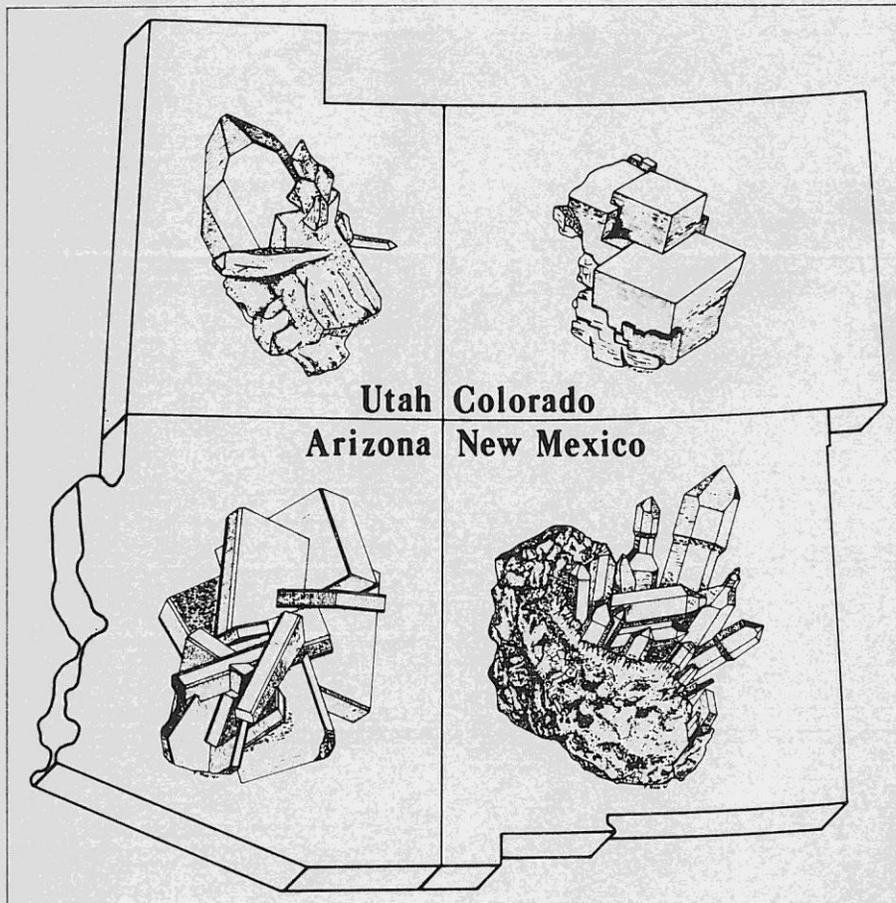




NEW MEXICO MINERAL SYMPOSIUM

November 14 & 15, 1987



NMIMT Campus, Socorro, New Mexico

Welcome to
THE EIGHTH ANNUAL
NEW MEXICO MINERAL SYMPOSIUM

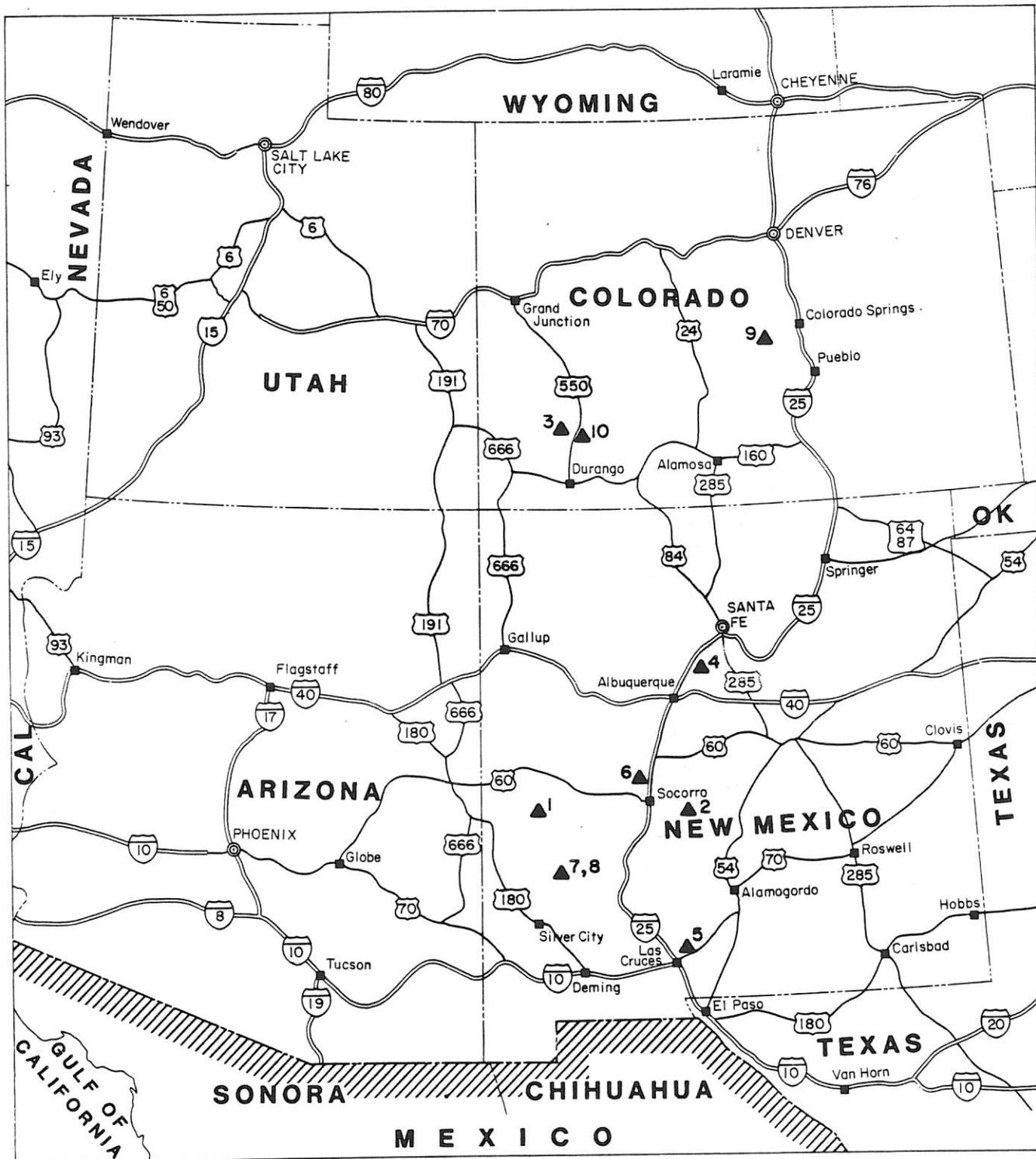
November 14 and 15, 1987

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
Los Alamos Geological Society
New Mexico Geological Society
New Mexico Tech Cooney Mining Club

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 Eighth 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.



Geographic Index Map

8th New Mexico Mineral Symposium

SCHEDULE

Numbers in parentheses refer to geographic location on index 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

9:00 Opening Remarks

9:10 (1) Magnesioferrite, hematite, and other minerals from Old Horse Springs, Catron County, New Mexico--Peter J. Modreski and James C. Ratte

9:45 (2) Mining development and minerals of the Hansonburg mining district, Socorro County, New Mexico--Ramon S. DeMark

10:20 Coffee break

10:45 (3) The story of the Liberty Bell mine, Telluride, Colorado--William R. Jones

11:30 (4) Geology and mineralogy of the San Pedro mine, Santa Fe County, New Mexico--Robert M. North

12:00 Lunch

1:30 (5) Tellurium minerals of the Organ district, Dona Ana, New Mexico--Virgil W. Lueth, Philip C. Goodell, Ramon Llavona, Heidi Mertig, William Sharp

2:00 Diamond mining in Arkansas--Albert L. Kidwell

2:40 Coffee break

3:00 Colorado fluorite--Barbara Muntyan

3:30 (6) Mineralogy of the Lemitar carbonatites, Socorro County, New Mexico: A petrographic, cathodoluminescence, and electron microprobe study--Virginia T. McLemore and Peter J. Modreski

5:00 Sarsaparilla and suds: cocktail party, upper lobby, Macey Center

6:00 Dinner, upper lobby, Macey Center, with keynote address, Copper throughout history, by Robert W. Jones and an auction to benefit the New Mexico Mineral Symposium

Sunday, November 15

- 9:00 (7) Minerals from the Squaw Creek tin mine, Taylor Creek mining district, Black Range, Catron County, New Mexico--Patrick E. Haynes
- 9:40 (8) Three new minerals from Squawcreek, stolzite from Nugget Gulch, and tilasite from Willow Springs Draw, Black Range tin district, New Mexico--Eugene E. Foord, Paul F. Hlava, Joan J. Fitzpatrick, and Charles H. Maxwell
- 10:15 Coffee break
- 10:45 (9) Iron phosphates of Cripple Creek, Colorado--Robert R. Cobban
- 11:15(10) Geology and mineralogy of the chimney ore deposits, Red Mountain mining district, Ouray and San Juan Counties, Colorado--Tom Rosemeyer
- 12:00 Lunch
- 1:15 pm Silent auction, sponsored by the New Mexico Tech Cooney
-3:00 Mining Club

**MAGNESIOFERRITE, HEMATITE, AND OTHER MINERALS FROM
OLD HORSE SPRINGS, CATRON COUNTY, NEW MEXICO**

(Location 1 on index map)

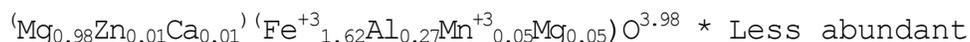
Peter J. Modreski and James C. Ratte U.S. Geological
Survey, Box 25046, MS 922 Denver Federal Center,
Denver, CO 80225

An unusual suite of ferric iron-bearing minerals occurs in xenoliths within a dacite pumice breccia. The 33-m.y.-old dacite pumice and ash flow, part of the Mogollon-Datil volcanic field, crops out along NM-12 approximately 1.5 mi (2.4 km) west of Old Horse Springs. The flow is as much as 200 m thick and crops out sporadically within a north-south belt up to 5 km wide and 20 km long.

Xenoliths of pre-Tertiary sedimentary rock and cognate(?) inclusions of coarse-grained quartz monzonite are concentrated in the upper part of the pumice breccia. The most common xenoliths are of limestone altered to a red, iron-rich jasperoid. These silicified nodules, from a few centimeters to as much as 0.3 m in size, consist of variable amounts of quartz, iron oxides, and calcite. Many xenoliths show concentric banding of layers rich in quartz and iron-oxide minerals; some are composed of nearly solid masses of iron oxides. Many xenoliths are surrounded by a skarn-like reaction zone a few centimeters thick composed largely of green diopside with or without andraditic garnet, phlogopite, and clay minerals. Other iron-bearing minerals occur in fractures in xenoliths of argillaceous or calcareous sandstone and in miarolitic vugs within quartz-monzonite inclusions.

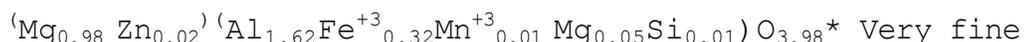
Hematite is the most obvious of the oxide minerals; it forms black, lustrous, platy crystals typically 1 mm or less in diameter. A variety of spinel-group minerals are present in the xenoliths. Magnesioferrite occurs as minute octahedral crystals about 0.5 to 200 μm in size, usually embedded in fibrous, spheroidal-textured chalcedonic quartz. Magnesioferrite, ideally $\text{MgFe}_2^{+3}\text{O}_4$, is transparent to translucent in thin section and

orange brown to blood red in color; the red color of most fine-grained jasperoid is due to magnesioferrite rather than hematite. The magnesioferrite is slightly zinc bearing, ranging from about 0.1 to 4.0 wt % ZnO; a typical formula (for magnesioferrite with 0.49% ZnO) is



* Less abundant is aluminous spinel, brownish-yellow in thin

section, containing several percent ZnO; a typical formula (for spinel with 1.0% ZnO) is



* Very fine grained (one to a few μm in size) zinc-rich spinels, detected only with the microprobe, have a complex composition

approaching franklinite. One analysis of a specimen containing 27.46% ZnO gives the formula



corresponding to end-member proportions of 51% franklinite, 21% gahnite, and 28% other components.

Diopside in the skarn rims is zoned, ranging from about 4 to 11% FeO. Green to brown andradite garnet, often in euhedral dodecahedra about 1 mm across, ranges in composition from about $\text{Andradite}_{90}\text{Grossular}_{8}$ to $\text{Andradite}_{63}\text{Grossular}_{34}$ with the balance in other components. Diopside also forms free-growing transparent yellow-green prisms a few tenths of a millimeter in length in cavities in metasedimentary and monzonite nodules. Commonly present in cavities with diopside is pseudobrookite $\text{Fe}_2^{+3}\text{TiO}_5$ small (about 0.2 mm long) prismatic to bladed crystals. X-ray diffraction and scanning electron microscopy

show that some pseudobrookite prisms are coated with an irregular layer of titanite. Forsteritic olivine occurs as inclusions in hematite crystals; it contains about 1.8 wt % total iron expressed as FeO. However, bright-red cathodoluminescence of this forsterite suggests that only ferric iron is present in it, leading to the formula $\text{Mg}_{2.09}\text{Fe}^{+3}_{0.04}\text{Si}_{0.93}$ the mineral shows a consistent excess of Mg and deficiency of Si.

Mineral assemblages in the jasperoid xenoliths are unusual

for their highly oxidized state--all iron in the oxide minerals appears to exist as Fe^{+3} --and the presence of zinc in the oxides. Bulk composition of the nodules ranges up to 10,000 ppm (1%) Zn, and anomalous amounts of Mn, Cu, V, Ni, and Pb are also present. A probable sequence of events for the nodules was 1) silicification of limestone beds to form iron- and zinc-bearing jasperoid; 2) stoping of silicified limestone blocks into the intruding dacite magma; 3) reaction of limestone xenoliths with the enclosing magma to form calc-silicate skarn rims--at least part of this reaction appears to have occurred after eruption because the skarn minerals surround the nodules as an undisturbed zone extending into the host dacite; 4) oxidation and recrystallization within the xenoliths to produce the present assemblage of hematite and zincian magnesioferrite, probably after eruption of the pumice breccia and contemporaneously with 3); and 5) retrograde (deuteric) development of phlogopite and montmorillonite in the skarn rims by reaction with water vapor in the cooling pumice flow.

**MINING DEVELOPMENT AND MINERALS
OF THE HANSONBURG MINING DISTRICT,
SOCORRO COUNTY, NEW MEXICO**

(Location 2 on index map)

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The Hansonburg mining district is located in southeastern Socorro County, New Mexico, is bounded on the west by the large desert valley known as the Jornada del Muerto, and includes the northern portion of the Oscura Mountains as an eastern boundary. Remote from population centers and isolated from development by lack of water and location on the northern extension of White Sands Missile Range, the Hansonburg mining district has gained notoriety primarily because of the occurrence of rare and attractive minerals.

The district was developed initially in 1901 from a copper mine. That was followed in 1916 by the development of lead mining in the northern Oscura Mountains. The original copper mine, located six miles east of the lead mine in the Jornada del Muerto, ceased production in 1917, and for the next six decades mining activity was focused on lead (with minor silver) and barite production. From a mining perspective these decades must be viewed as marginally successful at best.

In April 1987 the mineral-producing areas of the Hansonburg mining district entered a new era. The unpatented claims previously held by mining companies were abandoned, and control was assumed by a group of individuals whose primary motivation was the recovery of minerals as specimens.

Recent activity in the Blanchard mine has centered on the Sunshine #1 tunnel that had gained instant notoriety in 1980 for yielding world-class linarite crystals. Most recently, a pocket in this tunnel has produced two-inch lavender cubes of fluorite that rival the best that the Blanchard produced. Additionally, some specimens of the newly approved polymorph of PbO_2 , scrutinyite (J. Taggart, pers. comm.), have been found. The Sunshine #1 tunnel of the Blanchard mine is the type location for this mineral. Also of interest has been the confirmation of the mineral caledonite, which had been reported previously but not observed for longer than 30 years, and the recovery of large selenite crystals more than 40 cm in length.

A rare opportunity to visit the Hansonburg copper mine on October 2, 1987 was made possible by Jim Eckles, Public Affairs Officer for White Sands Missile Range. Specimens collected on this visit confirm that the primary ore mineral at this mine was tennantite as reported by Samuel G. Lasky (1932, The ore deposits of Socorro County, New Mexico: New Mexico Bureau of

Mines and Mineral Resources, Bulletin 8). More recent reports had refuted the occurrence of tennantite at the Hansonburg copper mine, but these determinations were made without the benefit of sample analysis. Secondary copper arsenates along with azurite were also found, and preliminary analysis (microprobe) indicates that olivenite and conichalcite are the predominant minerals.

The recent discovery of superb smoky quartz crystals with chrysocolla and lustrous bright-green microcrystals of antlerite has stimulated the search for new species and attractive specimens. The Blanchard mine has a long history of producing excellent mineral specimens. Today the mine is open to collectors on a fee basis for the surface areas (no underground collecting permitted) and in the foreseeable future the present owners intend that this rich collecting area will remain open for the enjoyment of all mineral collectors.

HANSONBURG MINING DISTRICT CHRONOLOGY

(Refer to Figures 1 and 2 following the table.)

- | | |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------|
| 1872 | First attracted attention of prospectors. Apparently discovered by Pat Higgins. Received name from old prospector Hanson. |
| 1885-1901 | Copper deposits were worked at frequent intervals. |
| 1901 | Hansonburg copper mine property developed by <u>Alcazar Copper Company</u> . One carload of ore shipped. |
| 1916 | <u>Western Mineral Products Company</u> takes over Hansonburg lead mine and erects a 50-ton dry mill on property to extract galena. |
| 1916-17 | Fifteen carloads of ore shipped from the Hansonburg copper mine. |
| 1917 | Several carloads of lead concentrates shipped from Hansonburg lead mine. |
| 1917-33 | Hansonburg district inactive. |
| 1938 | <u>Louis & Halstead</u> shipped a small, unknown amount of lead-silver ore. |
| 1939 | <u>Globe Mining Company</u> shipped nine tons of lead-silver ore. |
| 1943 | F. L. Blanchard of Roswell assumes ownership of six unpatented claims in area of Hansonburg lead mine. |
| 1947 | <u>Portales Mining Company</u> working the Hansonburg lead mine (Blanchard mine). |

Dec. 1947 Mex-Tex and Royal Flush Nos. 1 and 2 claims are located.

1948 Portales Mining Company builds a mill approximately one mile east of San Antonio and hauls ore to it by truck.

Feb. 1949 Royal Flush Nos. 3 and 4 added to other Royal Flush claims and sold to Ben B. Scott, who organizes the Scott Mineral Company. Ships two or three carloads of lead ore to El Paso smelter.

1949 Mex-Tex Mining Company of Artesia begins work on 30 claims north of the Hansonburg lead mine.

Late 1949 Royal Flush group is sold by Scott Mineral Company to Erwin & Bishop of Houston.

Early 1950 Erwin & Bishop purchase the Mex-Tex group and add it to their Royal Flush claims. Mex-Tex Mining Company name retained.

1950 Portales Mining Company processes and markets 14,377 tons of lead ore at San Antonio mill. Mex-Tex Mining Company constructs a 200-ton/day barite mill near San Antonio.

1952 Portales Mining Company and the Mex-Tex Company (from open pits) truck about 150 tons/day to their respective mills in San Antonio.

Hurlow Mining & Milling Company erects a mill on the northeast end of the district. Clarence Barrett from Portales operates surface workings above and south of Blanchard claims. Legal conflict with the Blanchards develops.

1954 Portales Mining Company mill in San Antonio burns down.

Nov. 1958 Sunshine Mining Company begins exploratory drilling, drifting, crosscutting, and raising in vicinity of Hansonburg lead mine.

July 1959 Atomic Mineral Corporation purchases the Mex-Tex property (Galber, Inc. of Carlsbad, operating). Company produces 812 tons of barite in 1959 and 1960.

June 1960 Sunshine Mining Company completes operations (six adits containing cross drifts, raises, and winzes). Linear footage excavated totaled approximately 2300 ft. No ore marketed.

Early 1960's Galber, Inc. mines and explores the Mex-Tex, Royal Flush, Mountain Canyon, and Malachite mines; several carloads of lead concentrate shipped by truck and rail to the ASARCO smelter in El Paso.

1960-66 Sporadic mining and exploration continues.

1968 Ora Blanchard passes away.

1972 Basic Earth Science Systems, Inc. conducts exploration, including core drilling, for several years.

1977 Hansonburg Mines, Inc. begins extensive exploration. Ore reserves estimated at one million tons containing an average of 6% galena, 20% barite, and about 10% fluorite.

1979 Hansonburg Mines, Inc. construct mill projected to handle 400 tons/day with recovery of silver, galena, barite, and fluorite.

1980 World-class linarite specimens recovered from Sunshine #1 tunnel of the Blanchard mine.

1983 Wayne Thompson and Delma Perry under contract from Western General Resources, Inc. mine Sunshine #1 tunnel for mineral specimens. Operation closed down by OSHA.

1984-85 Exploratory drilling of 1,000-ft holes conducted by Ozark-Mahoning Co.

Jan. 1987 Hansonburg district claims are abandoned and revert to public domain.

April 1987 Blanchard, Mex-Tex, and Royal Flush properties claimed by private individuals interested in the recovery of mineral specimens.

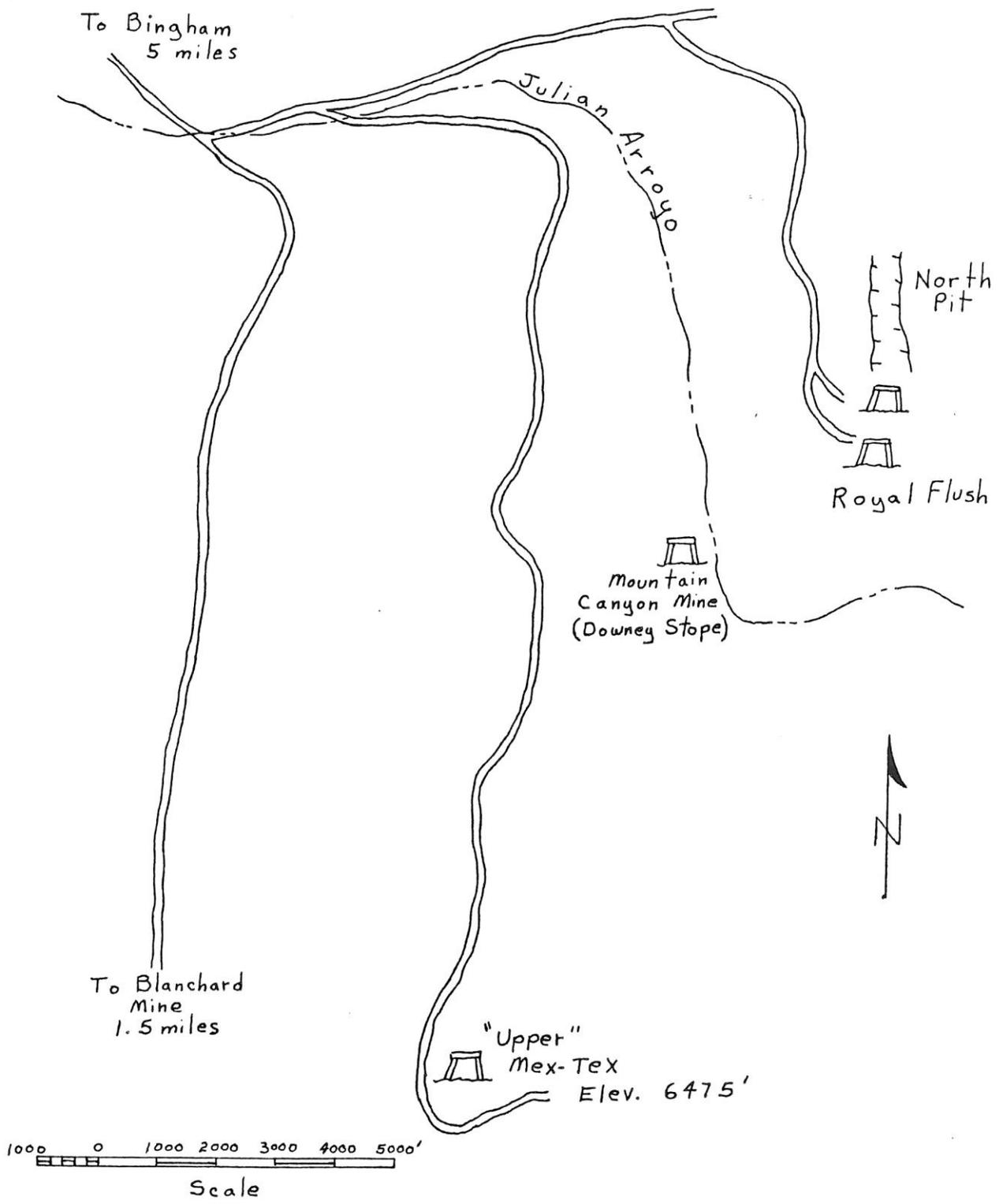


FIGURE 1

THE STORY OF THE LIBERTY BELL MINE, 1898-1921

(Location 3 on the index map)

William R. Jones, R.A.
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Silverton, CO 81433

During the period from 1890 to 1925 the San Juan Mountains of Colorado achieved world-wide recognition as a gold mining district. The story of three of these mines, the Campbird, the Tomboy, and the Smuggler-Union, is well known. The fourth of these major gold producers, the Liberty Bell mine of Telluride, is rarely mentioned today. Although its history lacks the fame of a Thomas Walsh and Hope Diamond or the English charm of the Tomboy, the Liberty Bell is the classic example of American innovation achieving success under difficult conditions.

The Liberty Bell mine was discovered in 1876 by William Cornett in the basin north of Telluride, Colorado that bears his name today. Some development occurred on the high outcrops when the property was acquired and consolidated by Arthur Winslow in 1897. Unlike most of the local mines, the company was formed and capital was raised in Kansas City, Missouri where Winslow had been state geologist. The company began production in December 1898. In 1899 a young mining engineer, Charles A. Chase from Georgetown, Colorado, joined the firm. Chase soon rose to be Superintendent and spent the next twenty years managing the property.

Production was increased from 50 tons per day with a 20-stamp mill to 400 tons per day and an 80-stamp mill. Because of the oxidized nature of the ore, the mill was the first in the San Juans to use new South African cyanide-process technology. A notable disaster occurred on February 28, 1902 when a snowslide destroyed the portal and tramhouse at the mine. Rescue teams sent up from Telluride were hit by a second slide at the mine, and yet a third ran down others on the trail. Sixteen people were killed. The company immediately devised a snowslide deflector to help in future winters and began a 3000-foot-long crosscut tunnel at a lower and safer elevation.

The mine was a pioneer of low-cost mining techniques using the latest technology. Though the grade of ore decreased in later years, profits stayed high as costs decreased. By the end of mining of the orebody more than 750,000 ounces of gold had been produced from 2.5 million tons of ore. More than \$16,000,000 had been invested in production, and more than \$3,000,000 in dividends had been paid to stockholders. Rather than waste assets looking for more ore that was unlikely to exist, the company was liquidated in 1923. All debts were paid and investors obtained many times their original capital in profits.

The story of the Liberty Bell mine is presented with more

than 130 original photographs of the operation taken by Charles A. Chase and others. The collection is being presented on slides through the courtesy of the C. H. Chase family of Tucson, Arizona. The program will also feature photos of other famous San Juan mines taken during the period 1902-1919.

GEOLOGY AND MINERALOGY OF THE SAN PEDRO MINE,
SANTA FE COUNTY, NEW MEXICO
(Location 4 on index map)

Robert M. North
New Mexico Bureau of Mines & Mineral Resources
Socorro, NM 87801

The San Pedro mine is located approximately 2.1 air miles southeast of the town of Golden, in the western San Pedro Mountains, New Placers district, Santa Fe County, New Mexico. The mine was discovered in 1840 and was operated intermittently until 1982. Although total production is unknown, published lode production for the New Placers district from 1904 to 1938 was 203,965 short tons of ore yielding 11,402.57 troy ounces of gold (0.056 oz/ton), 242,791 troy ounces of silver (1.19 oz/ton), and 9,773,773 pounds of copper (2.4%). Most of this production came from the San Pedro mine.

The ores of the San Pedro mine are contact metasomatic (skarn, tactite) deposits in the upper limestone beds of the Pennsylvanian Madera group. The dip of the Madera beds in the vicinity of the mine is about 15° to the east. The tabular orebodies are localized beneath a rhyolite sill, locally known as the Puzzle sill. Heat and accompanying mineralizing solutions probably emanated as a late stage from the underlying monzonite porphyry laccolith that forms the core of the western part of the San Pedro Mountains.

At least three stages of skarn formation are recognized. First, limestone was metamorphosed to andradite garnet with minor epidote. Reduction in volume during the alteration of limestone to garnet resulted in a vuggy, porous garnet bed. These pores were partially filled by a second mineralizing event consisting of chalcopyrite, bornite, pyrite, pyrrotite, calcite, specular hematite, quartz, and chlorite. The final mineralizing event filled the larger cavities with calcite, quartz, pyrite, chalcopyrite, scheelite, and adularia. Wire gold was deposited locally along the edges of these large vugs and has been recovered recently as beautifully contrasting specimens of gold in calcite.

Other minerals of interest to collectors include chalcopyrite, Japan-law twin quartz crystals, twinned scalenohedrons of calcite (rarely sixlings), and rarely amethyst, scheelite, native copper with cuprite, and pyrite pseudomorphs after calcite. Large chalcopyrite crystals (up to 3 inches on an edge) were collected for many years from the district. They are commonly coated with a dusting of malachite. Recently, limonite-coated Japan-law twins were collected that exhibit unusual scepter terminations. Gold in calcite and occasionally on garnet and pyrite were collected in 1984 by Wayne Holland of Albuquerque. These specimens came from a restricted zone of abundant calcite (possible an extremely vuggy area) discovered some time earlier by Ira Young.

**TELLURIUM MINERALS OF THE ORGAN DISTRICT,
DORA ANA COUNTY, NEW MEXICO**

(Location 5 on index map)

Virgil W. Lueth, Philip C. Goodell, Ramon Llavona,
Heidi Mertig, and William Sharp
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University of Texas at El Paso
El Paso, TX 79968

The Organ district has long been known to contain tellurium mineralization associated with base-metal sulfides. The tellurium minerals, occurring as carbonate replacements in favorable beds, are confined generally to areas in the district where galena is the primary ore mineral. The minerals occur as discrete, macroscopic grains and as inclusions in other sulfide minerals, usually galena or sphalerite. Interestingly, tellurium mineralization appears to be confined to areas above 6,000 ft elevation (except at the Memphis mine where tetradyomite is reported in the Roos workings). A short description of the individual minerals and their mode of occurrence in the district follows:

ALTAITE (PbTe)--a white-gray mineral that usually occurs as cleavage masses associated with black shale contacts and with tremolite where it is paragenetically earlier than the sulfides. Microscopic grains have been observed in galena and sphalerite and associated with pyrite. Common in the Hilltop mine, reportedly with native tellurium.

RICKARDITE (Cu₃Te₂)--occurs as a purple metallic mineral (similar to tarnished bornite) when observed macroscopically (rare) with pyrite and sphalerite. Reported at Hilltop mine and most common at the eastern-most of the Rickardite claims. Occurs occasionally as microscopic inclusions in sphalerite. It is recognized by its fire-orange reflections with crossed polars under reflected light.

TETRADYomite (Bi₂Te₂S)--fairly common with sphalerite and galena at the Memphis mine. Occurs as microscopic inclusions in galena and sphalerite at other deposits where it is galena-white and anisotropic under reflected light. It is the most widely distributed telluride in the district where it also occurs in veins along rhyolite dikes on the west slope of San Agustin Peak. Largest grains of the mineral occur in the Memphis mine as cleavage flakes or radiating masses.

Precious-metal mineralization occurs in the Little Buck workings associated with high-tellurium assays. A quartz-gold orebody is reported in the Hilltop mine. No precious-metal mineral phases have been recognized other than isolated occurrences of free gold. Precious-metal telluride systems are notable for their wide variety of telluride mineralogies. The

presence of gold and silver tellurides is suspected and attempts to document these minerals are underway. Tennantite was observed at the Little Buck (new occurrence for this mine) and is considered a potential precious-metal phase.

Tellurium mineralization is associated most commonly with silicified zones that resemble hot-spring deposits. Preliminary fluid-inclusion homogenization temperatures in this quartz fall between 230 and 240 degrees C. Sulfide zoning appears opposite that suggested by earlier workers in the district. The accepted zoning pattern is concentric (Cu-Zn-Pb) from the Organ batholith. The recent recognition of a porphyry copper deposit north of the town of Organ provides a better "center" or source of the mineralizing fluids and, correspondingly, zoning appears best reconciled in an opposite direction than previously postulated. The distribution of tellurium mineralization can also be used to define distal zoning along with proximal porphyry-skarn zoning. The origin of the tellurium and precious-metal hot-spring system may be: 1) part of the porphyry copper-skarn system, 2) superimposed on the porphyry-skarn system as a retrograde phase of that mineralization, or 3) a completely different mineralizing event.

DIAMOND MINING IN ARKANSAS

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The first diamonds were discovered near Murfreesboro, Pike County, Arkansas in 1906. Since then, there have been numerous attempts at commercial mining. All of these have been thwarted by a combination of factors: divided ownership, thievery, intense jealousy between owners, and possible interference from outside sources determined to block the successful exploitation of the diamonds.

The deposit was opened first as a tourist attraction in 1949 by one of the mine owners. It was acquired by the State of Arkansas in 1972 and since that time has been operated as Crater of Diamonds State Park. A nominal daily fee is charged, and finders are keepers of diamonds and other mineral and rock samples.

During the period 1972 to 1986, a total of 1,166,381 visitors found 10,719 diamonds, an average of one diamond for each 109 visitors. However, these figures are somewhat misleading because at least half of these diamonds were found by a few frequent visitors who have become very proficient. The only restrictions on collecting procedures, other than normal safety precautions, are that they involve no wheels or motors. Estimates of the total numbers of diamonds found since 1906 range as high as 400,000. One diamond-cutting firm in New York reportedly handled approximately 100,000 Arkansas diamonds over the years.

The largest and best-known diamond-bearing intrusive is the Prairie Creek pipe that crops out over approximately 73 acres, all within the state park. The diamondiferous rock is now called a lamproite breccia, in distinction to kimberlite breccia, and is similar to the rock type that is the source of the diamonds of western Australia. Famous diamonds from the deposit include the Uncle Sam (40.25 Ct), the Amarillo Starlight (16.37 Ct), the Star of Arkansas (15.33 Ct), and a magnificent, flawless, yellow crystal of 17.86 Ct now in the Roebling collection at the US National Museum.

Early in 1987 a bill was passed by the Arkansas State Legislature and signed by the governor authorizing a possible lease for commercial diamond mining within some part of the state park. Collecting by visitors to the park will continue, but possibly on a different basis.

COLORADO FLUORITE

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Fluorite occurs in a wide variety of geologic conditions throughout Colorado: in pegmatites, in hydrothermal veins, and in lead-silver deposits. It is found most often as simple cubes or octahedrons, sometimes growing to 10 cm on edge. Crystals of a lavender or purple color are the most common, but fluorite in Colorado also can be lemon yellow, light green, dark green, blue, colorless, or zoned purple-green or purple-lavender combinations.

In the pegmatites of the Pikes Peak granite, fluorite is found in association with amazonite, smokey quartz, albite, and goethite. Cubes to 10 cm have been reported, but more commonly grow to about 4 cm. In the huge molybdenum deposit at Climax, fluorite occurs as complex octahedrons of a green or bluish-green color, typically with purple zonations, in association with rhodochrosite, quartz, and pyrite. In the central part of the state, at Mt. Antero, fluorite forms large octahedrons of dark purple or green in association with aquamarine, mica, phenakite, and microcline. In the Cresson mine at Cripple Creek, lemon-yellow fluorite has been found. It is also found there as massive, earthy-textured, purple material. In Unaweep Canyon, Mesa County, at the Nancy Hanks mine, fluorite forms lime-green octahedrons consisting of plates with individual crystals approximately 10 mm across associated with amethyst. In the San Juan Mountains of southwestern Colorado, fluorite occurs in many locations as pale- to medium-green octahedrons in association with drusy quartz, rhodochrosite, and barite. Notable occurrences in this region include the Sunnyside mine at Silverton, the Ransom mine at Eureka, the Thistledown mine near Ouray, and the Gertrude and Grizzly Bear mines, also in Ouray County.

Fluorite also occurs at many other localities through Colorado, including the Bonanza mining district, where it forms lime-green octahedrons associated with rhodochrosite at the Eagle mine (not to be confused with the mine of the same name at Gilman), in the Northgate district, and in the Central City district. In these and other localities fluorite forms large well-formed single crystals and attractive clusters.

**MINERALOGY OF THE LEMITAR CARBONATITES
SOCORRO COUNTY, NEW MEXICO:
A PETROGRAPHIC, CATHODOLUMINESCENCE,
AND ELECTRON MICROPROBE STUDY**

(Location 6 on index map)

Virginia T. McLemore
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Carbonatites are unique carbonate-rich rocks of apparent magmatic origin that are characterized by a distinct but variable mineralogy, composition, and association alteration. In the Lemitar Mountains, central New Mexico, Paleozoic carbonatite dikes (minimum age 449 ± 16 m.y.) intrude Precambrian granites, diorite/gabbro, metamorphic rocks, and amphibolite dikes. They contain greater than 50% carbonate minerals (calcite, dolomite, and ankerite) and varying amounts of apatite, magnetite, biotite, and other accessory minerals.

Cathodoluminescence (CL) is the characteristic visible radiation (color) produced in a mineral subjected to a bombardment of electrons. Many features of a sample observed under CL are not seen using either standard optical petrographic techniques or using an electron microprobe; this is especially true of carbonatites. Luminescence as observed under a CL stage is manifested as different colors and intensities than are seen under the electron microprobe. This is a consequence of the different current densities of the electron bombardment, about 0.1 to 1 A/m for typical CI_1 -stage operation compared to 10^2 A/m² (10 μ m diameter beam) to 10^4 A/m² (1 μ m beam) on the microprobe. Thus quartz, which exhibits no CL, appears orange pink under the microprobe whereas normally red CL calcite appears to show only weak luminescence under the microprobe.

The Lemitar carbonatites exhibit bright-red CL, characteristic of carbonatites elsewhere in the world. The bright-red luminescence is due to compositional variations in fine-grained carbonate minerals. For example, calcites that luminesce red contain variable FeO and 1-2% MnO; non-luminescing dolomites contain variable FeO and 0.03-0.8% MnO. Color zonation in vein calcite under CL is related to variation in MnO from no detectable MnO in lighter orange CL calcite to 0.5% MnO in bright-red CL zones. Apatites luminesce blue to green-gray to gray in carbonatites and are typically zoned whereas apatites in unaltered country rock luminesce yellow. Electron microprobe studies reveal that bright-blue apatites are enriched in SrO (about 1.8% SrO) relative to gray luminescing apatites (about 0.4% SrO) and yellow luminescing apatites (no detectable SrO). Other elements (such as rare-earth elements) in addition to Sr may cause the difference in luminescence color of apatite when exposed to CL.

Cathodoluminescence and electron microprobe studies of opaque grains reveal complex intergrowths of magnetite, ilmenite, rutile, leucoxene, calcite, and quartz; zoning within the magnetite is evidenced by red CL of the inclusions. Additional minerals detected by the electron microprobe include Nb-bearing rutile, Nb-bearing titanite, chalcopyrite, and pyrite or pyrrhotite. Cathodoluminescence reveals zoning of fluorite that is not seen with the normal petrographic microscope.

**MINERALS FROM THE SQUAW CREEK TIN MINE,
TAYLOR CREEK MINING DISTRICT, BLACK RANGE,
CATRON COUNTY, NEW MEXICO**

(Location 7 on index map)

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In September 1984 I was searching the Taylor Creek mining district for tin prospects that might be hosts for the mineral durangite. Access to most of the prospects is via forest roads connected to NM-59, sometimes referred to as the "Beaverhead Highway." I was investigating the Squaw Creek tin mine, located in sec. 34, T9S, R11W, when microscopic red crystals were seen in both outcrop and randomly scattered loose rock near the mine's upper portal. Any assumptions that the material was durangite were subsequently proved incorrect by Paul Hlava's microprobe analyses and Eugene Foord's x-ray diffraction results. Research showed the red crystals were a new durangite-like arsenate. In the same material was found a new cassiterite-like oxide, recently named squawcreekite, and a new yellow chernovite-like arsenate. Chernovite ($YAsO_4$) was also identified in the groundmass of the rhyolite.

In the weeks following the initial analyses I collected a significant amount of rhyolite that had specimen potential. It was eventually broken up and checked under a microscope. In addition to the three new minerals, the following were observed: cassiterite, hematite, pseudobrookite, quartz, tridymite, mordenite, heulandite, and stellerite(?).

Field identification of the new minerals is difficult because of their small grain size and their color similarity. Generally, the new red arsenate resembles cassiterite in color but has a slight orange tint compared to a dark blood red, almost purplish tint, for the cassiterite. The crystals can be recognized by their monoclinic morphology. The red arsenate also tends to form nice euhedral crystals in lithophysae; the cassiterite tends to form aggregates on or near seams. The red arsenate is altered more easily by ground-water activity and sometimes may resemble cassiterite when it is altered. Hematite is ever present in most of the samples, but when hematite crystals are in contact with cassiterite, the cassiterite tends to smear/spread out over the crystals; the red arsenate does not exhibit this characteristic. It is also common to have squawcreekite crystals growing on tiny hematite crystals. The squawcreekite can have an epitaxial overgrowth of Fe-Sb-rich cassiterite, but this apparently does not affect the overall color. Squawcreekite is less common than the red arsenate and tends to be amber to root-beer brown in color. Generally, the finer grained the squawcreekite is, the lighter its color tends to be. For example, an aggregate of squawcreekite may be a golden-brown color, but a single tiny crystal sitting adjacent to

it may be a light-amber color (yellow with brown tints). Tiny, easily recognizable tetragonal crystals, resembling natrolite in form, are quite rare. The new yellow arsenate is apparently visually similar in color to chernovite, but chernovite is apparently rarer and hence not likely to be seen. The chernovite-like arsenate is strictly lemon yellow in color, very fine grained and usually found as grains in the groundmass. Generally, if a tiny yellow grain has any hint of a brown tint, then it is more likely to be the more prolific squawcreekite and not the new yellow arsenate.

I wish to thank Paul Hlava, Eugene Foord, and Charley Maxwell for their lab and/or field work and Arnold Hampson for microphotography.

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Stolzite, $PbWO_4$, has been identified from hematite-cassiterite veins at the head of Nugget Gulch. Crystals resemble cassiterite in color, lemon yellow, but are slightly more adamantine. Most crystals are euhedral and have a tapered ditetragonal pyramidal habit, much like that of some wulfenite, $PbMoO_4$. The mineral is very rare, and the maximum grain size observed is about 250 micrometers.

A tin prospect in rhyolite adjacent to NM-59 along Willow Springs Draw contains several interesting minerals in the miarolitic cavities. Fresh rhyolite contains cavities with hematite, pseudobrookite, calcite, clinopyroxene, titanite, sanidine, tridymite, and quartz. Some of the titanite is unusual in composition, containing elevated amounts of REE's, Pb, Nb, Fe, and F. Crystals are all clear, lustrous, and sharp. Color ranges from red brown to orange brown, and the crystals may be as much as 1 mm or more in maximum dimension. All crystals are euhedral. The clinopyroxene occurs as orange or yellow-orange, thin, slender, euhedral needles as much as several millimeters long but only 100 micrometers wide. Miarolitic cavities in hydrothermally altered rhyolite contain hematite, quartz, sanidine, tridymite, calcite, pseudobrookite, and minor amounts of tilasite and the Fe-analogue of durangite. Crystals of both minerals are extensively corroded and etched. A solid solution exists between these two minerals. Most of the material found is tilasite, and the maximum grain size is about 1 mm. Color ranges from medium red to pale pink. Only small amounts of the arsenate minerals were found whereas the titanite and clinopyroxene were fairly abundant.

**THREE NEW MINERALS FROM SQUAWCREEK, STOLZITE FROM NUGGET GULCH,
AND TILASITE FROM WILLOW SPRINGS DRAW,
BLACK RANGE TIN DISTRICT, NEW MEXICO**

(Location 8 on index map)

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Three new mineral species have been identified at a tin prospect on the north side of Squaw Creek, Catron County, New Mexico. The first is squawcreekite $(\text{Fe,Sb,Sn,Ti})\text{O}_2$, the iron- and antimony-dominant member of the rutile group. Cassiterite is also a member of the rutile group. Trivalent iron and pentavalent antimony substitute in equal amounts (atomic) to preserve charge balance. This new mineral is associated with a high-temperature assemblage of quartz, cassiterite, hematite, pseudobrookite, tridymite, chernovite-(Y), the cerium-dominant analogue of chernovite (a new species), and the iron-analogue of durangite, $\text{NaFeAsO}_4\text{F}$ (a new species). Squawcreekite occurs in very sparse amounts and the maximum crystal size observed is about $50 \times 120 \times 200$ micrometers. The mineral usually occurs mantled by epitaxial overgrowths of Fe- and Sb-bearing cassiterite, adjacent to hematite-cassiterite veins, disseminated within and in small miarolitic cavities in hydrothermally altered rhyolite. The squawcreekite is light to medium yellow brown with a very pale yellow-brown streak. Cell data are: \underline{a} 4.6673(7)Å, \underline{c} 3.1006(8)Å, V 67.542 (2)Å³, $Z = 2$; space group $P4_2/mnm$. Relative to pure SnO_2 (cassiterite), there is a reduction in squawcreekite of 1.5% for the \underline{a} parameter, 2.7% for the c parameter, and 5.6% for the volume. Crystals have a prismatic habit, and all are euhedral. Forms present include (100), (110),

(111), and (101). Twinning, by rotation about [101], is present in some crystals.

The iron-analogue of durangite has not yet been named but is currently before the IMA (International Mineralogical Association) for voting and approval. It is the most abundant of the three new minerals at Squaw Creek. Crystal size is 0.05 to 1 mm, and aggregates may be as much as 3 mm in maximum dimension. The crystals are euhedral to subhedral. Most crystals show some evidence of solutional etching and are somewhat opaque, but others are clear and lustrous. Crystals are medium to dark red with a medium red-orange streak. The typical crystal habit is unlike that of durangite found at the "clearing" near Boiler Peak. Higher-order crystal forms dominate rather than the simpler forms for durangite. The mineral is strongly compositionally zoned and somewhat color zoned and shows solid solution towards durangite ($\text{NaAlAsO}_4\text{F}$) and tilasite ($\text{CaMgAsO}_4\text{F}$). The average analysis is: Na_2O 8.0 wt %, CaO 8.0, Fe_2O_3 14.0, MgO 3.5, Al_2O_3 5.0, TiO_2 5.0, Mn_2O_3 0.5, SnO_2 0.6, ZnO 0.1, As_2O_5 51.0, ZrO_2 0.3, Nb_2O_5 0.2, Li_2O 0.1, F 6.0, total 102.3, 0 for F 2.5, total 99.8. An empirical formula calculated on the basis of 5 (F,O) atoms is: $(\text{Na}_{0.59}\text{Ca}_{0.33}\text{Li}_{0.02})\Sigma_{0.94}$
 $(\text{Fe}^{+3}_{0.40}\text{Al}_{0.22}\text{Mg}_{0.20}\text{Ti}_{0.14}\text{Mn}_{0.01}\text{Sn}_{0.01}\text{Zn}_{0.01})\Sigma_{0.99}$
 $(\text{As}_{1.01}\text{O}_4)(\text{F}_{0.72}\text{O}_{0.28})\Sigma_{1.00}$ ' Ion microprobe studies (R. W. Hinton, Univ. of Chicago) yielded results in agreement with the electron microprobe results. Optical properties for the mineral are: biaxial (+), α 1.748, β 1.772, γ 1.798, $\gamma - \alpha = 0.05$, 2v meas 86° , 2v calc 89° . Dispersion $r > v$, strong. Cell data are: a 7.161A, b 8.780A, c 6.687A, IS 114.58° , Z = 4, V 382.4A^3 . Space group Aa or A2/a.

The third new mineral appears to be the Ce-group dominant analogue of chernovite-(Y), which is YAsO_4 . The mineral is bright lemon yellow and occurs in very sparse amounts. It is the rarest of the three new minerals. Maximum grain size is about 75 micrometers in length. Habit is short prismatic. Crystals are euhedral to subhedral. The mineral is easily confused with yellow cassiterite.

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A tin prospect in rhyolite adjacent to NM-59 along Willow Springs Draw contains several interesting minerals in the miarolitic cavities. Fresh rhyolite contains cavities with hematite, pseudobrookite, calcite, clinopyroxene, titanite, sanidine, tridymite, and quartz. Some of the titanite is unusual in composition, containing elevated amounts of REE's, Pb, Nb, Fe, and F. Crystals are all clear, lustrous, and sharp. Color ranges from red brown to orange brown, and the crystals may be as much as 1 mm or more in maximum dimension. All crystals are euhedral. The clinopyroxene occurs as orange or yellow-orange, thin, slender, euhedral needles as much as several millimeters long but only 100 micrometers wide. Miarolitic cavities in hydrothermally altered rhyolite contain hematite, quartz, sanidine, tridymite, calcite, pseudobrookite, and minor amounts of tilasite and the Fe-analogue of durangite. Crystals of both minerals are extensively corroded and etched. A solid solution exists between these two minerals. Most of the material found is tilasite, and the maximum grain size is about 1 mm. Color ranges from medium red to pale pink. Only small amounts of the arsenate minerals were found whereas the titanite and clinopyroxene were fairly abundant.

IRON PHOSPHATES OF CRIPPLE CREEK, COLORADO

(Location 9 on index map)

Robert R. Cobban

**GEOLOGY AND MINERALOGY OF THE CHIMNEY ORE DEPOSITS,
RED MOUNTAIN MINING DISTRICT,
OURAY AND SAN JUAN COUNTIES, COLORADO**

(Location 10 on index map)

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The ore deposits of the Red Mountain district, Ouray and San Juan Counties, Colorado, occur as chimneys and less important veins that are associated with volcanic pipes. These pipes are confined to a belt of fractured and altered rocks along ring faults on the west and northwest sides of the Silverton caldera.

The volcanic pipes are usually vertical cylinder-like bodies that are elliptical to concentric in cross section. The pipes consist of breccias and intrusives of quartz latite porphyry and rhyolite. Brecciation occurred first from magmatic emanations that followed fracture zones. Volume and chemical changes resulted in cracking and slumping. The zone of brecciation spread outward from the fracture zone forming curved surfaces that formed the elliptical pipes. The pipes then were intruded by rhyolite and quartz latite porphyry. The breccias formed earlier were moved aside or were assimilated by the intrusive rocks.

The orebodies are of two types. The first formed within the pipes and occur as short veins and chimneys composed of massive sulfides. The second type formed at the margins or outside the pipes. This latter type is localized by structures related to the formation of the pipe, such as cone sheet pipe.

The common ore minerals include enargite, galena, sphalerite, tennantite, tetrahedrite, chalcopyrite, covellite, stromeyerite, and bornite. Rarer ore minerals are proustite, pyrargyrite, polybasite, and cosalite. Gangue minerals include quartz, sericite, dickite, barite apatite, and zunyite.

The district was active between 1882 and 1900 when the National Belle, Yankee Girl, Silver Bell, Guston, and Genessee mines were active. During the 1950's the Longfellow mine was discovered and operated. At present, no mines are operating in the area.