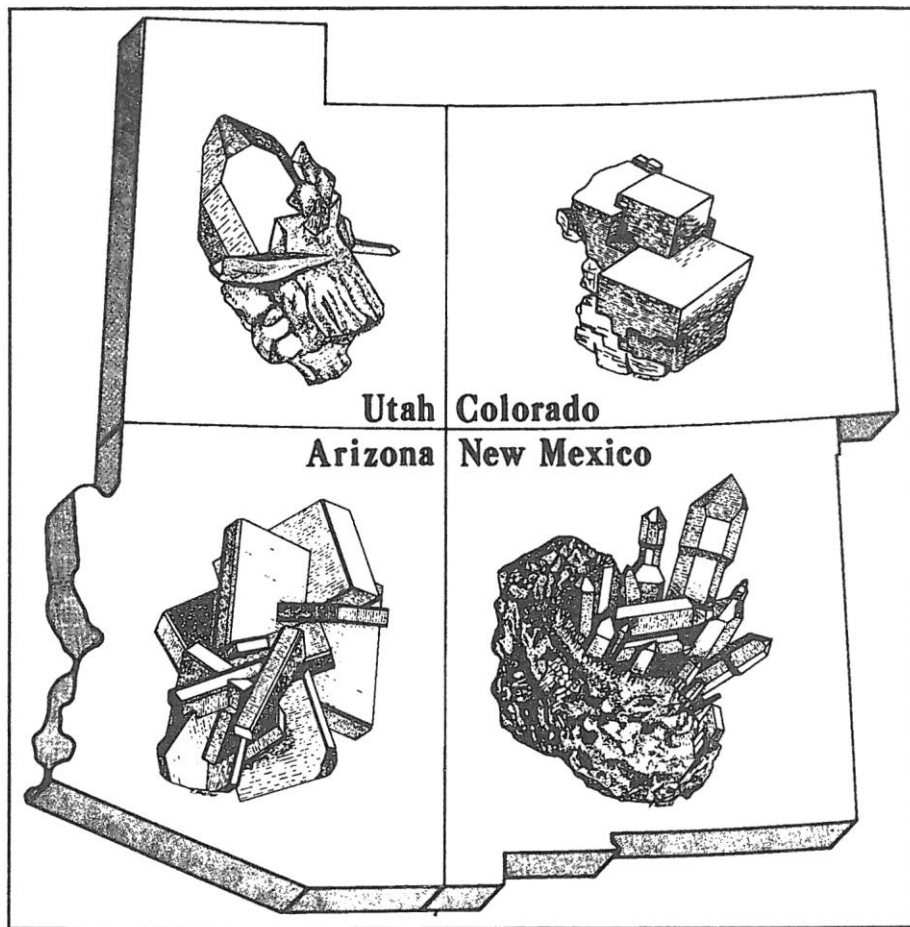




NEW MEXICO MINERAL SYMPOSIUM

November 9 & 10, 2002



New Mexico Tech Campus, Socorro, New Mexico

Welcome to

THE TWENTY-THIRD ANNUAL

NEW MEXICO MINERAL SYMPOSIUM

November 9 and 10, 2002

Macey Center Auditorium

New Mexico Institute of Mining and Technology

Socorro, New Mexico

Sponsored by

New Mexico Bureau of Geology and Mineral Resources

Albuquerque Gem and Mineral Club

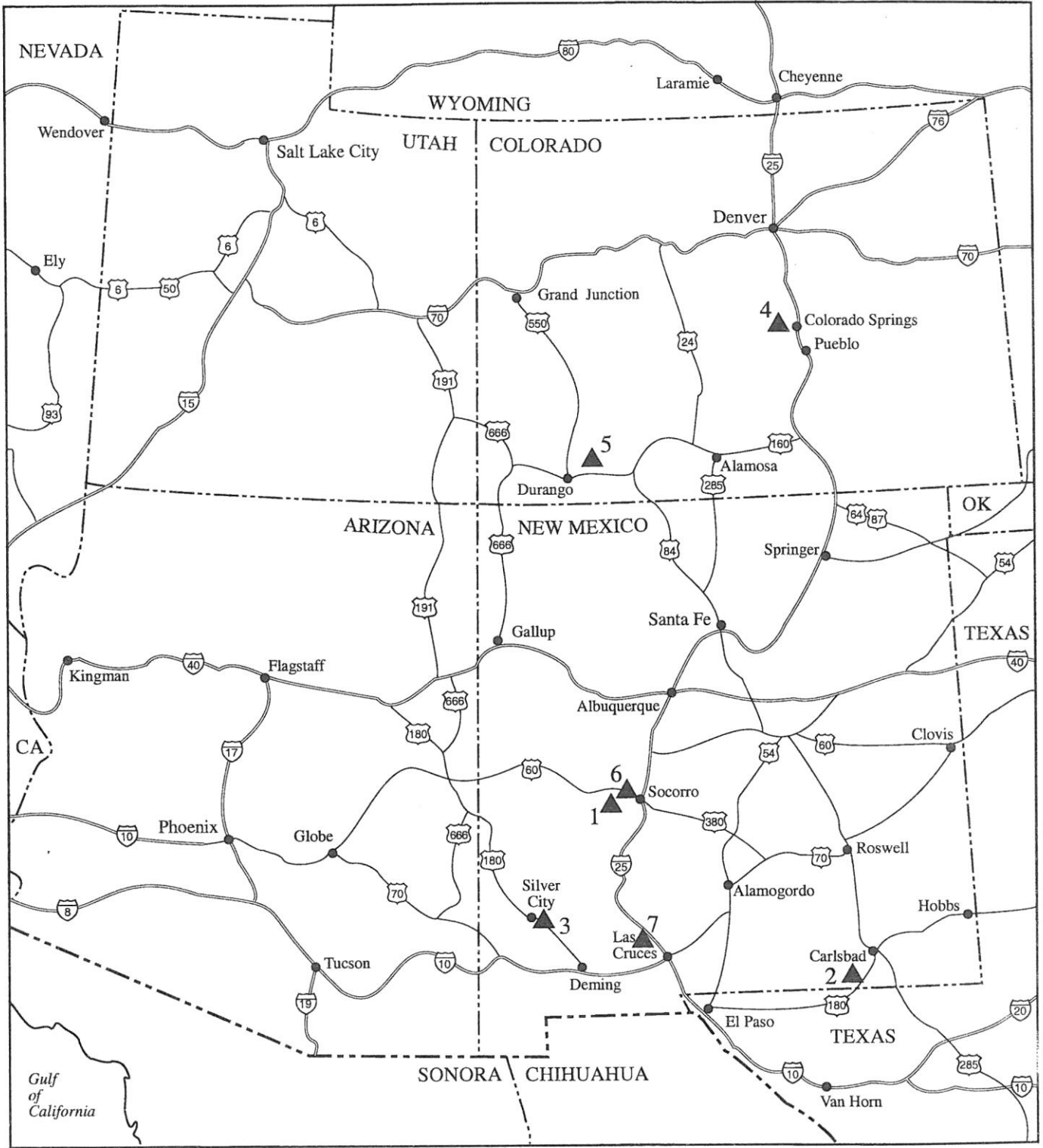
Los Alamos Geological Society

New Mexico 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 Twenty-third 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 FOURCORNERS 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.



Geographic Index Map
 23rd New Mexico Mineral Symposium

SCHEDULE

Numbers in parentheses refer to geographic location on the index map.

FRIDAY, NOVEMBER 8

6:00 p.m. Informal tailgating and social hour individual rooms, Super 8 Motel (free)	3:30 (6) <i>Mines and minerals of Socorro Peak, New Mexico</i> — Ramon S. DeMark
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SATURDAY, NOVEMBER 9

8:30 a.m. Registration: Macey Center, continental breakfast	4:00 <i>Recovery of the 17 ton copper boulder from Lake Superior</i> — Bob Barron, featured speaker
9:20 <i>Opening remarks</i> , main auditorium	5:30 Sarsaparilla and suds: cocktail hour, cash bar
9:30 (1) <i>The colors of smithsonite: a microchemical investigation</i> — Patricia L. Frisch, Virgil W. Lueth, and Paul F. Hiava	6:30 Dinner followed by an auction to benefit the New Mexico Mineral Symposium

SUNDAY, NOVEMBER 10

10:00 (2) <i>Of microbes and minerals</i> — Mike Spilde	8:15 a.m. Morning social: coffee and donuts
10:30 Coffee break	9:00 <i>Welcome to the second day of the symposium and follow-up remarks</i>
11:00 <i>Public fluorescent mineral displays of the western United States: an overview</i> —Aaron Rever	9:10 (7) <i>Hematite collecting in the Iron Hill district, southwestern Robledo Mountains, Dona Ana County, New Mexico</i> — Robert D. Beard
11:30 (3) <i>Geology, geochemistry, and historical significance of the native copper at the Chino mine, Santa Rita, Grant County, New Mexico</i> —Robert M. North and Virgil W. Lueth	9:40 <i>Red garnets from Lake Jaco, Mexico, and the chemical controls of color in garnets</i> — Virgil W. Lueth
12:00 p.m. Lunch	10:10 Coffee break
1:00 Museum tours	10:40 <i>Digital photography of minerals</i> — John Sobolewski
2:00 (4) <i>Colorado turquoise</i> — Peter J. Modreski and Jack A. Murphy	11:10 <i>Open forum</i>
2:30 (5) <i>Thirty years of mineral collecting in the San Juan Mountains, southwestern Colorado, 1970-2000: part II, field collecting</i> —Tom Rosemeyer	12:00 p.m. Lunch
3:00 Coffee break	1:15-3:00 Silent auction, upper lobby, Macey Center, sponsored by the Albuquerque Gem and Mineral Club (free)

The colors of smithsonite: a microchemical investigation

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(Location 1 on the map)

We analyzed four smithsonite (ZnCO_3) samples with electron microprobes in an attempt to decipher the origins of the different colors. We examined samples that were blue green (Kelly mine, New Mexico), yellow (Hanover, New Mexico), blue purple pink with white bands (Sinaloa, Mexico), and green yellow (79 mine, Arizona). Previous authors have proposed, with some geochemical evidence, that the green color of smithsonite is due to copper, the yellow to cadmium, and the blue to cobalt. However, until now, no one has used modern microchemical studies to investigate the chromophores in smithsonite.

The Kelly mine sample exhibits strong color banding that corresponds to a change in solid solution of copper carbonate (CuCO_3) in the smithsonite, with higher CuCO_3 contents (as much as 3.0 wt %) occurring in the strongly colored green bands. No mineral inclusions occur in this sample, and there is little variation of the other minor elements present (calcium and lead). Therefore we believe that copper is the coloring agent in the green smithsonite from the Kelly mine.

"Cadmean" smithsonite from the Hanover mine contains inclusions of pyrite (FeS_2) —300 μm on a side, iron-rich sphalerite or $[(\text{Zn},\text{Fe})\text{S}]$, and either hexagonal greenockite or isometric hawleyite (CdS). The CdS occurs in brightly colored bands, which are —10 μm thick and contain about 17 % of these —1 μm diameter inclusions. In addition, as much as 19.5 wt % iron carbonate (FeCO_3) is present in solid solution. From this evidence we hypothesize that both CdS inclusions and iron in solid solution are the coloring agents in yellow smithsonite from this mine.

The blue-purple-pink smithsonite sample from Sinaloa, Mexico, contains copper and cadmium but no cobalt! In addition to our work, others have found that pink "cobaltian" smithsonite lacks cobalt. Thus, the term "cobaltian" smithsonite should be abandoned. Line scans across the color zones show that CuCO_3 is high in the purple-pink regions (1.5 wt %) and even higher (3.0 wt %) in the blue zones. Solid solution cadmium carbonate (CdCO_3) concentrations are fairly uniform from 1.0 to 1.5 wt % in both blue and purple zones of the mineral. The coloring agents in this sample appear to be copper and cadmium but because CdCO_3 is colorless, the cadmium is not coloring the smithsonite directly but it must be altering the way copper colors the mineral. Where the copper concentration is highest, the smithsonite is blue instead of green. As the concentration of copper gets lower, the color goes to purple pink in the presence of cadmium. The white zones are due to abundant inclusions of hemimorphite.

The green smithsonite from the 79 mine contains inclusions of hemimorphite, aurichalcite, a manganese and copper oxide, and CuCO_3 and manganese carbonate (MnCO_3) in solid solution. The inclusions are as much as 1 mm in size and are present mainly at the edges of the material. CuCO_3 and MnCO_3 have the greatest concentrations (as much as 1.7 and 2.0 wt %, respectively) of solid solution impurities and the strongest variation. The copper concentration is not as high as in the blue-green smithsonite from the Kelly material. The combination of lower amounts of copper and the presence of manganese may therefore account for the lighter green and yellow color of this smithsonite sample.

Acknowledgments

Part of this work was supported by the U.S. Department of Energy under Contract DE-AC04-94AL85000. Sandia is a multiprogram laboratory operated by the Sandia Corporation, a Lockheed Martin Company, for the U.S. Department of Energy.

Dr. Nelia Dunbar and Lynn Heizler (New Mexico Bureau of Geology and Mineral Resources) assisted with the electron microprobe analysis. The Cameca SX-100 electron microprobe at the New Mexico Institute of Mining and Technology was partially funded by the National Science Foundation, Grant STI-9413900.

Of microbes and minerals

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(Location 2 on the index map)

We usually don't think of microbes in the same context with minerals. Microbes (bacteria, algae, fungi) are ubiquitous on (and in) our planet. But for the most part, we know very little about what they do, other than the small percentage that make us ill, like anthrax. Even the scientific community has had a very limited understanding of these marvelous little critters outside of the laboratory. In fact, a whole new branch of life, the archaea, was only just discovered in the 1980s. Because they could not be cultured in the lab, no one knew they existed until the tool of DNA analysis was invented. We are now making amazing discoveries in the world around us: the archaea may comprise over 95% of the biomass in the world's oceans.' Indigenous living organisms have been found deep into the earth's crust, in the deepest gold mines in South Africa for example, when only a few decades ago it was believed that microorganisms could not survive deeper than a few meters into the earth' Scientists have speculated that microbial life may extend many kilometers into the earth's crust and that the biomass there may far exceed that of all other life'.

It is becoming increasingly clear that many of the mineral-forming processes are influenced, to some extent, by microbial action. Bacteria can process nearly every element in the periodic table. They can precipitate sulfur from hydrogen sulfide gas, fix arsenic from ground water, reduce gypsum into elemental sulfur and calcite, or precipitate volumes of oxides from minute quantities of manganese present in seawater. Microbes do these things in order to provide themselves with energy and nutrients or to sequester toxic elements such as heavy metals out of harms way. Furthermore, they can live happily in the most hostile environments: precipitating calcium carbonate from boiling hot springs in Yellowstone, corroding stainless pipes inside nuclear reactors, or forming metal sulfides at thousands of meters depth in the ocean.

There is a growing collection of information about the ability of microbes to directly precipitate minerals, or certainly to cause the indirect formation of minerals. Some examples of minerals or mineral environments that may result from microbial activity:

- Agates
- Fossil bone & other fossilized material
- Manganese nodules
- Banded iron formations
- Cave speleothems
- Travertine

There is even evidence that bacteria may be responsible for gold accumulation in some placer deposits ⁴S With the knowledge that microbes can act upon most elements, there are new applications being developed that utilize microbial communities to extract ore, clean up waste, and to remediate toxic waste sites and spills. In addition, a question that many researchers are trying to answer is whether there are certain minerals that can help us determine if there is life elsewhere in the solar system.

The search for life on Mars will begin in the subsurface of Earth.⁶ Researchers at the University of New Mexico and New Mexico Tech are studying caves in Carlsbad Caverns National Park because they represent unique environments at the interface between the microbial world and the realm of minerals. The researchers have discovered unique

microorganisms that live deep in Lechuguilla Cave, dissolving limestone to release iron and manganese that are then oxidized as an energy source. The oxides accumulate into thick deposits on the cave walls, ceilings, and floors. Minerals include iron oxides (lepidocrosite, goethite, hematite) and manganese oxides (todorokite and lithiophorite), which may be the direct result of microbial activity. There are also more usual minerals whose origin is less certain, such as nordstadite (aluminum-hydroxide) and svanbergite (aluminum-strontium sulfate-phosphate). Another line of research involves some of the unusual mineral forms that decorate Carlsbad Caverns and Lechuguilla Caves, among others. These forms, called moonmilk, pool fingers, and U-loops, were deposited on and around microbial filaments deep in the caves.

End Notes

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Public fluorescent mineral displays of the western United States: an overview

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On any one of my various road trips, I have wondered if I've missed any interesting fluorescent mineral displays. There has been precious little information as to their localities, with the notable exception of the Fluorescent Mineral Society member Bruce Naylor, who several years ago compiled a general listing of fluorescent mineral displays. My presentation will attempt to update and add to his work for the western United States and specifically for the Rocky Mountain region. It will provide information for the traveler with an interest in fluorescent mineral displays: their location, scope, approximate size, wavelengths of light, and other pertinent information.

In my research I have found that many of the better displays are located outside of the major cities in small, somewhat isolated towns. For instance some of the best displays I have seen (judged mainly for quality of specimens and in some cases for educational value) include the South Dakota School of Mines Museum in Rapid City, the Badlands Petrified Gardens in Kadoka (both in South Dakota), the Adams County Historical Museum in Brighton, Colorado, and right here in Socorro, New Mexico, at the New Mexico Bureau of Geology and Mineral Resources Mineral Museum. This of course does not preclude outstanding displays at many larger museums and universities throughout the region.

In addition to permanent displays, I will also include information on several major gem and mineral shows with sizable fluorescent mineral displays, including those held in Tucson, Denver, and the California Mineral Federation shows.

Reference

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Geology, geochemistry, and historical significance of the native copper at the Chino mine, Santa Rita, Grant County, New Mexico

Robert M. North¹ and Virgil W. Lueth²

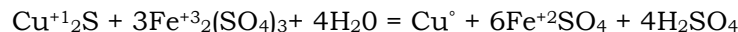
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(Location 3 on the index map)

Native copper at Santa Rita resulted in some of the earliest mining in the Southwest. Native copper artifacts from a Georgia archaeological site dated at A.D. 880 have been identified by trace element chemistry as being from Chino, and a copper bell dated ca A.D. 1150 has been excavated from a Mogollon site. Spanish explorers came north from Mexico to explore the area beginning with Don Juan de Otiarte in 1598. The exact time when the Spanish gained knowledge of the deposit is unknown, but ca 1795 Captain Francisco Martinez stationed at El Presidio de Carizal mentions "El Cobre" near Santa Lucia Springs as a "criadero." A criadero or nursery (where minerals "grow") ~was at the time considered a natural wonder, with such occurrences of metals reserved to the Spanish Crown. Consequently, there was little incentive to develop such deposits of native metal "growing" from the soil until Jose Manuel Carrasco, a soldier stationed about 150 mi south of Santa Rita at El Presidio de Janos, took the initiative to develop the deposit in the early 19th century. By about 1801 Carrasco had interested his friend Don Francisco Manuel Elguea a wealthy and influential merchant from Chihuahua in Santa Rita copper, which by 1804 resulted in contracts to supply copper for Mexican coinage.

Native copper is common in the oxidation zone of porphyry copper deposits, typically forming near the top of chalcocite enrichment. Here, copper in chalcocite is reduced to the native state with accompanying oxidation of sulfur to sulfate, as suggested by Lindgren from observation of Morenci ore and by the reaction:



Even though ferric iron is responsible for the oxidation of chalcocite in this geologic setting, little hematite associated with native copper is present in recent finds at Chino perhaps because of the relatively low pyrite content in this area of the pit. Much of the native copper at Chino is in the Santa Rita granodiorite stock to the west and beneath retrograde skarn mineralization in a "roof pendant" in the East pit area of the mine. Shiny, flattened specimens were collected in 1998 from fractures in skarn hosted by the Syrena Formation, which suggested a change in pH, rather than Eh, was responsible for the deposition of native copper from solution.

The best native copper specimens are found in the stock and in the most recent finds intimately associated with alunite. Additional associated minerals at Chino include quartz, sericite, gypsum, and minor orthoclase. Pyrite and hematite are present but in relatively small amounts. Cuprite is often found as an oxidation product on the native copper as coatings and in crystalline form as cubes, octahedrons, and dodecahedrons. Native copper has also been found recently in the South pit area of the Chino mine as finely crystalline masses in fractures associated with chrysocolla and the chalcotrichite variety of cuprite.

The main body of native copper mineralization in the East pit was first encountered at about 700 ft below the original surface at an elevation of 5,650 ft. The best specimens have been found sporadically between an elevation of about 5,500 ft and the current pit bottom on the 5,150-ft bench. Mining was stopped in 2001 about 50 ft above the bottom of the native zone that produced the most recent nicely crystallized specimens. Copper mineralization extends in an adjacent zone to about the 4,750-ft elevation, a total vertical extent of 900 ft, but current plans include mining only to the 5,000-ft elevation.

The New Mexico Bureau of Geology and Mineral Resources Mineral Museum contains specimens from at least as far back as the early part of this century (C.T. Brown Collection). Additions to the museum collections over time provide us a potential chronology for the production of fine specimens from the mine. The earliest documented specimens are typically massive vein fillings of native copper. A few early examples consist of arborescent growths of crystals. Later specimens often dominated by spinel and polycyclic twinning were produced from the 1970s to the early 1980s. A discovery in late 1993 had some nicely crystallized copper and cuprite and included some unusual forms. More recently a single specimen mined in March 2001 was recovered from an inactive concentrator stockpile that yielded some spectacular crystalline specimens sold in early 2002. Crystal forms include spinel twins, dodecahedrons, and modified cubes. Often single specimens show differing crystal habits. Some finely crystalline copper "wool" is present on some specimens as a secondary crystallization. Additionally, many examples of good quality crystalline copper, reasonably priced, were found in the area. Additional discoveries are anticipated when mining resumes.

Colorado turquoise

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(Location 4 on the index map)

Turquoise is not a well-known gem material from Colorado, but the state has four localities that have produced significant amounts of turquoise in the past, two of which are still worked today. All the deposits are associated with Tertiary-age felsic igneous rocks, though at Leadville and Cripple Creek the productive turquoise veins are hosted by adjacent Precambrian granite. The turquoise occurs as near-surface supergene veins and veinlets, which are characteristically free of other normally common secondary copper minerals such as azurite, malachite, or chrysocolla.

The King turquoise mine is in Conejos County, in the San Luis Valley, about 9 mi east of Manassa and 19 mi west of the town of San Luis. The workings are in a hill composed of chalky, hydrothermally altered silicic volcanic rock, part of the Conejos Formation of Oligocene age. Turquoise was discovered here by Israel Pervoise King in 1890, but extensive Native American workings already existed and tools made of stone and horn have been found here (Harvey and Harvey, 1938). The most extensive mining took place in the 1940s and included open cuts, inclines, and shafts. An 8.75-lb nugget was reported to have been recovered in 1941 (Pearl, 1951). The property is still worked sporadically by Bill King of Manassa, who markets silver jewelry set with the material. Polished turquoise from the mine includes blue-green material intergrown with brown limonitic matrix in an attractive pattern, and sky-blue turquoise that tends to be more solid but does require some stabilization treatment (King, pers. comm. 2002).

The Hall turquoise mine is about 8 mi northwest of Villa Grove in Saguache County. It lies about 5 mi east of the Bonanza mining district and near the head of the Turquoise Gulch drainage. Said to have been developed first as a copper mine, turquoise production was reported by Kunz (1894), who described the workings as the Blue Gem and Manitou mine. The turquoise veinlets occur in a highly fractured and altered, light-colored silicic volcanic rock, near the edge of the Bonanza caldera. The visible mine workings consist of a pit (now partially water filled) and open cuts. The mine is said to have also once included underground workings. Pearl (1941a,b) reported that 4-5 tons per day of dump material were hand sorted daily to produce several pounds of turquoise, valued at \$15—\$45 a pound. Colorado Bureau of Mines records show that the most extensive production was during the mid-1950s. The patented mining claims are currently inactive and posted.

Most of the turquoise reported from Cripple Creek has come from the Florence mine, located on the south side of Mineral Hill at the northern edge of town. Mining for turquoise was begun here by Wallace C. Burtis in 1939 and continues today on a small scale. Turquoise occurs as residual weathered nuggets and as veins along fractures in moderately weathered Pikes Peak Granite at the northwest edge of the Cripple Creek volcanic center. Two slabs of pure turquoise, each weighing slightly over 6 lb, were recovered around 1987 by Burtis' son, Wallace F., who now works the property to produce silver and turquoise jewelry. Contiguous workings slightly higher on Mineral Hill are operated by David and Harriet Graham (business name, The Bad Boys of Cripple Creek), who also mine, polish, and sell the turquoise. Limonitic vein material in some of the Grahams' turquoise is reported to contain flecks of native gold (Jones, 2001). The nearby Roanoke shaft is also known to have intersected turquoise veins.

The Turquoise Chief and nearby smaller mine workings are in Lake County, about a mile north of the center of Turquoise Lake. They are about 6 mi northwest of the Leadville mining

district, and closer to (about 1 mi southeast of) the St. Kevin mining district. The Turquoise Chief mine is reported (Pearl, 1951) to have been initially worked by two Navajos in 1935, at which time a thousand pounds of turquoise is said to have been mined over a 2 yr period. Excavations apparently continued over the next half century, but little has been published about the deposits or the mining history. The present workings consist of a relatively large open pit at the Turquoise Chief mine proper and several smaller open cut workings (the Josie May mine) about 1/4 mi to the southwest, adjacent to San Isabel National Forest Road 103. Turquoise occurs as veinlets and nodules in variably altered Silver Plume-age (1.4 Ga) St. Kevin Granite.

In addition to the references cited, Murphy and Modreski (2002) summarize the history and mining activity at the four deposits and give additional literature references. The location of and information about these deposits is being incorporated into a database on Colorado gemstone occurrences at the Denver Museum of Nature and Science (Murphy, 2002).

Small amounts of turquoise have also been reported from Creede, Summitville, the Holy Cross mining district in Eagle County, and the Sugarloaf district in Lake County, south of Turquoise Lake.

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**Thirty years of mineral collecting in the San Juan Mountains,
southwestern Colorado, 1970-2000: part II, field collecting**

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(Location 5 on the index map)

Now that I have reached the age of 60 it seems like an appropriate time to look back at the last 30 yrs of mineral collecting in the San Juan Mountains of Colorado and all of the enjoyable and some not so enjoyable memories I have of securing mineral specimens for my collection.

My first mining-related job in the San Juans was in 1968 when I was employed as a mining engineer with the Cleveland Cliffs Iron Company in Summitville, Colorado. Cleveland Cliffs was sinking a shaft on an enargite-pyrite vein called the Missionary orebody and was planning to mine the deposit by underground methods. At this time the Vietnam War was in full swing, and I was drafted into the U.S. Army for the next 2 yrs. When I was honorably discharged in the summer of 1970, the Summitville project had already gone belly up, but I was determined to return to the San Juans.

I landed a job with the Camp Bird mine at Ouray where they were just starting to mine a base metal replacement orebody in the Telluride Conglomerate. During the 1970s a number of mines were operating, and most of my time was spent in securing specimens from the operating mines and only occasionally field collecting. By the end of the 1970s most of the major mines had shut down, and my interest now turned to active field collecting during the short summer season from June through September. During the 1980s a number of important discoveries were made including anatase on quartz, large quartz crystals from a solution cavity in the Leadville Limestone, and a number of important finds in the Red Mountain mining district.

In the early 1990s the Mined Land Reclamation Division of the Colorado Bureau of Mines initiated a program of sealing all accessible shut down mines, and it then became a race against time to collect and preserve minerals that would never again see the light of day. The 1990s saw a number of mineral finds including rare secondary lead-copper-zinc minerals, colorful silver sulfosalt minerals, and more discoveries of anatase and additional discoveries of quartz in the Leadville Limestone.

During the past 2 yrs only a few notable mineral discoveries have been made in the San Juans. This is not to say that the mountains are worked out but only that the elusive pocket is still out there waiting to be discovered.

Mines and minerals of Socorro Peak, New Mexico

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(Location 6 on the index map)

The Socorro Peak mining district is quiet today, but 120 yrs ago it was a different story. The town of Socorro, also known then as the "Gem City" was alive with mining and smelting activity, and there was great hope for a bright future (Silver City Southwest Sentinel, 1889). During the early 1880s as many as 150 oxen and mule teams were busy hauling lead and silver ores from the Magdalena district (Kelly, Graphic, and other mines west of Socorro; Eveleth, 1983). They pushed through Blue Canyon on the south side of Socorro Peak ("M" Mountain) to the busy smelters of Gustav Billing in Park City, 2 mi west of Socorro. The ores from the Socorro Peak district also added to the activity. The Socorro Chieftain (1892) cites that "768,410 oz of silver came from Socorro Mountain mines: one half from Tarrance and the rest from Merritt, Silver Bar, and New Find." Enthusiasm was riding high during this time. The Socorro Tunnel Mining Company of New Mexico prospectus (Robinson, 1881) uses the word "immense" on many occasions to describe the orebody and cites the "extensive deposits of auriferous rock that occurs." With regard to the mines on Socorro Peak, the Socorro Chieftain also writes: "It is a well known fact that these claims are permeated with an inexhaustible supply of silver in a chloride form." This is not exactly true because in 1904, Fayette Jones reported: "This once prominent smelting plant is now practically dismantled and with the dying fires of its stacks, the life of the Socorro district passed out."

Today we can still see the dumps of the mine shafts and the tunnels that fired the dreams of the early prospectors, miners, and residents of Socorro. On the east face of Socorro Peak they remain a silent testimony to the activity that once dominated the area. Much of the production history of these mines has been lost, and little of the mineralogy has been documented. In *Rocks and Minerals* magazine geologist and mineral collector Will Moats offers the most comprehensive information on the minerals of Socorro Peak (Moats, 1991).

These days the mines of Socorro Peak beckon to the mineral collector, but access to the mines is only possible through the written approval of the Energetic Materials Research Test Center (EMRTC), an affiliate of the New Mexico Institute of Mining and Technology. With the approval of EMRTC, I was able to visit the following Socorro Peak mines in preparation for this presentation: May Flower, Socorro (Woods) Tunnel, Silver Bar, Dewey Load, Merritt, Tarrance, and the Maine Tunnel. In most cases, hazardous underground conditions, vertical shafts, and collapsed drifts prevent underground inspection and collecting, but the mine dumps can produce most, if not all, of the minerals of interest to collectors (primarily microminerals). Minerals collected during this investigation include: mottramite, mimetite, vanadinite, wulfenite, willemite, hemimorphite, bromargyrite/chlorargyrite, barite, malachite, cerussite, chrysocolla, calcite, quartz, and gypsum. Caledonite, descloizite, and linarite (Moats, 1991) and argentite/acanthite and fluorite (Lasky, 1932) have been reported but were not observed.

Acknowledgments

I would like to thank EMRTC director, Dr. John Meason, and associate director of administration and support, Mr. Rudy Correa, for granting permission to visit and collect at the Socorro Peak mines. I would also like to thank EMRTC engineer and raconteur, Mr. Alan Perryman, for his helpful assistance and for his company while visiting the mines.

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Recovery of the 17 ton copper boulder from Lake Superior

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For well over a century, the Keweenaw Peninsula has served as a home to a multi-billion-dollar copper industry. The roots of mining go back several thousand years when Native Americans first discovered the nearly pure copper and silver deposited in fissure veins cutting across the Keweenaw Peninsula. Along the sparsely vegetated shores of Lake Superior and inland lakes of the post-glacial period, the Native Americans mined the red metal for possibly 10,000 yrs. The malleable copper was easily shaped into tools and other valued implements and was traded across North America and perhaps beyond.

As an avid scuba diver and mineral collector for over 25 yrs, I was drawn to Lake Superior because mineral collecting for fine specimens on the Keweenaw was becoming an activity of the past. With the closing of many old mines and the crushing of rock piles, it was becoming exceedingly difficult to obtain high-quality specimens. I was spending countless hours sifting through old geology maps of the Keweenaw and studying the copper-bearing series along its length when one day it struck me—why not follow the fissure veins into Lake Superior and see where they cross the offshore shallow reefs? So in the summer of 1991, I concentrated my efforts on a large reef between the old seaports of Eagle River and Eagle Harbor and realized within a short period of time it was well worth the effort.

During July of 1991, I discovered the largest piece of fissure vein copper, 30 ft offshore of Great Sand Bay just northeast of Eagle River, Michigan. It measures 19 ft long, 8 ft wide, and weighs approximately 17 tons. Salvage permits had to be obtained from the Michigan Department of Natural Resources and the U.S. Army Corps of Engineers before the recovery project could begin. We had two nylon straps specially made to support the copper and to prevent damage to the natural color during the lift. A single 20-ton hydraulic jack was used to lift the copper high enough to slide the straps underneath. Then the U.S. Army Corps of Engineers' barge and crane were used to lift the boulder from where it had been resting for thousands of years.

The state-owned boulder now resides in the historic Quincy mine 1894 hoist house just north of Hancock, Michigan, and will be curated by the A. E. Seaman Mineral Museum. It is the largest piece of natural native metal ever recovered from a body of water and resides on probably the largest hydraulic mineral display stand in the world! Hopefully, its final destination will be in the main foyer of the new museum to be located in the blacksmith and machine shops of the Quincy mine complex, which is slated to break ground in 2005.

**Hematite collecting in the Iron Hill district, southwestern Robledo Mountains,
Doña Ana County, New Mexico**

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(Location 7 on the index map)

The Iron Hill district is located on the west flank of the low hills in the southwestern Robledo Mountains in Dona Ana County. The district is approximately 3 mi southwest of Robledo Mountain, and is in the NW 1/4 sec. 16 T22S R1W. The latitude and longitude of the center of the district is 32° 23' 51"N, 106° 57' 00"W. Adits and prospect pits of the Iron Hill district are readily visible on the Leasburg, New Mexico quadrangle.

The district is not directly accessible by any roads or trails. It is best reached by taking Interstate 10 to Road C 9 and a dirt road that exits Road C 9 to the north, which parallels the north-south trend of the Robledo Mountains. The mines are approximately 2 mi east of the dirt road. A hike over relatively flat ground with arroyos is required to get to the mines.

The geology of the district was summarized by Dunham (1935). Hematite is present in dark-red botryoidal masses with radiating fibers and minor quartz and gypsum. Many of the botryoidal masses are aggregates of rough spheres of hematite that have grown together and often resemble bunches of small grapes. The rough spheres range in size from less than a millimeter to a few centimeters. The botryoidal character is similar to that of manganese oxide deposits near Socorro and Deming, but no significant manganese mineralization is apparent in the Iron Hill district.

The hematite bodies replace sections of Pennsylvanian limestone of the Magdalena series, which dip to the southeast approximately 20°. The orebodies are lenticular and appear to be related to fissure zones that cut across the bedding of the limestone in various directions. Sixteen bodies of hematite have been opened up, and many other outcrops have not been explored. The dimension of the bodies varies, from small masses to large bodies as much as 200 ft long, 120 ft wide, and of unknown vertical extent. Dunham indicated that a moderate resource of iron was available, but the remoteness of the deposits and their distance to markets made them uneconomic to mine.

The deposits are reported to be mineralogically similar to the hematite deposits of West Cumberland and the Forest of Dean, England, which are known for "kidney ore" hematite. Like these deposits in England, the Iron Hill district formed in Carboniferous limestones that were formerly overlain by a great thickness of "red bed" deposits. The red beds may have provided hematite cement that leached and subsequently precipitated into the underlying limestones.

Fourteen short tunnels are reported in the hills, and there are many shallow shafts. The dumps are loaded with excellent specimens of botryoidal hematite, and collecting is easy once you get to the mines. The mines are easily spotted on the hillsides because the dumps are a distinct dark red against the outcrops of light-gray limestone.

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Red garnets from Lake Jaco, Mexico, and the chemical controls of color in garnet

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A recent find of garnets from the famous grossular garnet locality near Lake Jaco, on the Chihuahua—Coahuila border is unique for the bright red color exhibited by the specimens. The geology of the area and petrology of the rock types involved are not exceptionally unique for skarn-type garnets of the grossular-andradite (grandite) series. These garnets typically exhibit colors ranging from pure white (grossular) to dark brown (andradite). Most grandite garnets are typically greenish in color and intermediate in composition. Some of the andradite garnets are black (a variety known as melanite) when they contain significant amounts of titanium. Red colors are typically observed in pyrope-almandine-spessartine (pyralspite) series garnets and until now, never observed in the grandite series. Pyralspite series garnets are never observed in skarn environments.

A detailed geochemical study of the garnets was undertaken to determine the cause of the red coloration using petrography and electron microprobe microanalysis. The cores of the garnets are typically black and contain elevated concentrations of titanium (as much as 4.5 wt %) consistent with the andradite (Ad_{15-20}) variety of melanite. The immediate layer adjacent to the black core is white grossular. Minor variations in calcium and iron indicate increasing amounts of andradite component outward from the core. The red coloration in the Lake Jaco garnets is due to elevated concentrations of manganese from 1.0 to 1.7 wt % ($Sp_{1.6-3.7}$) in the latest stage of garnet growth with a distinct change toward more grossular-rich compositions. Geiger et al., 1999, determined the red coloration in these garnets is due to the presence of Mn^{3+} in the octahedrally coordinated silicate site using spectroscopic analysis. They postulate that the color is derived from a similar mechanism that causes the red color in the mineral piemontite of the epidote group.

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Digital photography of minerals

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Although conventional 35 mm film cameras have a resolution of more than 2 orders of magnitude greater than today's consumer digital cameras (1 billion pixels versus about 1-7 million pixels or picture elements), the difference in the pictures produced by each is increasingly difficult for the human eye to distinguish, especially those produced by digital cameras with a resolution greater than 2 million pixels. Moreover, digital cameras have a number of significant advantages over 35 mm film photography. They are becoming better, more affordable, and easier to use, with results that are immediately viewable, and there are no film or processing costs. Perhaps more important and exciting is what you can do with digitally stored pictures that you cannot readily do with conventional film. Collectors can create an electronic catalog of their collections complete with pictures of specimens, share their collection with others on the web, transmit images via e-mail to potential trading partners, and buy or sell specimens via on-line auctions.

The purpose of this presentation is to give a brief overview of digital photography, discuss its advantages over conventional film mineral photography, review the equipment needed (camera, computer, printer, light source, microscope adapters, and other useful accessories) as well as the image editing software needed to transform an average or good picture into an even better one.

Techniques for both macro and micro digital photography will be discussed. The latter can be a problem because conventional "point and shoot" digital cameras are not designed for microphotography and require special adapters between the camera and microscope optics. Such adapters are not readily available commercially, but they can be easily and inexpensively built from PVC plumbing parts that are generally available at most hardware stores. Whereas the images produced by such homemade contraptions may not be as good as those produced by specialized equipment for professional magazines, they are nevertheless affordable to many collectors and are quite acceptable for the applications for which they are used.

Throughout this presentation I will emphasize simplicity and cost containment—making digital photography of minerals affordable to as many mineral collectors as possible.