the Silver Bill Mine is accessed by a declined shaft and large surface stope on the west side of Gleeson Ridge or the Mystery Tunnel on the east side. While not particularly known for its smithsonite, an area north of the decline's bottom was zinc-rich, running 20 to 30 percent zinc when it was being mined. A winze accesses the area, called the Copper Stope. The authors and others collected this area heavily in the mid to late 1970s. The dominant zinc mineral in the area is smithsonite, but much of it is not of interest because of its massive appearance as drab-looking limestone-like "dry-bone." In contrast, the aesthetic mammillary crusts and balls of rosasite are well known among collectors; the quality of these specimens rivals or exceeds any rosasite found elsewhere. Light green to blue-green smithsonite occurs as botryoidal groups to rounded rhombohedral crystal clusters up to about 7 centimeters and as drusy coatings on wad of similar size or smaller. The luster is very good to somewhat dull, with the duller smithsonite occurring as thicker mammillary crusts on wad.

About 50 kilometers northwest of Tucson, the Silver Hill Mine is located on the south side of the Waterman Mountains. The mine accessed an oxidized copper orebody in limestone; the ore was primarily composed of azurite and malachite. In the late 1970s and early 1980s, collectors worked the mine for specimens including azurite, malachite, smithsonite, rosasite, aurichalcite, and the rare mineral osarizawaite. Silver Hill smithsonite occurs as indistinct white to very light green to light gray rice grains associated with rosasite and aurichalcite on a limonitic matrix. In addition, moderately thick, attractive, light green to variably blue botryoidal crusts were found in at least one area of the workings. The best

pockets were discovered by a number of collectors over a period of several years in the late 1970s and early 1980s.

The Glove Mine is located in Santa Cruz County, near Amado, Arizona, on the southern flank of the Santa Rita Mountains. In the 1950s, a series of solution cavities and fractures in the mine produced spectacular wulfenite specimens, which deservedly became world famous.

Good smithsonite specimens have been recovered from near the bottom of the main easterly plunging ore shoot, which is equivalent to the 300 level of the mine. While smithsonite is common as dry bone ore and dark brown to limonite-coated ribs and flattened odd-shaped pieces, good specimen-quality smithsonite is limited to small cavities in the limestone and oxides. Color ranges from white to gray to light green. The better smithsonite is also found off the 300 level, where it lines cavities and forms small botryoidal groups with very nice luster. The color is light gray to white.

The 79 Mine produces Arizona's best, crystallized smithsonite specimens. The mine is located in the Banner Mining District, about 8 kilometers northwest of Hayden, Arizona, near the southwest corner of Gila County. Prominent mineral collector George Godas and his partner John Callahan now own the mine. This base metal mine has an extensive oxidation zone down to about the fifth level. Notable collector quality minerals from the 79 Mine include wulfenite, aurichalcite, hemimorphite, mimetite, rosasite, cerussite, chrysocolla, calcite, and smithsonite. While the smithsonite is present throughout fractured mineralized areas of the oxidized zone (and even associated with pyrite and quartz on the sixth level), much of it is not collector quality. However, the best collector quality smithsonite occurs just above the fourth level and down to the fifth level. It is intimately associated with the aurichalcite area on the fourth level and immediately below. The smithsonite lines cavities and forms ribs composed almost solely of smithsonite. The most desirable color is apple green; other colors include gray, tan, olive, yellow, white, and blue. Elsewhere in the mine, smithsonite occurs as isolated rounded rhombohedra and, more commonly, lines cavities in the fractured and oxidized limestone. Beautiful ribs and plates are quite often studded with calcite crystals, rosasite balls and blebs, aurichalcite, hemimorphite sprays, and wulfenite.

Outside of Bisbee in Cochise County and the Red Cloud Mine in La Paz County, the Mammoth-St. Anthony mines in Pinal County probably produce the best known Arizona minerals. The mines have been closed for years, and the shafts are now plugged, and there is no access. One of the lesser known minerals from the Mammoth-St. Anthony mines is smithsonite. It occurs are reasonably nice

specimens and is a top 5 candidate for Arizona. While we don't have much information, we know that smithsonite was widely distributed in the ore zones but was probably not always recognizable, largely because it occurred as drab-colored dry bone type porous masses in the veins and was usually gray, white, or tan. Botryoidal, green to white and even light blue crusts of smithsonite were found adhering to limonitic matrix also occurred within the oxidized portions of the vein fillings, however.

Surviving specimens in private and institutional collections are typically individual pastel-colored light green or gray to light blue balls of smithsonite approaching 2 centimeters that are on a limonite matrix. These balls all show some veining or crusting of what is probably another generation of smithsonite. More rarely, small colorless rhombahedra of smithsonite are found adhering to wulfenite and vanadinite.

THE HUNT FOR SIERRITA MOUNTAIN AQUAMARINE

Barbara L. Muntyan
Tucson, Arizona

This is a detective story: how a collector goes about finding a "lost" mineral locale.

Aquamarine, the gem variety of beryl, is not abundant in Arizona, especially in large crystals. There are a few localities reported, including one in the Sierrita mountains in Pima County. There have also been occasional reports of aquamarine crystals up to 1 inch from the Swisshelm Mountains. Recently, aquamarine crystals were collected in the Santa Teresa Wilderness area of Graham County, including one excellent spray of terminated crystals approximately 2 1/2 inches across, without matrix, now in the collection of Evan Jones.

In September, 2008, I obtained a single aquamarine crystal from another collector; it was a cloudy sky-blue color, with minor mica association, 2 1/4 inches long and without matrix. The specimen was labeled as having been found at the *"Palo Verde claim, Sierrita Mountains, Pima County, Arizona."* The label was one of Les Presmyk's, so I called him to find out more about the specimen's origin. He told me that it had come from the late Dick Jones, the claim designations of Palo Verde and Bella Donna claims were given by Jones, and that Jones had collected this crystal and others in the 1960s. Presmyk had no reason to doubt the information. Thus began my quest to find this lost aquamarine locality.

Neither the "Bella Donna" nor the "Palo Verde" claims were ever patented, so there is no record of location. Moreover, Jones was known to rename and/or "relocate" his digging spots in order to discourage others horning in on his finds (the well-known Catron County, New Mexico purple octahedral fluorites being an example).

Checking the literature, only one locality was found for Pima County, named the Bella Donna claim. "*Massive and crystals of blue-green... in quartz veins in granite*" were described by Galbraith and Brennan in 1959 and subsequently repeated in both editions of the *Mineralogy of Arizona* by Anthony *et al.* F. L. Ransome in "*Ore Deposits of the Sierrita Mountains of Arizona*", in U.S.G.S. Bulletin 725, wrote in 1922 that the "Sierrita Mountains consist essentially of an intrusive granitic core flanked by more or less metamorphosed rock of sedimentary and eruptive origin." There are a number of unpublished theses on the Sierrita Mountains in the University of Arizona Libraries, but they shed little light on the aquamarine occurrences.

The next step was looking at aquamarine specimens in other collections which were from the Sierrita Mountains. This was to familiarize myself with what the material I was seeking looked like. The Arizona Sonora Desert Museum has two specimens labeled from the Sierrita Mountains. The Flandreau Museum has several specimens for different pockets in the Sierritas. Evan Jones owns a fine little matrix aqua about 1 1/4 inch long, deep sky-blue and quite gemmy, supposedly coming from the Bella Donna claim. Les Presmyk has two crystals: one a toenail size single crystal from the same pocket as Evan's. The other specimen is a fine 3" crystal on massive white quartz matrix and is a cloudy medium sky blue, labeled as coming from the Palo Verde claim. Both of Presmyk's pieces were supposed to have been collected by Dick Jones and were previously in the collection of the late Tom McKee of Scottsdale. Yet another collector had a matrix piece in his rock garden which contained several sky blue crystals on massive white quartz with minor mica; he presented this specimen to me as a gift.

The only factual bit of information from the literature search seemed to be that aquamarine has been found in quartz veins in granite. This was certainly compatible with the musings of some old-time collectors. Thus a review of the geology and topography of the Sierrita Mountains seemed to be the next step. Then would follow a slow, systematic program of looking for white quartz float while covering as much ground possible, This strategy seemed to point the way to at least narrowing down the search area of the roughly 60 square miles of rugged Sierrita Mountains.

This mountain range is more or less lens-shaped, about 12 miles long from north to south and perhaps 5-6 miles wide. There are virtually no roads into the heart of the range. Mission Road bounds the mountains on the east and State Highway 286 on the west. Samaniego Peak is the highest in the mountains chain, at 6,000 feet. There are broad bajadas flowing outward in all directions, and these are cut by numerous washes and arroyos. Vegetation is sparse: grasses, ocotillo, cholla, occasional barrel cactus, mesquite and palo verde trees, and not much more. The San Javier section of the Tohono O'odham reservation bounds the north side of the Sierritas. The majority of the mountain range is public land (BLM or State), much of it leased out for grazing. There are several large ranching operations which run Charlois cattle, a religious commune on the east side, and a number of smaller properties including the Wrangler Ranches, Ocotillo Ranches, and the Diamond Bell Ranch subdivisions of 1 to 5 acres on both the east and west sides.

On one of the expeditions to look for aquamarine, my collecting partner, Sheila Powell of Tucson, and I stopped the vehicle on a hillside because the track we were following clearly cut a white quartz dike. As soon as we stopped and got out, I spotted telltale sky blue – small, weathered aquamarine crystals to 1/2 inch on white massive quartz. By most standards, these were pretty poor specimens, but they *were* aquamarine. And they were our first personal validation of the earlier reports. A subsequent grid search of that hill pro-duced about a dozen other examples of aquamarine, all massive and all found as crack-filling between massive white quartz. Over the next eighteen months, a lot of time, energy, and will power

was spent trying to locate more -- and hopefully better – aquamarine (and perhaps the "lost" Bella Donna and Palo Verde claims).

The quartz float in the Sierritas is generally flat-lying and masked by tall grasses and is not easy to spot until you are right on it. As the grid search was extended, we did come upon several zones with scattered pegmatite outcrops. This basically meant finding concentrated white quartz float. From experience, we knew that white quartz alone without coarse feldspar and mica, preferably coarse mica, was less likely to contain aquamarine crystals, although some had been found enclosed in massive white quartz alone and several aquamarine crystals occurred in massive feldspar and in the granite itself.

To date, we have located and inventoried approximately 300 separate quartz outcrops in twelve distinct pegmatite regions. They occur from the northwest side of the Sierrita mountains all the way around to the middle of the east side of the range. So far we have found ten pegmatite outcrops which contain aquamarine crystals. That is slightly over 3%. Years ago, writing on the Pikes Peak granite in Colorado, I estimated that for every ten holes dug, one contained a crystal pocket, and for every ten such pockets, only one contained good crystals. That is 1% success ratio, so we are having somewhat better luck in Arizona.

It would be nice to think that we had found either the lost Bella Donna or the Palo Verde claim and we probably have. In fact, some of our specimens look very similar to the matrix piece owned by Les Presmyk and labeled "Palo Verde claim." We have collected several flats of aquamarine specimens on matrix from various crystal pockets. However, neither Dick Jones nor the Bella Donna operators likely would have left that much material in plain sight. While it is possible the pegmatites furthered weathered and broke down, thereby exposing these specimens, it is unlikely, given the dryness of the area (no frost heaving).

My opinion is that there is surely more aquamarine "out there," assuming you are searching in the right geology and are persistent enough. That may also be true for other Arizona aquamarine locales. And for all mineral locales. Proper research and lot of persistence will yield results.

"Never quit looking."

THE EUREKA MINING DISTRICT & VICINITY (T13.5-15.5N, R9W) YAVAPAI COUNTY, ARIZONA

Anna M. Domitrovic
Curator *Emeritus*
Arizona-Sonora Desert Museum
Tucson, Arizona

The Eureka Mining District lies in Yavapai County, west central Arizona, about 100 miles northwest of Phoenix and 42 miles west of Prescott. It includes such notable mines as Bagdad, the Black Pearl, Hillside and the Old Dick. This presentation will encompass the area from T13.5-15.5N, R9W, with details of the district gleaned and extrapolated from the history of the Bagdad Mine.

The district and vicinity lies within the Mogollon (Mountain) geographic province, central volcanic highlands stretching across the state from northwest to southeast. Consequently, rocks are igneous in origin (basalt, granite and rhyolite) and metamorphic schists, intruded by a series of dikes and plugs. Quaternary sediments buried portions of the district during the Pliocene/Pleistocene, which, by that time, had experienced considerable uplift.

Using information from studies at the Bagdad Mine, the district's ore deposits are based on extrapolation of the deposit at Bagdad. Red and brown iron staining on the granite porphyry is widespread throughout the district and is thus an indication of the presence of an ore body in the area. It had been determined that the ore is of three types - hypogene (primary lead sulfides, the result of ascending thermal solutions), supergene (enrichment from descending solutions) and oxidation of the hypogene and supergene sulfides.

The principle ore mineral discovered and mined is chalcocite with minor chalcopyrite and pyrite. Some molybdenum lenses have been noted in veinlets and microveinlets, but not in veins containing copper. A paragenetic sequence of events shows early deposition of arsenopyrite, with quartz, pyrite and gold continually deposited throughout the formation of the ore body. Galena, sphalerite and chalcopyrite were deposited about the middle of the ore body's formation; and tetrahedrite, argentite and manganosiderite arrived late.

The history of the district began about 1886 when the first claims were discovered at Bagdad, the district's principle copper mine. But these claims were not seriously worked until about 1906 when the Giroux Syndicate laid claim to Bagdad. In 1908, the Bagdad Copper Company took over Giroux Syndicate's claims, followed by Bagdad Copper Corporation in 1930 mining underground. The transition to open pit mining began in 1945 and continued through ownership by Cyprus Amax Minerals Company until Phelps Dodge absorbed Cyprus and the Bagdad Mine in 1999. And in 2007, Phelps Dodge merged with Freeport-McMoRan, current operator of the Bagdad Mine.

THE EUREKA MING DISTRICT & VICINITY
THE MINERALS

acanthite
adularia
albite
allunite (orthite)
andalusite
andersonite
anglesite
anthophyllite
antlerite
apatite (carbonate-rich)
analcime
argentite
arsenopyrite
atacamite
azurite
barite
bayleyite
bermanite
beryl
biotite
bismite
bismuthenite
bismutite
bohmite
bornite
brochantite
calcite
carbonate-fluorapatite (francolite)
carnotite
cerargyrite
cerussite
chalcanthite
chalcedony (quartz)
chalcocite
chalcopyrite
chamosite
chlorapatite
chloragyrite
cobaltoan arsenopyrite
chlorite group
chrysocolla
clay
conichalcite
copper
covellite
cubanite
cuprite (chalcotrichite)
enargite
epidote
feldspar group
ferrimolybdate
fluorapatite
fluorite
galena
goethite
gold
goslarite
grossular
gypsum
hectorite
hematite
hemimorphite
herschelite
hisingerite
hureaulite
ilmenite
jarosite
johannite
kaolinite
lepidolite
leucophosphite
limonite
mackinawite
magnetite
malachite
manganosiderite
melanocalcite
mimetite
molybdenite
montmorillonite
muscovite
natrolite
natro-zippeite
nickel-zippeite
olivenite
opal (quartz)

THE MINERALS, con't

orthoclase
paulkerrite
pharmacosiderite
phosphosiderite
pyrite
pyromorphite
pyrrhotite
pumice
quartz
rutile
saponite
scheelite
schrockingerite
sericite
siderite
sillimanite
silver
smithsonite
sodium-zippeite
spurrite
sphalerite
strengite
swartzite
switzerite
talc
tennantite
tetrahedrite
torbernite
tourmaline
triplite
uraninite
vivianite
willemite
wolframite
wulfenite
zinc-zippeite
zippeite
zoisite

THE EUREKA MINING DISTRICT & VICINITY
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MAPS

Arizona Bureau of Mines (AZGS) "Geologic Map of Yavapai County, Arizona", 1958

U.S. Geological Survey, 15 minute topographic, "Bagdad, Arizona", 1948

How to Find Meteorites in Arizona

By Carleton B. Moore
Professor Emeritus
Arizona State University
Meteorite Center

Over fifty meteorites from different locations have been found in Arizona. The majority of finds have been in the counties of Mohave, Maricopa, Pima and Cochise. The luck of finding a new meteorite is both a function of population and an interest of local hunters, usually spiked by a reported successful find.

Only two falls have been recovered. The Holbrook chondrite fell in 1912 just east of that community. Following the pattern of many stony meteorite falls it scattered thousand of fragments over a wide area. Pieces may still be found near the Aztec railroad siding just east of Holbrook. In 1998 I spoke with Pauline McCleve of Tempe who was a teenager when the meteorites fell over her family ranch in Holbrook. She said, "We thought we were going to die." Her family picked up several hundred pounds of meteorites that they sold to the Foote Mineral Company. Good luck.

The only other recovered fall from Arizona was last year. It is named Whetstone.

The recovery of finds is a combination of luck and talent. I think finding meteorites is as much an art as a science. A metal detector sometimes helps but a good eye and knowledge of what meteorites look like is important, together with a strong magnet to check likely suspects.

The best place to look is on ancient desert pavement where the black meteorites may have survived for many years and stand out from the often light colored granitic rocks around them.

Some of the most recent Arizona finds include three pieces along the Wickenburg-Vulcan Mine Road. These were part of a shower and there are likely more pieces near there.

A recent find near Kingman is the Gold Basin strewn field where well over 1000 small pieces have been recovered. The first were recognized by Jim Kreigh of Tucson who was successfully looking for gold in the area. He and his hunting partner Twink Monrad started the success that had attracted other searchers to the area. The meteorite is an ordinary chondrite that fell about 18,000 years ago.

CROWN KING ORE DEPOSITS

Brian Beck, Beck Environmental and Remediation, Ltd.

The geology of the Crown King Area is described as part of the Bradshaw Mountains in with the USGS Bradshaw Mountains Folio #126, 1905. The geology definitions of the area has changed with radiometric dating of the geologic units and more detailed mapping of the region north of Mayer.

In a series of steeply dipping (60 to 85 degrees), northeast-southwest trending structures that are cross-cutting all other geologic units, are the Quartz Dikes/Veins, which occur in or along what appears to be a series of en echelon faults. The relative age of these Quartz Dikes/Veins is between 24 and 33 million years old. These faults do not show any lateral (strike slip) movement past a few tens of feet, but appear to have dip slip movements of several hundred feet at least. The mineralizing solutions were deposited along the fault surfaces, but in an apparent, distinct manner. The style of these deposits can be termed "saddle reef" or lenticular, where a flexture in the fault surface separated sufficiently to allow mineralization to occur.

The Quartz Dikes/Veins have a very distinct mode of occurrence in both the internal structure and mineralogy of the ore deposits. From the name of the structure, Quartz Dike/Vein, quartz is the main mineral found. The quartz is found in several different forms within the structure and does not appear to have distinct mode of occurrence. These forms of quartz are:

I. Massive Quartz
   Grading from a semi-clear textured quartz to milky quartz.
II. Granular Quartz
   This quartz typically has semi-equate appearance.
III. Drusy and Comb Quartz
   Commonly, pockets of drusy quartz are found within the upper portion of the ore deposits and can grade into comb quartz bands which will parallel the side walls of the fault. The drusy quartz size range from 0.01 inches to 0.5 inches. The comb quartz has been found to up 4 inches, but typically are less than 0.2 inches.
IV. Blue Quartz
   Pockets of a very distinct blue quartz are found in the upper portion of the ore deposits and have a flinty texture and flow banding.

There is very little, if any, intrusion of quartz into the country rock. The only observed occurrence was with a secondary fault or fracture that appeared to be filled at the same time as the ore deposition.

The common metallic minerals found are: pyrite, arsenopyrite, sphalerite, chalcopyrite, galena, tetrahedrite, anglesite, hematite, and magnetite. Pyrite is the most common of the metallic minerals, followed by sphalerite, chalcopyrite, galena, tetrahedrite, aresenopyrite and anglesite. Hematite and magnetite commonly appear as small grains (up to 0.1 inches) within the quartz.

Rare minerals observed in these veins are: molybdenite, gold, native silver, argentite, horn silver, ankerite, jarosite, barite and siderite.

Rare Minerals from Tiger, Arizona

Harvey Jong and Joe Ruiz

The mines near Tiger, Arizona have produced many spectacular mineral specimens. The various mines, the Collins, the Mammoth, and Mohawk-New Years, were consolidated in 1934 and are collectively known as the Mammoth-St. Anthony mine. Currently, ninety-nine species have been reported for this locality and include both common and rare minerals. A previous *Minerals of Arizona* symposium presentation[1] provided a history of the mine and specimen collecting along with exceptional, large-size examples of more common minerals. This program, however, will focus on rare species which tend to have dimensions of only a few millimeters.

The rare minerals from Tiger have always attracted the attention of mineral collectors and mineralogists. Tiger minerals were one of the favorite subjects of Richard Bideaux, and he commented:

> "The nearly 100 species recognized to date seem to occur in endless combinations; while outstanding cabinet specimens of some of the minerals were produced, the full impact and range of the mineralogy can only be appreciated in micromount-size crystals."

In 1980, he proposed that some of the rare minerals formed via an anomalous oxidation sequence.

This presentation begins with an overview of the geology of the gold-molybdenum-vanadium-lead-zinc deposits of the Mammoth area. Two "behind-the-scenes" discussions follow that describe the making of the minerals and the making of the mineral photos.

The paragenesis of Tiger minerals is complicated where more than one generation of nearly every secondary species and widespread pseudomorphism have been observed. The making of the minerals segment will review Creasey's six stages of mineralization and Bideaux's "closed system" theory on the formation of complex copper-lead minerals.

Photographing millimeter to sub-millimeter crystals presents many challenges, and the making of the mineral photos section covers some recent developments in digital photomacrography and photomicrography. Both hardware and software for rendering extended depth of field images are described.

The program concludes with several examples of rare Tiger minerals, including some recent finds.

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[1] Presmyk, Les, The Mammoth-St. Anthony Mine, Tiger, Arizona, *Proceedings of the 16th Annual Minerals of Arizona Symposium*, March 15, 2008.

List of Minerals from the Mammoth-St. Anthony mine:
99 valid species, 9 type minerals

(after mindat.org)

Acanthite
Alamosite
Allophane
Amesite
Anglesite
Antigorite
Atacamite
Aurichalcite
Azurite
Barite
Beaverite
Bideauxite (TL)
Biotite
Boleite
Bornite
Brochantite
Calcite
Caledonite
Cerussite
Chalcanthite
Chalcocite
Chalcopyrite
Chlorargyrite
  var: Bromian Chlorargyrite
Chrysocolla
Connellite
Covellite
Creaseyite (TL)
Crocoite
Cuprite
  var: Chalcotrichite
Descloizite
  var: Cuprian Descloizite
Devilline
Diaboleite
Dioptase
Djurleite
Epidote
Fluorite
Fornacite
Fraipontite
Galena
Goethite
Gold
Hematite
  var: Specularite
Hemimorphite
Hisingerite
Hollandite
Hydrocerussite
Iodargyrite
IMA2009-068 (TL)
Iranite
Leadhillite
Linarite
Macquartite (TL)
Magnetite
Malachite
Mammothite (TL)
Matlockite
Melanotekite
Microcline
Mimetite
Minium
Mixite
Mottramite
Munakataite
Murdochite (TL)
Muscovite
Palygorskite
Paralaurionite
Paratacamite
Phosgenite
Phosphohedyphane
Pinalite (TL)
Plancheite
Plumbonacrite
Plumbotsumite
Pseudoboleite
Pyrite
Pyrolusite
Pyromorphite
Quartz
  var: Amethyst
Queitite
Ramsdellite
Rosasite
Shattuckite
Silver
Smithsonite
Sphalerite
Stolzite
Sulphur
Surite
Tenorite
Tetrahedrite
Tsumebite
Vanadinite
Wherryite (TL)
Willemite
Wulfenite
Wurtzite
Yedlinite (TL)

(TL) = type locality

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Geology and Mineralogy of the Grandview Copper mine, Grand Canyon, Arizona

Ray Grant, Malcolm Alter, Peter Williams

The Grandview mine (also called the Last Chance mine) is located on Horseshoe Mesa near the South Rim of the Grand Canyon. Pete Berry located the property in 1890. In 1892 and 1893 he and others built a four-mile long trail up 2,500 feet from the mine to the rim.

Copper mining began in 1893. The ore was hauled by mule train (eight to ten mules) to the rim. From there the ore was taken by wagon to the railroad and then by train to the smelter in El Paso. The mine workings were extensive considering the location. There were 7 levels with over 3000 feet of tunnel and hundreds of feet of shafts and winzes. Mining ended in 1916 and it is reported that $75,000 worth of copper was mined.

The deposit is one of the many collapse breccia pipes located on the Colorado Plateau. Extensive cave systems formed in the Redwall limestone. This was followed by collapse of the overlying formations into the caves forming the breccias. Initial mineralization of this breccia occurred in several episodes from 200 to 260 million years ago. The Grandview deposit is unusual in that most of the breccia pipe has been eroded away and only the bottom level in the Redwall limestone remains. It is also unusual in that it is the one breccia pipe deposit well known to mineral collectors. The mine is famous for the cyanotrichite collected there. They are among the best cyanotrichite specimens in the world. Recent work on the minerals from the Grandview mine have found several minerals new to the Arizona list and a new mineral species.

Thirty-five mineral species have been identified from the Grandview. They are mainly carbonates, sulfates, and arsenates of copper, zinc, uranium, lead, iron, aluminium, and calcium. These minerals formed from the oxidation and weathering of the primary minerals during the more recent erosion of the Grand Canyon. New for the Arizona mineral

list are arthurite and philipsbornite and the new species is grandviewite.

GRANDVIEW MINE MINERAL LIST

Sulfides
- Chalcocite
- Chalcopyrite
- Covellite
- Pyrite

Oxides
- Cuprite
- Goethite

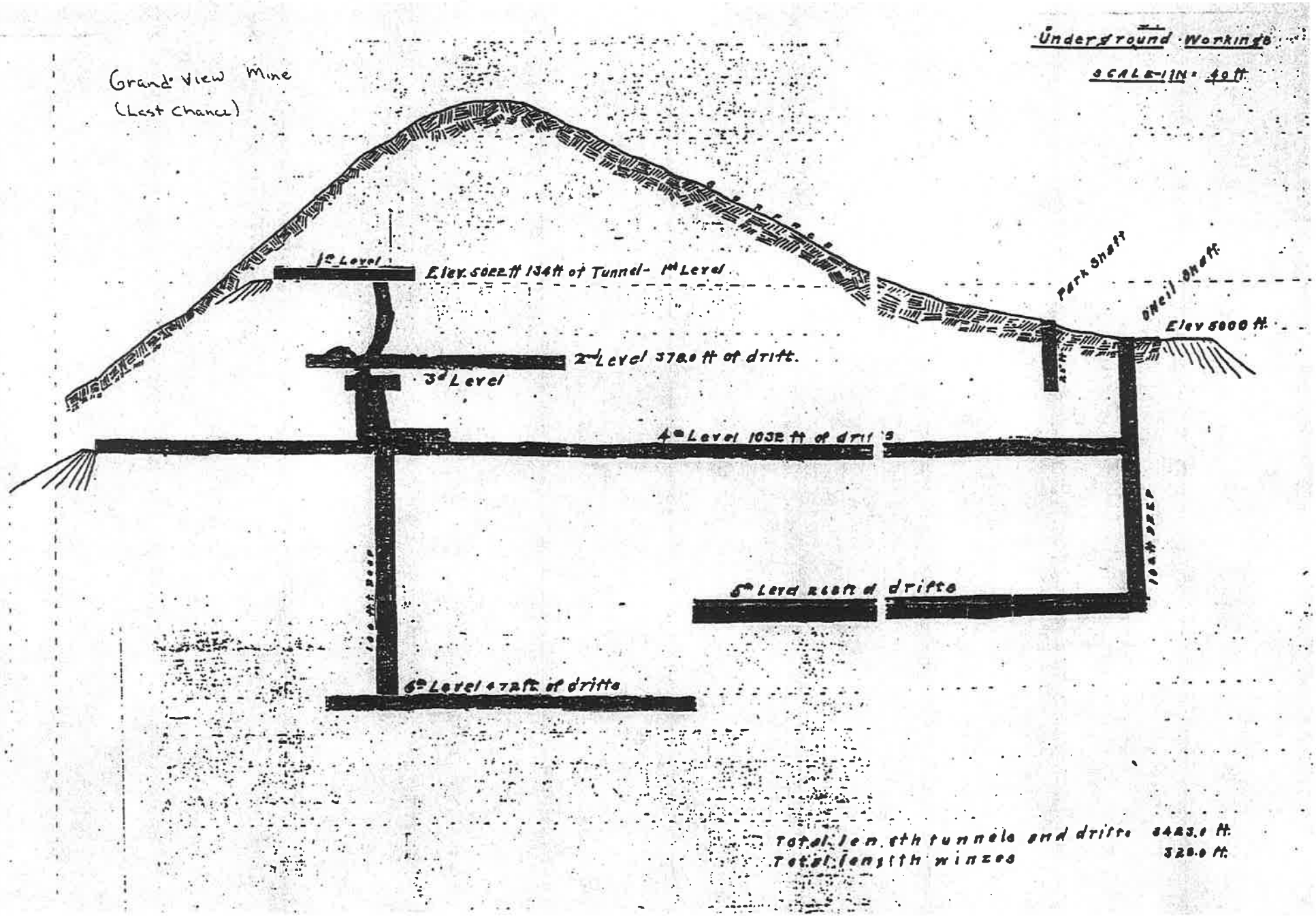
Carbonates
- Aurichalcite
- Azurite
- Cerussite
- Malachite
- Smithsonite

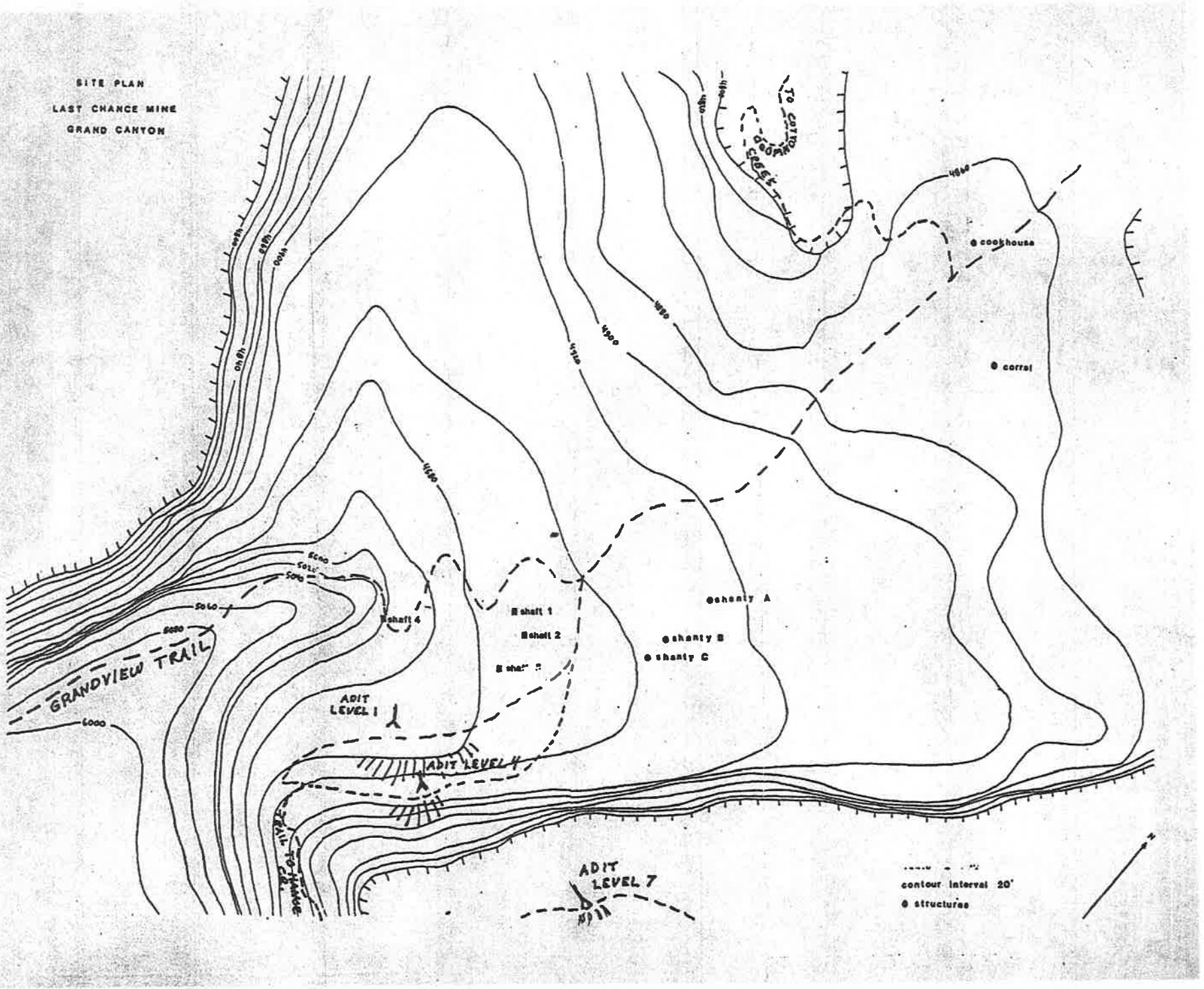
Sulfates
- Anglesite
- Antlerite
- Barite
- Brochantite
- Carbonatecyanotrichite
- Chalcanthite
- Chalcoalumite
- Cyanotrichite
- Devilline
- Grandviewite
- Gypsum
- Langite
- Serpierite

Arsenates
- Adamite
- Arthurite
- Metazeunerite
- Olivenite
- Osarizawaite
- Parnauite
- Pharmacosiderite
- Philipsbornite
- Scorodite
- Zeunerite

Silicates
- Hemimorphite
- Illite
- Kaolinite
- Quartz

Mindat has Dickite listed.


Grand View Mine
(Last Chance)
Underground Workings
SCALE-1IN = 40ft
1st Level
Elev. 5022 ft 134 ft of Tunnel- 1st Level
Park Shaft
O'Neil Shaft
Elev 5000 ft.
2nd Level 378.0 ft of drift.
3rd Level
4th Level 1032 ft of drifts
5th Level 228 ft of drifts
6th Level 472 ft. of drifts
Total length tunnels and drifts 3423.0 ft.
Total length winzes 328.0 ft.


SITE PLAN
LAST CHANCE MINE
GRAND CANYON
TO COTTONWOOD CREEK TRAIL
cookhouse
corral
shanty A
shanty B
shanty C
shaft 1
shaft 2
shaft 4
ADIT LEVEL I
ADIT LEVEL II
ADIT LEVEL 7
GRANDVIEW TRAIL
TRAIL TO HANCE CR.
contour interval 20'
structures

Updating the Mineralogy of Arizona

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In 2012, Arizona will celebrate its 100th year of statehood. To commemorate this event, the Tucson Gem and Mineral Society has chosen Arizona minerals as the 2012 show theme. Additionally, a new edition of the *Mineralogy of Arizona* is planned. The first reports covering the mineralogy of Arizona are by William Blake, 1909, and another by Frank Guild in 1910, both reporting about 120 species. An update in 1941 by Frederic Galbraith listed 193 species and a 1959 edition listed 403 species. The 1977 book Mineralogy of Arizona by John Anthony, Richard Bideaux, and Sid Williams listed 577 species. The third edition in 1995 brought up the species count to 809. With directed efforts, possibly 1000 mineral species could be found by 2012. One place to find species new to Arizona would involve the careful study of rock-forming minerals, especially samples of amphibole, mica and tourmaline. There will be a discussion of proper methodologies to identify minerals, highlighted with details of two new mineral species just found.

What's New in Arizona Minerals

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Grandview mine, Grand Canyon National Park, Coconino County

A project conducted by Malcolm Alter, Ray Grant, and Peter Williams to map and study the Grandview mine has produced a few new Arizona mineral occurrences that include:

- **Arthurite** $CuFe_2(AsO_4)_2(OH)_2 \cdot 4H_2O$
- **Osarizawaite** $Pb(Al,Cu)_3(SO_4)_2(OH)_6$
- **Philipsbornite** $PbAl_3(AsO_4)_2(OH,H_2O)_6$

These minerals were found around a pod containing galena.

Additionally, a new unknown mineral was found on samples of cyanotrichite. The mineral appears as patches of black acicular needles; however, under high magnification (50X or greater) the needles have a purplish color and are often coated with brochantite. A preliminary analysis indicates that the mineral may be a cobalt analog of cyanotrichite, but samples are too small for a more detailed characterization.

[Ref: Hager, S.L., Leverett, P., Williams, P.A. (2009) Possible Structural and Chemical Relationships in the Cyanotrichite Group. *The Canadian Mineralogist*; June 2009, **47**, 3, 635-648.]

Mammoth-St. Anthony mine, Tiger, Pinal County

Joe Ruiz's continuing search for new and unusual minerals from Tiger has yielded two new finds. His efforts led to the discovery of a new mineral that is a possible analog of yedlinite. The new mineral was approved in Nov. 2009 and is called **IMA2009-068**. Frank C. Hawthorne analyzed the material and reported the following:

Chemical formula: $Pb_4(CrO_4)_2(OH)_2FCl$.
Crystal system: Orthorhombic
Cell parameters: *a* 7.6257(6), *b* 11.6078(9), *c* 6.8961(5) Å

The thin orange, transparent bladed crystals are extremely small (sub-millimeter) and are associated with white needles of an unknown mineral.

[Ref: New Minerals Approved in 2009, Nomenclature Modifications Approved in 2009 by the Commission on New Minerals, Nomenclature and Classification International Mineralogical Association]

The second find involves **surite**. While the occurrence of this mineral has been previously reported, new specimens include well-formed balls of white to clear platy **surite** crystals.

[Joe Ruiz, pers. communication, Feb. 2010]

Rowley mine, near Theba, Maricopa County

Joe's investigations are not limited to just Tiger material. He identified Arizona's second occurrence of **mammothite** in recent samples from the Rowley mine. The tiny (sub-millimeter), teal blue crystals form in "spongy" patches of atacamite and exhibit the distinctive asymmetric beveled terminations.

[Joe Ruiz, pers. communication, Feb. 2010]