

Abstracts

New Mexico Mineral Symposium

The Twenty-First Annual New Mexico Mineral Symposium was held November 11 and 12, 2000, at New Mexico Institute of Mining and Technology, Socorro. Following are abstracts from all talks given at the symposium.

PSEUDOMORPH CITY—THE MINERALOGICAL TREASURES OF THE GRAPHIC-WALDO AND KELLY MINES, MAGDALENA DISTRICT, NEW MEXICO, *Robert Eveleth and Virgil W. Lueth*, New Mexico Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, NM 87801

(Location 1 on index map)

Any discussion of the Magdalena mining district in Socorro County, New Mexico, ultimately focuses on the beautiful blue-green gem variety of the mineral smithsonite and for good reason. Specimens from the Kelly mine have become famous the world over for their superb color and luster. The Kelly mine, as a result, has tended to enjoy all of the mineralogical accolades over the past 50 yrs or so, and our very own mineralogical museum here in Socorro is responsible, at least in part.

A reason for the fame of the Kelly is the C. T. Brown collection. Acquired by the New Mexico School of Mines in 1938, the collection contains an abundance of superb smithsonites, most of which have been on open display to the public since that time.

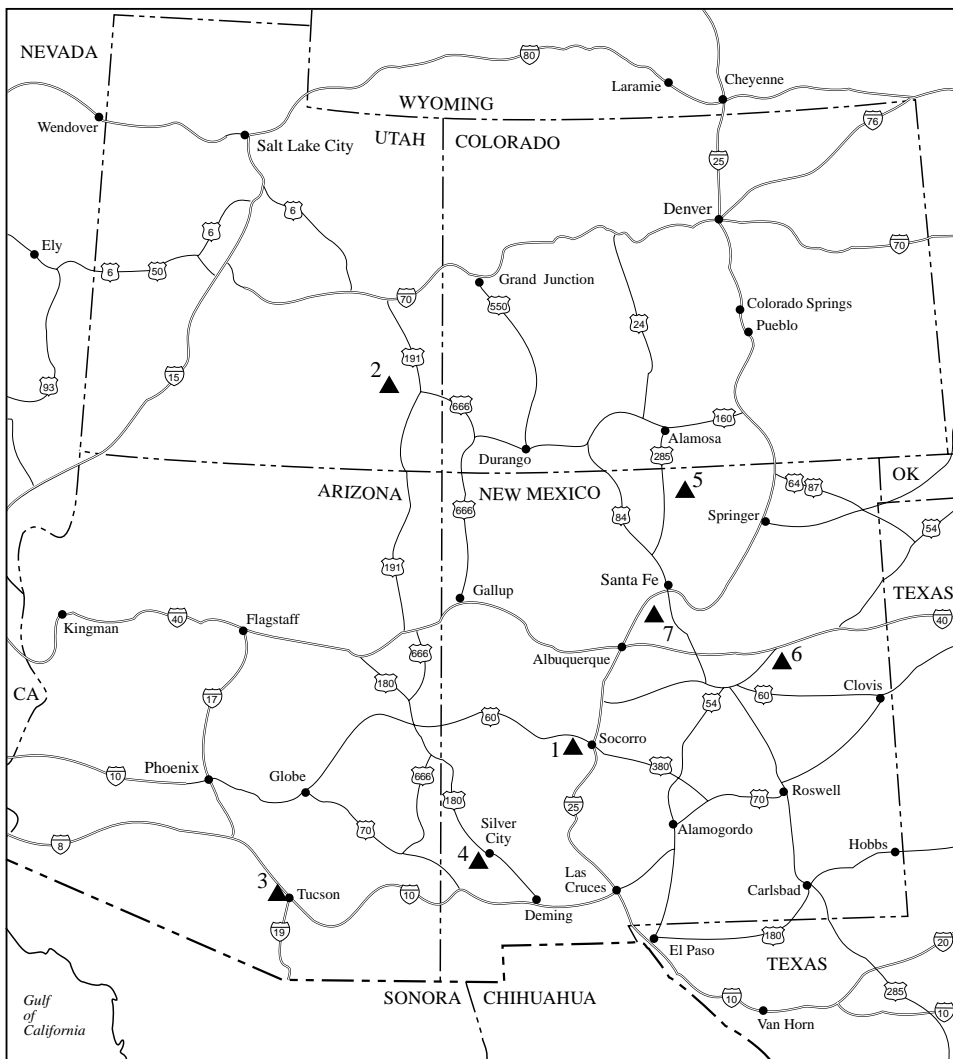
However, with the mineral museum's acquisition of the Mahlon T. Everhart collection in 1990, it became apparent that there is another mine in the district that has produced an equally impressive array of mineralogical treasures. That mine is the Graphic-Waldo, located over the hill to the north of the Kelly. C. T. Brown's mining partner in the district was Asa B. Fitch, and he, like Brown, assembled an impressive collection of minerals. Whereas Brown tended to focus his attentions on the Kelly, Fitch collected primarily at the Graphic. Thus, the two collections complement one another. Mahlon acquired the Fitch collection during the 1930s and subsequently donated it to the museum in 1990.

Specimens in the Fitch/Everhart collection are remarkable in that they clearly demonstrate that zinc carbonate has tended to replace many of the other ore minerals in the Graphic orebody—sometimes with spectacular results. Examples of such replacements are seen as smithsonite pseudomorphs of barite, calcite, cerussite, cuprite, galena, and native copper. With this presentation, the authors hope to place the Graphic-Waldo back where it belongs—on an equal mineralogical standing with the Kelly.

MINERALOGY OF THE JOMAC MINE, SAN JUAN COUNTY, UTAH, *Patrick E. Haynes*, P.O. Box 1531, Cortez, CO 81321

(Location 2 on index map)

The Jomac mine is located on Brown's Rim, in the White Canyon mining district of San Juan County, Utah. It has recently become the type locality for a uranium-carbonate mineral named



blatonite. A second new uranium mineral from the mine has recently been submitted to the International Mineralogical Association for approval. The Jomac mine is the world's second reported location for the minerals swamboite and mbobomkulite. The mine saw most of its ore production in the 1950s and had an active claim until 1985. Obviously, the mine was a wonderful source for interesting minerals. Unfortunately, the mine lies within the boundaries of the Glen Canyon National Recreation Area, and it was reclaimed in 1992. Mineral collecting since then has not been allowed.

The Jomac mine's three adits lie in the Shinarump Conglomerate Member of the Triassic Chinle Formation. Petrified wood, coal, and sooty black organic debris are scattered throughout the conglomerate. The organic remains, apparently setting up a reducing environment, make the sediments more amenable for the precipitation of primary minerals. Uraninite and the sulfide minerals pyrite, chalcopyrite, and sphalerite were deposited. Tiny specks of cuprite are very common in a basal siltstone, but cuprite may or may not be a primary mineral. Oxidation of these minerals led to the formation of an unusual assortment of mostly copper and uranium minerals. The minerals hematite, jarosite, hydronium jarosite, and limonite are common. Also common in the conglomerate are coconinoite and metazeunerite. A mixture of asbolan-birnessite occurs as dendritic smears on fracture surfaces.

The basal siltstone is the host for most of the mine's minerals. They are found as microscopic crystals locally concentrated in two different assemblages, a copper sulfate assemblage and a blatonite assemblage. Minerals found in the copper sulfate assemblage include anhydrite, carbonate-cyanotrichite, antlerite, malachite, azurite, serpierite, alunite, sparse smithsonite, boltwoodite, and very rare brochantite. The blatonite assemblage can have sparse amounts of the minerals found in the copper sulfate assemblage, but has a greater amount of carbonate mineralization. This latter assemblage has blatonite; uranopilite; increased amounts of malachite and smithsonite; sparse amounts of swamboite, sklodowskite, rutherfordine, schoepite, metaschoepite, meta-autunite, and mbobomkulite; the recently submitted uranium mineral; an unidentified orange uranium mineral; and some fine-grained, yellow uranium minerals. Impurities in the minerals cause various changes in their habits, making identifications challenging. Cobalt and nickel are common in trace amounts in most of the secondary copper minerals.

The Jomac mine's portals were sealed with mortar and backfilled, and the access road has been blocked with boulders. Despite the reclamation efforts, previously recovered specimens are producing interesting results. Two of the remaining unidentified uranium minerals have unique X-ray diffraction (XRD) patterns.

TAKING CARE OF THE LITTLE THINGS:

THE MICROMOUNT COLLECTIONS AT THE ARIZONA-SONORA DESERT MUSEUM, Anna M. Domitrovic, Collections Manager, Mineralogist, Arizona-Sonora Desert Museum, 2021 N. Kinney Road, Tucson, AZ 85743

(Location 3 on index map)

The Arizona-Sonora Desert Museum's Permanent Mineral Collection has 14,250 catalogued specimens. Over the course of its 25-yr history, minerals have been purchased, exchanged, and donated. Acquisitions have come one specimen at a time or, especially in the case of the micromounts, thousands in one acquisition.

The micromount collection is extremely important to the Desert Museum. Because many rare or unusual minerals generally occur only as microscopic specks, micromounts provide the means of acquiring as many species as possible that occur within the boundaries of the Desert Museum's interpretive realm—the Sonoran Desert region of Arizona and Baja and Sonora, Mexico. The micromount collections are valuable research tools. They allow researchers to see representative minerals of a given locality in one sitting. They provide mineralogists with a visual means of identifying other species by physical comparison when other means of identification such as X-ray and scanning electron microscopy are not readily available. These are just two of the major uses for the micromount collections at the Desert Museum.

Micromounts have been a part of the Desert Museum's Permanent Mineral Collection since the middle 1970s. More than two decades ago, their importance was impressed upon the museum administrators, which resulted in getting the first of the Desert Museum's micromount collection started. Through the efforts of William Hunt, Robert Mudra, Earl Pemberton, and Arthur Roe hundreds of micromounts have a lasting home within the confines of the museum's mineral vault. Entire micromount collections were generously donated by Edna Andregg, Marvin Deshler, Jean Rogers, and Frances Saunders. The most substantial of these donations was that of Marvin Deshler. The Desert Museum is proud to own 4,625 micromounts in this valuable collection. The Andregg Collection numbers 2,069, the Saunders Collection numbers 833, and the Rogers Collection numbers 252. These numbers alone attest to the value of their acquisition to the Desert Museum. Most recently, the Desert Museum acquired a collection of 232 regional micromounts from the collection of the late G. Robert Massey.

Several Tucson micromounters continue the Desert Museum's efforts in adding to its micromounts. Museum docent and volunteer Mark Goldberg presently handles micromount repairs and additions to the Permanent Mineral Collection. Sven Bailey had the job in the 1980s. Carol Amshoff, co-owner of Tucson's Kino Rocks & Minerals, and Desert Museum docent Janet Reue demonstrate and instruct in the fine art of micromounting for museum visitors at the annual Mineral Madness Showcase & Sale held in January every year. Arthur Roe was initially responsible for photographing the first of the museum's micromounts. That tradition is continued today by Green Valley photographer William Meinert.

THE ORIGIN OF RHYOLITIC SPHERULITES AT ROCKHOUND STATE PARK, NEW MEXICO, Nelia W. Dunbar and Virginia T. McLemore, New Mexico Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, NM 87801

(Location 4 on index map)

One of the geologically interesting features of Rockhound State Park, in southern New Mexico, is the presence of many spherulites within the rhyolite lava. The spherulites range in size from less than 1 mm to greater than 30 cm, and many are solid, concentrically zoned, dark-gray to pinkish colored material with a distinct, nodular, reddish core. Others consist of the same material but are partly hollow. A third population consists of two distinct parts: a dark-gray to pinkish outer part that appears similar to the material that forms the solid spherulites and a white, blue, or gray inner part, or core, which is recognizable as agate, chalcedony, and quartz crystals. These two parts appear to be a shell and a filling. This type of filled spherulitic form is commonly called a "thunderegg." In order to gain some insight into the process by which these spherulites form, samples were examined using back-scattered electron imaging and qualitative X-ray analysis and imaging using a Cameca SX-100 electron microprobe. Microprobe examination of the "shell" part of Rockhound spherulites shows that they are composed of intergrown crystals of quartz (SiO₂), alkali feldspar (K,Na)[AlSi₃O₈], plagioclase feldspar Na[AlSi₃O₈]-Ca[Al₂Si₂O₈], and magnetite (Fe₃O₄). The images from the microprobe show that the spherulites are formed either of intimately intergrown quartz, feldspar, and magnetite, or of bands of quartz systematically interspersed with bands of intergrown feldspar and quartz. The bands range in width from approximately 100 to 200 microns, and it is this banding that produces the concentric structure that is apparent in some parts of the spherulites. The reddish, nodular core of the spherulites is composed mainly of intergrown quartz and plagioclase, whereas the outer part of the spherulites contains quartz and alkali feldspar.

The observed patterns in the spherulites suggest that they may have formed during the cooling of the rhyolite lava. Similar spherulitic forms, with similar internal growth features, were observed in an artificial melt that was rapidly cooled (Jacobs et al., 1992; Dunbar et al., 1995). The temperature of the artificial melt was monitored during the cooling process, and exothermic crystallization was observed at high temperatures (1,100°C). Spherulitic growth occurred during this crystallization process, and the internal structure of the spherulites was indistinguishable from the internal structure of Rockhound spherulites. This similarity suggests that the Rockhound spherulites may have formed by a similar high-temperature rather than sub-solidus process. Furthermore, the feathery and non-equant crystal shapes observed in the Rockhound spherulites are very similar to crystal forms described by Lofgren (1970, 1971) for crystals that grew rapidly at high temperatures (~700°C), probably very soon after the rhyolitic lava was erupted onto the Earth's surface.

The agate, chalcedony, and quartz veins and open-space fillings within voids in the spherulites formed later by multiple cycles of hydrothermal fluids. Hydrothermal fluids are a mixture of late-stage fluids escaping the magma and local ground water. Some of these fluids move into hollow spherulites through fractures and precipitate crystals along the walls of the inner cavity, forming geodes and filled geode-like spherulites. The Rockhound spherulites show evidence of multiple hydrothermal events expressed by multiple colors and textures of fills, which could be accounted for by different temperatures and fluid compositions. By carefully

studying the crystal fill and textures in spherulites and geodes, we hope to piece together the different processes through time that formed them. The banding found within some spherulites and geodes consists of multiple layers of different colored agate, chalcedony, and local quartz and may have been formed by fluids supersaturated in silica (Fournier, 1985). The different colors of the bands are a result of trace amounts of impurities, such as iron (red), manganese (black, pink), cobalt (blue, violet-red), copper (green, blue), chromium (orange-red), nickel (green), etc.

Faceted quartz crystals indicate that the fluids were somewhat supersaturated with silica, and that precipitation occurred under relatively slow-changing conditions (Fournier, 1985). Tilted thundereggs, locally found at Rockhound State Park, are filled with horizontal layers of agate and chalcedony that are overlain by concentric-banded agate and chalcedony; the contact between the layered and banded agate resembles an angular unconformity. These thundereggs record either small local landslides or tilting of local fault blocks within the Little Florida Mountains while the crystals were precipitating from the fluid (Shaub, 1979; Colburn, 1999).

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ARIZONA'S COLORFUL CALCITES, Les Presmyk, Salt River Project Fuels Division, P.O. Box 52025, Phoenix, AZ 85072

Arizona certainly contains its share of potential calcite-producing geology. The northern third of the state consists of the Colorado Plateau and contains exposed layers of limestone hundreds of feet thick. As one moves south, limestone beds are not only exposed in the mountain ranges and valleys, but a few of the layers play host to some of the richest copper mines in the world. Whereas Arizona is not known for large watercourses of calcite crystals similar to those found in the Tri-State area, there are a number of localities that have produced distinctive and brightly colored calcite crystals. The specimen colors range from colorless and white to black and virtually every hue in between.

The journey starts at Arizona's newest state park, the Kartchner Caverns. The caverns were discovered in the mid-1970s by two avid cave explorers. They managed to keep their discovery secret for a number of years. When it became

obvious that the word was beginning to leak out, they went to the Kartchner family, who owned the land where the caverns are located and made them aware of their discovery. Together, they decided the caverns should be preserved for the benefit of the State of Arizona, and negotiations began with the State Parks Department. After an extended design and construction period, the first part of the caverns was opened to the world in 1999. The formations are great, but even more spectacular is the effort to preserve the interior in a pristine condition—with more effort to come.

Next on the journey are the great copper mines of Bisbee. In the early days of mining at this location, the miners learned that one of the ways to find orebodies was to look for caverns. When the sulfide minerals oxidized, the total volume decreased, which left a void above the oxide zones. Because the sulfide mineralization was emplaced in limestone beds, open voids were left in which calcite and aragonite could form. Some of the percolating waters moved through copper minerals, so not only were white calcite crystals formed but also a number of pale-blue and green formations resulted. Over the years of copper mining, a number of watercourses were encountered in many of the mines. These produced some very distinctive specimens, including the iron-stained, hexagonal, "poker-chip" style crystals. Of course, the most desirable of the Bisbee calcites are those colored bright red and bright green by included cuprite and malachite, respectively.

In spite of a lot of mining activity in the eastern fourth of the state, there is a dearth of good calcite localities. One has to travel back to the central part of the state to the copper mines of Globe–Miami, Superior, Ray, and San Manuel to find collectible calcites. The Old Dominion mine in Globe produced white calcites, and though not colorful, the contrasting matrix makes for pleasing specimens. The calcite crystals occur on chrysocolla-stained drusy quartz pockets and on just plain chrysocolla. There are cuprite included calcites that come from here as well.

The Magma mine at Superior produced small pockets of calcites throughout its history. It is much more famous for its barites and pyrites, so the calcites have been somewhat overlooked. The calcites range from pink manganocalcites (collected at the bottom of number 5 shaft in 150° water) to a number of white and off-white specimens of various crystal shapes. The best single pocket of calcites ever collected at the Magma mine was discovered in one of the drift headings in the fall of 1986. A pocket approximately 5 ft long by 1 ft wide by 4 ft high was discovered that contained clear, twinned crystals up to 3 inches across sitting on a dark crystallized matrix.

The copper mine at Ray (now called Kearny because the town of Ray has long since become part of the open pit) has produced a number of nice calcite specimens over the years. The best pocket consisted of yellow calcite crystals with cuprite inclusions. Within the past 2 yrs, a large quantity of chrysocolla was mined, which included vugs with white calcite crystals. Although these aren't colorful calcites per se, it is a truly colorful association.

San Manuel is a large, underground copper mine about 50 mi north of Tucson. Unlike some of the other great copper deposits that were deposited in limestone beds, this orebody is a porphyry. There are a number of small cracks and openings in the rock mass that have allowed calcite crystals to grow. While not on a caliber with the Magma mine or the Ray mine, they are interesting nonetheless. Some occur with associ-

ated gypsum or pyrite crystals.

Continuing south and to the west is the copper mine at Ajo. The New Cornelia mine has a long history and has produced some of the reddest cuprite-included calcite crystals in the state. It is best known for its crystallized coppers and azurite and malachite specimens; however, it is one of the finest localities for red calcite crystals.

Before heading north one last time, the Red Cloud mine should at least be mentioned. The major gangue mineral in the vein is brown calcite. Whereas a number of localities in Arizona contain this dark-brown calcite, the Red Cloud is the only place a collector might want one of these specimens—particularly if there are wulfenites scattered across the calcite. Otherwise, they are the ugliest calcite crystals I have collected.

Leaving the Red Cloud, there are three localities left that are noteworthy. The Bruce mine at Bagdad produced colorless to white, highly lustrous crystals that display fishtail twinning up to 3 inches long. Unfortunately, the miners broke the larger twins off, so it is unusual to have a specimen with twins over 1½ inches long still on matrix. The same thing occurred in the initial collecting at the Brushy Creek mine in Missouri when the watercourse with the gray calcites and iridescent marcasite was encountered.

Heading east and down into the Verde Valley, a locality known to any rockhound or mineral collector in Arizona is the Salt mine. It was the second locality I ever went to, and I still direct people to the area to collect. It is known for its calcite after glauberite pseudomorphs, along with gypsum after glauberite, aragonite after glauberite, and just plain glauberite crystals.

The last locality of our journey is in Mohave County in western Arizona. A vein of calcite crystals was discovered that is more typical of English crystallization than any other Arizona locality. The locality produced specimens from the size of thumbnails to the size of a large cabinet, with crystals in excess of an inch. The collecting ended when the area changed ownership and the vein got too deep.

A NEW PSEUDOBROOKITE LOCATION IN TAOS COUNTY, NEW MEXICO, *Ramon S. DeMark*, 530 E. Arch Street, Marquette, MI 49855, and *Jessie M. Kline*, 5094 NDCBU, 511 Apache, Taos, NM 87571

(Location 5 on index map)

The No Agua mining district in northern Taos County, New Mexico, is composed of several mines that have been operated for perlite and scoria since the 1950s. The mining district is located within the Taos Plateau volcanic field (TPVF), which consists of mostly Tertiary volcanics 2–5 m.y. old. The most voluminous and widespread rock type of the TPVF is the 3.6–4.5 m.y.-old Servilleta basalt (Lipman and Mehnert, 1979).

In the fall of 1998, a field trip guided by Dr. Tony Benson of the University of New Mexico at Taos was conducted to look at various rocks and structures of the TPVF. One of the stops was at the open pit of the former United Perlite Corporation mine on Brushy Mountain, which is about 12.5 mi east-northeast of Tres Piedras and 3.5 mi west of the Rio Grande. Brushy Mountain, a local lava dome of silicic rhyolite containing phenocrysts of quartz and sodic sanidine, is overlain by lava flows of olivine-augite andesite and hornblende rhyodacite. The rhyolite has yielded a K–Ar age of 22.3 m.y. (Lipman and Mehnert, 1979).

During the visit, one of the authors, Jessie M. Kline, picked up some lithophysal rhyolite from

a small prospect about 100 m east of the main pit. This rock contained unknown crystals of orange and black acicular minerals in the vesicles. Following the November 1999 New Mexico Mineral Symposium, both authors traveled to Brushy Mountain to investigate the minerals of this prospect. The black acicular mineral appeared, with some certainty, to be pseudobrookite, and the quartz (amethystine) was obvious, but identification of several other minerals was in question. Further study and microprobe analysis by Paul Hlava of Sandia National Laboratory (pers. comm. 1999) have recognized the following species:

Pseudobrookite: Black, lustrous blades up to 2 mm, some found on amethystine quartz, and also as inclusions in the quartz. The crystals are associated with tridymite, spessartine, and aegerine.

Aegerine: Slender, prismatic crystals with steep pyramidal terminations to 1.5 mm. These crystals are orange to burnt-umber color. Aegerine is also found as short (0.2 mm), brown prismatic crystals that are opaque with a dull luster. They are often found with monazite.

Monazite: Monazite is found as dull-yellow, subhedral crystals up to 0.4 mm in length. They are uncommon but are found with the dull-brown aegerine crystals.

Hematite: Small brown to black tabular crystals about 0.2 mm across are sparsely found. Associated with the short, brown aegerine and monazite crystals.

Tridymite: Aggregates of bladed, twinned, bluish-gray, transparent crystals with a vitreous luster are commonly found in the lithophysae. Individual crystals are about 0.5 mm across.

Quartz: Much of the quartz at Brushy Mountain is amethystine and gemmy with a vitreous luster. Pseudobrookite is often found on and as inclusions in the quartz.

Spessartine: Spessartine crystals are uniformly small (0.5 mm), black trapezohedrons. They are found with pseudobrookite, aegerine, tridymite, and quartz (amethyst).

Opal: Colorless, hyaline opal commonly coats the minerals at Brushy Mountain. It fluoresces green under short wave UV.

Brushy Mountain is the first documented location for pseudobrookite in Taos County and northern New Mexico. It also appears to be the first reported occurrence of aegerine and tridymite in Taos County. Finding pseudobrookite and other minerals at Brushy Mountain suggests that investigation of other rhyolites in the TPVF might result in additional discoveries.

Reference

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AN UPDATE ON THE FLUORESCENT MINERALS OF NEW MEXICO, *Dru E. Wilbur* and *Virgil W. Lueth*, New Mexico Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, NM 87801. Twenty-three mineral species, previously unreported from New Mexico as fluorescent, have been identified in recent work at the Mineral Museum of the New Mexico Bureau of Mines and Mineral Resources (see accompanying table). Three of these, allophane, chabazite, and rhodochrosite, have responses that are highly esthetic and deserve to have a place in any collector's display. The total number of described

fluorescent mineral species now known from New Mexico is up to 62.

This presentation is a product of an ongoing project to update the New Mexico Bureau of Mines and Mineral Resources' (NMBMMR) Circular 15 (Tables of fluorescent and radioactive minerals). Since 1947, the NMBMMR has continuously published tables of fluorescent minerals. These have been exhaustive lists that encompassed all known species of fluorescent as well as radioactive minerals. There have been three editions of Circular 15 that have periodically reviewed and revised these lists (Hersley, 1947; Sun, 1955; Stephenson, 1962). The current revision, to be issued as a bulletin, will focus entirely on the fluorescent minerals of New Mexico. New to the report will be locality and collecting information, fluorescent responses, and illustrations of specimens in both plain and ultraviolet light. In addition to Circular 15, the other primary source for New Mexico fluorescent mineral information has been a 1987 New Mexico Geological Society (NMGS) article by Peter Modreski that includes a good treatment of the science of the fluorescent phenomena. Since the time of the publication of these reports, the study and enjoyment of mineral fluorescence has grown from a very specialized interest into one of wider appeal. The appearance of inexpensive and easily obtainable fluorescent lamps has allowed a great number of people to enjoy this phenomenon. It is hoped that this publication will help to increase awareness of the mineral riches of New Mexico and the beauty of fluorescent minerals.

The classic mineral producing localities of New Mexico are well known; however, their fluorescent counterparts have been relatively unexplored. It will come as no surprise that in most cases the localities are the same. Nevertheless, the fluorescent mineral collector should be aware of three localities in particular. First, the Magdalena district, known primarily for its apple-green smithsonite, is also a motherlode of fluorescent mineral species. Among the most prevalent and attractive of known fluorescent species found are allophane, anglesite, calcite, cerussite, fluorite, hemimorphite, hydrozincite, powellite, scheelite, smithsonite, sphalerite, and willemite. Smithsonite from this area exhibits an extremely wide range of fluorescent responses. Specimens have been found that fluoresce white, yellow, electric pink, purple, blue, red, and green under short wave UV (257 nm). The long wave UV (365 nm) response is generally a dull yellow. Unfortunately, the famous apple-green specimens have not been found to produce a significant response. Second, the Picuris district, which includes the Harding pegmatite, is also an excellent source of fluorescent mineral specimens. The fluorescent species found include albite, andalusite, bertrandite, bityite, calcite, eucryptite, fluorapatite, fluorite, kyanite, orthoclase, phlogopite, scheelite, spodumene, uranophane, zircon, and zoisite. Third, is the Iron Mountain No. 2 district in Sierra County. This tungsten-magnetite skarn deposit has a number of interesting fluorescent mineral species that include calcite, fluorite, helvite, powellite, scheelite, smithsonite, willemite, and zoisite.

In addition to the fluorescent mineral species found within New Mexico, there are a large number of minerals from other localities around the world known to be fluorescent. Examples of these have not been found in New Mexico and should serve as a focus for the future fluorescent mineral collector.

New record of minerals from New Mexico displaying a fluorescent response.

Mineral species	Chemical formula	SW response (257 nm)	LW response (365 nm)	Locality
allophane	Al ₂ O ₃ ·SiO ₂ ·H ₂ O	dark-blue green	bright-blue green	Juanita mine, Magdalena district, Socorro County
anhydrite	CaSO ₄	creamy yellow	creamy yellow	Carlsbad, Eddy County
bertrandite	Be ₂ Si ₂ O ₇ (OH) ₂	yellow	none	Harding pegmatite, Taos County
chabazite	(Ca,K,Na) ₄ Al ₄ Si ₅ O ₂₄ ·12H ₂ O	violet	violet	East Fork, Gila River, Grant County
clinohumite	(Mg,Fe) ₉ (SiO ₄) ₄ (F,OH) ₂	peach to grayish-white	yellow to white	West of Camel Mtn., Luna County
dickite	Al ₂ Si ₂ O ₅ (OH) ₄	violet	violet	Mex-Tex mine, Hansonburg district, Socorro County
fluorapophyllite	KCa ₄ Si ₈ O ₂₀ (F,OH)·8H ₂ O	violet	light-violet	Gila Mountains, Grant County
gonnardite	(Na,Ca) ₆₋₈ [(Al,Si) ₂₀ O ₄₀]·12H ₂ O	violet	violet	Pinos Altos, Grant County
helvite	Mn ₄ Be ₃ (SiO ₄) ₃ S	yellow to pale-white	pale-yellow	Victorio district, Luna County
heulandite	(Ca,Na,K) ₉ [Al ₉ Si ₂₇ O ₇₂]·24H ₂ O	pale-white	pale-white	Gila Mountains, Grant County
levyne	(Ca _{0.5} ,Na,K) ₆ [Al ₆ Si ₁₂ O ₃₆]·17H ₂ O	violet	violet	West Fork, Gila River, Grant County
mesolite	Na ₁₆ Ca ₁₆ [Al ₄₈ Si ₇₂ O ₂₄₀]·64H ₂ O	white	white	Middle Fork, Gila River, Grant County
minium	Pb ₂ PbO ₄	very dark orange	dull-orange	Hillsboro district, Sierra County
mordenite	(Na ₂ ,Ca,K) ₄ [Al ₈ Si ₄₀ O ₉₆]·28H ₂ O	violet	violet	Santa Rita district, Grant County
phlogopite	KMg ₃ AlSi ₃ O ₁₀ (OH) ₂	none	yellow on crystal edges	Picuris district, Taos County
pickeringite	MgAl ₂ (SO ₄) ₄ ·22H ₂ O	white-violet	brightwhite-violet	Guadalupe County
prehnite	Ca ₂ Al ₂ Si ₃ O ₁₀ (OH) ₂	none	yellowish-violet	Sierra Blanca, Lincoln County
rhodochrosite	MnCO ₃	deep-pink	pink	Dictator mine, Cuchillo Negro district, Sierra County
sepiolite	Mg ₄ Si ₆ O ₁₅ (OH) ₂ ·6H ₂ O	dull-violet	blue-violet	Pinos Altos district, Grant County
stilbite	(Ca,Na,K) ₉ [Al ₉ Si ₂₇ O ₇₂]·14H ₂ O	pale-yellow	yellow	Catron County
titanite	CaTiSiO ₅	yellow	none	Organ district
tridymite	SiO ₂	gray-pink	gray	Doña Ana County
zoisite (thulite)	Ca ₂ Al ₃ (SiO ₄) ₃ (OH)	brick-red	dark-pink	Picuris district, Taos County

STERLING HILL: YESTERDAY, TODAY, AND TOMORROW, Richard Hauck, Sterling Hill Mine and Museum, 30 Plant Street, Ogdensburg, NJ 07439

Sterling Hill is one of two mines that make up one of the most renowned mining districts in the world. Who would think that the mineral deposits at the Sterling mine and its sister mine in nearby Franklin would be one of the great geological mysteries known to earth science today? They exist in the Skylands of New Jersey, just an hour from midtown New York.

The Sterling mine is named for William Alexander, Lord Sterling, who owned the property from 1761 to 1776 and attempted to smelt the local ores. Dutch prospectors and the Lenni Lenape Indians probably knew about the Sterling Hill orebody much earlier, which cropped out in plain sight above the Wallkill River.

The Franklin–Sterling Hill mining district represents two centuries of American mining history and technology, mining law, and the earth sciences. It was not until after the perfection of ore-dressing techniques in the early 1800s that mining the deposits became economically feasible.

The ore mined in the district was primarily zinc ore and consisted of the minerals known as: zincite, a zinc oxide; willemite, a zinc silicate;

and franklinite, a zinc-iron-manganese oxide.

These three minerals are very rich in zinc and are just a few of the 340+ minerals found in the district. This is about 10% of all those known and constitute a world record for the number of mineral species from a single locality. Yet, zincite and franklinite are nowhere else mined outside the district. Willemite is found in very limited quantities scattered around the globe. Besides the richness of the ore, many of these minerals fluoresce. Again, this is a world record of at least 80 species that are fluorescent—more than any single place on Earth.

The Sterling Hill mine closed for a variety of reasons in 1986. When this mine closed, it meant the end of all underground mining in the State of New Jersey. The Sterling Hill Mining Museum was established in 1989 and opened to the public on August 4, 1990. The museum has been listed on the Register of Historic Sites since 1991. The museum continues today as a non-profit foundation. The museum is also a Mines, Metal, and Men Site.

ARAGONITE PSEUDOMORPHS OF PUERTO DE LUNA, GUADALUPE COUNTY, NEW MEXICO, Dale G. Wheeler, 9000 Trumbull Ave. SE, Albuquerque, NM 87123, (Location 6 on index map)

Among the many descriptions to be found of aragonite, none is more challenging than that given by Frederick H. Pough (1960, pl. 22) in his book, *A Field Guide to Rocks and Minerals*, where he describes a variety of aragonite from New Mexico as "a pseudomorph after a trilling." Stuart A. Northrop (1959, p. 117) mentioned in his book, *Minerals of New Mexico*, "early settlers used them as sad-iron rests." The specimens from Puerto de Luna can be reddish brown, cream, or washed-out green; with full six-sided or partial (rotten) forms; displaying roses, light-brown posts, and six-sided posts, with six-sided micro₁ rosettes all over. The specimens range from 7/8 inch to 4 inches in height and from 6 to 8 inches in width with varying weights.

I first went to the sites in 1959 while visiting my parents in Santa Rosa, New Mexico. They were managers of the Sun 'n Sand Motel. Mom, a rockhound, took advantage of the opportunities offered to get out in the area. Mom and Dad would have a few specimens at the motel desk for guests to admire or "swap for" as rockhounds do, and most of the specimens were accepted as aragonite based on Pough's (1960) description. Only one negative comment was ever made, and of course remembered, when Mom was accused of going out and making them! Initially, through my parents' influence, I developed many questions like:

(1) Are these pseudomorphs calcite after aragonite, dolomite, and/or gypsum because they are found in lengthy gypsum beds?

(2) Why are the specimens all perfect or near perfect at one site (southeast), and why are they rotten in the same formation to the northwest?

(3) Is this an "evaporite deposit," and if so, is it similar to that of the Great Salt Plains at Jet, Oklahoma?

(4) Are the specimens old or new in terms of historical geology? Are they still growing?

(5) What is the chemistry and crystallography (floating atoms, exchange, and changing crystal shape from orthorhombic to hexagonal)?

If a pseudo-hexagonal twin seems to pierce another pseudo-hexagonal twin at an angle in the same specimen, is this a true penetration twin?

Location—southeast of Santa Rosa, Guadalupe County, New Mexico, near the historic town site of Puerto de Luna on the Pecos River. North and west of the Pecos River bridge, a layered formation is littered with clear plates of selenite; all specimens are rotten. Whole specimens are found weathering out of gypsum red beds approximately 1 mi to the south and east in an always-dry, trenched, soft floodplain deposit (10 ft deep by 30–50 ft wide). The exposure of material extends for at least 1 mi. The collecting of specimens is done on private land, and due to the severe fire danger in recent years on both grasslands and in forests, it is doubtful if permission could be obtained to cross this area.

Geology—Triassic sandstone and siltstone consisting of multicolored sandstone, conglomerate, locally with limestone pebbles of the Santa Rosa Formation, capping reddish-brown and tan sandstone with gypsum and dolomite in the lower part of the Grayburg and Queen Formations. Advancing and receding warm seas still present in Permian through Cretaceous time formed shallow lagoons in southeastern New Mexico. Thin limestone, evaporites, and red beds were deposited. Connections of the lagoons became so severely restricted that when the waters evaporated, a great thickness of gypsum and salt was left.

Seawater contains 0.14% calcium sulfate, 0.01% calcium carbonate, 0.32% magnesium chloride,

and others. As the seawater becomes trapped, evaporation sets in. As the volume of water is reduced, dissolved salts become more concentrated. If the volume of water is reduced by evaporation to approximately half, salinity is doubled, with calcium carbonate and iron oxide being precipitated. As the original volume of seawater is reduced by evaporation to approximately 20%, gypsum is deposited. It is estimated that 25 mi of seawater would be required to yield 100 ft of gypsum.

The evaporating basin must have been repeatedly replenished during a very long period of evaporation under fairly constant climatic conditions of aridity and rapid evaporation. The great salt, gypsum, and anhydrite deposits of the world were formed during the Silurian, about 400 m.y. ago, and the Permian, about 200 m.y. ago. The salt deposits of New Mexico are Permian; hence, it is believed that formation of beds ranged from the Permian to the Triassic. Within the Upper Triassic Santa Rosa Formation are bands of dark, reddish-brown mudstone. Between these are the layers of gypsum. As reported by Hurlbut (1970), "the sequence of deposition of oceanic salts is as follows: first, calcium carbonate and iron oxide; next, gypsum and anhydrite; then, sodium chloride; and finally, salts of potassium and magnesium." The aragonite pseudomorphs are weathering out of the vertical banks at all levels and down on and into the floor of the dry creek bed.

Mineralogy—sedimentary, deposition from water movement. The loose sediment is cemented into coherent solid rock by any of several processes—one of which is crystallization. Sandstone, shale, and carbonate rock constitute the most abundant rock.

Carbonates are formed when carbon dioxide contained in water combines with oxides of calcium and magnesium. Many sedimentary rocks are nonclastic—formed by intergrowth of crystals. Nonclastic rocks can be formed from material directly precipitated. Again, we have our carbonate friends including calcite crystallizing in the hexagonal crystal system, aragonites of the orthorhombic system, and dolomite also in the hexagonal system. After calcium carbonate has accumulated, it becomes recrystallized or otherwise consolidated into indurated rock (a process of the hardening of a rock material by the application of heat or pressure or by the introduction of a cementing material).

The aragonite pseudomorphs at Puerto de Luna are definitely trillings as defined by Pough (1960). For aragonite to form it must be in a proper environment not only for its development but also for it to maintain its stability. The growth is not always steady. The slightest impurity may cause uneven growth resulting in "weird" crystal shapes with perhaps over development of some crystal faces and partial formation of others (rotten?). The formed aragonite is altered when some quirk in the environment changes—when it loses its chemical composition to a combination of factors (temperature and pressure, loss of water, loss or gain of chemical elements) or when its chemical composition changes but its crystal structure remains the same. Then, it is known as pseudomorph. The pseudomorph at Santa Rosa is one whose chemical composition has changed twice. Virgil Lueth analyzed five specimens by X-ray diffraction to determine whether they are calcite, dolomite, or gypsum, with all specimens retaining the pseudo-hexagonal form of aragonite. In the common table of pseudomorphs relating to this paper three examples are given:

Replacing mineral after	Replaced mineral
Calcite	Aragonite, celestite
Gypsum	Anhydrite, aragonite
Dolomite	Aragonite

Off the Yeso–Fort Sumner Highway (US–60) to the north, Pecos "diamonds" may be found that are definitely quartz dolomite paramorphs. Did the dolomite extend into the Santa Rosa Formation? Yes, according to Kelley (1972).

Crystallography—In a review of aragonite, Sinkankas (1964) states that an orthorhombic crystal is uncommon. Sinkankas further describes the crystals as short to long, prismatic along the c-axis, in six-sided prisms, nearly hexagonal in cross sections, and terminated by a pair of faces making a wedge. Practically all crystals are twinned along the plane m {101}, forming sixling prisms, nearly hexagonal in cross sections.

Pough (1960) describes the crystal shape as trillings (three intergrown individuals), common, and looking like short hexagonal prisms or hexagonal plates. Re-entrant angle visible in fresh, sharp crystals in the center of each apparent prism of these pseudo-hexagons and striations on the apparent base disclose the three individuals.

Sinkankas (1964) also discusses "cyclic and penetration twins," which produce misleading shapes resulting in a determination of a crystal shape in one form when actually it is in another. In an example, he shows an aragonite twin with the impression that it is a hexagonal crystal being viewed. However, on examination small re-entrants were seen. Because a penetration twin is one in which two or more complete crystals seem to cross through each other with each crystal having a common center, as in staurolite, it is believed that a parallel layer of growth on top of an existing circular form or at right angles to perpendicular (Santa Rosa pseudomorph posts) would make these a penetration twin. However, perhaps the temperature-pressure equation during the forming led to crystals cementing themselves to each other with the outer layer being gypsum covering the original joining line.

Are the crystals still growing? I believe they are just "weathering out."

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RAINDROPS ON ROSES AND WHISKERS ON SILVER: THE TRUTH (?) BEHIND PRIMARY ACANTHITE, Bruce Geller, Advanced Geologic Services, 700 Vista Lane, Lakewood, CO 80215, and Bob Jordan, 315 Iowa Drive, Golden, CO 80403

Over 120 yrs ago, argentite was first reported in Colorado (Endlich, 1878). Since that time, all of

the argentite studied in Colorado has been found to be acanthite, the monoclinic form of silver sulfide, which is the stable form of Ag_2S below 177(?)°C. In Colorado, acanthite is usually found in secondary enriched zones of epithermal silver-base metal deposits such as the limestone replacements at Leadville and Aspen or the veins at Creede; however, it has been reported from at least 27 additional districts and undoubtedly occurs sporadically throughout the state (Eckel et al., 1997).

Collectable and much sought after silver-bearing minerals such as native silver, Ag-sulfides (primarily acanthite, stromeyerite, and jalpaite), Ag-sulfosalts (primarily pyrrargyrite, pearceite, matildite, polybasite, schirmerite, proustite, and stephanite), Ag-tellurides (primarily hessite, petzite, and sylvanite), and Ag-halides (primarily bromargyrite-chlorargyrite) are known from many mining districts within Colorado (Eckel et al., 1997). The most famous of these districts include: Caribou, Gold Hill, and Ward in Boulder County; Georgetown–Silver Plume in Clear Creek County; Rico in Dolores County; Gold Brick in Gunnison County; Creede in Mineral County; Montezuma in Park and Summit Counties; Aspen in Pitkin County; Silverton in San Juan County; and Telluride in San Miguel County.

Colorado's silver mining tradition dates back to 1864, when its first silver lode was discovered "on Glacier Mountain, about a mile south of Montezuma" (Lovering and Goddard, 1950, p. 123). Interestingly, samples from this district were the catalysts for this investigation. The samples are examples of high grade silver mineralization, but they were unusual for two other reasons. First, they contain microscopic arborescent growths. Second, the fine growths were not noticed until a decade after they were collected. In fact, it is believed that they have formed since they were collected, similar to some polished sections studied from Creede (Raines, pers. comm. 2000; Plumlee, pers. comm. 2000) and elsewhere (Mozgova et al., 1994).

To confirm this last point, a trip was made in August 2000 to the mine where the specimens originated in the early 1980s, the Burke–Martin mine, also known as the Bell, California, Meteor, Silver Wing, Sunburst, or Wing lode (Lovering, 1935). Many samples were taken from the exact 1980s stockpiles of mineralized material from the Albany or Old Timer vein by three different mineral collectors. Each collector found native silver and various hypogene and supergene associates, yet none found any of the arborescent growths.

Laboratory investigations using standard X-ray diffraction failed to establish the identity of the growths. Neither did comparisons with silver minerals observed in a talk given at last year's symposium by Regis and Regis (1999). However, scanning electron microscopy verified that they are acanthite and indeed delicately exquisite. In fact, the name acanthite "is from the Greek for thorn, referring to the shape of the crystals" (Mason, 1997, p. 42).

One explanation why the X-ray diffraction study proved fruitless is that acanthite is very sectile and does not pulverize well using a mortar and pestle. Hence, it could not diffract the X-ray beam to produce characteristic peaks, as

most other minerals do.

Disappointingly, a literature search combining the terms *primary* or *arborescent*, or *acicular* or *dendritic* or *needle* or *hair* or *tree* with *acanthite*, or *argentite* failed to obtain any matches. The combination of *monoclinic* and *acanthite* only found four marginally useful references. The combinations of *habit* or *form* or *morphology* and *acanthite* proved slightly more productive.

What many authors really mean when they use the term *primary acanthite* is acanthite that crystallized as itself, rather than forming as a paramorph after argentite, the higher-temperature, isometric form of Ag_2S . However, the use of the word *primary* as a descriptor for acanthite is actually a misnomer because much acicular acanthite is formed by supergene processes after some other Ag phase. Use of morphological terms such as *acicular*, *arborescent*, or *needle-like* are far clearer in describing not only the form of the acanthite in question (monoclinic), but also its genesis (independent crystallization and not paramorphic replacement after primary, isometric argentite).

Illustrations will be provided showing acicular acanthite from Colorado. It has been reported from at least seven other districts: Creede (Plumlee, pers. comm. 2000), Gilman (this study), Leadville (Raines, pers. comm. 2000), Rico (Chester, 1894), Ruby/Irwin (this study), Silver Plume (crystals coating argentite and later coated by pyrite), Silverman (this study), and Ward (crystals coating native silver, pearceite, and galena; Eckel et al., 1997).

Further questions to be discussed include: Is there anything unique to Creede, Leadville, Montezuma, Rico, Ruby/Irwin, Silver Plume, and Ward that causes their deposits to generate acicular acanthite? Why wasn't the acicular acanthite on the Montezuma specimens observed in the field? How does acicular acanthite form? Why doesn't acicular acanthite form on household silverware or jewelry?

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REVISITING THE SAN PEDRO MINE: A HISTORICAL AND MINERALOGICAL PERSPECTIVE, Jerry Simmons, 1463A State Rd 344, Sandia Park, NM 87047

(Location 7 on index map)

Historically, the San Pedro mine represents a grand view of New Mexico's history. Five eras of activity by differing or mixed ethnic groups depict this once thriving mining scene of north-central New Mexico. The first of these eras saw the Native Americans foraging for big game and materials for utensil use. The second era, the Colonial Spanish Period, would be represented by Spanish royals looking for profitable areas to mine precious metals. During the subsequent settlement of land and the use of land grants (the third era, called the Mexican Period), Spanish shepherds, in their daily routine of herding goats and sheep, discovered float gold in both the Ortiz and San Pedro Mountains. The fourth era, which correlates roughly with the opening of the Santa Fe Trail as a trade route in 1821, saw the influx of eastern US citizens, merchants, mining specialists, and fortune seekers. Local as well as non-local companies vied for the right to mine the profitable mineral values. This would be the time of greatest exploration and expansion of mining the state would experience. As the discovery of ore deposits became less frequent, the final era, which began somewhere around 1938, involved only a few large businesses and many small or local interest groups who were active at the mine. Some of these ventures were profitable, whereas most were only marginally successful. The final pages of history for the San Pedro mine were opened in 1999 when the mine was sold to a former local resident. Reclamation involving recontouring and reseeded of the old tailing piles; but only entrances where major tunnels once existed; and no trespassing, hunting, or prospecting signs all give evidence to the closing of a grand old mine and the opening of a new era, which may include a museum.

Mineralogically, the San Pedro mine area, commonly known as the New Placers district, has produced 93 different mineral species. Of this large number of species the most common are garnet (andradite), calcite, quartz, hematite (specular), and chalcopyrite. Recent discoveries have added to these: tetradymite, ankerite, powellite, smithsonite (pink), and amethyst sceptered Japan law quartz. Reports of brochantite, molybdenite, talc, and fluorite (green and purple) were verified. This assemblage of minerals is not uncommon for this skarn-type deposit. The fascinating aspect of collecting has been the seemingly endless variety of forms of the common species. Current use of UV equipment will most likely reveal more new species. All current collecting is with the new owner's permission. Planning is underway to put more San Pedro specimens in the Bureau's display and to develop a historical as well as a mineralogical museum at the mine site.