

Abstracts

New Mexico Mineral Symposium

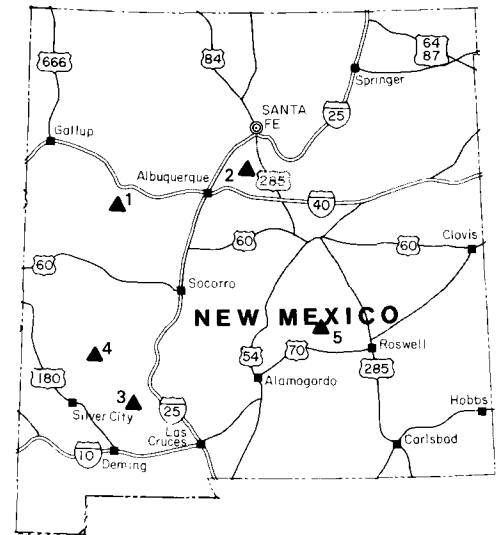
The Tenth Annual New Mexico Mineral Symposium was held November 11–12, 1989, at New Mexico Institute of Mining and Technology, Socorro. Following are abstracts from talks given at the symposium that concern New Mexico. The numbers in parentheses refer to locations on the map.

MINERALS AND ROCK FORMS IN LAVA TUBES OF EL MALPAIS NATIONAL MONUMENT, CIBOLA COUNTY, NEW MEXICO, by *Kent Carlton*, El Malpais National Monument, Grants, NM 87020, and *Christopher G. McKee*, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801 (1)

El Malpais National Monument was established recently by Congress. One of the outstanding features of the monument is its lava-tube systems. The concentration of tubes is so high here that Hatheway and Herring (1970) chose El Malpais as a terrestrial analog to what are believed to be similar structures called "rills" that occur on the moon. The El Malpais tubes are also significant because of the length of many of the systems. For example, one tube system within the monument is reported to be 17.9 mi (28.6 km) long by Elston and Wohletz (1987). Such a considerable length is not believed to be typical of lava tubes in other locales. Further, the intact (cave) portions of El Malpais lava tubes are often noteworthy relative to tube lengths observed elsewhere. Four lava caves within the monument exceed one kilometer in length and one is two kilometers. Finally, the size of many of the El Malpais tubes appears to be uncommonly large. Tubes that exceed 50 ft in height and 60 ft in width are not uncommon. Kent Carlton collected cave minerals during a 1988 lava-tube inventory and submitted them to New Mexico Institute of Mining and Technology for identification. Chris McKee analyzed the samples by x-ray diffraction. The samples contain quartz, feldspar, calcite, thenardite, gypsum, trona, and burkeite.

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- MINERALS OF THE CARNAHAN MINE, SANTA FE COUNTY, NEW MEXICO, by *Ramon S. DeMark* and *Judith L. DeMark*, 6509 Dodd Place, NE, Albuquerque, NM 87110 (2)
- The Carnahan mine, located in the San Pedro Mountains (New Placers district) of Santa Fe County, New Mexico, has not been a major ore producer. Nonetheless, it has had a long, but intermittent, record of production of lead-silver, zinc, and manganese ores. Since 1968, the mine has been owned by the San Pedro Mining Corporation (Patrick Freeman, personal communication 1989). The mine workings consist predominantly of an inclined tunnel (5–20°) trending N75°E to N90°E with minor drifts and some stoping. Near the end



of this tunnel another north-trending inclined tunnel proceeds approximately 500 ft before intercepting the water table. The geology and mineralogy of the Carnahan mine was looked at most extensively in 1903 (Yung and McCaffery). More recent studies have, in most cases, cited the mineralogical findings of Yung and McCaffery in reporting occurrences of specific minerals. Northrop (1959), crediting Dale Carson, cited a number of oxidized minerals including anglesite, cerussite, botryoidal hematite, limonite, possibly minium, pyrolusite, and native silver. Since 1985, however, a number of new species have been identified from the Carnahan mine, species that were either overlooked by earlier investigators or possibly misidentified. With the help of microprobe (Paul Hlava, personal communications 1989) and x-ray diffraction/SEM (Peter Modreski, personal communications 1989) analyses, 20 species new to the Carnahan mine have been confirmed. Two of the species (adamite and hetaerolite) are the first reported occurrences of these minerals in New Mexico. The new minerals are all secondary minerals resulting from the oxidation of primary iron, copper, zinc, and manganese sulphides. They include one native element (copper), oxides, carbonates, sulfates, arsenates, a molybdate (wulfenite), and silicates. Although galena and pyrite have been found in the oxidized zone, the predominant occurrence of primary sulphides is reputed by Atkinson (1961) to occur below the ground-water level approximately 400 ft below the surface. Most of the secondary copper minerals were found in a very restricted zone substantially down the tunnel. The arsenates, adamite, and agardite-(Y) were found in association with cuprite octahedrons that were partially or completely altered to rosasite, malachite, and chrysocolla. Native copper commonly occurs in the cores of the less altered cuprite octahedrons. Adamite most often occurs as transparent green spheres, but crystal morphology is evident on some of the balls. This adamite is cuprian, which accounts for the green color. Some individual colorless crystals to 0.5 mm are very low in copper content (Hlava, personal communication 1989). None of the Carnahan mine adamite is fluorescent. Aurichalcite and azurite, although scarce, were also found in association. Agardite-(Y) occurs in very fine acicular sprays and tufts. Linarite occurs as sky-blue, bladed crystals about 0.1 mm long and also as fine sprays of crystals about 0.3 mm across. They are found in association with pyrite, galena, and green spheres that appear to be a mixture of malachite and brochantite (Hlava, personal communication 1989). The pyrite in some cases is

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coated with a dark-purple to black layer of drusy covellite that is argentiferous. Gibbsite, opal (hyaline), and allophane are also found in the same area. Gibbsite occurs as white spheres and irregular masses often coated with hyaline opal while the allophane is in blue, transparent to opaque bands. Wulfenite is surprisingly sparse. It was only found in a very restricted horizon near the end of the main tunnel in association with cerussite. The uncommon zinc manganese oxide, hetaerolite, is found in many areas throughout the mine, often in fine splendiant tetragonal dipyramids about 1 mm in size. Chalcophanite, cerussite, and hemimorphite are ubiquitous throughout the mine. The habit and forms of chalcophanite at the Carnahan mine are varied. It may be in lustrous black, brown, or red pseudo-hexagonal crystals that resemble hematite or goethite or more commonly as reniform, botryoidal, vermiform, or stalagmitic masses. Plattnerite is restricted in occurrence (one site) and was found on reniform chalcophanite in lustrous, black, prismatic crystals. A manganous variety of smithsonite has been identified in association with secondary copper minerals. It has a dark-brown color and glassy luster on cleavages. The crystals have the typical rice-grain habit. Calcite is common throughout the mine and may be in paper-spath crystals or in transparent colorless rhombs, or in prisms. Botryoidal and cave-type forms are also found. As mineral investigations are continued, additional species are expected to be added to the current list. ACCESS TO THE CARNAHAN MINE IS STRICTLY PROHIBITED AND ILLEGAL WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE SAN PEDRO MINING CORPORATION, P.O. BOX 1670, TRUTH OR CONSEQUENCES, NEW MEXICO 87901.

TABLE 1—Minerals of the Carnahan mine. *, reported for first time; +, reported but not observed by authors.

NATIVE ELEMENTS

- + Silver, Ag
- * Copper, Cu

SULFIDES

- + Acanthite, Ag₂S
- + Alabandite, MnS
- + Chalcopyrite, CuFeS₂
- * Covellite, CuS
- Galena, PbS
- + Marcasite, FeS₂
- Pyrite, FeS₂
- + Sphalerite, (Zn,Fe)S

OXIDES

- * Chalcophanite, (Zn,Fe⁺²,Mn⁺²)Mn₃⁺⁴O₇·3H₂O
- * Coronadite, Pb(Mn⁺⁴,Mn⁺²)₈O₁₆
- * Cuprite, Cu₂O
- * Gibbsite, Al(OH)₃
- + Hematite, Fe₂O₃
- * Hetaerolite, ZnMn₂⁺³O₄
- + Minium(?), Pb₂⁺²Pb⁺⁴O₄
- * Plattnerite, PbO₂
- + Pyrolusite, MnO₂

CARBONATES

- * Aurichalcite, (Zn,Cu)₅(CO₃)₂(OH)₆
- * Azurite, Cu₃(CO₃)₂(OH)₂
- Calcite, CaCO₃
- Cerussite, PbCO₃
- * Malachite, Cu₂(CO₃)(OH)₂
- * Rosasite, (Cu,Zn)₂(CO₃)(OH)₂
- + Siderite, Fe⁺²CO₃
- Smithsonite, ZnCO₃

SULFATES

- Anglesite, PbSO₄
- * Brochantite(?), Cu₄(SO₄)(OH)₆
- * Linarite, PbCu(SO₄)(OH)₂

ARSENATES

- * Adamite, Zn₂(AsO₄)(OH)
- * Agardite-(Y), (Y,Ca)Cu₆(AsO₄)₃(OH)₆·3H₂O

MOLYBDATES

- * Wulfenite, PbMoO₄

SILICATES

- * Allophane, Hyd. Aluminum Silicate
- * Chrysocolla, (Cu,Al)₂H₂Si₂O₅(OH)₄·nH₂O
- Hemimorphite, Zn₄Si₂O₇(OH)₂·H₂O
- Koolinite, Al₂Si₂O₅(OH)₄
- * Opal (hyaline), SiO₂·nH₂O
- Quartz, SiO₂

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MICROMINERALS FROM THE FOUR-CORNERS STATES, by Patrick E. Haynes, P.O. Box 1531, Cortez, CO 81321

microphotography by Arnold Hampson, 1003 N. Dolores Road, Cortez, CO 81321

This visual presentation shows some microminerals from Colorado, Utah, Arizona, and New Mexico, collectively known as the four-corners states. The specimens shown will be limited to those collected personally from about 30 localities.

LAKE VALLEY'S FAMED BRIDAL CHAMBER—A BEAUTIFULLY LARGE AND SOLID-LOOKING STREAK, by Robert W. Eveleth, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801 (3)

The famous vug known as the Bridal Chamber, discovered at Lake Valley during the early 1880's, is so well known that it has entered oral tradition and become part of New Mexico's folklore. Contrary to popular belief, the bonanza deposits did not lead to long-term profits. The Sierra Grande Company of Lake Valley in fact had its hands full contending with sudden wealth, sudden fame, and sudden failure.

MINERALS OF THE BLACK RANGE AND VICINITY, SOUTHWEST NEW MEXICO, by Allen V. Heyl, U.S. Geological Survey, Denver, CO 80225 (4)

Many mines and mineral localities are along the Rio Grande trench in south-central and southwestern New Mexico. Many of the best localities are along the Black Range, particularly south of Alamosa Creek. (The well-known tin deposits on the west side of the range are not discussed here because many recent papers have described them.) The best-known mineral locality is the Iron Mountain deposit in the Sierra Cuchillo, east of the main Black Range, about 2 mi east of the junction of the road to Dusty and NM-52. Many minerals have been reported in the iron manganese skarn at Iron Mountain, including helvite, danalite, fluorescent

fluorite, and fluorescent molybdenum-bearing sheelite (Richard Jahns and J. J. Glass, U.S. Geological Survey, Bulletin 945). Manganous calcite that fluoresces red and hypogene pale-yellow granular willemite that fluoresces bright yellow-green (similar to that at Franklin, N.J.) are also common in the main tunnel workings and at the adjacent large ore bin. Both minerals are intergrown with banded andradite garnet, magnetite, and inconspicuous danalite. Nonfluorescent supergene grayish-pink transparent willemite crystals occur in vugs. The helvite occurs in yellow-brown tetrahedrons; the danalite, where present as euhedral crystals, has a similar habit but is pale brown to pink. South of NM-52, 1.2 miles into the Black Range, a mine road leads southward to the Great Republic mine in a branch of Poverty Creek, where large open pits expose gold-quartz veins. The veins contain beautiful coarse amethyst crystals that are suitable for slabbing, bands of silver-copper minerals, sparse grains of gold, and pale-green chlorargyrite. A rocky point of andesite, adjacent to the north side of the Winston-Chise road, 7 mi south of Winston, contains crystals of heulandite, stilbite, and uncommon natrolite. Along the same road 6.1 miles south of Winston, Cuchillo Negro Creek is joined by a valley from the south that becomes Coyote Canyon. South 1.1 miles, on a 4-wheel-drive road up the canyon, along the northwest side of the road, are outcrops of semiprecious white opal. West of Chloride, about 14 miles up Chloride Creek on a 4-wheel-drive road, are the dumps of the Silver Monument mine. The dumps contain beautifully colored massive bornite and much nearly microscopic native silver. South of NM-152, 2.5 mi east of Hillsboro, a passable road extends down Ready Pay Gulch to the east end of Percha Creek Box. Here old vanadium mines have well-formed pale-yellow crystals of endliche (arsenian vanadinite), orange vanadinite, wulfenite, and yellow-brown descloizite. Far to the south of the Black Range, 2.3 mi due south of Deming and 10 mi south on NM-517, are the old silver-lead mines of the Mahoney mining area that are at the foot of the northwest corner of the Tres Hermanas Mountains. These mines and their dumps have well-formed supergene crystals of willemite and smithsonite, masses of cerussite, pale-green fornacite (Pb,Cu)₃(Cr,As)₂(OH), wollastonite, hyrozinicite, malachite, and hemimorphite.

SILVER DISTRIBUTION IN ORE MINERALS OF NEW MEXICO, by Peter J. Modreski, U.S. Geological Survey, Box 25046, Federal Center, MS 905, Denver, CO 80225

The precious metal, silver, may occur in a variety of mineralogical forms within base metal, gold, or silver ores, including: native silver; silver sulfide (argentite/acanthite); silver halides (chlorargyrite/bromargyrite); alloyed with gold (electrum); gold-silver tellurides; silver sulfosalts (proustite, polybasite, etc.); substituting in other sulfosalts (tetrahedrite, etc.); substituting in galena; substituting in other sulfide minerals; in supergene minerals (Mn-oxides, jarosite, other sulfates, and carbonates). Of the primary (hypogene) silver-bearing minerals, aside from those sulfosalts that contain essential silver (proustite-pyrrargyrite, pearceite-polybasite, stephanite, matildite, miargyrite, etc.), a major host for silver is the tennantite-tetrahedrite-freibergite series. This solid-solution series of isometric "gray copper ores" can be characterized by the general formula (Cu,Fe,Ag)₁₂(As,Sb)₄S₁₃, or more accurately as (Cu,Ag)₁₀(Fe,Zn,Cd,Hg,Cu)₂(As,Sb,Bi)₄S₁₃. A complete series extends from tennantite, ideally Cu₁₀(Fe,Zn)₂As₄S₁₃, to tetrahedrite, Cu₁₀(Fe,Zn)₂Sb₄S₁₃. From this binary series, solid solution extends part way to freibergite, (Ag,Cu)₁₀(Fe,Zn)₂(Sb,As)₄S₁₃, and to the recently (1988) de-

scribed argentotennantite, $(\text{Ag,Cu})_{10}(\text{Zn,Fe})_2(\text{As,Sb})_4\text{S}_{13}$. Silver-bearing members are more common in the tetrahedrite (Sb-rich) members of the group. True freibergites are rare; silver contents in tetrahedrites commonly range from <0.1 to approximately 15–20 wt % Ag (equivalent to approximately 25–35 mole % freibergite). Silver enters galena through a coupled substitution with either bismuth or antimony: $\text{Ag} + \text{Bi} = 2 \text{Pb}$ or $\text{Ag} + \text{Sb} = 2 \text{Pb}$. Thus, in the absence of these semi-metals, synthesis experiments have produced not more than about 0.4 wt % Ag in galena. Galenas containing Bi or Sb, however, can contain as much as 10 wt % Ag. Low-silver galena (less than a few percent Ag) may be homogenous, but high-silver galenas (>5% Ag) usually contain exsolved silver-bearing sulfosalts, such as tetrahedrite or matildite. Estimates of the average or typical concentration of silver in galena worldwide are on the order of 0.1 wt % Ag (= 1000 ppm, = 29.16 oz/ton of galena), but this may range from <0.005% to 1% or more in different types of ore deposits. Silver contents in other sulfide and sulfosalt minerals worldwide, reported in the literature plus some analyzed by the author via KEVEX semi-quantitative energy-dispersive x-ray spectrometry, fall into the following (all highly variable) ranges:

chalcopyrite	<1–20,000 ppm	(median = 55–300, mean = 90–550)
sphalerite	<1–8,000 ppm	(median = 55–110, mean = 110–535)
enargite	<100–6,000 ppm	
bornite	80–4,000 ppm	
pyrrhotite	10–1,600 ppm	(median = <10–15, mean = 15–25)
arsenopyrite	100 ppm	
pyrite	<10–300 ppm	(median = <10–30, mean = 15–70)
marcasite	2 ppm	

The higher values reported for some of these minerals probably represent bulk admixture of native silver or other silver-rich minerals. Few accurate analytical data exist for tetrahedrite–tennantites from New Mexico. Galenas from the Hansonburg and other districts of lead–zinc–barite–fluorite replacement deposits are quite low in silver (<0.01 to 0.02 wt % Ag), a feature they have in common with the Mississippi Valley-type ore deposits they resemble. Some galena from other deposits in the state, probably higher temperature and more closely igneous-related ore deposits, shows higher silver values (one sample from the Groundhog mine, Grant County, contains 0.20 wt % Ag); Northrop (1959) quoted eight analyses of galena, ranging from 0.02 to 0.17 wt % Ag. A specimen of coarsely bladed enargite (Denver Mus. Nat. Hist. #2334) from New Mexico, locality unknown, contains 0.03 wt % Ag. Analyses by Burnham (1959) showed a range from 1 to 20,000 ppm Ag in chalcopyrite from New Mexico mines (median = 65 ppm; $n = 36$), and 2 to 1000 ppm Ag in sphalerite (median = 50 ppm; $n = 42$). Additional new analyses of chalcopyrite by the author show 0.005 to 0.05 wt % Ag (Bonney mine, Lordsburg district); 0.04 to 0.06 wt % Ag (Jones Hill Precambrian massive sulfide deposit, Santa Fe County); 0.08 to 0.12 wt % Ag (San Pedro mine, Santa Fe County); and 0.10 to 0.50 wt % Ag (Groundhog mine). New analyses of sphalerite show <0.01 wt % Ag in sphalerite from the Groundhog mine and the Blanchard mine; 0.02 wt % Ag (Pinos Altos); 0.02 wt % Ag (Mason Tunnel, Hanover district, Grant County); and 0.02 to 0.05 wt % Ag (Waldo mine, Magdalena district). Analysis of massive bornite from Pinos Altos shows 0.35 to 0.50 wt % Ag. Analysis of massive arsenopyrite from Jones Hill shows <0.01 wt % Ag.

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RARE-EARTH MINERALS OF NEW MEXICO, by Virginia T. McLemore, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801

The rare-earth elements (REE) include a group of 15 chemically similar elements called the lanthanide group (La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu). Yttrium (Y) is included in this group because it has chemical properties similar to the REE and it typically occurs with them. REE are found in more than 100 minerals, but significant concentrations are rare. Five types and examples of REE deposits recognized in New Mexico are: 1) veins and breccias (Laughlin Peak, Colfax County), 2) pegmatites (Harding Pegmatite, Taos County), 3) carbonatites and alkalic rocks (Lemitar Mountains, Socorro County), 4) Cretaceous heavy-mineral, beach-placer deposits (Sanostee, San Juan County), and 5) Recent stream-placer deposits. REE minerals also are found in numerous other types of deposits and host rocks but not in economic concentrations. Economically, the most significant deposits in the state are found in veins and breccias; however, REE-bearing minerals can be found in any of the deposit types. The only production of REE from New Mexico, although not significant, has come from pegmatites and from the Gallinas Mountains, Lincoln County. However, Molycorp, Inc. recently announced it will develop the Pajarito Mountain deposit, Otero County, and mine eudialyte for Y and Zr; eudialyte occurs in Precambrian syenite. Other favorable areas for development include Laughlin Peak, Colfax County, and the Gallinas Mountains, Lincoln County, both vein and breccia deposits. Some of the REE minerals form attractive specimens and

are collected by mineral collectors. Point of Rocks Mesa, Colfax County, although not an REE deposit, has yielded micromounts of eudialyte, mosandrite, steenstrupine, and tundrite. No doubt other REE-bearing minerals will be collected from this locality. Bastnaesite from the Gallinas Mountains, Lincoln County, is well known to collectors. Many of the pegmatites in New Mexico have yielded REE minerals such as betafite, zircon (cyrtolite), euxenite, xenotime, and others. Zircon, monazite, and garnet are common in Recent stream-placer deposits. A list, complete for New Mexico, of REE minerals and minerals that may contain REE as impurities are: (*species reported new to New Mexico since Northrop, 1959)

aeschynite, $(\text{Ce,Ca,Nd,Y,Fe,Th})(\text{Ti,Nb})_2(\text{O,OH})_6$

*agardite, $(\text{Y,Ca})\text{Cu}_4(\text{AsO}_4)_3(\text{OH})_6 \cdot 3\text{H}_2\text{O}$

allanite, $(\text{Ce,Ca,Y})_2(\text{Al,Fe}^{+3})_3(\text{SiO}_4)_3(\text{OH})$

apatite group, $\text{Ca}_5(\text{PO}_4)_3(\text{F,Cl,OH}) \pm \text{REE}$

bastnaesite, $(\text{Ce,Lu})(\text{CO}_3)\text{F} \pm \text{U,Th}$

betafite, $(\text{Ca,Na,U})_2(\text{Ti,Nb,Ta})_2\text{O}_6(\text{OH}) \pm \text{Fe,REE}$

brannerite, $(\text{U,Ca,Ce,Y})(\text{Ti,Fe})_2\text{O}_6$

*brockite, $(\text{Ca,Th,Ce})(\text{PO}_4)_2 \cdot \text{H}_2\text{O}$

*chernovite-(Y), YAsO_4

*chevkinite, $(\text{Ce,Ca,Th})_4(\text{Fe}^{+2},\text{Mg})_2(\text{Ti,Fe}^{+3})_3\text{Si}_4\text{O}_{22}$

*crandalite, $\text{CaAl}_3(\text{PO}_4)_2(\text{OH})_5 \cdot \text{H}_2\text{O}$

eudialyte, $\text{Na}_4(\text{Ca,Ce})_2(\text{Fe,Mn,Y})\text{ZrSi}_5\text{O}_{22}$

$(\text{OH,Cl})_2 \pm \text{REE}$

euxenite-(Y), $(\text{Y,Ca,Ce,U,Th})(\text{Nb,Ta,Ti})_2\text{O}_6$

fergusonite, $(\text{Y,La,Ce,Nd})(\text{Nb,Ta})\text{O}_4$

fluorite, $\text{CaF}_2 \pm \text{REE}$

gadolinite-(Y), $\text{Y}_2\text{Fe}^{+2}\text{Be}_2\text{Si}_2\text{O}_{10}$

garnet, $(\text{Ca,Fe}^{+2},\text{Mg,Mn}^{+2})_3(\text{Al,Cr}^{+3},\text{Fe}^{+3},\text{Mn}^{+3},\text{Si,Ti,V}^{+3},\text{Zr})(\text{SiO}_4)_3$

*gasparite, CeAsO_4

monazite, $(\text{Ce,La,Nd,Th})\text{PO}_4$

*mosandrite (rinkite), $(\text{Na,Ca,Ce})_2\text{Ti}(\text{SiO}_4)_2\text{F}$

samarskite-(Y), $(\text{Y,Ce,U,Fe})_3(\text{Nb,Ta,Ti})_5\text{O}_{16}$

*steenstrupine-(Ce), $\text{Na}_4\text{Ca}_2\text{Mn}^{+2}\text{Mn}^{+3}\text{Fe}^{+2}$

$(\text{Zr,Th})(\text{SO}_4)_2(\text{PO}_4)_7 \cdot 3\text{H}_2\text{O}$

*thorbastnaesite, $\text{Th}(\text{Ca,Ce})(\text{CO}_3)_2\text{F}_2 \cdot 3\text{H}_2\text{O}$

titanite, CaTiSiO_5

*tundrite-(Nd), $\text{Na}_3(\text{Nd,La})_4(\text{Ti,Nb})_2(\text{SiO}_4)_2$

$(\text{CO}_3)_3\text{O}_4(\text{OH}) \cdot 2\text{H}_2\text{O}$

uraninite, $\text{UO}_2 \pm \text{REE,Th,Y,Pb}$

*xenotime-(Y), YPO_4

yttrotantalite-(Y), $(\text{Fe}^{+2},\text{Y,U})(\text{Nb,Ta})\text{O}_4$

zircon (cyrtolite), ZrSiO_4

*zirkelite, $(\text{Ca,Th,Ce})\text{Zr}(\text{Ti,Nb})_2\text{O}_7$

MINERALOGY AND GEOCHEMISTRY OF VEINS IN THE CAPITAN MOUNTAINS, CENTRAL NEW MEXICO, by Randall S. Phillips, New Mexico Institute of Mining & Technology, Dept. of Geological Sciences, Socorro, NM 87801, Virginia T. McLemore, New Mexico Bureau of Mines & Mineral Resources, Socorro, NM 87801, and Marc A. Willis, Washington University, Dept. of Earth & Planetary Sciences, St. Louis, MO 63130 (5)

The Capitan Mountains, northeast of Capitan, Lincoln County, range in elevation from 5,800 to 10,200 ft. The Capitan Mountains are composed of an east–west-trending Tertiary (26.5 Ma, K/Ar-biotite; Allen, 1988) alaskite stock that intrudes the Permian Yeso and San Andres Formations. The alaskite stock, the largest Tertiary intrusive in New Mexico, is 23 mi long, 3.5–5.0 mi wide, and is aligned along the east–west-trending Capitan lineament (Chapin et al., 1978). The alaskite is cut by several faults and many small brecciated zones. The mineral deposits of the Capitan Mountains consist of five types: 1) quartz veins with rare-earth elements (REE); 2) thorium–uranium–REE quartz veins; 3) feldspar; 4) magnetite skarns near limestone–alaskite contacts; 5) manganese veins. Some iron and manganese were produced but exact production figures are unknown. Extensive

prospecting for radioactive ore deposits was conducted during the 1950's, which resulted in the discovery of a number of thorium and uranium anomalies. A thorium mill was constructed during the 1950's by the New Mexico Thorium Company, but no ore was ever processed. At present, only veins containing mineral specimens are being developed in the Capitan Mountains. The alaskite hosting the mineralized veins can be classified chemically as an alkali granite according to de la Roche et al. (1980). It exhibits the following chemical composition: SiO₂ 70–75%, TiO₂ 0.1–0.2%, Al₂O₃ 13–14%, Fe₂O₃ 1.5–1.9%, MgO 0.2–0.3%, CaO <0.5%, Na₂O <5%. The mineralized zones occur as fillings in brecciated veins and as joint or fracture fillings in the alaskite. The mineralogy of the quartz veins is of two types. The first type is quartz veins with REE, characteristic of the Mina Tiro Estrella (MTE) quartz prospect. The minerals consist of quartz, allanite, titanite, adularia, chlorite, and clay minerals. Quartz occurs as massive, somewhat transparent, vein-filling material; as clear, single crystals as large as 3 cm filling open spaces; as the famous, clear to smoky, Japanese Law twinned crystals, averaging 1–2 cm. Allanite, host mineral for REE, occurs as black tabular crystals as large as 3 cm, averaging 5 mm. Titanite crystals are reddish brown, wedge shaped, and range from less than 1 mm to 1 cm. Adularia is pink to white and commonly occurs as massive intergrowths with quartz. Chlorite has been observed as needle-like inclusions within single quartz crystals and as part of the clay gangue. Clay minerals are present within the vein material and may be related to the alteration of the feldspars. The second type is thorium-uranium-REE quartz veins, characteristic of most of the vein occurrences in the Capitan Mountains. The minerals consist of quartz, fluorite, adularia, hematite, calcite, titanite, magnetite, allanite(?), and thorite(?). Quartz ranges from smoky to clear and occurs as massive, vein-filling material and as euhedral crystals filling open spaces. Fluorite occurs as subhedral to euhedral, colorless to yellow to purple cubes, as long as 1 cm. Hematite occurs as cements and coatings on brecciated vein material. Adularia generally forms small, pink euhedral crystals. Calcite occurs as small veinlets in brecciated vein material. Most of the mineralized zones appear to be the result of cracking of the stock during cooling, followed by injection of the mineralizing fluids into fractures and brecciated zones. The unique feature of quartz from the Capitan Mountains is its abundance of fluid inclusions, from which we can tell a great deal about the mineralizing fluids. The quartz from the MTE quartz prospect is an excellent example. The inclusions, ranging from less than 1 micron to 40 microns long, consist of a multi-phase system composed of 5 to 20% vapor, 20 to 30% liquid, and 50 to 70% solids (daughter minerals). The daughter minerals consist of halite, sylvite, hematite, titanite, and possibly Ca-Fe-Mg chloride salts, anhydrite, barite, and other unidentifiable minerals. From optical microscopy and fluid-inclusion microthermometry of 80 inclusions, the MTE quartz vein possibly was derived from fluids that: 1) were of high temperature, vapor homogenization, and halite-dissolution temperatures averaging 550 to 600°C; 2) were of high salinity, to 72 eq. wt% NaCl; 3) were of high densities, approximately 1.3 to 1.5 g/cm³; 4) were complex, with the inclusion fluid containing between 6 to 15 daughter minerals; 5) were emplaced at pressures of 0.4 kbar and depths of 1.5 km; and 6) exhibited a single fluid population that showed a simple cooling trend. Stable isotope data from the inclusion fluid and quartz of the MTE vein has δD values from inclusion fluid of -56‰ to -58‰ and δ¹⁸O values from quartz of 8.6‰ to 8.9‰, corresponding to water values

of 7.6‰ to 7.9‰. Field relationships and petrographic and geochemical data suggest that the mineralizing fluids are of magmatic origin and were derived from the alaskite stock that hosts the MTE quartz vein. Future work will concentrate on other veins in the Capitan Mountains to determine their fluid origin.

References

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 Chapin, C. E., Chamberlin, R. M., Osburn, G. R., White, D. W., and Sanford, A. R., 1978, Exploration framework of the Socorro geothermal area, New Mexico: New Mexico Geological Society, Special Publication no. 7, pp. 114–129.
 de la Roche, H., Leterrier, J., Grandclaude, P., and Marchal, M., 1980, A classification of volcanic and plutonic rocks using R₁R₂-diagram and major-element analysis—its relationships with current nomenclature: Chemical Geology, v. 29, pp. 183–210. □

NOTICE—NEW DATE

Due to scheduling difficulties, the Eleventh Annual New Mexico Mineral Symposium will be held on November 10 and 11, 1990 instead of November 17 and 18 as previously advertised. The informal tailgating session will be held at the El Camino Motel on Friday, November 9. The coordinators of the symposium apologize for any inconvenience this change of date may cause and hope it will not interfere with plans for attendance. For more information on the symposium, call Marc Wilson, (505) 835-5246 or Judy Vaiza, (505) 835-5302.

NMBMMR Mineral Museum Notes

The New Mexico Bureau of Mines and Mineral Resources Mineral Museum is pleased to announce the recent acquisition of a fine collection of mineral specimens donated by Anita N. Martin in memory of her husband Andrew J. Martin. Andrew worked for the U.S. Bureau of Mines from 1924 through 1958 in Denver, Colorado, in the Tri-State district centered on Joplin, Missouri, and in Arlington, Virginia. His collection contains many superb display specimens of calcite, sphalerite, and galena from the Tri-State district as well as gold from Colorado and New Mexico, silver from Colorado, copper and silver from Michigan, and ore samples from many U.S. localities.

Other recent display acquisitions include a collection of 11 smithsonite samples from the Kelly mine, Magdalena, New Mexico; a superb linarite crystal, 3.3 cm tall, on a matrix of malachite pseudomorphs of linarite from the Blanchard claims, Bingham, New Mexico; and a sheet of native copper, 37 cm × 24 cm, encrusted with cuprite crystals to 1 cm, from the Chino mine, Santa Rita, New Mexico, donated by Ruth Andrews in memory of Tom Lottritz.

These and other newly acquired specimens are on display at the museum from 8 am to 5 pm on weekdays and on weekends and holidays by appointment with the Bureau's Mineralogist and Curator, Marc L. Wilson, (505) 835-5246.

