33rd Annual
New Mexico
Mineral Symposium

November 10 & 11, 2012

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

Socorro 2012

Welcome to

The Thirty-Third Annual
New Mexico Mineral Symposium
and
Third Mining Artifact Collectors Association Symposium

November 10 and 11, 2012

Macey Center Auditorium
Joseph A. Fidel Center
New Mexico Institute of Mining and Technology
Socorro, New Mexico

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

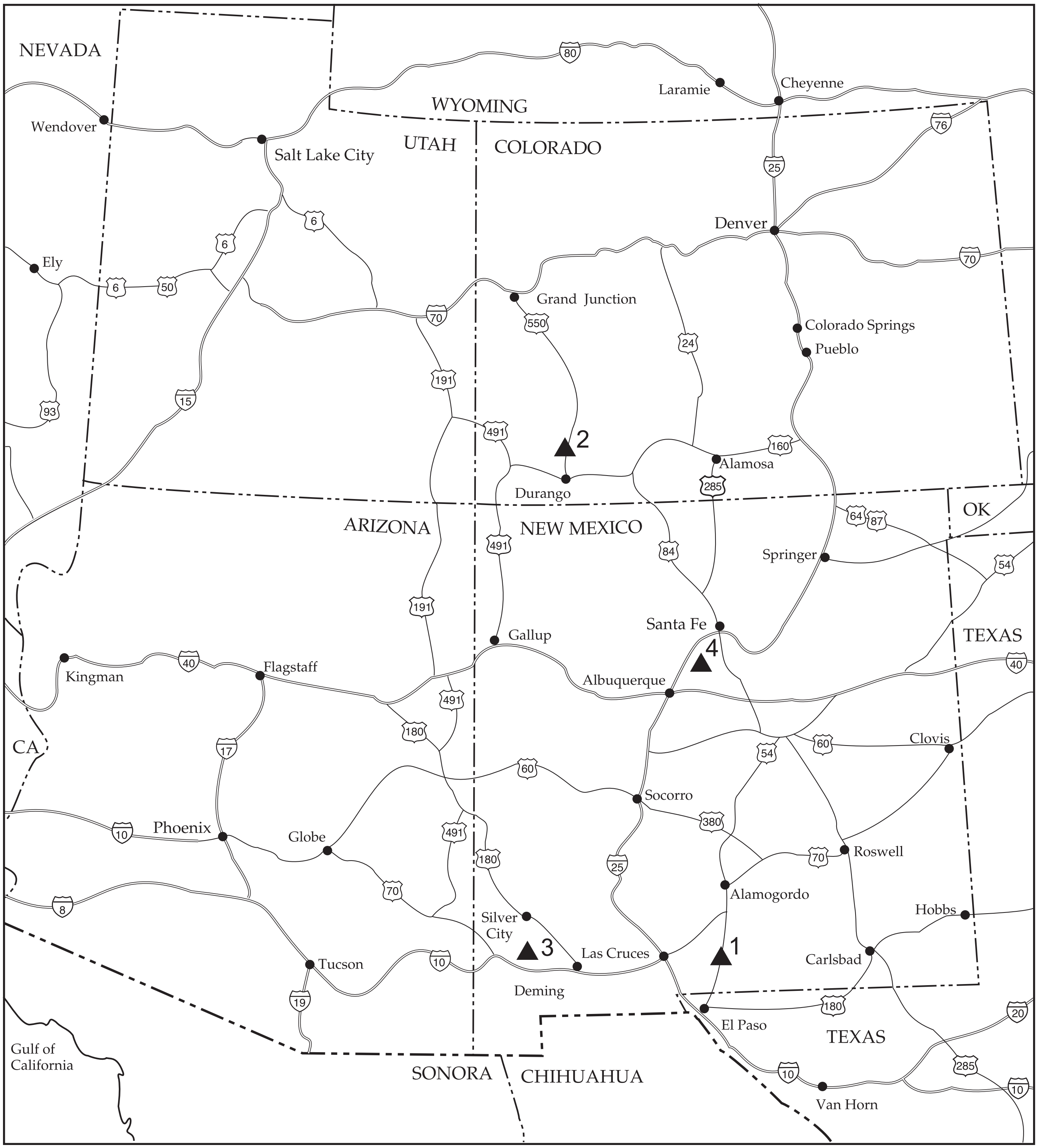
Sponsors this year include:

Albuquerque Gem and Mineral Club
Chaparral Rockhounds
Los Alamos Geological Society
New Mexico Geological Society Foundation
Grant County Rolling Stones
Friends of Mineralogy
City of Socorro

CITY OF SOCORRO

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 allows for intimate discussions among all interested in mineralogy and associated fields.

New Mexico minerals on the cover: top left – pyrolusite, top right – halite, bottom left – malachite pseudomorph of linarite, and bottom right – magnetite.



Geographic Index Map

33rd New Mexico Mineral Symposium

33rd Annual New Mexico Mineral Symposium 2012

SCHEDULE

Friday, November 9

6:00 pm	Informal tailgating and social hour, individual rooms, Comfort Inn & Suites (# 1 on map)—FREE

Saturday, November 10

8:00 am	Registration, Macey Center; continental breakfast
8:50	*Opening remarks,* Main auditorium
9:00	*Azurite suns from the Malbunka copper mine, Northern Territory, Australia*—Ray Grant and Dehne McLaughlin
9:30	*Arizona type minerals*—Anna Domitrovic
10:00	*Mines, minerals, and history of the Orogrande mining district, Otero County, New Mexico*—Fred Hurd **(1)**
10:30	Coffee break
11:00	*Copper-banded agates from upper Michigan*—Tom Rosemeyer
11:30	*New Mexico silver*—Ray DeMark
12:00 pm	Lunch and Museum tour
1:30*	*Blasting machines*—Jack Purson
2:00*	*Blasting cap tins: anomalies, goofs, and got ya's*—John Kynor Sr.
2:30*	*Postcards of mining from Silverton and Ouray, Colorado: then and now*—Jane Bardal **(2)**
3:00	Coffee break
3:30	*Minerals: hidden in plain sight*—Robert Walstrom **(3)**
4:00	*Ancient and modern uses of gems and minerals: talismans, tools, and medicine*—Dr. Jean DeMouthe, featured speaker
5:30	Sarsaparilla and suds: cocktail hour, cash bar—Fidel Center Ballrooms
6:30	Silent auction and dinner followed by a voice auction to benefit the New Mexico Mineral Symposium—Fidel Center Ballrooms

Sunday, November 11

8:00 am	Morning social, coffee and donuts
8:50	*Welcome to the second day of the symposium and follow-up remarks*
9:00	*Zeolites and associated minerals from Sugar Grove, Pendleton County, Virginia*—Patrick Haynes
9:30	*New Mexico copper*—Virgil Lueth
10:00	Coffee break
10:30	*The San Pedro mine—a record of the history, geology, and mineral collection*—William Atkinson and Sherman Marsh **(4)**
11:30	Open forum
12:00 pm	Lunch
1:15- 3:00	Silent auction, upper lobby, Macey Center, sponsored by the Albuquerque Gem and Mineral Club for the benefit of the Mineral Museum (FREE)

*denotes Mining Artifact Collectors Association talk.

Azurite suns from the Malbunka copper mine, Northern Territory, Australia

Ray Grant, 20323 S. 187th Street, Queen Creek, Arizona 85142
Dehne McLaughlin, 5 Tenth Avenue, West Moonah, Tasmania, Australia 7009

The Malbunka copper mine is located within the Ltalaltuma Aboriginal Land Trust in the Northern Territory of Australia, 130 mi west of Alice Springs. The copper mineralization was discovered in the 1950s by the late Albert Namatjira, Australia's best known Aboriginal artist. Mineralized boulders were found in a creek and green copper stained outcrops were located nearby. The mineralization was prospected in the 1960s by bulldozer cuts and a 120-ft-long adit. The deposit was not economic because of the low grade and limited size. After the mining exploration, there were few visits by collectors because the site is remote, difficult to drive to, is under tenure, and requires a travel permit from the Central Land Council to enter the land. Specimens collected from the area were first noted by Bob Sullivan in "Letter from Europe" in the March–April 1979 *Mineralogical Record* where he described azurite sun specimen from the mine that were sold at shows in Europe. Currently, Dehne McLaughlin operates the Malbunka mine for mineral specimens. It took 11 yrs of negotiation for him to get approval for mining. The most important mineral specimens from the mine are the azurite suns.

Unique geologic circumstances have come together at the Malbunka copper mine to produce the azurite suns. The mine is located in the Namatjira Formation, a mixed carbonate and clastic sequence with sandstone, carbonate mudstone, and shale. This formation is Early Cambrian in age and is only found in the Gardiner Range, which is part of the Amadeus Basin. The Amadeus Basin succession is a sequence of marine and terrestrial sediments deposited from the late Precambrian to the Devonian. It was uplifted starting in the Late Devonian and faulted and folded in a major compressional event from 400 to 300 m.y. ago. At the mine the azurite suns are found in a limited kaolinite lens as much as 8 ft thick bounded below and above by gray clay-rich sandstone containing soft sediment deformation features such as recumbent folds and flow structures. The lens has the appearance of a channel deposit, and the kaolinite shows bedding structures. This kaolinite lens is at the crest of an anticline, called the Gardiner Range anticline. Thin sections of the sandstone, and the lack of rounding of the grains indicate the quartz grains were deposited in a turbulent environment of possible fluvial origin with a short travel time.

Copper mineralization, mainly in the form of azurite suns and minor malachite is evident in bedding planes, soft sediment flow planes, and vertical fractures in the kaolinite. The azurite is at its highest concentration within 12 inches of the upper sandstone in a series of as many as five horizontal thin layers. In the layer closest to the upper sandstone, large-diameter azurite specimens are found, sometimes in direct contact with the sandstone. Azurite suns and nodules are found occasionally in the lower sandstone and as large light-blue discs in iron oxide-rich kaolinite near the floor. The copper-bearing fluids penetrated into the upper and lower layers of the kaolinite lens next to the sandstone and to a lesser extent into the central thickest part of the kaolinite. The off-white color of the kaolinite in the azurite-rich portions of the mineralized bed is probably due to bleaching of the clay by the penetrating solutions. Higher concentrations of iron oxide or lack of bleaching gives the kaolinite a red color for at least two-thirds of the layer.

Azurite is the most common mineral found at the mine. Light to deep blue suns are normally from 1 to 5 inches in diameter and rarely reach 12 inches in diameter. These azurite specimens have a unique discoidal form, and are composed of numerous small, flat crystals of azurite arranged in radial and concentric forms. They occupy bedding planes and joints in the white and rarely in the red kaolinite host rock. Azurite is commonly found in kaolinite deposits, such as at the Nevada lode in Utah and the Blue Ball mine in Arizona.

At these localities the azurite occurs as spheres and nodules, and it is thought the bedding planes in the kaolinite at the Malbunka mine are responsible for the discoid (sun) shape of the azurite. Also, azurite pieces are prolific through the waste rock dump from the earlier exploration. The most ascetic azurite specimens are those where the suns are found sitting adjacent to each other and distributed evenly across the white matrix. Light-blue suns owe their color to incorporation of fine white clay between micro-azurite crystals during crystallization. Malachite is less common at the mine, and two occurrences of malachite have been found. One is the replacement of azurite, and the second is small disks of malachite, which are closely associated with azurite disks and do not appear to be an alteration of azurite. Atacamite is found as fine crystals and small crystal tufts in the hanging and footwall sandstone wherever the kaolinite-sandstone contact is exposed. Crystallization space in sandstone joints and fractures limits the size of the atacamite. Chrysocolla has only been seen in the sandstone mixed with atacamite at the end of the adit both in sandstone underlying the kaolinite and in the floor of the adit.

The following is the proposed sequence of events leading to the formation of the azurite suns and the reason for their unique shape. First is the deposition of the Namatjira Formation including a clay-rich channel in the sandstone. This channel material would become shale or siltstone over time. Next the channel material is altered to kaolinite by invading solutions, copper sulfides are deposited in the more porous sandstone, and azurite is deposited in the kaolinite. Because there is no igneous activity or other ore deposits in the area, a basin dewatering model would work here as the source of the copper bearing solutions. The flat disks form because of the bedding in the kaolinite that restricts their growth to a plane. The common azurite nodule formation in kaolinite is rounded forms because there is no bedding present. The fact that the kaolinite lens is at the crest of an anticline may have helped direct copper-bearing fluids to the deposit versus other masses of kaolinite in the region with no copper mineralization.

Arizona type minerals

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There are different *types* of *types*. As defined by Dunn and Mandarino in 1987, a **holotype** is that single specimen used to determine the original description of a proposed new mineral. All data used in the description must have been derived from this single specimen. If more than one specimen from the type locality (where the new mineral was first discovered) was used to describe a new species, then these additional specimens are called **cotypes**. Cotypes are used to confirm any additional measurable data. Unfortunately, examining the specimen visually doesn't count. And then there are **neotypes**. This is mineral material from the type locality used to re-examine and possibly redefine a mineral when the holotype or cotype can't be found. In 1970, Embrey and Hey first proposed a system of "types" for minerals. Four other "types" were included in their proposal, but the three mentioned above are those used most frequently.

Of the more than 4,000 known minerals, 88 are Arizona type minerals. They were first discovered and described within the state of Arizona. Of those 88, four have been discredited, proven to be variations of known species. These four are arizonite, bisbeeite, cliftonite, and duhamelite.

Minerals receive their names by various means, but it is the discoverer/describer who determines what that name will be. Then it must be approved by the Commission on New Minerals and Mineral Names and the Commission on Museums of the International Mineralogical Association. Minerals are named after places, in particular, the place where they were discovered. Of Arizona's 88 type specimens (including those discredited), 23 are named after places. Minerals are named after individuals (often times, after the discoverer) or groups of people. Fifty-three of Arizona's type minerals are named after people. And finally, minerals are named after some physical or chemical property. There are 12 such minerals on the list of Arizona's types.

The Permanent Mineral Collection (PMC) in the Earth Sciences Center (ESC) at the Arizona–Sonora Desert Museum (ASDM) has 53 of Arizona's type minerals, two of which are discredited species—bisbeeite and duhamelite. All but two are from the type localities but not the holotypes. Specimens of emmonsite and discredited duhamelite are from Sonora. The ASDM does have a cotype of shattuckite from the type locality in Bisbee, though, in the PMC.

The goal of the ESC at the ASDM is to acquire examples of all of Arizona's type minerals, preferably from the type localities, and to compile a catalog that will include the mineral name and how that name was derived, its chemical and physical description, the type locality, an image of the mineral, and a hard copy of the published citation.

Arizona type mineral species	
Ajoite	$(K,Na)Cu_7AlSi_9O_{24}(OH)_6 \cdot 3H_2O$
Andersonite	$Na_2Ca(UO_2)(CO_3)_3 \cdot 6H_2O$
Antlerite	$Cu_3SO_4(OH)_4$
Apachite	$Cu_9Si_{10}O_{29} \cdot 11H_2O$
Aravaipaite	$Pb_3AlF_9 \cdot H_2O$
Arizonite*	$Fe_2Ti_3O_9$ (pseudorutile)
Artroeite	$PbAlF_3(OH)_2$
Bayleyite	$Mg_2(UO_2)(CO_3)_3 \cdot 18H_2O$
Bechererite	$Zn_7Cu(OH)_{13}[SiO(OH)_3SO_4]$
Bermanite	$Mn_3(PO_4)_2(OH)_2 \cdot 4H_2O$
Bideauxite	$AgPb_2(F,OH)_2Cl_3$
Bisbeeite*1977	$(Cu, Mg)SiO_3 \cdot H_2O$(variation chrysocolla)
Brezinaite	Cr_3S_4
Butlerite	$FeSO_4(OH) \cdot 2H_2O$

Arizona type mineral species

Butschliite	$K_2Ca(CO_3)_2$
Calcioaravaipaite	$PbCa_2Al(F,OH)_9$
Carmichaelite	$(Ti,Cr)O_{1.5}(OH)_{0.5}$
Chalcoalumite	$CuAl_4SO_4(OH)_{12} \cdot 3H_2O$
Cliftonite*	C (variety graphite pse kamacite (Fe, Ni) in meteorites)
Coconinoite	$Fe_2Al_2(UO_2)_2(PO_4)_4(SO_4)(OH)_2 \cdot 20H_2O$
Coesite	SiO_2
Coronadite	$PbMn_8O_{16}$
Cowlesite	$Ca(Al_2Si_3)O_{10} \cdot 5.3H_2O$
Creaseyite	$Cu_2Pb_2(Fe,Al)_2Si_5O_{17} \cdot 6H_2O$
Cryptomelane	KMn_8O_{16}
Cuprotungstite	$Cu_3(WO_4)_2 \cdot 2H_2O$
Dugganite	$Pb_3(Zn,Cu)_3(TeO_6)(AsO_4)(OH)_3$
Duhamelite*2002	$Cu_4Pb_2Bi(VO_4)_4(OH)_3 \cdot 8H_2O$(variety mottramite)
Emmonsite	$Fe_2(TeO_3)_3 \cdot 2H_2O$
Fairbankite	$PbTeO_3$
Fairchildite	$K_2CA(CO_3)_2$
Flagstaffite	$C_{10}H_{22}O_3$
Georgerobinsonite	$Pb_4(CrO_4)_2(OH)_2FCl$
Gerhardite	$Cu_2NO_3(OH)_3$
Gilalite	$Cu_5Si_6O_{17} \cdot 7H_2O$
Girdite	$H_2Pb_3(TeO_3)(TeO_6)$
Graemite	$CuTeO_3 \cdot H_2O$
Grandreefite	$Pb_2(SO_4)F_2$
Grandviewite	$Cu_3Al_9(SO_4)_2(OH)_{29}$
Guildite	$CuFe(SO_4)_2(OH) \cdot 4H_2O$
Haxonite	$(Fe,Ni)_{23}C_6$
Hemihedrite	$ZnPb_{10}(CrO_4)_6(SiO_4)_2F_2$
Henryite	$Cu_4Ag_3Te_4$
Jeromeite	$As(S,Se)_2$
Junitoite	$CaZn_2Si_2O_7 \cdot H_2O$
Jurbanite	$AlSO_4(OH) \cdot 5H_2O$
Khinite	$Cu_3PbTeO_4(OH)_6$
Kiddcreekite	Cu_6WSnS_8
Kinoite	$Ca_2Cu_2Si_3O_{10} \cdot 2H_2O$
Krinovite	$NaMg_2CrSi_3O_{10}$
Laurelite	$Pb_7F_{12}Cl_2$
Lausenite	$Fe_2(SO_4)_3 \cdot 6H_2O$
Lonsdaleite	C
Luddenite	$Cu_2Pb_2Si_5O_{14} \cdot 14H_2O$
Luetheite	$Cu_2Al_2(OH)_2(AsO_4)_2 \cdot H_2O$
Macquartite	$CuPb_3(CrO_4)SiO_3(OH)_4 \cdot 2H_2O$
Mammothite	$Cu_4Pb_6AlSbO_2(SO_4)_2Cl(OH)_{16}$
Maricopaite	$Ca_2Pb_7(Si, Al)_{48}O_{100} \cdot 32H_2O$
Markascherite	$Cu_3MoO_4(OH)_4$
Moissanite	SiC
Murdochite	$Cu_{12}Pb_{12}O_{.5}(Cl, Br)_2$
Navajoite	$V_2O_5 \cdot 3H_2O$
Nickel–zippeite	$Ni_2(UO_2)_6(SO_4)_3(OH)_{10} \cdot 16H_2O$
Oboyerite	$H_6Pb_6(TeO_3)_2 \cdot 2H_2O$
Papagoite	$CaCuAlSi_2O_6(OH)_3$
Parakhinite	$Cu_3PbTeO_4(OH)_6$
Paramelaconite	Cu_4O_3
Paulkerritek	$(Mg, Mn)_2Ti(Fe, Al)_2(PO_4)_4(OH)_3 \cdot 15H_2O$
Pinalite	$Pb_3(WO_4)OCl_2$
Pseudograndreefite	$Pb_6SO_4F_{10}$
Ransomite	$CuFe_2(SO_4)_4 \cdot 6H_2O$
Rongibbsite	$Pb_2(AlSi_4)O_{11}(OH)$
Ruizite	$Ca_2Mn_2Si_4O_{11}(OH)_4 \cdot 2H_2O$
	SCHIEFFELINITE $Pb(Te, S)O_4 \cdot H_2O$
Selenium	Se
Shannonite	$Pb_2O(CO_3)$
Shattuckite	$Cu_5(SiO_3)_4(OH)_2$
Sodium–zippeite	$Na_4(UO_2)_6(SO_4)_3(OH)_{10} \cdot 4H_2O$
Spangolite	$Cu_6AlSO_4(OH)_{12}Cl \cdot 3H_2O$
Stishovite	SiO_2
Swartzite	$CaMg(UO_2)(CO_3)_3 \cdot 12H_2O$
Wherryite	$CuPb_4O(SO_4)_2(CO_3)(OH, Cl)_2$
Wickenburgite	$CaPb_3Al_2Si_{10}O_{24}(OH)_6$
Winstanleyite	$TiTe_3O_8$
Wupatkiite	$(Co, Mg, Ni)Al_2(SO_4)_4 \cdot 22H_2O$
Yavapaiitek	$Fe(SO_4)_2$
Yedlinite	$Pb_6CrCl_6(O, OH, H_2O)_8$
Zinc–zippeite	$Zn_2(UO_2)_6(SO_4)_3(OH)_{10} \cdot 16H_2O$

(*indicates discredited species)

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Mines, minerals, and history of the Orogrande mining district, Otero County, New Mexico

Fred Hurd, 4262 Colt Road, Las Cruces, New Mexico 88011

The Orogrande mining district is situated immediately north and west of Orogrande, New Mexico, in the Jarilla Mountains. The district is surrounded by the White Sands Missile Range on the west and by the McGregor Artillery Range on the south and east sides. Orogrande lies approximately 35 mi south of Alamogordo and 50 mi north of El Paso, Texas, on US–54.

The Jarilla Mountains cover as area of approximately 40 mi^2 rising to 1,200 ft above the surrounding Tularosa Basin. The highest point is an unnamed peak rising to 5,295 ft above sea level. No springs or other sources of potable water are known to exist in the area. The mountains are composed of mostly upper Paleozoic limestones, sandstones, and shales intruded and domed by Tertiary igneous intrusions. The ore deposits are in the contact skarns. For more detailed information on the geology of the Jarilla Mountains and the Orogrande mining district, you are referred to Schmidt and Craddock (1964) and North (1982).

Prehistoric mining for turquoise is the first evidence of mining in the district. J. M. Perkins is credited with being the first historic prospector in the district in 1879. Amos J. Meules rediscovered the turquoise deposits and began mining them in the early 1890s. By 1883 the district was very active developing outcropping mineral showings. The district was being touted as a source of potential bonanzas with only the lack of water preventing development.

By the late 1890s a branch rail line was extended from Jarilla Junction (later to be named Orogrande) to Brice, the first camp in the district due to the discovery of copper, lead, silver, and gold ores. The line was later extended north through Ohaysi to end at Zora in 1916. This greatly assisted with the development of the iron mines in this area of the district.

In 1904 a 6.5 oz gold nugget was discovered on the Little Joe claim during a dry washing operation. This event triggered a minor gold rush and led to Jarilla Junction being renamed Orogrande with much promotion and speculation following.

In 1907 the Southwestern Smelting and Refining Company brought water to the district with the completion of a 50 mi pipeline from the Sacramento Mountains. Also, the SSRC smelter came online on November 6, 1907, causing further interest in the district. However, the smelter was shut down six months later and sold when sufficient quantities of ore could not be produced to keep the smelter running. It was sold and reopened only to be shut down again in 1910.

Significant ore was produced until 1918 with little production since then. The estimated total production of all metals is around $2,000,000.

Although Orogrande never lived up to its name, it has produced a number of interesting anecdotes and still continues to be the source of recreational gold mining, turquoise mining, and mineral collecting. Currently a group is attempting to get permits to mine the iron ore left in the dumps of the iron mines in the northern portion of the district.

North (1982) lists the occurrences of 42 different minerals in the district. Northrop (1959) lists three museum quality minerals that occur in the district: orthoclase, jarosite, and turquoise.

This power point talk will focus mainly on the collectable minerals found in the district, photos of current mines, and the anecdotes that contribute to the colorful history of the district.

Refer to the North (1982) report for an extensive bibliography of articles related to the Orogrande mining district.

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Copper-banded agates from the Kearsarge copper-bearing amygdaloidal lode, Houghton County, Michigan

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For the past 60 yrs (1952–2012) copper-banded agates of exceptional beauty and rarity have been recovered from various mine dumps along the Kearsarge copper-bearing amygdaloidal lode in Houghton County, Michigan. The unusual agates, which range in size from 1 to 4 cm, occur in a basaltic lava flow that is about 1.1 Ga (billion years old).

The Keweenaw Peninsula, which juts out into Lake Superior at the western end of Upper Michigan, is located along the arch-shaped Middle Proterozoic midcontinent failed rift system. Over a period of geologic time 1,109 to 1,060 Ma (million years ago) the rift valley was filled with a thick sequence of subaerial tholeiitic lava flows and intercalated sedimentary beds now collectively called the Portage Lake Volcanics (PLV).

The agate-bearing Kearsarge lava flow lies within the PLV and can be traced for a strike distance of 35 mi. The flow pinches out at both ends, but the central portion may be up to 200 ft thick and can be divided into four zones from top to bottom. The uppermost zone is a brecciated flow top consisting of a porous and permeable basalt that ranges up to 30 ft thick. This was the zone that was commercially mined from 1882 to 1967 and produced 2,271,997,325 lbs of native copper. Below the amygdaloidal flow top, the flow changes into a semi-permeable zone that is about 10 ft thick and contains the copper-banded agates. Below this zone is a widespread layer of plagioclase phenocrysts embedded in a dense basalt that may be up to 15 ft thick. The lowest zone is an impermeable aphanitic basalt up to 145 ft thick that rests on the Wolverine Sandstone.

Initial filling of some of the vesicles with silica in the agate-bearing zone probably took place within a few million years after the deposition of the lava flow and formed agates in about 25% of the vesicles. The copper mineralization event that formed the commercial orebodies to place about 32–45 m.y. after the deposition of the PLV and lasted for a duration of 13 m.y. Copper-bearing hydrothermal solutions permeated the uppermost zones of the Kearsarge flow and deposited copper in vesicles, fractures, and replaced certain bands of chalcedony in the earlier formed agates.

Copper manifests itself in a variety of forms in the partially replaced agates. The simplest is an outer band of copper along the contact of the host rock and initial band of chalcedony. More intense replacement took place where the pervasive copper solutions were more concentrated and replaced the more porous band of chalcedony within the agate structure. In some cases almost total replacement has taken place leaving only shards of chalcedony remaining.

Collecting of the rare agates has continued at the Wolverine #2 and C & H 21 mines—the two most productive localities for the agates. With luck, the elusive can still be collected with hard work and digging.

New Mexico silver

Ramon S. DeMark, 8240 Eddy Ave. NE, Albuquerque, New Mexico 87109

Silver has been reported from 17 New Mexico counties with Grant and Sierra Counties being the major producers. Twenty-two silver minerals are reported from New Mexico, but at least three of these (miargyrite, petzite, and stetefeldite) are doubtful (Northrop 1959).

The search for silver in New Mexico began in earnest after the first important discovery at Pueblo Springs, near Magdalena in 1863 (Northrop 1959). During the next 30 yrs, most of the major silver districts had been located, Georgetown in 1866, Chloride Flat in 1871, Lake Valley in 1878, Chloride in 1879, Kingston in 1880, and Blackhawk in 1881 (Northrop 1959).

Incredibly rich silver ores were discovered in some of these districts, particularly at Lake Valley and the Blackhawk district. This in turn led to extravagant claims. A news item in the Las Vegas *Mining World* (Sept 1882) stated that "…The Lake Valley district was certainly the richest mining district in the world." Unfortunately, while these ore deposits were extraordinarily rich, they were not extensive. With the demonetization of silver in 1893 and the ensuing panic, most of the silver producing mines in New Mexico closed down. Silver, of course, continued to be produced in New Mexico and is still being produced, mostly as a byproduct of copper mining.

The period between 1863 and 1893 undoubtedly was the most important for production of silver mineral specimens in New Mexico. Fabulous descriptions of occurrences during that era conjure up images of arborescent silver and acanthite crystals and masses of silver halides with sparkling faces. Specimens promoting the state's mineral wealth (including silver) were sent to Chicago for the 1893 Columbian Exposition. Mental images and fantasies of specimens that must have come forth are, however, not the reality that exists today. The specimens from the 1893 Columbian Exposition never returned to New Mexico, and the disposition of the minerals is unknown. When the New Mexico School of Mines museum burned down in 1938, all records of the collection and the specimens themselves were destroyed. What exist today are bits and pieces that turn up now and then from old collections, and, with luck, they find their way to the New Mexico Bureau of Geology and Mineral Resources Mineral Museum.

Of course, another factor regarding silver minerals is their reactive nature to light and oxidation. The fabulous chlorargyrite and bromargyrite specimens that were recovered from the Bridal Chamber of Lake Valley are now brown, formless lumps. Most silver and acanthite specimens survive as dull black masses and unimpressive patches on gangue.

All is not lost however! In recent years, diligent collectors have recovered wonderful crystals of unaltered, lustrous, silver halides and bright, unoxidized crystals and arborescent groups of silver, and acanthite from many of New Mexico's classic locations. A selection of these will be shown during this presentation.

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Blasting machines

Jack Purson, Mining Artifact Collectors Association

This talk will outline the history of the electric blasting machine, why it was developed, and the evolution of the hardware up to the 1950s. There are many brands of blasting machines, but all work on the same principle. Early 1880s versions were bulky and heavy with little firing power making electric-fired blasting less attractive for the small-time miner until well into the 1920s when motorcar access to most mines was made possible and their usage "exploded." The same basic plunger design was used into the 1950s and1960s but fell into relic status as mines became bigger along with blasting requirements. Blasting machines are a well-recognized and quintessential icon of both serious mining and Roadrunner cartoons. They are wonderful to collect and display with minerals as a testament to the hard and dangerous work of mineral extraction.

Blasting cap tins: anomalies, goofs, and “got ya’s”

John Kynor Sr., Mining Artifact Collectors Association

A simple study of many interesting sidelights involved in the collection of blasting cap tins. Blasting cap “tins” also includes nonmetal, cardboard containers that held caps. If you were in attendance two years ago, you can consider this an extension of the talk presented by Jack Purson. As there are little published data on the field of collecting blasting cap tins, the majority of the findings related here are based on almost 40 yrs of observation as a collection of more than 400 containers was assembled.

Depending on how one might assemble a collection, some of the anomalies, goofs, and got ya’s may go unnoticed. Today’s discussion will assist your efforts in not overlooking a valued addition to a collection.

The pictures will show you that tins may appear to be look-a-likes, but are actually very different. Tins that fit this category get overlooked, which can be a goof or a got ya. Several companies made their tins in batches that were ever-so-slightly different, and those details can give you information not available any other way. Most existing literature does not address this.

For example, when you find the same lid on several tins, don’t overlook the bottoms. They do make a difference. Certain style lids only go with a specific bottom; however, you will often find them mixed up. Lids can tell a story even though they appear the same. Look closely and observe carefully.

Goofs are not only committed by the collector but can be made by the factory. I believe these enhance a collection if you can find them. Blasting cap containers came in three sizes: 10, 25, and 100 caps to a tin. You can find differences in all. A very rare and interesting anomaly is the tin made by companies that have merged. One buys the other out but continues to use the old logo, often to save money by using existing stock.

Just like when examining a mineral specimen, do not be hasty when sorting through a box of tins. You might miss some important feature that would make it valuable, or at least very interesting…got ya! The devil is in the detail! If the tin does not look right for some reason take it home and research it. If it turns out to be in your collection already, you can resell it, but in 99 cases out of 100 you can’t go back and find the tin.

Postcards of mining from Silverton and Ouray, Colorado: then and now

Jane Bardal, jbardal@q.com, Albuquerque, New Mexico

The "golden age" of postcards was from 1908 to 1915, which also coincided with large-scale mining operations in the San Juan Mountains of Colorado. Postcards illustrated many aspects of mining: the mines, mills, miners, towns, and railroads. This talk will describe stories of events that occurred during this era, such as the mine owner who consulted a psychic for advice, and dangers of riding the tram while drunk. The author has traveled to many of the areas shown in the postcards and will present current photos that show what the areas look like now. Treasures still abound in this part of Colorado when it comes to mineral collecting, photography, hiking, jeeping, and discovering the remnants of mining.

This talk will also discuss where to obtain postcards and how to start your own collection. Different types of postcards will be shown: postcards printed in Germany, locally published postcards, and real-photo postcards. A few stereo views will also be included.

Minerals: hidden in plain sight

Robert Walstrom, P.O. Box 1978, Silver City, New Mexico 88062

As field collectors we are defined by our success. That success can be driven by research, personal knowledge, financial resources, published references, networking with other collectors, having the right tools, and many other factors. Yes, luck also plays a role. However, tenacity, hard work, and sweat are usually the bottom line that produces results. Minerals, especially microminerals, can be found in the most unlikely places: prospects right beside the road you take into areas to reach larger mines, in small outlying prospects; or right under foot at localities already heavily collected. The following list outlines just a few of those localities situated in southwestern New Mexico where minerals were found hidden in plain sight.

Mine	County	Location	Significant Minerals
Alabama	Grant	N32.82866° W108.98562°	acanthite, gold, descloizite
Copper	Grant	N32.82294° W108.99117°	libethenite, copper
Pennsylvania	Grant	N32.85003° W108.95729°	gold, azurite, cerussite
Pole Line P.	Hidalgo	N32.31832° W108. 73380°	wulfenite
Independence	Luna	N32.17727° W108.07848°	dioptase, duftite, mimetite
Parole Lode	Luna	N32.18107° W108.08907°	bromargyrite, willemite
Tungsten Hill	Luna	N32.18895° W108.10127°	perite, kettnerite, rosasite
Irish Rose	Luna	N32.18909° W108.10602°	kettnerite, rosasite
Rock Island	Luna	N32.53392° W107.57965°	vanadinite
Copper	Luna	N32.54257° W107.68621°	creaseyite, fornacite, wulfenite, murdochite, vanadinite, dioptase, bromargyrite
Forgotten G.	Grant	N32.83877° W108.01433°	murdochite, willemite, rosasite
Edith	Grant	N32.84484° W108.01622°	bromargyrite
Naiad Queen	Grant	N32.84645° W108.02176°	bromargyrite
Alhambra	Grant	N32.84014° W108.01582°	wulfenite, vanadinite, bromargyrite
Mine	Grant	(Black Range area)	azurite, malachite, hydrozincite, Mineral A: possible new mineral

So, when you are out there scrounging around in the mining districts, take a little more time, dig a little deeper, and the results could amaze you.

Ancient and modern uses of gems and minerals: talismans, tools, and medicine

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For thousands of years, people have relied on natural materials for making tools, weapons, decorations, talismans, and medicine. Using examples of common and unusual stones and materials, the speaker will discuss the physical and optical properties that make each useful or attractive. This will all be explored in a lavishly illustrated talk that will provide a glimpse into the fascinating world of gemstone lore and tradition.

Zeolites and associated minerals from Sugar Grove, Pendleton County, West Virginia

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Microscopically crystallized minerals were found many years ago in a basaltic sill emplaced between Devonian-age Millboro shales 5.5 mi west of Sugar Grove, adjacent to Highway 21, Pendleton County, West Virginia. The sill has a maximum thickness of approximately 9 ft. and is exposed for approximately 125 ft. It is an amygdaloidal olivene-free pyroxene-basalt, with cavities to 10 cm, which contain numerous zeolites, and associated minerals. According to Mindat.org's Sugar Grove page, the basalt is Eocene, 45 Ma, and "These are the youngest volcanic rocks east of the Rocky mountains."

Minerology

Pyrite, FeS_2, despite being a very common mineral, is quite interesting at this location. The pyrite crystals can form cubes and pyritohedrons, with octahedral and trapezohedral modifications. However, the main attraction is when filiform crystals, ± right-angle bends occur. Acicular pyrite is believed to form rapidly from a mechanism called a "screw dislocation." One might think that such crystals should have rounded edges, but electron photomicrographs of some lab-grown n-hectane crystals show that a crystal can retain its sharp edges during spiral growth. A screw dislocation can also occur at right angles to the pre-existing crystal, causing a right-angle bend. The right-angle bends usually occur at the tip of an elongated crystal, when one screw dislocation ends, and another takes off at 90 degrees.

Henderson and Francis (1989) studied 35 locations with filiform pyrite and concluded that twinning was not the mechanism causing the right-angle bends. Pyrite crystals commonly show striations caused by an alternation between cube and pyritohedral faces. A twinned crystal should have striations at 90° to each other at the twin plane. Right-angled Sugar Grove pyrite crystal faces show a single striation direction. Henderson and Francis also found that when performing a single-crystal X-ray diffraction upon the bend portion of a Sugar Grove right-angle pyrite, that the diffraction pattern showed two-fold symmetry, not four-fold as would be expected from a twin junction.

The thinnest crystals are sometimes curved. Relatively thick curved crystals have not been observed. Henderson and Francis deduce that if a later period of growth occurs then the acicular crystals thicken, and upon doing so, straighten out.

One might consider rapid hopper growth as a simple answer to the occurrence of acicular pyrite. This would have to be dramatic growth in just one direction, which although it can occur in theory, challenges the accepted idea of screw dislocations.

Pyrite is the earliest mineral to form in the Sugar Grove cavities. Normal cubic or pyritohedral crystals have reached 3 mm, whereas the filiform crystals have reached 6 mm. Nontronite commonly coats the pyrite.

Nontronite, $Na_{0.3}Fe_2^{3+}(Si,Al)_4O_{10}(OH)_2 \cdot H_2O$, is generally gray in color and forms spheres and coatings. It commonly coats pyrite and harmotome. Nontronite, when freshly exposed, is green to blue in color, but it rapidly dehydrates and then turns black. Others have suggested that the nontronite oxidizes; however, the author has observed that freshly opened nontronite-lined cavities leave adjacent wet spots, indicating that a water-filled cavity has been breached. It can form wild spindly/wirey coatings, which when broken, usually reveal a tiny core of pyrite, but not always.

Chabazite-Ca, $Ca_2(Al_4Si_8O_{24}) \cdot 13H_2O$, is the most common zeolite found. It usually forms "phacolite" penetration twins, which are formed by a 60° rotation about the c-axis. It is rhombohedral, transparent, and usually colorless. It sometimes has an attractive pale peach color.

Analcime, $NaAlSi_2O_6 \cdot H_2O$, forms transparent colorless trapezohedra and is the earliest formed zeolite, often forming drusy cavity coatings.

Harmotome, $Ba_2(NaKCa_{0.5})(Al_5Si_{11}O_{32}) \cdot 12H_2O$, forms beautiful transparent Marburg-type penetration twins. Nontronite frequently coats harmotome crystals, while leaving adjacent chabazite-Ca crystals alone.

Thomsonite-Ca, $Ca_2Na[Al_5Si_5O_{20}] \cdot 6H_2O$, forms white divergent fans, and also translucent gray spheres of acicular crystals. The fans are often associated with nontronite and mesolite.

Mesolite, $Na_2Ca_2(Al_6Si_9O_{30}) \cdot 8H_2O$, almost always is found as colorless acicular crystals emerging from a fan of thomsonite. Nontronite spheres are sometimes attached to the tips or sides of the crystals.

Calcite, $CaCO_3$, is a common late mineral. It usually forms colorless transparent rhombohedra, which can reach 12 mm. Tiny spherical aggregates of scalenohedra are gray to white and translucent.

Aragonite, $CaCO_3$, is a very late mineral and is quite sparse. It forms colorless transparent long prisms. Kearns (1993) noted rare sixling twins.

Baryte, $BaSO_4$, is relatively rare at Sugar Grove. It is found as thin colorless to white blades, sometimes forming tiny twinned pinwheel aggregates. These tiny pinwheels has been shown by Kearns to be strontian baryte. The larger crystals show no strontium.

Quartz, SiO_2, does not occur in the vesicles, but Kearns observed it as drusy crusts on joint and fracture surfaces.

Unknowns. Kearns noted two unknowns. The author has seen three others: tiny colorless erionite (?) crystals (only three specimens found), colorless, transparent prisms, which are highly lustrous (only two found), and extremely thin wafers, which are coated with erionite (?) and then nontronite.

Acknowledgments

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Casa de Cobre—the geologic history of copper in New Mexico

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New Mexico's place in geologic history reflects its location on the margins of tectonic plates. Hence, the state has seen abundant geologic activity throughout its 1.8 b.y. history. Mineral deposits often result as a consequence of tectonic activity and record the history of interactions between magmas, sediments, and the movement of fluids in the crust. Much of New Mexico's long and unique geologic history can be told with respect to copper minerals that are contained in a large number and wide variety of deposit types.

Part of New Mexico's copper history is a direct result of tectonic activity that resulted in the gradual accumulation of continental material. Repeated accretions of microplates and island arcs eventually resulted in the formation of continental crust during the assembly of the supercontinent of Rodinia. During this stage, massive sulfide deposits were obducted from the sea floor and onto the continent, represented by the deposits at Copper Hill and Pecos. New Mexico remained perched near the margin of the continent through much of the Paleozoic after the breakup of Rodinia.

The next episode of significant copper deposit formation came during the assembly of Pangea. The Ancestral Rocky Mountains rose in the Pennsylvanian, and as they weathered, the copper from the older Proterozoic deposits was transported and deposited as red-bed copper deposits on the arid supercontinent during the Permian–Triassic. One can find these types of deposits in almost any of the "red rocks" of the state, but the largest is the Nacimiento mine near Cuba.

Following the breakup of Pangea, New Mexico rode slightly inboard from the continental subduction zone off the west coast. Andesite stratovolcanos developed in the southwestern portion of the state as part of a continental volcanic arc. The porphyry copper deposits at Chino, Tyrone, Fierro, and Hillsboro formed beneath the volcanos of the Laramide orogeny during Cretaceous to Eocene time.

The complete subduction of the Farallon plate and spreading center led to the great ignimbrite flareup of the Oligiocene. Rhyolitic calderas were popping off throughout New Mexico, and many ore deposits formed on the margins of those calderas. Many became the mining areas that were developed in the late 1800s, predominantly for silver.

It was not until the formation of the Rio Grande rift, approximately 30 m.y. ago, that the modern geologic situation in New Mexico became established. Initial rifting requires the crust to bulge up and eventually fracture, creating the horst and graben structures that dominate the modern landscape. As uplift commenced, the earlier-formed ore deposits were exposed to weathering, and a myriad of secondary copper minerals formed from the pre-existing deposits. Modern tectonic and hydrologic processes continue to create and modify ore deposits along the rift further encoding the history of geologic processes in new ore deposits.

The San Pedro mine—a record of the history, geology, and mineral collection

W. W. Atkinson Jr., and Sherman P. Marsh

The San Pedro mine has held a certain fascination for the authors since they were teenagers, first as a place to explore and then, as we began to notice the crystals, a source for a new hobby and later a profession. Thus inspired, we both went on to careers in geology, Bill as a professor at the University of Colorado and Sherm as a geologist for the U.S. Geological Survey. The mine is located approximately 40 mi south of Santa Fe, and 32 mi northeast of Albuquerque. The mine exploited a skarn deposit, producing copper, gold, and silver. Garnet associated with metal deposition replaced limestone beds around a mineralizing porphyry copper-molybdenum type intrusion.

History—Historical records are fragmentary. Fray Dominguez made a journey surveying the missions of New Mexico in 1776. His map of the missions shows a village of San Pedro at the location of the mine. It is most likely that it was a mining village at that time, in an area poor for agriculture, and far from protection from Indian raids.

Gold was discovered in the nearby Ortiz Mountains in 1833, followed by discovery of the New Placers in the San Pedro Mountains in 1839. Miscellaneous historical references mention activity at the San Pedro mine 1840–1846, which was owned by Mexican mining interests. The Mexican government awarded the Cañon del Agua land grant, just to the west of the San Pedro mine, to a rancher at some time before 1846, which was later recognized by the United States in 1875. In 1880 a criminal gang arranged to have the grant resurveyed to include San Pedro mine, then seized the mine. When the owner at that time, M. A. Otero, a former governor of New Mexico, sued to recover the mine, the gang fortified it. In a raid at night, Otero brought a dozen armed men who entered the mine by sliding down a rope in a shaft, forced 162 miners out of the mine and took it over. The owner eventually recovered the mine through legal proceedings.

Production—From 1904 to 1967, 273,129 tons of ore was produced yielding 16,549 oz gold, 304,625 oz silver, and 7,476 tons of copper. Average grade about 2.7% Cu, 0.05 oz/t gold, 0.8 oz/t Ag.

Geologic setting—The mine lies in a short chain of intrusions parallel with the Rio Grande rift, aproximately 10 mi to the west. The intrusions may represent an early stage of rifting. The rocks intruded include Precambrian granite and gneiss, Pennsylvanian limestone and shale, Permian siltstone and sandstone, and Triassic siltstone, shale, and sandstone.

Skarn formation—High temperature solutions from the mineralizing intrusion in San Lazarus gulch brought abundant trace elements through stockwork veinlets, producing mineralogical alteration of the surrounding rocks, and forming the mineral deposit. High-temperature solutions from the intrusion, some trapped as fluid inclusions in crystals, introduced SiO_2, Al, Fe, Mg, Na, K, Ba, Mn, Ti, Cu, W, Ag, Au, Mo, Cl, S, and F, among other elements, most of which were transported by chloride ions. On encountering the calcite of the limestone, calcium quickly robbed the chloride ions to deposit magnetite, garnet, pyroxene, wollastonite, quartz, chalcopyrite, pyrite, pyrrhotite, molybdenite, scheelite, fluorite, and gold in prograde early deposition. At high temperatures, sulfur is carried mostly as sulfur dioxide. During cooling of the system, sulfur dioxide reacted with water to produce sulfuric acid and hydrogen sulfide at temperatures of about 400° C. The then somewhat acid solution destroyed the garnet to produce quartz, chlorite, calcite, pyrite, and specular hematite partially filling cavities in the garnet. Chalcopyrite was remobilized to form very large crystals, up to 4 inches across.

Less common minerals include adularia, sphalerite, galena, idocrase, scapolite, epidote, sphene, anatase, allanite, laumontite, and siegenite. The nickel in the rare sulfide siegenite was shown by Lee (1987) to have come from the Pennsylvanian limestone and shale. Supergene minerals include bornite, covellite, malachite, azurite, chrysocolla, limonite, cuprite, and native copper.

The skarn is zoned outward from the mineralizing intrusion from (1) the garnet zone, (2) the ore zone (also designated as the “marble line”), containing garnet, chalcopyrite, gold, scheelite, quartz, and calcite, (3) the marble zone to (4) unaltered limestone. Shales interbedded with limestone are altered to fine-grained hornfels, which shows complex zoning from the intrusion outward from a light-green zone characterized by diopside and actinolite-tremolite to a peripheral zone characterized by biotite to unaltered rocks consisting of clays. All zones contain significant amounts of calcium plagioclase or anorthite. Orbicules common in the hornfels have complex mineralogy differing somewhat from that of the main hornfels, with an inner zone adjacent to the intrusion characterized by orbicules containing garnet and wollastonite and an outer zone with orbicules containing epidote, diopside, actinolite-tremolite, and chlorite. Alteration of shales extends beyond the marble zone in the limestones, providing a guide for exploration.

Mineral specimens—Some of the largest chalcopyrite crystals in the world come from the San Pedro mine. One specimen collected in 1956 by the authors and Bill’s fiancée at the time, Carol Bambrook, measured 3.5 inches! This specimen was later donated to the University of New Mexico Geology Museum. Many of the chalcopyrite crystals enclose cubes and pyritohedrons of pyrite. In addition, many of the chalcopyrite specimens exhibit very unusual twinning. Many other good mineral specimens collected by the authors occurred principally in the marble line zone, where replacement of limestone reduced the volume of the rock, producing abundant cavities. In addition to the chalcopyrite, notable specimens include pyrite intergrown with calcite, quartz, and small rosettes of specular hematite on a base of garnet crystals. In certain areas of the mine all the quartz occurs as Japanese twins. Calcite shows a number of habits, including scalenohedrons, some twinned on the basal pinacoid, and rhombohedrons, some twinned on rhombohedral planes. The surfaces of chalcopyrite crystals are partially oxidized down to the water level, but a few excellent unoxidized specimens were recovered in early mining and by the authors. A very few specimens of pyrite pseudomorphous after calcite scalenohedrons were found at the water level. Some spectacular specimens of gold are exhibited in the museum of New Mexico Tech.

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Notes