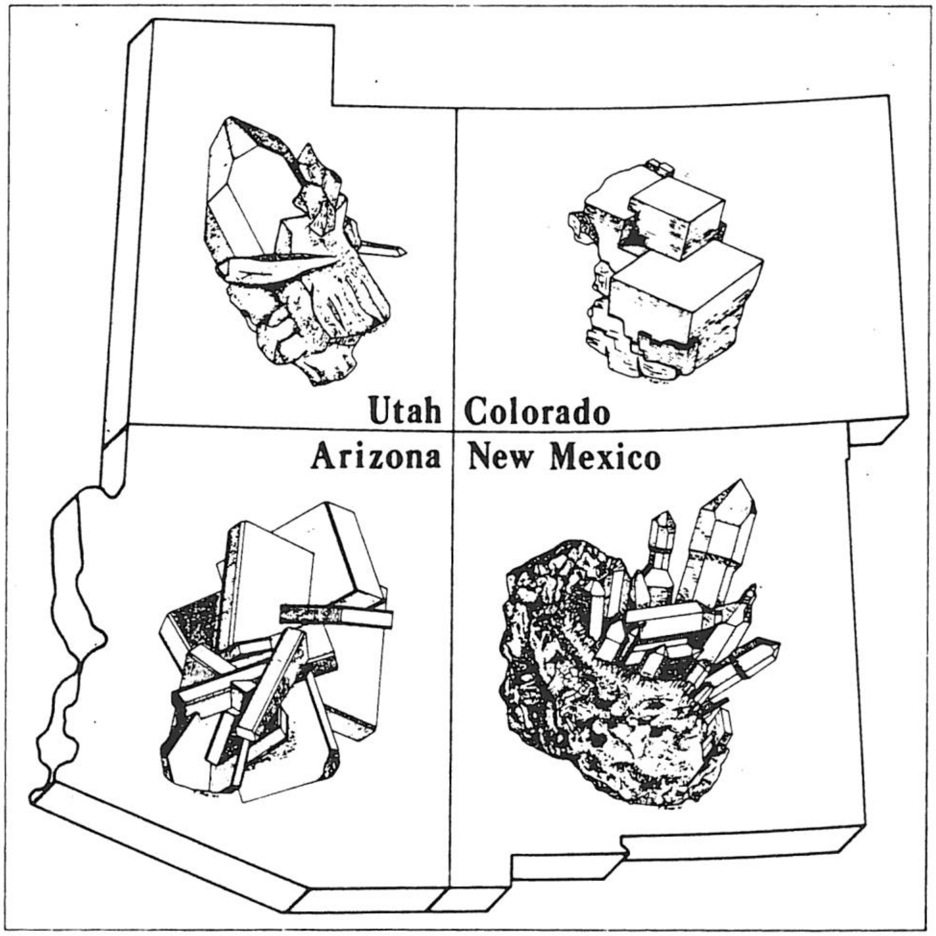
13th
annual

NEW MEXICO MINERAL SYMPOSIUM

November 14 & 15, 1992



NMIMT Campus, Socorro, New Mexico

Welcome to

THE THIRTEENTH ANNUAL

NEW MEXICO MINERAL SYMPOSIUM

November 14 and 15, 1992

Macey Center Auditorium
New Mexico Institute of Mining and Technology
Socorro, New Mexico

sponsored by
New Mexico Bureau of Mines and Mineral Resources
Albuquerque Gem and Mineral Club
New Mexico Geological Society
Los Alamos Geological Society
Chaparral Rockhounds

The purpose of the New Mexico Mineral Symposium is to bring together for an exchange of ideas both professionals and amateurs interested in mineralogy. The sponsors hope that the Thirteenth New Mexico Mineral Symposium will give both groups a forum to present their cumulative knowledge of mineral occurrences in the state. In addition to the formal papers, informal discussions among mineralogists, geologists, and hobbyists should benefit all.

Cover—MINERALS OF THE FOUR-CORNERS STATES. Scepter quartz from Kingston, New Mexico; rhodochrosite from Silverton, Colorado; topaz from the Thomas Mountains, Utah; and barite from Superior, Arizona represent the four-corners states in the cover design by Teresa Mueller.

SCHEDULE

Numbers in parentheses refer to geographic location on map.

Friday, November 13

6:00 pm Informal tailgating and social hour, individual rooms, El Camino Motel

Saturday, November 14

8:00 am Registration; coffee and donuts

9:30 *Opening remarks,* main auditorium

9:40 *New Mexico meteorites: mineralogical messengers from the early solar system—Adrian* Brearley

10:05 *(1) Mineralogy of Kartchner Caverns, Kartchner Caverns State Park, Arizona—Carol* A. Hill

10:40 Coffee break

11:10 (2) *Mineral suite from the Snake Pit mine, Mex-Tex claims, Hanson district, New Mexico—Steve* Bringe, Tom Massis, Marc Wilson, Mike Spilde, and Chris McKee

11:40 (3) *Microminerals from the Big Lue Mountains, Greenlee County, Arizona, and Grant County, New Mexico—Ron* Gibbs

12:00 pm Lunch, Museum tours

2:00 (4) *Geology of mantle xenoliths and maars of Data Ana County, south central New Mexico—* Mark A. Ouimette and Andrea Reade

2:25 *Metamunirite, haynesite, and other microminerals from the four-corners states—Pat* Haynes

2:50 Coffee break

3:15 **(5)** *Azurite and malachite from the Morenci district, Greenlee County, Arizona—Robert* North

3:45 *Mining history and specimen mineralogy of the Lake Superior copper district—Stanley* J. Dyl, featured speaker

5:30 Sarsaparilla and suds: cocktail hour (with cash bar)

6:30 Dinner at Garcia Opera House with an auction to benefit the NewMexico Mineral Symposium

Sunday, November 15

9:00 am (6) *Spangolite and other secondary minerals from the Buckhorn mine, Lincoln County, New Mexico-* Ramon DeMark and Paul Hlava

9:30 (7) *Silver and copper mineralization near the Buckhorn mine, Gallinas Mountains, New Mexico—Peter* Modreski and Russell Schreiner

10:00 Coffee break

10:40 (8) *Gem minerals of the Franklin Mountains, El Paso, Texas—Philip* C. and Kathryn Evans Goodell

11:30 *What's new: open forum Paul* Hlava, moderator

12:00 pm Lunch

1:15-3:00 Silent auction, upper lobby, Macey Center, sponsored by the Albuquerque Gem and Mineral Club

NEW MEXICO METEORITES: MINERALOGICAL MESSENGERS FROM THE EARLY SOLAR SYSTEM

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Meteorites are the oldest known examples of solar system material available for study on Earth, with formation ages of around 4.6 billion years. They represent rocks from a variety of planetary bodies within our solar system including asteroids, comets, the Moon, and Mars. Thus, with the exception of the Moon, they provide us with specimens of bodies that have not been sampled by space missions, manned or robotic. The vast majority of meteorites come from within the asteroid belt, a region of small rocky planetessimals located between the orbits of Mars and Jupiter. Since their formation they have largely escaped the wide-scale geologic processes that have affected Earth, the Moon, and Mars. As such they are extremely important for providing insights into the early geological history of the solar system and subsequent evolution of small planetary bodies.

Three broad groups of meteorites can be recognized: stones, characterized by the presence of common terrestrial silicate minerals, such as olivine and pyroxene; stony irons, consisting of a mixture of silicates and iron-nickel metal; and irons, consisting almost entirely of iron-nickel metal. The stones can be further divided into two groups called the chondrites and achondrites. Chondrites are characterized by the presence of abundant, millimeter-sized silicate spherules called chondrules, while the achondrites are igneous rocks with affinities to terrestrial mafic to ultramafic lavas. The mineralogy of these meteorites is of special importance in determining their origins and conditions of formation.

The arid climate of New Mexico makes the state particularly suitable for the preservation and recovery of meteorites after they have fallen. Approximately 160 meteorites have been recovered in New Mexico, many from the eastern plains region, particularly in Roosevelt County, in the southeastern part of the state. This area alone has yielded close to 200 meteorite samples corresponding to some 80 separate meteorite falls. Of the meteorites discovered to date in New Mexico, most are stones (~85%), the majority being of a type called the ordinary chondrites, the most common group worldwide. Only one carbonaceous chondrite, similar to the famous Allende meteorite that fell in northern Mexico in 1969, has been recovered in the state. The remainder are irons (~11%) and stony irons (2.5%). Of the stony irons, two pallasitic meteorites, Acomita and Dora, are especially fine examples with centimeter-sized olivine crystals set in an iron-nickel metal matrix.

More than 140 minerals occur in meteorites. Many occur on Earth, but a significant number are found uniquely in meteorites. The main constituents of stony meteorites are olivine and pyroxene, but inclusions containing Ca- and Al-bearing minerals such as hibonite, gehlenite, corundum, spinel, fassaite, mellite, and perovskite also occur, especially in the carbonaceous chondrites. Iron-nickel metal is also present attesting to the reducing conditions under which these meteorites formed. Iron meteorites and pallasites contain a number of unusual carbides, phosphates, phosphides, and sulfides, such as cohenite ($(Fe,Ni)_3C$), haxonite ($Fe_{23}C_6$), and schreibersite ($(Fe,Ni)_3P$). The most unusual meteoritic minerals occur in a group of chondrites and achondrites called the enstatite meteorites, which are not represented among New Mexico meteorites. These meteorites are dominated by the pyroxene, enstatite ($MgSiO_3$), but contain numerous exotic sulfides, nitrides, chlorides, silicides, and phosphides. These include oldhamite (CaS), caswellsilverite ($NaCrS_2$), heideite $(Fe,Cr)_{1+x}(Ti,Fe)_2S_4$, djerfisherite ($K_3CuFe_{12}S_{14}$), osbornite ($TiN$), lawrencite $(Fe,Ni)Cl_2$, sinoite (Si_2N_2O), and perryite $(Ni,Fe)_5(Si,P)_2$. The minerals and mineral assemblages found in meteorites attest to the wide range of physical conditions (gas pressure, temperature, etc.) that were present during the early stages of the formation of our solar system.

MINERALOGY OF KARTCHNER CAVERNS
KARTCHNER CAVERNS STATE PARK, ARIZONA

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Kartchner Caverns, located just south of Benson, Arizona, contains a diverse and significant mineralogy. It is diverse in that six chemical classes are represented by the cave mineralogy: carbonates, nitrates, oxides, phosphates, silicates, and sulfates. It is significant for a number of **reasons:**

world's longest soda straw

largest and most massive column in Arizona

first reported occurrence of nontronite and rectorite as cave minerals first cave
occurrence of "birdsnest" needle quartz

first modern description of nitrocalcite and its rare occurrence as a cave mineral one of the
most extensive occurrences of brushite moonmilk in the world

first reported occurrence of "turnip" shields

The diverse and interesting mineralogy of Kartchner is due to an unusual set of circumstances. Unlike most limestone caves, Kartchner Caverns is located near igneous terrain. Alaskite granite borders the Escabrosa Limestone along fault zones to the west, and the Pinal Schist underlies the cave. The dry Arizona desert supplies another condition: the low relative humidity causes the efflorescence of nitrocalcite in the entrance zone of the cave. Bats add the third ingredient, bringing phosphates and nitrates into the cave. In setting and mineralogy, Kartchner Caverns most nearly resembles the caves of the Transvaal, South Africa, where a hot and dry climate combined with an igneous rock/bat guano source of cations and anions has produced an unusual cave environment in which a number of minerals can form.

MINERAL SUITE FROM THE SNAKE PIT MINE MEX-TEX CLAIMS, HANSONBURG DISTRICT SOCORRO COUNTY, NEW MEXICO

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In September of 1991, during a field reconnaissance of the Hansonburg district in connection with a NMBMMR project, a small tunnel was located on the Mex-Tex claims by two of the authors (SKB and MLW). Referred to as the Snake Pit mine, this tunnel is located 0.25 mi to the northwest and approximately 150 ft lower in elevation than the now-collapsed upper Mex-Tex. A truly interesting mineral suite was observed at this locality.

Along with superb specimens of fluorite and galena reminiscent of upper Mex-Tex material, the mineralized zone exposed by a recent collapse revealed a suite of well-crystallized microminerals, including plattnerite, murdochite, rosasite, aurichalcite, calcite, linarite, cerussite, brochantite, hemimorphite, wulfenite, caledonite, and other minerals typical of the district. Perhaps of most significance was the discovery of a mineral that closely resembles scrutinyite. Only a limited amount of this unknown material was recovered, and on a second trip additional specimens were collected for analysis.

MICROMINERALS FROM THE BIG LUE MOUNTAINS

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The Big Lue Mountains of eastern Arizona and western New Mexico offer several good collecting opportunities for the micromounter. Good micromount specimens have been found in several localities near the state line along New Mexico and Arizona State Highway 78 west of Mule Creek, New Mexico.

The Big Lue Mountains are composed of Tertiary rhyolitic volcanics and younger Tertiary basaltic volcanics as flows and tuffs. The volcanics are often vesicular and host two distinct suites of minerals of interest to collectors. Minerals found in the older volcanics are similar to the Black Range topaz-bearing rhyolites and include:

pseudobrookite
titanite
hematite
tridymite
phlogopite
hollandite

Several unidentified minerals are present but they appear to be pseudomorphs after an undetermined mineral. Pseudobrookite is fairly common, occurring as slender elongated euhedral blades that are rarely over two mm long. Titanite is also common, occurring as very small, equant, transparent, reddish-orange crystals. Hematite is common as small blocky to thin lustrous black crystals rarely over two mm in size. Tridymite is found in nearly every vesicle in some places and occurs as multiply twinned crystals up to one cm across. Phlogopite occurs as thin, transparent, light-brown crystals up to 4 mm across. Hollandite is locally abundant as black dendritic growths and coatings in vesicles and overgrowths on some of the other minerals.

The younger volcanics host a suite of zeolites and associated minerals that include:

erionite-offretite
heulandite
mesolite(?)
quartz
calcite

These minerals are more sparsely distributed but locally abundant. Heulandite and erionite-offretite occur as small euhedral crystals in vesicles. A mineral that resembles mesolite is sometimes found with calcite and quartz.

The localities examined so far have been in roadcuts or along stream banks. There are many unexplored hills, cliffs, and streams that may yield additional species.

THE GEOLOGY OF MANTLE XENOLITHS AND MAARS OF DOÑA ANA COUNTY, SOUTH-CENTRAL NEW MEXICO

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A variety of mantle and crustal xenoliths are found in the base-surge and air-fall deposits of the five Pleistocene maars of Doña Ana County, south-central New Mexico. The mantle xenoliths are ultramafic in composition and include lherzolite, spinel peridotite, dunite, and pyroxenite. These xenoliths represent a portion of the spinel peridotite mantle found beneath the southern Rio Grande rift and record chemistry and petrology of the mantle at 27 to 65 km depth. The maars are located in the Potrillo volcanic field and are typical of other maars located in the southwestern United States. These maars appear to be confined to mafic alkaline volcanic fields rather than to tholeiitic volcanic fields.

A maar is a large volcanic crater that is cut into the country rock and possesses a low rim composed of pyroclastic debris. The pyroclastic material is ejected into the air and forms base-surge and air-fall deposits near the vent. Three types of maar are recognized based on changes in the geometry and amount of pyroclastic material. An explosion crater is formed and the conduit is partially filled in with pyroclastic material and later by slump and often lacustrine material. Tuff-ring maars form with a basal breccia composed of the mobilized surface material and a base-surge deposit. The depression forms within the tuff ring and is usually above the level of the surrounding countryside. Tuff-cone maars form with a basal breccia composed of the mobilized surface material, a base-surge deposit, and a thick air-fall tuff.

Kilbourne Hole is the largest and most popular maar in the group. It is approximately 1,600 m long by 2,000 m wide and has the largest array of mantle and crustal xenoliths exposed. Hunt's Hole is smaller, approximately 1,500 m wide, and is 17,000 years old (W. Williams, J. Poths, and E. Anthony, personal communication 1992). It is 3 km south of Kilbourne Hole. Hunt's Hole may be synchronous with Kilbourne Hole. Both mantle and crustal varieties of xenoliths have been reported to occur at Hunt's Hole. Potrillo maar is located 17 km to the south and straddles the international border. It is 4,000 m north-south, and 3,000 m east-west, and is 55,000 years old. A vast array of mantle and large crustal xenoliths are present at this maar. All three maars are explosion craters.

Malpais maar is a tuff-ring or tuff-cone maar and is 20 km west of Potrillo maar in the southern part of the West Potrillo volcanic field. It is 1,400 m in diameter and stands about 400 m above the surrounding area. It is one of the oldest maars in the area, about 232,000 years old. Anorthoclase megacrysts and olivine xenocrysts have been reported in the pyroclastic deposits. Riley maar is a less-known tuff-cone or tuff-ring maar and is approximately 14 km north of Malpais maar. It measures approximately 1,000 m in diameter. Mantle xenoliths of spinel peridotite have been reported from this locality, as well as pyroxene and anorthoclase megacryst.

METAMIJNIRITE, HAYNESITE, AND OTHER MICROMINERALS FROM THE FOUR-CORNERS STATES

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Metamunirite, $NaV0_3 \bullet H_20$, is a new mineral from two locations in San Miguel County, Colorado. The type location is the Burro mine at Slick Rock. Only a few square inches of microscopic acicular crystals of metamunirite were found there as efflorescent crusts on the dumps. Some metamunirite was also found in the Deremo-Snyder mine as white acicular crystals to 1 mm. In both cases the metamunirite is associated with rossite, metarossite, and pascoite on vanadium-rich ore. Only about 35 samples have been found so far.

Also found at the Deremo-Snyder mine was the world's fourth(?) locality for chalconatronite. It was associated with andersonite. Pascoite was locally common. Mr. Phillip Allen located a potentially new uranium carbonate mineral.

At the Long Park #15 mine in Montrose County, Colorado, white efflorescent crusts of a microscopic acicular mineral that resembled metamunirite were collected. It turned out later to be hexahydrite.

The Big Indian mine, south of La Sal, San Juan County, Utah, has been producing some interesting secondary copper minerals. Clinoclase, tyrolite, chrysocolla, aurichalcite, olivenite (var:leucochalcite), azurite, malachite, barite, and psilomelane have been found.

Haynesite, $(UO_2)_3(OH)_2(Se0_3)_2$. $5H_20$, was found at the Repete mine in San Juan County, Utah. It occurs as microscopic yellow acicular crystals associated with boltwoodite, andersonite, and ferroselite.

Arnold Hampson showed me some interesting things at the Monument #2 mine in Apache County, Arizona. Research and identification is continuing but the species verified so far include tyuyamunite, metatyuyamunite, rauvite, bokite, variscite, metahewettite, fervanite, and a lone sample of schubnelite.

Mr. Hampson and I also collected clinoptilolite, mordenite(?), and erionite at a roadcut 3.5 mi west of the New Mexico border in Greenlee County, Arizona on Hwy 78.

Marc Wilson and I found some interesting species on Socorro Peak, Socorro County, New Mexico. These included linarite, caledonite, fornacite, rosasite, and anglesite as microspecimens.

Acknowledgments—I wish to thank the following: Marc Wilson for the use of the NMBMMR's microphotography equipment; Debra Wilson for microphotography; researchers Paul Hlava, Peter Modreski, Howard Evans, Jr., Marc Wilson, Michel Deliens, and Paul Piret; Phillip Allen and the staff at the Deremo-Snyder mine; Marcelino, Marc, and the late Felix Mendisco; and Ron Gibbs and Will Moats for locality information.

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AZURITE AND MALACHITE FROM THE MORENCI DISTRICT GREENLEE COUNTY, ARIZONA

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Azurite and malachite are common in oxidized skarn deposits in Paleozoic carbonate rocks adjacent to Laramide porphyry intrusives in the Morenci district. Recently, some excellent specimen-and polishing-quality azurite and malachite have been collected from fault breccias cutting igneous rocks in the Northwest Extension area of the Morenci district. Malachite with minor azurite also commonly occurs as thin fracture coatings in the oxidized ores in the district, but specimen-quality material is restricted to the skarn and Northwest Extension occurrences.

The Paleozoic section at Morenci includes two carbonate units, the Ordovician Longfellow Limestone and the Mississippian Modoc Formation, both of which have some dolomitic beds. Calcsilicate skarn has been developed in both units on the southeast side of the Morenci mine where they have been intruded by monzonite porphyry dikes and sills and in the Metcalf mine where intruded by granite porphyry. The skarns contain diopside, epidote, garnet, and tremolite with some localized actinolite, chlorite, magnetite, idocrase, specular hematite, and talc. Original sulfide minerals occurred as late-stage pyrite-chalcopyrite ± bornite veins, which subsequently reacted with oxygenated water forming acidic solutions that were almost immediately neutralized by remaining calcite, and perhaps dolomite, resulting in the precipitation of azurite and malachite. Other minerals formed from the supergene oxidation of the skarn deposits include chrysocolla, tenorite, and occasionally native copper and cuprite. Azurite and malachite commonly occur as alternating layers, usually with chrysocolla, as coatings on bedding planes and fractures. Occasionally, azurite crystals to approximately 2 mm occur as complete drusy coatings of open spaces. Azurite and malachite stalactites are a minor occurrence. Well-formed, deep-blue, blocky to platy azurite crystals to 2 cm have been found in a vuggy hematite-goethite matrix along a fault cutting Longfellow Limestone and a monzonite porphyry dike in the southeastern portion of the Morenci mine. Pseudomorphs of malachite after azurite are common from this zone. Cuprite, native copper, and native silver also occur in the fault, with cuprite crystals to 1 cm commonly coated by a pale-green silky aggregate of malachite and sericite.

Azurite and malachite are also common in faults cutting Precambrian granite and Laramide granite porphyry in the Northwest Extension deposit in the Morenci district. The Northwest Extension deposit is an oxide-copper deposit with chrysocolla as the major copper mineral with lesser brochantite, azurite, and malachite. Azurite cements fault breccias in some of the larger faults, and small, blocky azurite crystals have been found lining vugs in the breccias and "floating" in hematite-stained clay gouge. Breccia clasts to several inches are occasionally coated by several generations of thin bands of fine-grained malachite, followed by the deposition of more coarse grained azurite. Azurite also occurs as rosettes on chatoyant malachite. Some very dark green pseudomorphs of malachite after azurite have also been collected from the Northwest Extension deposit.

MINING HISTORY AND SPECIMEN MINERALOGY OF THE LAKE SUPERIOR COPPER DISTRICT

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The Lake Superior copper deposits of Michigan's Keweenaw Peninsula are unique. The Keweenaw Peninsula is the only place in the world where pure elemental or "native" copper naturally occurs in large, economically recoverable amounts.

The Lake Superior copper district is, in fact, the "cradle" of American copper mining. Prehistoric Native Americans mined native copper at least 5,000 years ago and produced an estimated 500 million pounds of copper using crude hand methods. They used the copper to make ornaments, tools, and weapons. By the seventeenth century, European missionaries and explorers became aware of the Lake Superior copper deposits. Later, in 1843, the region became the scene of the first mining boom in U.S. history. From 1850 to 1887 Michigan's copper mining industry was the largest in the United States and in the world. Michigan's native copper mines produced 11 billion pounds of copper from 1845 to 1968.

Because of its longevity, the Lake Superior copper district is a unique place to study the history of technological change in hard-rock mining methods. Historians can trace how manual mining methods, used by skilled Cornish miners and learned by apprenticeship, gave way to mechanical methods employed by a larger, unskilled labor force that was supervised by scientifically trained mining engineers. Immigrants from more than thirty nationalities came to Lake Superior to work in the copper mines. By 1907, 21,000 workers were employed in the Michigan mining industry. At that time, 95,000 persons lived in the Keweenaw Peninsula. Approximately 30,000 people live there today.

Only twenty-four of some 400 mining ventures were successful. During the first century of operation shareholders in these companies received some $350 million in dividend payments. The most famous of the Lake Superior copper mines was the Calumet and Hecla mine. Calumet and Hecla alone accounts for 50% of the total Michigan copper production. From 1871 to 1887 Calumet and Hecla was the most profitable metal mine in the world.

The Lake Superior copper deposits occur in the Portage Lake Volcanics Formation, which constitutes the "spine" of the Keweenaw Peninsula. The Portage Lake Volcanics consists of some 200 flood-basaltic lava flows, sporadically interbedded with conglomerate and sandstone beds. These rocks are late Precambrian and have been dated to be 1.5 billion years old. The native copper and associated minerals were deposited from hydrothermal solutions into faults and fissures, into the brecciated and vesicular flow tops of basaltic lava flows, and into the pore spaces and voids of sandstones and conglomerates. These solutions are now believed to have originated from formational brines that were heated at depth and remobilized. The resulting mineralization is associated with very low grade prehnite-pumpellyite metamorphism.

Crystallized native copper and native silver specimens from the Lake Superior copper deposits can be found in most fine museum and private mineral collections the world over. Calcite crystals with native copper inclusions occur in great variety of crystal form and habit and are by themselves sufficiently important to establish the region as a major mineral locality. In addition, exhibit-quality specimens of analcime, apophyllite, datolite, natrolite, powellite, prehnite, and pumpellyite have been found in the Michigan copper mines.

Michigan Technological University's Seaman Mineral Museum is the official "Mineralogical Museum of Michigan" and is on the Fifth Floor of the Electrical Energy Resources Center. Founded in 1902 by geology department head Arthur Edmund Seaman, the museum collection contains some 60,000 mineral, gem, and rock specimens, of which 20,000 are on display. The Seaman Mineral Museum conserves the world's finest collection of minerals from the Lake Superior copper and iron mining districts. In addition, the museum's collection contains many fine exhibit- and reference-quality specimens from most classic mineral localities in North America and around the world.

Michigan's Keweenaw Peninsula, home of the famous Lake Superior copper deposits, possesses a remarkable blend of natural beauty, historic significance, and scientific importance that is characteristic of a world-class mineral deposit.

SPANGOLITE AND OTHER SECONDARY MINERALS FROM THE BUCKHORN MINE

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Spangolite, the rare copper sulfate ($Cu_6Al(SO_4)(OH)_{12}Cl\bullet 3H_{2}0$), was recently found to occur at the Buckhorn mine in the Red Cloud district of the Gallinas Mountains Previously known New Mexico localities for this species are restricted to the Hansonburg mining district and a single occurrence at the Kelly mine in Socorro County. The Buckhorn mine lies in the northern portion of the Gallinas Mountains about eight mi southwest of Corona in Lincoln County, New Mexico. Perhac (1970) reported several supergene copper and lead minerals from this mine including pyromorphite, anglesite, chrysocolla, malachite, and azurite. Recent investigations of supergene minerals from the Buckhom mine have established 12, possibly 13, additional species. These include the sulfates brochantite, cyanotrichite, celestite, linarite, and spangolite. Although arsenates and vanadates have not previously been reported from this mine, duftite, mimetite, olivenite, mottramite, and vanadinite were found to occur. Arsentsumebite has been tentatively identified (by microprobe/SEM) but additional analyses (x-ray diffraction) are required for confirmation. The lead molybdate, wulfenite, was also found in very small amounts. Previous reports of pyromorphite could not be substantiated.

Spangolite crystals are found in association with free-standing, bright-green sprays of brochantite and mostly flat-lying sprays of light-blue cyanotrichite. Spangolite crystals are generally a lustrous blue green and are transparent to translucent. Although spangolite is hemihedral, being in the ditrigonal pyramidal crystal class, it usually assumes a morphology that looks holohedral, consisting of striated hexagonal prisms terminated by hexagonal pyramids. A few crystals exhibit small pedial terminations while others have large pedial faces, give which give them a blocky appearance similar to spangolites from the Hansonburg district. Buckhom spangolites range in size from 0.5 to 3.0 mm.

Extensively fault-brecciated, Permian Yeso sandstone/arkose forms the host rock for these minerals (Perhac, 1970). Tertiary intrusives are responsible for the mostly fissure-filling, mineralizing solutions that deposited the primary or hypogene ore minerals of fluorite, galena, and bornite. Bastnaesite, for which the Red Cloud district is famous, was not noted at the Buckhom mine either by Perhac or by the authors.

Perhac, R. M., 1970, Geology and mineral deposits of the Gallinas Mountains, Lincoln and Torrance Counties, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 95, 51 pp.

SILVER AND COPPER MINERALIZATION AT THE BUCKHORN MINE, GALLINAS MOUNTAINS, NEW MEXICO

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The Buckhom mine is in the Red Cloud mining district, Gallinas Mountains, Lincoln County, New Mexico. The district contains alkaline igneous rocks with associated base-metal and rare-earth mineralization. The Gallinas Mountains are one of a series of alkalic igneous intrusive centers that form stocks, laccoliths, dikes, and sills of middle to late Tertiary age along and near the margin between the Great Plains and the Rocky Mountains or Basin and Range physiographic provinces in New Mexico.

Intrusive igneous rocks of Oligocene age in the Gallinas Mountains include rhyolite, trachyte, latite, intrusive breccia pipes, and a few dikes of andesite and basalt. Host rocks include Precambrian granite and gneiss and the sedimentary Abo, Yeso, and Glorieta Formations of Permian age. Mineral deposits in the Gallinas Mountains include limestone-replacement iron deposits and veins and breccias that contain concentrations of copper, lead, fluorine, barium, and rare-earth elements, with some anomalous amounts of gold and silver. The intrusive breccias and adjacent country rocks in the district show evidence for several types of alteration, primarily fenitization (introduction of K- and Na-feldspar, sodic pyroxenes, and sodic amphiboles) and carbonatization (replacement by calcite). Apatite, zircon, pyrochlore, monazite, thorite, pyrite, and rutile occur in the ferrite veinlets.

The Buckhom mine, about 2,000 ft east of Rough Mountain in the southeastern Gallinas Mountains, consists of one adit, three shafts, and several prospect pits along a northwest-trending breccia zone. Primary ore minerals include cavity-filling galena, tennantite, argentian tennantite/freibergite, and proustite, plus K-feldspar, xenotime, zircon, fluorite, barite, quartz, calcite, and pyrite. Secondary alteration of the tennantite and sulfide minerals has produced other sulfides (covellite, digenite); silicates (chrysocolla, shattuckite); carbonates (malachite, azurite, cerussite); sulfates (brochantite, cyanotrichite); a sulfate-halide (spangolite); arsenates (adamite, cuprian austinite, comubite, duftite, arsentsumebite); a chloroarsenate (mimetite); and a late-stage copper-bearing clay mineral. An unusual feature is the presence of secondary silver halide minerals including iodargyrite (AgI) and a silver-mercury-sulfide-iodide mineral, possibly related to perroudite, $Hg_5\text{-}xAg_{4+x}S_5\text{-}x(Cl,I,Br)_{4+x}$, or capgaronnite, HgAgS(Cl,Br,I). The iodargyrite occurs as thin prismatic crystals (<30 microns long) within rims of shattuckite and chrysocolla that surround proustite. The Ag-Hg-S-I phase occurs as <5-micron crystals around altered tennantite.

GEM MINERALS OF TELE FRANKLIN MOUNTAINS, EL PASO, TEXAS

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West Texas and southern New Mexico are not known for the presence of gem stones, thus this comes as a surprise when we tabulate the gem minerals found in the Franklin Mountains. Given the gemstones of each month, nearly one half the year is present. As yet, no gemstones have been faceted from Franklin Mountain minerals because they lack quality, but their presence provides a tantalizing feeling that there is more yet to be discovered.

Topaz was the first gem mineral reported from the Franklin, and it was discovered as an accessory mineral in the tin pegmatites mined between 1908 and 1911. Photomicro-graphs of topaz are included in the published literature of that time.

Garnet has been reported from several localities in the Precambrian rocks on the eastern side of the range, particularly in the Castner Formation. These are visible in roadcut #3 ascending from the east, and assume large dimensions in the valley past roadcut #1, *up* to 5 inches on a crystal face. Hitt Canyon also has garnets. The colors are brown, and the mineral forms as a result of contact metamorphism.

Blue beryl is present in pegmatitic rock from Fusselman Canyon, but the only known specimens are in the UTEP Centennial Museum and Department of Geological Sciences collections, and the exact site has been lost. Host material is grey quartz, but aplite dikes in the area are the suspected producers. The sky-blue color makes the material very attractive, and with increased size and transparency the crystals would present an outstanding gemstone. An El Paso 'old timer' maintains that the discovery site is underneath Trans Mountain Road, a distinct possibility.

Zircon crystals up to 1 inch on an edge have been found in the riebeckite dike in the Precambrian rocks. The dike can be seen in roadcut #1 east, but the large zircon crystals are found about 1 mile away to the northwest. The crystals are lustrous and dark red brown and make attractive specimens.

Finally, many fine agates, generally carnelian, banded, and common grey varieties, have been found on the fluvial slopes away from the Franklin Mountains. These agates were actually borrowed from New Mexico by the Rio Grande in eons past.

Other than the latter material, the gem minerals of the Franklin Mountains originated from Precambrian magmatic processes, approximately 1.1 billion years ago. These magmas were of the A or anorogenic type, and the concentration of rare metals, such as Be, Sn, and Zr, and of the halogen F to make topaz, is not unusual.

In the future will there be a Franklin Mountains gemstone district? No. The area is protected in the Franklin Mountain Wilderness Park of the State of Texas, the aggressive and pistol-packin' caretaker lives in Canutillo, Texas, nearby, and collecting is prohibited.