COLORADO II

the Mineralogical Record

Volume Ten, Number Six
November-December 1979 $3

affiliated with the Friends of Mineralogy

the Mineralogical Record

(USPS 887-700)

Volume Ten, Number Six
November-December 1979

COLORADO ISSUE #2

Articles

Departments

address
The Mineralogical Record
P.O. Box 783
Bowie, Maryland 20715

published
bimonthly by the Mineralogical Record Inc.

subscriptions
$13 per year, domestic and foreign. Personal checks in foreign currency accepted, but equivalent of $3 extra must be included to cover exchange charges.

foreign payments
remittance may be made in local currency, without surcharge, to the following people:

England:
Roger S. Harker
2 Wellsic Lane, Rothley
Leicestershire LE7 7Qb

Canada:
Mrs. J. W. Peat
36 Deepwood Crescent
Don Mills, Ontario M3C 1N8

COVER: AMAZONITE with smoky quartz, 10 cm tall, from the Yucca Hill claim, Park County, Colorado. Richard A. Kosnar specimen; photo by John Muntyan.

South Africa:
Horst Windisch
30 Van Wouw Street
Groenkloof, Pretoria

Belgium:
Paul Van Hee
Deuzeldlaan 16-bus 1
B-2120 Schoten

back issue sales:
Write to the circulation manager for a list of the copies still available. Out-of-print copies are being handled by Si & Ann Frazier (see their ad).

telephone:
circulation office
301-262-8583
editorial office
301-261-3912

contributed manuscripts
Contributed articles and news items are welcome. Acceptance is subject to the approval of the editor.

suggestions for authors
See vol.9, no.3, p.135, or write to the editor for a copy.

The Mineralogical Record Inc. is a non-profit organization
Inquiries about opportunities for tax deductible gifts on a present, deferred or pledge basis should be made to the editor.

Special Second Class postage
paid at Bowie, Maryland

notes from the EDITOR

THANKS . . .

. . . to Randy Rothschild for once again donating the funds for color photography, this year in the March-April and September-October issues.

. . . to our anonymous donor for the funds to put color photography into this issue and a coming issue.

. . . to John Barlow and Forrest Cureton for donating to the *Record* a complete set of Goldschmidt's *Atlas der Kristallformen,* an invaluable reference which should provide us with crystal drawings to illustrate articles for centuries to come.

. . . to Jack Murphy of the Denver Museum of Natural History for conceiving the idea of a second Colorado issue and for helping a great deal in bringing it to completion.

. . . to all of those mineralogists (in addition to those on our board of associate editors) who graciously donated their time for the reviewing of articles: F. J. Barlow, E. B. Eckel, E. E. Foord, C. Frondel, R. I. Gait, R. A. Kosnar, J. A. Mandarino, P. B. Moore, D. R. Peacor, H. E. Pemberton, M. Romero S., and H. R. Steacy.

IT'S THAT TIME AGAIN

In order to protect the financial viability of the *Record* against creeping inflation, the devaluation of the dollar and the associated increases in production costs, we are forced to increase the subscription cost by $3 as of this coming January 1, 1980. Subscriptions and renewals at the current rate ($13 for one year; $24 for two years) will be accepted until January 1, after which date the new rates will be $16 for one year and $30 for two years. Lifetime subscriptions for individuals will continue to be $200 until January 1, after which time the lifetime rate will be $250.

ANNUAL SLIDE COMPETITION

With the Tucson Show coming up in February it's time once again for all you mineral photographers to look through your files and send us your best two slides.

Rules:

1. The following information must be *on each slide*
   a. Mineral name and location
   b. Your name and mailing address
   c. "AM" for "amateur" or "PRO" for "professional." Only those who have never been paid for photography and have never won first place in the *Record* slide competition are "amateurs."
2. Maximum of two entries per person.
3. All slides must be original 35 mm transparencies in cardboard mounts.
4. Photos must be of minerals (not under ultraviolet light).
5. The entrant must be the sole owner of copyright for the entered slides and by entering grants the *Mineralogical Record* permission to publish the slides at no charge.
6. All entries should be mailed to **Dr. Arthur Roe, 3024 E. Sixth St., Tucson, Arizona 85716,** so as to be received before February 9. No return envelope is required and all entries will be returned.

Prizes: (Prize money once again contributed by Dr. Richard Webster)

Amateur category	*Professional category*
First prize: $100	First prize: $100
Second prize: $25	Second prize: $25
Third prize: $25	Third prize: $25

Twenty semi-finalist slides will be selected from the entries, and the Saturday night show audience will then select the winners by ballot.

Colorado Locality Index

by
Barbara L. Muntyan
Coordinator
6978 Wapiti Court
Boulder, Colorado 80301

and

Colorado Chapter, Friends of Mineralogy
Locality Index Committee

The following Index represents a joint effort by the Colorado Chapter of Friends of Mineralogy to identify and list the most significant mineral localities in Colorado, by county. In addition, there is a complete listing of all Colorado type localities, and an alphabetical cross-index by mine name.

INTRODUCTION

In the Spring of 1976 a group of volunteers gathered to compile and edit a listing of Colorado mineral localities. This same group later became the nucleus of the Colorado Friends of Mineralogy chapter; the initial call for help, however, was based upon the need to develop a section of the locality index project for the National Friends of Mineralogy.

The group of volunteers represented a variety of backgrounds and training. Several were serious amateur collectors, two were professional geologists working for private industry, two were associated with museums in Denver, and several worked either for the U.S. Geological Survey or the Colorado Geological Survey. In all, we had about a dozen people donating their talents. Scores of others submitted locality data for the project.

Our first task was to define the scope of our project. In keeping with the general outlines of the national index project, we decided that the primary users of a locality listing would be (1) amateurs cataloging their collections or seeking more information about their own specimens, (2) museums wishing to revise their labeling system, (3) individuals interested in historically significant mineral localities, (4) individuals preparing labels for displays, and (5) those interested in Dana localities in Colorado. We decided we would only include those localities which produced significant quantities or high quality specimens, or those for type material.

Considering that Colorado is one of the most highly mineralized areas in the world, and that many of the possible listings were only small prospect pits, we arbitrarily limited our undertaking to approximately one hundred "most significant" localities in the state. The determination of importance was a joint effort by the group: after we reviewed all locality data submitted for inclusion, we began a culling process which eventually left us with the desired number of localities. Obviously, this was a subjective choice; we could have listed 1,000 Colorado localities almost as easily. While this data will surely be revised and expanded in the future, we hope we have made a significant start in the long-awaited locality index project. Your comments are invited.

[1] Not all Dana occurrences have been verified in recent times.

[2] Some localities are not within town limits, but are nearer the town given than any other.

COLORADO LOCALITY INDEX

BOULDER COUNTY

Caribou Mine
Caribou (near Nederland), Caribou District
(Silver, Uraninite, Galena, Magnetite, Proustite, Pearceite, Polybasite, Pyrargyrite, Jalpaite)

Copper Rock
Ward District
(Azurite, Malachite, Cerussite, Galena)

Gold Hill
Gold Hill District
(Nagyagite, Hessite, Petzite, Altaite, Sylvanite, Tellurium, Gold, Coloradoite, Stützite)

Golden Age Mine
Jamestown[2]
(Tellurium, Gold)

Illinois mine,
Bonanza mine,
Conger mine,
Georgia mine,
Hoosier mine,
Lone Tree mine,
Oregon mine,
Phillips mine,
Spider Leg mine,
Sunday mine,
Town Lot mine,
(others)
Nederland
(Ferberite)

James Creek
Jamestown
(Epidote, Garnet, Calcite, Vesuvianite, Diopside)

Keystone mine,
Mountain Lion mine
Magnolia District
(Coloradoite (T), Tellurium, Sylvanite, Schirmerite, Gold)

White Raven mine
Black Jack mine
Ward, Ward District
(Silver, Barite, Galena, Siderite)

CHAFFEE COUNTY

California mine
Nathrop, Browns Creek Area
(Beryl var. Aquamarine and Goshenite, Molybdenite, Ferrimolybdite, Quartz, Fluorite, Brannerite)

Calumet mine
Salida, Turret District
(Epidote, Actinolite var. Uralite after Diopside, Magnetite, Quartz var. Smoky, Sphene, Grossular, Corundum var. Sapphire, Diopside, Clinochlore)

Mount Antero,
White Mountain
Nathrop, Browns Creek Area
(Beryl var. Aquamarine, Phenakite, Quartz var. Smoky, Fluorite, Bertrandite, Muscovite, Orthoclase, Topaz, Albite, Columbite)

Ruby Mountain
Nathrop
(Spessartine, Topaz, Quartz, Hematite)

Sedalia Copper Mine
Salida, Turret District
(Almandine, Magnetite, Chlorite)

CLEAR CREEK COUNTY

Alice Glory hole
Alice, Yankee Hill District
(Pyrite, Chalcopyrite, Bismuthinite, Gold, Quartz)

Dixie mine
Idaho Springs District, Ute Creek Area
(Gold, Quartz, Amethyst, Galena)

Freeland mine
Freeland, Lamartine District
(Chalcopyrite, Tennantite, Tetrahedrite, Pyrite, Sphalerite, Quartz, Galena, Siderite)

Griffith mine,
Anglo-Saxon mine,
Colorado Central mine,
Mendota mine,
Pelican-Bismark lode,
(others)
Silverplume, Georgetown District
(Pyrite, Galena, Silver, Gold, (Sphalerite, Proustite, Chalcopyrite, Hessite, Argentite, Quartz, Pyrargyrite, Siderite, Jalpaite)

Grover mine (and outcrops)
Floyd Hill, Beaver Brook Area
(Allanite, Microcline, Beryl, Gadolinite, Monazite, Columbite)

Mary Murphy mine
Chalk Creek
(Rhodochrosite, Pyrite, Galena, Silver, Sphalerite)

Stanley mine,
Little Mattie mine,
Newton mine,
Treasure Vault mine,
Virginia mine,
(others)
Idaho Springs District
(Gold, Pyrite, Galena, Tetrahedrite, Tennantite, Sphalerite, Chalcopyrite, Quartz, Siderite, Rhodochrosite)

Urad mine
Berthoud Falls
(Rhodochrosite, Molybdenite, Fluorite, Pyrite, Barite, Sphalerite, Galena)

CONEJOS COUNTY

King mine
Manassa
(Turquoise)

DOLORES COUNTY

Argentine shaft,
Mountain Springs mine,
Wellington mine,
Rico, C.H.C. Hill
(Pyrite, Galena, Silver)

DOUGLAS COUNTY

Devils head
Deckers
(Quartz var. Smoky, Topaz, Microcline var. Amazonite, Albite, Cassiterite, Ellsworthite, Columbite)

Longhollow
Deckers, Devils Head Area
(Quartz var. Smoky, Topaz)

Pine Creek
Deckers
(Quartz var. Smoky, Microcline var. Amazonite, Fluorite)

EAGLE COUNTY

Eagle mine
Gilman
(Pyrite, Barite, Apatite, Siderite, Galena, Sphalerite, Rhodochrosite, Pyrrhotite, Tetrahedrite, Freibergite, Chalcopyrite, Dolomite, Ankerite, Covellite, Quartz, Cerussite)

Ground Hog mine
Gilman
(Gold, Pyrite, Barite)

EL PASO COUNTY

Crystal Park
Manitou Springs, Pikes Peak Area
(Microcline var. Amazonite, Phenakite, Topaz, Quartz, Zircon, Bastnaesite, Fluorcerite, Columbite, Fluorite, Albite)

Eureka Tunnel
Colorado Springs, St. Peters Dome Area
(Zircon)

Fountain Creek
Colorado Springs
(Gypsum var. Selenite (roses))

Garden of the Gods (and vicinity)
Colorado Springs
(Celestine, Gypsum)

Glen Cove
Pikes Peak
(Topaz, Quartz var. Smoky)

St. Peters Dome
Colorado Springs
(Riebeckite, Zircon, Astrophyllite, Elpasoite (T), Fayalite, Gearksutite, Cryolite, Zircon var. Crytolite, Pyrochlore, Pachnolite, Prosopite, Arfedsonite, Mircocline, Quartz var. Smoky, Albite, Loellingite)

Stove Mountain (Cookstove Mountain)
Colorado Springs
(Microcline var. Amazonite, Bastnaesite, Fergusonite, Fluocerite, Fluorite, Genthelvite, Lanthanite, Phenakite, Quartz var. Smoky, Topaz, Zircon, Hematite, Goethite, Amethyst)

FREMONT COUNTY

Cotopaxi mine
Cotopaxi
(Amphibole, Chalcopyrite, Gahnite, Uraninite, Garnet)

Devils Hole mine
Texas Creek
(Quartz var. Rose, Beryl, Columbite)

School Section mine,
Border No. 2 mine,
Magnuson mine,
Van Buskirk mine,
Mica lode,
Meyers Quarry
Canon City, Royal Gorge Park Area
(Feldspar, Beryl, Tourmaline, Quartz, Muscovite, Biotite, Columbite)

GILPIN COUNTY

Bellman mine,
Gem mine,
Moose mine
Central City District
(Rhodochrosite, Fluorite, Pyrite)

Evergreen mine
Central City District, Apex Area
(Bornite)

Hampton mine
Central City
(Enargite, Pyrite)

Kirk mine
Central City
(Uraninite, Metatorbernite, Pyrite, Tennantite, Chalcopyrite, Galena, Johannite)

Mammoth mine,
Bobtail mine,
Cook mine,
Fisk mine,
Gregory mine
Blackhawk District
(Pyrite, Chalcopyrite, Quartz)

Manchester mine,
Nugget mine
Rollinsville
(Ferberite, Scheelite)

Notaway mine,
War Dance mine
Central City District
(Calaverite, Sylvanite, Krennerite)

Saratoga mine,
Frontenac mine,
Gunnell mine,
Leavenworth mine,
Topeka mine,
The Patch (Gloryhole)
Central City District
(Pyrite, Chalcopyrite, Gold, Galena, Sphalerite, Quartz, Tennantite, Enargite, Tetrahedrite, Silver)

Wood mine
Central City District, Quartz Hill
(Uraninite, Sphalerite, Chalcopyrite,

Tetrahedrite, Tennantite, Galena, Johannite (formerly "Gilpinite"))

GRAND COUNTY

Blue River Valley Area
Kremmling
(Marcasite, Pyrite)

GUNNISON COUNTY

American Eagle mine,
Horace Porter mine,
Luona mine
Elk Mountains, White Rock and Teocalli Mountains
(Loellingite, Smaltite, Pyrargyrite, Proustite, Silver, Argentite, Acanthite, Erythrite, Pryrostilpnite, Xanthoconite)

Brown Derby mine
Ohio City, Quartz Creek District
(Tourmaline, Lepidolite, Microlite, Columbite, Tantalite, Beryl, Monazite)

Courtland mine
Gold Brick District
(Pyrargyrite, Stephanite, Arsenopyrite)

Domingo mine
Ruby, Elk Mountain District
(Boulangerite, Jamesonite, Silver, Owyheeite)

Forest Queen mine,
Sylvanite mine
Ruby, Irwin District
(Proustite, Pyrargyrite, Pyrite, Silver, Argentite, Quartz, Pyrostilpnite, Xanthoconite)

Good Hope mine
Vulcan District
(Rickardite (T), Berthierite, Copper, Petzite, Pyrite, Coloradoite, Roscoeite, Selenium, Sulfur, Sylvanite, Tellurite, Tellurium, Weissite (T))

Italian Mountain
Taylor Park
(Idocrase, Grossular, Diopside, Chabazite, Lazurite, Heulandite, Stilbite, Sahlite, Epidote, Mesolite, Titanite, Andradite)

Northeast of Lot mine
Powerhorn, Cibolla District
(Anatase)

Scofield Pass
Gothic
(Orthoclase var. Sanadine)

Vulcan mine
Vulcan District
(Sylvanite, Tellurite, Tellurium, Copper)

HINSDALE COUNTY

Champion mine
Lake City
(Rhodochrosite, Siderite, Galena, Sphalerite)

Golden Fleece mine
Lake City
(Hinsdalite (T), Barite, Pyrite, Galena, Tetrahedrite, Rhodochrosite, Quartz)

JEFFERSON COUNTY

Bigger Pegmatite mine
Morrison
(Bertrandite, Beryl, Bismuthinite, Bismutite, Columbite, Monazite, Zircon, Muscovite, Feldspar)

Drew Hill,
Guy Hill,
Robinson Gulch
Golden, Golden Gate Canyon
(Chrysoberyl, Tourmaline, Beryl, Columbite, Almandine, Epidote)

Genessee Mountain pegmatite
(Grossular, Spessartine, Epidote, Titanite, Vesuvianite, Diopside)

North Table Mountain
Golden
(Analcime, Chabazite, Mesolite, Thompsonite, Natrolite, Stilbite, Aragonite, Levynite, Cowlesite, Shoshonite, Apophyllite, Scolecite, Garronite, Laumontite)

Schwartzwalder mine
Golden
(Uraninite, Liebigite, Meta-autunite, Johannite, Autunite, Torbernite, Meta-torbernite, Pyrrhotite, Pyrite, Calcite, Bayleynite)

Wigwam pegmatite
Deckers Area
(Microcline var. Amazonite, Quartz, Fluorite)

LA PLATA COUNTY

Bessie G. mine,
May Day mine
La Plata District
(Calaverite, Gold, Hessite, Petzite, Sylvanite, Pyrite)

LAKE COUNTY

A. Y. and Minnie mine
Julia Fisk mine,
Mammoth mine,
Matchless mine
Leadville District
(Rhodochrosite, Pyrite, Galena, Sphalerite, Silver, Gold, Cerussite, Siderite)

Black Cloud mine
Leadville District
(Pyrite, Galena, Barite, Sphalerite, Dolomite, Quartz, Siderite, Cerussite)

Climax mine
Climax District
(Rhodochrosite, Pyrite, Fluorite, Molybdenite, Huebnerite, Ferrimolybdite, Wolframite, Apatite, Sphalerite, Galena, Chalcopyrite, Brannerite, Cassiterite, Topaz, Sericite, Torbernite)

Colonel Sellers mine
Leadville District, Iron Hill Area
(Sphalerite, Silver, Siderite)

Fremont Pass
Climax District
(Orthoclase)

Ibex mine,
Irene mine,
Little Johnny mine,
(others)
Leadville District, Johnny Hill Area
(Pyrite, Gold, Scheelite, Huebnerite)

John Reed mine
Alicante District
(Rhodochrosite, Pyrite, Quartz, Sphalerite)

Maid of Erin,
R.A.M. shaft,
Tucson mine,
Wolfton mine,
(others)
Leadville District, Carbonate Hill Area
(Pyrite, Vivianite, Hemimorphite, Cerussite, Hydrohetaerolite, Tetrahedrite, Galena)

Sherman mine
Leadville
(Silver, Pyrite, Sphalerite, Barite, Rhodochrosite, Dolomite, Siderite, Malachite, Cerussite, Smithsonite)

Turquoise Chief mine
Leadville District
(Turquoise)

LARIMER COUNTY

Copper King mine
Red Feather Lakes, Prairie Divide
(Coffinite, Uraninite, Actinolite, Monazite)

Owl Canyon (limestone outcrops)
Owl Canyon
(Aragonite, Calcite, Gypsum var. Satin Spar and Alabaster)

Rainbow lode
Red Feather Lakes
(Quartz var. Amethyst)

Waverly (outcrops in shale)
Waverly
(Marcasite)

Big Thompson pegmatite
Drake
(Molybdenite, Almandine, Tourmaline, Ferrimolybdite, Apatite, Bornite, Quartz, Muscovite)

MESA COUNTY

Book Cliffs
Grand Junction
(Barite, Calcite, Siderite)

Unaweep Canyon mine
Unaweep Canyon
(Quartz var. Amethyst, Fluorite)

MINERAL COUNTY

Bachlor mine
Creede
(Cerussite, Amethyst, Sphalerite, Galena, Silver)

Bulldog Mountain project
(Homestake mine)
Creede
(Silver, Acanthite, Argentite, Fluorite, Barite, Quartz var. Amethyst, Sphalerite, Galena, Chalcopyrite, Cuprite var. Chalcotrichite, Pyrite, Pyrostilpnite, Pyrargyrite, Polybasite, Calcite, Marcasite)

Commodore mine
Creede
(Sphalerite, Galena, Quartz var. Amethyst, Silver, Barite, Chalcopyrite)

Wolf Creek Pass
Pagosa Springs, Del Norte
(Mordenite and other zeolites, Quartz var. Chalcedony and Agate)

Wagon Wheel Gap
Wagon Wheel Gap
(Covellite, Fluorite, Barite, Creedite (T), Gearksutite)

MONTROSE COUNTY

Cashin mine
Paradox, La Sal Creek
(Silver, Copper, Bornite, Chalcocite, Covellite, Cuprite, Domeykite, Luzonite, Uraninite)

OTERO COUNTY

La Junta (outcrops in greenhorn and graneros shale)
La Junta
(Barite, Calcite)

OURAY COUNTY

Camp Bird mine
Ouray Area
(Galena, Chalcopyrite, Sphalerite, Pyrite, Quartz, Epidote, Fluorite, Ankerite, Dolomite, Barite, Gypsum var. Selenite, Greenockite, Hematite, Gold, Hessite, Zoisite, Siderite, Rhodochrosite, Tetrahedrite, Chalcocite)

Dunmore mine
Ouray
(Huebnerite, Pyrite, Sphalerite, Quartz)

Guston mine,
National Belle mine,
Silver Bell mine,
Yankee Girl mine
Red Mountain Pass District
(Enargite, Dickite, Fluorite, Rhodochrosite, Covellite, Polybasite-Pearceite, Proustite, Pyrargyrite,

Colusite, Scorodite, Stromeyerite, Zunyite, Zinkenite, Kobellite, Aikinite, Tennantite, Freibergite, Tetrahedrite, Miargyrite)

Idarado mine
(See San Miguel County)

Michael Breen mine
Mountain Monarch mine
Ouray
(Rhodochrosite, Quartz, Fluorite, Pyrite, Tetrahedrite, Galena, Sphalerite, Chalcopyrite)

Mineral Farm mine
Ouray, Ouray District
(Argentite, Quartz, Barite, Tetrahedrite, Galena, Bismuthinite, Enargite, Bornite, Chalcocite, Pyrite)

Portland mine
Ouray
(Sphalerite, Calcite, Pyrite, Amethyst, Galena)

PARK COUNTY

American mine
London mine
Mosquito Pass
(Gold, Quartz)

Boomer mine
Lake George, Badger Flats Area
(Wolframite, Cassiterite, Beryl, Bertrandite, Topaz, Arsenopyrite, Unaninite)

Crystal Peak (Topaz Butte)
Lake George, Pike Forest
(Microcline var. Amazonite, Quartz var. Smoky and Amethyst, Goethite, Hematite, Fluorite, Albite, Barylite, Columbite, Goethite after Siderite, Microcline, Monazite, Phenakite, Tantalite, Manganotantalite, Stibiotantalite, Cassiterite, Zircon, Topaz)

Harris Park
Pine Junction, Elk Creek Area
(Microcline var. Amazonite, Quartz var. Smoky, Topaz)

Hartsel Barite mine
Hartsel
(Barite)

Meyers Ranch pegmatite mine
Micante, McGuffey Area
(Beryl, Columbite, Bismutite, Beyerite)

Pipe Springs Campground
Wilkerson Pass Area
(Tourmaline, Almandine, Adradite, Monazite, Quartz)

Russia mine
Mt. Lincoln
(Rhodochrosite, Tetrahedrite, Freibergite, Fluorite, Apatite)

Spruce Grove,
Lone Lode pegmatite
Tarryall Mountains
(Topaz, Quartz var. Smoky, Microcline)

HomeSweet Home mine
Alma District, Buckskin Gulch
(Rhodochrosite, Fluorite, Huebnerite, Quartz, Sericite, Xenotime, Topaz, Silver, Molybdenite, Galena, Tetrahedrite, Freibergite, Tennantite, Stromeyerite, Goyazite, Apatite, Sphalerite, Bornite, Chalcopyrite, Quartz var. Amethyst, Barite, Dickite)

Teller pegmatite
Lake George
(Allanite, Gadolinite, Molybdenite, Monazite, Xenotime, Yttrofluorite, Samarskite)

Tanner Boy
Loveland Mountain
(Rhodochrosite, Fluorite, Pyrite, Huebnerite, Bornite, Chalcopyrite, Sphalerite, Galena, Quartz)

Wilkerson Pass Area pegmatites
Wilkerson Pass Area
(Tourmaline, Fluorite, Beryl, Quartz, Epidote, Muscovite, Monazite, Almandine, Andradite)

PITKIN COUNTY

Durant tunnel,
Millinee mine,
(others)
Aspen, Aspen Mountain Area
(Silver, Argentite, Anglesite, Barite, Cerussite, Galena)

Little Annie mine,
Midnight mine
Aspen District
(Silver, Barite, Sphalerite, Tetrahedrite, Calcite, Galena, Argentite, Acanthite)

Molly Gibson mine,
Della S. mine,
Smuggler mine
Aspen, Smuggler Mountain Area
(Silver, Pearceite, Argentite, Stromeyerite, Barite, Galena, Sphalerite, Stephanite)

RIO GRANDE COUNTY

Reynolds Tunnel
Little Annie Vein
Summitville
(Covellite, Enargite, Gold)

Summitville mine
Del Norte, Summitville District
(Covellite)

SAGUACHE COUNTY

Beidell Gulch
La Garite
(Quartz var. Rock Crystal and Amethyst, Gold, Beidellite (T))

Eagle mine
Express mine
Rawley Tunnel mine
Bonanza District
(Rhodochrosite, Fluorite, Pyrargyrite, Rickardite, Silver, Empressite, Proustite, Pyrite, Galena, Sphalerite, Quartz)

Hall turquoise mine
Villa Grove
(Turquoise)

SAN JUAN COUNTY

Adams mine
Red Bonita mine
Gladstone, Silverton District
(Huebnerite, Fluorite, Quartz, Pyrite)

Alaska mine,
Sultan mine
Poughkeepsie Gulch, Silverton District
(Galena, Tetrahedrite, Chalcopyrite, Sphalerite, Pyroxmangite, Rhodonite, Jordanite, Rhodochrosite)

American tunnel (see Sunnyside mine)
Gladstone, Silverton District

Brooklyn mine
Cement Creek District
(Gold, Rhodochrosite, Sphalerite, Altaite, Petzite, Pyrite, Galena, Chalcopyrite, Electrum, Quartz)

Iowa mine,
Royal Tiger mine,
Silver Lake mine
Silver Lake Area, Silverton District
(Tetrahedrite, Pyrite, Chlorite, Quartz)

Kitty Mac mine
Minnie Gulch
(Pyrite, Wolframite, Quartz, Tetrahedrite, Tungstite)

Longfellow mine
Red Mountain Pass, Silverton District
(Enargite, Tetrahedrite, Pyrite, Fluorite)

Osceola mine
Cunningham Gulch
(Fluorite, Quartz, Barite, Sphalerite, Galena, Chalcopyrite, Tetrahedrite, Siderite, Dolomite, Calcite)

Silver Wing mine
Burns Gulch
(Tetrahedrite, Chalcopyrite, Sphalerite, Quartz, Galena)

Sunnyside mine (American Tunnel)
Eureka Gulch, Silverton District
(Gold, Rhodochrosite, Pyroxmangite, Quartz, Fluorite, Hydrozincite, Galena, Sphalerite, Pyrite, Tetrahedrite, Freibergite, Helvite, Freidelite, Chalcopyrite, Gypsum, Calcite, Anhydrite, Tephroite, Alleghanyite, Alabandite, Petzite, Calaverite, Altaite, Electrum)

Zuni mine
Zuni Gulch, Silverton District
(Zunyite (T), Pyrite, Enargite)

SAN MIGUEL COUNTY

Idarado mine
Black Bear Vein
Marshall Basin
Smuggler-Union
Tomboy
(Quartz, Calcite, Dolomite, Siderite, Rhodochrosite, Pyrite, Sphalerite, Galena, Chalcopyrite, Tetrahedrite, Fluorite, Barite, Epidote, Piemontite, Amethyst, Gold, Electrum, Marcasite, Gypsum)

SUMMIT COUNTY

Big Four mine
Dillon, Green Mountain Reservoir
(Sphalerite)

Ontario mine,
Wapiti mine,
Wire Patch mine
Gold Flake vein
Breckenridge, Farncomb Hill
(Gold)

Sullivan Mountain
Montezuma District
(Matilkite, Pyrite, Quartz)

TELLER COUNTY

Ajax mine,
El Paso mine,
Cripple Creek District
(Calaverite, Sylvanite, Krennerite, Fluorite, Gold, Pyrite, Melonite)

Cresson mine,
Blue Bird mine,
Independence mine,
John Logan mine,
Last Dollar mine,
Portland mine,
Vindicator mine
Cripple Creek District
(Calaverite, Sylvanite, Krennerite, Fluorite, Empressite, Amethyst, Gold, Melonite, Pyrite, Dolomite)

Crystal Peak Area (see also Park County)
Florissant
(Microcline var. Amazonite, Quartz var. Smoky, Goethite, Fluorite, Albite, Barylite, Ilmenite, Goethite after Siderite, Columbite, Microcline)

WELD COUNTY

Stoneham (outcrops in White River formation)
Stoneham
(Barite, Calcite)

Raymer (outcrops in White River formation)
Raymer (on some maps, "New Raymer")
(Barite, Calcite)

COLORADO TYPE LOCALITIES

Beidellite
Beidell Gulch mine
La Garita
Saguache Co.
Brockite
near Bassick mine
Querida
Custer Co.
Carnotite
Surface outcrops
Uravan-Paradox Valley Region
Montrose Co.
Cebollite
Iron Hill
Powderhorn-Cibolla District
Gunnison Co.
Coffinite
La Sal No. 2 mine
Gateway District, Lumsden Canyon
Mesa Co.
Coloradoite
Keystone and Mountain Lion mines
Magnolia, Magnolia District and Smuggler mine
Balarat
Boulder Co.
Creedite
American Fluorspar and Mining Co. mine
Wagon Wheel Gap
Mineral Co.
Cuprobismutite
Missouri mine
Hall Valley
Park Co.
Danalite
Stove Mountain (West Cheyenne Mountain)
Colorado Springs, Pikes Peak District
El Paso Co.
Delrioite
Jo Dandy mine
Bull Canyon District, Paradox Valley
Montrose Co.
Doloresite
La Sal No. 2 mine
Gateway District, Lumsden Canyon
Mesa Co.
Duttonite
Peanut mine
Paradox Valley, Bull Canyon District
Montrose Co.
Elpasoite
Saint Peters Dome
Colorado Springs, Pikes Peak District
El Paso Co.
Empressite
Empress Josephine mine
Bonanza District
Saguache Co.
Fervanite
Tiny mine
Gympsum Valley
San Miguel Co.
Genthelvite
Stove Mountain (West Cheyenne Mountain)
Colorado Springs, Pikes Peak District
El Paso Co.
Guitermannite
Zuni mine
Silverton, Zuni Gulch
San Juan Co.
Hendersonite
J. J. mine
Paradox Valley, Bull Canyon district
Montrose Co.
Hinsdalite
Golden Fleece mine
Lake City District
Hinsdale Co.
Hummerite
Hummer mine (Jo Dandy group)
Paradox Valley, Bull Canyon District
Montrose Co.
Ilesite
McDonnell claim
Hall Valley
Park Co.
Juanite
Iron Hill
Powderhorn-Cibolla District
Gunnison Co.
Kogarkoite
Hortense hot spring
Chalk Creek
Chaffee Co.
Lillianite
Lillian mine
Leadville District, Printer Boy Area
Lake Co.
Metahewettite
Numerous localities in Colorado
Metarossite
McElmo formation
Bull Pen Canyon
San Miguel Co.
Metatyuyamunite
Jo Dandy mine
Paradox Valley, Bull Canyon District
Montrose Co.
Montroseite
Bitter Creek mine
Paradox Valley
Montrose Co.
Murataite
St. Peter's dome
Colorado Springs
El Paso Co.
Ourayite
Old Lout mine
Poughkeepsie Gulch
San Juan Co.
Paramontroseite
Bitter Creek mine
Paradox Valley
Montrose Co.
Rickardite
Good Hope mine
Powderhorn-Vulcan District
Gunnison Co.
Rilandite
J. L. Riland clain
Meeker
Rio Blanco Co.
Rossite
McElmo formation
Bull Pen Canyon
San Miguel Co.
Sauconite
New Discovery and Yankee Doodle mines
Leadville
Park Co.
Schirmerite
Treasure Vault lode
Geneva (Montezuma) District
Summit Co.
Sherwoodite
Peanut mine
Paradox Valley, Bull Canyon District
Montrose Co.
Siderophyllite
Pikes Peak
Colorado Springs, Pikes Peak District
El Paso Co.
Simplotite
Sundown claim
Gypsum Valley
San Miguel Co.
Steigerite
Sullivan Brothers claims and Ponto No. 3 claim
Gypsum Valley
San Miguel Co.
Treasurite
Treasure Vault lode
Geneva district
Summit Co.
Vanoxite
Jo Dandy mine
Paradox Valley, Bull Canyon District
Montrose Co.
Vulcanite
Good Hope mine
Vulcan district
Gunnison Co.
Weissite
Good Hope mine
Powderhorn-Vulcan District
Gunnison Co.
Zinc-melanterite
Vulcan district
Gunnison Co.
Zunyite
Zuni mine
Silverton, Zuni Gulch
San Juan Co.

ALPHABETICAL LOCALITY INDEX

by mine name,
County in parenthesis

Dixie (Clear Creek)
Domingo (Gunnison)
Drew Hill (Jefferson)
Dunmore (Ouray)
Durant Tunnel (Pitkin)
Eagle (Saguache)
Eagle (Eagle)
El Paso (Teller)
Eureka Tunnel (El Paso)
Evergreen (Gilpin)
Express (Saguache)
Fisk (Gilpin)
Forest Queen (Gunnison)
Fountain Creek (El Paso)
Freeland (Clear Creek)
Fremont Pass (Lake)
Frontenac (Gilpin)
Garden of the Gods (El Paso)
Gem (Gilpin)
Genessee Mtn. pegmatite (Jefferson)
Georgia (Boulder)
Glen Cove (El Paso)
Golden Age (Boulder)
Golden Fleece (Hinsdale)
Gold Flake (Summit)
Gold Hill (Boulder)
Good Hope (Gunnison)
Gregory (Gilpin)
Griffith (Clear Creek)
Ground Hog (Eagle)
Grover (Clear Creek)
Gunnell (Gilpin)
Guston (Ouray)
Guy Hill (Jefferson)
Hall Turquoise (Saguache)
Hampton (Gilpin)
Harris Park (Park)
Hartsel Barite (Park)
Homestake (Mineral)
(Home) Sweet Home (Park)
Hoosier (Boulder)
Horace Porter (Gunnison)
Ibex (Lake)
Idarado (Ouray)
Idarado (San Miguel)
Illinois (Boulder)
Independence (Teller)
Iowa (San Juan)
Irene (Lake)
Italian Mountain (Gunnison)
James Creek (Boulder)
John Logan (Teller)
John Reed (Lake)
Julia Fisk (Lake)
Keystone (Boulder)
King (Conejos)
Kirk (Gilpin)
Kitty Mac (San Juan)
La Junta (Otero)
Last Dollar (Teller)
Leavenworth (Gilpin)
Little Annie (Pitkin)
Little Annie (Rio Grande)
Little Johnny (Lake)
Little Mattie (Clear Creek)
London (Park)
Lone Lode (Park)
Lone Tree (Boulder)
Longfellow (San Juan)
Longhollow (Douglas)
Luona (Gunnison)
Magnuson (Fremont)
Maid of Erin (Lake)
Mammoth (Gilpin)
Mammoth (Lake)
Manchester (Gilpin)
Mary Murphy (Clear Creek)
Matchless (Lake)
May Day (La Plata)
Mendota (Clear Creek)
Meyers Quarry (Fremont)
Meyers Ranch (Park)
Mica Lode (Fremont)
Michael Breen (Ouray)
Midnight (Pitkin)
Millinee (Pitkin)
Mineral Farm (Ouray)
Mollie Gibson (Pitkin)
Moose (Gilpin)
Mountain Lion (Boulder)
Mountain Springs (Dolores)
Mount Antero (Chaffee)
National Belle (Ouray)
Newton (Clear Creek)
Northeast of Lot (Gunnison)
North Table Mountain (Jefferson)
Notaway (Gilpin)
Nugget (Gilpin)
Ontario (Summit)
Oregon (Boulder)
Osceola (San Juan)
Owl Canyon (Larimer)
Patch (Gilpin)
Pelikan-Bismark (Clear Creek)
Phillips (Boulder)
Pine Creek (Douglas)
Pipe Springs Campground (Park)
Portland (Ouray)
Portland (Teller)
Rainbow Lode (Larimer)
R.A.M. Shaft (Lake)
Rawley tunnel (Saguache)
Raymer (Weld)
Reynolds Tunnel (Rio Grande)
Robinson Gulch (Jefferson)
Royal Tiger (San Juan)
Ruby Mountain (Chaffee)
Russia (Park)
Saint Peters Dome (El Paso)
Saratoga (Gilpin)
School Section (Fremont)
Schwartzwalder (Jefferson)
Scofield (Gunnison)
Sedalia (Chaffee)
Sherman (Lake)
Silver Bell (Ouray)
Silver Lake (San Juan)
Silver Wing (San Juan)
Smuggler (Pitkin)
Smuggler-Union (San Miguel)
Spider Leg (Boulder)
Spruce Grove (Park)
Stanley (Clear Creek)
Stoneham (Weld)
Stove Mountain (El Paso)
Sullivan Mtn. (Summit)
Sultan (San Juan)
Summitville (Rio Grande)
Sunday (Boulder)
Sunnyside (San Juan)
(Home) Sweet Home (Park)
Sylvanite (Gunnison)
Tanner Boy (Park)
Teller Pegmatite (Park)
Tomboy (San Miguel)
Topaz Butte (Park)
Topeka (Gilpin)
Town Lot (Boulder)
Treasure Vault (Clear Creek)
Treasury Tunnel (Ouray)
Tucson (Lake)
Turquoise Chief (Lake)
Unaweep Canyon (Mesa)
Urad (Clear Creek)
Van Buskirk (Fremont)
Vindicator (Teller)
Virginia (Clear Creek)
Vulcan (Gunnison)
Wagon Wheel Gap (Mineral)
Wapiti (Summit)
War Dance (Gilpin)
Waverly (Larimer)
Wellington (Dolores)
White Mountain (Chaffee)
White Raven (Boulder)
Wigwam Pegmatite (Jefferson)
Wilkerson Pass (Park)
Wire Patch (Summit)
Wolf Creek Pass (Mineral)
Wolfton (Lake)
Wood (Gilpin)
Yankee Girl (Ouray)
Zuni (San Juan)

What's New in Colorado Minerals?

by **Richard A. Kosnar**
Route 6, Box 263
Golden, Colorado 80401

S *ince the publication of the first Colorado issue of the* **Mineralogical Record** *in November of 1976 a number of significant developments have occurred with regard to the specimen-producing mines and mineral localities in Colorado.*

First, on a depressing note, a number of prolific specimen localities have terminated activity on a more or less permanent basis. Some of the localities have been temporarily hampered and a few of the newer potential specimen-producing localities have gone the way of so many other great promotions in the mining industry. Even in the case of good mines, some promoters have reaped more profit directly from the pockets of investors than they have from pockets of ore.

Probably the most significant mine closure in the state of Colorado was that of the Idarado mine in Telluride. For almost 100 years it has been a prolific source of classic minerals indigenous to the San Juan Mountains of Colorado. Very few collections, both private and public, are without a representative specimen of fine quartz groups that have come from the Idarado, often erroneously labeled Ouray and Silverton. Prior to closing, a small but very interesting pocket was found in the lower workings. It contained beautiful reddish brown acicular crystal groups of piemontite (up to 3/8 inch) implanted on clear drusy quartz crystals and associated with some very fine but small crystals of adularia and large, typical, scalenohedral crystals of calcite up to 1½ inches. The free-flowing nature of these piemontite groups makes for beautiful display specimens and exceptional representatives of the species. Small quantities of fine crystallized gold on quartz and sulfides were also found in the area but did not approach the quality of the larger and more spectacular pieces being found at the same time in the upper workings of the Sunnyside mine at Silverton.

Another interesting specimen producer was the Camp Bird mine, near Ouray, which is the source of numerous, high quality sulfide specimens including the rare mineral greenockite. These were found in association with quartz and fluorite, and occasionally also barite, calcite, dolomite, siderite and epidote. This mine as well had operated sporadically for approximately 100 years but it wasn't until the early 1970's, when work was commenced in the replacement ore body on the 2100 level, that some really exciting specimens came to light.

Both the Idarado and Camp Bird mines were closed due to the depressed market values of base metals and a lack of ore reserves. Prospects for the reopening of either of these two mines seem dim.

One of the most popular specimen localities in Colorado, the Sunnyside mine (American tunnel), near Silverton, was closed rather unexpectedly by a quasi-natural disaster. It seems the management of the mine felt compelled to stope underneath Lake Emma (due to the fact that the lake was sitting on some of the richest gold ore anywhere in the state), and one Sunday morning the lake caved in on the C level, completely flooding and destroying miles of mine workings at a cost of millions of dollars. Fortunately, no one was in the mine at the time, but had the accident occurred the following day at least 150 miners would have been killed, making it potentially one of the most catastrophic mine accidents in the western United States.

Since the 1960's, the Sunnyside mine has produced numerous pink and rose-colored rhodochrosite specimens, usually on drusy white quartz crystals sometimes associated with green fluorite octahedrons. These specimens have been prized and sought after by collectors and, due to the abundance of specimens found, have been widely dispersed throughout collections in the U.S. and Europe. On the bright side, it seems apparent that the Sunnyside mine will resume production, probably in the early part of 1980, however, prospects for more good rhodochrosite specimens from the lower workings do not seem very good at this time. In some of the stopes below Lake Emma, prior to the cave-in, truly exceptional crystallized and wire gold specimens were recovered. Some of the gold crystals have a brilliant, mirror-bright luster and reach 3/8 inch on a face.

Another well-known and specimen producing mine, the Eagle mine at Gilman, which had been operated from around the turn of the century, has also succumbed to unfavorable economic conditions and has terminated operations. The Eagle mine was most noted for its classic, gemmy, golden barite crystals and plates of fine, bright pyritohedral pyrite which have also been prized and widely distributed in collections. More recently, the Eagle mine has been a source of some very fine and interesting rhodochrosite specimens, the best of which were disk shaped, rose-red crystals perched on black sphalerite (see *M.R.*, **7**, p. 306) as well as some lustrous, pale green, gemmy apatite crystals reminiscent of some of the material from Panasqueira, Portugal, with crystals usually found up to ½ inch and implanted on crystallized sulfides sometimes associated with siderite.

Less prolific localities such as the Urad mine in Berthoud Pass, which was the source of fine red rhodochrosite crystals (*M.R.*, **7**, Fig. 5, p. 282) and fine, transparent fluorite octahedrons (*M.R.*, **7**, Fig. 16, p. 287), also has been closed permanently. The adjoining property owned by the AMAX Corporation has been opened but, to date, has not produced many significant mineral specimens. Nevertheless, the potential here seems good for rhodochrosite, fluorite, pyrite, galena and other species.

Mining operations have also ceased at the Bachelor mine at Creede, which has produced excellent sphalerite and galena specimens; at the Little Annie vein in Summitville, which produced some fairly good crystallized covellite; at the Buffalo Boy mine, up Cunningham Gulch outside of Silverton, which had started to produce some good ruby silvers; at the Dixie mine up on Ute Creek outside of Idaho Springs, which produced some fine crystallized matrix gold specimens; and, lastly, at notable mines such as the Osceola and Ransom mines in the Silverton area, shut down without prospects of reopening in the near future.

On the positive side, a number of good Colorado specimen localities have come into existence since 1976, and have yielded some exciting mineral specimens, some of which transcend anything found previously in Colorado. Several of the most noteworthy localities are in Leadville. The Sherman mine, which has been taken over by Day Mining Corporation, has produced some incredibly fine, large (up to 4 inches) gemmy golden barite crystals on matrix. In our opinion, the best of these is much more spectacular than any of the golden barites produced from the now-defunct Eagle mine at Gilman. The Sherman mine has also produced some excellent, bright pyrite groups, some of which consist of pyrite crystals on crystallized dolomite, a few incredible, large, gemmy red sphalerite crystals (up to 1 inch), and minor amounts of crystallized and wire silver associated with sulfosalts and secondary ore minerals in the oxidized zone of the mine. This could well be one of the most significant Colorado localities if mining continues and specimen preservation prevails. There have also been a number of fine specimens of pyrite, galena and sphalerite produced from the Black Cloud mine in Leadville. The prospects for more material look very good.

Figure 1. **Golden barite crystals to 0.75 inch on dolomite 2.5 inches across, from the Sherman mine, Leadville, Lake County, Colorado. Specimen and photo: R. A. Kosnar.**

The Climax Molybdenum mine still remains a tragic case for mineral collectors in view of the fact that the mine processes 47,000 tons of ore a day from the well-mineralized deposit, but the management makes a concerted effort to destroy every crystal encountered. The insensitivity of the management at this mine has been a cause of consternation for mineralogists and mineral collectors familiar with this operation. The Climax mine, in spite of these adverse circumstances, has produced some incredible gemmy red rhodochrosite crystals up to 2 inches on quartz matrix, often associated with gemmy sky-blue fluorite cubes (*M.R.*, **7**, ref. 48, p. 283), as well as some of the largest bright cubic pyrite crystals found anywhere in the world.

In the San Juan area mining activity has produced very fine specimens, including fine deep purple amethyst groups from the Bulldog mine (Homestake's Puzzle System Mining and Milling complex, Creede). The best specimen of this material recovered is now in the collection of the Denver Museum of Natural History (11 by 8 by 6 inches). Very fine wire silver has also been recovered. The specimens were very interesting and esthetic: wires of silver perched

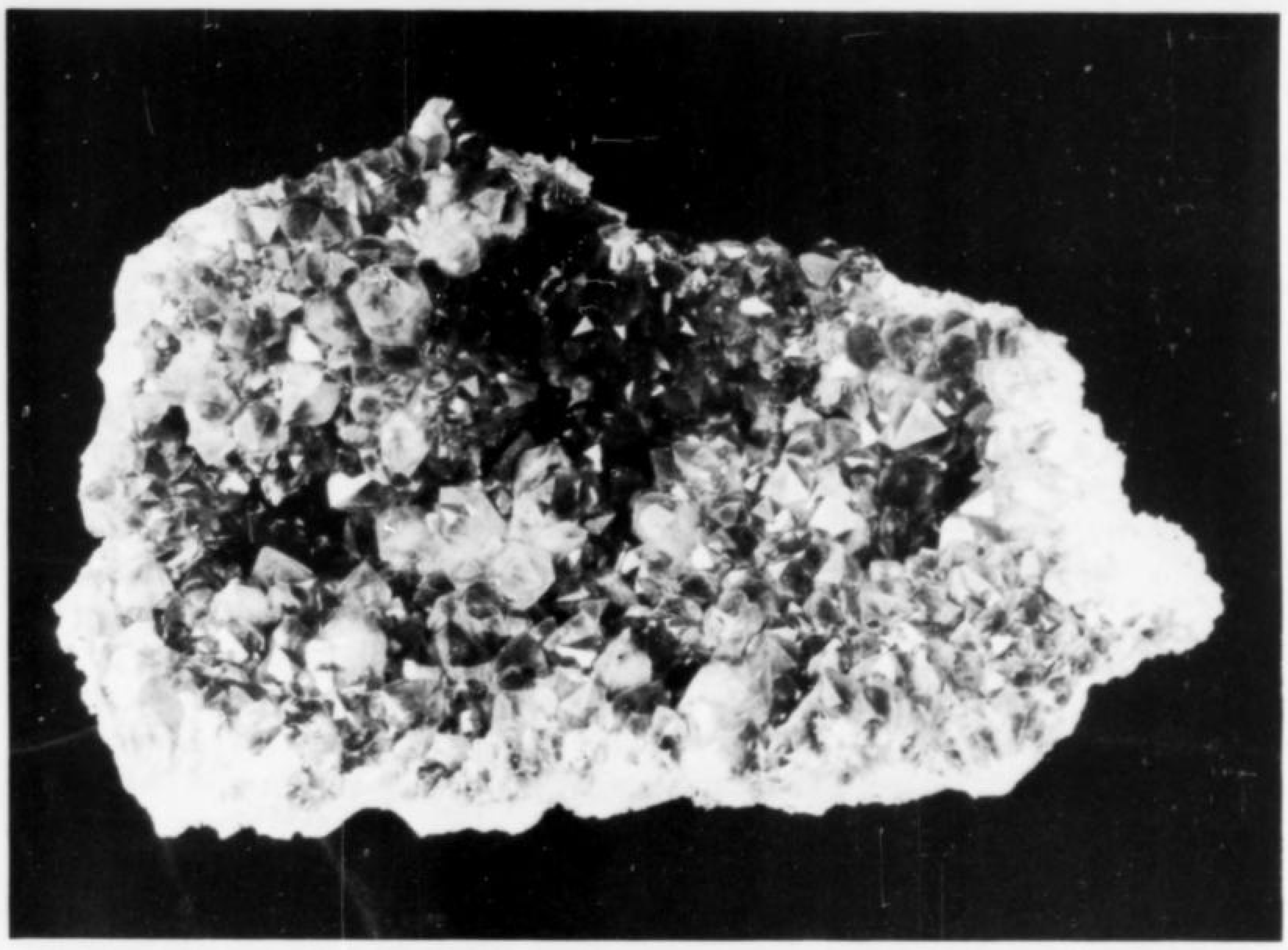


Figure 2. **A plate of amethyst crystals 11 inches across from the Bulldog mine, Creede. Collection of the Denver Museum of Natural History.**

Figure 3. **Jalpaite crystals to 1.2 inches in a group 2.5 inches tall, from the Caribou mine, Caribou, Colorado. Specimen and photo: R. A. Kosnar.**

on bright cubes of "argentite" (actually acanthite after argentite). Fine crystals of pyrostilpnite (up to ½ inch long), bright polybasite (½ inch crystals), tetrahedrite (½-inch crystals, silver bearing) and pyrargyrite crystals (up to 5/8 inch long) were recovered from this area of the mine.

At the Champion mine, Lake City, some very interesting rose-pink rhodochrosite rosettes associated with common sulfides were recently found. This mine certainly has the potential for producing bigger and better things.

Two interesting mines opened in the Silverton area have produced fine specimens. The Yukon mine, located up Cement Creek, produced an abundance of fine crystallized huebnerite, associated with pale green fluorite crystals, which makes for attractive display specimens. This mine also produced minor amounts of crystallized rhodochrosite and sulfides although nothing of great importance. The Brooklyn mine, which is located north of Silverton, was recently reopened and a crystal cavity was found containing specimens of crystallized, wire, and leaf gold in association with pink rhodochrosite rosettes, well crystallized, gemmy sphalerite and bright galena, pyrite and chalcopyrite crystals. These specimens are not only attractive but unique and indicative of the interesting associations that can be encountered in the Silverton area. In association with these specimens are some brilliant, modified crystals of petzite and altaite (up to ¼ inch). These crystals are commonly perched on the ends of crystallized and wire gold and represent some of the most attractive examples of this specimen found anywhere. This mine is currently operating and specimens are being preserved, so the locality should be a good source of this very desirable and attractive material in the future.

A number of small mines in the Ouray area were also opened and worked sporadically in the past few years. The most notable is the Portland mine, located in the amphitheater southeast of town, which was worked on a limited basis during 1977. It produced truly fine, gemmy, olive-green, modified and twinned crystals of sphalerite up to 1 inch in diameter, in crystal groups usually on quartz and calcite matrix, often associated with brilliant pyrite pyritohedrons and minor amounts of skeletal galena cubes. Also found during this period were very esthetic, pale amethyst groups with crystals up to 4 inches long; most were doubly terminated which made for handsome cabinet specimens.

The Michael Breen and the Mountain Monarch mines, located on Engineer Mountain several miles south of Ouray, are also being worked concurrently, on a very limited basis, and have produced some spectacular crystallized rhodochrosites, the best of which were gemmy red, highly lustrous, sharp rhombohedrons perched on fine, clear, crystallized quartz. A number of attempts were made to secure some of these specimens for exhibit and illustration but, due to the intransigence of the local mine operator, all efforts have resulted in dismal failure. In any event, these two mines have produced, and probably will continue to produce, some of the finest quality rhodochrosite crystals found anywhere in Colorado. Due to the lack of mill facilities available in this area at the present time, it doesn't seem probable that any of these small operations will be able to continue, inasmuch as it is not economically feasible to ship what amounts to very marginal ore any great distance.

A silver/gold base metal mining operation at the Cross mine in Caribou, Colorado, was started several years ago by Tom Hendrix of Boulder, Colorado. This mine is located in a very highly mineralized area of the Colorado mineral belt. To date, the number of good specimens recovered has been small. But the finely crystallized sphalerites on quartz and gemmy, colorless crystals of anglesite associated with galena crystals, other common sulfides, and small quantities of wire silver make this a potentially good specimen locality. It is worth noting that as mining operations have progressed the amount of good specimen material has increased almost proportionately.

Production from the pegmatite deposits in Colorado in the last few years has been limited but a significant find of superb, gem-quality aquamarine was recovered up on Mt. Antero, the largest crystal of which, a gem-quality crystal (½ inch by 2-¾ inch), now resides in the collection of the Denver Museum of Natural History. Several fine pockets of dark blue-green amazonite associated with smoky quartz and albite were found by members of the Coil family of Colorado Springs in the Lake George district of Park County. The Coil specimens remain the standard of excellence for amazonite crystals.

Several semi-commercial amethyst mining ventures were undertaken in the Unaweep Canyon area, the results of which rate mixed reviews. However, some of the gem material produced rivals the best quality commercial amethyst on the market today. The amethyst is characterized by distinct zones of alternating dark purple and colorless areas.

A very significant find was made during the past few years at the old Calumet iron mine in the Turret district northeast of Salida, Chaffee County. Several local field collectors exploited a contact zone along a fault and found very esthetic groups of smoky quartz and epidote associated with garnet, clinochlore and "uralite" (actinolite pseudomorph after diopside). The mineral assemblage and appearance of the finer specimens is very reminiscent of some of the fine, pale, gemmy smoky quartz found in the famous alpine clefts in Switzerland. Some of the smoky quartz crystals reach 3 inches long and are commonly doubly terminated. Almost all have a brilliant luster and were found both as singles and as cabinet-size crystal clusters. As a rule, the quality of these smoky quartz specimens is much higher than the better known material from the Crystal Peak area (usually found associated with microcline and various pegmatite minerals). The epidotes are, for the most part, black in appearance but a good percentage of these crystals passed light and exhibit the desirable pistachio-green color. The largest of these bright, lustrous epidotes is approximately 1 inch long. Some are doubly terminated and are perched on both the fine quartz crystals as well as "uralite."

The Book Cliffs area outside of Grand Junction still remains a source of fine, large, clear, colorless barite crystals and probably will remain a good collecting locality for many years to come. Fine specimens show up at an astonishing rate and there seems to be no end in sight to this extensive deposit.

The locally well known barite locality at Hartsel in Park County has also produced very fine sky-blue barite groups rivaling the old classic Frizington (England) specimens. John and Barbara Muntyan of Boulder, Colorado, have recently recovered attractive specimens from this locality and prospects for more of this material seem very good.

As old collections and accumulations of Colorado minerals have come to light over the past three years, a number of superb specimens have been enountered. A noteworthy example of this is a cluster of incredibly large, well-formed crystals of jalpaite (largest crystals 1-¼ by ¾ inches in diameter) from the famous Caribou mine in Caribou, Boulder County. A very large, crystalline, 15-ounce gold on quartz, found in 1948 by Mr. Clancey Fleetwood, of Ouray, in the lower Black Bear vein of what is now the Idarado mine, Telluride, represents one of the finest Colorado specimens ever recovered and preserved from the San Juan Mountains. A spectacular, large, crystallized tetrahedrite on quartz from the Idarado mine, which was once in the collection of Ed McDole, has also surfaced and is probably one of the finest tetrahedrite specimens from anywhere. A comprehensive list of the fine mineral specimens found in the Sweet Home mine, during the 1977 operation by the Intercontinental Mining Corporation and by previous operations, is given in an accompanying article in this issue.

The list of fine Colorado mineral specimens goes on and on. Due to the large number of interesting minerals found in Colorado, as well as the abundance of fine specimens, a book is now being prepared by Hal Miller of Boulder and myself which, we hope, will prove to be an accurate and comprehensive reference work on the mineral occurrences in the state. People interested in seeing examples of the fine specimens that have come out of Colorado localities will do well to visit the mineral section of the Denver Museum of Natural History, which is currently being expanded to facilitate the display of their fine collection of minerals, and also the mineral exhibits at the Colorado School of Mines.

the Home Sweet Home mine

by **Richard A. Kosnar**
Route 6, Box 263
Golden, Colorado 80401

Two stopes in the Mosquito Range of central Colorado have produced extraordinary specimens of rhodochrosite and huebnerite, arguably the world's finest, and also superb crystals of fluorite, goyazite and stromeyerite. Many of these specimens were found as a result of recent mining operations.

INTRODUCTION

The Home Sweet Home mine is located on the south slope of Mt. Bross (14,172 feet) along Buckskin Creek, approximately 3½ miles northwest of the town of Alma. Mt. Bross is on the east slope of the Mosquito Range in Park County, Colorado. The mine, popularly known as the Sweet Home mine today, was originally located around 1895 as a silver prospect. Relatively little production came from the mine, but numerous indications of mineralization extend over approximately 20 adjoining claims. The main development work comprises about 2 miles of underground workings, most of which was done in the 1930's by the owner at that time, Edwin Spray. Mineralization in the area is controlled by minor northeast-trending faults, possibly related in character to the major northeast-trending mineral belt of Colorado.

GEOLOGY

The specimen-rich tetrahedrite/fluorite/rhodochrosite veins are Cenozoic intrusives cutting Precambrian granite gneiss which is exposed along Buckskin Creek from the Home Sweet Home mine to the head of the creek. The most productive veins occur within a zone of alteration characterized by sericitization of the wall rock. The veins are localized in northeast-trending minor fractures cutting the altered zones. The vuggy characteristics of these veins seem to imply open-space deposition, perhaps in tensional fractures.

MINERALOGY

The minerals observed in the Colorado vein, which passes through both the Home Sweet Home and the Pulaski claim, are typical of the fluorite/rhodochrosite veins occurring in the area, quartz being the primary and earliest of the hypogene minerals along with huebnerite and sulfides.

The paragenesis of the hypogene sulfides consists of pyrite as the first to crystallize, followed by sphalerite, galena and chalcopyrite along with argentite, tetrahedrite, tennantite, freibergite and later depositions of bornite, stromeyerite and minor amounts of native silver. The later depositions include crystallized rhodochrosite, fluorite, apatite, calcite, siderite and goyazite. In some of the altered wall rock, sericite aggregates associated with quartz, huebnerite, pyrite and molybdenite were encountered in contact with small pegmatites which contained microscopic crystals of topaz, zircon, rutile, xenotime and brannerite. These minerals amount to little more than mineralogical curiosities, as they do not occur in large or esthetic crystallizations.

THE #1 STOPE

Typical crystal cavities in the #1 stope on the Colorado vein (which is approximately 300 feet from the portal) are quartz-lined, and contain euhedral crystals of pyrite, galena, sphalerite, chalcopyrite and fine, dark red, gem-quality rhodochrosite rhombohedrons up to 2 inches in diameter perched on the sulfide/quartz matrix. Minor amounts of pale green apatite as well as fine, dark purple fluorite dodecahedrons and pink to rose-colored fluorite octahedrons were deposited on and with the rhodochrosite crystals. Most of the crystal cavities encountered in this stope were free of any late stage alteration but occasionally small cavities on the hanging wall were found to be full of a bone-white dickite clay and etched and deteriorated rhodochrosite crystals. Where this dickite clay is very compacted and hard, it is nearly impossible to remove without damaging the underlying rhodochrosite crystals.

In the hanging wall of this stope, small quartz cavities with dark purple fluorite dodecahedrons and cubes also occasionally contained rare, perfect, brilliant orange, euhedral crystals of goyazite to ¼ inch across; however, most of the goyazite present was found disseminated in the wall rock and again only represented a mineralogical curiosity. Although the potential for larger and more

Figure 1. **Goyazite crystal, 0.16 inch, with quartz and sphalerite from the Home Sweet Home mine. Specimen, R. A. Kosnar.**

Figure 2. (below left) **Fluorite dodecahedrons 0.24 inches across with quartz from the #1 stope, Colorado vein, Home Sweet Home mine. Specimen, R. A. Kosnar.**

perfect crystals seems promising because of the extensive nature of this quartz/sulfide/fluorite mineralization, no more have thus far been encountered. Bladed rosettes of opaque barite were also found in this area, the only area in the mine where barite has been found.

THE #2 STOPE

The #2 stope, approximately 700 feet from the #1 and approximately 1,000 feet from the portal on the main level, produced the most exceptional rhodochrosite crystals. The earliest recorded production of these crystals came in the early 1960's during leasing operations which were in part financed by mineral dealer Ed McDole. During this period, a good number of exceptional rhodochrosite crystals up to 4 inches on an edge were recovered through an operation conducted by McDole and a local miner living in Alma. One of the crystal cavities first encountered during this period had dimensions of 6 by 4 by 2 feet and contained dozens of large, perfect, deep red, gem-quality rhodochrosite rhombs, usually found implanted on quartz crystals and accompanying sulfides and sulfosalts.

Figure 3. **Fluorite dodecahedron on quartz; note the tiny blue apatite crystal perched atop the fluorite. From the #1 stope, Colorado vein, Home Sweet Home mine. Specimen, R. A. Kosnar.**

Figure 5. **A 2.5-inch rhodochrosite crystal on matrix from the Home Sweet Home mine. Smithsonian specimen; photo by Breck P. Kent.**

Figure 4. **A gemmy huebnerite crystal 1 inch tall with bornite and pale green apatite, from the Home Sweet Home mine. Specimen, R. A. Kosnar.**

Figure 6. **A 4.8-inch rhodochrosite with a small piece of matrix attached, from the Home Sweet Home mine. Collection of the Denver Museum of Natural History. Photo by John Muntyan.**

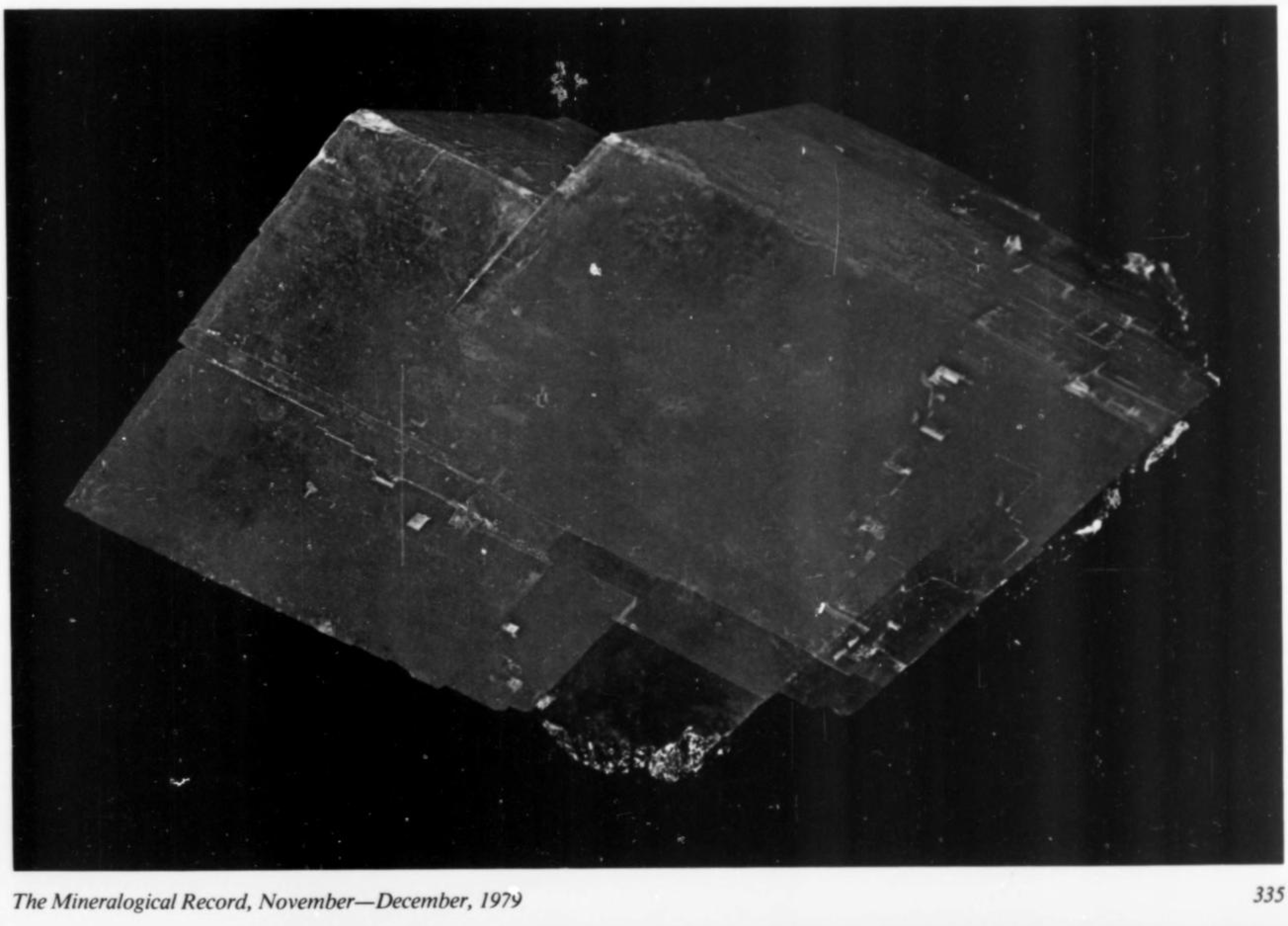


Figure 7. **Location map showing the town of Alma and the various important mines in the nearby mountains.**

From the early 1960's until 1977, when a legitimate mining operation was undertaken by Intercontinental Mining Corporation (Richard Kosnar and John Saul, owners, who obtained a five-year lease from Leonard Beach of Denver), numerous specimen collecting operations were undertaken by various mineral collectors from Colorado as well as Arizona and California. The results of these operations were phenomenal in view of the fact that the mining procedures and equipment used were somewhat less than ideal and all work had to be done without the aid of proper ventilation, compressors and standard drilling equipment. On numerous occasions large sulfide pockets were encountered. Probably the best rhodochrosite crystals ever recovered from this mine were taken out during this period. The minerals observed during the Intercontinental Mining Corporation's venture in the summer of 1977 were extensive although the rhodochrosite crystals found were not nearly as spectacular as some of those recovered during earlier operations.

The paragenesis of the #2 stope follows that of normal tetrahedrite/rhodochrosite/fluorite vein structures in this area. Quartz crystals represent the earliest mineral deposited in the vein, usually as elongated, clear, needle-like crystals along with euhedral crystals of pyrite, sphalerite and galena. The sulfide crystals rarely exceed ½ inch but are usually well formed, highly modified and brilliant. Some of the galena crystals, combinations of cube and octahedron, are perfectly formed. The crystals of chalcopyrite and bornite,

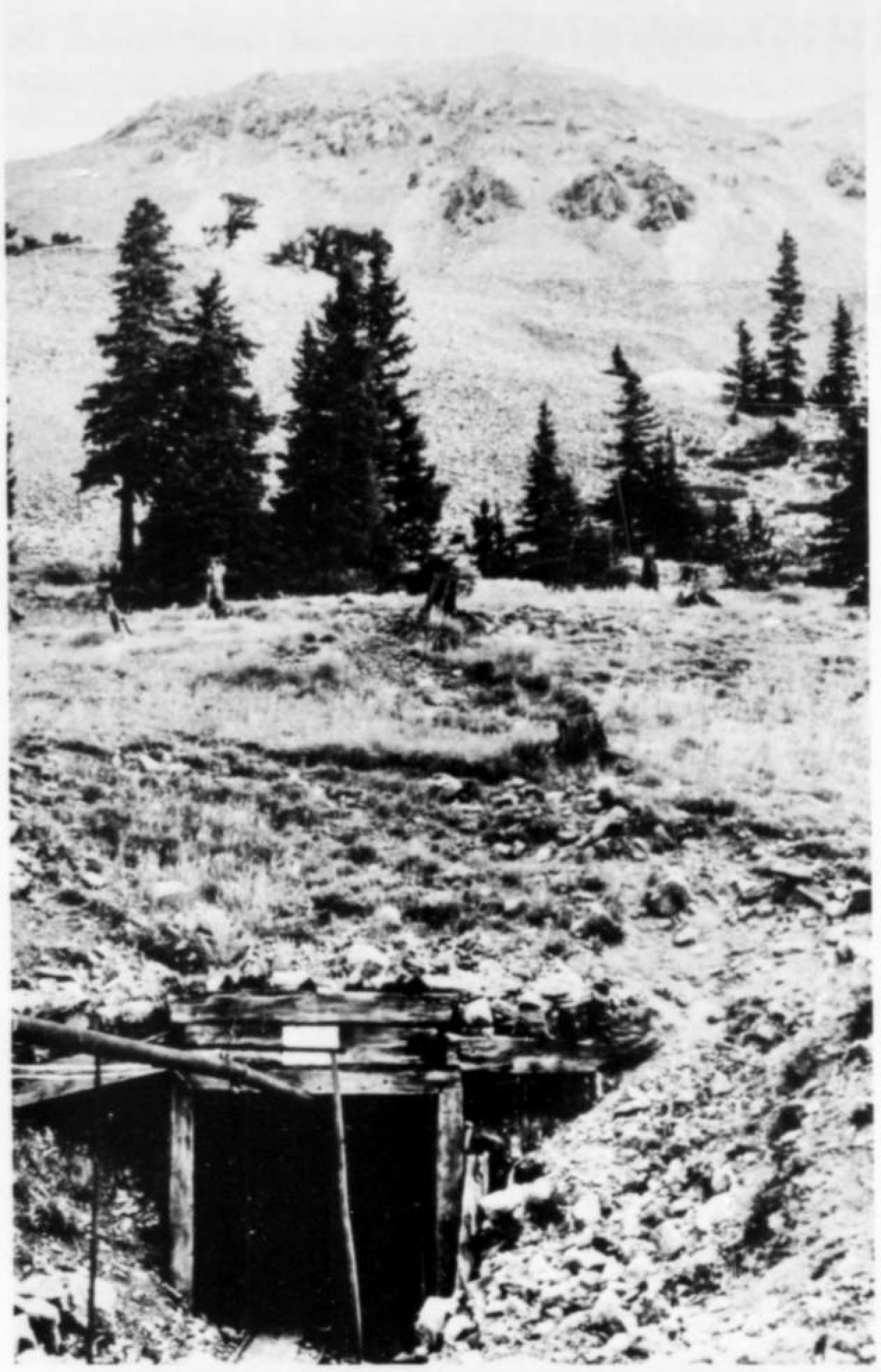


Figure 8. **The portal of the Home Sweet Home mine in August, 1977. Photo by R. A. Kosnar.**

found as rough and rounded masses up to ½ inch, do not exhibit distinctive morphology.

One of the crystal cavities in the footwall of the #2 stope did produce some very fine but small (3/8 inch) crystals of tetrahedrite, tennantite and freibergite associated with the common sulfides, huebnerite and rhodochrosite. It is worth noting that some of the huebnerite crystals, though small, are lustrous, gemmy, ruby-red, euhedral crystals that are far and away the finest quality huebnerite crystals ever seen by the author, even transcending the very fine specimens which have been found at Pasto Bueno, Peru, in recent years. Although the Peruvian material has been found in exceptionally large crystals (7 to 8 inches) the quality, for the most part, has been less than ideal except for occasional crystals. The #2 stope also produced small but very perfect, twinned stromeyerite crystals associated with the common sulfides, quartz, rhodochrosite, apatite, and fluorite.

Fluorite in the #2 stope occurs in a wide range of colors and crystal forms, the most common form being the simple cube, as well as cubes modified by dodecahedrons. Colors range from colorless to white, lilac, deep purple, sky-blue, greenish blue, mint-green and, rarely, orange. Some bi-colored green and lilac octahedrons were also found. The rarest and most interesting fluorite morphology encountered was the dodecahedron, in blue and purple crystals of textbook perfection. A number of these crystals were found during earlier operations and some of the crystals observed by the author measured up to 1½ inches in diameter. Quite possibly these variously colored, gemmy fluorite dodecahedrons represent the finest examples of this crystal form of fluorite found anywhere in the world. These fluorite specimens are further enhanced by their association with gemmy red rhodochrosite rhombs, quartz crystals, various crystallized sulfides, and gemmy, pale green apatite crystals.

Apatite crystals were found, at times abundantly, although usually as small crystals. They are very attractive, doubly terminated, prismatic, pale green to greenish blue crystals usually implanted on quartz, sulfides, huebnerite and, primarily, rhodochrosite. Some of the associations of the dark red, gemmy rhodochrosite; purple, gemmy, dodecahedral fluorite and lustrous, gemmy apatite make for some of the most attractive and unique specimens, not only from the Sweet Home mine but from anywhere in Colorado. The associations and morphologies of these crystals are unique to the Colorado vein and, to the best of our knowledge, have never been observed anywhere else in the Colorado mineral belt.

IMC MINING IN 1977

Our mining operation consisted of drifting, raising and occasionally stoping in and along the vein where crystal cavities were prolific. Almost all of the material from the crystal cavities encountered was preserved during the operation due to the diligence and patience of Dave Bergman, the mine foreman. His years of ex-

Figure 9. **David Bergman, mine foreman, working in the #2 stope, Colorado vein, in the Home Sweet Home mine, August, 1977. Photo by R. A. Kosnar.**

perience collecting crystals in the Camp Bird mine in Ouray, Colorado, were an invaluable asset during this operation due to the fact that removal of these particularly soft and cleavable minerals from an incredibly hard granite gneiss wallrock at times seemed an almost impossible feat. During the author's six months of supervising this operation, it became painfully obvious that recovering a large, gemmy rhodochrosite rhomb intact on matrix was almost impossible. These conditions account for the fact that almost all of the matrix specimens recovered during prior specimen collecting operations had to be repaired or, more accurately, reconstructed from numerous fragments. The conditions present during our mining operations, as well as during previous endeavors, were certainly not conducive to recovering the ideal collector's items that are so sought after and so highly prized.

CONCLUSIONS

Because of the erratic nature of the rhodochrosite-bearing vein (Colorado vein), further development work was not feasible due to the exorbitant costs as well as the lack of visible indications of rhodochrosite on any of the faces in the #2 stope. Intrusions of pegmatite dikes had cut and totally obliterated the vein structure. The problems encountered in the #1 stope of the Colorado vein were equally disastrous; highly altered rock on the hanging wall became hazardous and presented a potentially deadly situation. On several occasions large slabs of this material came down unexpectedly while mining was under way and made it almost impossible to continue work. Additionally, this highly altered rock was almost barren of any rhodochrosite crystals that had not been attacked by late stage alteration. The potential for any further production from this mine seems to be very small with the exception of the tungsten and molybdenum veins present at a much higher altitude than the rhodochrosite vein.

In summation, our observations of the various minerals found at the Sweet Home mine have covered a number of species in crystals of a quality as good as or better than crystals found anywhere else in the world, the most obvious of these being the fine, large, gemmy red rhodochrosite crystals as well as the very rare but nonetheless exceptional crystals of goyazite and stromeyerite. It is also noteworthy that the enormous number of fine specimens produced from this mine have come from two stopes that are no more than 50 feet in length and 25 feet in height, far and away the most concentrated and prolific specimen-producing veins in the Colorado mineral belt, and one of the greatest specimen producing mines in the world.

Mount Antero

by
Mark I. Jacobson
575 Market Street
San Francisco, California 94104

Since the first discovery there in 1885, the popular collecting area around Mt. Antero has produced outstanding specimens of aquamarine, phenakite, bertrandite, fluorite, topaz and smoky quartz.

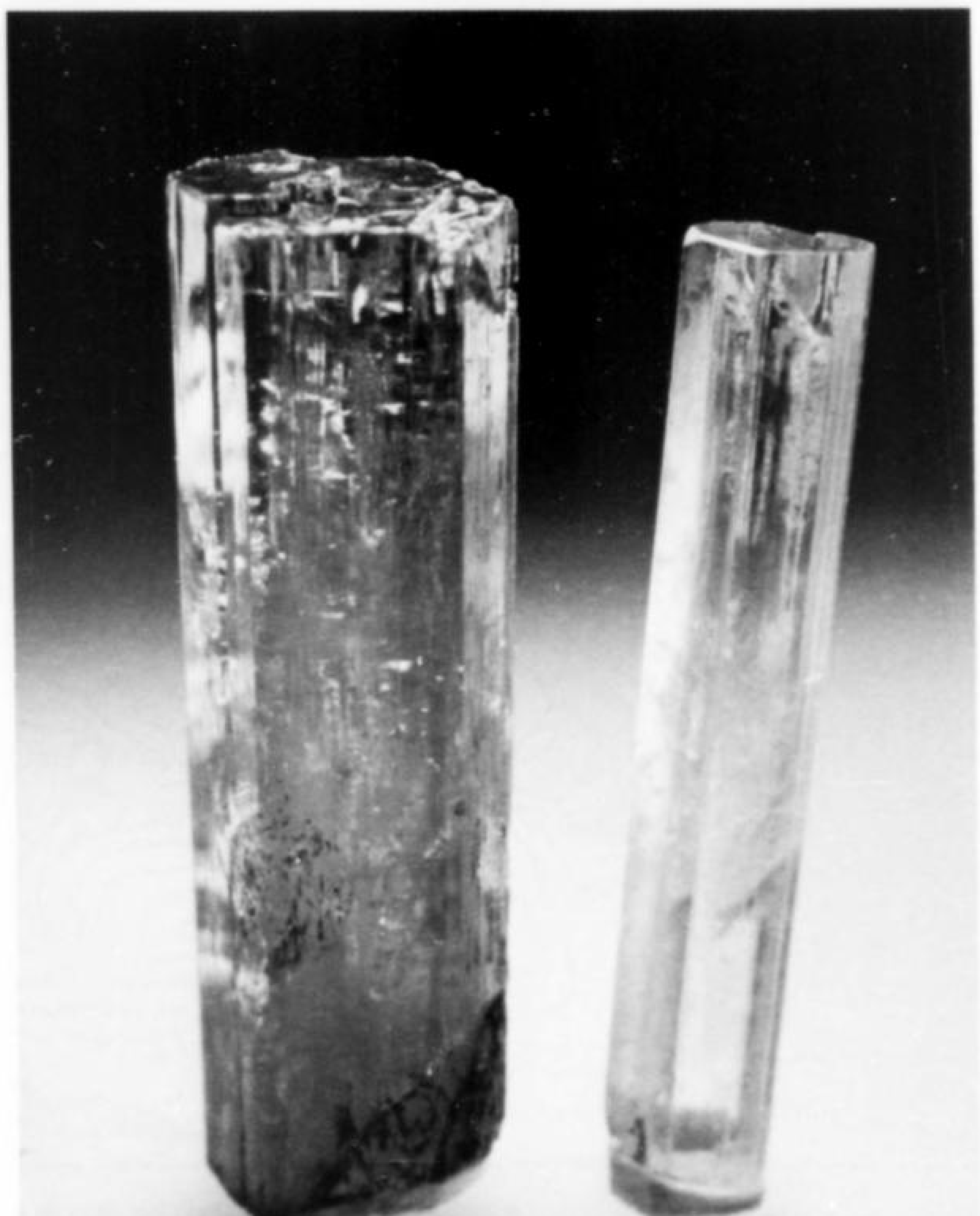


Figure 1. **Aquamarine crystals from Mt. Antero; the left crystal is 7.3 cm tall, DMNH# 11659; the right crystal is DMNH# 12639.**

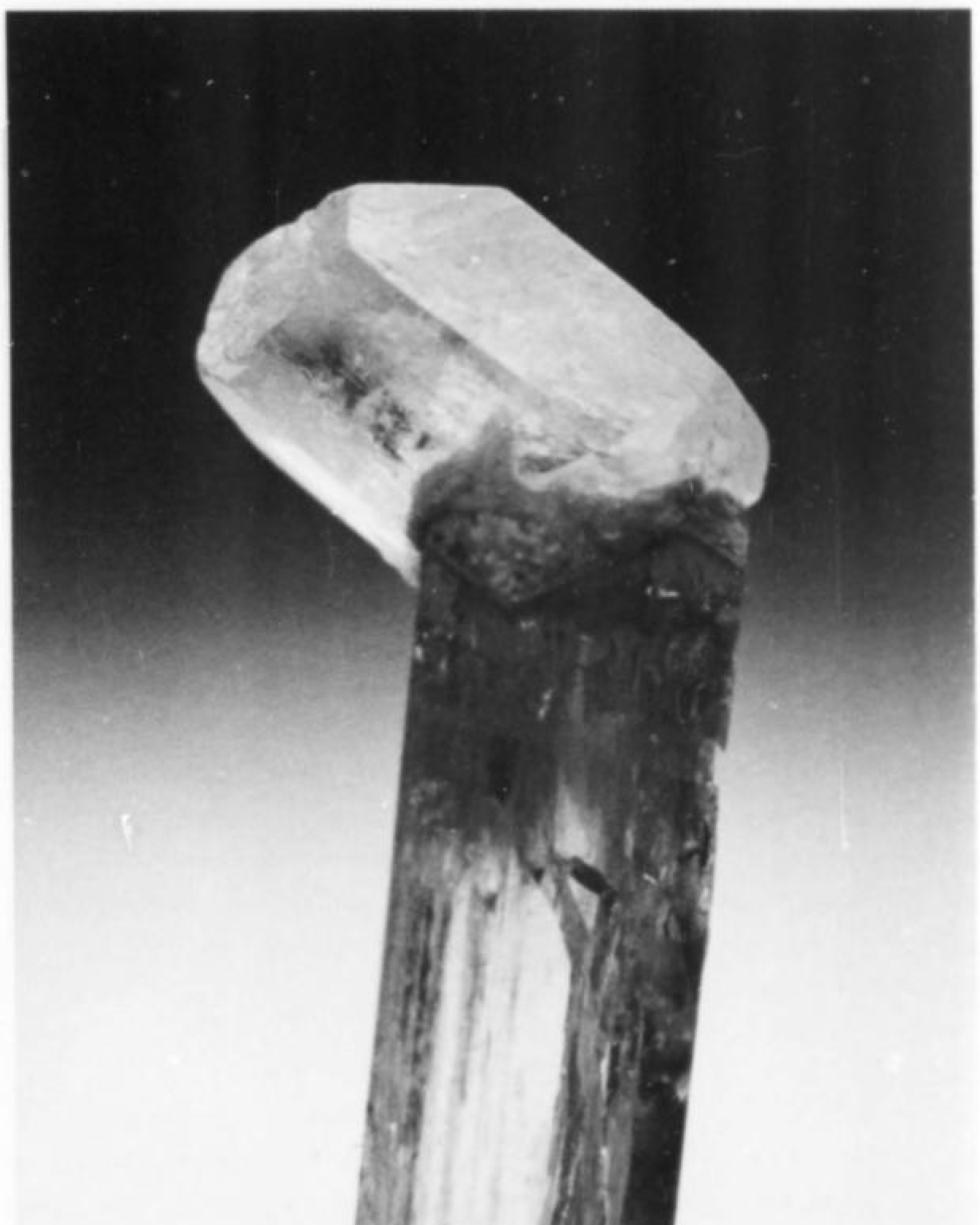


Figure 2. **An 8-mm phenakite crystal perched atop a crystal of aquamarine from Mt. Antero. DMNH# 1709.**

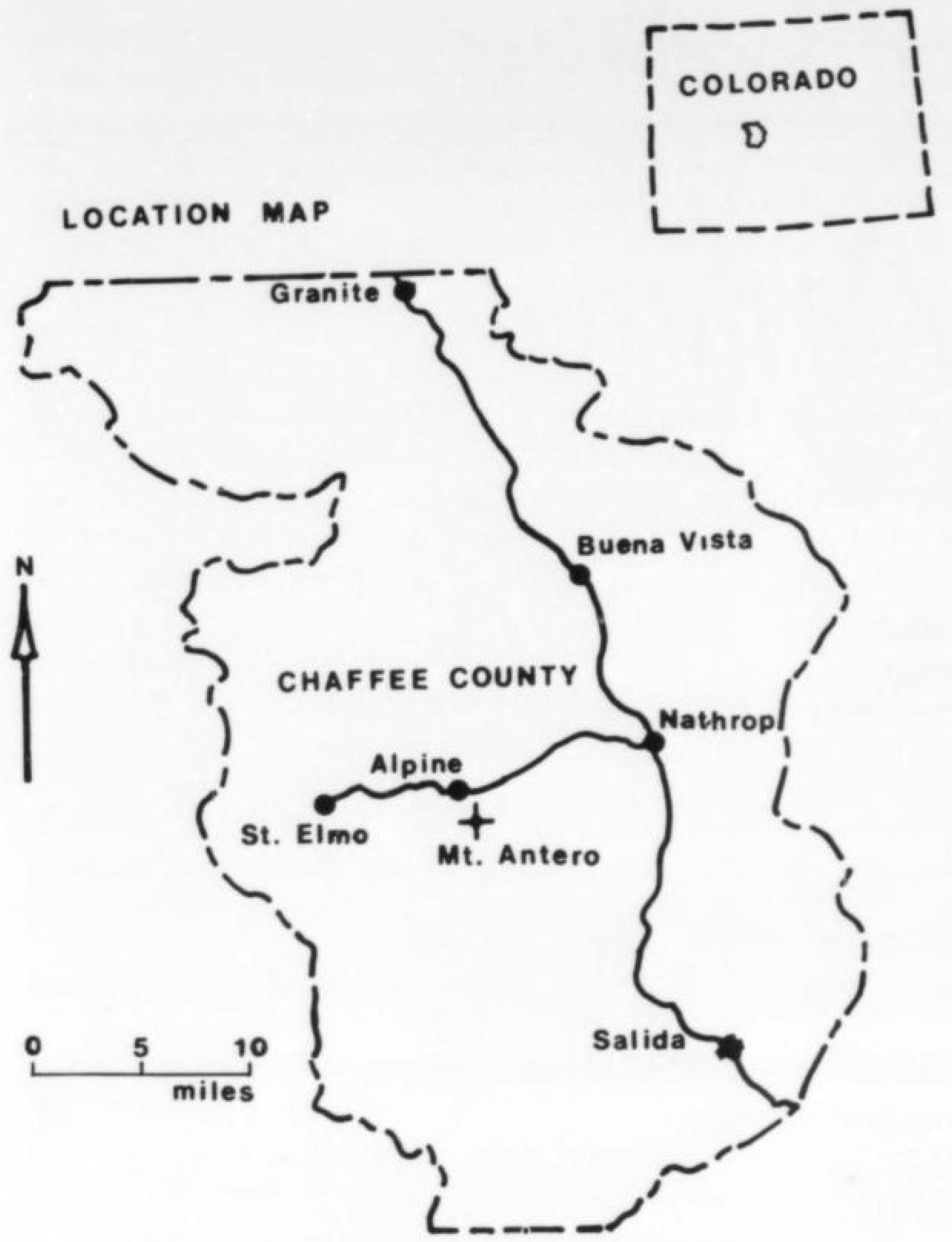


Figure 3. **Location map showing Chaffee County in Colorado and Mt. Antero within the county.**

INTRODUCTION

Mt. Antero is possibly the highest collecting area in the contiguous 48 states, with an elevation above 13,000 feet. Melting snows allow the road to the locality to open in June or July, and autumn snows close off the road in late September; the collecting season is very short. Summer afternoon hailstorms and the low oxygen content of the cold air at these elevations demand persistence and strength from collectors.

The physical beauty of the locality rivals that of the minerals. The tundra meadows flower with alpine sunflowers, asters, and forget-me-nots. While prospecting in the early morning, one can often see a marmot running across an old bulldozer road, or a small bird pecking at insects on a snowbank.

The quality and rarity of the minerals found on Mt. Antero can make them the prize in any collection. Pitch-black smoky quartz, sherry-colored topaz nested on white microcline, amber phenakite on etched aquamarine, purple fluorite octahedrons, and deep-colored aquamarine growing on smoky quartz crystals are treasures that numerous collectors search for each summer. Indeed, it is still possible for the individual collector without explosives or earthmoving machines to find excellent mineral specimens.

LOCATION

Mt. Antero is located in southwestern Chaffee County, Colorado. It is about 8 miles west of Nathrop, and about 15 miles northwest of Salida. Alpine, a cluster of summer homes on Chalk Creek, is situated near the start of a dirt road which is passable only by four-wheel drive vehicles. This road leads to Mt. Antero as well as to the neighboring mountains that are part of a chain of 14,000-foot peaks in the Collegiate Range. The collecting locality is well above the treeline at elevations of 12,000 to 14,000 feet on the upper slopes of White Mountain and Mt. Antero. Mt. Antero has three peaks aligned in a north-south direction, the summit (14,269 feet) is the center peak. A flat alpine meadow south of Mt. Antero separates it from the two peaks of White Mountain. Neither the eastern peak (13,347 feet) nor the western peak (13,600 feet) of White Mountain are as high as Mt. Antero.

HISTORY

Beryl (aquamarine) and other minerals were first reported from Mt. Antero by R. T. Cross (1887). He had been given several aquamarine crystals that were collected by N. D. Wanamaker two or three years before. George F. Kunz, the noted New York gemmologist, published the first notice of Mt. Antero aquamarine in 1887, but listed the locality as the Arkansas Valley. Kunz (1892) considered the color of Mt. Antero aquamarine to be almost as rich as that of the best Brazilian stones. The largest phenakite found at this time (Kunz, 1892) was an inch across and nearly an inch long. W. B. Smith, another Mt. Antero collector in the late 1880's, donated several bertrandite, phenakite, and aquamarine crystals for mineralogic study to S. L. Penfield (Penfield, 1887, 1888, 1889, 1890). R. C. Hill (1889) described the needle-like etched terminations of some Mt. Antero aquamarines. J. D. Endicott was a successful collector during the 1909-1910 seasons (Over, 1935).

Edwin Over, Jr. actively collected on Mt. Antero in 1928, 1931, 1932, 1933, 1938, 1951 and 1953. He carried out limited exploration on Mt. Antero in 1928. Over's subsequent expeditions were for one week in 1931, ten weeks in 1932, and six weeks in 1933. During these trips he camped at the treeline and hiked every day up to the diggings at 14,000 feet. The 1933 expedition resulted in the finding of many single crystals of phenakite (½ to ¾ inch in length) on etched quartz but no aquamarine of importance. The 1932 expedition was probably Over's most successful. That summer he discovered approximately 7 pounds of aquamarine. Three crystals discovered on White Mountain were each approximately 7 inches in length and 1 inch in diameter and of deep

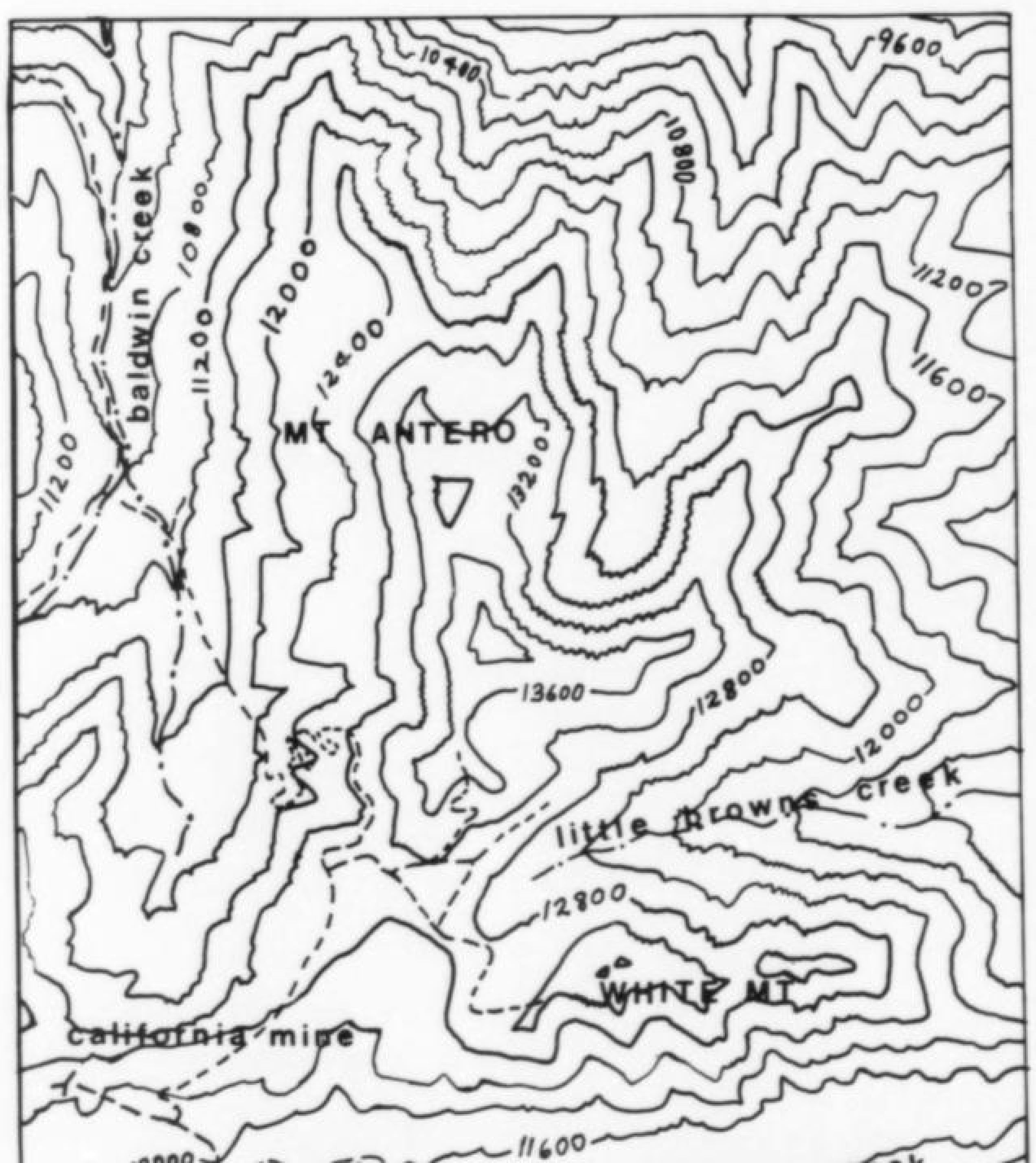


Figure 4. **The Mt. Antero-White Mountain area.**

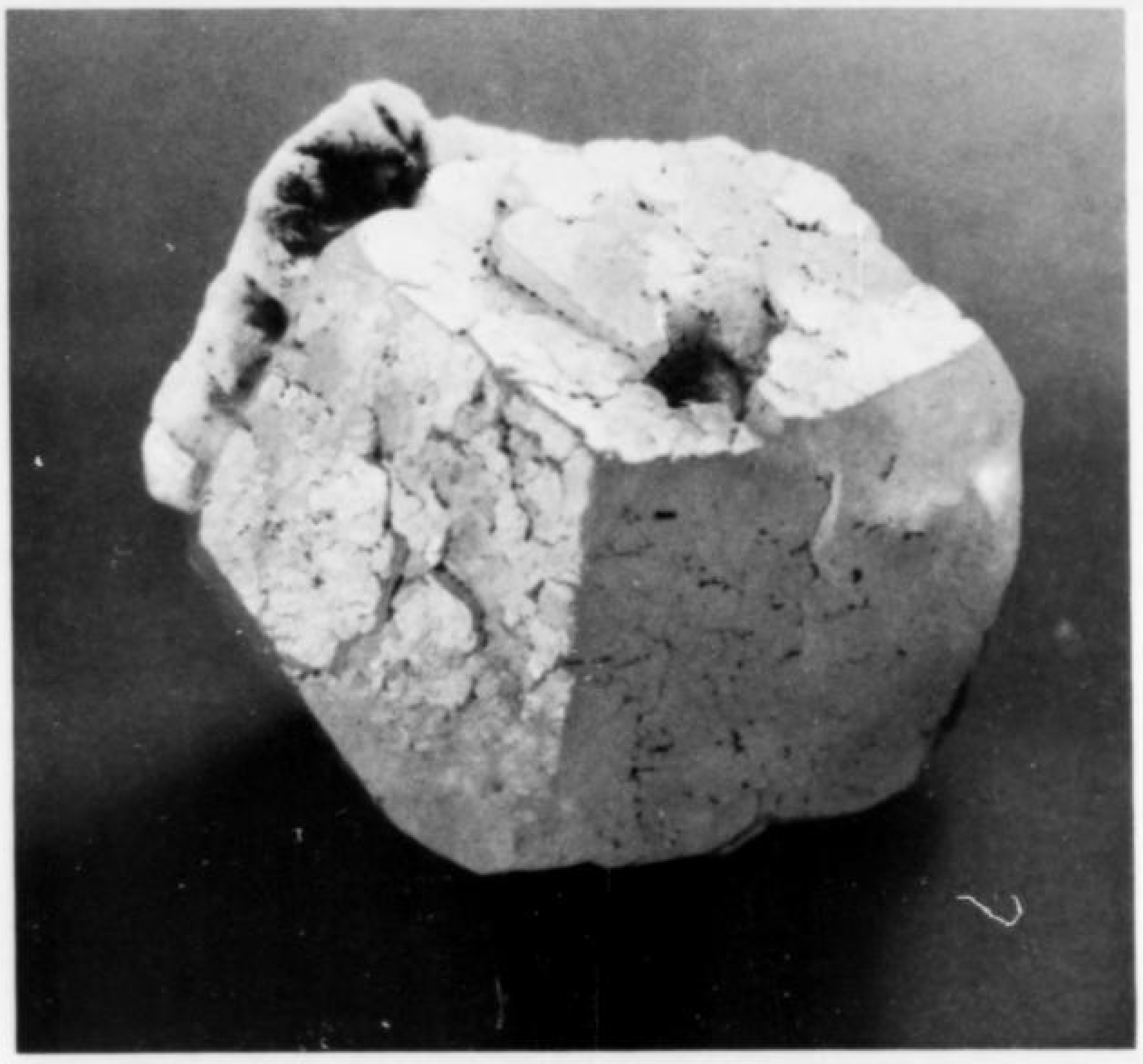


Figure 5. **Two views of an equant, white phenakite crystal about 2 cm in size from Mt. Antero. Collection of the author.**

aquamarine color. All three crystals were sold to Harvard University. He also uncovered 1000 pounds of smoky quartz crystals. One crystal weighed 50 pounds. A miarolitic pocket opened by Over was 5 feet by 2 feet in dimension. From this pocket obsidian-black quartz crystals and white microcline crystals were removed. One microcline crystal weighed 22 pounds.

Ed Over and Arthur Montgomery spent the 1938 collecting season together at Mt. Antero. Ed Over collected primarily on White Mountain, whereas Arthur Montgomery focused his search on Mt. Antero. George Switzer, a guest at their field camp for six weeks that year (and later to be curator of minerals at the Smithsonian), researched the pegmatite occurrences of the Mt. Antero region (Switzer, 1939). The work of Over and Montgomery that summer resulted in many new discoveries. Together they found hundreds of smoky quartz crystals (some a foot in diameter), purple fluorite octahedrons, over 200 crystals of aquamarine, numerous pale yellow phenakite crystals (some 1½ inches in length), and several white bertrandite crystals on quartz. Perhaps the outstanding finds of 1938 were several specimens of aquamarine crystals resting on a matrix of etched feldspar and quartz crystals. Another discovery of note was a fan-shaped cluster of aquamarine crystals which merged to one crystal at the base. Both of these discoveries were found on White Mountain.

Interest in Mt. Antero minerals led collectors to discuss creating a mineral park on Mt. Antero. These thoughts were acted upon on Colorado Day, August 1, 1949, when the Colorado Mineral Society erected a metal plaque on Mt. Antero dedicating the establishment of a mineral park. They hoped a mineral park would secure collecting privileges for everyone and discourage mineral claiming by individuals. The plaque is located along a trail traversing a ridge from the summit to the southern spur.

The U.S. Geological Survey has maintained an interest in the Mt. Antero region over the years, first as a potential source of beryllium and second as a recreational area for amateur mineralogists. Adams (1953) investigated the beryllium potential of the Mt. Antero region. He concluded that the beryllium concentration in the Mt. Antero granite could not be economically exploited. Sharp (1964) made a progress report on the Mt. Antero granite, in which he described the pegmatites as the late derivatives of magma. Sharp (1976) later mapped the geology of the Mt. Antero region. His detailed geologic maps of the California mine and the southern spur of Mt. Antero show the local concentration of the pegmatites.

In 1956, a road was built almost to the summit of Mt. Antero (Fisher, 1957). This road provided access for several mining groups. The Antero

Figure 6. **Colorless, prismatic phenakite crystals about 1.3 cm tall on feldspar. Smithsonian collection (USNM# C5662).**

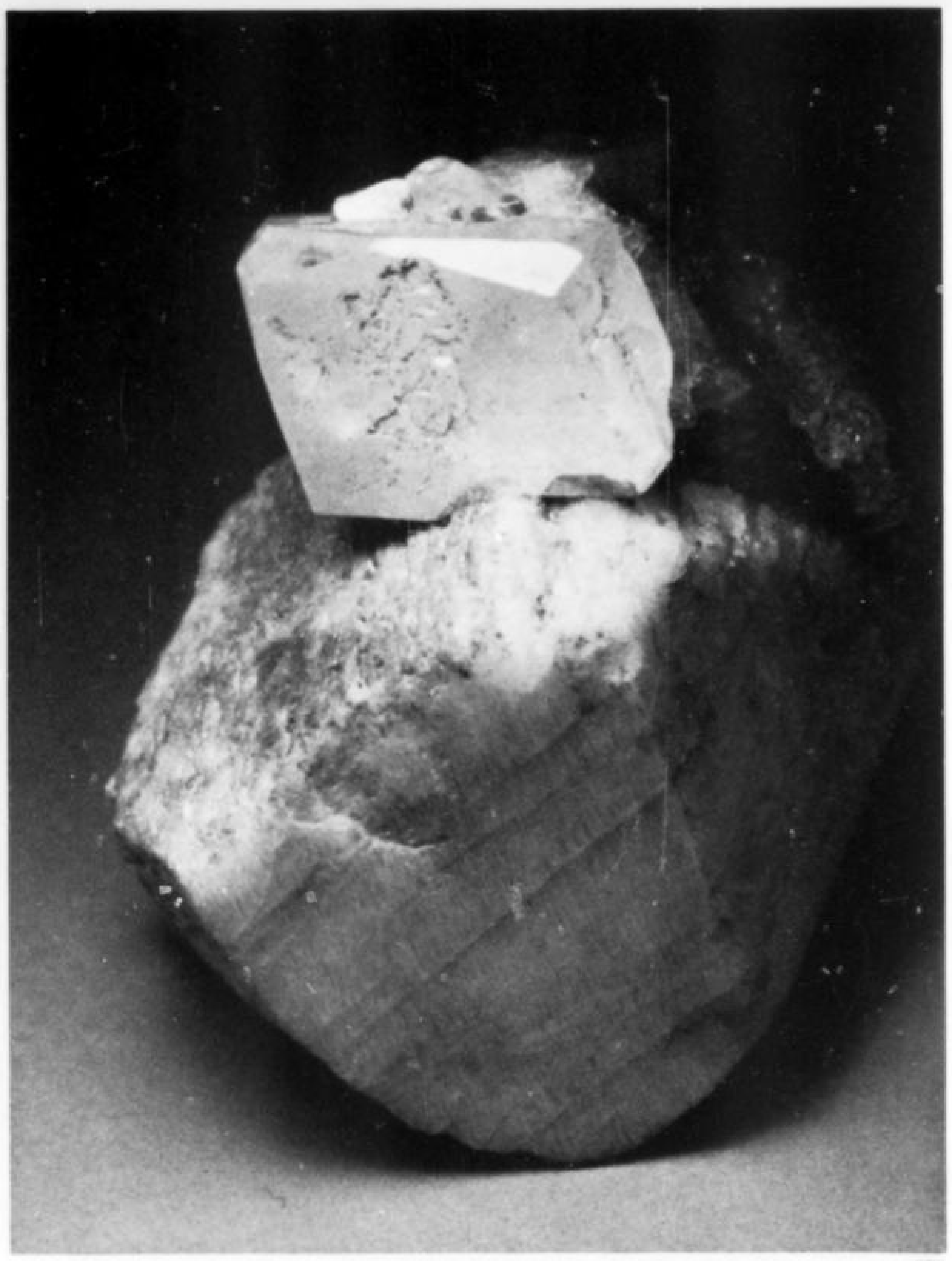


Figure 7. **A phenakite crystal showing rhombohedral habit, about 1.5 cm across, from Mt. Antero. Smithsonian collection (USNM# C2854).**

Mining Company was reported by Pearl (1972) to have started mining in 1956. This may be the company name for a Texas(?) group. They unsuccessfully operated the CYAC group of claims on the southern spur of Mt. Antero for beryllium from 1956 until probably 1962 (Meeves, 1966; Sharp, personal communication, 1978). Wayne Johnson for Vanguard Chemicals took over these claims for the years 1963–1964(?). The claims lapsed soon thereafter. The CYAC workings are composed of one main pit, several small pits and about a dozen open trenches littering the southern spur of Mt. Antero. The Beryl and Atlas group of claims on White Mountain were also unsuccessfully operated for beryllium, mostly during the years 1963–1964 (Sharp, personal communication, 1978) by a Kansas group of partners. This group was responsible for the bulldozing just east and west of the parking saddle on White Mountain. In 1960, a private operator reopened the adit workings of the California mine to examine it for its beryllium potential. In 1963–1964 Union Carbide obtained and released an option on the vein for molybdenum (Meeves, 1966; Sharp, personal communication, 1978).

Mineral prospecting on Mt. Antero and White Mountain during and after these operations has been done by numerous weekend and seasonal collectors. Intense collecting at this locality has made finding pegmatite pockets more difficult, but persistent prospectors are still successful. Collections of Mt. Antero minerals in Denver and Colorado Springs show an abundance of high quality specimens of aquamarine, phenakite, bertrandite, and topaz.

ACCESS

The locality is entirely within the San Isabel National Forest. The land is accordingly in the public domain except for the patented California mine. Access to the pegmatites on Mt. Antero and White Moun-

Figure 8. **Colorless, twinned phenakite crystal about 1 cm in size on matrix with purple fluorite octahedron (upper left). Smithsonian collection (USNM# C5659).**

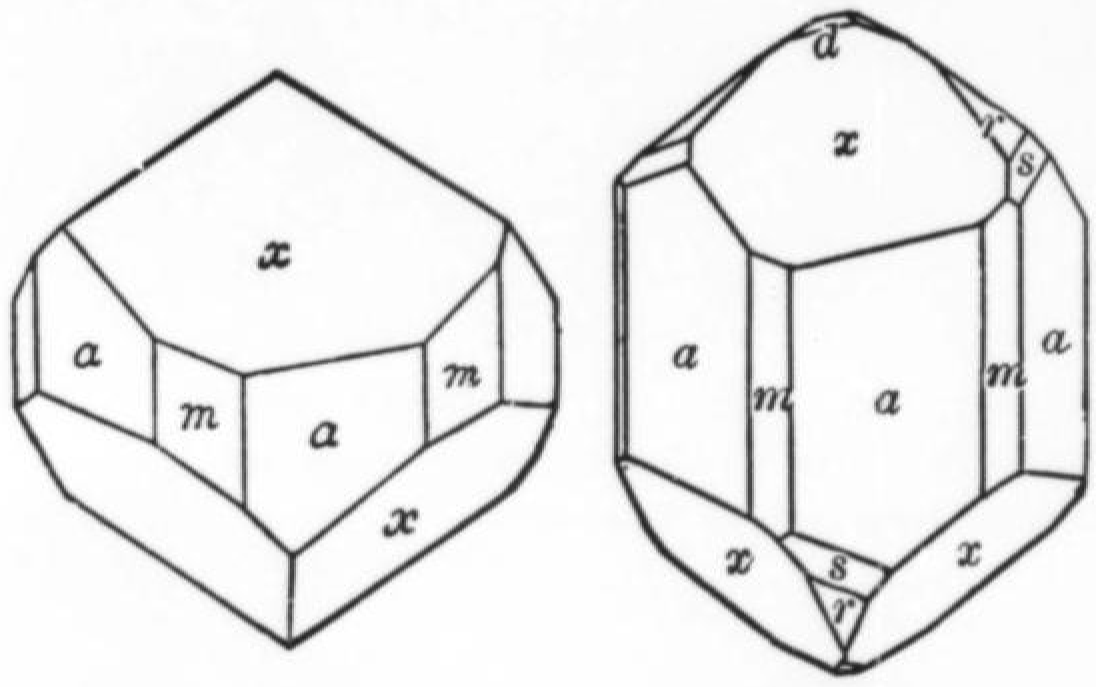


Figure 9. **Crystal drawings of Mt. Antero phenakite (after Penfield). The crystal forms are: $a\{11\bar{2}0\}$, $m\{10\bar{1}0\}$, $x\{12\bar{3}2\}$, $d\{01\bar{1}2\}$, $r\{10\bar{1}1\}$, and $s\{3\bar{1}\bar{2}1\}$.**

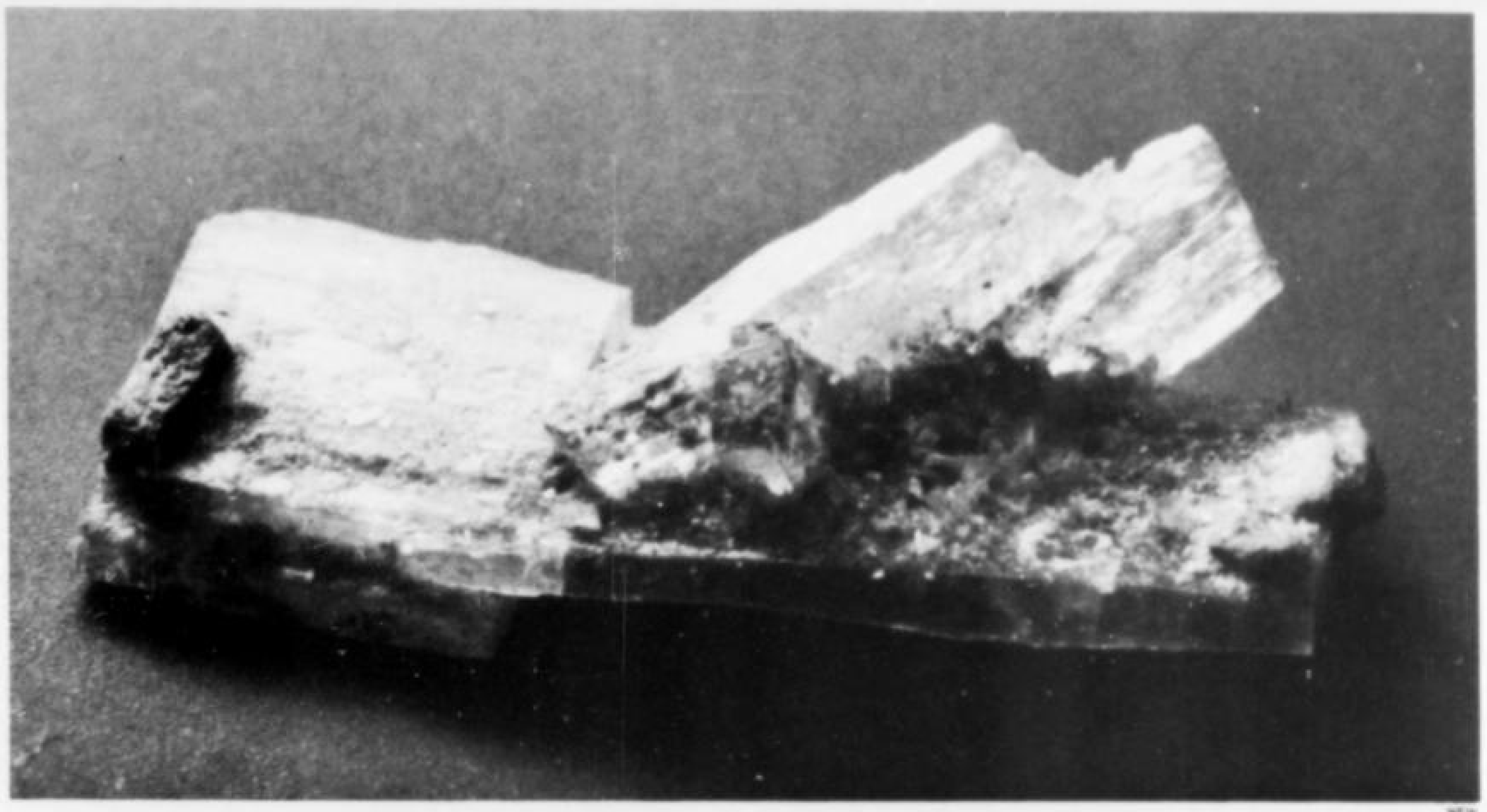


***Figure 10.* A colorless bertrandite crystal, about 1.6 cm long, in platy habit characteristic of Mt. Antero bertrandite. Collection of the author.**

tain was difficult, until recently. The 1917–1918 operations at the California (molybdenum) mine on the eastern ridge from Baldwin Mountain provided a wagon road from Nathrop on the valley floor to the beaver dams on Browns Creek. A 6-mile trail from there led to the mine. In addition, a road 4 to 5 miles long following Baldwin Creek went from Alpine to within 1 to 2 miles of the California mine (Worcester, 1918). After a few years, these roads reverted to trails. Access until 1956 continued to be along trails up either Browns Creek and Little Browns Creek on the east side of the mountain, or up Baldwin Creek on the west side. Many collectors probably camped just below the treeline instead of hiking up the mountain every day, thus reducing the climb to the locality to 2000-3000 feet. The amount of climbing necessary to reach the pegmatites in the early days required any collector to be determined, if not heroic. Present-day collectors no longer need such determination. Fisher (1957) reported that a road had been built from Alpine to the basin at the foot of Baldwin Mountain to reach the lead mines located there. The year 1956 marked the beginning of activity by the Antero Mining Company (Pearl, 1972). This company and possibly others, built bulldozer roads to the southern spur of Mt. Antero (the Antero lode of Ed Over) and also onto White Mountain. In 1975, the road from Alpine to Baldwin Creek was again bulldozed. Open access to 4-wheel drive vehicles has made this locality increasingly popular among collectors. On an average weekend there may be a total of six to ten vehicles parked on both mountains.

COLLECTING CONDITIONS

The southern spur of Mt. Antero (or the Antero lode) is the site of some of Edwin Over's diggings. These diggings extend west from the top of the spur partially down to the "bench," a flat area where the dirt road up the mountain makes a turn. The top area in the past has produced smoky quartz, aquamarine, Baveno twins of white microcline and sherry-colored topaz. It has been prospected so heavily that recognition of undisturbed portions is nearly impossible. The author has seen several persons digging in refuse from a pit that he observed being dug the year before. Surprisingly, there have been a few finds of minerals in such refuse.

The bench diggings are currently the most popular and successful. The bench is a flat grassy area where the dirt road makes one last switchback before reaching the saddle between Mt. Antero and White Mountain. To reach the digging area, a collector should park his vehicle on the "bench" and hike uphill towards the southern spur of Mt. Antero. By hiking northward (left) toward a permanent snow field, he will head toward the current digging area. It is located on either side of the snow field, about one-fourth to one-half the way up the ridge. In 1976 the author inspected a flawless terminated crystal of aquamarine about pencil diameter and three inches long that had just been uncovered in this area.

White Mountain, south of Mt. Antero, has been productive in the past. The collecting areas are east of the parking saddle, a flat area with a bulldozer road leading to it. Nothing has been found west of the parking saddle according to an employee of the U.S. Bureau of Mines. The gentle slope on the north side of White Mountain included an active claim in 1976, however its status in 1977–78 is unknown. The slopes on this side have been extensively turned over and float indicators of undiscovered pegmatites are rare. The steep and rocky south side has much better potential because it has fewer old prospect pits and more float indicators due to the steeper slope. The hardy collector has much to gain by prospecting here. However, much hiking is necessary to find untouched pegmatites and at 13,000 feet above sea level hiking is extremely difficult due to the rarified air.

The quartz veins at the California molybdenum mine and adjacent areas have been prospected sporadically for many years. In this area, the sought-after minerals are the colorless variety of beryl (goshenite), but occasionally blue to green beryl is also found. Crystals have been found up to 3 inches in length. This area is not heavily collected, and is relatively easy to work.

COLLECTING METHODS

The most common method for locating unexcavated pegmatites is to trace pegmatite debris or float appearing at the surface back uphill to the original pegmatite. It is easier to do this in areas where less digging has been done, as the excavated material is misleading. The float is traced upslope until no more can be found. At the point where it disappears beneath the surface, a trench is dug to follow the buried float until either a pegmatite is found or all float vanishes.

Desirable float would include fragments of graphic granite, smoky quartz, coarse crystals of mica, or beryl. Tracing opaque, massive white quartz fragments is not recommended, since there are abundant white quartz veins in the area. Pockets of minerals may be found either *in situ* (where they formed) or as colluvial segregations (eroded pockets) in the talus. The major limitation in digging prospect pits is the presence of ice. Permafrost, which may appear anywhere from 2 to 10 feet below the surface, marks the lower digging limit.

GEOLOGIC SETTING

Mt. Antero and nearby White Mountain are composed of Mt. Antero granite of Oligocene age (approximately 30 million years old). The Mt. Antero granite is the youngest of the plutons in the vicinity of Mt. Antero and is part of the Mt. Princeton Batholith. This batholith was intruded into Precambrian gneisses and Paleozoic rocks (Sharp, 1976). The Mt. Antero granite has been subdivided into five variants that are

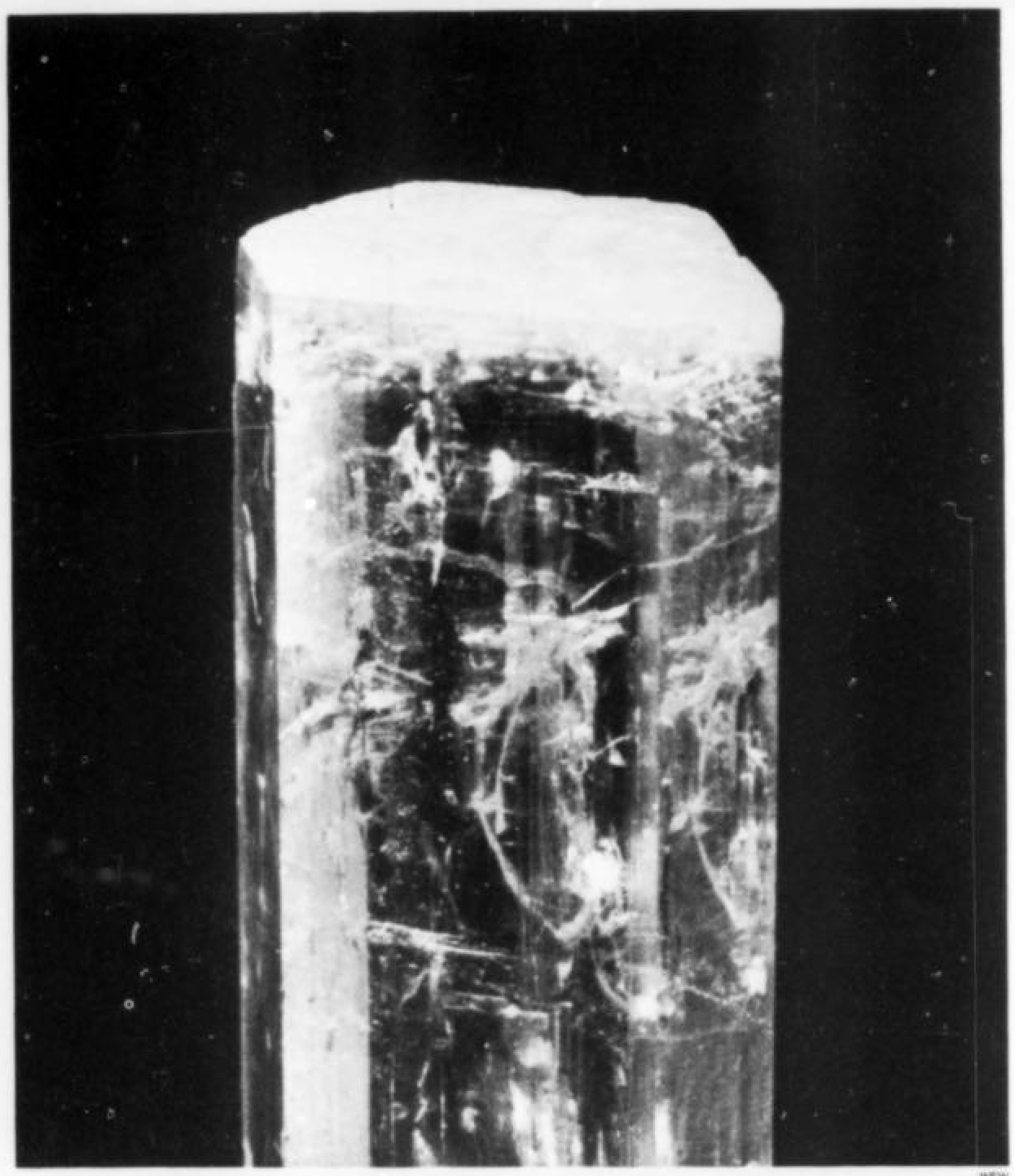


Figure 11. **A pale blue aquamarine crystal about 1.5 cm wide from Mt. Antero. Collection of Don Olson.**

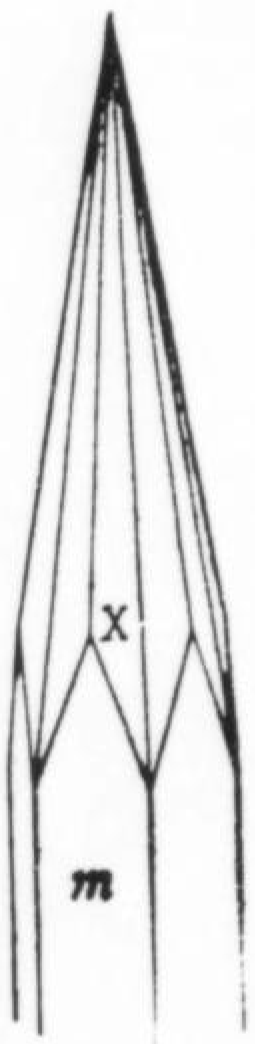


Figure 12. **Crystal drawing of Mt. Antero beryl (after Penfield).**

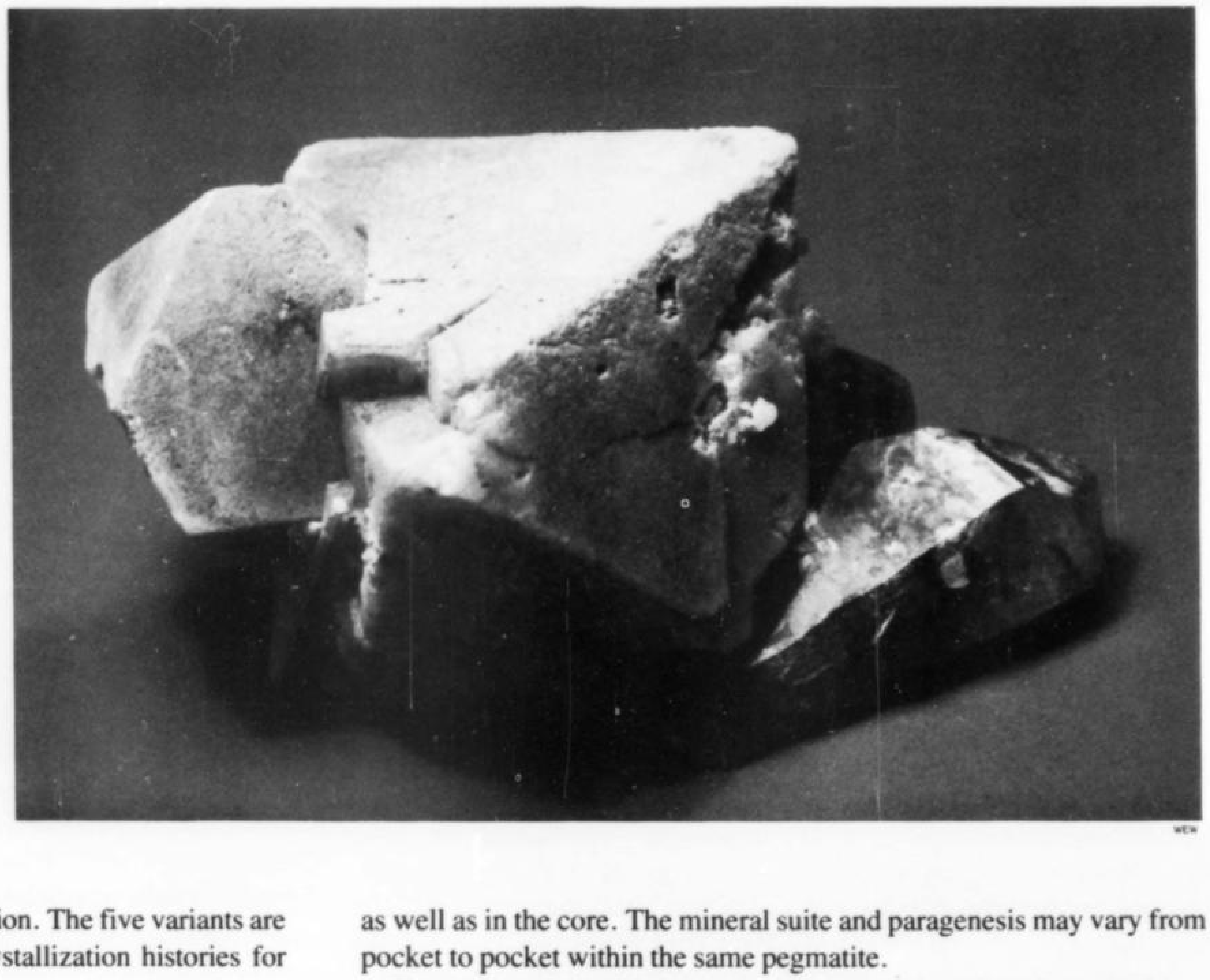


Figure 13. **Purple fluorite octahedrons having a thin, pale green outer zone, with smoky quartz, from Mt. Antero. The large crystal is 2.6 cm on an edge. Smithsonian collection (USNM# C5654).**

recognized by grain size and mineral composition. The five variants are believed to represent different cooling or crystallization histories for portions of the parent magma (Sharp, 1976).

The rock type in which the mineral deposits are most abundant is the fine-grained leucogranite variant of the pluton (Sharp, 1964), but the pegmatites occur in all five granite variants as well as in the Mt. Princeton quartz monzonite along the contact of the Mt. Antero granite (Pearl, 1972). The typical Mt. Antero minerals are found in miarolitic cavities, zoned pegmatites (quartz pegmatites and feldspar-quartz-beryl pegmatites), and veins. The pegmatites and miarolitic cavities are most abundant in the upper zone of the pluton, a zone 500 feet thick which Adams (1953) believes to be near the original top of the pluton.

The miarolitic cavities, or gas cavity pegmatites as they are often called, are characterized by graphic granite outer zones, an abrupt change to pocket minerals of quartz, feldspar, and mica, possibly with accessory minerals such as beryl, fluorite, topaz, phenakite, and bertrandite. Since miarolitic cavities usually have only one crystal pocket, Switzer (1939) classified them into different types on the basis of pocket mineralogy. He identified pocket mineral assemblages of:

phenakite-smoky quartz-microcline-muscovite ± albite ± fluorite
topaz-smoky quartz-microcline-muscovite ± fluorite
beryl-phenakite-bertrandite-microcline-muscovite-albite-fluorite-quartz
beryl-smoky quartz-microcline-muscovite-albite

It should be understood that these are only a few of the mineral assemblages a collector might find.

The zoned pegmatites seem to occur less frequently than the miarolitic cavities in the Mt. Antero region. They are characterized by mineralogic zoning with a crudely concentric geometry. Massive quartz or quartz crystal pockets may occur in the central part or core of the pegmatite. The two most common types of zoned pegmatites are quartz pegmatites and feldspar-quartz-beryl pegmatites, distinguished on the basis of their bulk composition. In these pegmatites, small crystal pockets, if they are present, may be randomly distributed in outer zones as well as in the core. The mineral suite and paragenesis may vary from pocket to pocket within the same pegmatite.

The veins of the Mt. Antero region contain mineral assemblages similar to the pegmatites and miarolitic cavities. Veins can be recognized as being relatively continuous along their length, consisting dominantly of quartz, and containing sulfide minerals. The mineral assemblages identified from veins are:

quartz-phenakite-muscovite-fluorite-albite (Switzer, 1939)
quartz-beryl-mica-metal sulfides (Sharp, 1976)
quartz-phenakite
quartz-hematite (Pearl, 1972)

Thirty-three minerals have been identified from this region. They are:

albite
apatite
bertrandite
beryl
biotite
bismuthinite
bismutite
brannerite
calcite
columbite
ferberite (huebnerite)
fluorite
gadolinite
geothite
hematite
jarosite
magnetite
microcline
molybdenite
molybdite
(ferrimolybdite?)
monazite
muscovite
orthoclase (adularia)
phenakite
pyrite
quartz (smoky, and clear)
rutile
spessartine
sulfur
topaz
tourmaline group
triplite
zircon (cyrtolite)

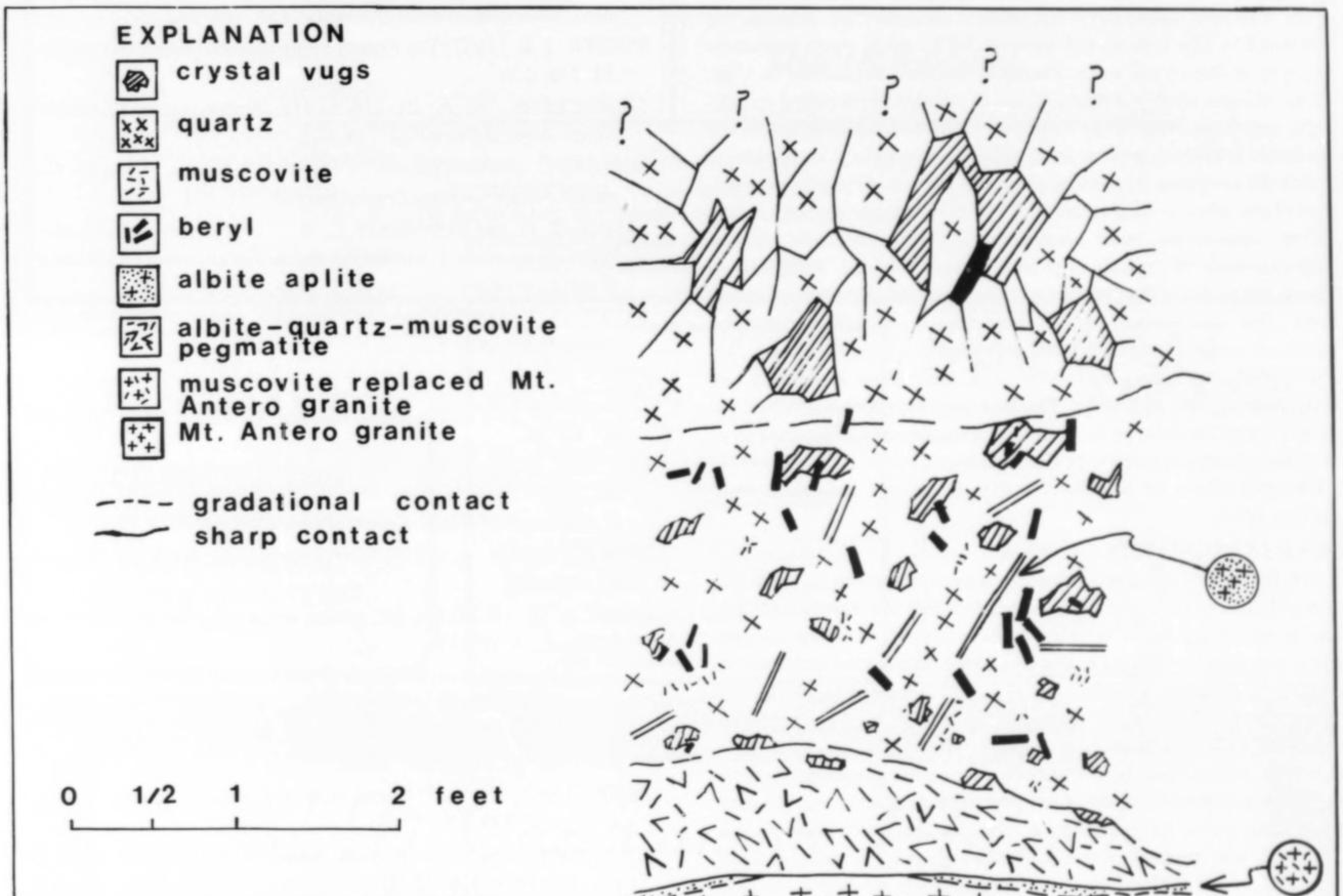


Figure 14. **Diagram of a pegmatite section typical of Mt. Antero.**

COMPOSITION AND INTERNAL STRUCTURE OF A QUARTZ PEGMATITE

In August of 1975, a quartz pegmatite was discovered on the northwest slope of Mt. Antero. The pegmatite was located within the porphyritic variant of the Mt. Antero granite at 13,600 feet elevation. Excavations in the pegmatite through 1977 exposed a varied mineral assemblage, consisting of quartz, beryl, albite, muscovite, phenakite, adularia, fluorite, and bertrandite in approximate order of abundance. Even though the pegmatite occurred as large talus blocks (2 by 4 by 4 feet), reconstruction indicated that it was an elongated disc-like body with probable maximum dimensions of 20 feet in length and 10 feet in diameter.

The pegmatite had three roughly concentric zones: the border, wall, and core zones. The country rock adjacent to the pegmatite exhibited a 0.4 to 0.8 inch altered zone containing muscovite crystals. In the pegmatite the border zone (2 inches to 1 foot thick) was composed of fine grained quartz-albite-muscovite. Crystal vugs were found only along the margin of this zone, adjacent to the wall zone. The vugs contained an assemblage of quartz-albite-muscovite ± fluorite. The wall zone (2 to 3 feet thick) was composed of quartz-beryl-albite with abundant crystal vugs. This zone was composed of coarse-grained quartz, aplitic albite in scattered bands 1 inch thick, muscovite crystals as random clusters, and long prisms of opaque blue beryl interspersed throughout. Several gradational changes were observed from the outer edge of the zone inward: 1) the amount of beryl present increased; 2) the frequency and size of crystal vugs increased; 3) aplitic banding became less frequent; 4) quartz grain size increased. The wall zone crystal vugs were equidimensional and 3 to 6 inches in diameter. Several different mineral assemblages were found:

(1) clear quartz-beryl ± adularia
(2) clear quartz-phenakite ± beryl ± adularia
(3) clear quartz-bertrandite

The core zone, up to 1 foot in diameter, was composed of interlocking foot-long milky white quartz crystals. Abundant vug space was present near crystal apexes. Rare aquamarine crystals projected into these vugs. No additional minerals were found.

Vug Descriptions

(1) Border zone margin fluorite vugs. The vugs had walls of quartz

crystal faces and albite (<0.04 inch). On these walls were crusts of muscovite (<0.04 inch) and occasionally octahedral purple fluorite. One fluorite octahedron obtained was ½ inch on a face edge.

(2) Wall zone quartz-beryl ± adularia vugs. The vug walls were usually prism faces of large colorless to milky-white quartz crystals. Beryl within the vug occurred as combinations of crystal faces projecting from the quartz matrix or was doubly terminated crystals. The doubly-terminated crystals appear to have one termination that is a rehealed break, indicating that it detached from the wall. The average crystal was 0.8 inches in length and light to dark blue. Many beryls terminated in a color darker than the rest of the crystal. The largest aquamarine crystal discovered was 2.2 by 0.6 inches and of light blue color. Beryls in matrix were found up to 6 by 1.2 inches in size. This beryl showed color zoning with pale aquamarine cores. Frost damaged minerals were common in the vugs already open to the weather. Most vugs contained unetched crystals, but where etched aquamarine was present, it was more severe on terminations than prism faces. Adularia, the low temperature variety of orthoclase, was a minor constituent of several vugs. It occurred as white pseudo-rhombic crystals up to ⅝ inch in diameter. These were found encrusted on quartz and beryl.

(3) Wall zone quartz-beryl-phenakite ± adularia vugs. Average vug size was 2 by 2 by 1 inches in dimension. Milky-white quartz formed the majority of the crystal walls. Phenakite occurred exclusively in vugs, either as loose doubly terminated single crystals or encrusted on adularia, quartz, or beryl. They range from 0.04 to 1.0 inch in length and are amber (cloudy to gem-clear) or milky white in color. Corroded beryl fragments projected from some phenakite crystals. One notable specimen of phenakite is clear amber (0.24 by 0.16 inch) resting on a lightly etched aquamarine, with encrusting (0.2 inch) adularia crystals. Approximately 90 crystals of phenakite were obtained. Adularia was found intergrown with phenakite and as druses with phenakite nested on them. The aquamarine found in these vugs is moderately (corroded faces and terminations) to severely (rounded blue lumps) etched.

(4) Wall zone quartz-bertrandite vugs. Bertrandite was a very rare constituent of this pegmatite. The best specimen found is white and doubly terminated (⅝ by ¼ inch) with a smaller crystal attached to it. The crystal shape appears to be flattened normal to the *c*-axis, similar to a bertrandite from the Strickland quarry, Portland, Connecticut (Henderson, 1975).

QUARTZ PEGMATITE GENESIS

The features of the quartz pegmatite appear to conform to the model of pegmatite crystallization as described by Jahns and Burnham (1969). The quartz pegmatite is believed to have crystallized from a highly silica-rich melt (molten rock) that co-existed with a water-rich solution containing dissolved volatiles such as carbon dioxide, and fluoride and chloride ions. The lack of microcline feldspar in the pegmatite may indicate that the pegmatite magma (both the melt and water-rich solution) was residual fluid from a partially crystallized pegmatite. Accordingly, the composition of the quartz pegmatite represents only the inner zones from a once larger pegmatite. The ultimate source of the pegmatite fluid was probably the Mt. Antero granite. Muscovite metasomatism of the wallrock by the pegmatite fluids resulted in the fine-grained texture of the border zone due to the loss of water to the wallrocks. The importance of water in pegmatite crystallization is stressed because the effect of water in molten rock at high temperatures and pressures is believed to allow rapid crystallization (rapid ionic transport) and to inhibit crystal nucleation. Both effects together would promote fewer crystals, each of large size.

The deposition of beryl in primary cavities is ascribed to the presence of water-rich "bubbles" and not to the melt. Continued action of the water-rich phase in the crystal vugs at relatively low temperatures is believed responsible for aquamarine etching, and the formation of phenakite, bertrandite, and adularia (the low temperature variety of orthoclase). The association of bertrandite, adularia and fluorite appears to be typical of low temperature deposits (Levinson, 1962).

The aplitic or fine-grained bands of albite are believed to have crystallized from the silica melt and are probably not due to quenching of the melt in response to a sudden drop in confining pressure. Crystallization of albite in this way would permit the quartz and beryl to crystallize largely from the water-rich phase, thus accounting for crystal size differences.

CONCLUSIONS

Despite its inaccessability and short collecting season, Mt. Antero is heavily collected and initial attempts at locating specimens may discourage the collector. But, geologic knowledge, persistence and hard work have rewarded recent collectors with discoveries of fine mineral specimens. Such qualities should reward future collectors with further discoveries.

ACKNOWLEDGMENTS

W. N. Sharp was helpful in providing historical information regarding the locality.

REFERENCES

ADAMS, J. W. (1953) Beryllium deposits of the Mount Antero region, Chaffee County, Colorado *U.S. Geological Survey Bulletin 982–D*, 120 p.

CROSS, R. T. (1887) Notes on aquamarine from Mt. Antero, Colorado. *American Journal of Science*, **133**, 161–162.

FISHER, J. K. (1957) The Fishers visit Colorado. *Rocks and Minerals*, **32**, 148–150.

HENDERSON, W. A. JR. (1975) The Bertrandites of Connecticut. *Mineralogical Record*, **6**, 114–123.

HILL, R. C. (1889) Etched beryls from Mt. Antero, Colorado. *Colorado Scientific Society Proceedings*, **3**, 191–192.

JAHNS, R. H. and BURNHAM, C. W. (1969) Experimental studies of pegmatite genesis: I. a model for the derivation and crystallization of granitic pegmatites. *Economic Geology*, **64**, 843–864.

KUNZ, G. F. (1892) *Gems and precious stones of North America*. Dover Publication Edition, New York (1968), 367 p.

LEVINSON, A. A. (1962) Beryllium-fluorine mineralization at Aquachile Mountain, Coahuila, Mexico. *American Mineralogist*, **47**, 67–74.

MEEVES, H. C. (1966) Non-pegmatitic beryllium occurrences in Arizona, Colorado, New Mexico, Utah, and four adjacent states. *U.S. Bureau of Mines, Report of Investigations 6828*, 68 p.

MONTGOMERY, A. (1938) Storm over Antero. *Rocks and Minerals*, **13**, 355–369.

OVER, E. JR. (1928) The Mt. Antero aquamarine locality. *Rocks and Minerals*, **3**, 110–111.

_____ (1935) Further explorations on Mt. Antero, Colorado. *Rocks and Minerals*, **10**, 27–29.

PEARL, R. M. (1972) *Colorado gem trails and mineral guide*. Swallow Press Inc., Chicago, 222 p.

PENFIELD, S. L. (1887) Phenacite from Colorado. *American Journal of Science*, **133**, 130–134.

_____ (1888) Bertrandite from Mt. Antero, Colorado. *American Journal of Science*, **136**, 52–55.

_____ (1889) Crystallized bertrandite from Stoneham, Maine and Mt. Antero, Colorado. *American Journal of Science*, **137**, 215–216.

_____ (1890). Some observations on the beryllium minerals from Mt. Antero, Colorado. *American Journal of Science*, **140**, 488–491.

SHARP, W. N. (1964) Mt. Antero area, Colorado. *U.S.G.S. Prof. Paper 401–A*, 9.

_____ (1976) Geological map and details of beryllium and molybdenum occurrences, Mt. Antero, Chaffee Co., Colorado. *U.S.G.S. Misc. Field Studies Map MF–810*.

SWITZER, G. (1939) Granite pegmatites of the Mt. Antero region, Colorado. *American Mineralogist*, **24**, 791–809.

WORCESTER, P. G. (1918) Molybdenum deposits of Colorado. *Colorado Geological Survey Bulletin*, **14**, 34–38.

The San Juan Mountains of Colorado

by **Jack A. Murphy**
Denver Museum of Natural History
City Park
Denver, Colorado 80205

The exploration and mining of Colorado's San Juan Mountains make for an interesting tale of pioneers, discoveries and disappointments. Rich deposits of gold and silver, not to mention splendid mineral specimens, have continued to pour from the San Juans since the first recorded strike more than 130 years ago.

HISTORY

The first major discovery of gold in the San Juan Mountains probably occurred in 1860, in what Smith (1977) called "one of the most improbable rushes." Settlement and mining could not be established for a decade because of the region's inaccessibility and the fact that it was traditionally the territory of the Ute Indians. Geologist Frederick L. Ransome (1901) aptly appraised the status of the land at the time by stating "the area now included in the Silverton quadrangle had been visited by but a few white men, and at a time when every gulch of the Sierra Nevada was a scene of picturesque activity the Indian and the mountain sheep were as yet undisturbed in their possession of the San Juan." The well known historian Hubert H. Bancroft (1890) described the San Juans as "the wildest and most inaccessible region in Colorado, if not in North America. . . . It is as if the great spinal column of the continent had bent upon itself in some spasm of the earth, until the vertebra (sic) overlapped each other, the effect being unparalleled ruggedness, and sublimity more awful than beautiful."

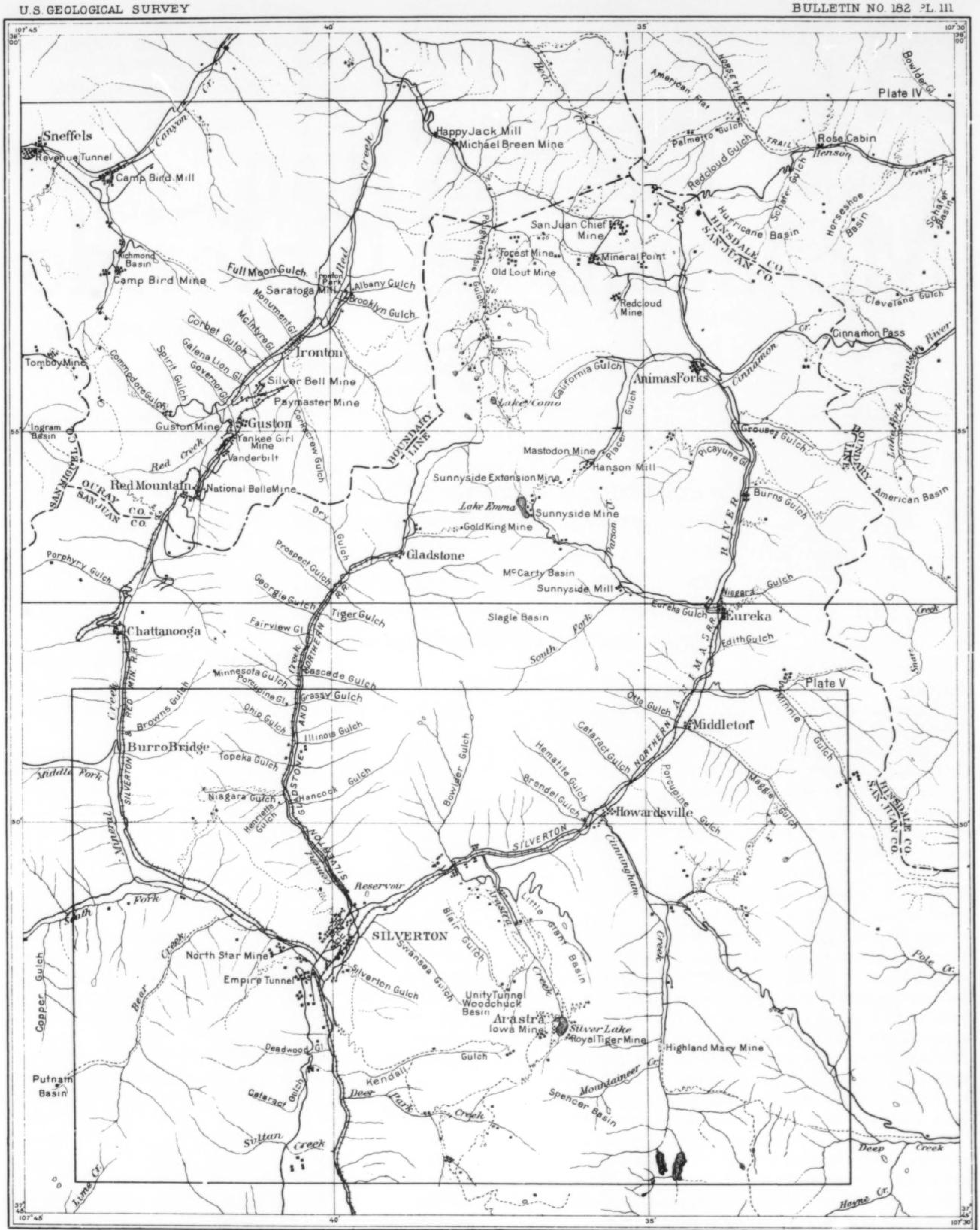
During the seventeenth and eighteenth centuries periodic Spanish expeditions ventured north into Colorado in search of gold. The first documented Spanish exploration, led by Don Juan Mana de Rivera from Santa Fe in 1765, reached the Gunnison River in central Colorado. It is reported (Ubbelhode and others, 1972) the party "returned with ore samples, although they were not rich enough to generate great excitement."

Eleven years later, at the time of the signing of the Declaration of Independence in 1776, two Franciscan fathers, Francisco Dominguez and Silvestre Escalante, made a detour around the western margin of the central San Juan Mountains. On this celebrated cross-country expedition seeking an overland route to California, the small party of ten men explored, mapped and named many features in the south-western portions of the San Juans (Cerquone, 1976). The existence of earlier mining was noted in the mountains they named "La Platas." Other reports indicate Spanish mining activities prior to 1765 (Smith, 1977).

Historians believe the Spanish failed to discover any "bonanza" deposits and left Colorado's minerals virtually untouched for the American mining pioneers who were to follow. Early prospectors reported Spanish mine workings in various parts of Colorado. A typical story, reported in the *Ouray Times* (July 13, 1878), described a tunnel found north of Silverton in Poughkeepsie Gulch "driven upwards of a hundred feet in which have been found copper tools clearly indicating the work of the Spaniards at an early day in the history of the Americas." Benham (1977) reported the discovery of a Spanish coin dated 1772, found during the excavation of a cellar at Howardsville on the Animas River near Silverton. Stories such as these do not prove the existence of Spanish habitation; nevertheless, they contribute to the history of the region where early sites may have been obliterated by nineteenth century mining activities.

Itinerant French and American fur trappers were the next to venture into Colorado's mountains. The 1803 Louisiana Purchase almost doubled the size of the United States and opened the western frontier. It is not known if trappers explored the upper valley of the Animas River or Red Mountain area in the early 1800's, but in 1832–37 a large party of trappers from St. Louis was in the Dolores River valley (Sloan and Skowronski, 1975). Their seasonal migration between the mountains, eastern plains and regional rendezvous at Taos, New Mexico, established trails others would follow. In this same period a series of expeditions began the exploration of these western territories. Men such as Pike, Long, Fremont and Gunnison were among the first to officially explore Colorado; however, none ventured directly into the San Juans. During this era gold was initially reported in Colorado, but created little attention.

U.S. GEOLOGICAL SURVEY BULLETIN NO. 182 PL. III



OUTLINE MAP OF THE SILVERTON QUADRANGLE, COLORADO
Showing areas covered by Plates IV and V

Scale

1 0 1 2 3 MILES

Figure 1. **Important mines in the western San Juan Mountains are shown on this map of the Silverton quadrangle from Ransome (1901).**

Figure 2. **Howardsville in 1875, at that time the county seat for La Plata County. The view is to the north across the Animas River Valley, three miles downstream from Eureka Gulch. Photo by W. H. Jackson, courtesy of the U.S. Geological Survey.**

In 1848, the same year gold discoveries in California created a rush across the continent, a privately financed expedition was organized by a group of St. Louis businessmen to find a transcontinental railroad route. The renowned leader, "Pathfinder of the West," John C. Fremont, guided his party of 33 men southwest across the San Luis Valley and into the San Juan Mountains near Del Norte. The winter expedition, when snows and freezing temperatures halted the group, saw the death of 11 men in the party in the upper Rio Grande region near Creede. Brown (1965) reports the first discovery of gold in the San Juans by a member of the Fremont party.

The San Juan Mountains remained isolated and virtually unexplored for the next decade. In 1860, however, prospectors began migrating westward from the Front Range mining centers. A party of some 100 individuals started for the San Juans in July but rigorous traveling caused all but 16 to turn back before they were in sight of the mountains (Smith, 1969).

An adventurous frontiersman, Charles Baker, holds the historical claim of leading the first party into the central San Juans and discovering gold. The event, involving more than a thousand people, made front page news at the time but the destiny of this "gold rush" was nearly a disaster. The Baker party left Leadville with a grubstake from Denver's Samuel B. Kellogg and Company and in a month's time they reached the 9,000-foot flat valley of the upper Animas River, the location of present day Silverton. They christened the valley Baker's Park, and Howardsville, the first town, carries the name of George W. Howard, an enterprising 18-year-old member of the expedition (Ayres, 1951). Howard is credited with discovering the Sunnyside mine, but much later in the history of the district.

The Baker party found a minor amount of placer gold at Eureka Gulch, 3 miles upstream from Howardsville. Optimistic reports

Figure 3. **A pioneer camp in Poughkeepsie Gulch, north of Silverton, in the 1870's. Photo by W. H. Jackson, courtesy of the Colorado Historical Society.**

were sent to Kellogg who, on hearing the news, excitedly left Denver in December, 1860, with his family and more than a hundred others. As word of the strike spread, several hundred additional prospectors set out for the area—much to the concern of William Byers, owner of the *Rocky Mountain News.* He warned readers in the November 9, 1860, edition, "we have yet to learn upon what reliable information all these glowing accounts from that far off region are predicated and we advise our friends to move cautiously in this subject."

The Denver prospectors spent the worst of the winter in small, southern camps, especially at Abiquiu on the Chama River in New Mexico. They learned Baker had laid out a townsite and started a road into the area even though little gold had been found. Rumored gold discoveries were highly exaggerated and may have been in part fabricated by traders with a surplus of provisions on hand. Despite such reports, an optimistic letter arrived from Baker himself, published in the *Rocky Mountain News* (July 21, 1861). Baker stated the placer diggings were sufficient to give "profitable employment" and "there will not be less than 25,000 Americans engaged in mining and agriculture pursuits upon the waters of the Rio San Juan within a year from the present writing and perhaps double that number."

By the spring of 1861 several hundred prospectors awaited favorable weather to make their way to Baker's Park. Their expectations were not to be realized, however, as gold panning the following summer brought poor results. The history of the area might be different if someone acquainted with geology had taken part in the explorations but these early miners were searching only for placer gold, not veins yielding other metals. For this reason, silver, which brought fame to the district, was unrecognized at the time.

Reports that Baker knew less of prospecting than originally believed, impending starvation, inhospitable weather and constant threats from Ute Indians created a violent atmosphere. Benham (1977) stated that two attempts were made to lynch Baker. These conditions, along with the beginning of the Civil War, contributed to the abandonment of the area by the end of 1861.[1]

Within ten years the San Juans received renewed attention. The next group of prospectors, arriving in Baker's Park in 1870, discovered lode gold at the Little Giant mine in Arrastra Gulch (Smith, 1969). 1872 brought a second "rush" of so many hundreds of miners that army troops were ordered to keep them out of Indian territory (Brown, 1965). Despite conditions, prospectors staked over a thousand claims.

By 1872, George Howard, one of the original Baker party, returned to the townsite previously named for him and with his partner, R. J. McNutt, ventured up Eureka Gulch to Lake Emma on Hanson Peak (13,454 ft.) and discovered the Belle Creole, Washington and Sunnyside veins (Ayres, 1951). They also staked claims on the nearby Ben Franklin and made some of the earliest mineral discoveries two miles north at Lake Como in Poughkeepsie Gulch (*Ouray Times,* July 6, 1868).

An 1873 treaty with the Ute Indians finally opened the San Juans to permament settlement. Howardsville (Fig. 1), on the main trail to the nearest post office at Del Norte 125 miles to the east, became the center of shipping and mining for the region. Conditions were rugged, most people establishing tent homes for the summer (Fig. 2), and traveling to lower elevations in the winter. Many people migrated to the area and over alpine divides to the adjacent, growing camps at Ouray, Sneffels, Telluride, Red Mountain and others.

[1] Charles Baker went back to his native Virginia to fight for the Confederacy. He returned to the West in 1868, to be killed by Indians in the San Juan River canyon (Dellenbaugh, 1902).

Figure 4. **The town of Red Mountain beside the National Belle mine in the 1880's. Photo by W. H. Jackson, courtesy of the Colorado Historical Society.**

The Red Mountain district, situated in the high mountains between Silverton and Telluride 3 miles south of Ouray, was unique for rich silver and copper found in intrusive chimney deposits rather than (typically) in veins along faults. John Robinson is credited with the discovery of these deposits (August, 1881) while hunting (Brown, 1965). Named the Yankee Girl, his claim with adjacent ones like the Robinson, Guston and National Belle (Fig. 4) produced a wealth of silver ore in a short period of time. According to Ransome (1901), "No where else in the quadrangle has mining been carried on so extensively." Two towns were centered around these mines, Ironton and Red Mountain, with a combined population of 3,000 (Rockwell, 1965).

The National Belle mine was the center of activity for the town of Red Mountain (Fig. 4) as well as the depot of the Silverton Railroad. The town burned down in August, 1892 (Sloan and Skowronski, 1975) and the mine was abandoned by 1897 (Ransome, 1901). The rest of the district also declined due to increased costs to mine at depth but principally to the repeal of the Sherman Silver Purchase Act which reduced the price of silver from $1.29 to $.50 an ounce (Smith, 1977).

After San Juan County was established in 1876, Silverton flourished as the mining and railroad center of the region. It was the hub of three important camps: at Gladstone (the Gold King), at Animas Forks (the Gold Prince), and at Eureka (the Sunnyside). Ransome (1901) stated the "Sunnyside enjoys the distinction of having been an almost continuous producer from the first discovery of the region."

It is not known to what extent Howard and McNutt developed the Sunnyside mine and other properties. Ayres (1951) reports they sold their claims to two Canon City businessmen by the 1880's. Dividing their properties, Howard received $11,000 for the Ben Franklin and McNutt acquired $10,000 for the Sunnyside.[2] The new owners of the Sunnyside mine, Louis Thompson and his brother-in-law Milt Engleman (Wolle, 1977), operated a dry goods store in Canon City. Little is known of their activities or the amount of ore produced; however, Ransome (1901) reported a production of $385,000 for one year.

The *Silverton Democrat* (July 21, 1883) carried an account of a visit by its editor to the Sunnyside. A tunnel had been driven more than 400 feet and a stockpile of ore was on the dump ready to move to the mill. The editor commented, "there is a larger body of minerals in sight in the Sunny-side (sic) workings than in any mine we have yet seen in the San Juan country." The ore, higher in gold values than most in the Silverton area, proved the editor correct. Mining at the Sunnyside involved the extraction of ore from rich surficial veins but, as years passed, deeper tunnels and shafts were required to penetrate underground veins. An article in the *La Plata Miner* (October 17, 1885) gave first mention of the Washington shaft as "85 feet deep on an enormous vein scattered through a width of 20 feet." Ten miners were employed but more ore was extracted than could be packed out. Ore from the increasingly low-grade veins created the need for a mill to reduce and concentrate the ore, and so John H. Terry acquired the Sunnyside upon the death of Louis Thompson (Wolle, 1977).

John Terry's life is a classic of western experience. A pioneer at 23 of the Pikes Peak gold rush, Terry gained early mining and milling experience at the Gregory Consolidated Mining Company in Blackhawk, Colorado. In 1870 Terry, his wife and three children moved to a ranch near Canon City where he engaged in agriculture and served as a Fremont County Judge for 16 years. His interest in

[2] Howard, in later years, lived in his log cabin at Howardsville in the summers but moved to Del Norte for the winters. He died, at age 77, in a Denver hotel in 1919 (*Denver Times,* August 9, 1919).

Figure 5. **Sunnyside mine buildings at Lake Emma in the early 1900's, at an elevation of 12,240 feet. The view is southeast down Eureka Gulch. The portal at left-center is the B level, entrance to the Washington shaft 700 feet above the lowest workings. Snowslides cover the tracks to the tramway. Other buildings include workshops, the boardinghouse and hospital. Photo courtesy of the San Juan County Historical Society.**

the Sunnyside mine began in 1886 (*Silverton Standard,* July 23, 1910), and in 1890 he moved his family to Silverton, installing a small 10-stamp mill at Lake Emma to process the Sunnyside gold ore. A second mill, larger and more efficient in yielding lead-zinc concentrate, was installed in 1896 a mile down Eureka Gulch at Midway (Wolle, 1949).

The future prosperity of the Sunnyside and other mines in the area depended on efficient transportation to smelters and on the processing of low grade ores. Great progress was made toward this when, in 1882, the Denver and Rio Grande narrow-gauge railroad reached Silverton from Durango (Henderson, 1926). Tracks for the Silverton Northern were extended to the town of Eureka in the Animas valley in 1895 while John Terry was constructing his new large mill for the Sunnyside at Eureka (Sloan and Skowronski, 1975). The new mill was connected with the mine's Lake Emma facilities (Fig. 5) by an impressive 3-mile tramway which transported ore to the mill in 100 buckets, each hauling 500 pounds of ore. The mill's capacity was 150 tons per day, enough to protect Terry from the 1892–93 decline in the price of silver which caused many other mines to close (Burbank and Luedke, 1969).

In the early 1900's when the Sunnyside was approaching its peak years, John Terry died. This Silverton resident was not regarded as a man of great wealth; however, newspapers at the time reported he left a fortune of $5,000,000 (*Rocky Mountain News,* July 16, 1919). His sons, William and Joe, and a daughter, Mrs. Milo Strong, acquired the property and continued to operate it. In 1917 the majority of shares were sold to the U.S. Smelting, Refining and Mining Company for half a million dollars (Sloan and Skowronski, 1975).

The new management, the Sunnyside Mining and Milling Company (a subsidiary of U.S. Smelting, Refining and Mining Company), acquired other prospects in the area, notably the large Gold Prince mine at Animas Forks. Its large mill was added to the existing Sunnyside mill at Eureka to treat an increased capacity of 500 tons per day. This progressive installation was the first commercial lead-zinc selective flotation plant in North America (Burbank and Luedke, 1969). It allowed the mine to operate successfully but in a year a disastrous fire burned most of the mine buildings at Lake Emma. Reconstruction was completed late in 1917 but before production could begin, another fire destroyed the mill at Eureka. The mill was rebuilt and the mine operated until December, 1921, when a drop in prices caused it to temporarily close. It reopened the

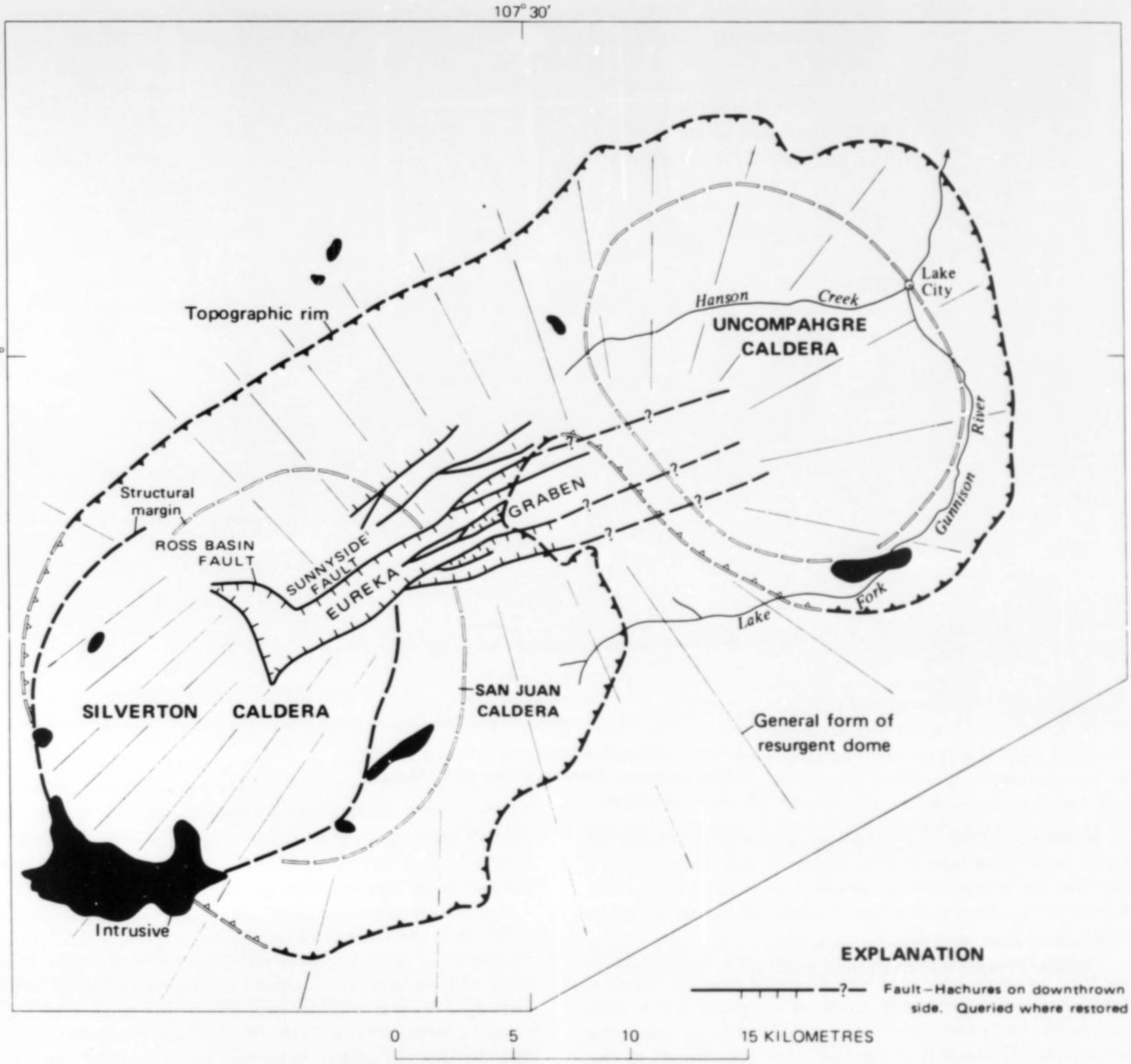


Figure 6. **The caldera complex of the western San Juan Mountains. The location of the Sunnyside mine, the Eureka graben and other faults rich in mineralization are indicated (from Steven and Lipman, 1956).**

following year and was a major producer until the stock market crash in 1929 (Sloan and Skowronski, 1975).

During its years of operation the ore was hoisted from the mine and then transported down the tramway to the Eureka mill—a costly operation. In 1938 plans were started to drive a 3-mile tunnel from Eureka to connect with the lower mine workings; however, the mine once again closed (Colorado Mining Association, 1939). Plans for a lower access tunnel were not realized until 20 years later when Standard Metals Corporation of Silverton leased the mine from U.S. Smelting, Refining and Mining Company (now U. V. Industries, Salt Lake). The new mine management decided to drive the tunnel from the Gold King mine at Gladstone, 8 miles north of Silverton on Cement Creek. Utilizing some of the old workings of the Gold King, the new 2-mile-long American Tunnel[3] was finished and connected with the Washington shaft and upper Sunnyside workings in the early 1960's.

GEOLOGY

So much has been written on the geology of the San Juans, in particular the history of Cenozoic volcanics, that no attempt is made here to completely describe this subject. Several workers in the field continue to revise old data and accumulate new data which appear in a variety of sources. The following is intended to provide a brief overview of the geologic history as it applies to the Sunnyside mine, and to serve as a reference to geologic literature about the western San Juans.

The volcanic history relating to the mineral deposits in the western San Juans occurred in the comparatively recent Cenozoic era. The preceding millions of years of the Mesozoic and Paleozoic were times when continental and marine sediments were deposited

[3] Mineral specimens should be labeled American tunnel (Sunnyside mine), Gladstone, Silverton district, Colorado.

Figure 7. **Telluride miners posing with a chunk of high-grade ore. Photo courtesy of the Homer E. Reid collection.**

on an ancient surface of Precambrian igneous and metamorphic rocks. Information regarding the geology of these early periods is described by several authors, notably Larsen and Cross (1956), Kelley (1957), Varnes (1963), Barker (1968) and Steven and others (1969).

The San Juan region has experienced intrusions and volcanics in the late Cretaceous associated with Laramide tectonics (Lipman, 1976). A general crustal uplift produced a highland and features such as the Needle Mountains were revealed by Eocene times, after the overlying sedimentary and igneous cover was removed by erosion.

By mid-Tertiary (35 million years ago) eruptions were renewed from several large intermediate-composition central vent volcanoes (Steven and Lipman, 1976). The resulting lavas, breccias, mud flows and other related rocks formed the widespread San Juan formation, divided into three facies according to Lipman and others (1973).

Twenty-eight million years ago a new episode of volcanism created deposits of ash-flow tuffs. Fifteen known calderas (Steven and Lipman, 1976) developed over a suspected shallow batholith identified by Plouff and Pakiser (1972). These calderas were the source for the volcanic rocks that hosted the deposition of ores in adjacent mineralized areas such as Bonanza, Summitville, Platoro, Creede, Lake City and others. In the vicinity of Silverton and Lake City, two calderas, the San Juan and Uncompahgre, (Fig. 6), formed as the result of extensive outpouring of the Sapinero Mesa tuff. This thick sheet of rhyolitic ash-flow tuff was deposited northward as far as Gunnison and eastward to Creede.

A large-scale subsidence of the San Juan and Uncompahgre calderas occurred because the underlying magma chamber was evacuated by the extensive eruptions of Sapinero Mesa tuff. Accompanying landslides from the caldera walls created an accumulation of debris up to a kilometer thick forming the intercaldera Eureka member and the recently redefined Picayune megabreccia member of the Sapinero Mesa tuff (Lipman, 1976).

Volcanic eruptions continued, resulting in thick accumulations of the Burns and Henson formations, the main rocks in the present vicinity of the Sunnyside mine and Eureka mining district. Other flows within and between calderas accumulated about 27 million years ago, but it is with the great outpouring of the next major rhyolite ash-flow (Crystal Lake tuff) that another subsidence structure, the Silverton caldera, originated within the older, previously formed San Juan caldera (Lipman and others, 1973).

Renewed uplift between 26 and 27 million years ago created resurgent doming of the area. Longitudinal fractures developed along the crust of the broad structure forming, according to Steven and Lipman (1976), "the deeply faulted Eureka graben." This important structural feature spanned the intersection between the Silverton and San Juan calderas and was the locale for the northeast-trending Sunnyside fault. The system of faults and fractures related to this graben produced the sites where mineral concentrations formed the gold and sulfide veins of the Eureka mining district. Continued stress to the rocks around the calderas during subsequent tectonic activity created other major linear fractures. The Argentine, Montana, Tomboy, Black Bear and other large, parallel, rich mineral veins formed in these faults on the northwest edge of the Silverton caldera.

MINERALIZATION

Ore deposits and accompanying minerals are related to caldera structural features. The Eureka graben and associated system of faults into Ross basin were the control for vein mineralization at the Sunnyside mine. Chimney deposits are not as significant in the Eureka district as they are further west at Red Mountain. There they are confined to solfataric zones on the edge of the cauldrons (Burbank and Luedke, 1969).

The complex history of ore deposition in the Eureka district involved several periods of mineralization, six according to Casadevall and Ohmoto (1977), and eight according to Langston (1978). This activity did not occur at the time when the Silverton and Lake City calderas were actively subsiding about 22 million years ago. According to studies by Steven and Lipman (1976) based on structural relationships with intrusives dated closer to 10 million years, mineralization was younger.

The nature and origin of mineralized solutions is a subject still being investigated. Ransome (1901) described the initial deposits as precipitated from ascending hydrothermal water possibly derived from a meteoric source. Mineral deposition within fissures was a function of hydrothermal alteration of wall rock and accompanying replacement processes.

Burbank and Luedke (1969) expanded on earlier interpretations about mineralization, especially the extent to which ore forming solutions intermixed with meteoric waters. They investigated the paragenetic sequences of sulfide and gangue minerals in great detail, and described the role of chemical leaching and fissure reopening as methods of concentrating ore in chimney and vein deposits.

The recent work of Casadevall and Ohmoto (1977) at the Sunnyside mine provided an expanded and detailed geochemical interpretation of mineralization. Their model for ore deposition involved principal elements being gathered by northward-flowing meteoric water through Precambrian, Paleozoic and Mesozoic rocks on the outer margins of the Silverton caldera. Channeled through fissures, the heated fluids leached metals from adjacent wall rocks and redeposited them by precipitation in the fault systems of the Eureka graben.

The lead isotopic studies of Doe and others (1978) have revealed the source of lead in Cenozoic volcanic deposits as being derived mainly from underlying Precambrian rocks. This supports a "circulating cell" hypothesis where meteoric fluids mix and flow convectively through underlying rocks to the structures where ores were deposited.

Published mineralogical reports began in the 1880's when alaskaite was described by Koenig (1881 and 1888), from the mine of the same name in Poughkeepsie Gulch. Hillebrand (1885) described zunyite and guitermanite from the Zuni mine located on the southwest slopes of Anvil Mountain in San Juan County. He also reported the first U.S. occurrence of zinkenite from the Brobdignag mine about a mile northwest of the Zuni mine. R. C. Hills (1884) reported on kaolinite from the National Belle mine at Red Mountain in Ouray County.

Ransome (1901) reported 77 mineral species occurring principally in the Silverton Quadrangle (table 1). Most were common ore-forming metallic species; however, the lead, silver, antimony, bismuth minerals, silver sulfides and others were uncommon. Few of these have been found since the mines closed in the 1890's but some, such as zunyite, remained remotely available.

For the Sunnyside mine, Ransome (1901) described common minerals constituting ore assemblages: pyrite, galena, gold, sphalerite, etc. Gangue minerals consisted of quartz, fluorite, manganese silicates, calcite and rhodochrosite.

Diagnostic mineralogical work by Burbank (1933) centered on the manganese minerals at the Sunnyside mine. He felt their distribution and paragenetic relations could be used as a guide to determine sequences of mineralization. During his investigations seven manganese minerals were described: alleghanyite, tephroite, friedelite, helvite, alabandite, rhodochrosite and rhodonite.[4] In a later work by Burbank and Luedke (1969), 38 rock-forming and associated minerals were identified (Table 2).

In the following years other minerals were reported from various locales (Table 1). Rosenzweig (1957), Kushner (1973) and Kosnar and Miller (1976) gave excellent reviews of specimens and localities. Grybeck (1976) reported on analyses of uncommon species, mainly from specimens in the Colorado School of Mines collection. Slack (1976) has confirmed 62 species from the Lake City district; 14 have not been identified or reported from the Silverton-Telluride-Ouray areas including: acanthite, chalcostibite, coloradoite, emplectite, jamesonite, krennerite, luzonite, mawsonite, melonite, tellurium, tellurobismuthite, volynskite, wehrlite, and wurtzite. Overall the best mineral descriptions and information about localities are given by Eckel (1961).

A review of the variety of minerals shows individual districts have characteristic mineral assemblages. Gold, manganese minerals and tungsten are more common in the Eureka district north of Silverton, while the rich galena and silver veins are typically to the south. The chimney deposits of the Red Mountain district, northward to Poughkeepsie Gulch, contain the more unique enargite-tetrahedrite ores and sulfobismuthates. Copper, lead and zinc are found throughout all districts but generally concentrated within the base metal deposits of the Camp Bird and Idarado mines.

Through the years these localities have produced different mineral specimens in varying quality. Sphalerite, pyrite, galena, chalcopyrite, quartz, calcite, fluorite, epidote, enargite and tetrahedrite are among the most common minerals occurring in good quality specimens. Crystallized gold and the exceedingly fine, red rhodochrosite on white quartz are probably the minerals most in demand by collectors.

The most recent comprehensive mineralogical work at the Sunnyside mine was associated with the geochemical investigations of Casadevall (1977) and Casadevall and Ohmoto (1978). Within their six defined periods of mineralization in the Eureka graben faults they identified 25 ore and gangue minerals (Table 3) by X-ray diffraction and electron microprobe analysis. Pyroxmangite, petzite and calaverite were additional species previously unrecognized. Ten minerals comprised 99.5% of total vein volume and 15 others occurred in traces less than 0.5% (Table 3).

Table 1. **Principal ore and gangue minerals in the Western San Juan Mountains — San Juan, Ouray and San Miguel Counties.**

	Reference*	District	Co.	Comments
Aikinite	Kelly (1946) Rosenzweig (1957)	Ouray	O.	Massive—part of ore Dunmore mine
	Casadevall (1976)	Eureka	S.J.	Sunnyside mine
Alabandite	Burbank (1933)	Eureka	S.J.	As minute grains with other manganese silicates—Sunnyside mine
Alleghanyite	Burbank (1933)	Eureka	S.J.	As minute grains—Sunnyside mine
Altaite	Kosnar (1979)	Silverton	S.J.	As small crystals—Brooklyn mine
Alunite	Burbank & Luedke (1969)	Red Mountain	O.	Clay alteration product
Anglesite	Ransome (1901)	Silverton	S.J.	Massive, as part of ore in several mines including the Zuni
Anhydrite	Casadevall & Ohmoto (1977)	Eureka	S.J.	Sunnyside mine
Ankerite	Kushner (1973)	Camp Bird	O.	Carbonate gangue
Aragonite	Kosnar (1979)	Silverton	S.J.	Carbonate gangue

*References are to first descriptions, or the source of a report of mineral species.

[4] determined to be pyroxmangite, Casadevall (1977).

	Reference*	District	Co.	Comments
Argentite	Ransome (1901)	Silverton	S.J.	Silver ore with galena and other species
	Bastin (1923)	Red Mountain	O.	
	Kushner (1973)	Ouray	O.	
Arsenopyrite	Bastin (1923)	Red Mountain	O.	Minor part of ore
Atacamite	Eckel (1961)	Silverton	S.J.	Reported on Kendell Mountain by F.M. Endlich
Azurite	Ransome (1901)	Silverton	S.J.	General occurrence in some shallow oxidation zones—Senorita mine dumps
	Kushner (1973)	Ouray	O.	
Barite	Ransome (1901)	Silverton Red Mountain	S.J. O.	As a gangue mineral and small crystals
Beidellite	Kushner (1973)	Sneffels	O.	Clay found in tetrahedrite at Virginius mine. See Eckel (1961)
Bismuth	Eckel (1961)	Ophir	S.M.	Reported from the Santa Cruz mine by W. F. Hillebrand
Bismuthinite	Ransome (1901)	Silverton	S.J.	As slender, prismatic crystals from the Neigold claim, Galena Mountain
Bornite	Ransome (1901)	Red Mountain & Silverton	O. S.J.	Important ore mineral, especially at the Yankee Girl mine, Red Mountain Sunnyside mine
Boulangerite	Grybeck (1976)	Silverton	S.J.	Brobdignag mine
Bournonite	Ransome (1901)	Silverton & Ouray	S.J. O.	Zuni and Yankee Girl mines
Calaverite	Casadevall (1976)	Eureka	S.J.	Sunnyside mine
	Oswald (1979)	Telluride	S.M.	Idarado mine
Calcite	Ransome (1901)	General		Carbonate gangue mineral Found as good specimens at the Idarado and Sunnyside mines
Cerargyrite	Eckel (1961)	Ouray	O.	Reported by W. Cross from an unidentified locale
Cerussite	Ransome (1901)	Silverton	S.J.	Mined as ore at the Silver Lake mine. As crystals in the Alta mine
	Eckel (1961)	Telluride	S.M.	
Chalcocite	Ransome (1901)	Silverton & Red Mountain	S.J. O.	Important ore mineral with stromeyerite
Chalcopyrite	Ransome (1901)	Silverton & Red Mountain	S.J. O.	Common ore mineral
	Casadevall (1976)	Eureka	S.J.	3–5% of total vein volume at Sunnyside mine
Chlorite	Ransome (1901)	Silverton	S.J.	Microscopic constituent in ores, especially at Silver Lake
	Luedke & Hosterman (1971)	Red Mountain	O. & S.J.	Part of clay-mineral assemblage, Longfellow mine
Colusite	Nelson (1939)	Red Mountain	O.	Analysis of U.S. National Museum specimen
	Burbank (1947)	Red Mountain	O.	With enargite in ore
Copper	Ransome (1901)	Silverton	S.J.	As plates and branching forms in several mines. See Eckel (1961)—San Miguel County Occurrences
Cosalite	Pearce (1883)	Red Mountain	O.	Yankee Girl mine
	Ransome (1901)	Poughkeepsie	S.J.	Alaska mine
Covellite	Burbank & Luedke (1969)	Eureka	S.J.	Minor constituent in chimney deposits
Diaspore	Ransome (1901)	Silverton & Red Mountain	S.J. O.	With kaolin, as an alteration product
	Burbank & Luedke (1969)	Engineer Mountain	O.	Found in vein deposits
Dickite	Burbank & Luedke (1969)	Red Mountain	O.	With other clays as an alteration product
	Luedke & Hosterman (1971)	Red Mountain	O. & S.J.	Occurs with other clay minerals at Longfellow mine
Digenite	Kosnar (1979)	Silverton & Red Mountain	S.J. O.	With chalcocite in ore
Dolomite	Ransome (1901)	Silverton/ Eureka	S.J.	Minor constituent with rhodochrosite—Sunnyside mine
	Patton (1903)	Camp Bird	O.	Encrustation on calcite crystals
Electrum	Kosnar (1979)	Silverton	S.J.	Integral part of gold veins
Enargite	Ransome (1901)	Silverton	S.J.	Important ore mineral—occurs at Zuni and other mines
	Bastin (1923)	Red Mountain	O.	Specimens most notable from Red Mountain area; Yankee Girl and Longfellow mines
Famatinite	Bastin (1923)	Red Mountain	O.	Minor constituent of chimney deposits with other silver-copper minerals
Fluorite	Ransome (1901)	Silverton	S.J.	Common massive gangue
	Casadevall (1976)	Eureka	S.J.	1% total vein volume at Sunnyside mine
	Kosnar & Miller (1976)	General		Describes specimens with associated species
Freibergite	Rosenzweig (1957)	Silverton	S.J.	With tetrahedrite, as an important ore mineral
Freieslebenite	Eckel (1961)	Silverton	S.J.	Doubtful occurrence reported by F. M. Endlich
	Kosnar (1979)	Telluride	S.M.	Idarado mine
Friedelite	Burbank (1933)	Eureka	S.J.	Forms fine-grained translucent masses in the Sunnyside mine
Galena	Ransome (1901)	General	O. & S.J.	Major ore mineral with silver, often crystallized
	Casadevall (1976)	Eureka	S.J.	10–15% total vein volume at Sunnyside mine
Galeno-bismutite	Ransome (1901)	Poughkeepsie	S.J.	One of the unique bismith-bearing sulfosalts from the Alaska mine
Gold	Ransome (1901)	Silverton & Ouray	S.J. O.	Integral part of vein deposits, especially at the Sunnyside mine. Good specimens with quartz rarely showing crystal form
Graphite	Aurand (1920)	Silverton	S.J.	Low-grade deposit reported by W. C. Prosser
Greenockite	Kosnar (1979)	Ouray	O.	Camp Bird mine as small crystals with sphalerite
Guettardite	Grybeck (1976)	Silverton	S.J.	With zinkenite from the Brobdignag mine
Gypsum	Ransome (1901)	Silverton	S.J.	Common gangue mineral
	Kosnar & Miller (1976)	Eureka	S.J.	Fine specimens from the Sunnyside mine with rhodochrosite
Hematite	Ransome (1901)	Eureka	S.J.	Sunnyside mine and adjacent areas in Silverton quadrangle. Commonly as var. specular
Helvite	Burbank (1933)	Eureka	S.J.	As small grains and microcrystals with pyrite and manganese silicates at the Sunnyside mine
Hessite	Kushner (1973)	Ouray	O.	In grains with gold and galena at the Camp Bird mine
	Kosnar (1979)	Silverton	S.J.	In ore in Cement Creek mines
Huebnerite	Hillebrand (1885)	Uncompahgre	O.	First U.S. report
	Ransome (1901)	Silverton/ Eureka	S.J.	Important ore mineral—occurs as excellent specimens
	Eckel (1961)	General		Additional information
Illite	Burbank & Luedke (1969)	Silverton/ Eureka	S.J.	Alteration product
	Luedke & Hosterman (1971)	Red Mountain	O. & S.J.	Clay mineral complex
Jordanite	Rosenzweig (1957)	Silverton	S.J.	Zuni and Brobdignag mines
	Grybeck (1976)			See Eckel (1961)
Kaolinite	Hills (1884)	Red Mountain	O.	National Belle mine
	Ransome (1901)	Silverton	S.J.	Zuni mine
	Luedke & Hosterman (1971)	Red Mountain	O. & S.J.	Group of clay minerals
Kobellite	Keller & Keller (1885)	Red Mountain	O.	Massive—Silver Belle mine
Lillianite	Brown (1927)	Poughkeepsie	S.J.	In polished sections of ore from the Sultan mine

	Reference*	District	Co.	Comments
Magnetite	Kosnar (1979)	Silverton	S.J.	In ores with hematite in Cunningham Gulch mines
Malachite	Ransome (1901)	Silverton	S.J.	General occurrence in shallow oxidation zones
Marcasite	Kosnar (1979)	Silverton	S.J.	Minor constituent in some ores
Matildite	Eckel (1961)	Camp Bird	O.	In polished sections of ore
	Burbank & Luedke (1969)	Poughkeepsie	S.J.	Old Lout mine
	Grybeck (1976)	Poughkeepsie	S.J.	Alaska mine
Miargyrite	Kosnar (1979)	Red Mountain	O.	With other silver minerals at Yankee Girl mine
Molybdenite	Ransome (1901)	Silverton	S.J.	Found in the Sunnyside mine as scales, sometimes with free gold
Montmorillonite	Luedke & Hosterman (1971)	Red Mountain	O. & S.J.	Clay mineral complex
Pavonite	Grybeck (1976)	Poughkeepsie	S.J.	Alaska mine
Pearceite	Bastin (1923)	Red Mountain	O.	Generally with other silver-copper minerals comprising rich ore
	Kosnar (1979)	Sneffels	O.	Yankee Boy mine
Petzite	Schrader & others (1916)	Ouray	O.	Chief ore in Gold Bug mine
	Casadevall (1976)	Eureka	S.J.	In ore at Sunnyside mine
Piemontite	Kosnar (1979)	Telluride	S.M.	As small reddish brown acicular crystals on quartz from the Idarado mine
Platinum	Schrader & others (1916)	Telluride	S.M.	Unspecified locality
	Eckel (1961)	Ouray	O.	Additional reports
Polybasite	Ransome (1901)	Red Mountain	O.	Important constituent of ore, especially at Yankee Girl mine. Well crystallized specimens
Proustite	Bastin (1923)	Red Mountain	O.	Widespread in silver ore of the district, with pyrargyrite
	Eckel (1961)	Telluride	S.M.	Other reports
Pyrargyrite	Bastin (1923)	Red Mountain	O.	With proustite in silver ores. Rarely as well formed crystals or specimens
Pyrophyllite	Luedke & Hosterman (1971)	Red Mountain	O. & S.J.	Clay mineral complex with dickite and others
Pyrostilpnite	Kosnar (1979)	Red Mountain	O.	As minor constituent in silver-copper ore
Pyroxmangite	Casadevall (1976)	Eureka	S.J.	Massive gangue in vein deposits. 6–8% total vein volume at Sunnyside mine
Pyrrhotite	Kosnar (1979)	Eureka	S.J.	Identified from Sunnyside mine
Pyrite	Ransome (1901)	General	O. & S.M.	Overall important vein mineral
	Casadevall (1976)	Eureka	S.J.	6–8% total vein volume at Sunnyside mine
Quartz	Ransome (1901)	General	S.J.	Major gangue in vein deposits
	Casadevall (1976)		S.M. O.	Occur as fine crystallized specimens. 30–33% total vein volume at the Sunnyside mine
Rhodochrosite	Ransome (1901)	Silverton	S.J.	Major gangue in vein deposits
	Burbank (1933)	Eureka	S.J.	Sunnyside mine species
	Miller (1971)	General	S.J.	Important Colorado specimens
	Casadevall (1976)	Eureka	S.J.	5–8% total vein volume at Sunnyside mine
Rhodonite	Ransome (1901)	Eureka	S.J.	What has typically been
	Burbank (1933)	Eureka	S.J.	called rhodonite is pyroxmangite (see Casadevall (1976))
Sartorite	Grybeck (1976)	Silverton	S.J.	With fine-grained galena at the Zuni mine
Scheelite	Eckel (1961)	Silverton	S.J.	Reported as early as 1878 by F. M. Endlich
Schirmerite	Hillebrand (1885)	Ophir	S.M.	Santa Cruz mine
	Burbank & Luedke (1969)	Poughkeepsie	S.J.	Old Lout mine

	Reference*	District	Co.	Comments
Scorodite	Penfield (1893)	Red Mountain	O.	Green botryoidal incrustation on enargite at the Charter Oak mine
Semseyite	Grybeck (1976)	Silverton	S.J.	Massive: with other Pb species from the Brobdignag mine
Sericite	Ransome (1901)	Silverton	S.J.	Associated with clays in ores, Sunnyside mine
	Burbank & Luedke (1969)	Eureka	S.J.	An alteration product from volcanic rocks
Siderite	Kushner (1973)	Ouray	O.	One of the gangue minerals in the mines in Yankee Boy basin
Silver	Ransome (1901)	Silverton	S.J.	Rarely as crystals and wires—at the Sunnyside and other mines, an integral part of ore
Smithsonite	Heyl (1964)	Red Mountain	O.	Lark mine—minor part of ore
Sphalerite	Ransome (1901)	Silverton	S.J.	Common ore minerals, generally with galena
	Casadevall (1976)	Eureka	S.J.	10–15% total vein volume at Sunnyside mine
Stephanite	Bastin (1923)	Red Mountain	O.	Constituent of silver ore
	Rosenzweig (1957)	Red Mountain	O.	Forms tabular crystals of polybasite
Stibnite	Ransome (1901)	Silverton	S.J.	One report at the North Star mine
Stilpnomelane	Benthin (1973)	Eureka	S.J.	Brown micaceous coating on quartz and pyroxmangite from Sunnyside mine
Stromeyerite	Ransome (1901)	Red Mountain	O.	With chalcocite and other silver minerals—occurring massive in ore
Strontianite	Eckel (1961)	Red Mountain Pass	S.J.	Report by J. W. Adams of columnar crystals from Koehler tunnel
Sulfur	Burbank & Luedke (1969)	Silverton/ Eureka	S.J.	Important in process of solfaritic alteration of volcanic rocks
Sylvanite	Eckel (1961)	Telluride & others	S.M.	General reports at Smuggler-Union and other mines
Tennantite	Rosenzweig (1957)	Red Mountain	O.	Occurs with tetrahedrite and other silver-copper minerals in ore
Tenorite	Ransome (1901)	Silverton	S.J.	Var. melaconite, at the New York City Lode, Silver Lake area
Tephroite	Burbank (1933)	Eureka	S.J.	In small anhedral grains associated with alleghanyite at the Sunnyside mine
Tetradymite	Grybeck (1976)	Ouray	O.	With hessite and gold at the Jonathan mine
Tetrahedrite	Ransome (1901)	Silverton & Red Mountain	S.J. O.	Rivals galena as important ore mineral
	Kosnar (1979)	Telluride	S.M.	Forms notable specimens
	Casadevall (1976)	Eureka	S.J.	1–4% total vein volume at the Sunnyside mine
Tungstite	Kosnar & Miller (1976)	Silverton	S.J.	Small acicular crystals with tetrahedrite from the Kittie Mac mine
Uraninite	Eckel (1961)	Ophir	S.M.	Occurrence of var. pitchblende
Wittichenite	Eckel (1961)	Silverton	S.J.	Reported in 1893 by T. B. Comstock
Wolframite	Kosnar & Miller (1976)	Silverton	S.J.	Small black crystals on quartz from the Kittie Mac mine
Wollastonite	Aurand (1920)	Silverton	S.J.	Reported occurring in an old limestone quarry south of Silverton
Zinkenite	Hillebrand (1885)	Silverton	S.J.	First U.S. occurrence—crystals in barite and feldspar from the Brobdignag mine

	Reference*	District	Co.	Comments
Zoisite	Eckel (1961)	Telluride & Ophir	S.M.	Occurs as a vein mineral at several localities
	Kosnar (1979)	Telluride & Ouray	S.M. O.	Var. thulite in replacement deposits at the Idarado and Camp Bird mines
Zunyite	Hillebrand (1885)	Silverton	S.J.	Well formed small crystals with pyrite, enargite and other species. See Eckel (1961)

REFERENCES

AURAND, H. A. (1920) Mineral deposits of the western slope. *Colorado Geological Survey, Bulletin* **22**, 78.

AYRES, M. C. (1951) Howardsville in the San Juan. Colorado Magazine, **28**, 241–257.

BACKUS, G. F. (1969) *Tomboy Bride.* Pruett Publishing Company, Boulder, Colorado.

BANCROFT, H. H. (1890) *History of Nevada, Colorado and Wyoming, 1540–1888.* The History Company, San Francisco, California, 828.

BARKER, F. (1968) Precambrian geology of the Needle mountains, southwestern Colorado. *U.S. Geological Survey Professional Paper* **644–A**, 35.

BASTIN, E. S. (1923) Silver enrichment in the San Juan mountains, Colorado. *U.S. Geological Survey Bulletin* **735**, 129.

BENHAM, J. L. (1977) *Silverton.* Bear Creek Publishing Company, Ouray, Colorado, 63.

BROWN, R. L. (1965) *An Empire of Silver.* Caxton Printers Limited, Caldwell, Idaho, 328.

BROWN, W. H. (1927) A note on the occurrence of alaskaite. *American Mineralogist,* **12**, 21–23.

BURBANK, W. S. (1933) The manganese minerals of the Sunnyside veins, Eureka Gulch, Colorado. *American Mineralogist,* **18**, 513–27.

_________ (1947) Red Mountain district, Ouray County, *in* Vanderbilt, J. W. and others, *Mineral Resources of Colorado: Denver,* Colorado Mineral Resources Board, 340.

_________ and LUEDKE, R. G. (1969) Geology and ore deposits of the Eureka and adjoining districts, San Juan Mountains, Colorado. *U.S. Geological Survey Professional Paper* **535**, 35.

CASADEVALL, T. (1976) Sunnyside Mine, Eureka Mining District, San Juan County Colorado. PhD thesis, Pennsylvania State University, 146.

_________ and OHMOTO, H. (1977) Sunnyside mine, Eureka Mining District, San Juan County, Colorado: Geochemistry of gold and base metal ore deposition in a volcanic environment. *Economic Geology,* **72**, 1285–1330.

CERQUONE, J. (1976) *In Behalf of the Light.* The Dominguez-Escalante Bicentennial Expedition Inc., Denver, Colorado, 33.

COLORADO MINING ASSOCIATION (1939) *Mining Yearbook.* Colorado Mining Association, 96.

DELLENBAUGH, F. S. (1902) *The Romance of the Colorado River.* G. P. Putnam's Sons, the Knickerbocker Press, New York and London (reprinted: Rio Grande Press, Chicago, Illinois), 339.

DOE, B. R., STEVEN, T. A., DELEVAUX, M. H., STACEY, J. S., LIPMAN, P. W. and FISHER, F. S. (1978) *in* Geological Survey Research 1978: *U.S. Geological Survey Professional Paper* **1100**, 464.

ECKEL, E. B. (1961) Minerals of Colorado: A 100 Year Record. *U.S. Geological Survey Bulletin* **1114**, 399.

FETTER, R. L., and FETTER, S. (1979) *Telluride "From Pick to Powder."* Caxton Printers Limited, Caldwell, Idaho, 194.

GRYBECK, D. (1976) Additions to the ore mineralogy of Colorado. *Mineralogical Record,* **7**, 274–76.

HENDERSON, C. W. (1926) Mining in Colorado. *U.S. Geological Survey Professional Paper* **138**, 263.

HEYL, A. V. (1964) Oxidized Zinc Deposits of the United States. *U.S. Geological Survey Bulletin* **1135–C**, 98.

HILLEBRAND, W. F. (1885) Mineral notes, 121–23, and On zunyite and guitermanite, two new minerals from Colorado. *Colorado Scientific Society Proceedings,* **1**, 124–31.

HILLS, R. C. (1884) Kaolinite from Red Mountain, Colorado. *American Journal of Science,* 3rd series, **27**, 242.

KELLER, H. F. and KELLER, H. A. (1885) A new variety of kobellite. *American Chemistry Society Journal,* **7**, 7.

KELLEY, V. C. (1946) Geology, ore deposits, and mines of the Mineral Point, Poughkeepsie and Upper Uncompahgre districts, Ouray, San Juan and Hinsdale Counties, Colorado. *Colorado Scientific Society Proceedings,* **14**, 289–466.

_________ (1957) General geology and tectonics of the western San Juan Mountains, Colorado. *New Mexico Geological Society Guidebook, 8th Field Conference,* 154–162.

KOENIG, G. A. (1881) On alaskaite, a new member from the series of bismuth sulphosalts. *American Philosophical Proceedings,* **19**, 472–77.

_________ (1888) Ueber alaskaite. *Zeitschrift Kristallographie und Mineralogie,* **14**, 254.

KOSNAR, R. A. and MILLER, H. W. (1976) Crystallized minerals of the Colorado mineral belt. *Mineralogical Record,* **7**, 278–307.

KUSHNER, E. F. (1973) *A Guide to Mineral Collecting at Ouray, Colorado.* Ervin F. Kushner Books, Paterson, New Jersey, 78.

LANGSTON, D. J. (1978) The Geology and Geochemistry of the Northeasterly Gold Veins, Sunnyside mine, San Juan County, Colorado. MS thesis (TS 1918) Colorado School of Mines, Golden, Colorado, 184.

LARSON, E. S. and CROSS, W. (1956) Geology and Petrology of the San Juan Region, Southwestern Colorado. *U.S. Geological Survey Professional Paper* **258**, 301.

LIPMAN, P. W. (1976) Caldera-collapse breccias, western San Juan Mountains, Colorado. *Geological Society of America Bulletin,* **87**, 1397–1410.

_________, STEVEN, T. A., LUEDKE, R. G. and BURBANK, W. S. (1973) Revised volcanic history of the San Juan, Uncompahgre, Silverton and Lake City calderas in the western San Juan Mountains, Colorado. *U.S. Geological Survey Journal Research,* **1**, 627–42.

LUEDKE, R. G. and HOSTERMAN, J. W. (1971) Clay Minerals, Longfellow Mine, San Juan County, Colorado. *U.S. Geological Survey Professional Paper* **750–C**, C104–C111.

MILLER, H. W. (1971) Rhodochrosite crystal localities in the west. *Mineralogical Record,* **2**, 105–110.

NELSON, R. (1939) Colusite—its occurrence, paragenesis and genetic significance. *American Mineralogist.* **24**, 369–376.

PEARCE, R. (1883) Cosalite, stromeyerite and bismuth minerals. *Colorado Scientific Society Proceedings,* **2**, 188.

PENFIELD, S. L. (1893) Mineralogical notes. *American Journal of Science,* 3rd series, **45**, 396–399.

PLOUFF, D. and PAKISER, L. C. (1972) Gravity Study of the San Juan Mountains, Colorado. *In* Geological Survey research, 1972, *U.S. Geological Professional Paper* **800–B**, B183–B190.

RANSOME, F. L. (1901) A Report on the Economic Geology of the Silverton Quadrangle. *U.S. Geological Survey Bulletin* **182**, 265.

ROCKWELL, W. (1965) *Uncompahgre Country.* Sage Books, Denver, Colorado, 310.

ROSENZWIEG, A. (1957) Mineralogical notes on the Silverton quadrangle, Colorado. *New Mexico Geological Society Guidebook, 8th Field Conference,* 154–162.

SCHRADER, F. C., STONE, R. W. and SANFORD, S. (1916) Useful Minerals of the United States. *U.S. Geological Survey Bulletin* **624**, 412.

SLACK, J. F. (1976) Hypogene Zoning and Multistage Vein Mineralization in the Lake City Area, Western San Juan Mountains, Colorado. PhD thesis, Stanford University, 327.

SLOAN, R. E. and SKOWRONSKI, C. A. (1975) *The Rainbow Route.* Sundance Limited, Denver, Colorado, 416.

SMITH, D. A. (1969) *Silver coquette.* Westerners Brand Book, **25**, 223–252.

_________ (1977) *Colorado Mining.* University of New Mexico Press, Albuquerque, New Mexico, 176.

STEVEN, T. A. and LIPMAN, P. W. (1976) Calderas of the San Juan Volcanic Field, Southwestern Colorado. *U.S. Geological Survey Professional Paper* **958**, 35.

_________, LIPMAN, P. W., HAIL, W. J., JR., BARKER, F. and LUEDKE, R. G. (1974) Geologic map of the Durango quadrangle, southwestern Colorado. *U.S. Geological Survey Miscellaneous Geologic Investigation Map* **I-764**.

_________, SCHMITT, L. J., SHERIDAN, M. J., and WILLIAMS, F. E. (1969) Mineral Resources of the San Juan Primitive Area, Colorado. *U.S. Geological Survey Bulletin* **1261-F**, 187.

UBBELOHDE, C., BENSON, M. and SMITH, D. A. (1972) *A Colorado History.* Pruett Publishing Company, Boulder, Colorado, 390.

VARNES, D. J. (1963) Geology and Ore Deposits of the South Silverton Mining Area, San Juan County, Colorado. *U.S. Geological Survey Professional Paper* **378-A**, 56.

WOLLE, M. S. (1949) *Stampede to Timberline.* Sage Books, Denver, Colorado, 544.

_________ (1977) *Timberline Tailings.* Sage Books, Swallow Press Inc., Chicago, Illinois, 337.

The Society welcomes as members individuals who are interested in mineralogy, crystallography, petrology, or related sciences. Membership applications can be obtained from the business office at the address below. Membership is for the calendar year, and the annual dues are $20 for all except students, who pay only $6. All members receive two journals, **The American Mineralogist,** and **Geotimes,** and are also entitled to a reduced rate for subscription to **Mineralogical Abstracts. The American Mineralogist** is a bimonthly, technical publication of the Society and emphasizes the latest scientific aspects of modern mineralogy, crystallography, and petrology. **Geotimes** is the monthly news magazine for earth sciences published by the American Geological Institute. A price list for other publications of the Society may be obtained from the business office.

MINERALOGICAL SOCIETY OF AMERICA

1909 K Street NW
LL 1000
Washington, D.C. 20006
Telephone: (202) 331-0370

The Mineralogical Association of Canada

Publishers of the quarterly journal

THE CANADIAN MINERALOGIST

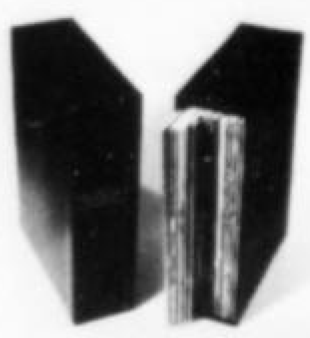
Invites you to join now by sending $15 (Canadian) to:

The Mineralogical Association of Canada
Department of Mineralogy
Royal Ontario Museum
100 Queen's Park
Toronto, Ontario, CANADA M5S 2C6

Papers on all aspects of mineralogy, petrology mineral deposits, crystallography and geochemistry are invited.

Editor Emeritus—Dr. L. G. Berry
Editors—Dr. Louis J. Cabri, Dr. R. F. Martin

Send your manuscripts to:
Dr. Louis J. Cabri
CANMET
555 Booth Street
Ottawa, Canada K1A OG1



The Deluxe Magazine File

The Blade-Lock Binder

Record BINDERS

HOW TO ORDER:

Both the file boxes and the binders are 3 inches thick. **One box or one binder** will hold Volumes 1-4 (22 issues), Volumes 5-7 (18 issues), or Volumes 8-9 (12 issues). (You can see that the *Record* has grown consistently thicker over the years!)

NOTE: Each binder comes with 12 blades to hold 12 issues. **You must order extra blades** if you wish to put more than 12 issues in a binder. Extra blades come in packages of 12.

Please specify catalog number and "Mineralogical Record" when you order:

Deluxe Magazine File—Title: The Mineralogical Record
Black only (# **23-220A**) . . . . $4.95 each postpaid
$3.98 each for 3 or more

Blade-Lock Binder—Title card: The Mineralogical Record
Gray only (# **A52-572A**) . . . $10.00 each postpaid
Package of 12 extra blades
(# **A52-565A**) . . . . $2.88 per package

Send Order Directly To
(and make checks payable to)
THE HIGHSMITH COMPANY
P.O. Box 25M
Fort Atkinson, WI 53538

(a catalog of other items is available on request)

Back issues of the *RECORD*

AVAILABLE ISSUES:

$3 each

VOL. 8 (1977)	(#5)*
VOL. 9 (1978)	(#2, 3, 4, 5, 6)
VOL. 10 (1979)	(#1, 2, 3, 4, 5, 6)

$5 each

*VOL. 8, #6 (California Issue)

Don't delay. Order from: **Mineralogical Record**
P.O. Box 783—H
Bowie, MD 20715

NOTE: Si & Ann Frazier (see their ad) are now handling all out-of-print issues of ***the Record.***

Mueller's

OF PHOENIX

FOR the COLLECTOR
the DECORATOR
the MUSEUM

FINE GEMS AND MINERALS

"the most unusual store you will ever visit."

Mueller's of Phoenix
1000 E. Camelback Road
Phoenix, Arizona 85014
Telephone: (602) 274-4724

renew now!

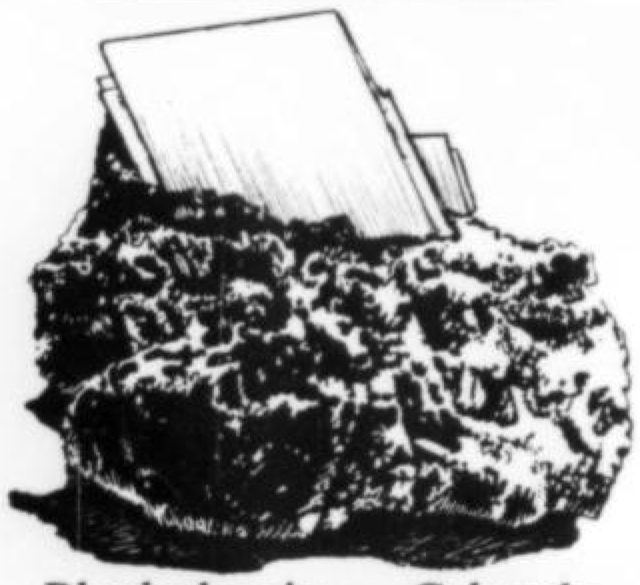
Mineralogical Record
P.O. Box 783
Bowie, Md. 20715

RICHARD A. KOSNAR

"Mineral Classics"

Offering
the finest quality worldwide
mineral specimens

Specializing in Colorado Minerals
and minerals for competitive displays.



Rhodochrosite — Colorado

Inquiries invited
no list available

Route 6, Box 263
Golden, Colorado 80401
(In Scenic Golden Gate Canyon)
Tel: (303) 642-7556

(By appointment only)

Ron L Sohn MINERALS

Distinctive Crystals & Crystal Groups For the Discriminating Collector

***Washington, D.C.**
New Carrollton
November 16–18

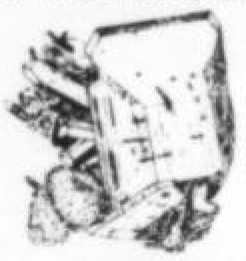
***Tucson Gem & Mineral**
Community Center
February 8–10

(513) 256-3071
By Appointment

2815 Lake Shore Place
Dayton, Ohio 45420

The Crystal Pocket of Alaska

Doug & Fran Toland
P.O. Drawer N ● Haines, Alaska 99827



Thinking about a good Prince of Wales epidote? Now is the time and we are the source. We collect and see a number of quality epidotes and mineral suites from both mountains. Be sure to ask about other specimens from Alaska and elsewhere. Our crystals are guaranteed to satisfy.

METERSKY'S MINERALS

SPECIALIZING IN CRYSTALS
T/N's AND MINIATURES
SPECIMENS YOU CAN AFFORD
SEND FOR FREE LIST
725 CHERYL DR., WARMINSTER, PA 18974

Wholesale Mineral Specimens

TSUMEB SECONDARIES
Dioptase—Cerussite
Smithsonite—Others

PERUVIAN SULFIDES
Huebnerite—Tetrahedrite
Orpiment—Pyrite—Chalcopyrite
Pyrargyrite—Quartz—Sphalerite
Calcite—Etc.

INDIAN ZEOLITES
Okenite puff balls
Apophyllite—Stilbite—Gyrolite
Prehnite—Etc.

&

MANY OTHER GOODIES

JEWEL TUNNEL IMPORTS
P.O. Box 267, or 1212 S. Mayflower
Arcadia, CA 91106
Tel: (213) 357-6338

MICROMINERALS and RARE SPECIES

Specializing in minerals from Mt. St-Hilaire and other Canadian localities. Ancylite, burbankite, catapleiite, dawsonite, donnayite, gaidonnayite, hilairite, lorenzenite, mackelveyite, nenadkevichite, synchysite, et.

MONTEREGIAN MINERALS
E. & L. Horvath 47 Bois Franc
Ste-Julie, Quebec, Canada JOL 2CO

Crystal Resources of New York

178 W. Houston St.
New York, New York 10014
(212) 243-6205
by Appointment
Large showroom
Wholesale - Retail
Specimens from South America, India, Mexico, Europe, and the U.S.

PROSPER J. WILLIAMS
Minerals for Connoisseurs
270 Sutherland Drive, Toronto, Ont., Canada M4G 1J3. Phone (416) 421-0858

Minerals from Tsumeb, Onganja, S.W. Africa, Hotazel area, S. Africa and sometimes other Southern African areas.

Hamel Mining & Minerals

★ **Cabinet specimens**
★ **Miniatures**
★ **Thumbnails**

6451 West 84th Place
Los Angeles, Cal. 90045
Telephone: 213-645-1175

THE HISTORICAL RECORD

by

Ron Bentley
P. O. Box 366
Windsor, Connecticut 06095

Several issues back, we briefly examined some of the different forms taken by early attempts at underground lighting. At the time, we skipped over oil-wick and sunshine lamps, promising to look at them another time. Well, there's no time like the present, so let's take that look. As with the earlier columns, I have taken most of the information from about the only detailed source available. Should you wish to avail yourself of this source, merely send $6.00 to the Arizona Historical Society, 949 East Second Street, Tucson, Arizona. Ask for Museum Monograph No. 6, *Early Underground Mine Lamps* by Henry A. Pohs. While you're at it you might want to drop a line to Mr. Pohs and ask to be put on the mailing list for his free periodical, *The Underground Lamp Post*. It's an interesting bulletin with news about new "old lamps" which he and other collectors have found, lists of people wishing to trade or sell, and other bits of information. His address is: Henry A. Pohs, 4537 Quitman, Denver, Colorado 80212.

After the last column on lamps, one of our readers sent copies to us of an article, "Early American mine lighting," which appeared in *The Mines Magazine*, October, 1978. The author, John Leahy, has an extensive collection of lamps. Data from his article have been added to that of Pohs to give a larger overview.

As you'll recall, the oil-wick lamps fill the space between candles and safety lamps. With the increased demand for metals and minerals brought about by the Industrial Revolution, it was inevitable that a light source brighter and more efficient than the candle would evolve. Thus it was that sometime around 1850, somewhere in Scotland, a small spout-type of wick lamp, roughly resembling a teapot, was invented (Fig. 1). Though dangerous, this "lard-oil" lamp was used for many years. In construction it had a conical font, between 1½ and 2½ inches tall and approximately 1 inch in diameter at the base, that held the fuel. A hinged snap cap sealed the top and a long spout extended up and outward from one side. Opposite the spout, a wire hook was fastened to hold the lamp onto the miner's cap.

The development of eastern U.S. coalfields and the discovery of the Mother Lode in California and the Comstock in Nevada required skilled miners. The majority of these were recruited from the British Isles: Wales, Cornwall and Scotland. In addition to a host of customs and traditions, these miners brought their lamps along with them. The spout lamps were used in metal mines in many districts; mainly the lead-zinc mines in the tri-state district around Joplin, Missouri; the copper mines of Michigan; and the iron mines of Michigan, Wisconsin, and Minnesota.

From the spout, a bushy, dripping wick brought the lard oil or some other fuel from the font to the tip, where it burned with a yellow, smoky flame. The fuel was a packing-house product with a consistency between lard and oil. Bacon grease or tallow compounds were also used. Whale oil was favored in a Chinese version of the lamp while rape-seed oil was popular in European mines.

Miners found several advantages in the oil-wick lamp. Principally they were cheaper and longer burning than the tallow candles. They were also light in weight, easier to carry and balance than the earlier Spanish, French and German hanging oil lamps. And as the spout lamps were produced in many sizes, they could be easily modified to suit the needs of the individual miner. Underground mule drivers, for example, appreciated the larger oil-wick lamp that could be attached to the mules and the ore wagons, as it was less likely to be extinguished by the air currents in the tunnels.

The first U.S. patent for an oil-wick lamp was number 35,264, issued to W. Seybold of McKeesport, Pennsylvania, on May 13, 1862. Another American device was the Spry lamp designed by F. E. Spry of Plymouth, Pennsylvania. It included an oval-shaped windshield between the spout and font which protected the flame in drafty mine tunnels. Spry may have borrowed the idea from the miners who often fashioned a shield from a tin can to mount on their own lamps.

One variation of the traditional oil-wick lamp was the "Sunshine" lamp, so-called because it burned "Sunshine" fuel, a patented mixture of paraffin wax and 3% mineral oil. Produced by the Standard Oil Company, "Sunshine" burned with a cleaner and brighter flame than most oils. To fill the lamp it was necessary either to melt the "Sunshine" or shave it up into small pieces. Old miners still tell tales about working "in the hole" at the age of fourteen when lard oil was sold at the company store by the gallon only and at a price higher than they could afford. So they used axle grease diluted with kerosene. It was smoky but provided light. Later they welcomed the "Sunshine," which was produced in blocks about 7 inches long and 3 inches square. It sold for five cents a block and it burned without smoke.

The lamp looked like and measured approximately the same as the standard oil-wick lamp but had several improvements in the fuel-burning spout, which contained two tubes instead of one (Fig. 2.). The inside tube, insulated by the air surrounding it, conducted enough heat from the flame to the font to melt the hard "Sunshine" fuel so it would rise more easily on the wick. Another method of conducting the flame's heat to the fuel was to insert a commercially produced copper rod in the wick.

Figure 1. **A very early oil-wick cap lamp.**

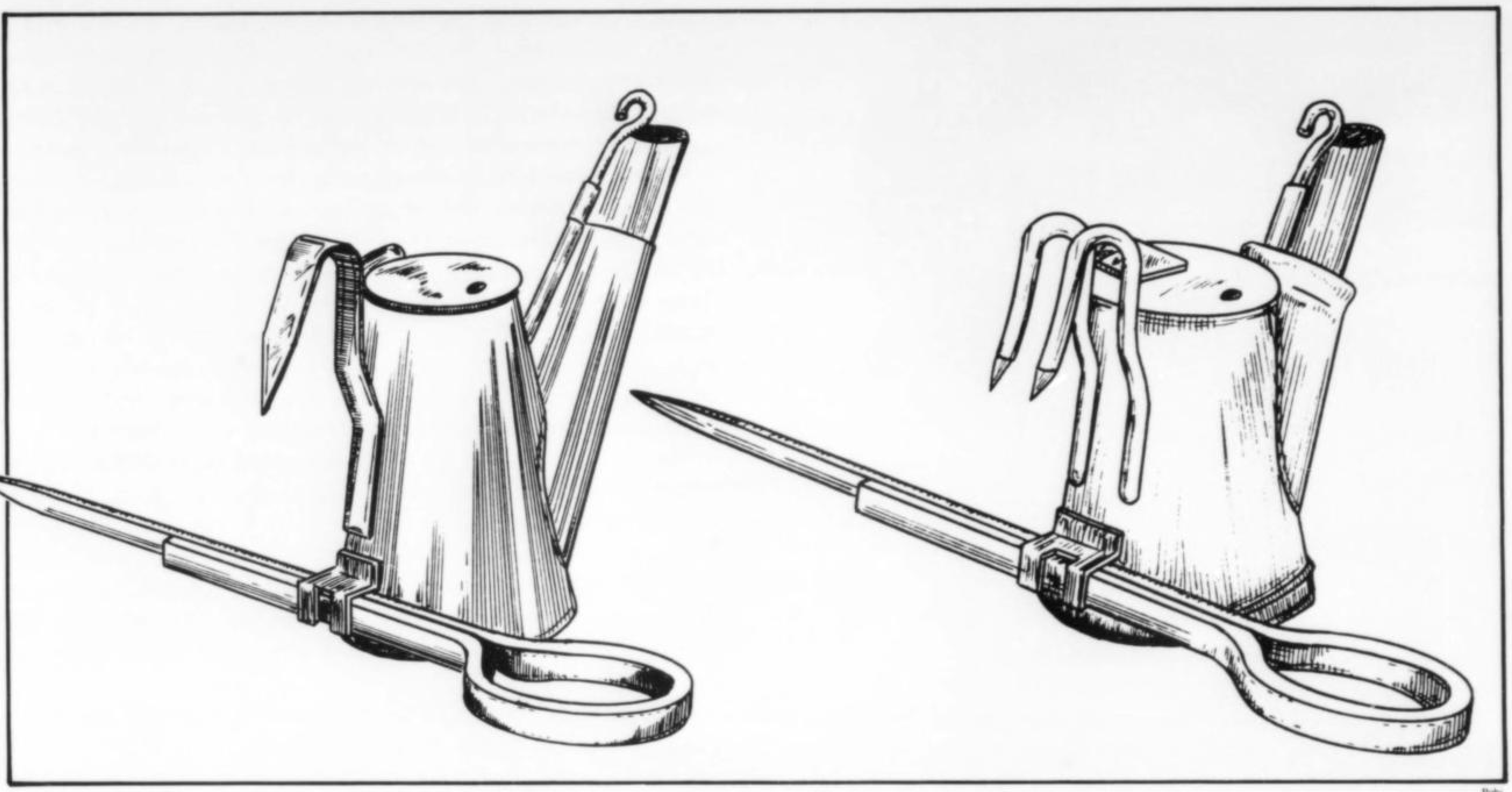


Figure 2. **Husson oil-wick cap lamps with hat hooks and detachable sticks. Left, #1; right, #6. Note copper rod on spout for conducting heat down to Sunshine fuel.**

Lard oil could be burned in a "Sunshine" lamp without alterations to the spout, but a wire insert had to be placed in a lard-oil lamp to use "Sunshine" fuel.

Old time miners were said to be more resistant to change than the normal person, especially where working methods were concerned, a fact that led to the overlapping of new and old methods in mine lighting. Combine this attitude with the manufacturer's desire to make anything that would sell, even if it didn't follow good design practice, and you get the peg lamp seen in Figure 3. The Husson No. 22 Peg Lamp, distributed by the Knippenberg Manufacturing Co., of Oshkosh, Wisconsin, was an oil-wick spout lamp with a ¾ inch "peg" attached to the bottom underside of the font. This enabled the miner who was reluctant to give up his favorite candleholder to insert the peg lamp instead of the traditional candle in the clip of his regulation candleholder.

Another modification to spout lamps, was reinforcement of the base of the spout. This was necessary because the miners commonly raised the wick by striking the base of a warm lamp on their boot heel.

The "little tin spout lamps" were produced in large quantities in the eastern United States, mainly for coal mines in which explosive gas was not too great a problem. In western and eastern coal mines, they were commonly referred to as "coal miner's lamps." Gradually, they found their way into hard rock mining. Both lard-oil and "Sunshine" lamps were commonly stamped with the names and trademarks of the various manufacturers.

Again, due to the motiviation to "make a buck with a patent" and as anything different could be patented, many variations and attachments for spout lamps flooded the market. Some were good; others not so good. They included:

- A wick raiser in 1868
- A fuel capsule in 1869
- A gasoline-type wick tube in 1875
- A hook stabilizer in 1876
- An air-feed burner tip in 1877
- A double-font, double wick design in 1878
- An oblong, oval spout in 1879
- A flame container in 1880
- A combination handle and wick cover in 1882
- A combination lamp and candlestick in 1883.

Despite the many advantages of the oil-wick spout lamp, there

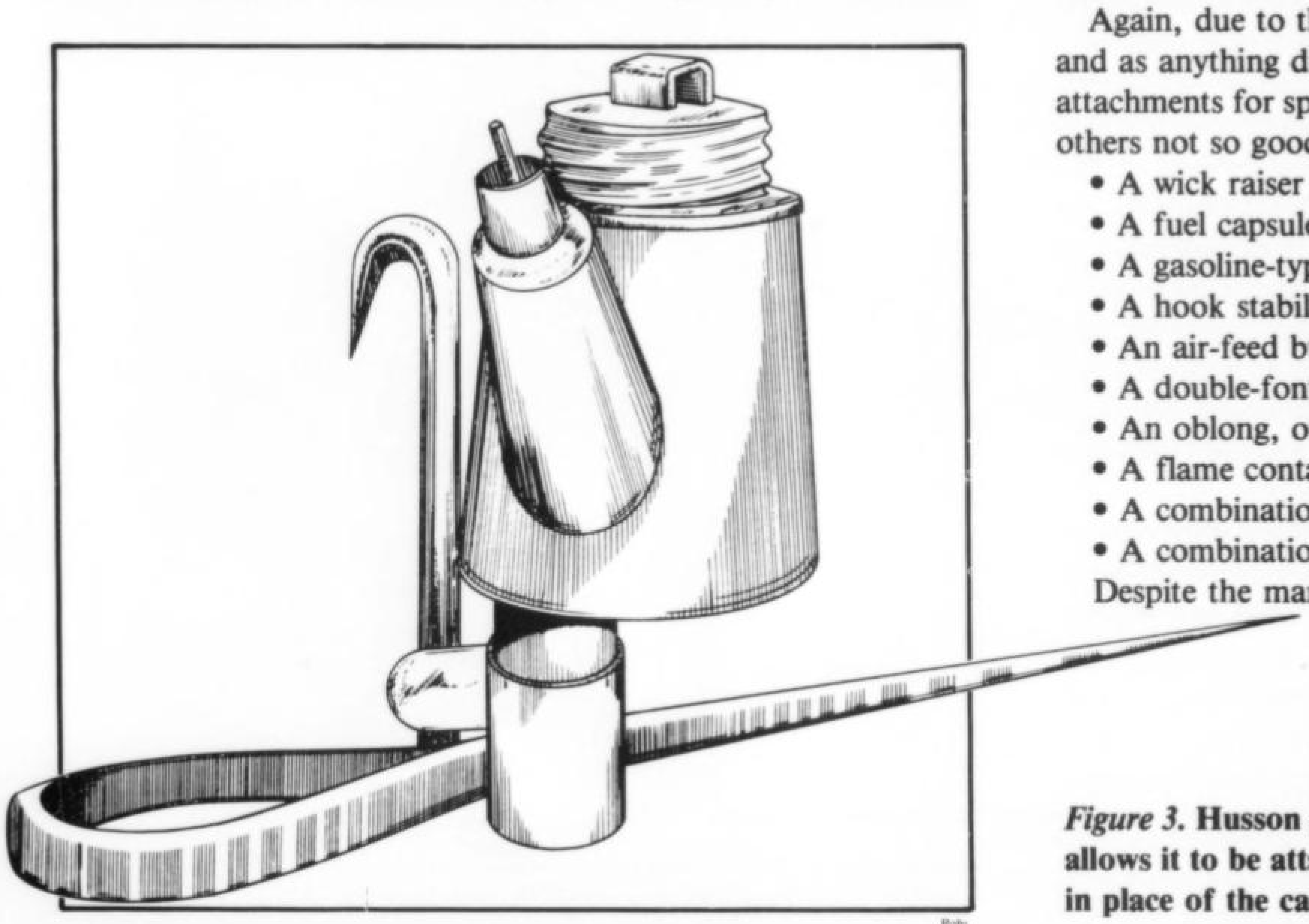


Figure 3. **Husson #22 oil-wick peg lamp; the peg allows it to be attached to a miner's candlestick in place of the candle, as shown.**

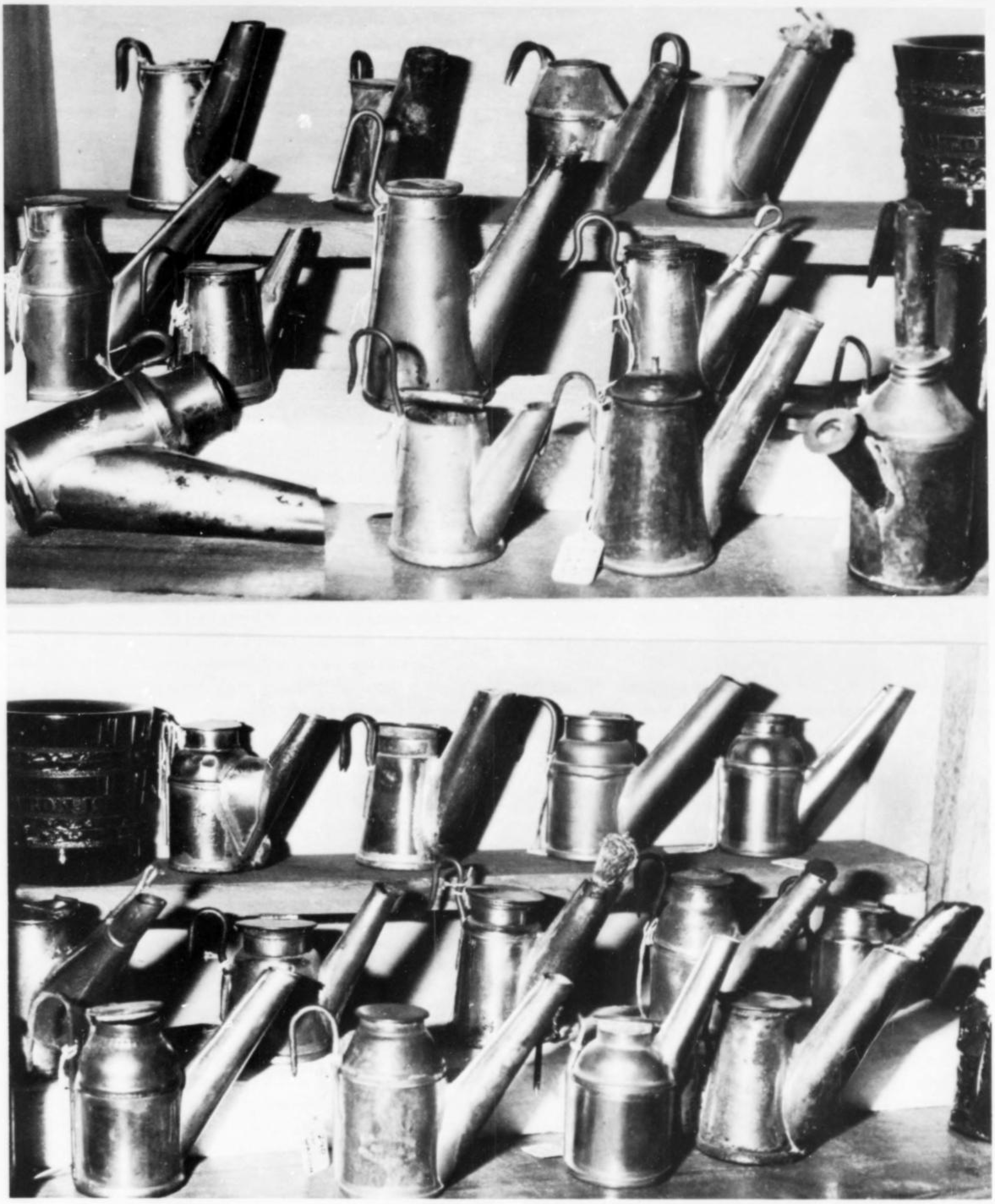


Figure 4. **Some of the many oil-wick cap lamps in the collection of Chuck Young, Fairfax, Virginia.**

were also inherent disadvantages such as the possibility of its large flame, used carelessly, igniting mine timbers or other flammable materials.

The wide variations in lamp construction, lamp manufacturer, and patents, only a few of which are pictured here, illustrate one of the attractions the hobby of lamp collecting holds for its followers.

While not directly connected with lamps, John Leahy in his article mentions the origin of some of the mining terms we have today. As we said, many miners were recruited from the British Isles. The Cornish miners had long been mining tin in hardrock mines, so they were in great demand in the mines of California, Nevada, Michigan, and elsewhere. In answer to the mine supervisor's common request for other miners of equal ability, the Cornishman frequently said, "I'll write back to me cousin Jack." Soon the Cornish miners were all called Cousin Jacks, drilling was known by the number of Cousin Jacks required (single-jacking or double-jacking), and the hammers used in the drilling are still called a single jack or a double jack.

FM friends of mineralogy

COLORADO FM CHAPTER UPDATING "MINERALS OF COLORADO: A 100-YEAR RECORD"

By **Edwin B. Eckel**
U.S. Geological Survey
Box 25046
Denver Federal Center
Denver, Colorado 80225

Updating of my publication, *The minerals of Colorado: a 100-year record,* is one of the major projects of the Colorado chapter, Friends of Mineralogy. This article describes the chapter's plan of attack, and tells a little about how the original book came to be.

Though I have successfully claimed the privileges of age in avoiding direct involvement in the project, I was pleased to be asked by chapter president Jack Murphy to act as guide and father confessor during the compilation stage; I will doubtless also play a part in putting the new book together.

Known to most collectors of Colorado minerals, and also used as a reference by professional mineralogists, *The minerals of Colorado* was published in 1961 as Bulletin 1114 of the U.S. Geological Survey. Though the original printing was much larger than usual, the book became something of a best seller and went out of print by 1969. It is again available, having been reprinted in 1978, but without the locality map.

Bulletin 1114 is an unprepossessing book of 400 pages, clad in "government-gray" paper covers and without illustrations. Arranged alphabetically by species names, it summarizes the available information on occurrences of 445 minerals in the state. A few descriptions came from unpublished sources, but most were taken from the published scientific literature. A nearly complete bibliography is included.

Though I was a member of the U.S. Geological Survey throughout its preparation (and still am, on a part-time basis), compilation of material on the minerals of Colorado was never an official USGS project. As a new recruit in 1930, I was assigned to a small group of geologists headquartered in Golden, Colorado, to work on a State cooperative study of Colorado ore deposits. As an end product of our mining-district investigations, we dreamed of a comprehensive volume on the ore deposits of Colorado, similar to the outstanding works on New Mexico by Waldemar Lindgren and on Utah by B. S. Butler. As a beginner, my own specific assignment was to write a chapter on mineralogy of the ore deposits. The comprehensive volume never materialized, but for a couple of years I devoted spare hours from other work to reading published reports on Colorado mining districts and taking copious notes on mineralogy. When the larger dream died and I went on to other work in other places, I was left with my notes, plus a strong conviction that what Colorado really needed was not just a brief chapter on ore minerals and their associated species, but a thorough compilation of what was known about Colorado mineral occurrences in general. Thus a new and smaller dream was born.

Many remarks, kind and unkind, have been made to the effect that my report on Colorado minerals, 1858–1958, took me 30 years to write. This is not the whole story. The dream persisted, and a succession of leaders and other friends gave moral support and encouragement. Actual work on the compilation, however, proceeded by fits and starts, separated by months or years of total immersion in other kinds of work and by what seemed at times to be constant travel. Still, the stack of notes and the list of read and unread references grew gradually. Toward the end of the 1950's the dream became an obsession; I realized that for my own peace of mind I had to complete the job or drop it out of my life. Blessed with a key to the U.S.G.S. library, I spent most of my free evenings and weekends, for several years, feverishly abstracting all the literature I could find on the shelves or that the librarian could borrow for me. Fortunately, the compulsion lasted, and I finally turned the rough notes into manuscript form. Even though the project had never been listed officially, and the manuscript came to those in charge of publications out of the blue, they accepted it for Survey publication as a Bulletin. Its appearance took a monkey from my back, and was a relief to my family and friends; it also gave me a good feeling that I had added a bit to the science.

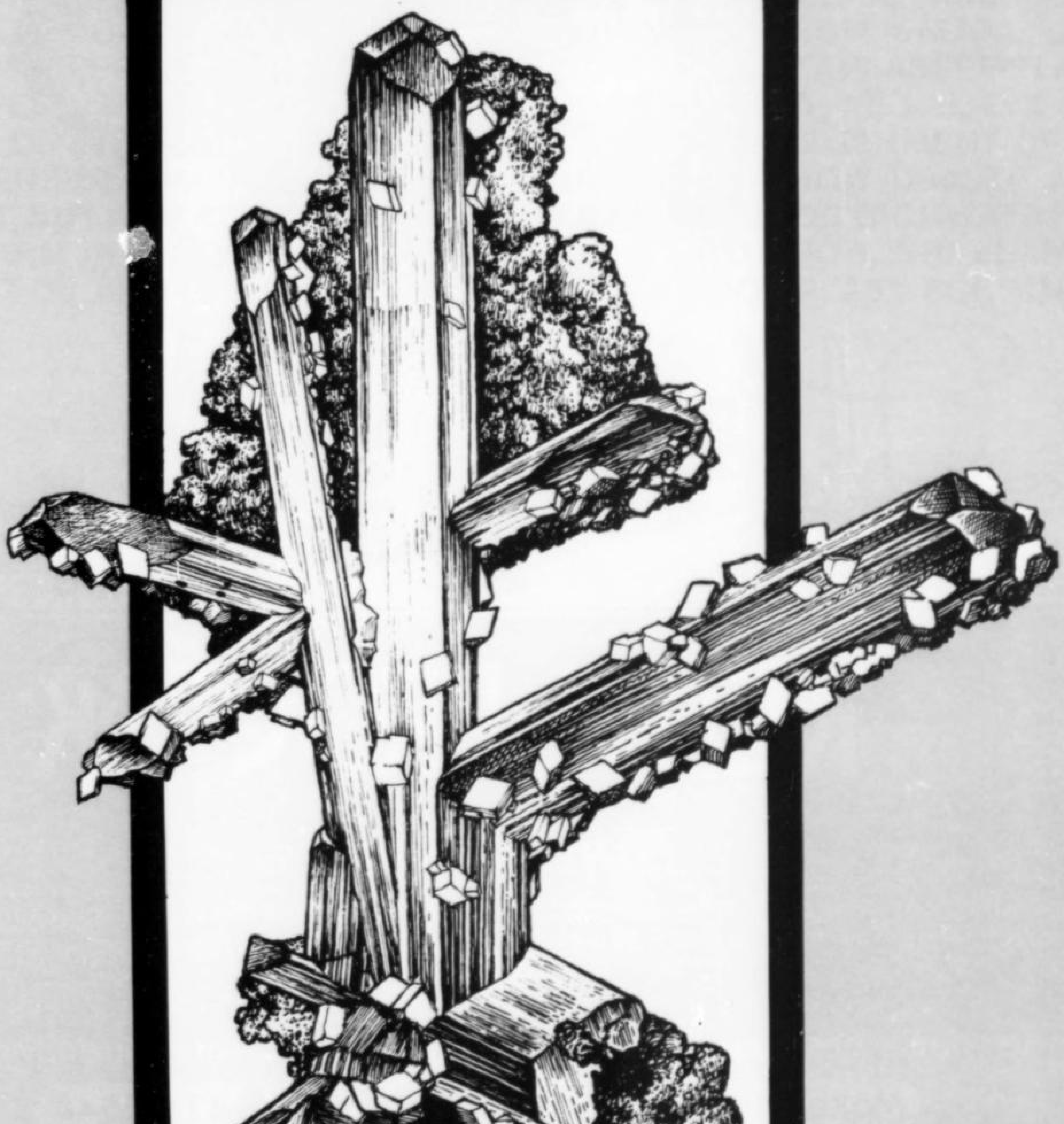
Since 1958, the closing date for entries in Bulletin 1114, knowledge of Colorado mineral occurrences has increased enormously. The scientific results of the great uranium boom of the 1950's were just beginning to emerge in print by 1958, Colorado oil shales have yielded new minerals, old metal mines have closed and new ones opened, and the state's pegmatites have been explored and studied far more thoroughly than during the preceding century. Scores of minerals new to science or at least new to Colorado have been discovered and described. Much of this mass of new knowledge is now in the literature, but much too is in the minds of amateur and professional collectors; specimens are in museums or private collections or are still being studied in laboratories.

The Colorado chapter's overall plan is to produce a book, similar to Bulletin 1114 in format and content, that assembles all information on the subject that has become available since 1958—a period of more than 20 years. In addition it will have a section on corrections to Bulletin 1114. Modern studies of some of the specimens described there have led to discrediting or changes in the names of some species, there are a few significant typographical errors, and some localities have been worked out or have become inaccessible.

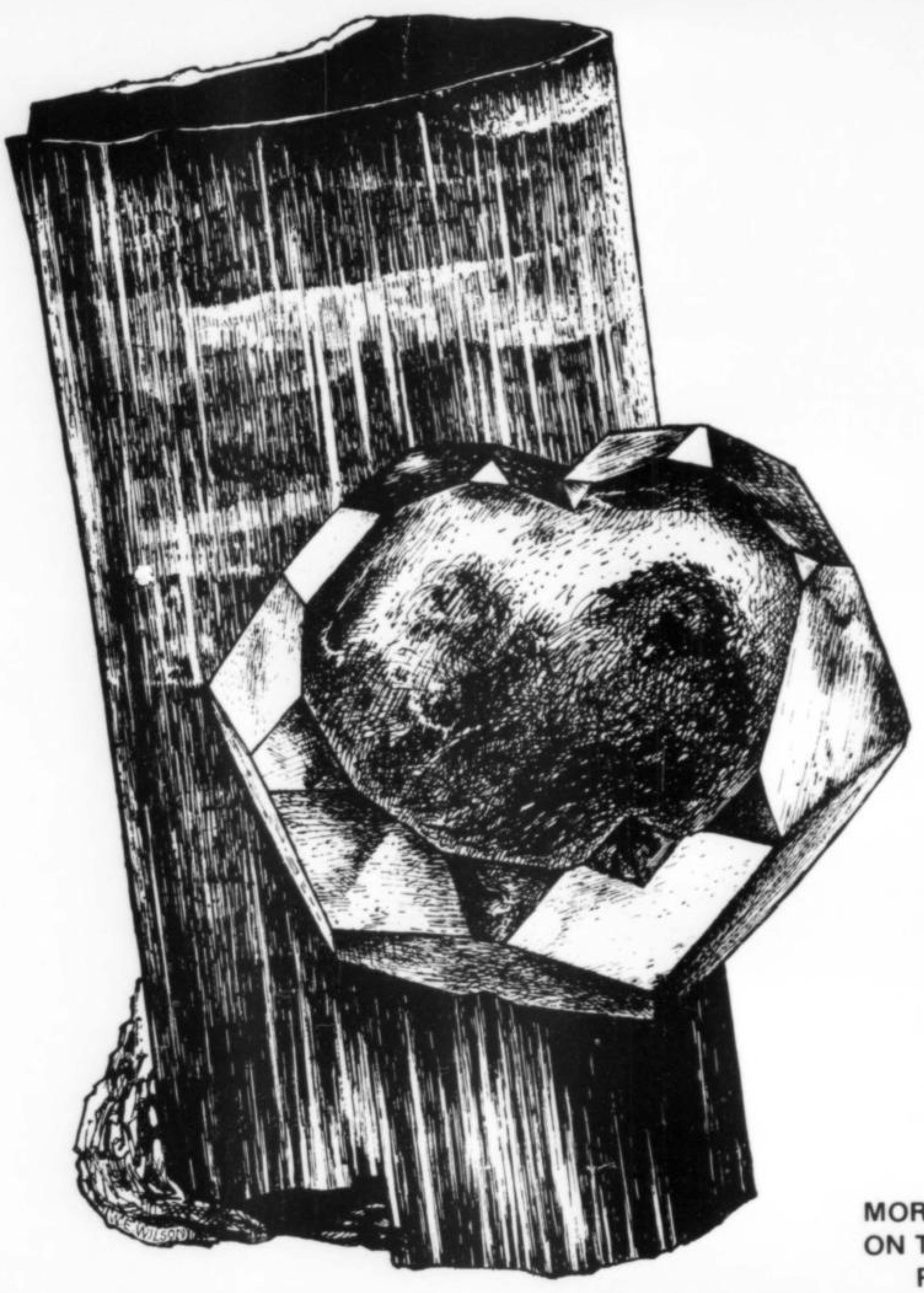
Rather than compilation by a single individual, work on the updated volume will be a group effort, done by a dozen or so dedicated volunteers. Workers will comb the literature, concentrating on one publication series at a time. Information will be recorded on uniform-sized cards, with one card per species per locality. A bibliographic reference card will be prepared at the same time. The unpublished literature will not be neglected. Dissertations and theses will be reviewed, as will the voluminous "open-files" of government agencies and private companies. All materials will be assembled in a central file ready for write-up or possibly for computer manipulation. Other volunteers will cover the main museums and private collections; they will seek help from local mineral clubs, as well as from amateurs or professionals who have unpublished information on recent work.

The time schedule for completion of the task, as well as plans for publication of the final product, must be left blank. The working group is optimistic, however, and hopes to complete its job within a couple of years.

Any readers who have specific or general knowledge of Colorado mineral occurrences that would aid the project should communicate with Jack Murphy, Denver Museum of Natural History, City Park, Denver, Colorado 80205. All help, big or little, will be deeply appreciated.



Unique Private Collection



MORGANITE
ON TOURMALINE
PALA, CALIFORNIA

KEITH PROCTOR

fine minerals

Few collections in history have received as many major awards as this superb collection of museum quality pieces. The most recent is the McDole Trophy—"Best Minerals at Tucson Gem & Mineral Show—1978."

Some specimens from this unique private collection are currently available.

Make arrangements to see it. Call 303-471-2544

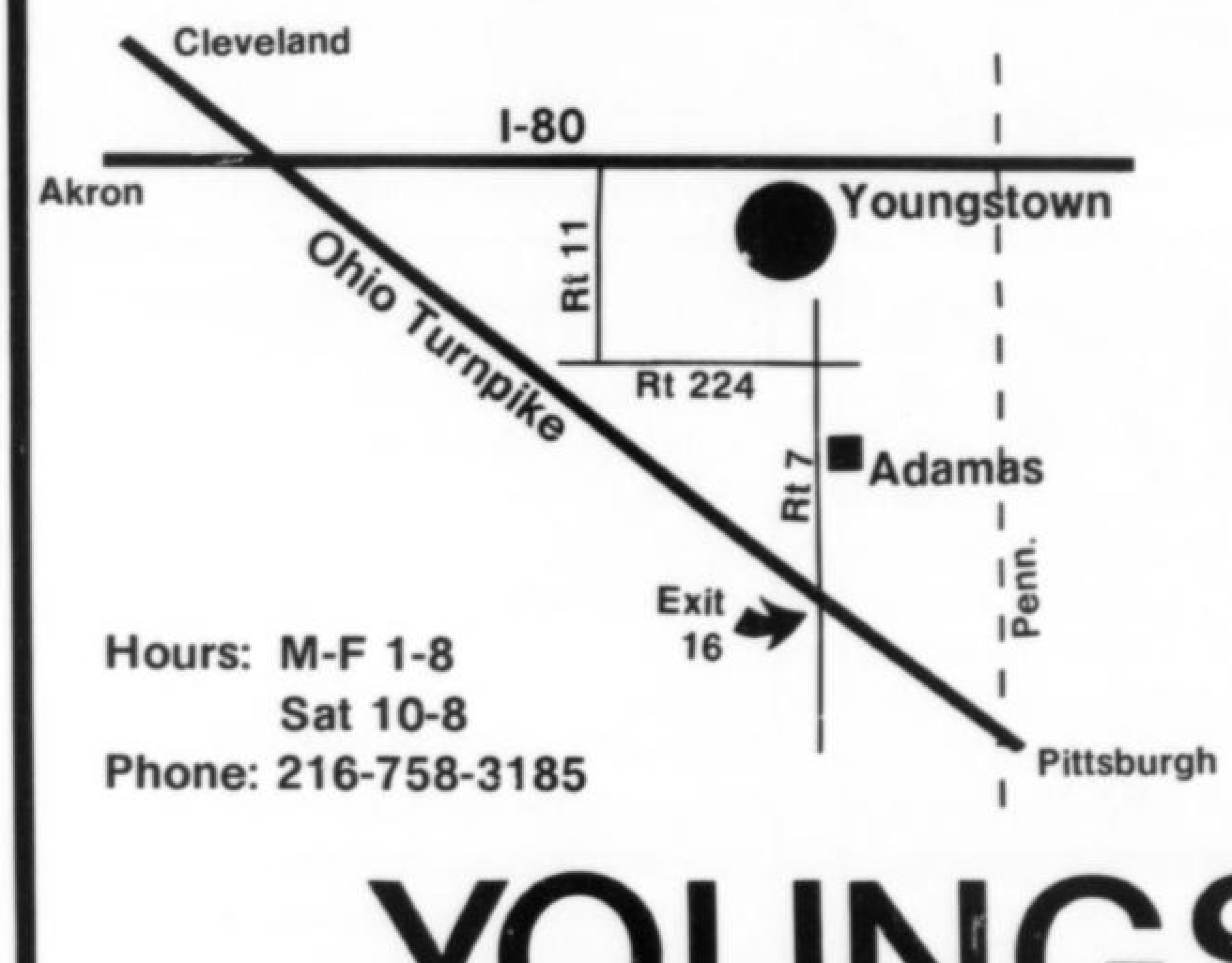
1422 N. HANCOCK, SUITES 1, 2 & 3, COLORADO SPRINGS, CO. 80903

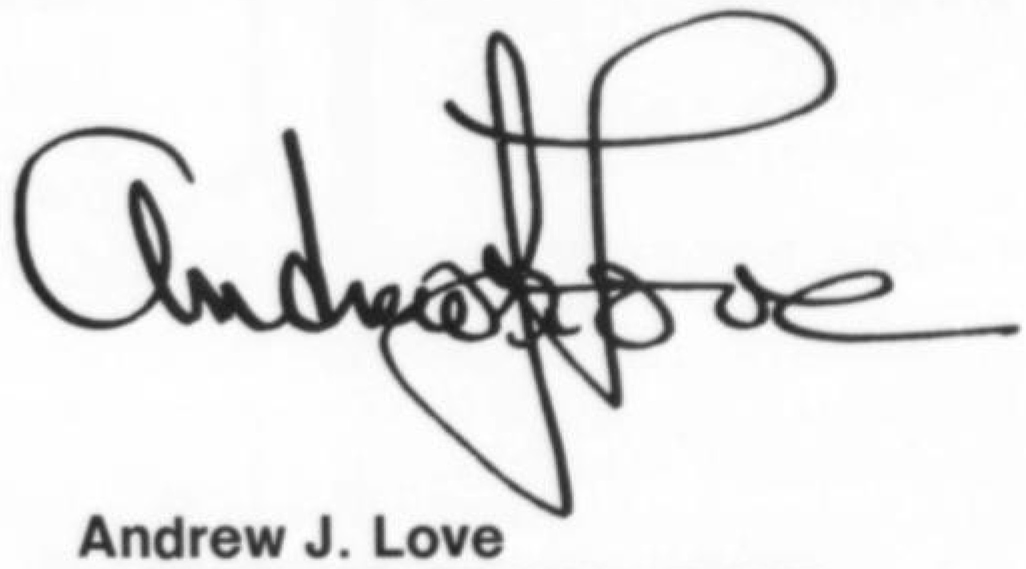
ADAMAS

"MINERALS FOR MINERAL COLLECTORS"

ADAMAS IS LOCATED 2 MILES NORTH OF THE OHIO TURNPIKE (EXIT 16) AND 20 MINUTES SOUTH FROM I-76 & 80. IF YOU PASS THROUGH YOUNGSTOWN GOING EAST OR WEST AND YOU ARE A MINERAL COLLECTOR, WE THINK YOU WILL FIND THE VISIT TO ADAMAS WORTHWHILE.

WE WOULD LIKE TO TAKE THIS OPPORTUNITY TO INTRODUCE OURSELVES AND EXTEND TO YOU A MINERAL COLLECTOR'S INVITATION, FOR WE ENJOY NOTHING MORE THAN TALKING TO MINERAL COLLECTORS. THE ADAMAS MUSEUM IS A MUST FOR ALL THAT SEE BEAUTY IN THE MINERAL KINGDOM AND HOUSES THE FINE COLLECTION OF THE LATE CLARENCE SMITH SR., AS WELL AS OUR RECENT ADDITIONS. WE THINK YOU WILL AGREE THAT THE MUSEUM ALONE IS WORTH THE VISIT, HOWEVER WE DO HAVE THE LARGEST VARIETY OF CRYSTALLINE ARCHITECTURES AVAILABLE TO THE COLLECTOR, THAT WE CAN MUSTER. AMONG THE RECENT ADDITIONS TO OUR STOCK ARE A FINE SELECTION OF HUBNERITE CRYSTALS FROM SILVERTON COLORADO AND SOME EXCELLENT TREMOLITE/ACTINOLITE AFTER PYROXENE FROM SALIDA, COLORADO. WE ARE PERHAPS MOST PLEASED TO OFFER YOU OUR ASSEMBLAGE OF CALCITE PENDLETON TWINS FROM ANDERSON, INDIANA. WE BELIEVE THE ABUNDANCE OF PERFECT TWINS TO BE NATURE'S ACCOMPLISHMENT OF AN INCOMPREHENSIBLE IMPROBABILITY. WE ARE NOT A SHOW DEALER AND HAVE NO LIST, BUT WE ARE EASILY ACCESSIBLE FROM MAJOR HIGHWAYS AND EXTEND A WARM INVITATION. WE WOULD BE PROUD TO SHOW YOU ADAMAS. PLAN TO VISIT US AND WHEN YOU COME TO YOUNGSTOWN; ASK FOR 'ANDY'.





Andrew J. Love
GEOLOGIC CONSULTANT

Hours: M-F 1-8
Sat 10-8
Phone: 216-758-3185

YOUNGSTOWN OHIO

8391 Market St. Youngstown, Ohio 44512

Collectors & Cutters

Don't Delay!

We have a limited quantity of

Russian Emerald Roughs

available to you for only

$1.00 Per Carat

Minimum orders $300 (300 carats); check, money order, Visa or Mastercharge accepted.

Excellent for:

Faceting, Cabbing Carving & Specimen Crystals

Many large crystals available

Call Toll Free
800-327-2413

or write Dept. M

DIAMOND SALES COMPANY
Ainsley Building
14 N.E. 1st Avenue
Miami, Florida 33132

In Florida,
CALL COLLECT
379-2438

STIBNITE

bentley's minerals

Distinctive specimens—
for museums and collectors

Write: P.O. Box 366
Windsor, Connecticut 06095
Telephone—(203) 247-1384

MICROMOUNTS

Are our specialty.

Our current catalog contains about 400 listings of quality micro crystal specimens both mounted and unmounted. Also included are reference collections, supplies and a discussion of micromount preparation.

Catalog 30 cents.

HATFIELD GOUDEY
1145 West 31st Avenue
San Mateo, California 94403

WHAT ON EARTH

WHEN YOU'RE PASSING THROUGH COLUMBUS, BE SURE TO STOP IN TO SEE US --IN 'THE CONTINENT' SHOPPING CENTER, ROUTE 161 & 171
MON - SAT: 11-9
SUN: 12 -5

6262 Busch Blvd.
Columbus, Ohio 43229
(614) 436-1458

Richard W. Barstow

Dealer in high quality British & World Mineral Specimens for the advanced collector.

Lists of fine specimens sent free on application.

List of rare Cornish & British Micromounts also available.

Callers welcome.

DRAKEWALLS HOUSE, DRAKEWALLS, GUNNISLAKE, CORNWALL, ENGLAND.

Tel: 0822-832381

VAM

di
alfredo
ferri

Fine mineral specimens from Europe and worldwide locales.

Dr. Alfredo Ferri

Show room:
C.so Vercelli, 7
20144 Milano, Italy

tel. 435000

PHILADELPHIA AREA
CAROUSEL
GEMS & MINERALS

FINE MINERAL SPECIMENS

SIZES TN'S TO CABINET

132 So. York Road
Hatboro, PA 19040
215-441-4257

Mon-Sat 10-5; Fri til 9
See us at the Munich Show
September 29, 30
SEND SASE FOR LIST

AMAZONITE from the Pikes Peak Batholith

by **Eugene E. Foord**
Box 25046, Mail stop 905
U.S. Geological Survey
Denver Federal Center
Denver, Colorado 80225

and **Robert F. Martin**
Dept. of Geological Sciences
McGill University
3450 University Street
Montreal, PQ, H3A 2A7
Canada

Amazonite, a bluish green to greenish blue variety of microcline of varying hues and intensities, has been known from the Pikes Peak batholith for over 110 years. The chemistry and mineralogy make for an interesting study.

INTRODUCTION AND HISTORY

Strictly speaking, the term amazonite (or amazonstone) includes not only green maximum microcline but also similarly colored orthoclase, intermediate microcline and other varieties as well (Cech and others, 1971). Rudenko and Vokhmentsev (1969) reported two blue-green oligoclases from pegmatites and called these plagioclase-amazonite.

The first description of amazonite from Colorado appears to have been that of Hollister (1867). Odiorne (1978) has provided a concise summary of the early literature as well as the historical development of the area. Crystals and specimens of Colorado amazonite are among the finest in the world; numerous examples are held in museum and private collections. Few other known amazonite localities have free-standing, euhedral, well-formed crystals in open cavities within pegmatite bodies. Such cavities are known as 'pockets'. The occurrences of such amazonite in Colorado are world-famous.

Numerous articles have been published on aspects of the mineralogy of the pegmatites found in rocks of the Pikes Peak batholith. Space does not permit discussion of all of them here. The three major groups that may be distinguished are (1) the Zn enriched rare alkalic pegmatites of the St. Peter's Dome region, (2) the fluorine and rare-earth-element enriched pegmatites of the South Platte region, and (3) the amazonite-bearing pegmatites. The descriptive mineralogy of these pegmatites has been summarized by Pearl (1974).

GENERAL GEOLOGY

Both amazonite and the far more common ordinary buff to cream-colored microcline are found in pegmatite dikes and lenses within the epizonal Pikes Peak batholith and cogenetic satellitic stocks of Precambrian age (1040 ± 13 million years, and 1048 to 980 m.y., respectively; Hutchinson, 1976). Figure 1 is a generalized geologic map of the Pikes Peak area slightly modified from Figure 1 of Barker and others, 1976. The composite batholith is exposed over an area of about 2800 km^2; its upper levels have been removed by erosion. The spatial distribution of aplite and pegmatite bodies within the batholith defines three separate intrusive centers: (1) Pikes Peak, (2) Lost Park, and (3) Buffalo Park (Fig. 5 of Hutchinson, 1976).

Pegmatites are classified as simple or complex based on their mineralogy, structure and zonation. Nearly all of the pegmatites encountered within the Pikes Peak batholith are of the simple type. Amazonite-bearing pegmatites within the Pikes Peak batholith are of the simple type but may be of the complex type in other localities (e.g. Amelia, Virginia, and the Soviet Union).

The pegmatite dikes within the Pikes Peak batholith may attain 50 m in length and several meters in thickness but generally are much smaller. The third dimension is poorly known because of lack of underground mining, but vertical and horizontal zonation characterizes many of the dikes. However, from the work done, it is known that a given dike may pinch and swell markedly over a very short distance. Sharp contacts are common between the pegmatites

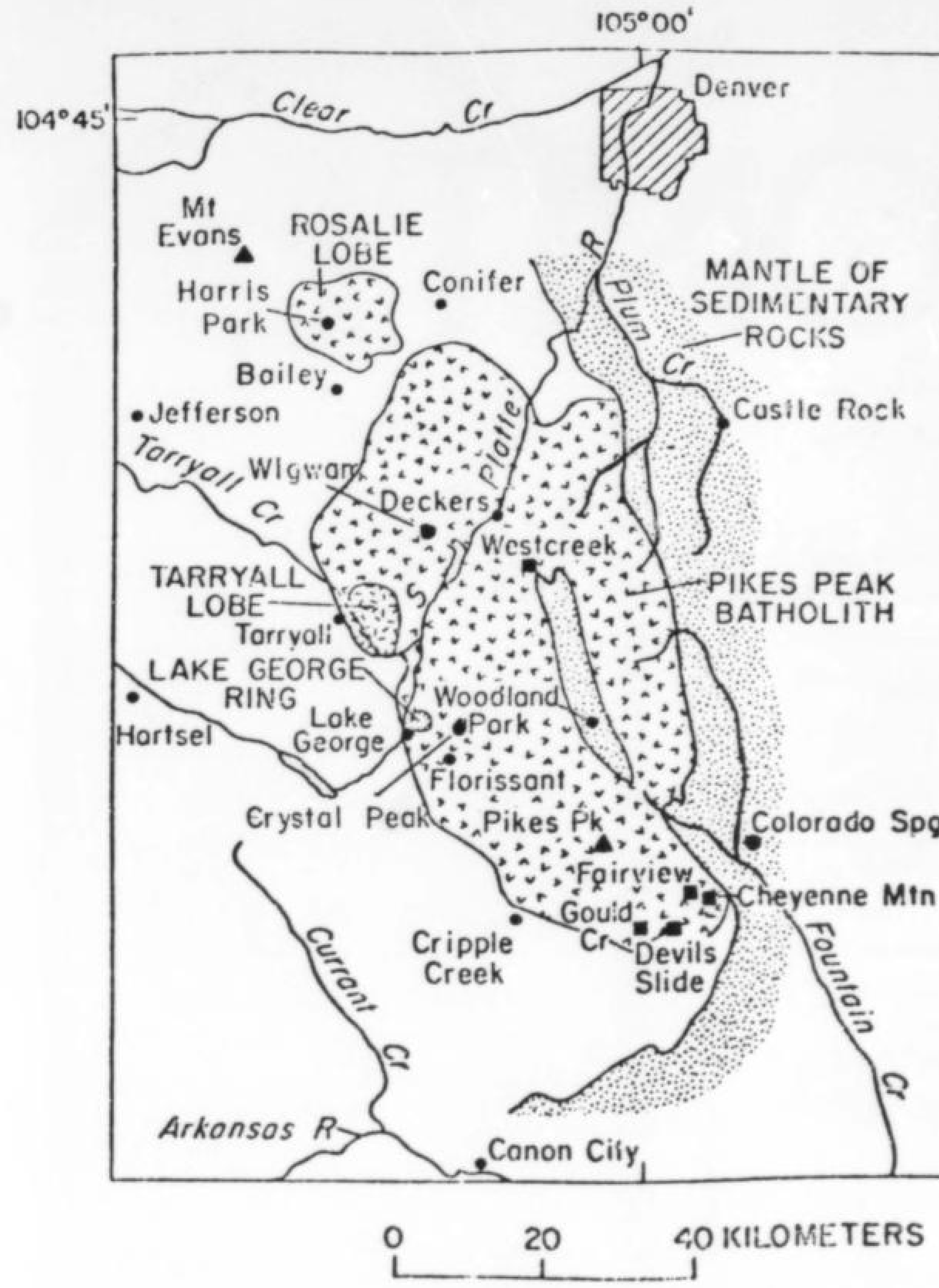


Figure 1. **Location map showing the general geology of the Pikes Peak batholith.**

and the host rock which may be either various units of the Pikes Peak batholith or the surrounding metamorphic rocks. Most of the pegmatite dikes occur between about 2100 and 2700 m in elevation, *en echelon* in rows or sub-parallel arrangement. This vertical distribution most likely results from the original geometry of the pluton and the process of its emplacement as well as subsequent post-crystallization tectonic activity. There seems to have been a high degree of structural control in the emplacement of the dikes in many areas within the batholithic complex. The pegmatite dikes are usually slightly more resistant to weathering than the host rocks and may under favorable topographic conditions be detected by differential relief.

The basal portions of many dikes are generally aplitic; these may show poorly defined mineral stratification though no 'line rock' such as that developed in the complex pegmatite-aplite dikes of San Diego County, California (Foord, 1977) has been observed. The basal portions usually contain more albite than the upper portions of the pegmatite dikes, which are generally coarse-grained, massive and rich in microcline and quartz. The principal mafic mineral is biotite.

The 'pocket zone' is centrally located or slightly above the median line of a dike. Graphic pegmatite is very well developed immediately above and below pocket occurrences. The mineralogy of the pocket zone is very similar to the graphic pegmatite portions of the dikes (microcline, quartz, albite and biotite) except for the presence of minor amounts of unusual or rare mineral species, with or without the development of amazonite. In some places, the graphic pegmatite beneath pocket cavities is strongly solution-etched whereby the quartz rods and blebs are effectively removed from the host microcline. Such rock resembles fossil sponge. This is believed to be a result of late-stage dissolution by corrosive fluids.

The pockets themselves may have no void space remaining and may be completely filled by crystalline phases; or they may have open space still remaining. Only a few open and uncollapsed pockets are found near the present ground surface. Most pockets have either partly or wholly collapsed at some time in the past from the effects of near-surface weathering and frost action. Pockets that have not been fractured open or breached by near-surface effects have most closely preserved the original configuration and structure. However, some fracturing and disruption occurred at the time of pocket formation or very shortly thereafter (Fig. 2). Such fractures are commonly lined with secondary quartz (clear or white) and/or other mineral phases (e.g. fluorite). A few pockets seem to have been "flooded" with late fluorite which commonly permeates and replaces the other mineral phases. Evidence of late-stage chemical etching (corrosion) is also commonly observed in the pocket environment. The vast majority of pockets excavated are filled to some extent with dark red-brown, brown, or black Fe-Mn hydrous oxides, micas and clay minerals. These very late-stage low temperature minerals contain fragments of previously formed pocket minerals. Deposition of such minerals may presently be occurring in many surface or near-surface pockets which still have void space remaining. If such a pocket has maintained its structural integrity, generally only the minerals on the floor or the lowest portions will be coated with these low-temperature minerals. The minerals in some pockets show light cream to buff-tan coatings as much as 0.4 cm in thickness which cannot be removed by repeated boiling in oxalic acid, and which have been found to be either an amorphous silicate or sanidine. These coatings predate the hydrous Fe-Mn oxides, but like them are deposited on the floors and/or lowest portions of pockets.

Since initiation of prospecting activity for amazonite in the Pikes Peak batholith, several tens of thousands of pockets have been excavated. Of all of the pockets discovered, perhaps 20 to 30 percent have contained amazonite of various hues. The remaining 70 to 80 percent have contained ordinary microcline. The particularly striking 'white cap' specimens of amazonite are found in less than one percent of all amazonite-containing pockets (Fig. 3). Rarest of all have been the very few pockets which contained deep green amazonite having flesh-colored overgrowths on selected prism and dome faces only (Fig. 11).

Most pockets are circular to elliptical in plan but they may be irregular in outline as well. "Arms" may extend from a given pocket cavity. In cross-section, pockets are commonly mushroom-shaped,

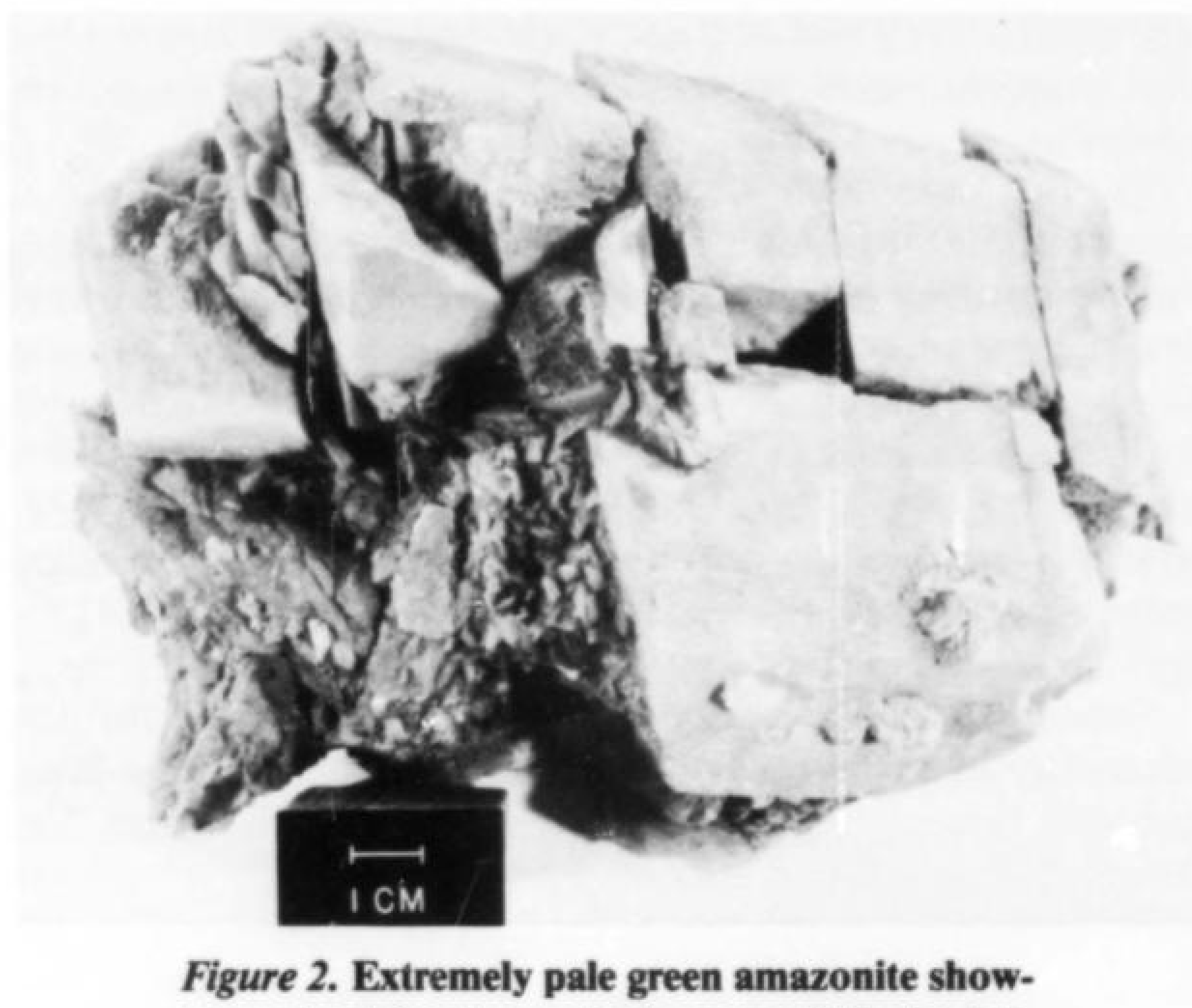


Figure 2. **Extremely pale green amazonite showing natural fractures which are partially healed. The specimen is from Harris Park; H. H. Odiorne specimen.**

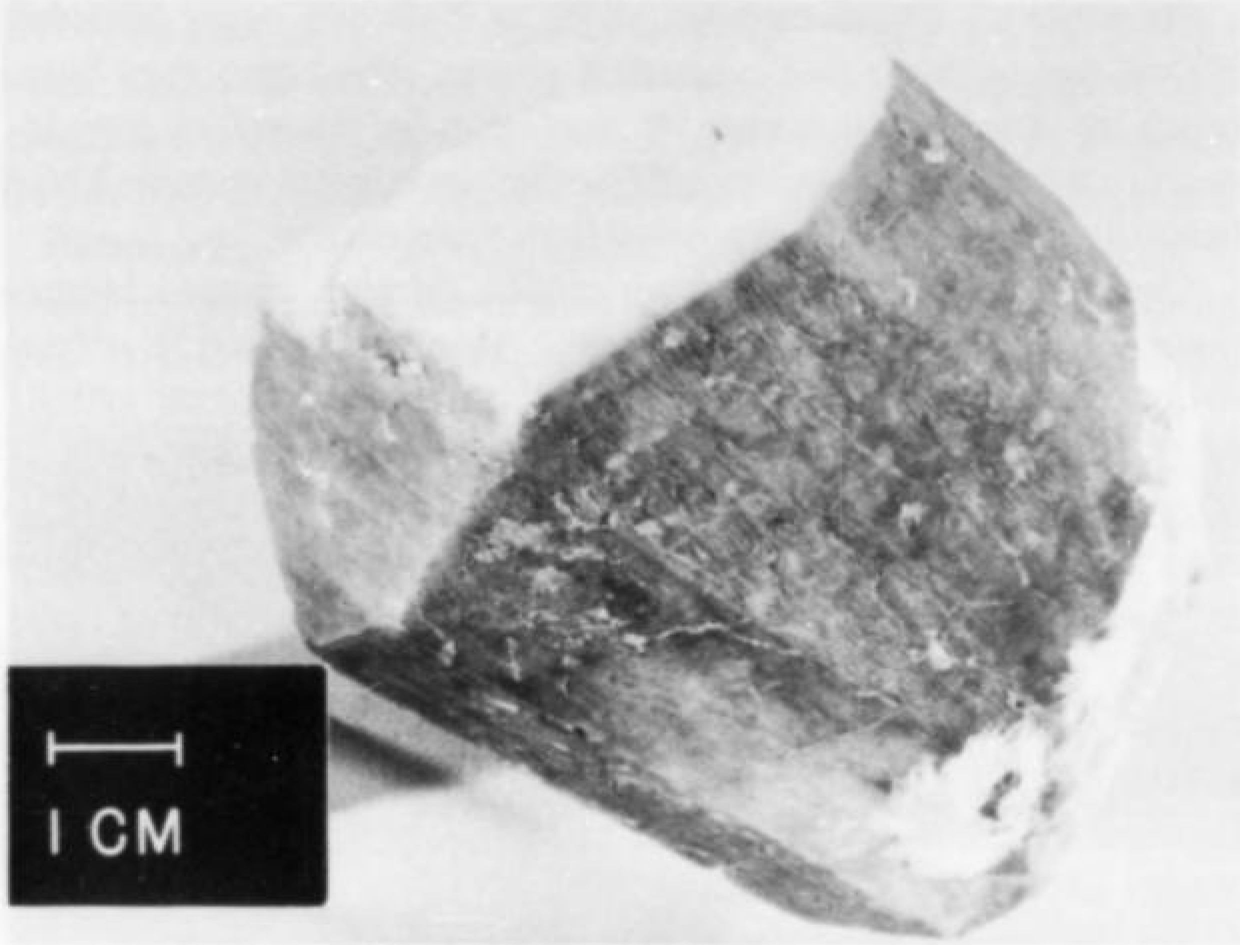


Figure 3. **A specimen of "white cap" amazonite from Crystal Peak. Collection of the Denver Museum of Natural History.**

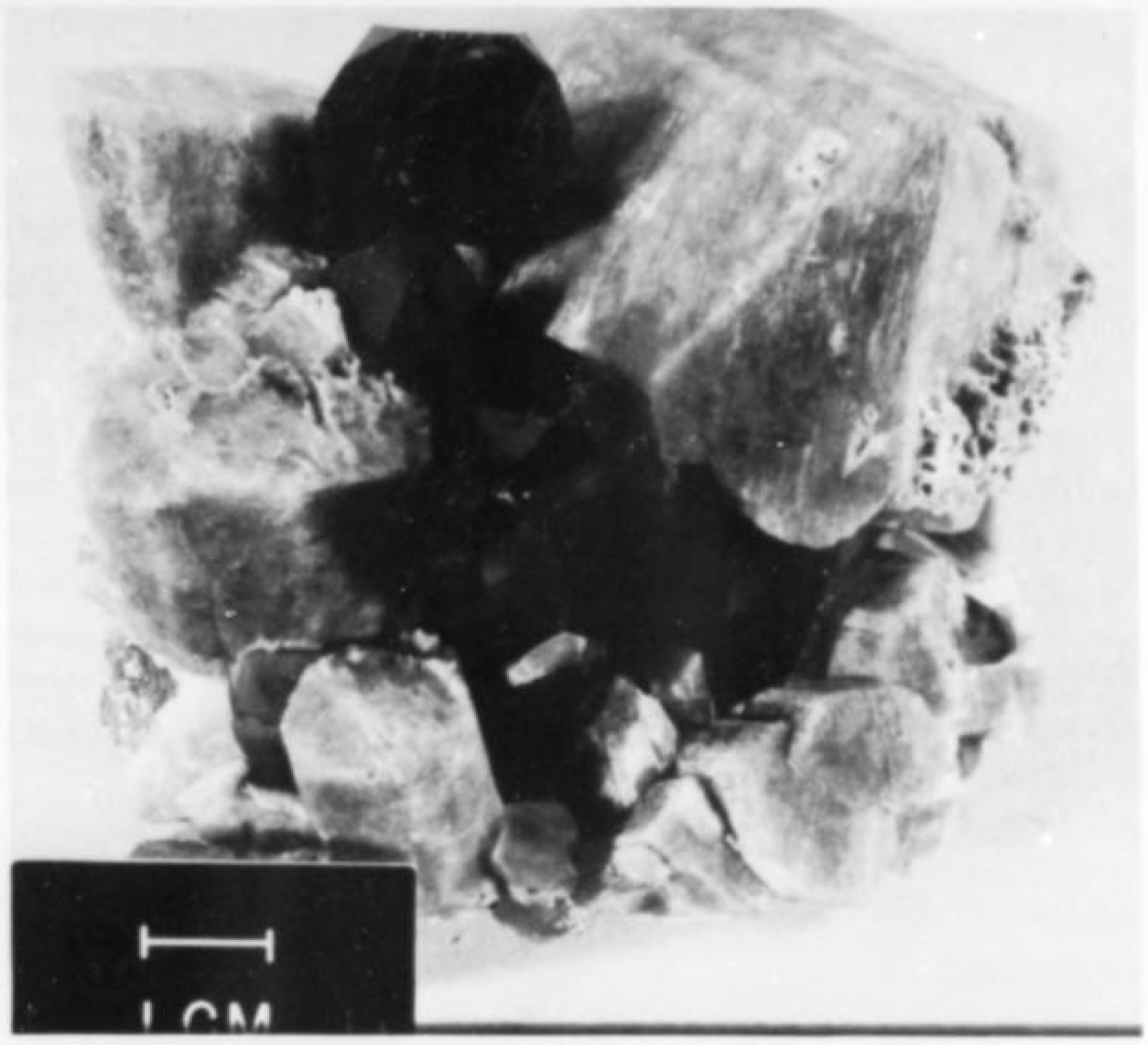


Figure 4. **A smoky quartz and amazonite group from near Crystal Peak. Note the residual overgrowths on {001} faces of the amazonite. Collection of R. A. Kosnar.**

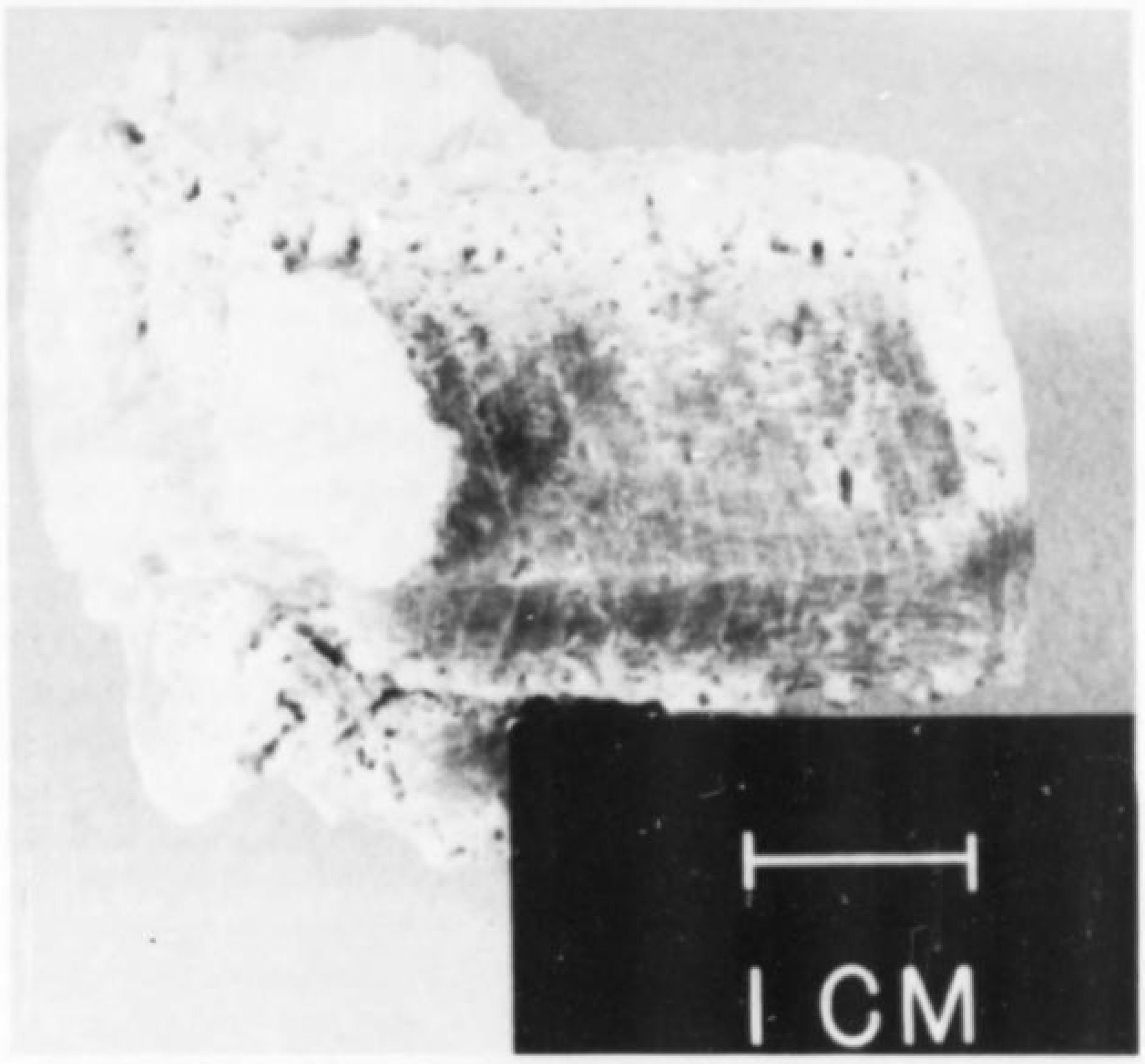


Figure 5. **An amazonite crystal with white blades of cleavelandite attached and cream-colored overgrowth on {001} and {010}. Note etching of host microcline and overgrowth. Collection of R. A. Kosnar.**

with the floors generally being flat. Dimensions vary from less than 1 x 1 x 0.4 m to more than 3 x 4 x 1.5 m. Pockets are usually symmetrically disposed to the dike margins whereby the floors are parallel to the walls but may be inclined. In some instances, however, the pockets are canted and the floors are not parallel to the dike margins.

Within a given pegmatite dike an amazonite-bearing pocket may occur immediately adjacent to an amazonite-free pocket bearing ordinary buff-tan microcline. Pockets may be separated from one another by only a meter or less or may be several meters or more apart. Because no extensive and complete excavation of pegmatite dikes has been done, details of structure and spatial distribution of pockets are incompletely known.

Most pockets have been found by tracing quartz and feldspar crystal float uphill and/or upstream to the source. Unabraded crystals of euhedral pocket minerals are the best indicators of nearby pockets. In some cases, tracing the crystal float has yielded no identifiable pockets. Such may be indicative of pockets that have been completely removed from their source by erosion.

In the majority of pockets microcline is more abundant than quartz which is more abundant than albite which in turn is more abundant than mica. All of these minerals are much more abundant than associated accessory minerals. Microcline and quartz are dominant; either microcline or quartz predominate. In some pockets, minerals such as topaz or fluorite may be relatively abundant; these pockets contain very little or no mica. Depending on the late-stage growth conditions, several generations of albite, microcline, quartz and other minerals may be present. This is indicated by multiple growths of cockscomb albite, "white caps" on microcline or amazonite, or clear to milky quartz overgrowths on smoky quartz. Finally, minerals such as goethite, hematite, limonite, todorokite, chlorite and clays may coat the earlier crystallized phases.

Maximum crystal dimensions may span several orders of magnitude in a given pocket but usually are within one or two orders. Microcline crystals as much as 0.5 m in length, and topaz and quartz crystals as much as 0.3 m long have been found. Doubly terminated pocket crystals of all mineral phases are rare, quartz being most common. Clear to buff or red-brown feldspar overgrowths as much as 1 cm thick may be present on crystal faces as well as on broken surfaces of pocket microcline or amazonite crystals. Selective chemical etching and corrosion of some crystal surfaces and of the overgrowths are relatively common (Figs. 4 and 5). Overgrowths in the relatively rare amazonite-bearing pockets show preferential growth on certain feldspar faces, most commonly {001}.

MINERALOGY OF AMAZONITE-BEARING POCKETS AND PEGMATITE DIKES

The mineralogy of the majority of the buff-to-tan microcline and amazonite-bearing pockets and pegmatite dikes themselves is rather simple: quartz and feldspar dominate. All of the quartz observed in the pegmatites crystallized in the low-temperature or alpha form. Clear and smoky quartz is developed within the dikes and pockets. A minority of pockets contain minerals enriched in rare elements (e.g. Nb, Ta, Be, REE, Sn).

Table 1 lists those minerals that have been positively identified from amazonite-bearing pegmatites. Primary minerals are those which have crystallized at elevated temperatures during formation of the pegmatite pocket zone. Secondary minerals are those which have crystallized at lower temperature conditions and at some later stage of pocket development. Included in this group are those minerals formed at very low temperature and pressure during weathering.

Table 1. **Minerals identified from amazonite-bearing pegmatites in the Pikes Peak batholith**

Primary	
Quartz (smoky, amethyst, citrine, colorless)	Barite
	Ilmenite
Microcline (amazonite and whitish)	Cassiterite
	Columbite-tantalite
Albite	Stibiocolumbite-stibiotantalite
Orthoclase	
Sanidine	Hematite
Apatite	Muscovite
Fluorite	Biotite-phlogopite
Phenakite	Zinnwaldite
Topaz	Calcite
Beryl	Siderite
Zircon	Rhodochrosite
Bastnaesite	Tourmaline (schorl-elbaite)
Xenotime	
Monazite	Bertrandite
Barylite	Pyrochlore-microlite
Galena	
Pyrite	Thorite
Secondary	Tapiolite
Goethite	Amorphous Fe-Mn hydrous oxides
Hollandite	
Psilomelane	Chlorite
Cerussite	Hematite
Todorokite	Epidote
Montmorillonite	Pyrolusite

NOTES ON SELECTED POCKET MINERALS

Quartz — Nearly all specimens of pocket quartz found are either clear or smoky; citrine and amethyst are relatively rare, and no rose quartz has been observed. Scepter growth is uncommon. Inclusions of various minerals, most often hematite, may be found. Figure 4 shows a group of smoky quartz crystals associated with amazonite.

Microcline — (including amazonite) — Maximum microcline* is usually the most abundant pocket mineral, and may be etched and corroded. Most crystals are apparently untwinned; in those that show obvious growth twins, the Baveno is more prevalent than Manebach, which in turn is more abundant than Carlsbad twinning. Additional details are given in the section on amazonite.

Albite — Three distinct types of albite are generally found: (1) exsolution lamellae (oriented) within the host microcline, (2) discrete euhedral laths (random) and rosettes of cleavelandite and (3) (rare) epitaxial overgrowths on host microcline. Where fresh,albite is white or colorless.

Orthoclase — This polymorph has been identified thus far in only one sample of pocket potash feldspar. It coexists with low albite* and maximum microcline* as an overgrowth (white cap) on maximum microcline.

Sanidine — This variety of K-feldspar has been identified as a cream-buff precipitate on all pocket minerals in a large pocket at Harris Park. The coating is as much as 5 mm thick.

Hematite — Shiny metallic plates of hematite occur included within and on top of other pocket phases. The plates may be as much as several mm across. It may also be present as pseudomorphs after siderite and possibly other carbonates as well. Some hematite pseudomorphs are more than 5 cm across.

Carbonates — Calcite, ferroan calcite, siderite, mangansiderite, manganoan calcite and rhodochrosite have been found in a relatively small number of pockets. The rhombs of carbonate usually occur as relics within masses of limonite, hematite, goethite and other Fe-Mn hydrous oxides. Excellent pseudomorphs are relatively common in certain areas. Apparently unaltered crystals of calcite and siderite have been found as well. Calcite is white, siderite buff-tan to light brown and rhodochrosite orange to red. Fine-grained masses of cerussite ($PbCO_3$) have been found associated with galena in a very few pockets. Calcite and cerussite are usually fluorescent under shortwave ultraviolet light; pink to reddish orange and yellow respectively.

Apatite — Short prism or botryoidal masses of apatite with radial structure have been found in the pockets. Euhedral crystals as much as several cm in length are clear, white or green; botryoidal masses are typically white to cream-tan. The mineral is generally fluorescent (shortwave ultraviolet) yellow-orange. Both fluorapatite and carbonate apatite have been found.

Barite — Crystals of barite were found associated with barylite (White, 1972a, b) in a pocket at Lake George. Some crystals are clear pale blue and as much as several mm in length. One very interesting specimen of white barite (Fig. 6) is a pseudomorph after microcline.

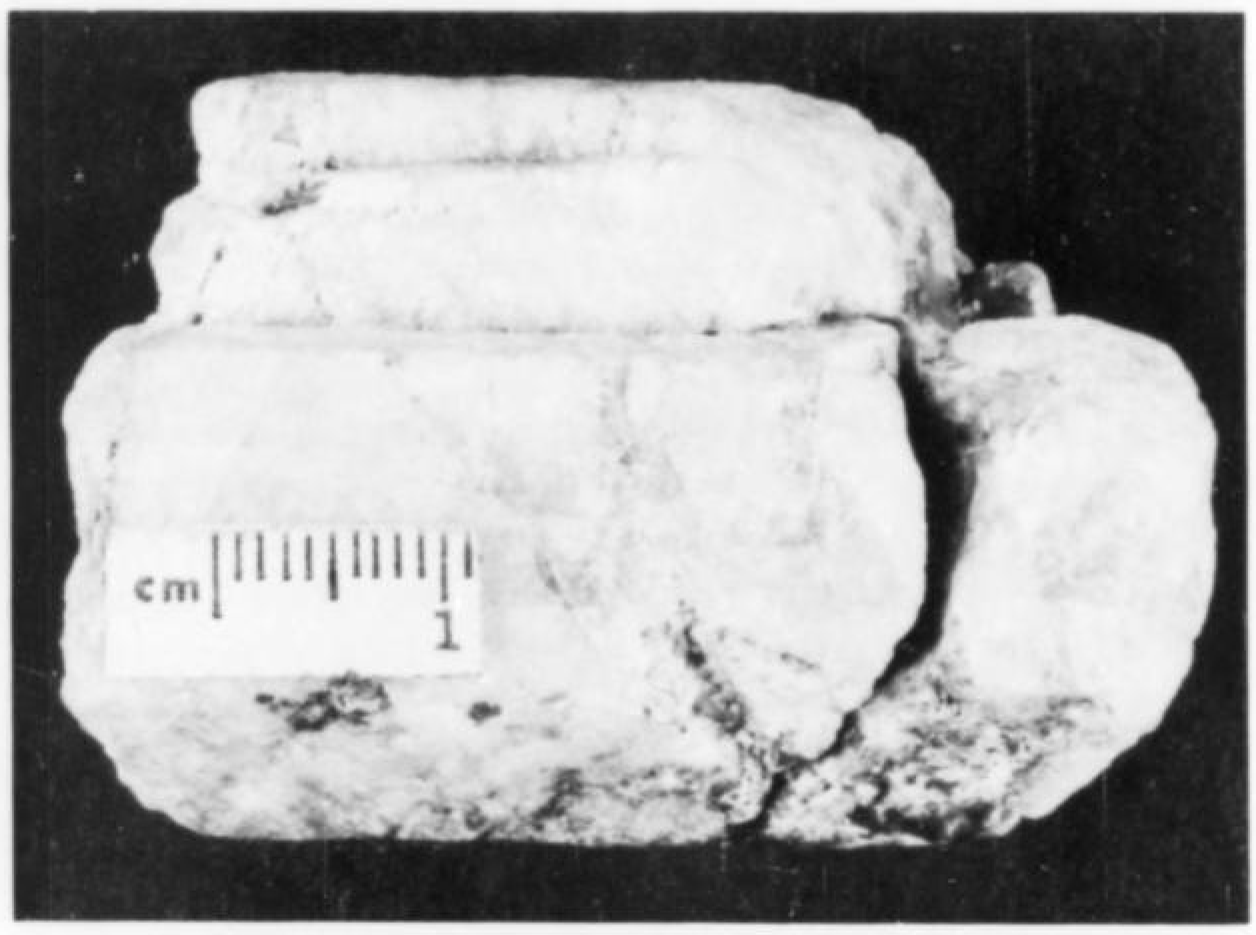


Figure 6. **A cream-buff colored pseudomorph of barite after microcline from a pocket at Lake George. Collection of R. A. Kosnar.**

Fluorite — Colorless, blue-purple, or green fluorite is usually present as euhedral crystals on top of other pocket phases and may show evidence of etching. Rare-earth-rich fluorite has also been found. Some specimens are fluorescent and phosphorescent. Sim-

*Sanidine, orthoclase, intermediate microcline and maximum microcline are interrelated; each shows a progressively increasing long-range regularity in the distribution of the one Al and three Si atoms per formula unit. Sanidine (random distribution of Al and Si) is a high-temperature feldspar usually found in young volcanic rocks. In maximum microcline, the regularity in Al distribution is perfect; this structural array probably becomes stable only below 500°C. Low albite is the sodium-rich analogue of maximum microcline. Because rates of reaction are much faster than in K-feldspars, Na-rich equivalents of sanidine, orthoclase and intermediate microcline are exceedingly rare.

ple cubes and cubes modified by octahedral faces are most common. Cubes 10 cm across or more have been reported. A few amazonite-bearing pegmatites are characterized by a late-stage influx of fluorite, which replaces and fills fractures in other minerals.

Bastnaesite — A few trigonal greenish-buff crystals 2 to 3 mm in maximum dimension have been identified on top of amazonite (Fig. 7). It is very rarely encountered in amazonite-bearing pockets.

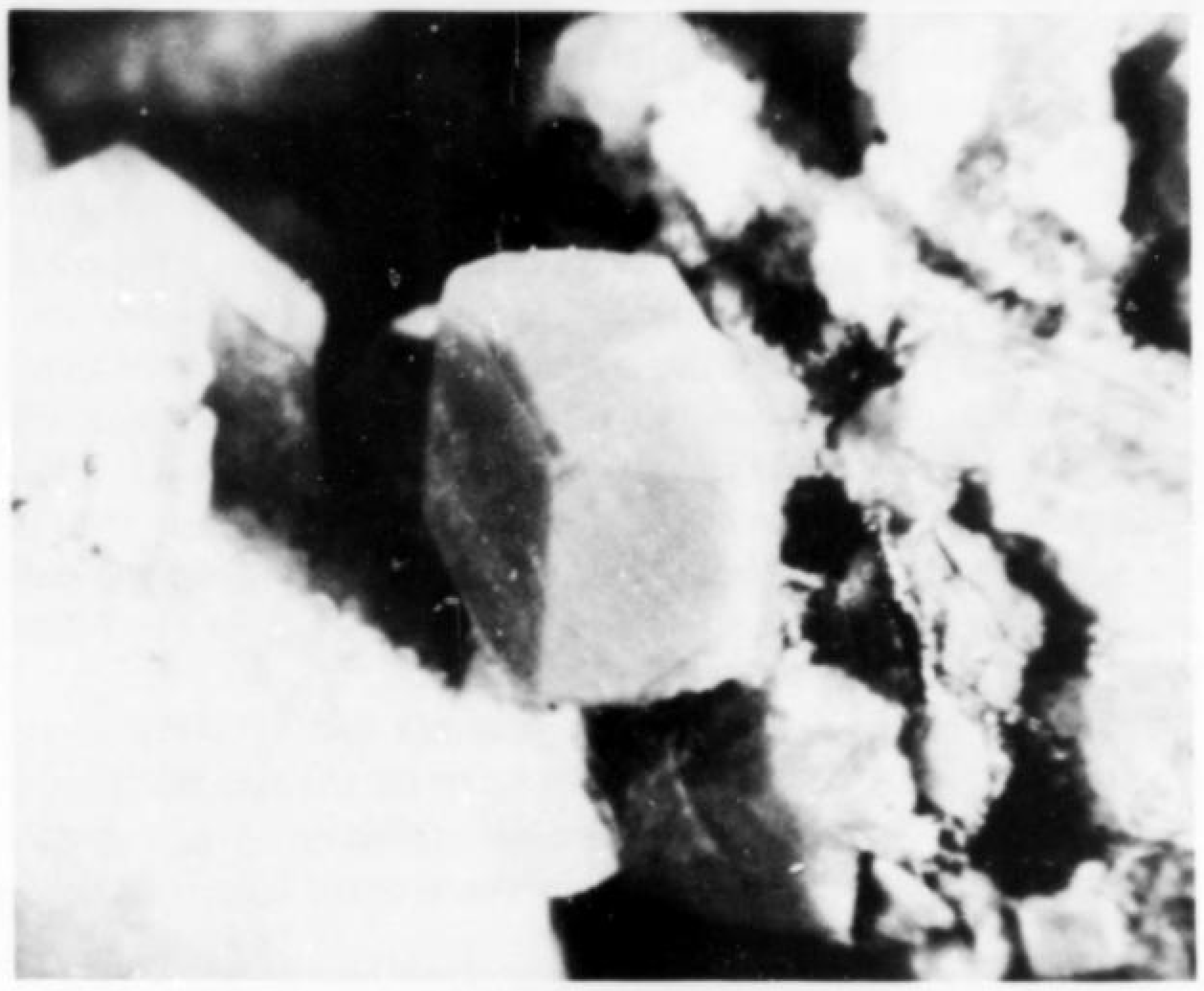


Figure 7. **A bastnaesite crystal on amazonite with hematite and albite.**

Xenotime — Isolated or clusters of reddish brown to amber translucent crystals 1 to 2 mm in maximum dimension have been observed on top of various pocket minerals.

Monazite — Individual or small groups of reddish brown to amber crystals 1 to 2 mm in maximum dimension have been found coating various pocket minerals.

Nb-Ta oxides — Columbite-tantalite, stibiotantalite-stibiocolumbite and tapiolite have been found associated with amazonite. Crystals of columbite-tantalite may be several cm in maximum dimension and are usually well-formed. Columbite-tantalite may also occur as inclusions in cassiterite. Honey-brown stibiotantalite-stibiocolumbite crystals have been positively identified from only one locality in the Lake George area, and attain several mm in length.

Cassiterite — Crystals of cassiterite are commonly found associated with columbite-tantalite. Individual crystals may be twinned and are as much as several cm in maximum dimension.

Galena — This mineral is only rarely found with amazonite. It has been found at St. Peter's dome associated with Zn-bearing rare alkalic pegmatites. Characteristic blue-gray metallic masses in amazonite-bearing pockets seldom exceed several cm in maximum dimension.

Pyrite — Pyrite is relatively rare and usually occurs as cubes less than 1 to 2 mm in maximum dimension. It is commonly completely or partly altered to limonite.

Topaz — Colorless, blue or brownish-red topaz crystals as much as several cm or more in maximum dimension are commonly euhedral and may be of gem quality. Some crystals show evidence of etching. Colored crystals may fade upon exposure to sunlight.

Bertrandite — Two colorless, euhedral crystals of bertrandite were found in a miarolitic cavity below an amazonite pocket at Lake George. The first crystal is 1 by 0.5 by 0.5 cm, and is partially coated by hydrous Fe-Mn oxides. The other is doubly terminated, 2 by 1 by 1 cm, and attached to ordinary microcline.

Tourmaline (schorl-elbaite series) — Tourmaline is a rare constituent of the amazonite-bearing pegmatites and occurs in typical needle-like aggregates as much as 1 cm or more in length. The color is black to blue-green.

Micas — Zinnwaldite and biotite are more commonly found in amazonite and ordinary microcline pockets than is muscovite. Usually, all of the micas are rare or minor in abundance. Crystals are commonly color zoned. Zinnwaldite crystals in pegmatite pockets from Wigwam Creek show numerous growth zones in the form of alternating light and dark reddish-brown bands (Fig. 8). This color zonation reflects compositional changes in the growth medium. At least two generations of mica are present, with the first being nearly completely hydrothermally altered. These euhedral, pseudo-hexagonal "books" of zinnwaldite attain as much as several cm across and have been found at Lake George and Crystal Peak as well. Green biotite has been found with amazonite at Crystal Peak as bright, euhedral crystals 1 cm or more across.

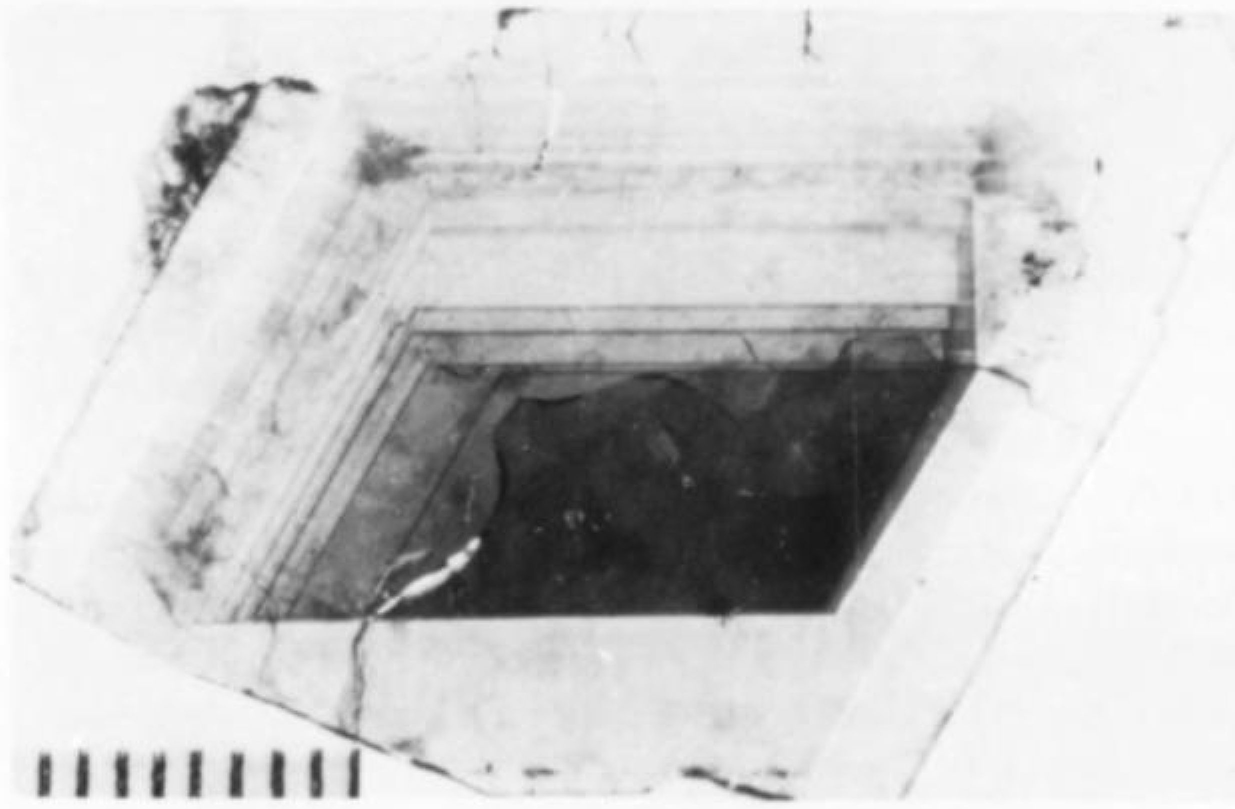


Figure 8. **A zoned crystal of zinnwaldite from Wigwam Creek. Note the sharp growth lines.**

AMAZONITE

Amazonite and microcline crystals within pegmatite pockets in the Pikes Peak batholith show good development of prism, dome and pedion faces. High-index forms are occasionally observed as well. The color of ordinary microcline ranges from nearly pure white to cream-buff-tan to reddish brown; that of amazonite ranges from extremely pale blue-green to deep blue-green, turquoise, or green-blue (see Figs. 3, 4, 5, 11, 12). Crystals which have not been subjected to surface alteration and corrosion may be very lustrous on all crystal surfaces. In many cases, coatings of Fe-Mn hydrous oxides stain the crystals shades of red-brown or black. Such coatings and discoloration generally can be removed by treatment in oxalic acid solutions. Many crystals show evidence of chemical etching prior to deposition of the Fe-Mn oxides and other secondary minerals. Still other crystals have been coated by late-stage sanidine or amorphous silicates which are very difficult or impossible to remove without damage to the host crystals and other coexisting phases (Fig. 9).

Rare overgrowths of (1) quartz on quartz and (2) K and Na feldspars on microcline very commonly occur in the same pocket. Overgrowths of quartz on quartz seem to be much more common than growth of one feldspar on another. Overgrowths of albite on microcline and microcline on microcline have been observed with about equal frequency. When the overgrowths are K-feldspar, they occur preferentially on certain crystal faces, as in the so-called "white caps" (Fig. 3), but may be random as well. Overgrowths of albite are more random and generally partial on various crystal faces. Overgrowth of K-feldspar on microcline is most commonly developed on {001} (Fig. 3). These overgrowths may be clear, white, buff-tan or red-brown and are as much as 1 cm thick. Such overgrowths may also be developed on broken crystal surfaces. If overgrowths are developed on crystals within a given pocket, all crystals generally show the same pattern of development. Next in

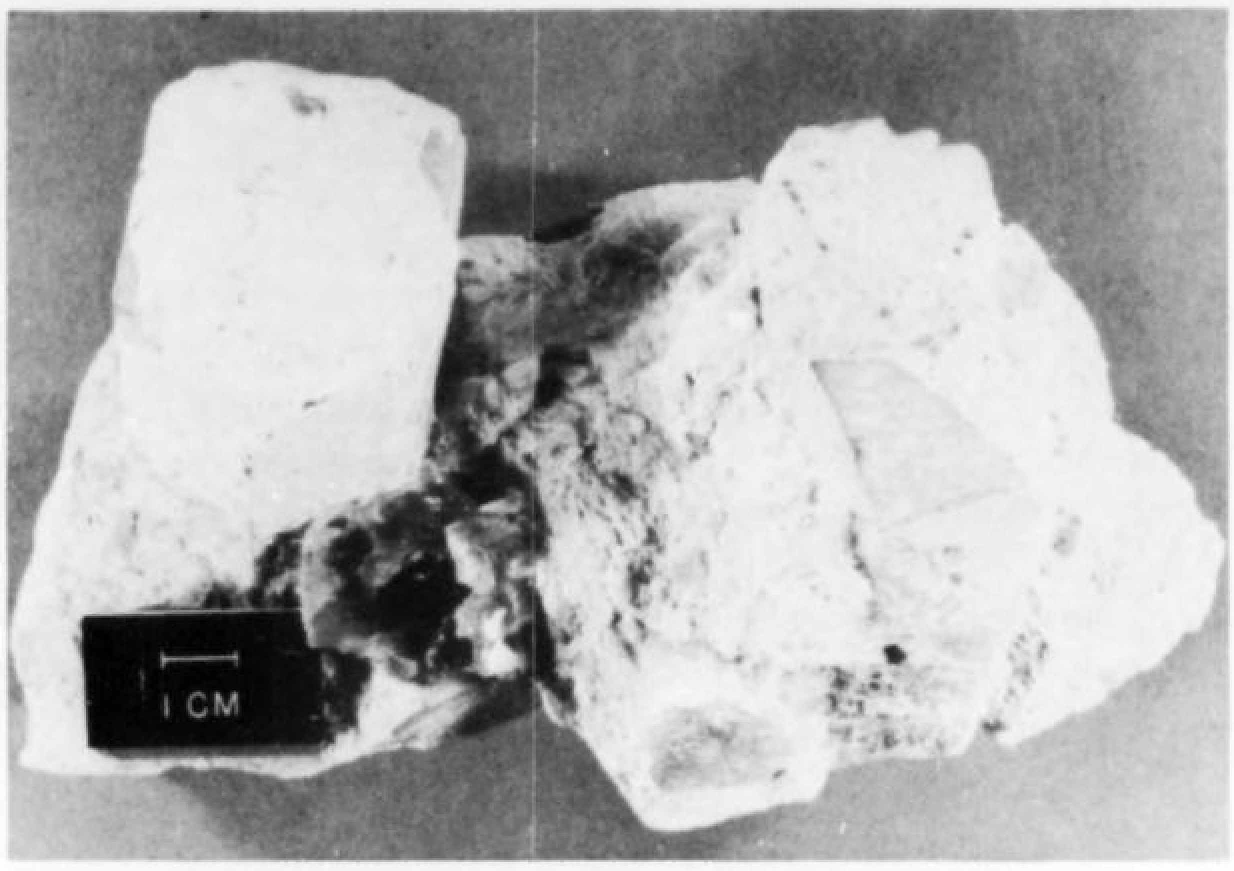


Figure 9. **A matrix group of amazonite with a cream-colored coating of sanidine on all phases. Collection of H. H. Odiorne.**

order of abundance are crystals with overgrowths on {001} and some of the prism zone faces with minor amounts on dome faces as well. Crystals with strong development of overgrowth on prism and dome faces and minor development on {001} are rare, but rarest of all is deep green amazonite with overgrowths present only on alternating prism faces and dome faces, found in one pocket only (Fig. 11). Both the host crystal and overgrowth may show evidence of chemical etching (Fig. 5). In this figure, one can see the distinct difference in color and habit between albite (*cleavelandite*) and maximum microcline. Clear or white albite forms partial or complete coatings on some crystals of microcline.

Detailed compositional data for Pikes Peak batholith amazonite and ordinary microcline have been lacking until present. Electron-microprobe, emission-spectrographic and atomic-absorption analyses for minor and trace elements and electron-mircoprobe analyses for major elements are given in table 2 for a number of crystals from four areas.

Semiquantitative spectrographic analyses of albite and K-feldspar show Fe contents (presumably all Fe^{3+}) in the range from 0.01 percent to 0.30 percent. Contents of some additional elements determined are: Mg, less than 0.001 to 0.015 percent; Mn, 5 ppm to 100 ppm; and Ga, 30 ppm to 200 ppm.

Data from electron-microprobe traverses on color-zoned crystals of amazonite show an excellent correlation between Pb content and degree of blue-green coloration. Most crystals show distinct color and growth-zoning, having cores of ordinary buff-tan microcline very low in Pb content which grade into green amazonite containing significant levels of Pb (Table 2) (Fig. 10). A number of occurrences have microcline crystals which show a blotchy and irregular distribution of buff-tan and blue-green coloration. In a few instances cores of amazonite are mantled by regular microcline. Additional quantitative determinations of lead in fourteen K-feldspars from Colorado, New Jersey, Pennsylvania, Virginia and the Soviet Union confirm the apparent correlation between green coloration and Pb content.

Reported lead contents in amazonite are relatively few and range from about 0.005 to 1.35 percent Pb. An unusual specimen of amazonite from a pegmatite at Pack, Austria, was reported by Alker (1959) *in* Cech and others (1971) to contain 1.35 weight percent lead. Reported values for Pb (Shmakin and others, 1973) of about 0.007 weight percent are significantly lower (by a factor of 10 or more) than in amazonite from the Pikes Peak batholith. Zhirov and Stishov (1965) have reported a range of 0.01 to 0.2 weight percent Pb for other amazonites from pegmatites. Two specimens of Russian amazonite were determined by us to have in excess of about 3000 ppm and 10,000 ppm respectively. Amazonites from Amelia, Virginia; Franklin, New Jersey; Mineral Hill, Pennsylvania; and additional localities within the Pikes Peak batholith all contained in excess of about 1000 ppm. No galena was observed in any of these specimens.

Rubidium and cesium values as much as 3.52 weight percent and 0.40 weight percent respectively, have been reported in K-feldspars (Afronina and others, 1978). The electron probe showed Rb contents in the twelve analyzed samples discussed here to be as much as 20 percent higher in the microcline portions (excluding albite) than in the bulk crystals as determined by atomic absorption techniques. Rubidium contents in the exsolved albite and included albite laths were below the limit of detection with the probe (0.03 percent). Rubidium shows a general enrichment trend with continued crystallization but reaches a maximum prior to the maximum content of Pb. Rubidium and cesium contents increase while barium and strontium contents decrease with continuing crystallization of K-feldspars. This is in agreement with the data of Shmakin (1979). Unlike alkali feldspars from complex pegmatites where Rb and Cs are associated in increasing levels, Cs is essentially absent in the microcline and amazonite from the pegmatites within the Pikes Peak batholith.

The analyzed crystals having a substrate and epitaxial overgrowth (78-7, 78-8; 78-13, 78-16; 78-9, 78-10) showed significant changes in major- and minor-element chemistry: Ab:Or ratios decrease from K-feldspar substrate to overgrowth; Ba and Sr contents generally increase sharply from substrate to overgrowth. In two cases, Rb decreases sharply. Beryllium, lithium, cesium and boron show little change. Lead consistently decreases sharply (see Table 2). Thus, as well as being visibly distinct from the substrate, overgrowths are also distinctly different chemically.

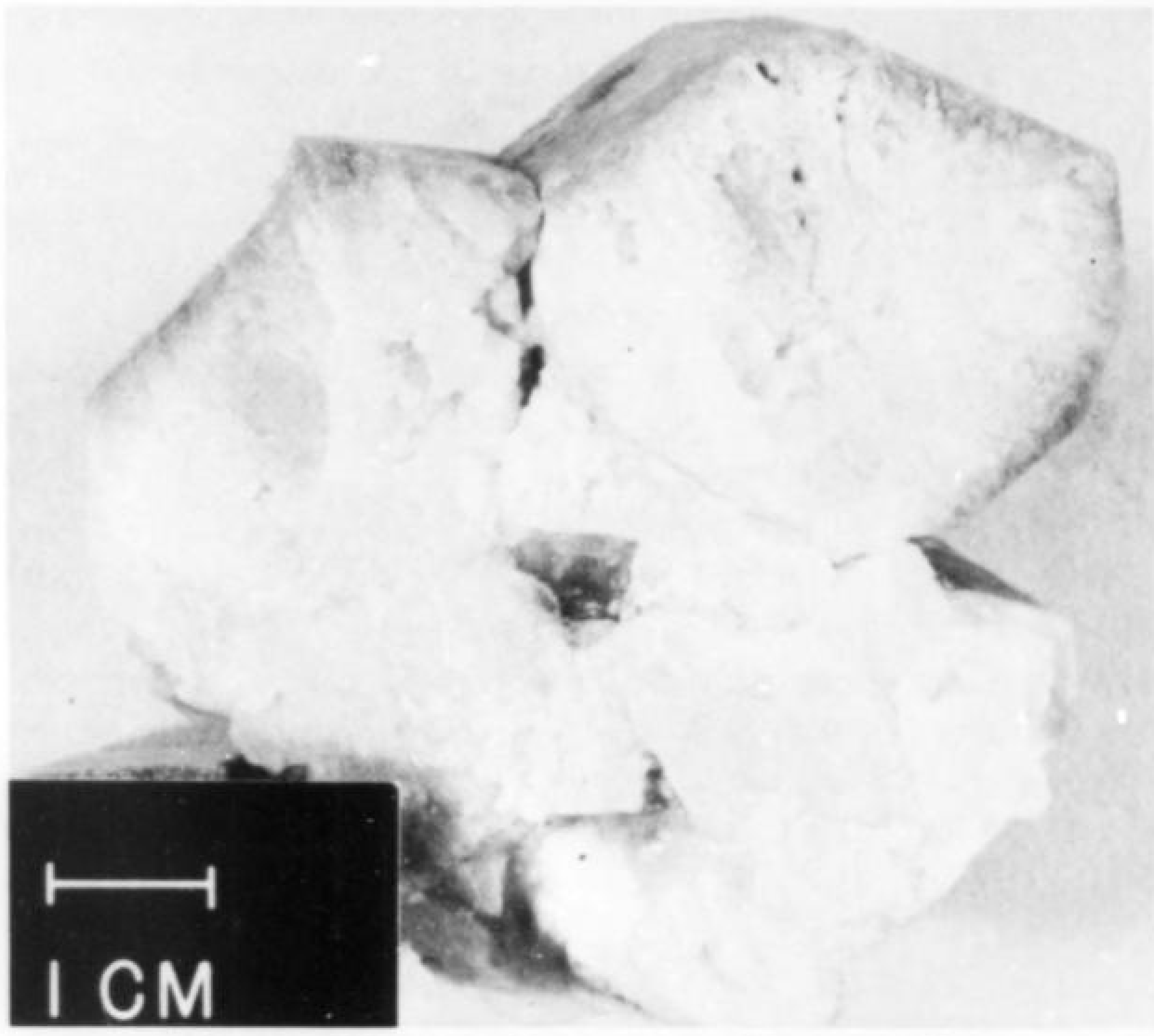


Figure 10. **A cleavage surface cutting amazonite. Note the strong color zoning near the exterior surfaces of the crystals. The green rim material is greatly enriched in lead. Collection of R. A. Kosnar.**

STRUCTURAL STATES AND DEGREE OF Si-Al ORDER

Precise unit-cell measurements have been determined by powder X-ray diffraction for 26 pegmatitic feldspars from pockets in the Pikes Peak batholith using a Guinier-Hagg camera. In summary, all albite encountered (exsolved lamellae in the K-feldspar substrate cleavelandite, random intergrowths, and late-stage coatings) is low (i.e. well-ordered) albite. Almost all microcline crystals studied (either amazonite or ordinary microcline) that host an overgrowth

Table 2. **Analytical data for amazonites from the Pikes Peak Batholith**

Locality	**Lake George**	**Crystal Peak**	**Crystal Peak**	**Crystal Peak**	**Crystal Peak**	**Wigwam Creek**	**Wigwam Creek**	**Wigwam Creek**	**Wigwam Creek**	**Harris Park**	**Harris Park**	**Harris Park**
Sample no.	78–2	78–7	78–8	78–16	78–13	78–3	78–12 DMNH #10934	78–9	79–10	78–4	78–5	78–6
Composition* (Major elements)												
albite	(3) $Ab_{99}Or_1$	(2) $Ab_{99}Or_1$	(0)	(3) $Ab_{98}Or_2$	(0)	(1) $Ab_{98}Or_2$	(4) $Ab_{98.5}Or_{1.5}$	(1) $Ab_{98}Or_2$	(0)	(1) $Ab_{98}Or_2$	(2) $Ab_{98.5}Or_{1.5}$	(4) $Ab_{99}Or_1$
microcline	(5) Ab_3Or_{97}	(7) Ab_3Or_{97}	(5) Ab_1Or_{99}	(6) Ab_5Or_{95}	(2) Ab_3Or_{97}	(3) Ab_1Or_{99}	(2) $Ab_{2.5}Or_{97.5}$	(8) Ab_4Or_{96}	(2) Ab_3Or_{97}	(5) Ab_2Or_{98}	(0)	(0)
Minor and trace elements (ppm)												
Ba	20	520	2500	38	350	160	≪10	42	820	71	≪10	≪10
Sr	52	25	62	10	≪10	15	≪10	10	16	20	≪10	≪10
Be	6	12	5	5	≪5	7	≪5	13	≪5	8	16	13
Li	0.5	1	2	1.5	1	4.4	1	1.0	0.5	1.0	0.5	0.5
Rb	5313	2935	950	2075	1280	2190	2000	2000	2310	1375	95	15
Cs	20	≪15	≪15	≪15	≪15	20	30	≪15	≪15	≪15	≪15	≪15
Pb	650	780	20	1200	20	170	450	140	≪15	60	≪15	30
B	≪20	≪20	≪20	≪20	≪20	≪20	≪20	≪20	≪20	≪20	≪20	≪20
Color	deep blue-green to buff-tan	medium blue-green	pale cream	deep green	flesh-cream	pale sky-blue	medium sky-blue	very pale blue	salmon orange	buff-tan	pale purple	white
Sample description and notes	color-zoned crystal with flesh-colored interior and green exterior	substrate microcline portion of a crystal having flesh-colored overgrowth on prism faces	overgrowth portion showing some chemical etching	substrate portion of a crystal showing well-developed flesh-colored overgrowth on {001}	non-etched overgrowth developed on {001} face	color-zoned crystal with white interior and pale blue exterior	color-zoned crystal with white interior and blue exterior	mottled blue-white with buff-flesh microcline. Substrate portion of crystal	overgrowth portion of crystal showing mottled coloration	microcline crystal with two stages of albite overgrowth	albite overgrowth coating microcline crystal	cockscomb albite coating purple albite (78–5)

* Compositions are expressed in terms of the components $NaAlSi_3O_8$ (Ab), $KAlSi_3O_8$ (Or). All electron microprobe data show that the component $CaAl_2Si_2O_8$ (An) is less than 0.5 mol. percent. Major element analyses are of individual phases present in the stated portions of crystals. Minor and trace element values are for bulk portions of crystals. Parentheses preceeding albite or microcline analyses enclose the number of determinations (microprobe) made.

consist of maximum (i.e. well-ordered) microcline. The fact that both albite and microcline contain a perfectly long-range-ordered distribution of Si and Al among the tetrahedral sites available in the structure indicates that these feldspars have reached equilibrium in the pocket environment. This is to be expected in such water-rich environments. The same commonly applies to amazonites from two localities in the Soviet Union and from Amelia, Virginia, included for comparison. In contrast, the overgrowth contains a more varied and complicated assemblage of feldspars that reflects events during a pocket's evolution: maximum microcline, intermediate microcline (less perfectly ordered than the former), mixtures of the two, or mixtures of intermediate microcline and orthoclase (a monoclinic K-rich feldspar that is only partly ordered). In all overgrowths, blebs of albite, invariably of the well-ordered variety, are rare to absent. In samples from one unusual pocket (Fig. 9), a ubiquitous coating of K-feldspar on the various pocket minerals was found to be sanidine, surely the oldest quenched-in high-temperature K-feldspar yet recorded in a terrestrial rock. This coating of a disordered alkali feldspar, clearly a late precipitate from a stagnant solution, suggests that the pocket ruptured but was subsequently sealed. Even in volcanic rocks, sanidines are only preserved far outside their field of stability if there has been no interaction with water in the range 500 to 100°C, in which conversion to microcline is most efficient. The presence of orthoclase and intermediate microcline in overgrowths also hints at attempted, but arrested, conversion of sanidine to microcline.

ULTRAVIOLET FLUORESCENCE OF FELDSPAR FROM THE PIKES PEAK BATHOLITH

Distinct red (crimson), orange and yellow fluorescence was noted in many samples of feldspar from the Pikes Peak batholith. Such fluorescence in short-wave ultraviolet light was described by Wilson (1950) for material from Australia. As noted by Wilson, detection of fluorescence is often only possible if the specimen is held very close to the source of the short-wave radiation, and the study made in a darkened room or light-tight enclosure. Feldspar shows its best fluorescence if placed under the radiation from a unit which has been in operation for at least two minutes. Intensity of the 2537A light diminishes greatly with a small drop in voltage; a constant voltage source is clearly desirable.

Wilson (1950) tested thousands of Australian and worldwide specimens of granitic and pegmatitic rocks and found that there are regions which have fluorescent feldspars and others that do not. Petrologic mapping by fluorescence of the feldspars can be a useful tool in distinguishing different granitic bodies.

Shortwave ultraviolet radiation excites emission of visible light whereas longwave ultraviolet radiation does not. A very few specimens of feldspar fluoresce blue-white. Fresh surfaces, if fluorescent, are intensely red or red-orange but some weathered or exposed surfaces are yellow. Numerous specimens show fluorescent color-zoning (red cores with thin yellow rims). The yellow fluorescent rims are generally 1 to 2 mm thick. The fluorescence is very temperature-sensitive: a decrease in temperature enhances the fluorescence. At about 100°C, there is very little emission, at 0°C it is very noticeable and distinct, and at -200°C it is extremely bright and vivid. The process is completely reversible. Specimens may be heated and cooled numerous times with the same results. Fine grinding does not diminish the observed fluorescence.

The effects of heating and cooling on the color and fluorescence of ordinary microcline and amazonite were studied as well. If the specimen is fused to a glass, the fluorescence color changes from red to blue-white. If the same material is heated to just below the temperature of fusion, a yellow-orange fluorescence is induced. At temperatures greater than about 400°C, rapid decolorization of both amazonite and regular microcline was noted. These results are in agreement with the earlier observations of Oftedal (1957). Such decolorization, which can also be produced in minerals such as fluorite and celestine, suggests that the visible color is due to structural defects and/or local differences in electron distribution.

Cathodoluminescence experiments by Mariano (1979) indicate that the vivid red luminescence color observed in K-feldspars from contact aureoles to structurally bound alkaline complexes is due to Fe^{3+}. More specimens of amazonite, ordinary microcline and other feldspars must be examined and completely characterized before a positive explanation can be offered for the origin of the red-orange-yellow and white fluorescence observed in feldspars from the Pikes Peak batholith.

ORIGIN OF THE CHARACTERISTIC COLOR OF AMAZONITE

The origin of the characteristic green or blue color of amazonite has been a subject of much discussion, and controversy. Cech and others (1971) have presented an excellent discussion of the coloration of amazonite. Our data for amazonites from the Pikes Peak batholith; Amelia, Virginia; Franklin, New Jersey; Mineral Hill, Pennsylvania; and two specimens from the USSR support the contention (e.g., Smith, 1974, p. 557) that lead plays an active role in the development of the green-blue coloration. Pb^{2+} probably can substitute for K^+ with charge balance being restored by Si^{4+} for Al^{3+} at a nearby site. This coupled substitution has the added virtue of compensating somewhat for the K^+ vs. Pb^{2+} size differential, as Al^{3+} is larger by a comparable amount than Si^{4+}. Fe^{3+} can easily substitute for Al^{3+} and the slightly larger radius will probably produce a tendency to occupy a position near a Pb^{2+} site, to take advantage of the Pb^{2+} vs. K^+ size mismatch. However, the defect color center that leads to the intrinsic blue-green coloration of amazonite is likely the result of the substitution $2K^+ \rightarrow Pb^{2+} + \square$, possibly modified by $K^+ + O^{2-} \rightarrow Pb^{2+} + OH^-$ (Plyusnin, 1969; Smith, 1974).

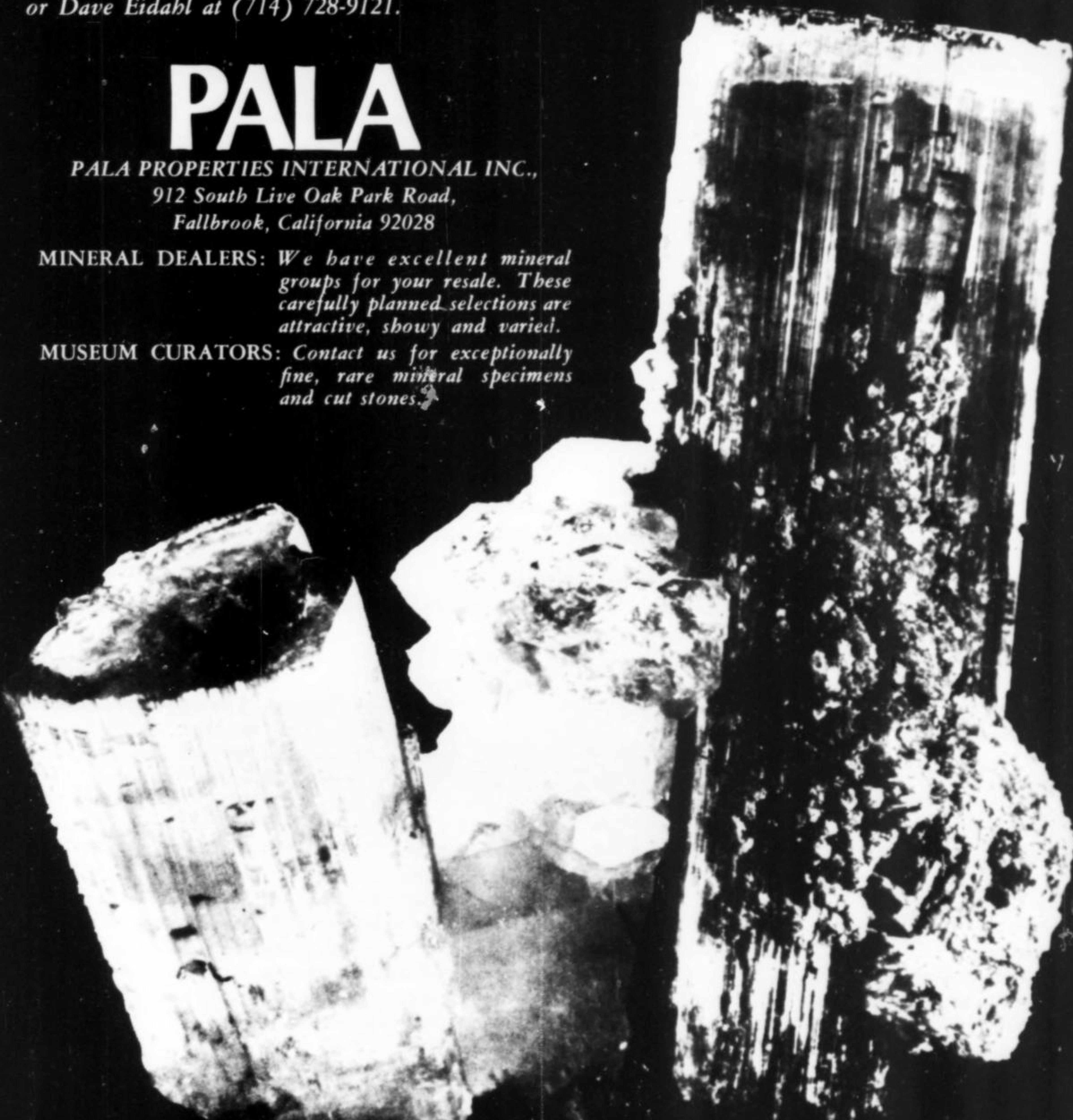
One sample of amazonite from Amelia, Virginia (Rutherford no. 2 mine) has ordinary white microcline and green amazonite abutting against one another. Both types of microcline contain about 1500 ppm Pb. However, the white material contains about 300 ppm Cu whereas the green material contains only about 7 ppm. All other elements are essentially the same for both varieties. In this case, Cu^{2+} may be forming a pair with Pb^{2+} "blocking out" the Fe^{3+}-Pb^{2+} near-neighbor pair, as Cu may be occupying the color producing Fe sites.

The K^+ for Pb^{2+}, Si^{4+} for Fe^{3+} coupled substitutions must also be considered, as from the point of view of size, they are not too much less probable than the K^+ --- Pb^{2+}, Si^{4+} --- Al^{3+} substitution scheme. Could these various types of substitution involving Pb^{2+}, occurring with varying probabilities in different pocket environments, account for the blue vs. green color variation? In either case, the color-producing electronic transition is probably $Pb^{2+} + Fe^{3+}$ --- $Pb^{3+} + Fe^{2+}$.

DISCUSSION AND CONCLUSIONS

Much additional work remains to be done on the amazonite-bearing pegmatites of the Pikes Peak batholith in order to fully understand the details of the genesis of these bodies. On the basis of the data presented here on amazonite, however, we contend that lead is essential for development of the characteristic blue-green coloration. However, lead may not be the only element playing an active role in coloration, ultraviolet radiation-induced fluorescence or cathodoluminescence; iron, manganese, and copper may also play an active role.

As mentioned above, galena does occur intergrown with flesh-colored microcline but is very rarely found associated with amazonite. Development of amazonite is controlled by silicate-sulfide equilibria (quartz-feldspar-mica-galena ± pyrite). Lead is an element with strong chalcophile tendencies; any sulfur present at



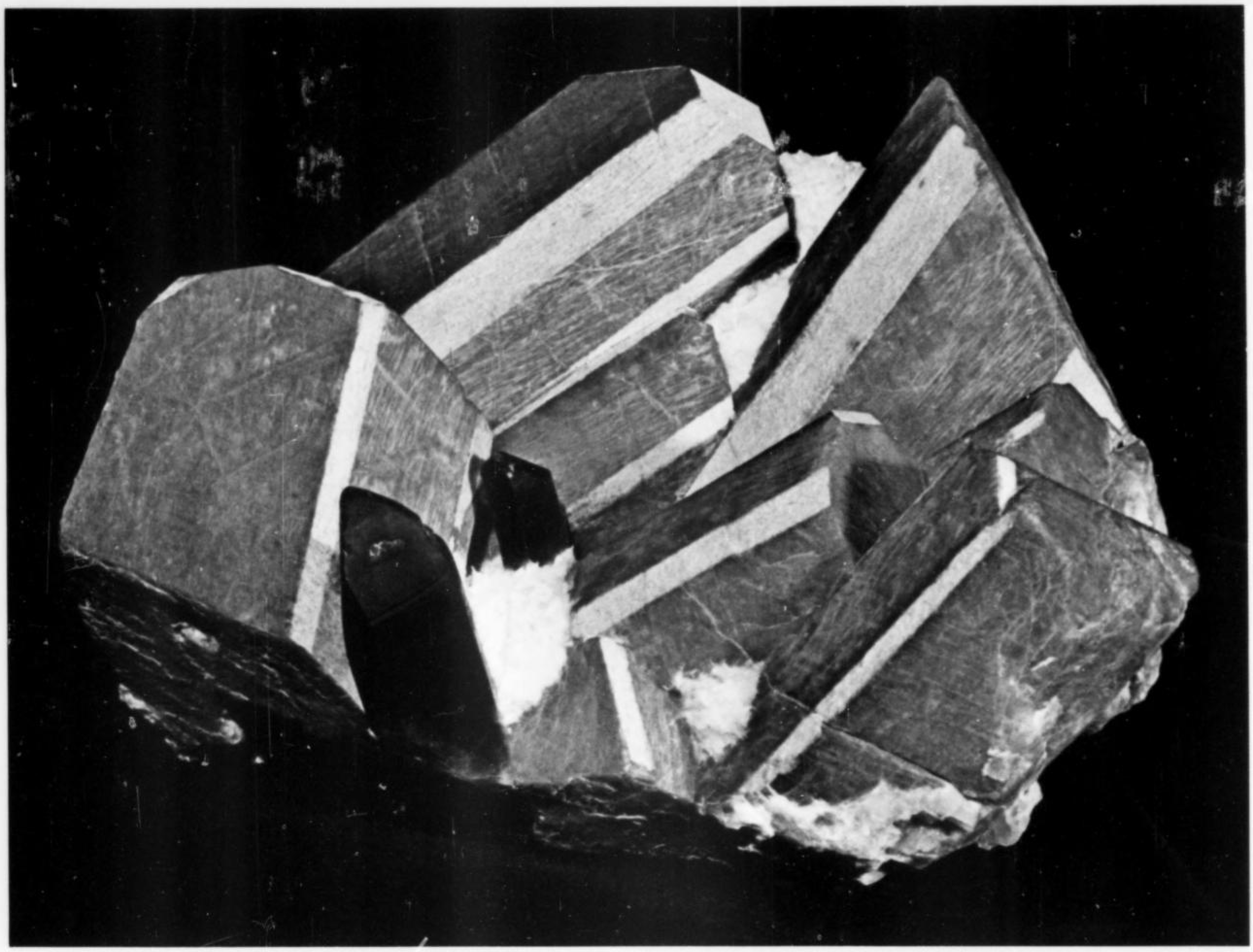


Figure 11. **Amazonite from Lake George showing preferential overgrowths on alternating prism and dome faces. The specimen, 14 cm across, is on display in the Denver Museum of Natural History.**

the pocket stage of pegmatite development will combine with lead before the final stages of crystallization. Once all the sulfur is consumed, lead plays a new role, that of a lithophile element. As such, it is residual and clearly incompatible, given the available cation sites in the crystallizing silicates. This behavior explains why the intensity of the coloration typically increases progressively towards the crystal margins in free contact with the growth medium. One might expect that amazonite and galena form an incompatible pair.

The white caps that overgrow some crystals of microcline, in some cases very selectively, represent a drastic change in physiochemical conditions within the pegmatite pockets. This is reflected in the structural state of the K-rich feldspars and in compositional data. These features are interpreted to indicate reopening of pocket systems. However, the falling temperatures clearly do not favor the efficient structural conversion of a monoclinic feldspar to fully ordejed microcline, such that metastable iny do not favor the efficient structural conversion of a monoclinic feldspar to fully ordered microcline, such that metastable intermediate products of reaction are preserved despite the influx of an aqueous fluid in the reopened pocket. The very unusual occurrence of sanidine proves that some pockets did remain hermetically sealed and free of water after crystallization of an overgrowth until temperatures were too low for reaction to occur.

Why are amazonites relatively common in the pockets of pegmatites in the Pikes Peak batholith? This batholith belongs to the anorogenic category; it is probably rift-related, and its origin bears little in common with the granitic batholiths along the west coast of North and South America. Anorogenic granites are ultimately related by crystal fractionation processes to a gabbroic parent magma (Martin and Piwinskii, 1974). As such, they are highly depleted in Ca, Mg and S owing to early crystallization and removal of olivine, pyroxene, calcic plagioclase and sulfide minerals from the basic magma, and definitely enriched in a number of minor elements that have been systematically rejected by the same crystallizing phases. The derivative magmas so produced follow a distinctive pattern of iron enrichment. Elements such as Fe^{3+}, Pb, Mn, Cu, and Rb thus attain relatively high levels of concentration in the granitic compositions that represent the end stages of a protracted history of differentiation. These enrichment trends are further enhanced at the pocket stage of development of pegmatites, in which environment the crystal-growth medium becomes dominantly aqueous. It is from these last "dregs" of an evolving anorogenic igneous complex that one expects spectacular development of amazonite.

ACKNOWLEDGEMENTS

Without the assistance of Roger and Norman Bennett, Donley Collins, Jeanne Halsey, Thelma and Jerome Hurianek, William Hayward, Louise Hedricks, Richard Kosnar, Jack Murphy, Barbara and John Muntyan, Howard Odiorne, Walter Risch, Luke Westervelt, Denzil Wiggins and Raymond Ziegler it would not have been possible to write this paper on Pikes Peak batholith

Figure 12. (top) **Amazonite crystals without overgrowths from the Yucca Hill prospect, Lake George area. The specimen, 8 cm across, is from the R. A. Kosnar collection. Photo by R. A. Kosnar.**

Figure 13. (bottom) **Amazonite with overgrowths, on a matrix of albite, from the Clarence G. Coil mine, Lake George area. The specimen, 9 cm across, is from the R. A. Kosnar collection. Photo by R. A. Kosnar.**

amazonite. All of the individuals listed above provided specimens of microcline and other pocket minerals for study, and contributed their observances of pegmatite occurrences within the batholith. Louise Hedricks performed a number of the shortwave ultraviolet experiments and helped to prepare the photographs used in this article. Nancy Conklin performed the quantitative and semiquantitative emission spectrographic analyses, and Violet Merritt and Carol Gent performed the quantitative analyses for Li, Rb and Cs. RFM acknowledges the continuing support of the Natural Sciences and Engineering Research Council of Canada (grant A7721).

REFERENCES

AFONINA, G. G., MAKAGON, V. M., SHMAKIN, B. M., GLEBOV, M. P., and MAKRIGIN, A. I. (1978) On the influence of rubidium and cesium on the structural state of potash feldspars from rare-metal pegmatites. *Zapiski Vses. Mineralog. Obshch.*, **107**, 33–41. *In Russian.*

BARKER, F., HEDGE, C. E., MILLARD, H. T., and O'NEIL, J. R. (1976) *in Professional Contributions of Colorado School of Mines, Studies in Field Geology,* edited by Rudy C. Epis and Robert J. Weimer. No. 8. Pikes Peak batholith: geochemistry of some minor elements and isotopes, and implications for magma genesis, 44–56.

CECH, F., MISAR, Z., and POVONDRA, P. (1971) A green lead-containing orthoclase. *Tschermaks Mineral. Petrog. Mitt.*, **15**, 213–231.

FOORD, E. E. (1977) Famous mineral localities: the Himalaya dike system, Mesa Grande district, San Diego County, California. *Mineralogical Record,* **8**, 461–474.

HOLLISTER, O. J. (1867) *The mines of Colorado.* Springfield, Mass., Sam Bowles and Co., 450 p.

HUTCHINSON, R. M. (1976) Granite-tectonics of Pikes Peak batholith, *in Professional Contributions of the Colorado School of Mines, Studies in Field Geology,* edited by R. C. Epis and R. J. Weimer, **8**, 32–43.

MARIANO, A. N. (1979) Enhancement and classification of fenitization by cathodoluminescence, *Geol. Assoc. Can./ Mineral. Assoc. Can. Program Abstr.* **4**, 65.

MARTIN, R. F., and PIWINSKII, A. J. (1974) The contrasting origin of orogenic and non-orogenic granitoid rocks. *(In) Proc. Symp. Andean and Antarctic volcanology problems, Bull. Volc.,* 482–496.

ODIORNE, H. H. (1978) *Colorado Amazonstone, the treasure of Crystal Peak.* 51 pp. Forum Publishing Co., Denver.

OFTEDAL, I. (1957) Heating experiments on amazonite. *Mineralogical Magazine,* **31**, 417–419.

PEARL, R. M. (1974) Minerals of the Pikes Peak granite. *Mineralogical Record,* **5**, 183–189.

PLYUSNIN, G. S. (1969) On the coloration of amazonite. *Zap. Vses. Mineral. Obshchest.,* **98**, 3–17. (In Russian.)

RUDENKO, S. A., and VOKHMENTSEV, A. Ya. (1969) Plagioclase-amazonite. *Dokl. Acad. Sci., Earth Sci. Sect.,* **184**, 113–115.

SHMAKIN, B. M. (1979) Composition and structural state of K-feldspars from some U.S. pegmatites. *American Mineralogist,* **64**, 49–56.

SHMAKIN, B. M., MAKAGON, V. M., KONEV, A. A., and IVANOV, A. N. (1973) Amazonite-bearing pegmatites of the Olkhon Region, western Trans-baikalia. *Zap. Vses. Mineral. Obshchest.,* **102**, 591–599. *In Russian.*

SMITH, J. V. (1974) *Feldspar Minerals. Vol. 1, Crystal Structure and Physical properties.* Chapter 12, Miscellaneous physical properties. 556–600. Springer-Verlag, N.Y.

WHITE, J. S. (1972a) What's new in minerals, *Mineralogical Record,* **3**, 125 and 132–133.

_________ (1972b) What's new in minerals, *Mineralogical Record,* **3**, 180–183.

WILSON, A. F. (1950) Fluorescent feldspar and zircon as petrological aids. *Mineralogical Magazine,* **29**, 225–233.

ZHIROV, K. K., and STISHOV, S. M. (1965) Geochemistry of amazonitization. *Geochem. Int.,* **2**, 16–24.

Mineral Collecting at the Sunnyside & Idarado Mines

by **Jack A. Murphy**
Denver Museum of Natural History
City Park
Denver, Colorado 80205

The San Juan Mountains of Colorado have been the source of some of America's finest mineral specimens. With the cooperation of mine officials, recent collecting and documentation programs initiated by the Denver Museum of Natural History at the Sunnyside and Idarado mines have resulted in the preservation of several tons of specimens.

AT THE SUNNYSIDE MINE

The Denver Museum of Natural History's collecting program at the Sunnyside mine began in 1975 and continued periodically until the mine closed in the spring of 1978. Our ultimate goal was to find a large quantity of rhodochrosite crystals suitable for reconstruction in an environmental exhibit. Realizing the remote chance of discovering such a cavity, we utilized time underground to advantage by initiating a mineral reference project. Verification of mineral species and locations in the mine was important for more than strictly mineralogical reasons. Such information increases the documentation data for specimens in museums and private collections. Accordingly, we visited most parts of the mine where active mining was in progress.

The first trips in the mine, led by chief geologist David Stalker, were for reconnaissance. In 1976 the extensive underground workings included miles of tunnels on seven main active levels. Mining of gold ore was under way in nine stopes and on five different veins at a rate of 700 tons per day (Casadevall, 1976). The best free gold occurrences were on the 2150 vein. High grade ore and some mineral specimens were found in the Spur, Washington, No Name, 2170 and 2250 veins.

On a later trip in 1977 with Dennis Krantz, mine geologist, we had poor luck collecting reference and exhibit specimens. Small specimens of sphalerite, pyrite and quartz were typical. In the 1880 stope on G level small crystals of rhodochrosite were retrieved. In the Washington vein on F level we encountered massive pod-like structures of what was commonly referred to as "rhodonite," but Casadevall (1977) found it to be pyroxmangite. This very hard manganese silicate is well known from the Sunnyside mine and was, at one time, available from the dump at Eureka. Its hardness made it satisfactory for use in ball mills for crushing the pyrite-quartz ore. The most desirable pieces contain free gold and are used in jewelry.

Bruce Benthin, an accomplished collector and mineral enthusiast, and I visited the Sunnyside mine in the summer of 1977. Again led by Krantz, we followed up on reports that some interesting minerals had been located on F level. We visited the area, accessible by climbing a 50-foot ladder up a raise to the 3660 stope. We could see a large pile of tan debris heaped on the floor of the stope. Even from that distance we realized this material was out of the ordinary! Through the dusty air we sighted a 4-by-5-foot hole in the ceiling (Fig. 1) that led upward for an unknown distance. A ladder was retrieved and soon we were poking our heads up into a large and beautiful watercourse cavity sloping up at an angle of 45 degrees for approximately 30 feet (Fig. 2). Our lamps scanned across walls covered with small, pale pink rhodochrosite growths with radial clusters of white quartz.

Upon close inspection we discovered that the rhodochrosite crystals were not typical rhombohedrons nor the intergrown tabular crystals common at the Sunnyside mine. Rather, these specimens occurred in small, tapered, paper-thin blades growing on a matrix of pink and white quartz (Fig. 3).

The 7-foot-wide fissure, opened the previous day from blasting, occurred adjacent and parallel to the base metal-quartz-pyroxmangite vein. Mineralization in the lenticular-shaped cavity consisted of two main growths; a manganocalcite crust was present on the lower pink quartz walls and floor, and white and pink quartz with rhodochrosite and some sulfides were above. The tan carbonate occurred massively and partly as intergrown pseudomorphic crystals (up to 2 cm in length) of manganocalcite after scalenohedral calcites.

We spent the next two days carefully collecting the delicate

Figure 1. **Entrance to a crystal cavity in the 3660 stope, F level, of the Sunnyside mine. Denver Museum of Natural History photo.**

rhodochrosite and photographing in the cavity. Conditions were cramped and it was difficult separating specimens from the hard quartz wall rock without damage. The most desirable specimens were located at the top of the opening. Assisted by Michael Ford and David Logan, two geology interns from Western State College at Gunnison, Colorado, we were able to reach an area where the blades were larger, up to 6 mm long and from 2 to 4 mm wide. The intergrown masses of paper-thin, bladed crystals formed a continuous coating on the walls of the fissure. In some places the blades were aligned in a pattern of parallel growth.

We originally thought these blades were pseudomorphs of rhodochrosite after gypsum, similar to material recovered from another part of the mine about ten years ago. X-ray diffraction, scanning electron microscope and electron microprobe studies made at the U.S. Geological Survey laboratory confirmed the mineral to be rhodochrosite. Investigations with their Scanning Electron Microscope were made to clarify the habit and morphology of the bladed crystals. Photographs of the individual blades did not show gypsum morphology; rather, the observed habit and cleavage are rhombohedral (Figs. 5 and 6).

Beautiful quartz rosettes (Fig. 7) resembling tiny, clear flowers were scattered throughout the cavity. The individual, 1-cm-long, prismatic crystals, some with scepter-like terminations, are intergrown radially around a cryptocrystalline core. Being the last mineral formed, the crystals were attached to the bladed rhodochrosite and massive quartz wall rock. After separation from the underlying mineral (by a slight touch) their appearance was similar to a small quartz button. Ten hours work in the cavity resulted in a few excellent rhodochrosite specimens. One large slab (30 by 48 cm wide and 29.7 kg) was collected and is the best museum exhibit piece.

Photo documentation required several rolls of 35 mm Kodak Ektachrome film, ASA 200. An HI Heiland Pentax, a 1:2.3 F 35 mm lens and a Vivitar electronic flash unit comprised the essential equipment. Few photographs have been made of a crystal cavity of this type and size. Documentation of collecting activities and crystal growths was difficult but helped contribute to the success of the expedition.

Due to the interest and cooperation of personnel at the Sunnyside mine, our endeavor was successful. Particular credit goes to Alan Bird, the mine manager at the time. Although we did not acquire specimens for a cavity exhibit, we did gain experience in mineral assemblages in a watercourse fissure and had the opportunity to preserve important specimens.

The mine had been active for the past 15 years but was closed unexpectedly in 1978 when Lake Emma broke through the upper workings and flooded the mine. An attempt is being made to reopen the mine since estimated resources include more than 304,000 ounces of gold and 7,200,000 ounces of silver (Casadevall and Ohmoto, 1977). Overall the mine has produced about $125,000,000 in minerals since 1874, more than 60 percent of all the ore from San Juan County.

AT THE IDARADO MINE

A realistic reconstruction of a natural cavity is an effective way for a museum to exhibit minerals. Such a display provides the opportunity for expanded interpretation on various subjects, especial-

Figure 2. **Michael Ford climbing into a cavity in the 3660 stope of the Sunnyside mine. A manganocalcite crust coats the cavity walls. Denver Museum of Natural History photo.**

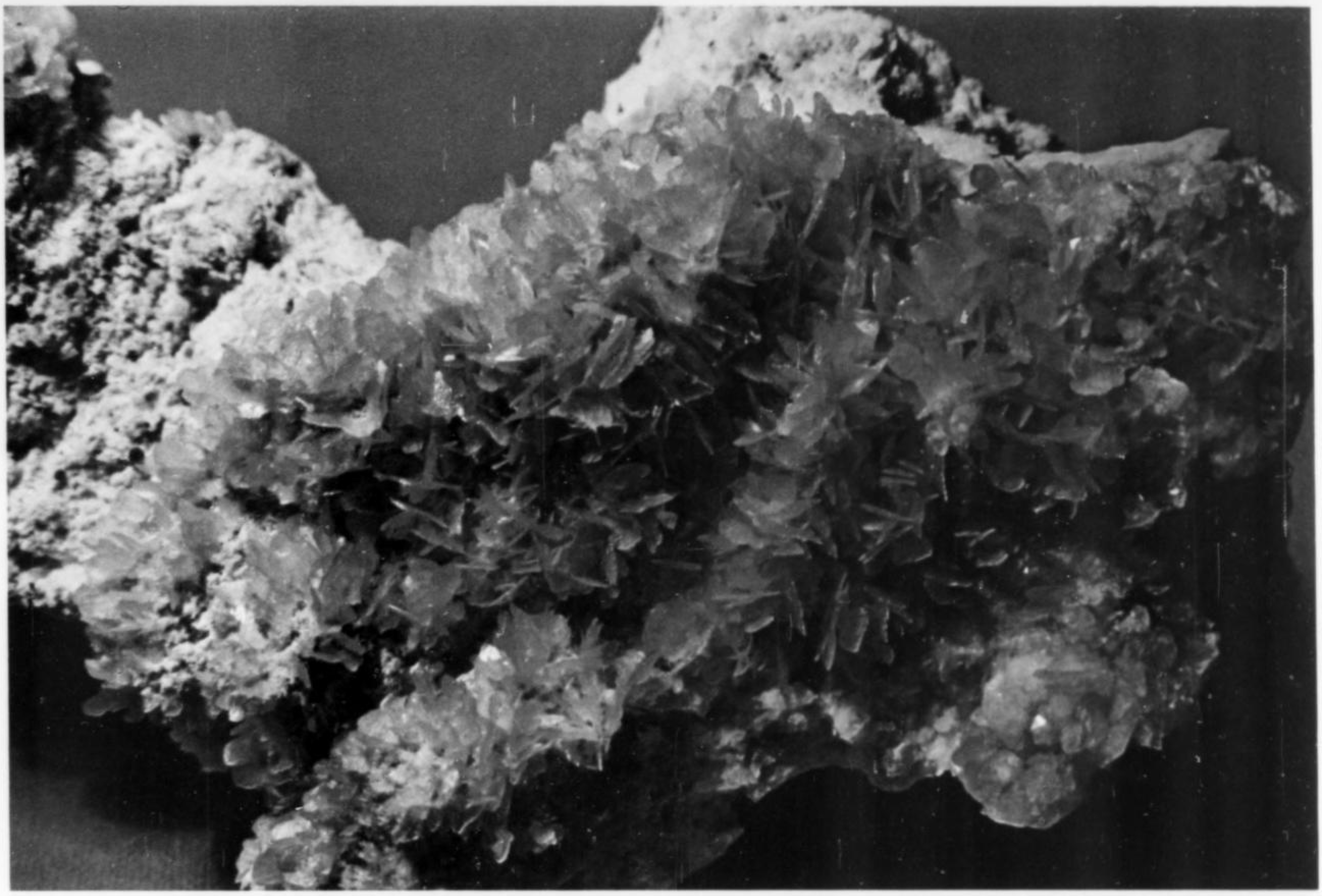


Figure 3. **A specimen of bladed rhodochrosite from the 3660 stope, F level, of the Sunnyside mine. The specimen as shown measures 10 cm across. Denver Museum of Natural History photo.**

Figure 4. **Manganocalcite coating pink and white quartz in the cavity in the 3660 stope. Small, bladed rhodochrosite crystals were found in the inner part of the cavity. Denver Museum of Natural History photo.**

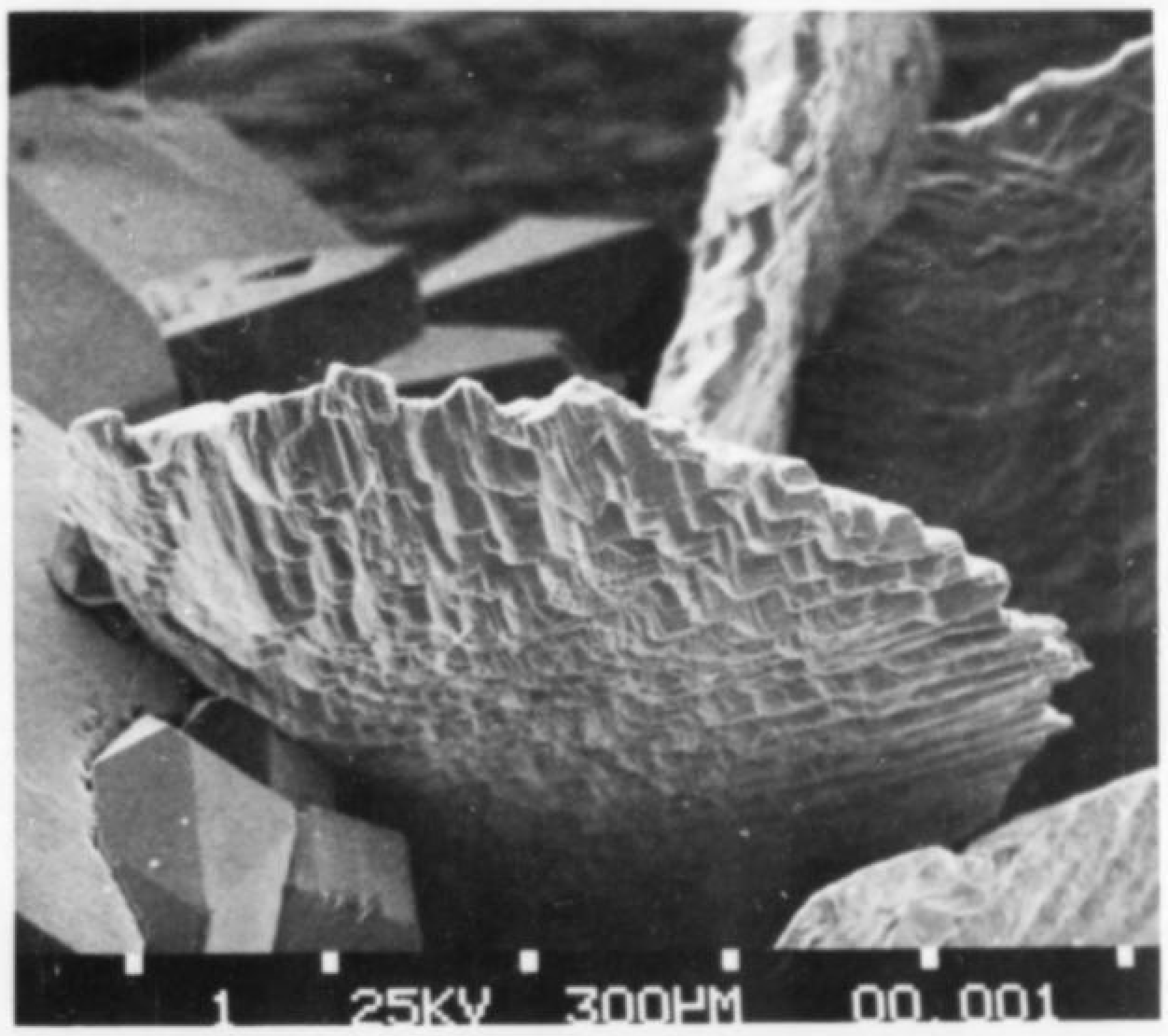


Figure 5. **A scanning electron microscope photograph of bladed rhodochrosite from the Sunnyside mine. The crystal, built up of rhombohedral faces, is about 0.02 mm across. Photo by Phoebe Hauff, U.S. Geological Survey.**

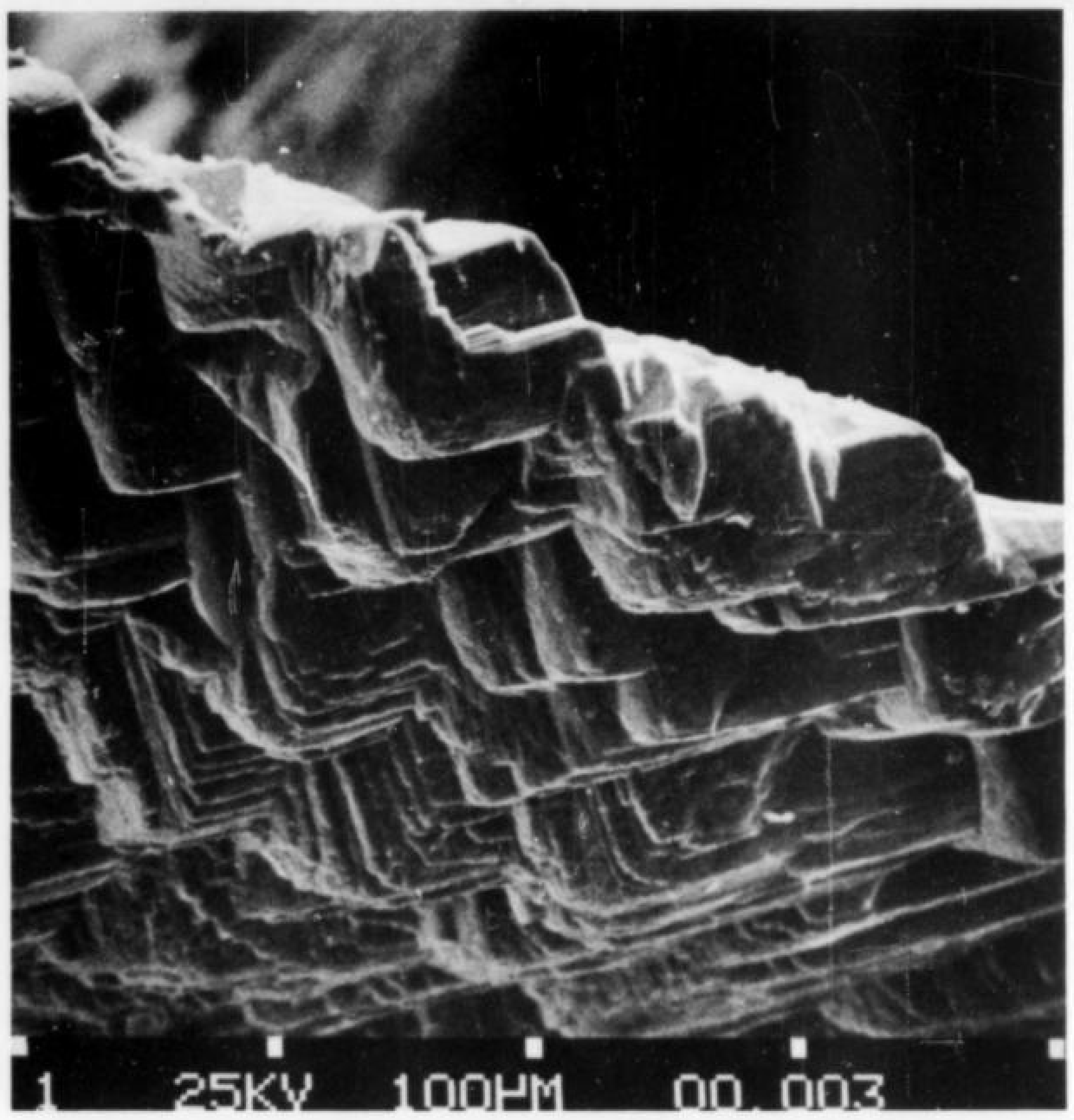


Figure 6. **A closer view of a bladed rhodochrosite crystal as shown in Figure 4, showing rhombohedral cleavage. Photo by Phoebe Hauff, U.S. Geological Survey.**

Figure 7. **"Button" of white quartz, composed of crystals in a radial array, from the Sunnyside mine. The button is 2.6 cm across. Denver Museum of Natural History photo.**

Figure 8. **The Idarado mine was built in 1945 on the site of the former Treasury tunnel mine and mill, as seen in this photo from the late 1940's. Photo courtesy of Mrs. Marvin Gregory.**

Figure 9. **White scalenohedral calcite on white drusy quartz from the Idarado mine. Denver Museum of Natural History photo.**

ly mineral paragenesis, geological settings, mining and regional history.

Not a new idea, some museums have some type of underground diorama, commonly a limestone cavern depicting stalagtites and stalagmites. This type of reconstruction is the easiest to manufacture in a museum because artificial material can be utilized to a great extent.

Reconstructing a mineralized pocket or crystal-lined fissure, unlike typical limestone caves, is more complex. Crystals in cavities and fissures in association with ore deposits and pegmatites are commonly formed from hydrothermal solutions. The cavities, usually discovered during underground mining operations, often contain beautiful, well developed crystals. Acquiring a cavity in its entirety is difficult. Few mineralogists have had the opportunity to examine and document cavities during active mining. The specimens preserved are usually collected with hammer and chisel near the edges of the opening. Crystal cavities are not customarily removed with the precision and care typical of other scientific excavations. Beautiful and valuable as they are, few attempts are made to preserve them in their entirety.

The Denver Museum of Natural History first became involved with crystal cavity reconstructions in 1912 when the Museum had the opportunity to acquire large amounts of aragonite, calcite and gypsum crystals from the El Potosi silver mine in the Santa Eulalia district east of Chihuahua, Mexico. This privately financed venture resulted in a splendid reconstruction on exhibit for 37 years. Removed in 1950 due to alterations in the museum building, it was reinstalled by the Geology Department in 1975.

Experience has shown this type of display to be popular and educational; therefore, we were motivated to find and build similar displays of minerals from Colorado. The large operating mines in the state were contacted regarding our plan. It appeared to be an impossible task until one of Colorado's major mines, the Idarado, south of Ouray, announced it would be closing in 1978. The decrease in activity during the phasing out of production provided a suitable time for a museum crew to collect. During the summer and fall of 1978, 3.5 tons of quartz and calcite were removed from the Idarado mine to be incorporated into a new cavity exhibit, part of renovations of the Mineral Hall made possible by a generous grant from the Adolph Coors Foundation.

History

The Idarado mine, a consolidation of several older, important properties between Telluride and Ouray, is an exceptional mine. Presently owned by Newmont Mining Company of New York, the original claims have familiar names such as the Smuggler-Union, Tomboy, Barstow and others. All are an integral part of the history of the western San Juans, in particular, the discovery and settlement of the Telluride mining district.

The mines of Telluride and the adjacent Red Mountain district produced steadily through the 1880's but eventually closed due to economic and other factors. Mines such as the Black Bear, Barstow, Imogene and Treasury tunnel lay dormant until, in 1939, the Idarado Mining Company was organized as a consolidation of these old properties. The Metals Reserve Company leased the Idarado's holdings in 1943 and drove the 7,000-foot Treasury Tunnel from Red Mountain westward to connect with the older workings of the Black Bear mine. They also renovated the Treasury mill (Fig. 8) in 1945 to concentrate lead, copper and zinc. Telluride Mines Incorporated drove the Mill Level tunnel from the Pandora mill site at Telluride, 9,500 feet to connect with the extensive underground workings of the Smuggler-Union mine at the same time. By 1949 several of the large mining companies holding claims in the area were involved in complex cooperative mining and milling agreements; they had consolidated these properties by the 1950's. The Idarado Mining Company continued to pursue underground development, the most notable being the physical connection of both mining sections: Red Mountain to the east and Pandora to the west. The Red Mountain Treasury mill was no longer used after the Pandora mill was reconstructed to accommodate greater tonnage.

Collecting Crystal Cavities

In the summer of 1978 I stopped to see mine manager Peter Loncar at the Red Mountain office of the Idarado mine. I knew the mine would be closing and inquired about the possibility of obtaining quartz or calcite crystals for a cavity exhibit. I explained the museum exhibit concept and emphasized the Idarado was one of the few mines in Colorado that had the potential for yielding quantities of crystals. I could not blame Mr. Loncar for his lack of encouragement regarding my request, especially at the difficult time of the mine closure.

The decision to stop mining at the Idarado drew the attention of local newspapers which forecasted a dim future for the town of Ouray. The mine was to cease operation due to economic conditions rather than the depletion of ore reserves. Among other factors, the cost of transporting ore to the distant smelters in British Columbia was high compared to the depressed market prices of lead and zinc.

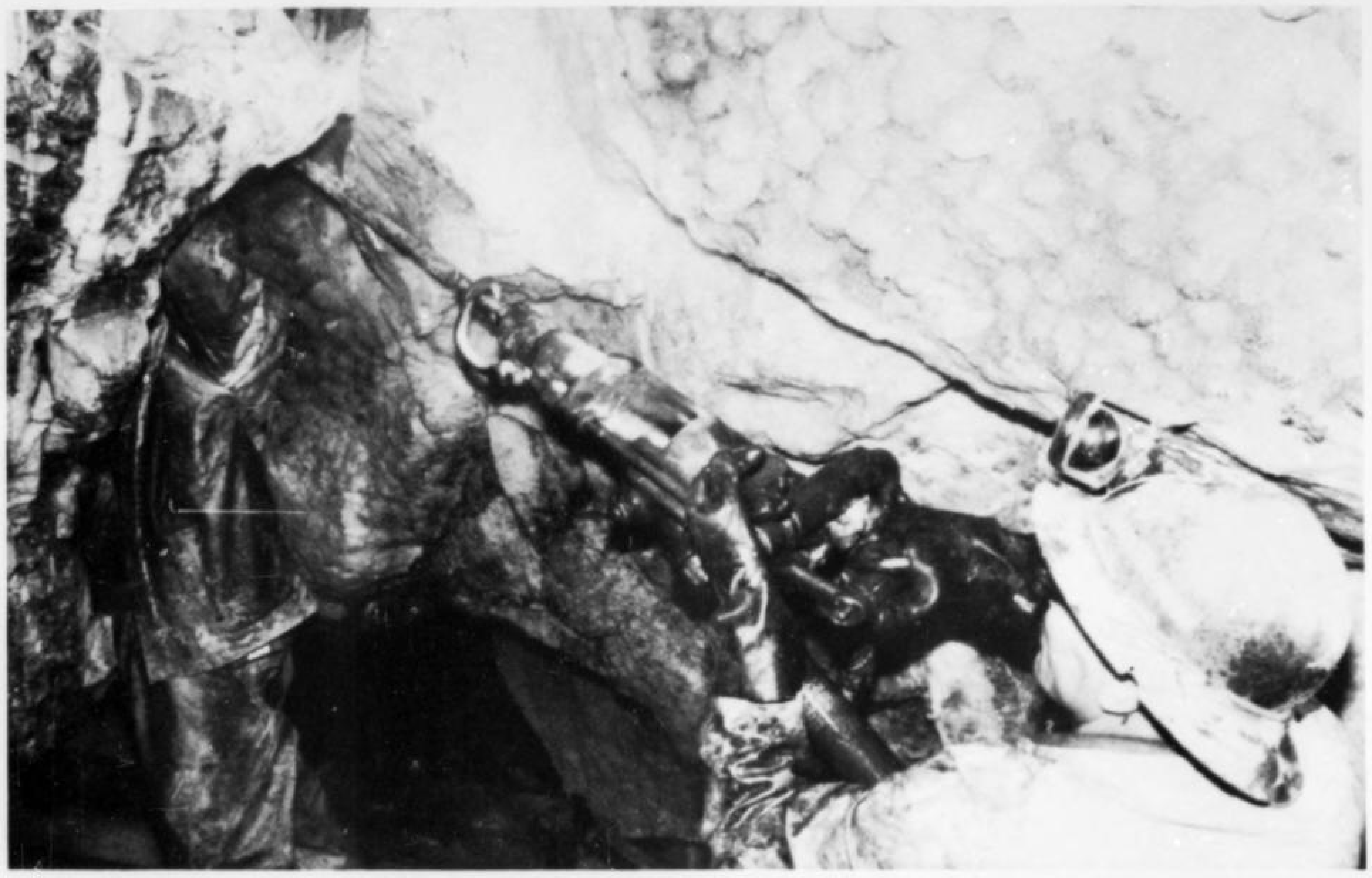


Figure 10. **Felix Archibeque is seen here using the hydraulic splitter to crack slabs of quartz from the wall of the Black Bear vein, 2400 level, Idarado mine. Denver Museum of Natural History photo.**

Loncar explained that quartz and calcite cavities were sometimes encountered during active mining operations;[1] however, he was not aware of any at the time and, furthermore, the mine operation did not lend itself to collecting for various reasons. I assured him that we had an experienced crew which possessed state and federal certifications for underground employment and promised to hire one of the unemployed Idarado miners to work with us and coordinate daily schedules. Realizing our interest in working within all regulations at the mine and the scope of the project, he gave permission for us to collect—if we could find the crystals.

Two capable people coordinated the museum's project at the mine; Walter Risch, a Denver contractor and mineral enthusiast, and Felix Archibeque, a 27-year veteran miner from Telluride. Work was initiated in August, 1978, by reconnaissance trips through the large underground workings of the mine led by supervisor Darrell Foster. We noted potential crystal-bearing areas for further exploration. Many of the engineering staff, including Robert Miller, Al Young and Jock Jollymore, assisted with our orientation. Staff geologist John Trujillo provided us with an account of the geology and mineralogy of the extensive vein systems. It was fascinating to see areas where notable specimens had been

[1] After miners detonate explosives to break out rock in a stope, they are sometimes privileged to see a rare and beautiful sight—a pristine, jewel-like cavity of fine crystals. An old timer at the Idarado told me of a "vug hole" discovered in the Ajax workings in a large fissure lined with clear quartz crystals. He recalled that the worst thing about it was the sound of quartz crystals cracking underfoot as the miners entered the cavity.

Figure 11. **Walt Risch and Felix Archibeque lower a slab of quartz crystals removed from the Black Bear vein. Denver Museum of Natural History photo.**

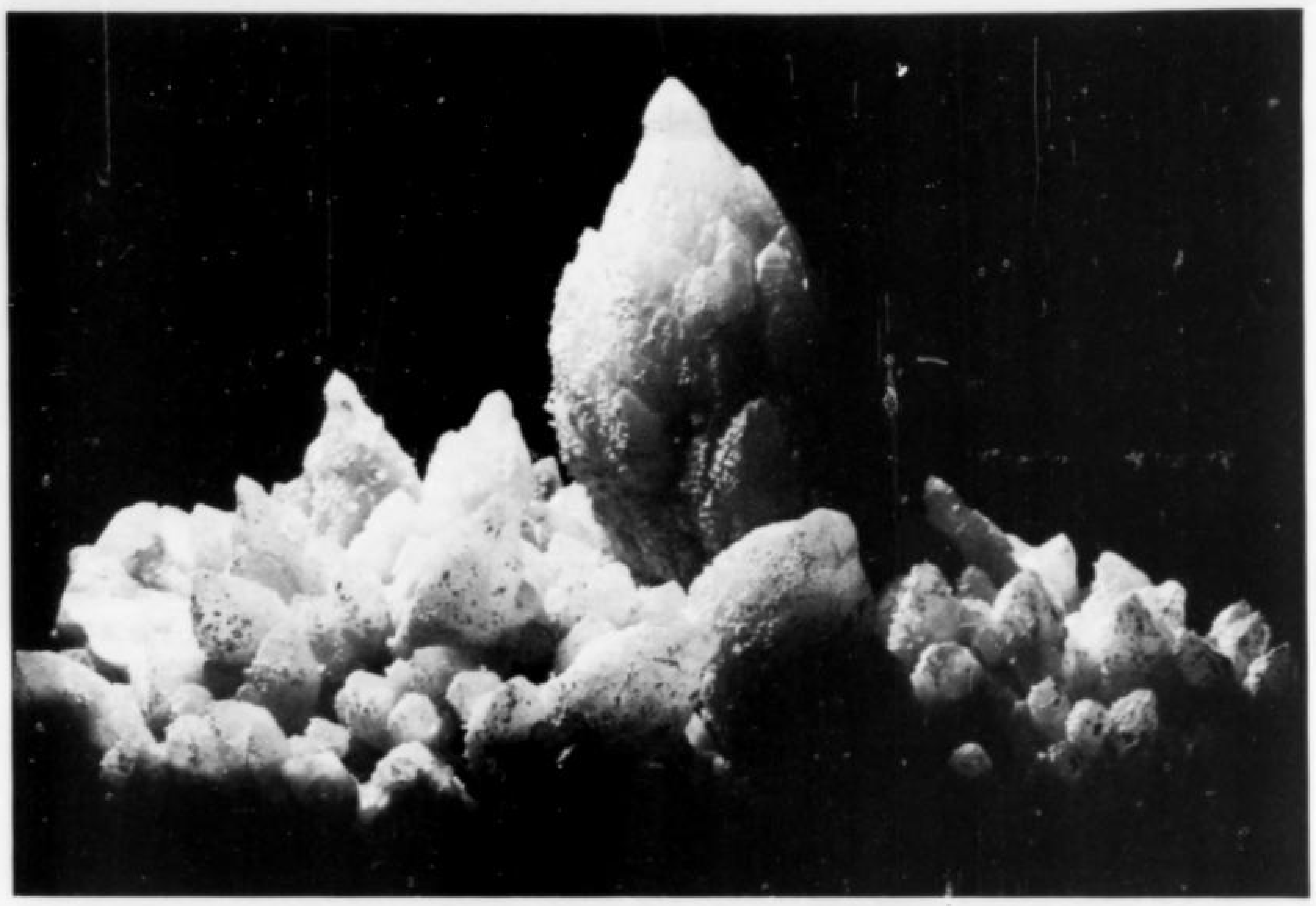
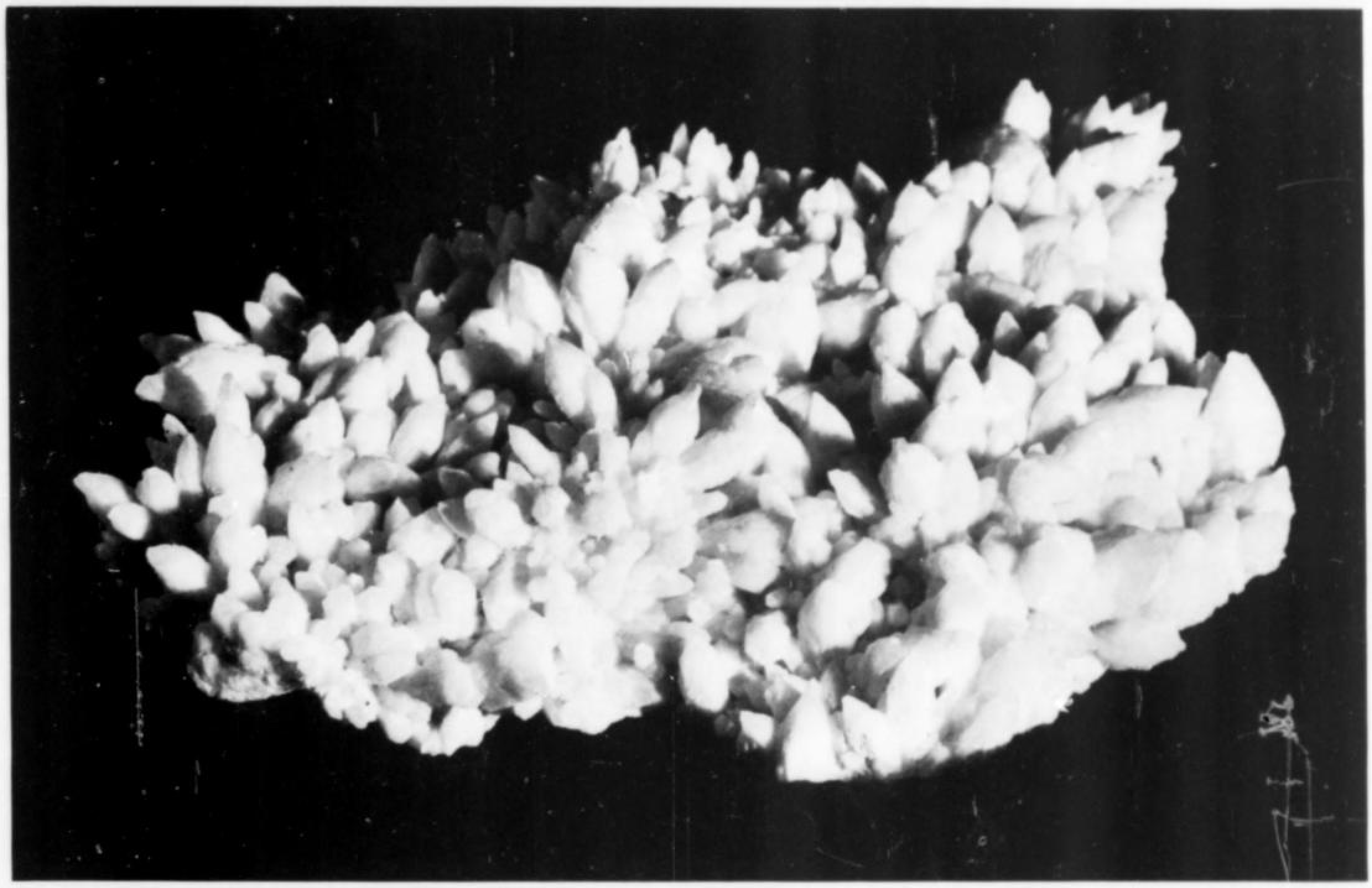


Figure 12. **Quartz crystals from the 800 level of the Idarado mine. The large composit crystal measures 5 by 11 cm. Denver Museum of Natural History photo.**

Figure 13. **Another large slab of white quartz crystals, this one 49 cm across, removed from the 800 level of the Idarado mine. Denver Museum of Natural History photo.**



found, expecially the well known pink manganocalcite and, more recently, fine crystals of chalcopyrite (Kosnar and Miller, 1976). They were discovered in the replacement ore body on the 2400 level, Argentine Strike, near the first quartz cavity Walt Risch and I located.

The first crystal excavation was instructive. Located in a tight quartz sulfide vein, 15 feet above the floor of the drift, the cavity was full of mud and water and difficult to reach. We built platforms up as far as we could but still had to work over our heads. Cold water ran down our sleeves all day, compounding the problem of collecting undamaged crystals. This work confirmed our belief that drills, powder and other heavy equipment would be necessary to extract large slabs.

We installed portable airlines and retrieved the necessary equipment. We proceeded to drill a series of six to eight standard-size holes about 2 feet deep into rock parallel to the crystal-lined sides of the opening. We used a hydraulic splitter[2] to slowly crack the rock which enabled us to carefully remove large, unbroken slabs.

An older part of the mine, the Black Bear vein on 2400 level, was our next area of concentration. Here we encountered a large, coarsely crystallized quartz wall that had the potential for use in an exterior section in part of a mine tunnel exhibit planned for the museum's new Colorado Mineral Hall. This wall was on the side of an 8-foot linear crack adjacent to the vein. It narrowed upward to a small crack 30 feet above the floor of the drift. Large, bluntly terminated quartz crystals overgrown with smaller quartz, and white scalenohdrons of calcite (Fig. 9) lined the sides of the cavity. It was an excellent area for our purposes; we could drill parallel to the wall and, by using the splitter, slowly crack large slabs away from the side (Fig. 10). Risch and Archibeque skillfully accomplished this while working on a timbered platform 20 feet above the drift. Slabs weighing up to 400 pounds were removed, lowered by block and

[2] A machine with a flange that moves a collar apart extending its width. When put into a drill hole it creates a force that breaks the rock.

tackle (Fig. 11), packed, loaded on a flat car, and transported out of the mine. The wall yielded a total of 2,898 pounds of quartz representing about 55 square feet. The entire process was documented on 16 mm color film and 35 mm slides.

After the first three weeks we were accustomed to the daily routine and worked closely with mine personnel, especially the shifters on the various levels: George Cappis, Cecil Goldsworthy and Archie Archuleta. We worked full shifts with the miners who were still extracting ore.

We entered the mine each morning via the Treasury tunnel, located at an elevation of 10,620 feet near Red Mountain pass about 10 miles south of Ouray. This tunnel, about 5 miles long, connected with the inner mine workings by a central shaft. Two hoists carried personnel and equipment down to the lower four levels. Drifts ran northwest into the old Tomboy mine along the Argentine vein system, or southwest to the old Ajax and Black Bear areas. The lowest level, at an elevation of 9,070 feet, connected to the mill-level tunnel where ore was hauled out to the Pandora mill at Telluride.

By September we began to excavate two other areas in the Idarado. The smaller of the two, on the 800 level, produced 400 pounds of well developed quartz crystals (Figs. 12 and 13). The specimens were "cathedral" quartz, more typical at the Camp Bird mine in Ouray County as compared to the long, prismatic, clear to white quartz most often seen from the Telluride side of the Idarado.

Finally, we removed a large cavity discovered by Risch on the lower level (2900) of the mine, located under some of the famous old workings of the Smuggler-Union. Splendid radiating calcite crystals coated with quartz were visible (Fig. 14) in what initially appeared to be a crack in the ceiling of the drift. Our procedure was the same as we used successfully in other areas. As work progressed, the cavity expanded dramatically to reveal excellent, intergrown, radiating crystal sprays with great potential for a reconstruction at the museum. Within a few days, a total of 1,420 pounds of crystallized material had been removed, representing some 125 square feet and 400 individual specimens.

ACKNOWLEDGMENTS

I am indebted to the personnel of the Sunnyside mine (Standard Metals Corporation), especially Allan Bird, David Stalker and Dennis Krantz; and to the following who have made important contributions: Jody Anderson, Pat Bacon, Bruce Benthin and family, Florian Cajori, Margaret Denny, Richard Kosnar, Cathleen A. Murphy, Steven Rich, Shorty and Leona Withers and Robert E. Wright. Special thanks to Edwin Eckel, Eugene Foord and Phoebe Hauff at the Denver U.S. Geological Survey for consultation, analytical work and photographs.

I am also indebted to the personnel at the Idarado mine and to the following people who have contributed in their own way: Felix Archibeque, Don and Dee Belsher, Charles T. Crockett, Margaret Denny, George Godfrey, Carolyn Jones, and Walter and Marie Risch.

renew now!

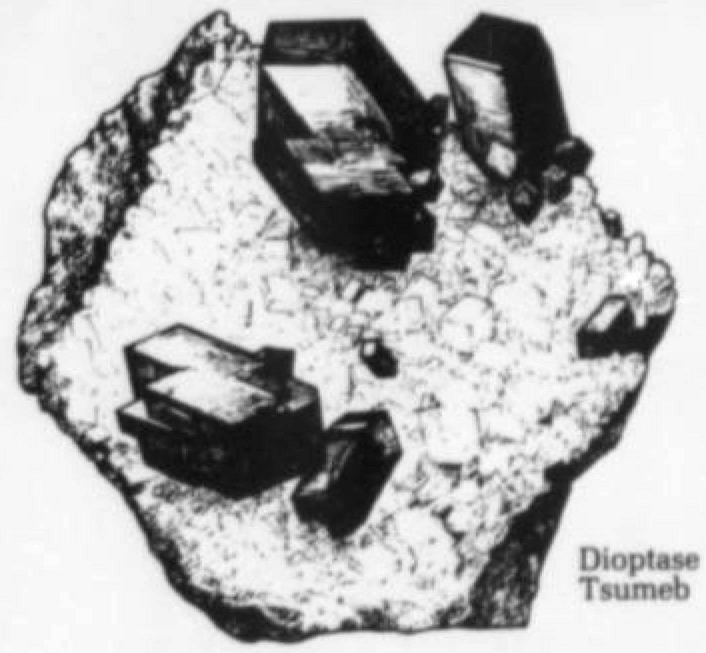
Mineralogical Record
P.O. Box 783
Bowie, Md. 20715

INDIAN MINERAL SPECIMENS
Wholesale Only

Green apophyllite, Natrolite, Mesolite, Scolecite, White Apophyllite, Babingtonite, Okenite puffs, Green, White and Brown Gyrolite, Prehnite, Calcite, Laumontite, Pink to White Stilbite and Heulandite, etc. **Also Ruby in matrix.**

RUPALEE GEMS
25/26 Kartar Bhuvan, Minoo Desai Road,
Colaba, Bombay 400005, INDIA.

The **Lesnicks**



Dioptase
Tsumeb

Specializing in thumbnails, miniatures, and rare cut stones

See us at these Shows:

New York City	
Statler Hilton	Nov. 23-25
Long Island, NY	
Smithtown Armory	Dec. 1-2
Tucson Comm. Center	Feb. 8-10

1454 Odell St., Wantagh, NY 11793

BENITOITE — NEPTUNITE

Other Fine Minerals

New in stock ....
Minerals from Majuba
Hill, Nevada

Showroom open by
Appointment only

BRUCE & JO RUNNER
13526 South Ave.
Delhi, Ca. 95315
Ph. (209)634-6470

MINERALS from FAMOUS MEXICAN LOCATIONS

Mapimi - Conception del Oro-Niaca
Santa Eulolia - Charcus
Write us your wants or
Ask for list

McGREGOR & WATKINS
Rt. 8 Box 487
Hot Springs, Arkansas 71901
7 Mi. West on U.S. 70

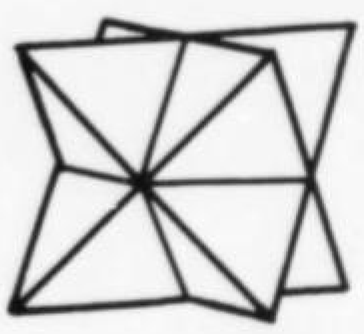
SILVERHORN

Mineral specimens & gemstones

Mike and Carol Ridding

215 Banff Avenue
P.O. Box 1407
Banff, Alberta, Canada
(403) 762-3918

MICROMINERALS
International
P. O. Box 649
Gatlinburg, Tennessee 37738



Micromount Specimens,
Mounting Material And Equipment
Exclusively

LISTS UPON REQUEST

TOPAZ-MINERAL EXPLORATION
DEPT. M
1605 HILLCREST
GRAND HAVEN, MI. 49417
WORLD-WIDE MINERALS
PSEUDOMORPHS
LIST

IF YOU ARE MINERAL COLLECTORS...

don't forget to see us when you come to visit Rome or Italy!

You will find a fine selection of xlled Mineral specimens personally sought all year round mostly in Italy and Europe

Good choice of U.W. fluorescent minerals

Swops with fine mineral specimens from old classic localities might be welcome

Fine Native El. and Tellurides are wanted

We are present at main European Shows

SEE OR ASK FOR:

G.CARLO FIORAVANTI
mineralogist

19-20 VIA PIE' DI MARMO
(between P.zza Venezia and Pantheon)

ROMA
ITALY

Hours Th.-Fri. 11-1 5-8
Monday pm 5-8
Saturday am 11-1
PHONE: 06 - 6786067

HANSEN MINERALS

Dr. Gary R. Hansen
1223 Port Royal, St. Louis, Missouri 63141

Mineralogical specimens
for museums, private collectors
Reference sets
Investment Gemstones

Fine old collection of SWISS MINERALS, Price list available. Contemporary Minerals from Mexico.

Office — 314-569-0842
Residence — 314-432-2882

INDEX TO VOLUME TEN (1979)

Articles

Departments

Mineral descriptions

Localities

Authors

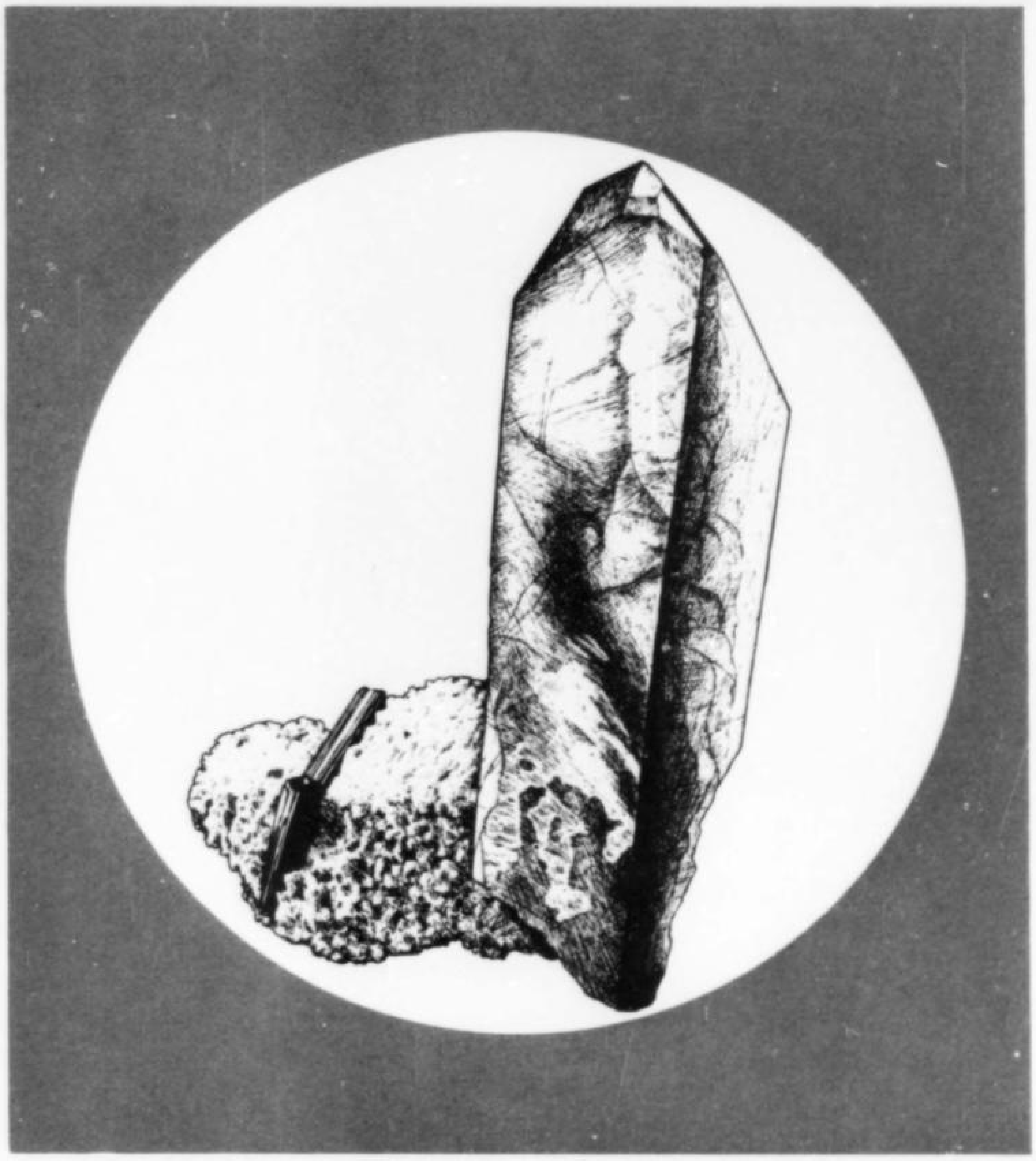
STATEMENT OF OWNERSHIP,
MANAGEMENT AND CIRCULATION
(Required by 39 U.S.C. 3685)

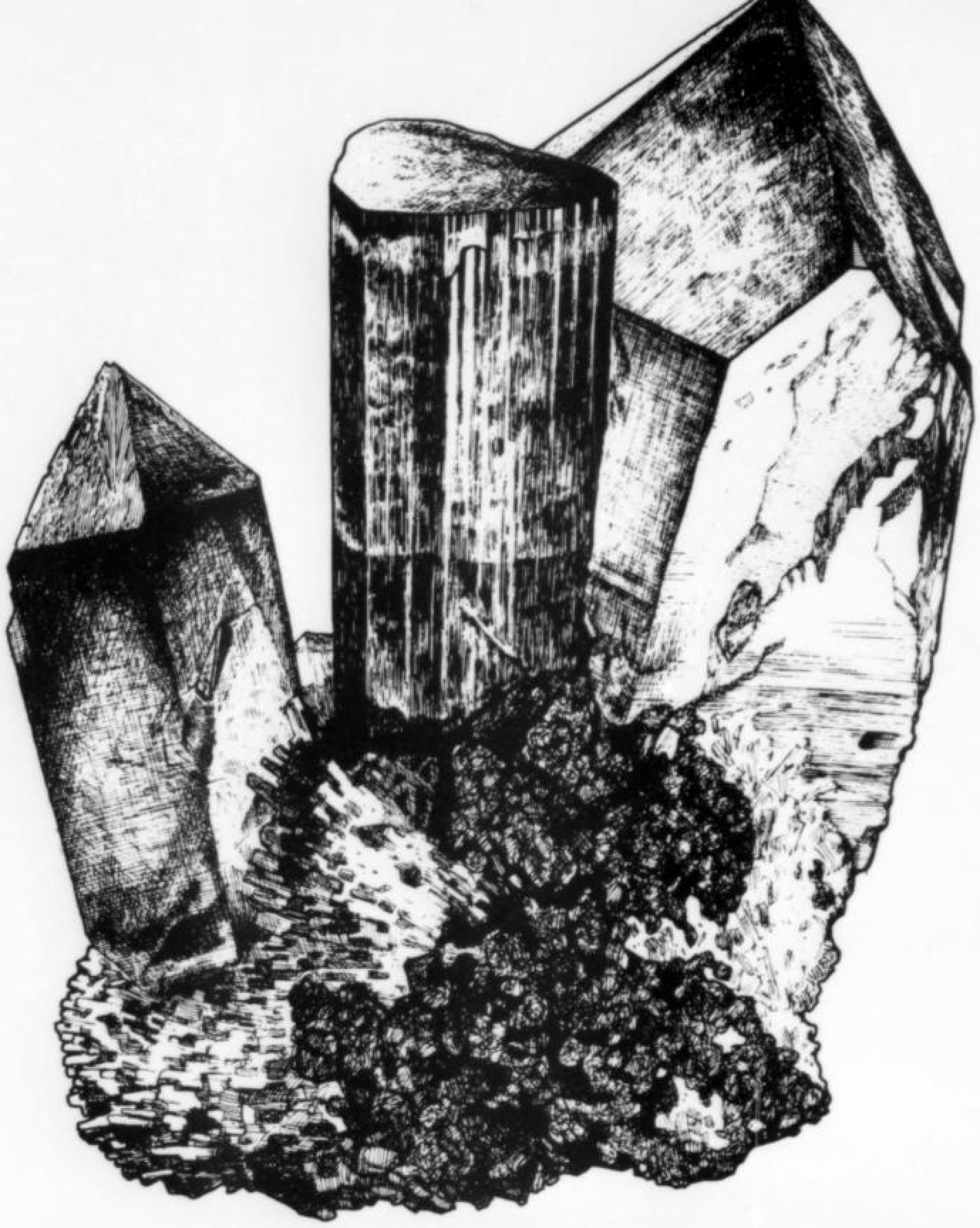
1. *Title of publication:* Mineralogical Record
2. *Date of filing:* September 25, 1979.
3. *Frequency of issue:* Bimonthly
   a. *Number of issues published annually:* Six.
   b. *Annual subscription price:* Thirteen dollars.
4. *Location of known office of publication:* 12304 Welling Lane, Bowie, Prince George's County, Maryland 20715.
5. *Location of the headquarters or general business offices of the publishers:* 12304 Welling Lane, Bowie, Maryland 20715.
6. *Names and complete addresses of publisher, editor, and managing editor: Publisher;* John S. White, Jr., 12304 Welling Lane, Bowie, Maryland 20715. *Editor:* Wendell E. Wilson, 1550 Bandury Court, Crofton, Maryland 21114. *Managing editor:* none.
7. *Owner:* The Mineralogical Record Incorporated, 12304 Welling Lane, Bowie, Maryland 20715. No stockholders.
8. *Known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities:* none.
9. *For completion by nonprofit organizations authorized to mail at special rates (Section 132.122, PSM).* The purpose, function, and nonprofit status of this organization and the exempt status for Federal income tax purposes have not changed during the preceding 12 months.
10. *Extent and nature of circulation:*

	Average no. copies each issue during preceding months	Actual no. copies of single issue published nearest to filing date
A. Total no. copies printed	9127	9000
B. Paid circulation		
1. Sales through dealers and carriers, street vendors and counter sales	130	135
2. Mail subscriptions	6240	6308
C. Total paid circulation	6370	6443
D. Free distribution by mail, carrier or other means, samples, complimentary and other free copies.	27	30
E. Total distribution	6397	6473
F. Copies not distributed		
1. Office use, left over, unaccounted, spoiled after printing.	2730	2527
2. Returns from news agents	0	0
G. Total	9127	9000

11. I certify that the statements made by me above are correct and complete. Wendell E. Wilson, editor.
12. In accordance with the provisions of this statute, I hereby request permission to mail the publication named in item 1 at the phased postage rates presented authorized by 39 U.S.C. 3626. Wendell E. Wilson, editor.

ADVERTISERS INDEX





POSTAGE-STAMP TOURMALINE