41st NEW MEXICO MINERAL SYMPOSIUM

Program and Abstracts

November 12 — 14, 2021

The Smithsonian Gem Collection, Unearthed: Surprising Stories Behind the Jewels

Dr. Jeffrey E. Post, Featured Speaker

Macey Center

New Mexico Institute of Mining and Technology
Socorro, New Mexico

WELCOME

to the

41st NEW MEXICO MINERAL SYMPOSIUM

November 12 – 14, 2021

Macey Center

New Mexico Bureau of Geology and Mineral Resources
A Research Division of New Mexico Institute of Mining and Technology

Socorro, New Mexico 2021

The Mineral Symposium is organized each year by the Mineral Museum at the New Mexico Bureau of Geology and Mineral Resources.

Sponsors:
Albuquerque Gem and Mineral Club
Chaparral Rockhounds
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New Mexico Geological Society Foundation
Friends of Mineralogy
City of Socorro
Grant County Rolling Stones
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The New Mexico Mineral Symposium provides a forum for both professionals and amateurs interested in mineralogy. The meeting allows all to share their cumulative knowledge of mineral occurrences and provides stimulus for mineralogical studies and new mineral discoveries. In addition, the informal atmosphere encourages intimate discussions among all interested in mineralogy and associated fields.
The cover photo is hemimorphite from the Stephenson-Bennett Mine, Doña Ana County, NM.
Gift of Rex Nelson. Photo by Kelsey McNamara.

Contents

PROGRAM

Friday November 12, 2021

9:00 am	Field Trip—Copper Flat Mine, Sierra County, New Mexico, meet at mine gate.
5:00–7:00 pm	Friends of the Museum reception—Headen Center (Bureau of Geology) atrium, appetizers, and cash bar
7:00 pm	Informal motel tailgating and social hour, individual rooms, Comfort Inn & Suites (#1 on map and other venues—FREE)

Saturday November 13, 2021

8:00 am	*Registration,* Macey Center, continental breakfast
8:00–1:00 pm	Silent auction to benefit the Mineral Symposium, lower lobby, Macey Center.
8:50	*Opening remarks,* main auditorium
9:00	*The Maybee Quarry, Maybee, Michigan*—Christopher Stephano
9:30	*Ramblings and Rumblings from the Keweenaw of Upper Michigan*—Thomas Rosemeyer
10:00	**Coffee and burrito break**
11:00	*A Rediscovery of Epidote Pseudomorphs after Orthoclase from the Orogrande District, Otero County, New Mexico*—Philip Simmons and Erin Delventhal
11:30	*Minerals of the Naica Mine, Chihuahua, Mexico*—Peter K.M. Megaw
12:00 pm	**Lunch**
2:00	*From Gold to Lead: The mineral riches of the Leadhills-Wanlockhead mining district, Scotland*—Nathalie Brandes and Paul Brandes
2:30	*Pyrites of Navajun, Spain (Geologist/Collector Odyssey—1993/2018)*—David Stoudt
3:00	**Coffee break**
3:30	*The Himalaya Pegmatite Mine, San Diego County, California: History and Minerals*—Mark I. Jacobson
4:00	*The Smithsonian Gem Collection—Unearthed: Surprising Stories Behind the Jewels*—Jeffrey Post (Featured Speaker)
5:30	*Sarsaparilla and suds: cocktail hour, cash bar*—Fidel Center Ballrooms
6:30	Dinner followed by a voice auction to benefit the New Mexico Mineral Symposium—Fidel Center Ballrooms

Sunday November 14, 2021

8:00 am	Morning social, coffee, and donuts
8:50	*Welcome to the second day of the symposium and follow-up remarks*
9:00	*Bagdad revisited—Barbara L. Muntyan*
9:00–1:00 pm	Silent auction, lower lobby, Macey Center, sponsored by the Albuquerque Gem and Mineral Club for the benefit of the Mineral Museum (FREE)
9:30	*Lighting your minerals*—Tony Gleckler
10:00	**Coffee break**
10:30	*A mid-1950s collection of uranium ore samples from Arizona, Colorado, Utah, and Canada*—Peter Modreski and Virgil W. Lueth
11:00	*Fabulous Vanadates, Arsenates, and Phosphates from New Mexico*—Ramon S. DeMark, Michael Michayluk, and Thomas Katonak
11:30	*Inclusions in fluorite from the Quebradas, Socorro County, and the Sandia Mountains, Bernalillo County, New Mexico*—Patrick Haynes
12:00 pm	**Lunch**

Symposium Keynote Speakers 1979–2021

Year	#	Keynote speakers and Abstract
1979–1982	1–3	
1983	4	Robert W. Eveleth, "Of Bridal Chambers, jewelry shops, and crystal caverns—a glimpse at New Mexico's mining camps, characters, and their mineral treasures"
1984	5	Laurence H. Lattman, President, New Mexico Institute of Mining & Technology; "High-tech materials for modern society"
1985	6	Peter Bancroft, "Gem and crystal treasures"
1986	7	Vandall T. King. "Pegmatite petrology through phosphate mineralogy"
1987	8	Robert W. Jones, "Copper throughout history"
1988	9	Peter Bancroft, "Gem and mineral treasures II"
1989	10	Philip C. Goodell and Kathryn Evans Goodell, "Adventures in the Sierra Madre, Batopilas, Chihuahua"
1990	11	Peter K.M. Megaw, "Mineralogy of the rhodochrosite-bearing "silicate" ore-bodies of the Potosi mine, Santa Eulalia mining district, Chihuahua, Mexico"
1991	12	Gilbert Gauthier, "Mineral classics of Shaba, Zaire"
1992	13	Stanley J. Dyl, II, "Mining history and specimen mineralogy of the Lake Superior copper district"
1993	14	Bernard Kozykowski, "Franklin—its mines and minerals;" and, "The Sterling mine—a precious hillside preserve"
1994	15	Fred Ward, "The 'precious' gems: where they occur, how they are mined;" and, "Jade"
1995	16	Dr. Miguel Romero Sanchez, "The Romero Mineral Museum"
1996	17	Robert W. Jones, "Gemstones of Russia"
1997	18	Carl A. Francis, "A fourth world occurrence of foitite at Copper Mountain, Taos County, New Mexico"
1998	19	Terry Huizing, "Collectible minerals of the Midwestern United States", and, "Colorful calcites"
1999	20	Rodney Ewing, "Mineralogy, applications to nuclear waste"
2000	21	Richard Houck, "Sterling Hill: Yesterday, Today and Tomorrow"
2001	22	Jeff Scovil, "Sampling the Finest"
2002	23	Robert Barron, "Recovery of A 17 Ton Copper Boulder from Lake Superior"
2003	24	John Rakovan, "The Cause of Color in Fluorite with special reference to the Hansonburg District, NM"
2004	25	Harrison H. Schmidt, "Lunar Geology and Mineralogy"
2005	26	Terry Wallace, "Silver of the American West"
2006	27	Ed Raines, "The Leadville Silver Deposits"
2007	28	John Rakovan, "Mineralogical Meanderings in Japan"
2008	29	John Medici, "Some highlights of 45 years of Medici Family field collecting"
2009	30	Ray DeMark, "Thirty Years of symposium presentations: a retrospective"
2010	31	R. Peter Richards "Geology and Mineralogy of Mont Saint-Hilaire, Quebec, Canada"
2011	32	Dr. Anthony Kampf, "Solving Mineral Mysteries"
2012	33	Jean DeMouthe, "Ancient and modern uses of gems & minerals: talismans, tools & medicine"
2013	34	Allan Young, "Collecting Thumbnail Minerals"
2014	35	Virgil W. Lueth, "The Past, Present, and Future of the New Mexico Bureau of Geology & Mineral Resources—Mineral Museum"
2015	36	Robert Cook, "An Overview of five great American Gold Specimen Locations"
2016	37	John Cornish, "Upside down and in the future, mining Tasmania's Adelaide Mine"
2017	38	Bob Jones, "The History of the Bristol Connecticut Copper Mine"
2018	39	Peter K.M. Megaw, "The Santa Eulalia Mining District, Chihuahua, Mexico"
2019	40	Brad Cross, "An overview of the agates of northern Mexico and southern New Mexico"
2020		Cancelled due to Covid-19
2021	41	Jeffrey Post, "The Smithsonian Gem Collection—Unearthed: Surprising Stories Behind the Jewels"

The Maybee Quarry
Maybee, Monroe County, Michigan

Christopher J. Stefano and William B. Barr Jr.

The Maybee quarry, located in central Monroe County, Michigan, is well known among local collectors in southern Michigan and northern Ohio as a source of world-class sulfur and celestine specimens. This gem of a locality has remained somewhat obscure on the national and international collecting scene, but the appearance of our article about it in the May-June 2021 issue of the *Mineralogical Record* may well make it better known.

Although the geology and mineralogy of the locality are relatively simple, there are important lessons to be learned from Maybee, perhaps most importantly concerning how native sulfur may be generated in sedimentary rocks. In 1906 Walter Hunt first worked out this geochemical process at Maybee, and it is summarized in the *Mineralogical Record* article.

The Maybee quarry has a surprisingly rich history, dating back to the 1850s. When Michigan state geologists visited around 1900 to study the quarry's stratigraphy they also noted the excellent sulfur and celestine crystals. Around 1905, Edward Kraus, founder of The American Mineralogist, visited the locality with his student, Walter Hunt, and wrote about the crystallography of the celestine and the origin of the sulfur. At that time the quarry was being worked as a source of building stone, but with the decline of that market prior to the first World War the quarry was abandoned and flooded. New owners eventually drained the quarry and put it back into production circa 1960, just as America's "rockhounding" craze was beginning, and so Maybee saw many visits by "rockhounds" between 1960 and circa 1990. It was during this period that most currently extant Maybee specimens were collected. The lion's share of the good pieces remain today with the collectors who found them, but others have made their ways to local museums, especially Michigan Technological University's A. E. Seaman Mineral Museum. Fine Maybee specimens are only rarely encountered on the international specimen market.

This lecture, which aims to inform the collecting community about this important Midwestern locality, is illustrated generously with images of Maybee specimens from museum and private collections in the Midwest.

Sulfur, Maybee Quarry, Monroe Co., Michigan. 3 cm, Christopher Stefano collection.

Ramblings and Rumblings from the Upper Peninsula of Michigan

Thomas Rosemeyer

It is now the end of September and the 2021 collecting season is coming to an end in the Michigan Copper Country. Fall is here—the days are shorter with cooler evenings are cooler mornings. The fall foliage is turning a vivid red and yellow and fall tourists are coming to the Keweenaw before everything turns white.

In the past two years since my last talk on the Copper Country, collecting has slowed down and so have I. I'm now an old geezer of 80 years and no more scrambling up mine dumps, hiking to remote localities, or midnight mining ventures. I still manage to collect almost every day but at a much slower pace. I'm fortunate in having a younger energetic partner who helps me in my liberations.

Crushing of mine dumps is still ongoing for construction and logging operations. The property owners of the mine dumps have been helpful with collectors and many specimens have been saved from the jaws of the crusher. There have been many small individual finds and some will be mentioned in my talk.

One in particular will be mentioned and that was the discovery of a vein of crystallized silver. The discovery was made along Silver Creek in Keweenaw County. Over a period of three weeks, almost 300 specimens of native silver were recovered from a 10 by 10 foot area. Most of the specimens were approximately a centimeter in size but about 20 pieces ranged up to 8 cm in size. Hopefully this will be a teaser to sit a few minutes longer and not leave to be early in line for the famous breakfast burrito on Saturday morning.

Curt Niemela holding the largest and best crystallized silver that was recovered from the South Silver vein that was discovered near the Cliff mine, Keweenaw County, MI. Photo by Tom Rosemeyer, 3 July 2020.

In early June 2020 a major near surface silver vein was discovered near Silver Creek, Keweenaw County, MI., and ranks as one of the major silver discovery in years. The specimen shown is 7.4 x 8.6 cm and is the best recovered to date. The discovery has been named the Enigma vein because of the puzzling nature of the occurrence. Photo by Tom Rosemeyer, 9 June 2020.

A Rediscovery of Epidote Pseudomorphs after Orthoclase from the Orogrande District, Otero County, New Mexico

Erin Delventhal, 1005 Hall Place, Farmington, New Mexico 87401
Philip Simmons, 11816 Harrington Rd SE, Albuquerque, New Mexico 87123

New discoveries, or rediscoveries of old localities, are very often some of the most challenging objectives within the field collecting world. Sparse information along with vague references or landmarks often lead to frustration in locating these areas, and more often than not result in many hours, if not days, of fruitless exploration. In this particular venture, we were fortunate to have at least a distinct starting location from which we could base all of our further exploration. This led to a wonderful find of pseudomorphs that, as far as we can determine, are unique in the mineral collecting world.

The Discovery

This adventure started with research for the New Mexico Pseudomorphs presentation given at the New Mexico Mineral Symposium in 2019. As Phil browsed the Ray Demark collection to find interesting pseudomorphs for the talk, Ray pointed out a couple of specimens that were easily overlooked. They were the typical sharp phenocrysts of orthoclase common from porphyries found at several localities across the state, but in this case they were green! Closer inspection revealed that the orthoclase had been fully replaced

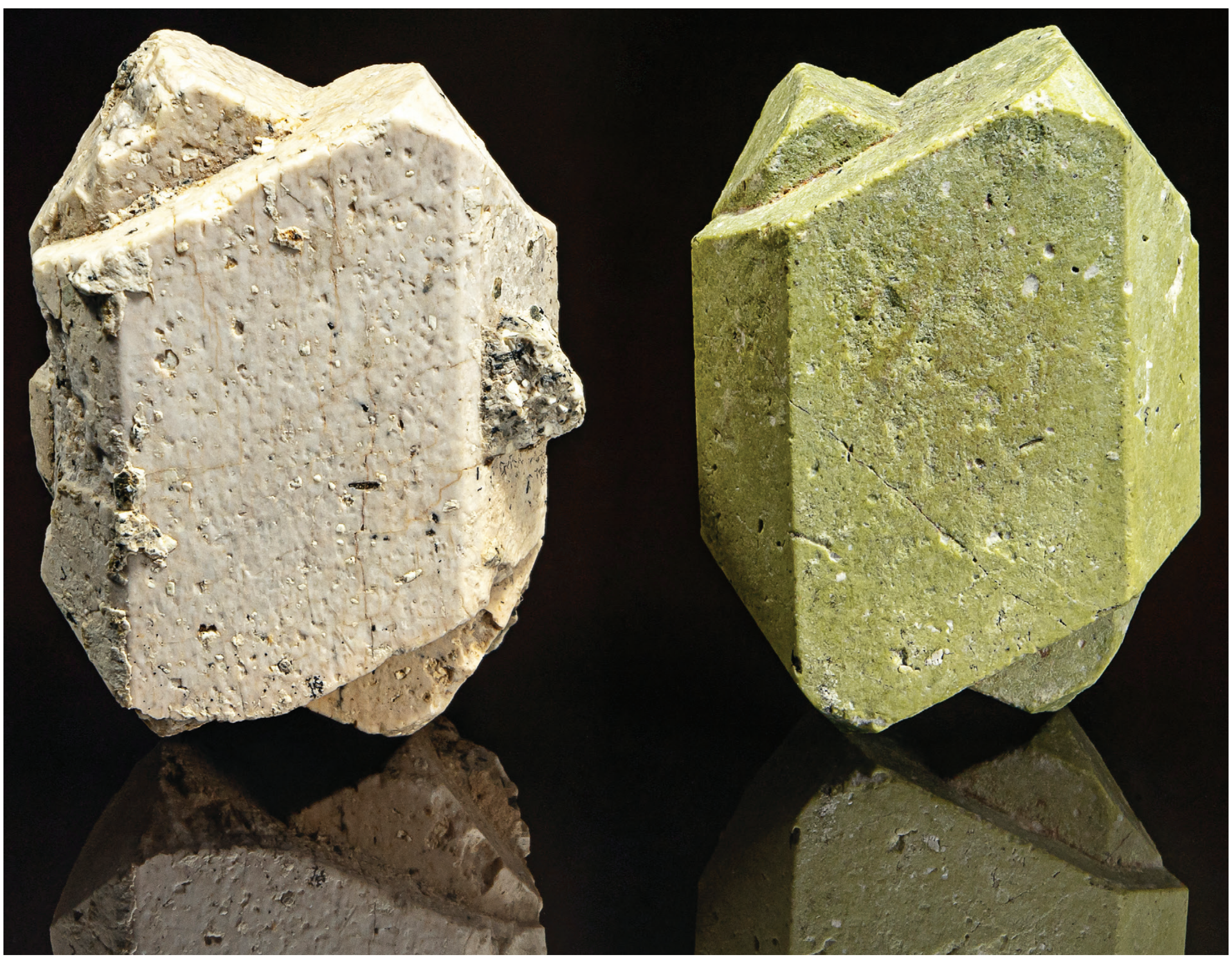


Figure 1. A comparison of an unaltered (4.2 x 3.1 cm) and an altered twin (4.1 x 3.1 cm). Note that the unaltered crystal still shows signs of surficial pitting, demonstrating that many of the defects of the pseudomorphs may have been defects in the original feldspar. The orthoclase twin is also one of the very few relatively complete crystals found on the mountain. Philip Simmons specimens. Photo by Erin Delventhal and Philip Simmons.

by epidote, a pseudomorph Phil had never seen before. An excited phone call to Erin was all that was needed to prompt us to ask Ray if he would be willing to tell us from where he had collected the specimens. Ray graciously agreed. Although the specimens observed in Ray's collection were found by an individual from Alamogordo years back, Ray had gone looking for the locality. The trip only resulted in a few crude crystals that were nowhere near the quality of the ones found previously. However, with the knowledge of where Ray had collected, we were able to pinpoint other promising targets that eventually led to the discovery (or possible rediscovery) of the premier zone that produced the sharp pseudomorphs in November of 2020.

Geology

Although the mineralogy is more complex in the parts of the Orogrande district that contain base and precious metal contact metasomatic deposits and hydrothermal turquoise deposits, the local geology of the pseudomorph locality is relatively simple. The collecting area is composed of a monzonite porphyry stock containing large, sharp phenocrysts of potassium feldspar reaching sizes of 6 cm. Late-stage mineralizing fluids, rich in iron and magnesium (known as propylitic alteration) worked their way through zones of the monzonite with higher permeability, resulting in an alteration mineral assemblage of epidote and albite with minor chlorite and calcite. This alteration targeted the feldspar, resulting in pseudomorphs of epidote/albite after orthoclase. However, the replacement is most often observed in fracture fillings and rounded "pods" up to about 20 cm in diameter. Most feldspar phenocrysts within these zones are replaced, while the effects of the replacement outside of the zone are sporadic.

Minerals and Mineralogy

XRD analysis of the rock and crystalline phases was performed by Virgil Lueth and Kelsey McNamara at the New Mexico Bureau of Geology and Mineral Resources X-ray Lab. Results concerning the feldspar species showed orthoclase, microcline, sanidine, and albite. Questions still exist regarding these results given two factors: 1) XRD has limitations in discerning various types of alkali feldspars; 2) the presence of some of these species raises questions given what is known of the broader geology of the region. Analysis concerning the replacement species resulted in clinozoisite—however since clinozoisite forms a solid solution series with epidote (Fe^{3+} substitutes for Al) and the distinct green color of the specimens in contrast to the typical brownish tinge of clinozoisite, we assume the replacement is epidote. Further analysis is needed for both the precursor feldspar species and the replacement species to determine the identity unequivocally. Small albite crystals form a replacement texture on the outside of the phenocrysts; some replaced by epidote and some unreplaced. Based on the replacement, it appears that the rind of the phenocrysts was less susceptible to epidote alteration. Replacement is variable within the phenocrysts, although the majority of crystals are fully replaced. Surficial replacement often consists of albite, and the crystals can exhibit cracks as a result of the volumetric change during pseudomorphism or later weathering.

A mix of single crystals and Carlsbad-law twinned crystals are found at the locality. The twins are both morphologically left- and right-handed pairs. Only two Baveno twins have been found, making them the rarest type of crystal growth. Coveted groups of intergrown crystals are found occasionally, as well as parallel growth crystals. Matrix specimens are occasionally found, and are some of the more desirable specimens from the locality. Since the crystals are found as phenocrysts, they have no point of attachment, and are fully complete all around when not broken by the weathering process.

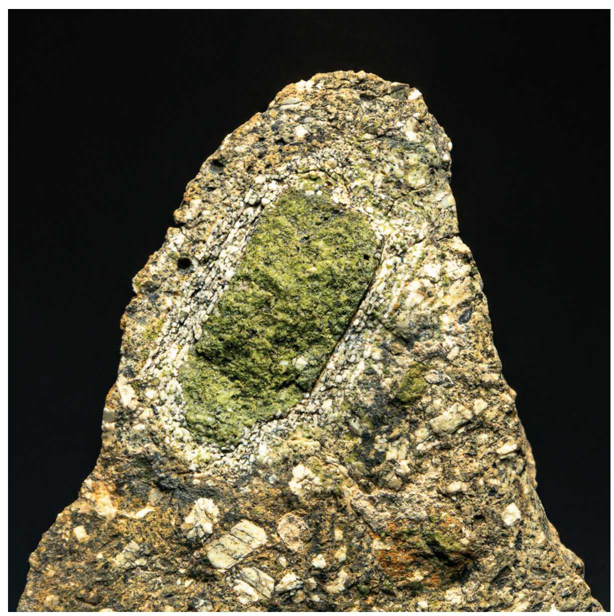


Figure 2. A cross-section of a broken epidote pseudomorph exhibiting a rind of concentric layers of flattened albite crystals, crystal is 3.0 cm long. Also of note are the other feldspar phenocrysts that, even in close proximity, show little sign of epidote alteration. Mike Sanders specimen.
Photo by Erin Delventhal and Philip Simmons.

The Naica Mining District, Saucillo Municipality, Chihuahua, Mexico

Peter K.M. Megaw: IMDEX Inc., Tucson AZ (pmegaw@imdex.com)

Naica is arguably the world's best-known mineral locality—not because of the wonderful specimens of fluorite, sulfides and anhydrite that grace many of the world's finest collections, but because of the enormous gypsum crystals in the Cave of the Crystals. Far beyond the mineral collecting community, these giant crystals have captured the imagination of millions worldwide—making them perhaps the first global crystal celebrities. Their sheer size makes them too big to even contemplate removing from the mine, which protects them for now but ensures that when the mine eventually closes permanently and floods they will be lost to us forever. Massive inflows of water inundated the deepest reaches of the mine in 2015 and forced closure, but the Cave of the Crystals was never touched by the flooding. Exploration teams have successfully identified new resources to the west and the mine is now headed back into production!

Geologically, Naica stands with related Carbonate Replacement Deposits in northern Mexico like Santa Eulalia, Ojuela, Los Lamentos and San Pedro Corralitos—districts famous for deep oxidation, elongate flat-lying "manto" and tubular "chimney" orebodies and long mining histories. Naica's story is different—she was not discovered until 1794 and her near-surface oxidized ores were too limited to support a sustained bonanza—so her history (and mineralogy!) is much less colorful. Only the top of the famous "Torino–Tehuacan" Chimney reached the surface—as an outcrop a mere 15 meters in diameter. This orebody produced half a million tonnes of oxide ores before the water table and sulfide ores were encountered and the mine was largely abandoned. The bulk of the deposit was not discovered until the mid-1900s, when the sulfides were followed to depth. Through the 1960s and 70s Naica became an increasingly important operation, producing over 40 million tonnes of ore by 2015. Mining has shown that Naica is composed of over 80 sulfide "chimneys" up to 800 meters tall that coalesce at depth into giant bodies of mineralized skarn (Fig. 1). It is probably the dominance of vertical orebodies that makes Naica such a superb primary species specimen locality; as the chimneys grew upward they collapsed periodically, repeatedly creating void-rich breccia columns into which large crystals of ore sulfides and gangue species could grow.

The Sierra de Naica is a broad northwest-southeast elongate dome 1.5 by 4 km developed in a thick sequence of homogenous Lower Cretaceous limestones of the Benigno, Lagrima and Finlay Formations, commonly referred to as the Aurora Group. These limestones are underlain by anhydrite-rich evaporites of the Cuchillo Formation and overlain by Upper Cretaceous shales and sandstones. This host rock sequence was folded and thrust faulted during the Laramide Orogeny (60–55 Ma) and the mine lies in a secondary flexure developed on the northeast flank of the principal dome. The dome is cut by prominent pre-mineral southwest-dipping thrust faults and high-angle N25-40E and N50W trending fault and fracture sets with pre- and post-mineral movements. Several show over 1 km of displacement and host the major gypsum caves. The mine area was invaded on its southwest side by a granitic intrusion, known from a combination of geophysics and drill holes. A series of crowded porphyry to aphanitic felsic dikes and sills, dated at 30.2 Ma, were derived from it and were intruded along the thrust fault upwards from the southwest to the northeast. The felsites also invaded the northeast and northwest faults, especially at their intersections. Early skarn-forming hydrothermal fluids followed the felsites laterally and vertically for several kilometers. In the proximal zone, the skarn-forming fluids replaced both the felsite and the surrounding limestone to massive calc-silicates, but with increasing distance from the fluid source the skarn development becomes progressively limited to the limestones, leaving a shell of skarn surrounding a felsite core. The sulfide mineralizing fluids followed, cutting and filling fractures in the skarn and developing massive sulfide replacement bodies in the surrounding limestone. Wherever the sulfide-mineralizing fluids encountered high-angle structures they followed them, especially where two sets intersected. The ultimate result was a series of orebodies that thicken and coalesce to the southwest towards the intrusive source. This includes 17 large skarn bodies that ramp upwards to the northeast and more than 75 massive sulfide chimneys that sprout off the upper surface of the skarn bodies. The skarn bodies range up to 25m thick and 500 x 500m wide and long. The massive sulfide chimneys range from 3 to over 80m in diameter and up to 800m tall—the largest being the Torino–Tehuacan chimney—the only orebody that reached the surface.

Mineralization at Naica is progressively zoned from copper-rich sulfide-mineralized skarns near the porphyry intrusive in the deep southwestern zone through intermediate zinc-lead-silver sulfide-mineralized skarns developed around felsite dike and sill offshoots from the porphyry to distal massive

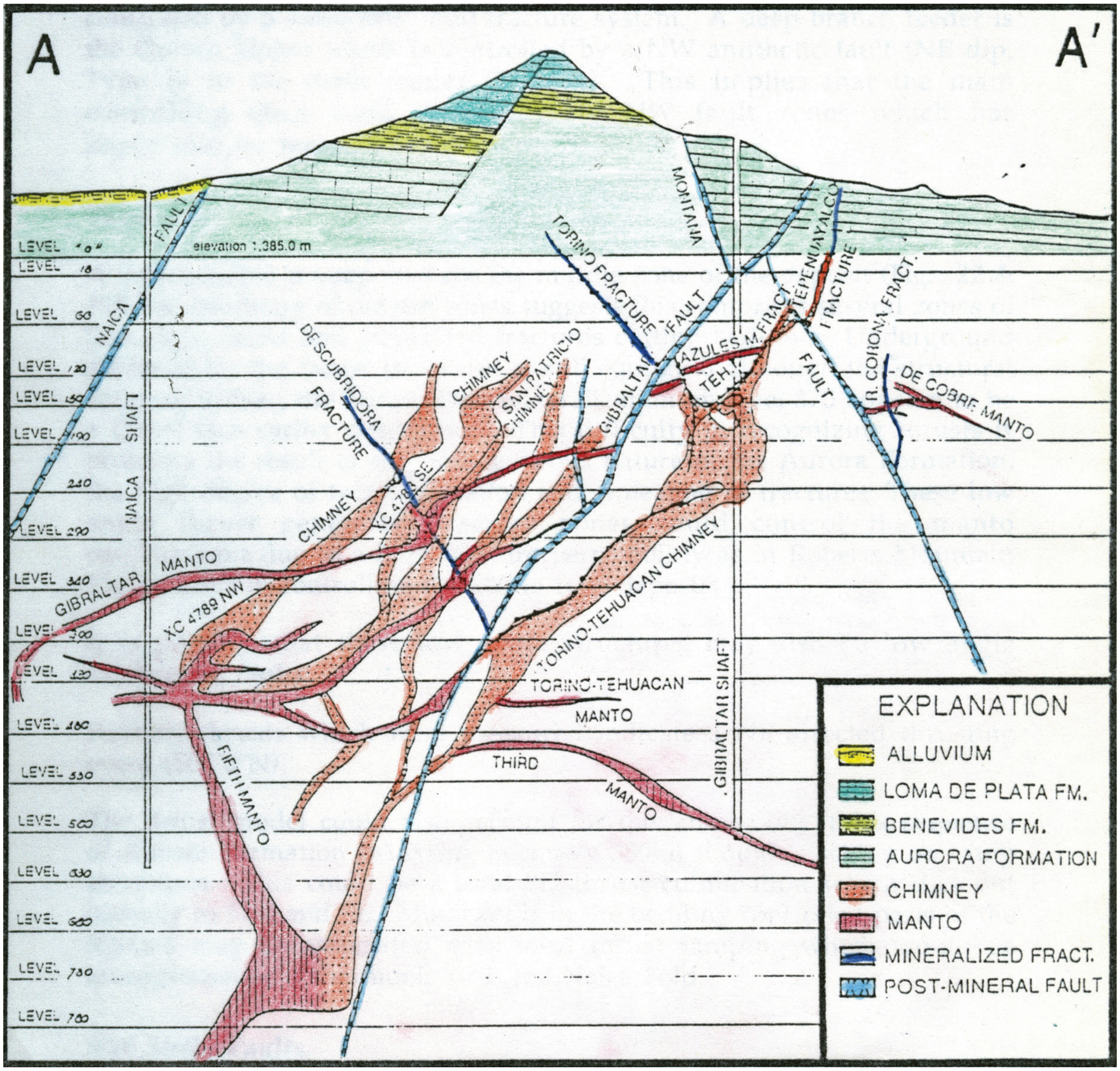


Figure 1. Cross-section of the Naica Deposit.

sulfide ores developed along the skarn margins and extending upwards as tubular chimneys. The sulfides are everywhere younger than the skarn silicates and either replace or cut them. The sulfide assemblages are dominated by pyrrhotite or pyrite (and pyrite after pyrrhotite), sphalerite, galena, chalcopyrite and arsenopyrite, with lesser amounts of complex sulfosalts, molybdenite, scheelite/powellite and cassiterite. Gangue mineralogy is dominated by massive garnet, epidote and vesuvianite skarn and void-filling quartz, calcite, dolomite, fluorite, anhydrite and gypsum.

Thirty million years of erosion exposed the uppermost sulfide ores to oxidizing surface waters, which removed most of the soluble sulfur, zinc and copper, leaving iron-oxide gossan bodies with insoluble secondary lead and silver minerals residually enriched by the removal of the soluble materials. These were the first ores encountered in the district and were largely worked out long before mineral collecting became widespread. By 1958 the various oxide producing mines in the district (including: the Descubridora, Estrella, Gibraltar, Lepanto, Maravillas, Reinas, San Francisco, San Francisquito, San Patricio, Santa Juliana, Siglo XX, and Xochitl mines) had all been consolidated into the Naica Mine and most access to them was sealed off. This means specimens of oxide minerals from the district are extremely rare outside museums and unless they are reliably attributed to a specific mine by a reliable source, it is safest to label them simply "Naica District." The closure of the oxide mines coincides both with the beginning of exclusive sulfide mining and significant mineral collecting from the district, so the overwhelming majority of primary sulfide and related gangue minerals from the sulfide zone are properly labeled "Naica Mine." Many dealer labels cite the "Gibraltar," "Maravillas" and Siglo XX mines, but none are valid for sulfide-mining era specimens. Proper labeling for most non-oxide specimens should be: Naica Mine (or Mina Naica), Naica, Saucillo Municipality, Chihuahua, Mexico.

Hot water, gypsum, and caves are inextricably intertwined at Naica. From the discovery of the Cave of the Swords in 1910, to the Cave of the Crystals in 2000, large voids lined with huge gypsum crystals have given Naica a prominent mineralogical profile. New insights into crystal growth and over 35 cave minerals have been documented through detailed scientific studies stimulated by the giants of the Cave of the Crystals. This combination also gave Naica a complicated mining history because she has long been plagued by floods of hot, sulfate-laden waters that pour into the workings. These began as 1,000 gallons per minute (gpm) inflows of 45°C water in the 1920s that grew to 18,500 gpm of 54°C water by 2006. Moving the equivalent of nearly 40 tons of water per ton of ore was an expensive challenge that ended abruptly in 2015 when unstemmable inflows estimated at over 40,000 gpm poured out of an open fault at depth and forced closure. But simply keeping the pumping infrastructure functional was a thornier problem because as the waters cooled below 52°C, gypsum crystals deposited everywhere-in sumps, pipes and even valves (Fig. 2). These human activity-related crystals grow to specimen size in few months and are routinely harvested with many getting mislabeled as coming from the Cave of the Swords. This misattribution is also true for most of Naica's natural gypsum specimens, when in fact, most natural gypsum crystals in collector's hands came from one of the myriad smaller caves scattered throughout the mine. Again, safest is to simply label them Naica Mine. Notably, no specimens have been harvested from the Cave of the Crystals.

Figure 2. Recently deposited gypsum crystals in mining equipment.

From Gold to Lead: The Mineral Riches of Leadhills–Wanlockhead Mining District, Scotland

Nathalie N. Brandes and Paul T. Brandes

Leadhills and Wanlockhead, straddle the border of South Lanarkshire and Dumfries and Galloway on the north slope of the Lowther Hills. The rugged hills reveal piles of waste rock, adits and shafts, and deep gullies of 500-year-old hushes from the area's long mining history.

Leadhills–Wanlockhead is located in the Southern Uplands Terrane. It is bounded to the south by the Iapetus Suture, which formed during the collision of Laurentia and Avalonia. The northern boundary is the Southern Uplands Fault, which separates the terrane from the Midland Valley. Rocks of the Southern Uplands Terrane are predominantly Ordovician and Silurian greywacke and shale that have been intensely faulted into an imbricate thrust belt. It formed as an accretionary wedge as the Iapetus Ocean closed. The southernmost (mid-Silurian) part of the terrane formed in a foreland fold and thrust belt setting overriding Avalonia during the collision with Laurentia.

The oldest rocks around Leadhills–Wanlockhead are the chert, mudstone, and basalt of the Crawford Group. Black shale, chert, and meta-bentonite of the Moffat Shale Group overlie the Crawford Group. All of these rocks are interpreted to have been deposited on the ocean floor. Turbidite greywackes deposited as submarine fans comprise the Kirkcolm Formation, Portpatrick Formation, and Shinnel Formation.

Leadhills–Wanlockhead is the largest and most productive lead-zinc deposit in Scotland. About 70 veins occur in an 8 km^2 area. Ore veins are hosted by the intensely fractured and faulted Portpatrick Formation and are confined to an area between the Leadhills Fault to the northwest and the Fardingmullach Fault to the southeast. Typical vein width is about 1 m, although the largest has a width of 4.3 m. The ore deposits were emplaced during the Carboniferous at a depth of about 600 to 1,200 m by saline fluids (19 to 30 equivalent weight percent NaCl + CaCl2) at temperatures calculated to be 143 to 281°C. A pre-mineralisation reverse fault with impermeable rocks in the hanging wall created a barrier for ore fluids and forms the northwest boundary of the mineral deposits. Ore fluids are thought to be derived from sedimentary basins in the Midland Valley. Crustal

An old walking beam.

Leadhills area ca. 1775

thinning and extension increased the geothermal gradient, causing migration of these fluids along major faults. An alternative source of the fluids suggested by some researchers could be metamorphosed Ordovician black shales.

Typical veins include the ore minerals galena, sphalerite, and chalcopyrite with the gangue minerals ankerite, calcite, dolomite, quartz, barite, and pyrite. The upper parts of the veins are oxidised, which has created numerous interesting oxidation minerals. In addition, interesting minerals can be found in slag heaps. Overall, 108 different minerals have been identified at Leadhills–Wanlockhead and it is the type locality of ten minerals: caledonite, chenite, lanarkite, leadhillite, macphersonite, mattheddleite, plattnerite, plumbonacrite, scotlandite, and susanite. The area also hosts alluvial gold deposits.

The earliest confirmed mining activity around Leadhills–Wanlockhead was in 1239, when the monks of Newbattle Abbey were granted a charter for lead mining. It is possible, however, that mining occurred much earlier. A study of lead concentrations in a nearby bog shows elevated lead levels that suggest possible Late Bronze Age and Iron Age mining around

Entry to the Lochnell Mine.

365 BC to AD 70. In addition, lead beads excavated at Carghidown, an Iron Age hillfort, date to 360 BC to 60 AD. Analysis showed these beads have a similar isotope chemistry to Leadhills galena. A possible stone hammer discovered at Wanlockhead in 1929 further supports an ancient history of mining in the area, although some researchers believe it is not a hammer, but a loom weight. In the late nineteenth century, stone and bronze picks were reportedly discovered at both Leadhills and Wanlockhead. Unfortunately, these artefacts have been lost and while ancient mining in the area is a possibility, there is no unequivocal evidence to prove it.

Mining became a major activity in the area in the sixteenth century. While lead mining was occurring, much of the focus was on the alluvial gold that had been discovered. Leadhills–Wanlockhead became an important source of gold for coinage during the reigns of James V and Mary, Queen of Scots. The gold was also used to make crowns and regalia for the Scottish monarchs. In 1620, George Bowes was using hushing in an attempt to find the source of the gold, but instead found rich lead veins. This ended the interest in gold and increased the extraction of lead.

Much of the early lead mining exploited ore by hushing in addition to hand extraction from shallow shafts and adits. As mining progressed, shafts became deeper, stopes were opened underground, and dewatering became an issue. Rope and bucket dewatering and drainage levels were initially used, but by the early eighteenth century water-driven beam engines and waterwheel-driven pumps were common at the mines. Using water power posed many problems as streams froze in winter, waterwheels were overwhelmed by spring runoff, and summer drought stalled them. The first steam engines to power pumps were installed in the late 1700s and remained the main source of power until the mid-nineteenth century, when the low price of lead and high cost of operating steam engines impelled a switch back to water power.

Production reached a peak during the Napoleonic Wars when the Leadhills–Wanlockhead mines accounted for 90% of the total lead and zinc production in Scotland before suffering a serious decline. Mining continued throughout the nineteenth century and experienced a short-lived revival with significant production in the early twentieth century. The last mine closed in 1934, the district having produced an estimated 270,000 tonnes lead ore, 13,800 tonnes sphalerite, and 23 tonnes silver.

The mines are silent and abandoned now, but the moors around Leadhills–Wanlockhead hold a long history for visitors to discover. Deep gullies from hushing, adits and shafts, and an old beam engine are ghosts of this former industry. The Museum of Lead Mining in Wanlockhead houses exhibits about the geology and mining history of the district as well as offering the only underground mine tour in Scotland and preserving miners' cottages.

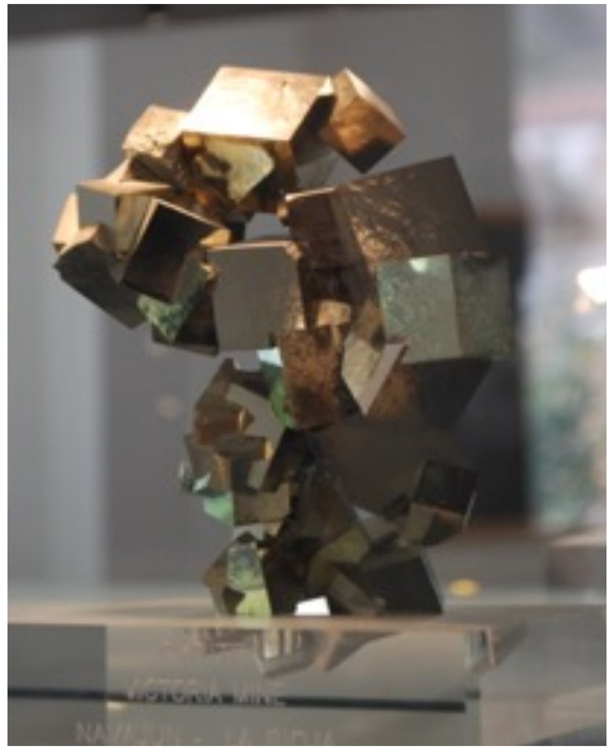
Pyrites Of Navajun, Spain (Geologist/Collector Odyssey: 1993–2018)

David Stoudt, Santa Fe, New Mexico
November 2021

Over the course of 25 years, the pyrites of Navajun, Spain have been for the author, a source of geological and mineralogical interest. In 1993, the author was sent to Spain by his oil company employer to investigate the Spanish offshore oil fields in the Mediterranean, south of Barcelona. Overlying these offshore Jurassic carbonate oil reservoirs are Cretaceous limey shales and carbonate rich marls which cap and seal the oil reservoirs. These "seal rocks" contain microscopic pyrites. These same Cretaceous limey shales and carbonate rich marls found onshore Spain in the Cameros Basin, host the pyrites of worldwide fame. In 2018, the author and his wife vacationed in Spain and took several days on a journey to visit and self-collect at the famous, "Mina Ampliacion de Victoria," 4 km N/NW of the village of Navajun, Cervera District, La Rioja Province, Spain.

The presentation will describe the geological and mineralogical occurrence of these incredible and unique pyrite specimens in a trip back to Spain. The interplay of a unique stratigraphic record leading to the pyrite formation will be discussed. Pyrite is found in over 43,836 worldwide locations, per Mindat (2021). But Navajun is an iconic location known for its almost perfect cubic crystals in a striking occurrence. Some of these cubic crystals are up to 19 centimeters (7.5 inches) on a side. These perfect crystals, to non-collectors, are believed to be manmade and on discovery of the truth, show expressions of amazement or disbelief.

For those who keep a bucket list of collecting locations to visit, Navajun should be found in their top 10. The author and his wife want to thank Victoria Mine owner, Pedro Ansorena Conde and his able associate, Raul Sesma for indulging us on the mine trip and making it a grand part of our visit to Spain. Incredible food and wine and world class transportation also added to the enjoyment of a return visit to Spain.



Pyrite in the personal collection of Pedro Ansorena Conde, owner of Piritas of Navajun, (specimen is 12 inches tall).

Mina Victoria, Navajun, Spain pyrite occurrence (field of view, 3 feet across).

The Himalaya Pegmatite Mine, San Diego County, California: History and Minerals

Mark Ivan Jacobson

Since 1890, the minerals from the pegmatites of southern California have become well known across the United States both for faceted and polished gemstones of colored tourmaline, aquamarine, morganite and kunzite but later, for iconic mineral specimens of the same species. Although the easy material was gone by 1912, this never slowed down the collectors. Despite diminished returns at a greater expense, mining on the Himalaya pegmatite vein has continued. New specimens and collecting stories continue to be revealed at mineral shows. This talk will briefly recount the mining history of the Himalaya pegmatite and reveal the minerals recovered from this amazingly prolific pegmatite vein.

The pegmatites of southern California were first discovered and exploited for gem tourmaline by Henry Hamilton on the southern slopes of Thomas Mountain, Riverside County in 1872. The gem tourmaline discoveries at Mesa Grande were reported in 1899. The pegmatite might have been known by 1875, based on local oral histories recounting that kids, both Indian

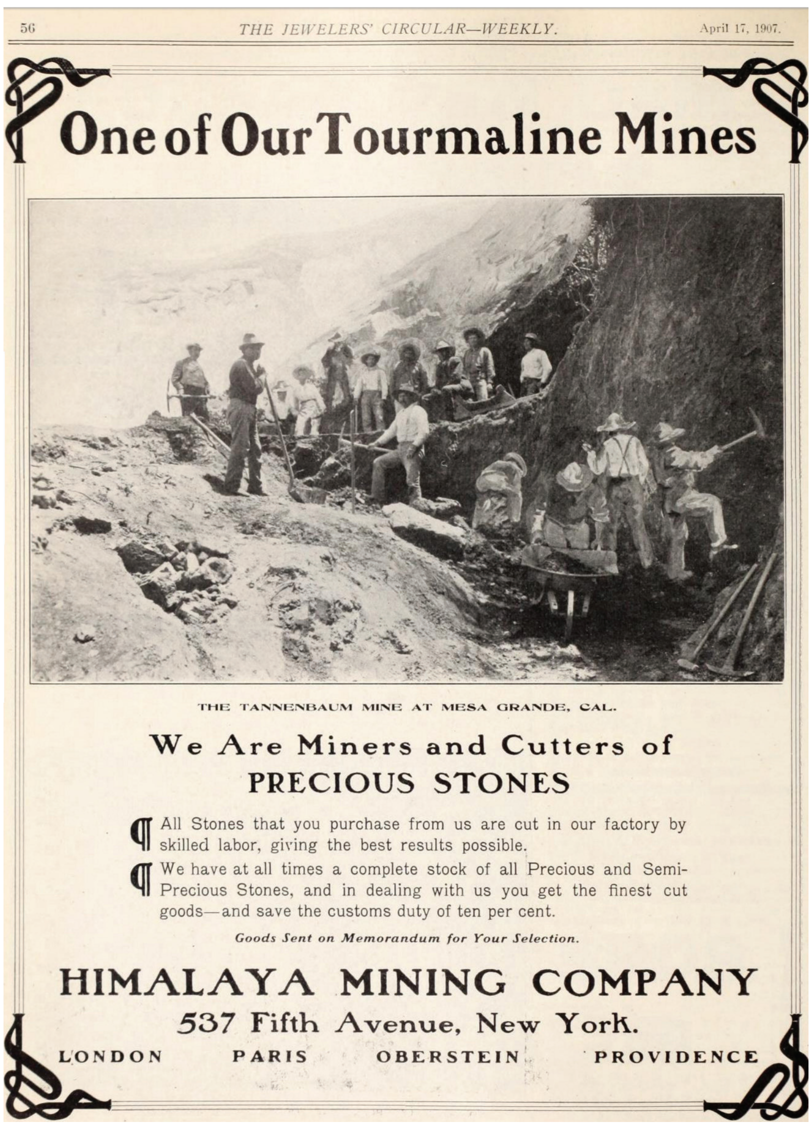


Figure 1. The Tannenbaum tourmaline mine, know today as the Himalaya mine, at Mesa Grande, circa 1907. From the Jeweler's Circular, April 17, 1907.

and settlers were bringing crystals home or trying to trade them away (Jacobson, 2009). A specimen in the California State collection in San Francisco proves that by 1896, local adults knew about gem tourmaline from what became known later as the Himalaya vein. Gail Lewis put in his claim on the southern end of the vein sometime between 1898–1902, whereas the northern end was claimed by Charles Orcutt on November 16, 1899. Orcutt mined his portion of the vein in 1899 and publicized his discoveries. His claim was soon overstaked by another group—D. L. Hoover, C. E. McGary, and the shoe retailers of Frank F. Wright, and Frank N. Wright. This group named their claims the Sancho Pancho Mine. The latter owners granted an option of their properties to Archibald Edward Heighway, Jr., the "Cincinnati giant," as the New York Times called him (Jacobson, 2008). He took over the property in 1901, started mining, reneged on the royalty payments, and overstaked the Sancho Pancho claims. He then sold the property to Lippman Tannenbaum who was promptly sued by the Hoover group. Just before this problem went to court, Tannenbaum paid the Sancho Pancho owners $6,000 in December 1903 and the problem went away (Jacobson 2010, 2017).

The height of mining activity by Tannenbaum peaked in 1910. Mining afterwards decreased radically due to both a sluggish domestic and foreign market and financial mismanagement by Tannenbaum. Tannenbaum filed for bankruptcy in April 1913. After the creditors took over the property it was leased circa 1914 probably to the George Ah Quin Company with periodic mining by Thomas Ah Quin, Jr.; Henry Quin and Fred Rynerson. By 1922, the Chinese market for pink tourmaline had regained sufficient strength that the southern California mines could no longer fulfill all the demand. Circa 1925, the General Electric Company of New York leased both the Himalaya mine and San Diego Mine on the Himalaya pegmatite dyke for exploratory mining for pollucite, the only known cesium ore.

In 1925, Thomas Ah Quin, Jr. was able to buy the Himalaya mine properties outright with Fred Rynerson buying the San Diego mine. In 1935, Ed Over and Arthur Montgomery leased the Himalaya mine for specimen and gem tourmalines. Although they found tourmalines, the quantity was inadequate for a profitable return on their effort. In 1937, Thomas Quin passed away with the Himalaya property being inherited by his married daughter, Helen Quin Kong. In turn, she sold the property to Ralph Potter in 1952. The long term on-site caretaker, Herb Hill, informally allowed specimen collectors on the mine site. By 1958, the underground workings were re-opened with the new tourmaline pockets being opened and specimens being marketed.

In December 1963, Ralph Potter formed the Himalaya Gem Mines, Inc. to own the patented and unpatented claims; shares of this company were sold a group of 8 local mineral collectors, with Potter retaining an interest in the company. Underground mining continued until the winter rains of 1969 which caused the adit that accessed the underground workings to collapse. In July 1977, William "Bill' Larson as principal for Pala Properties International obtained a ten year lease and reopened the mine. Due to weathered near surface bedrock, Larsen created a new, lower adit to intersect the pegmatite below the shallower mine tunnels to reach less weathered pockets. In 1988, Larson, as owner of Pala Properties International, purchased the mine. Afterwards the mine continued to be successfully and profitably operated by Pala Properties until 1997.

In 1998, Chris Rose took possession of the Lohrer Claim which had the open adit with the two more northern patented claims being sold by Pala Properties. In pre-covid 2020, the Himalaya mine on the Lohrer claim was being worked by Chris Rose with dump material moved off site to be sold as a pay-to-dig tourist activity. The San Diego mine, on the southern extend of the Himalaya pegmatite dyke is still retained by the descendents of Fred Rynerson.

The Himalaya pegmatite mine has been the most prolific producer of gem elbaite in the United States. Kunz (1905, p. 134) stated that "about 6 tons" of elbaite was shipped to New York—gems, carving material, and specimens. Weber (1963, p. 91) stated that perhaps 90 tons of elbaite and beryl has been produced! This was all before the mining activities of William Larsen who has only added to the mine's production. Due to all these efforts numerous specimens can be found in public and private collections as well as available on the market. In addition, the pegmatite is still capable of producing specimens and gems.

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The Smithsonian Gem Collection Unearthed: Surprising Stories Behind the Jewels

Dr. Jeffrey E. Post

One of the world's greatest collection of gems is in the Smithsonian Institution's National Museum of Natural History. It includes world famous stones such as the Hope Diamond, Star of Asia Sapphire, Carmen Lucia Ruby, Hooker Emerald, and Blue Heart Diamond. But the National Gem Collection is not one of just rare and beautiful gems, but also of the stories of the people who once owned, or were associated with them—kings, emperors, maharajas, movie stars, the rich and famous, and "ordinary" folks.

Gemstones are among Earth's rarest and most beautiful creations. They are history's preeminent symbols of wealth and power. They are valued because they are beautiful and rare, but also because their beauty is undiminished with time. Gems accumulate history, and in many cases that "provenance," the story, contributes as much to the perceived value of a gem, as its rarity, size and beauty. Who owned them, donated them? Why were they donated? Where were they mined, cut and fashioned into jewelry? We currently share a "moment" with these gems, and we can research and document their pasts, but only speculate about their futures.

Dr. Jeffrey E. Post, curator of the National Gem Collection for more than 25 years, and author of the recently published book: "The Smithsonian Gem Collection—Unearthed: Surprising Stories Behind the Jewels" (Abrams, 2021), recounts the natural history and human stories of some of the world's greatest gemstones, separating fact from fiction, revealing new information, and sharing anecdotes and tales that result from the unique perspective of decades of studying and helping to build this great collection. Did you know that New York ad-man Rosser Reeves donated his great star ruby because he couldn't resist the alliteration "Rosser Reeves Ruby," or that Polly Logan gave her huge sapphire in part because it reminded her of her unfaithful previous husband, or that the Napoleon Diamond Necklace was sold by swindlers for $3,000, resulting in an Austrian Archduke being tried for the crime in New York City, and that the Countess Mona Bismarck, who gave the spectacular Burmese sapphire necklace, was the daughter of a Kentucky horse trainer? These stories and more will be explored as Dr. Post provides a special curator's choice tour of our Smithsonian's National Gem Collection.

The Bismarck sapphire necklace features an extraordinary 98.6 carat Burmese sapphire and was a gift to the Smithsonian National Gem Collection from the Countess Mona Bismarck.

The Napoleon Diamond necklace, with 262 carats of diamonds, was a gift from Napoleon I to the Empress Marie Louise in 1811 to celebrate the birth of their son.

Bagdad Revisited

Barbara L. Muntyan

When I wrote about the history and minerals of the Bagdad mine (2015. Mineralgical Record, 46, 585–602), I intended to write the complete story. But when one is writing about an operating mine, there is no "final word": drilling and blasting continue to produce ore, the open pit gets deeper and perhaps wider, and sometimes previously unreported minerals are discovered. This has been the case with Freeport McMoRan's copper mine in west central Arizona in the historic mining town of Bagdad in Yavapai County.

As mining continued at Bagdad since I finished my article, there have been several major changes to pit operations. The decision was made to remove all of Giroux Point (site of many high wall failures over the years) and reshape pit contours. While removing the bulge from the north side of the pit, a heretofore unreported diatreme was found below Giroux Point (Bob Jenkins, personal communication May, 2021). A diatreme forms when hot magma forces its way toward the surface, encounters water, and forms a plug of highly fractured and altered rock. As the hot magmatic rock slowly intrudes the older host rock, heating and melting occurs and new minerals form in vugs around the margins of the diatreme. These vugs contained a suite of species previously unknown from Bagdad, including well crystallized dolomite, sphalerite, pyrite, large quartz crystals, chalcopyrite, and chrysocolla.

The Pit Geologist at this time was the late Erich Laskowski who worked at Bagdad for twelve years from (2008 to 2020). He was a lifelong field collector; as luck had it, his job at Bagdad was to inspect each blast in the pit and map the results. He also carefully collected the contents of various vugs exposed from May 2010 to November 2011 for himself. The results are noteworthy. But Laskowski died unexpectedly in 2020 and his mineral collection was sold off during the April 2021 mineral show.

The vugs surrounding the diatreme were all found at depth, well below the pit's oxide zone which had produced lovely copper minerals in the l970s. These new vugs produced an unusual assortment of well-crystallized species. Not only were these new minerals from Bagdad, but their appearance is more typical of Tri-State mines.

The Bagdad mine has never had the reputation for fine mineral specimens comparable to those from Bisbee, Morenci or Ajo. Yet Bagdad has produced its share of appealing finds. During the last decade a variety of new specimens were collected as miners removed the large diatreme located at the base of Giroux Point. Virtually all of the specimens, found earlier, came from the oxide zone high in the pit. These new finds all came from lower in the pit, in the sulfide mineralization.

As active mining continues, there is also the possibility of additional finds. A major pushback of the Bagdad pit margins is under consideration by Freeport MacMoRan (2021) because of the recent surge in copper prices. Thus, collectors may hope that there will be more specimens to come as pit expansion occurs. Only time will tell.

Chrysocolla over quartz. 8.5 x 7 cm. Bagdad pit, 3050-N bench. Muntyan collection.

Yellow doubly-teminated calcite crystals on a cluster of quartz crystals. 8 x 6 cm. Bagdad pit, 2900 bench. Muntyan collection.

Mineral Lighting
How Your Minerals, Your Lights, and Your Eyes all Interact

Anthony Gleckler, Ph.D.

While anyone can get light on a rock, getting it to look right is hard—getting it to look right for all of your specimens tends to make it a frustrating endeavor for many mineral collectors.

The reason for this difficulty is that multiple factors affect the optimal viewing of a mineral, of which most people only understand a few. Your lights, your minerals, and your eyes all interact to produce a combination of effects that impact your viewing pleasure… or displeasure. Properly lighting your minerals is a surprisingly difficult task that we seek to simplify.

We start with the fundamental part of seeing. In other words, how the human eye works—at least as far as viewing minerals is concerned. What catches your eye? What allows your eye to see your minerals better? How are colors perceived?

After that, we discuss the various types of lighting available: halogens, fluorescent bulbs, and the popular "white light" light-emitting diodes (LEDs). What most don't understand is that most "white lights" may fool your eye and appear white, but they are not. We demystify this assumption and explain how different lighting types affect the color and look of your minerals.

Using the information on lighting and how the eye works, we then provide information on how to light your minerals, what kind of lights to order, and how much light should you put on your minerals. This comes with Tony's three big rules on mineral lighting, which will aid you in understanding the things to look out for when designing and installing your own lighting.

About the Speaker

Dr. Gleckler has his Ph.D. in Optical Sciences and is the CEO of GEOST, an aerospace company that builds optical sensors for spacecraft. In his spare time, he is an avid mineral collector as well as a mineral photographer. He's given talks on mineral lighting to museums and groups, all with the purpose of better educating the community and enabling people to enjoy their rocks even more.

A Mid-1950s Collection of Uranium Ore Samples from Arizona, Colorado, Utah, and Canada

Peter J. Modreski, 3555 Miller St., Wheat Ridge CO 80033, pmodreski@gmail.com
and
Virgil W. Lueth, Museum Director, New Mexico Bureau of Geology & Mineral Resources, New Mexico Institute of Mining & Technology, 801 Leroy Place, Socorro NM 87801-4796

In October, 2019, I (PJM) examined several boxes of uranium ore samples that had been given to the Denver Gem and Mineral Guild, a Denver area rock and mineral club. One of the club members had been given them by someone from a family in the Golden, Colorado area, saying that they had been collected by a geologist in the family who had passed away some years ago, and they had no idea what to do with them. The samples were wrapped in paper, some with typed labels on index cards and some labels hand written in pencil on pieces of paper. A few of the specimens were wrapped in newspaper dated September, 1958 from *The Northern Miner,* an Ontario mining journal. They provided an interesting set of mostly well labeled specimens from uranium deposits that would have been mined in the 1950s. Modreski examined the specimens, and Lueth obtained powder XRD data on some of the uranium minerals in them. Those specimens of sufficient historical or mineralogical interest will be donated to the NMGGMR Mineral Museum. Descriptions of the specimens and localities follow. Below, the descriptions written in regular text were what appeared on the original labels; comments in italics were added by the authors. The letters/numbers used to refer to the specimens were added by us (PJM).

AM-1 "Pitchblende, Ascension mine, Jefferson Co., Colo." *Massive grayish-black material, appears slightly foliated or sheared. "Uraninite" had been written in pencil, but crossed out, below "Pitchblende" on the label. The Ascension mine, MRDS (USGS Mineral Resources Data System) #10107989, was one of the uranium-producing mines in the Ralston Buttes mining district, north of Golden, near Golden Gate Canyon and Tucker Gulch, Jefferson County, CO. Mineralization in the district occurs as Laramide-age (circa 70 Ma) veins cutting Proterozoic metamorphic rocks. The largest and most recently worked mine in the district (from the 1950s until 2000) was the Schwartzwalder mine. XRD = quartz, uraninite, pyrite, perhaps thorianite.*

HJ-1 "Copper-Uranium ore, Happy Jack mine, White Canyon, San Juan County, southeastern Utah. Uraninite (black), Zippeite (yellow-orange), Uranopilite (yellow), Johannite (green)." *The Happy Jack mine is a uranium-copper-vanadium deposit in the Shinarump Conglomerate (Triassic) (Trites and Chew, 1955). The rock sample consists of multicolored uranium minerals, yellow to orange to dark to light green, in a friable mostly-black sandstone. Some 65 minerals (including varieties and mineraloids; 60 valid species) are listed in mindat.org from the mine. These include 20 uranium minerals + 2 uranyl vanadates (carnotite, metatyuyamunite) + 1 other vanadate (metarossite). The variously colored areas on the sample each appeared, not surprisingly, to be a mixture of minerals. XRD (black material) = quartz, uraninite, chalcopyrite, pyrite, johannite. XRD (yellow material) = natrozippeite, johannite, metauranocircite, chalcopyrite, plus unidentified diffraction peaks. XRD (orange material) = natro-(?)zippeite(?), johannite, barnesite, quartz, plus unidentified peaks. XRD (green material) = johannite, quartz, blatonite, brannerite, chabazite, gypsum. Barnesite, $(Na,Ca)V_6O_{16} \cdot 3H_2O$, a red-brown, radiating/fibrous mineral, is not listed by Mindat from the Happy Jack mine; nor is blatonite, a yellow, fibrous uranyl carbonate, $(UO_2)CO_3 \cdot H_2O$.*

MM-1 "Pitchblende, Mena mine, Jefferson Co., Colo." *A small, metallic-black vein bordered by brick-red host rock. As with sample AM-1, "Uraninite" had been written, this time above, "Pitchblende," but crossed out. The Mena was one of the more prominent mines in the Ralston Buttes district, near Ralston Creek. Eckel (1997) lists a number of copper, bismuth, nickel, and silver minerals occurring here, as well as uranium. Eckel (p. 511) describes the pitchblende mineralization as "Pitchblende occurs as a colloform coating on rock fragments and fracture surfaces, and in thick, black veinlets in the breccias of the Mena vein." XRD (black + pink material) = dolomite, uraninite, calcite, pyrite.*

MV-1,2,3,4 "Carnotite, yellow, in sandstone host rock, Monument #2 mine, Monument Valley, northeastern Arizona." *According to mindat.org, the Monument #2 mine "is one of the richest U-V deposits in the Monument Valley area." Mindat reports 48 valid mineral species, including 11 uranium minerals, 18 vanadates, and 4 uranyl vanadates. The samples show yellow (with some greenish or orange tints) uranium mineralization in sandstone. Sample MV-1, not studied. MV-2, yellow mineralization in sandstone/breccia; XRD = quartz, carnotite. MV-3, yellow crusts, XRD = uranophane, plus peaks that may questionably match metakirchheimerite and vivianite. MV-4, multicolored crusts (yellow, orange, green), XRD = uranopilite, chalcopyrite, heulandite, jachymovite(?), and a possible but very unlikely match to margaritasite.*

TC-1-6, "Uranium ores, Tallahassee Creek district." *The Tallahassee Creek uranium district, Fremont County, Colorado, consists of uraninite and coffinite mineralization in the Tallahassee Creek Conglomerate (Oligocene) and Echo Park Alluvium (Eocene) (Eckel,1997). The uranium mineralization is commonly associated with fossil wood or other carbonaceous material. According to mindat, uranium minerals identified in the district include autunite, coffinite, meta-autunite, metatorbernite, torbernite, and uraninite. Sample TC-2 contained yellow uranium mineralization on sandstone; XRD = uranophane. Sample TC-4 labeled, "Autunite in petrified wood, Tallahassee Creek, Fremont Co., Colo." consisted of crusts of a yellow uranium mineral (unlikely to be autunite as labeled) on reddish-brown, poorly preserved (crumbling) fossil wood; XRD = quartz, montmorillonite, and other peaks not yet positively correlated with any specific uranium mineral. Sample TC-5 was black sandstone, presumed to contain uraninite or coffinite; XRD = quartz, pyrite, uraninite, biotite, glauconite, and possibly an amphibole. Sample TC-6 was of a bright yellow crust on sandstone; XRD = metatyuyamunite, calcite, quartz.*

Other ore samples in the collection (not studied further) included three samples of uraninite-bearing "Quartz pebble conglomerate–pyrite, uraninite–Blind River [Ontario], Canada."

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The Fabulous Vanadates, Arsenates and Phosphates from New Mexico

Ramon S. DeMark, Michael Michayluk, and Thomas Katonak

Long before spectacular discoveries of vanadinite in Morocco and descloizite in South West Africa, these minerals from New Mexico were highly sought after by collectors and museums in the United States and abroad. Vanadinite was first described in the region by Genth, F. A. and Rath, G.V . (1885) from Lake Valley. They described a new "species," endlichite, from the area, which was subsequently discredited as an arsenic rich variety of vanadinite. They briefly noted vanadinite from the Georgetown district. George L. English visited the area in 1889 (***Exchanger's Monthly***, Vol. 4, No. 7, page 8) and wrote a comprehensive description of the descloizite and vanadinite from the Georgetown district. This was followed by an ad by English in the ***Exchanger's Monthly*** (1889, Vol. 4 No. 6 page iv) titled "Descloisite From New Mexico. Several entirely new varieties: Red, Orange, Yellow and Brown." He goes on to describe them as "Incomparably finer than specimens of the mineral ever before known."

An ad by A. E. Foote (1897, Vol. 4, No. 5) in the Mineral Collector mentions "Endlichite in beautiful crystallization" and is most likely the first ad for endlichite from Hillsboro. George L. English in the Mineral Collector, 1897, Vol. 7, No. 9 (back cover) describes "Endlichite from New Mexico, surprisingly fine specimens of large gemmy, yellow crystals, \$2.00–\$10.00." His ad in the Mineral Collector, Vol. 6, No. 1 of March 1899 describes "Endlichite from Hillsboro, finest known, 10 cts to \$5.00." These crystals are undoubtedly from what has been known as the Macy mine. A search of the Sierra County courthouse, Claim Records Book 0, p.795, determined that the mine was first located in 1892 as the Percha mine by Robin, Macy and Strickland. It was located subsequently in 1980 as the "Barking Frog" by Dick Jones and others and located in 1983 as the "Bobbi Dee" by R. S. DeMark and others. In 1996, Mike Sanders and Tom Massis attempted to file on the claim after it had been abandoned but it was rejected by the BLM as "not federally leasable nor subject to claim."

Turquoise is undoubtedly the best-known phosphate mineral from New Mexico. It was extensively mined by indigenous peoples in pre-Colombian New Mexico, most famously from the mines near Cerrillos. An article in ***Exchanger's Monthly*** (1887), Vol. 3, No. 1, page 3, titled "***Minerals At The American Exhibition, London***" dubiously states "The precious turquoise comes from Los Cerrillos, New Mexico where Montezuma got his Chalchuhuitas that is valued above gold and silver".

Descloizite from the Mimbres Mine, specimen approximately 9 cm. Photo by Erin Delventhal.w

Vanadinite from the Macy Mine, field of view, 9mm.
Photo by Michael Michayluk.

Turquoise from the Burro mountains achieved great renown in the late nineteenth century. It was reportedly discovered by John E. Colman in 1875 (Northrop, S. A., 1959). Also reported was that the "Elizabeth pocket (Azure mine) opened in 1893 produced more high-grade turquoise than any single deposit on record."

Two arsenates and one phosphate were first described from New Mexico. Santafeite, a manganese vanadate, was found 12 miles north of Grants (Sun, M. S. and Weber, R. J. 1958). Maxwellite, a sodium iron arsenate fluoride from the Black Range tin district (Foord, E. E. et al., 1991) and meurigite, an iron phosphate found at the Chino mine by Ron Gibbs (Birch, W. D. et al., 1996). This was renamed meurigite-K in 2009 (Mindat).

Other New Mexico locations are notable for the occurrence of phosphate minerals. In particular, the Chino and Tyrone mines near Silver City, the Atwood mine area in the Lordsburg district and the Mex-Tex mine in the Hansonburg district. Ron Gibbs recognized 16 species alone from the Tyrone mine (Gibbs, R. B., 1986). Bob Walstrom recognized a remarkable number of new phosphate minerals from the Atwood mine area, including several new to New Mexico and the U.S.A. Ludjibaite was particularly notable (Walstrom, R. E., 2018). A mechanized dig at the Mex-Tex mine in 1995 by the claim owners revealed a half-dozen phosphate minerals that were previously unknown from the mine. Tsumebite, libethenite and pyromorphite were of particular interest (DeMark, R. S. and Massis, T. M., 1999).

Additional occurrences of vanadates, arsenates and phosphates are found throughout New Mexico. Some deserve mention because of their variety and exceptional or unusual morphology. Monazite (Ce) has been reported from many locations, but the Petaca district in Rio Arriba County has produced the most significant specimens. Blocky crystals several inches across and weighing many pounds have come from the Globe mine, along with "feathery" crystal aggregates. Pucherite, the rare bismuth vanadate, was found at the Harding mine (Hlava, P. F., 1985). In 2018, vesignieite, a rare barium copper vanadate was found in excellent spherical crystal aggregates at the Wilson prospect on Copper Hill in Taos County (DeMark, R. S., et al., 2018). Agardite (La), a rare-earth calcium copper arsenate was found and described (Modreski, P. J., 1979) from the Red Cloud mine in Lincoln County. It was subsequently approved in 1981 as a new mineral with lanthanum dominant in the rare-earth site. A green tabular mineral found at the Comfort claim in the Mahoney district of Luna County in 1980 was determined by Paul Hlava to be an undescribed lead, copper arsenate molybdate. It was later approved to be new a mineral (molybdofornacite) from Tsumeb, Namibia. The Comfort claim find is reputed to be the third world occurrence (Northrop, S. A. and La Bruzza, F. A., 1996).

Many other species and locations are worthy of mention but are too numerous to cover in this presentation. Additional discoveries will undoubtedly continue with the enthusiastic and intense probing by New Mexico field collectors of the state's mines and outcrops.

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Inclusions in Fluorite from the Quebradas, Socorro County, and the Sandia Mountains, Bernalillo County, New Mexico

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Interesting inclusions in fluorite have been recently observed from three different locations in New Mexico. This paper describes inclusions in fluorite from two locations in the Quebradas ("ravines" in Spanish); the Gonzales and the Bonita prospects, plus one stray 4 foot boulder found in the Sandia Mountains.

There is no shortage of published information about inclusions. Here are some basics—Inclusions in fluorite are common worldwide. Inclusions can occur as a gas, a liquid or a solid, or any combination of the three. Combinations of gas and liquid in bubbles, are common. They can be large enough to have visually movable bubbles. Most inclusions are microscopic, however they can be large enough to spot without visual aids. The more magnification one has, the more inclusions one can spot. Looking at a specimen under a microscope one can easily understand how there could be literally thousands of unseen inclusions in the field of view, but they are so small as to render them invisible to the eye. No three phase inclusions have been observed in fluorite from the Quebradas or the Sandias.

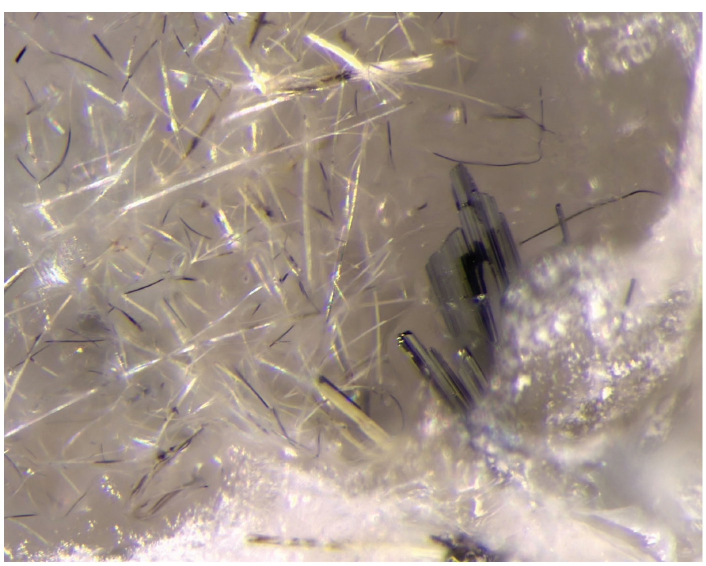
Fractures are considered to be inclusions. Fractures can occur as a material cools off after its initial crystallization or anytime later from a number of causes.

Primary inclusions formed before or during the precipitation of the fluorite. Primary inclusions can crystallize on the surface of a mineral or rock and then be covered over or enveloped by later fluorite. "Phantom" layers of fluorite represent stages of growth, with changes in the material being precipitated. Some layers appear to be clean unblemished fluorite, while other layers can have a plethora of various minerals, bubbles, etc.

Secondary inclusions are items that develop after a crystal's formation. A good example are manganese dendrites on a fracture.

Unfortunately taking images of inclusions in fluorite can be similar to taking images of something in a fog or a sandstorm. You may often think that something is "down there," but getting an image of it, a decent image, might be impossible. One can cleave the fluorite and hope for a clear, better shot of the intended inclusion. Good luck with that. It can work well with the Quebradas material. Grinding and polishing works well for fluorite from all locations, especially if one develops a feel for where the inclusions might be hiding. Note that fluorite will generally not take a nice polish on a cleavage face, and unfortunately, fluorite has some of those.

Minerals found at the Gonzales and the Bonita prospects include anglesite, baryte, cerussite, chalcopyrite, fluorite, galena, goethite, hematite, malachite, and sphalerite. All of the Quebradas minerals were visually identified. Minerals that were found only at the Bonita prospect, but not at the Gonzales, include covellite, marcasite (1 or 2 specimens), mimetite



Pyrite and baryte (upper left) in fluorite from the Bonita Prospect, Quebradas area, Socorro County, New Mexico. 3 mm field of view.

(?, 2 specimens with tiny yellow prisms), and pyrite. Brochantite was found only at the Gonzales prospect. It was distinguished from malachite by not effervescing in HCl. The Quebradas material has common distorted galena crystals. This is where the fluorite and the galena are crystallizing at the same time, being in "competitive" growth with each other. If the galena is crystallizing faster than the adjacent fluorite, then the galena crystal can widen. If the adjacent fluorite is crystallizing faster than the galena, then the fluorite takes away available space for the galena, causing the galena to lessen its girth. Some very random-looking shapes can develop.

Microscopic purple"fluorite spots" have been observed in colorless fluorite from all 3 locations. These are rounded purple-colored areas that have undefined boundaries. They have a purple rounded "core" that disseminates into the relatively colorless adjacent fluorite. Some theories exist regarding their formation, which I will avoid at this time.

Minerals found in a 4-foot-wide Sandia mountains boulder include aurichalcite, baryte, bismutite, calcite, cerussite, chalcopyrite, chrysocolla, friedrichite, galena, hemimorphite, malachite. quartz, rosasite, sphalerite, and 5 specimens of wulfenite. All were visually identified except cerussite, chalcopyrite, galena and friedrichite. These 4 were identified by Dr. Inna Lykova with PXRD and EDS, however, the identification of cerussite is not 100%.

The most interesting mineral found in the Sandia boulder was friedrichite, which was originally found in Austria and published in 1977. It was named for a noted Austrian mineralogist, Dr. Othmar Friedrich (1902–1991). Friedrichite is an orthorhombic member of the aikinite group. Its formula is $Pb_5Cu_5Bi_7S_{18}$. Long black or gray metallic laths/tendrils were observed in polished Sandia fluorite. The length to width ratio can be quite high, requiring magnification to spot the crystals. Dr. Inna Lykova was able to identify the friedrichite via EDS and PXRD using a tiny amount of material. Due to the tedious sample preparation, more testing of the sulfosalt tendrils may not be forthcoming.

The friedrichite crystals can abruptly change chemistry, turning into white or colorless cerussite. This would be caused by a change in the amount of oxygen in the solution. Cerussite can also coat friedrichite. Perhaps cerussite can pseudomorph friedrichite as well?

Sandia friedrichite may be mineralogically unique in some of its behavior, exhibiting habits not observed in other minerals by this author. The crystals have the luxury of having been formed in a liquid and then having their delicate characteristics preserved within the host fluorite. Such delicate features would have been obliterated had the crystals been formed in open cavities. The crystals can bend, twist, rotate, bisect, change chemistry (to cerussite) and seemingly do whatever they want. Chalcopyrite crystals may be catalysts for friedrichite growth. Certainly they are close associates.

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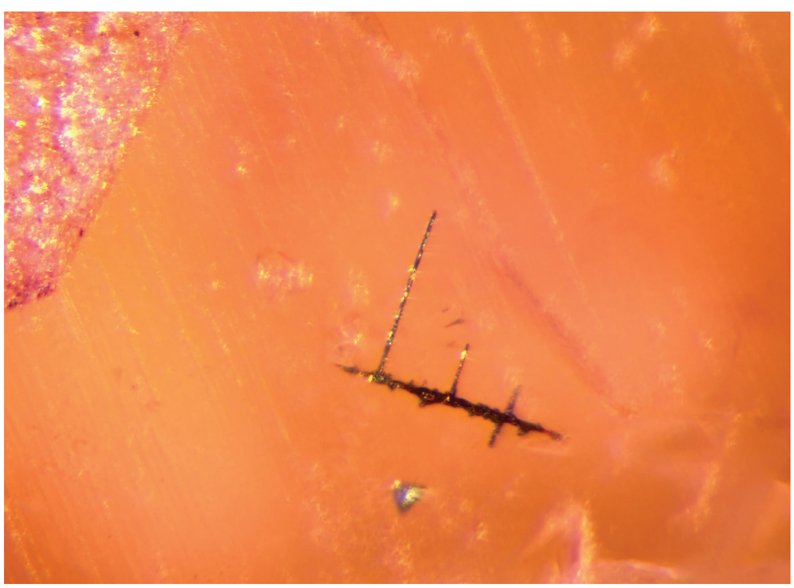

Friedrichite and cerussite in fluorite from the Sandia Mountains, Bernalillo County, New Mexico, 4mm field of view.

Notes