Minerals of Colorado
A 100-Year Record

GEOLOGICAL SURVEY BULLETIN 1114

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By EDWIN B. ECKEL

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A summary of the first 100 years of published knowledge, including the chief occurrences of 445 mineral species

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MINERALS OF COLORADO: A 100-YEAR RECORD

By Edwin B. Eckel

ABSTRACT

This is a summary of the known facts about the minerals that make up the rocks, soils, and ore deposits of Colorado. Compilation and abridgment of the literature from 1858, when gold was discovered, through 1957 (with a few additions for 1958 and 1959) is supplemented by information from unpublished sources.

Designed to be of use to both professional and amateur mineralogists, the main part of the report describes the chief occurrences of 445 mineral species, 42 of them first found in Colorado, together with many subspecies, varieties, and discredited "type" species.

The map that accompanies the text shows the location and means of access to all the metallic mining districts in the State, as well as a large number of other noteworthy mineral localities. Directions for finding these localities are also given in the text. The bibliography contains more than 800 selected references to the most significant literature on the subject.

INTRODUCTION

This is a summary, not of the mineral resources or mineral industry of Colorado, but of the known facts about the kinds of minerals that make up the rocks, soils, and ore deposits of the State. Of the several thousand distinct mineral species known to mineralogists, more than 440 have been identified in Colorado—more than in any State except California. In addition to these true species, dozens of varieties and subspecies are known. Some descriptions of new minerals, or of mineral occurrences, have later been found to be in error. The purpose of this report is to bring together condensations of all the significant facts on these minerals. The condensations are supported by references to all important source material from the earliest reports of gold discoveries in 1858, through 1958. Compilation and abridgment of the literature is supplemented, where possible, with notes of the unpublished observations of friends and colleagues. Although valuable, these personal contributions are so small as compared with the published literature that this volume is, in effect, a summary of the first 100 years of published knowledge on the occurrence of minerals in Colorado.

Compilation of the work of others on any subject, uncreative though it may be, is an essential step in any orderly research. In this instance future mineralogists in Colorado will at least have a stepping stone—a summary of the first 100 years of advancing knowledge of the subject—on which to base their further contributions. Moreover, a State as rich in minerals as Colorado deserves a summary description of its minerals comparable to similar descriptions for nearly all other States that can claim any fame whatever for the variety or abundance of their minerals.

I have intended this report to be of use to both the scientific mineralogist and the amateur mineral collector, but both groups will probably find shortcomings. I hope that the scientist will find more errors of omission than of commission. There are no chemical analyses, crystallographic data, or X-ray data, and very little on paragenesis or the meanings of the mineral occurrences. To have included all such facts would have made the report unduly large, and interpretations would have been presumptuous. To offset these lacks, the scientists will find as nearly complete as possible a bibliography of significant items, a complete listing of recorded occurrences of all but the most common minerals, and some indication of which papers contain the kind of facts he seeks.

The amateur, on the other hand, may find both too much and too little information. He will find descriptions of minerals that long ago went to mill or smelter, and of occurrences in which the minerals are identifiable only by X-ray techniques. He may also be discouraged by the great number of minerals that he would like to have in his collection, and he will certainly be disappointed in the paucity of directions on how and where to find mineral localities. Against these shortcomings, the book may inspire the amateur with the thought that he is a part of a flourishing science—that his next trip may lead to the discovery of a new mineral or a new crystal form. He can surely use the description for planning his collecting trips, and he can add immeasurably to his own intellectual growth by tracking down some of the source data in the bibliography.

I have depended heavily on published bibliographies and indexes, particularly the "Bibliographies of North American Geology," covering 1785–1957. These were published by the U.S. Geological Survey as Bulletins 746–747 (1785–18), 823 (1919–28), 937 (1929–39), 1049 (1940–49), 985 (1950), 1025 (1951), 1035 (1952–53), 1054 (1954), 1065 (1955), 1075 (1956), 1095 (1957). Examination of all the pertinent literature cited in these and other bibliographies, together with all promising cross references given in this literature has, I believe, resulted in nearly complete coverage of the subject.

The 800 entries in the bibliography contain, subject to the quality of personal judgment and its variations from day to day and from year to year, all truly significant descriptions of minerals or mineral occurrences. For each reference included, several others were examined and rejected. Most repetitions of the same or very similar reports are avoided, as are generalized reports and syntheses. Except for original descriptions of new minerals, if descriptions similar to those published in hard-to-get publications are contained in standard sources, the standard references are given, although the former may antedate them. Abstracts of published papers are ignored except in a few instances in which the original is in a relatively obscure journal. Published abstracts of significant oral presentations that were not followed by formal publication are included.

ACKNOWLEDGMENTS

Since this report is primarily a summary of published knowledge, credit must first go to the hundreds of authors whose work during the last 100 years has made this report possible and desirable. The compilation and abridgment of the literature are supplemented in many places with notes of the unpublished observations of friends and colleagues. All such contributions are acknowledged in the text as written or oral communications, but my thanks go to all who have contributed their knowledge. The late J. S. Randall of Georgetown, the late E. P. Chapman, Jr., of Leadville, Major R. G. Coffin of Fort Collins, and John W. Adams and Glenn R. Scott of the U.S. Geological Survey deserve special mention.

This compilation has been in progress as an avocation at intervals—some of them very long—since 1931. During the years, many people have contributed to it in one way or another. From early in the work several colleagues, especially G. F. Loughlin, W. T. Schaller, T. S. Lovering, W. S. Burbank, and W. P. Huleatt, as well as my wife, LaCharles G. Eckel, have not only offered many useful suggestions but contributed much more through constant encouragement. In later years and at various times Helen D. Varnes, Glenn R. Scott, and June T. Lemke generously took turns at bringing the bibliography up to date and in abstracting some of the references.

John W. Adams and Glenn R. Scott read all the descriptions of occurrences and not only added many new ones from their own stores of knowledge but detected many errors. Michael Fleischer kindly verified all mineral names and formulas for accepted usage. The Denver Museum of Natural History aided greatly in permitting

studies of its collections, and the librarians of the Denver Public Library, Colorado School of Mines, and the U.S. Geological Survey Library in Denver, were patiently and cheerfully efficient in meeting the calls for wholesale quantities of books.

SOURCE MINERALS OF COLORADO'S MINERAL INDUSTRY

From 1858 through 1957 Colorado's mines, quarries, and wells produced more than $6 billion in new mineral wealth. Of this wealth, about one-half was from metals, one-third from coal, petroleum, and natural gas, and one-sixth from construction materials and nonmetallic mineral products.

This $6 billion, it should be remembered, represents values of the materials as they came from the ground. This figure does not account for the increase of values on fabrication nor the enormous gross income produced by any commodity as the money paid for it in all stages of production and use is passed from hand to hand. The mineral industry laid the foundation for Colorado's growth and is still, and will continue to be, a cornerstone of the State's economy.

Except for coal, oil, and gas, which are arbitrarily excluded from discussion here, all of this wealth, or nearly $4 billion worth, came from minerals. Except for native gold and the rock-forming minerals that comprise construction materials, most of the minerals as such are destroyed soon after they enter the stream of industry. But this need not diminish the interest of the mineralogist, amateur or professional, in the knowledge that the minerals he studies as scientific phenomena are also of enormous economic importance.

Not all minerals have economic value, although nearly all the listed species that are commonly considered to be ore minerals have contributed directly to the State's mineral production in greater or lesser degree. A comparatively small number of nonmetallic minerals have also contributed, either through direct use, as limestone (calcite) and gypsum, or as sources of chemicals. Of the more than 400 mineral species described in this report, however, more than half have no value except as mineral specimens.

Among the 200 or more minerals that are economically important, it is interesting to speculate further as to which species are really outstanding in terms of money value. It is impossible to do more than speculate, as there are few facts on the relative abundance of minerals, as such, in the ores that have been produced in the State. Nevertheless, a few mineral species stand at the very top of the list in terms of money value. The facts, and educated guesses as to the values of each mineral species, are shown in the following table.

Approximate value of Colorado mineral production, 1858–1957, inclusive, showing principal source minerals and their values

Metal and source minerals	*Approximate value (millions of dollars)*
Gold:	
Native gold	$400
Calaverite	250
Krennerite	150
Other tellurides of gold	40
Auriferous sulfides [1]	66
Total	906
Silver:	
Argentiferous galena [1]	150
Silver halides, chiefly cerargyrite	145
Argentiferous tetrahedrite-tennantite [1]	100
Sulfantimonides and sulfarsenides of silver, chiefly polybasite-pearceite	100
Argentite	75
Native silver	25
Total	595
Copper:	
Chalcopyrite	58
Tetrahedrite-tennantite	25
Other copper minerals	5
Total	88
Lead:	
Galena	260
Cerussite	50
Anglesite	5
Other lead minerals	2
Total	317

[1] The distribution of gold and silver in auriferous and argentiferous sulfides is difficult to evaluate. Some such sulfides contain native gold, gold and silver tellurides, native silver or argentite in extremely fine but distinct form. In others, however, the mineral form of the precious metals has not been identified and they are only recoverable as metals by chemical or smelting processes.

Approximate value of Colorado mineral production, 1858–1957, inclusive, showing principal source minerals and their values—Continued

Metal and source minerals—Continued	*Approximate value (millions of dollars)*
Zinc:	
Sphalerite	$295
Smithsonite	35
Other zinc minerals	4
Total	334
Molybdenum:	
Molybdenite	542
Petroleum and natural gas	1,125
Coal	1,202
All other minerals, metals, and construction materials [2]	1,000

[2] Except for sand and gravel, no single commodity in this group has a total value of more than $100 million; no single mineral species has a total value of more than $25 million.

Excluding the enormous value of the hydrocarbons—coal, oil and gas—and assuming the correctness of my guesses as to the relative abundance of the different mineral species, only a few species have produced $100 million or more in money value. These total, however, about $2½ billion—more than the wealth produced by all other minerals in the list combined. Listed in order of decreasing value, these species are:

Molybdenite
Galena (including contained silver)
Native gold
Sphalerite
Calaverite
Krennerite
Cerargyrite
Tetrahedrite-tennantite (including contained silver)
Polybasite-pearceite.

MINERALS FIRST FOUND IN COLORADO

During the past 100 years Colorado has given 42 new, or type, minerals to the science of mineralogy. These are listed below, followed by a list of the 20 Colorado minerals that were first described as new but whose validity as species has since been discredited.

Interesting accounts of the minerals that are named for Colorado people and places are given by Pearl (1941b, 1948a, 1951b, 1952).

Colorado type minerals, with year of discovery

[Query (?) indicates status of species was in doubt as of 1959]

Mineral	*Year*	*Mineral*	*Year*
(?) Alaskaite	1881	Ilesite	1881
Beegerite	1881	Juanite	1934
Beidellite	1925	(?) Lillianite	1889
Carnotite	1889	Metahewettite	1914
Cebollite	1914	Metarossite	1927
Coffinite	1955	Metatyuyamunite	1956
Coloradoite	1877	Montroseite	1950
Corvusite	1933	Paramontroseite	1957
Creedite	1916	Rickardite	1903
Cuprobismutite	1883	(?) Rilandite	1933
Danalite	1892	Rossite	1927
Delrioite	1959	Sauconite	1946
Doloresite	1957	Schirmerite	1874
(?) Doughtyite	1905	Sherwoodite	1958
Duttonite	1956	Siderophyllite (variety of biotite)	1880
Elpasolite	1883	Simplotite	1958
Empressite	1914	Steigerite	1935
Fervanite	1931	Vanoxite	1924
Genthelvite	1944	Weissite	1927
(?) Guitermannite	1884	Zunyite	1884
Hinsdalite	1911		
Hummerite	1950		

Discredited Colorado minerals and mineral names

Domingite	Lionite	"Schirmerite"
Ferrotellurite	Magnolite	Telaspyrine
Fremontite	Natramblygonite	Tysonite
Gilpinite	Nicholsonite	Vandiestite
Goldschmidtite	Ptilolite	Warrenite
Gunnisonite	Robellazite	Wolftonite
Henryite	Sanfordite	

GROWTH OF MINERALOGIC KNOWLEDGE

Some Colorado minerals and mineral deposits were known long before the beginning of the written record. The Indians knew and used agate, chalcedony, and other forms of quartz for weapons and tools; they used clay for pottery and different mineral pigments for decorating pottery as well as their bodies; they produced turquois for decorations, and they cherished crystals of quartz or other minerals as amulets. After the Indians came the explorers, trappers, and guides. Although they left no records in the scientific literature, it is known that some of them found gold, and it is hard to believe that none among these hardy pioneers failed to recognize at least a few of the rocks and other minerals which they saw.

The first written record of the occurrence of minerals in Colorado begins in 1858, when gold was first authentically reported. Even then, the record of the first few years was confined to newspapers and personal letters, only a few of which survived the years, rather than to the scientific literature. C. W. Henderson (1926) gives a carefully documented summary of the beginning of Colorado mining history. Part of his summary is given here in the description of gold.

For some time, gold was the only mineral mentioned in popular or other literature, but even the first placer miners must have been familiar with other minerals, for they surely recognized the quartz sand, brilliant garnets, and magnetic concentrates that went through their crude washers; they must soon have learned to differentiate between real gold and "fool's gold"—commonly either muscovite or pyrite. As soon as vein gold was found in place in 1859 in the Gregory diggings near Black Hawk the miners, as well as the assayers and others who had a part in the burgeoning mineral industry, began to recognize, and eventually to record, many other metallic and nonmetallic minerals that were in or near the ore deposits. Thus began the literature of Colorado minerals, a literature that has continued to grow and that shows no signs of slackening with time.

One of the earliest descriptions of minerals other than native gold is that of Whitney (1865) who mentions the native silver and the richly argentiferous galena that had been recently found in the Tenmile district, Summit County. In his booklet, which today would be classed as a prospectus designed to attract speculative capital, as well as in a later work (1867), Whitney mentions other mineral deposits and notes a few minerals, such as "black sulphurets of silver," "ruby silver," "sulphates of copper," "limonite" and others. Few of these notes can be translated with any certainty into terms of modern mineral species. Whitney's 1867 report is useful, however, because it contains lists of the mines and mining districts that were active at the time in Clear Creek, Gilpin, and Summit Counties.

The first known attempt to list the mineral species of Colorado is that of Hollister (1867). In his interesting little book, Hollister not only reports the early history and status of the mining industry, but includes a list of all the species and varieties known at the time, with brief notes on their localities. His list was followed by many others, which vary in the amount of detail, and in the character of their documentation. In general, each succeeding list is longer than the last, thus recording the slow but reasonably steady growth of the knowledge of Colorado minerals. Among the more significant of such lists are those listed below. Complete bibliographic references appear in the section "Selected references."

Hollister (1867). Contains brief descriptions of most mineral occurrences reported prior to 1867.

J. A. Smith (1870). Catalogue of the principal minerals of Colorado.

Endlich (1878). Complete catalog of known minerals and occurrences, with a brief bibliography and many analyses. Includes all earlier lists of minerals by Peale, Endlich, and others in annual reports of the Hayden Survey.

J. A. Smith (1883). Contains a catalog of principal minerals in Colorado (1883, p. 127–149), with brief notes on occurrences and a few analyses. No bibliography was given, but he credits contributions of authors by referring to their names. This list supersedes and expands on J. A. Smith's several catalogs between 1870 and 1883.

Whitman Cross (1885). Lists 55 species, with notes on occurrences and adequate references for each.

S. F. Emmons (1885a). Contains notes, some of them extensive, on principal minerals in the mining counties; very few references.

Williams (1888). Contains fairly complete list of minerals, by counties, of actual or potential economic value.

Dana (1892). Lists occurrences of Colorado minerals by counties and districts.

George (1913). Primarily a text on mineralogy but contains brief notes on Colorado mineral occurrences.

Schrader and others (1916). Lists many Colorado minerals (p. 81–96) with chief localities of each and a few brief descriptions.

George (1927). Contains notes on many mineral occurrences, but no references.

The citations to J. S. Randall are from his compilations of the known facts on Colorado minerals. Many of his facts were based on personal observations or collections; others were abstracted from published reports or from personal communications of his friends. Parts of Randall's compilations were published at intervals from 1877 (or even earlier) until about 1930, partly in his newspaper, the Georgetown Courier, partly as limited-edition booklets, and partly in "The minerals of Colorado:" Colorado School of Mines Scientific Quarterly, v. 1, p. 98–106 and v. 2, p. 117–136 (1892–93). This journal was discontinued before completion of Mr. Randall's paper. Original citations, where known, are used here in preference to citation of one of Randall's compilations. Thus although he is cited in this report many times, the bulk of his contributions to the record of Colorado mineralogy has been obscured.

All these listings, as well as others, have been used in this report, both as checks against other information and as direct references when no other source material could be found. Several other lists are not included in the section "Selected references." Thus, Endlich's (1878) report is actually a summary of several earlier lists by Endlich himself, Peale, and other members of the Hayden Survey, the distinguished predecessor of the U.S. Geological Survey. Similarly, the report by J. A. Smith (1883) is only the last of a series of reports that he began in 1870, all of which are summarized in the 1883 volume. To credit each individual list would be tedious and serve no useful purpose except to date the discoveries of a few mineral occurrences a little more closely than is done here.

Lists of mineral occurrences, such as are discussed above, are mere summaries of available knowledge. The true source material of Colorado mineralogy is in the scientific and technical literature, supplemented by unpublished notes, oral descriptions, and study of museum specimens. I have summarized here the printed knowledge on the subject, from the earliest references through 1957, plus a few of the more significant reports published in 1958 and 1959. The list of references at the end of the volume will give an idea of the enormous mass of available knowledge on the subject.

The record of mineralogy in Colorado has gone through a series of transitions, partly owing to the changes in mining history of the State, and partly to the growth of the science of mineralogy. Thus, the early records emphasize the minerals of oxidized ore deposits and secondarily enriched sulfides of the precious and base metals. Later, as the oxidized ores were gradually exhausted, the primary sulfides became prominent, together with an increasing knowledge of the nonmetallic gangue minerals. Nonmetallic mineral deposits, such as fire clay, gypsum, and marble began to be exploited later than the metallic ore deposits, hence knowledge of the distribution of their component minerals lagged behind that of the sulfides.

As mining of the precious and base metals declined, so did additions to the literature of their mineralogy, the trend broken at intervals by thorough studies of entire mining districts, most of them by the U.S. Geological Survey or the Colorado Geological Survey. More recently the world need for radioactive raw materials, resulting in the most concentrated search for a single element—uranium—that the mining world has ever seen, has resulted in an enormous increase in the knowledge of the mineralogy of radioactive deposits. The terms "carnotite" and "pitchblende," known in Colorado literature almost from the earliest days of mining, are now known to include an array of other minerals, most of them new to science. Recently the minerals in pegmatite bodies, known from comparatively early days because of their gems and as sources of feldspar and mica, have been the subject of an almost equally rapid growth in knowledge. The search for such hitherto interesting but almost valueless materials as beryllium, tantalum, columbium, mica, and the rare earths has stimulated exploration for, and research on, the minerals that contain them since early in World War II. The mass of knowledge thus gained has been increased immeasurably by the great increase in numbers of amateur mineral collectors, or "rock hounds" during the past decade or two.

Concurrently with the economic changes of the mineral industry and changing emphasis on groups of minerals, there has been a parallel growth in the methodology and detailed knowledge of the science of mineralogy. The earlier descriptions of Colorado's minerals were based largely on sight determinations and chemical analyses, some of them crude or performed on impure materials. Later, microscopic examinations, first of transparent and then opaque minerals, added greatly to our knowledge. More recently the use of modern techniques such as X-ray and spectrographic analyses, coupled with refinements in chemical analyses has resulted in great increases in the basic knowledge of mineral species, permitting discovery of many new species as well as correcting descriptions or reidentifications of many of the old ones.

It should not be inferred from this, however, that all of the early mineral identifications are suspect merely because they are old. Mineralogy is older than geology, and there have been many shrewd and careful workers in every age from that of Plato and Pliny to the present. Colorado has had its share of capable mineralogic students since early in its history, and most of the older identifications are valid today.

FUTURE OF COLORADO MINERALOGY

Many scores of species, some of them new, will be added to the list of Colorado minerals in the years to come. Detailed studies of ore deposits, using new and improved methods of detection particularly on very fine grained ores, will continue to enlarge the list. The hydrous sulfate minerals, which occur in most metal and coal mines, and which coat the banks of intermittent streams and ponds in many parts of the State, have only to attract the interest of some mineralogist to yield a long list of mineral species hitherto unrecorded in Colorado. Despite the recent great advances in knowledge of the clay minerals, the literature is very weak in descriptions of their occurrences in this State.

A large number of uranium and vanadium minerals have been identified in the Utah, Arizona, and New Mexico parts of the Colorado

Plateau, but have not yet been found in Colorado. None of these are listed here, although the similarities in geology and in the uranium-vanadium deposits themselves make it seem virtually certain that many of these minerals exist in Colorado and will eventually be identified there. Similarly, many rare minerals, some of them new to science, have been found in recent years in the Green River formation, of Eocene age, of Wyoming and Utah. Few of these have yet been found in Colorado, although the Green River covers much of the northwestern part of the State. Also, the thick salt beds that underlie large parts of eastern and western Colorado surely contain many more minerals than halite, gypsum, and anhydrite, the only ones that have been mentioned to date.

New interest in the rare earths and their source minerals is already (1959) leading to discovery of additional minerals in the State; many more can be expected to be found in the search for these materials in pegmatite, skarn, and other kinds of rock. Finally, with the coming of the electron microscope and other techniques for study of ultra-small particles, mineralogists are beginning to understand the character, distribution, and meaning of the submicroscopic inclusions in minerals and the so-called impurities or trace elements that are known by precise analyses or other means to be present in many minerals. Some of these impurities are chemical elements or compounds that are in solid solution in their host minerals, but many of them will certainly prove to represent discrete minerals.

Most of the mineral species and occurrences found in the future will probably be discovered by professional mineralogists and geologists. But some of them will probably be found by dedicated amateurs. Those who discover additional minerals in Colorado will, I hope, label their specimens accurately and publish their findings so that the record of the State's minerals will continue to grow.

MINERAL LOCALITIES AND HOW TO FIND THEM

More than 400 mineral species have been reported in Colorado. Some of these minerals have been found only in a single locality, others are known only from certain districts, while many, like quartz, feldspar, and mica, occur in some form in every county in the State.

Among mineralogists, Colorado is known not only for the variety of minerals that have been found in the State and for their enormous economic value, but especially for its richness in certain groups of minerals that are less abundant or less well developed in other parts of the world.

The tellurium minerals are one such group. Many geologists, mineralogists, and mining engineers work with ore deposits for their entire lives without ever running across a single specimen of a telluride mineral, yet those who work in Colorado must learn to recognize the tellurides early, for 18 species of tellurium minerals are known in the State; 5 of these are type minerals and 2 species, calaverite and krennerite, have together yielded more than $400 million in gold.

Another large group of minerals for which Colorado ore deposits are well known comprises the sulfosalts, especially those of bismuth, arsenic, and antimony. These minerals, which include several type species, are present throughout the mineral belt that extends southwestward from Boulder County to the southern limits of the San Juan Mountains. They have yielded much of the silver and copper produced by Colorado mines.

Another group of species of great economic and scientific importance comprises the great number of uranium and vanadium minerals that have been found on the Colorado Plateau and elsewhere during the extensive and highly successful search for uranium raw materials.

Although fascinating, a search for the kinds of minerals mentioned above is likely to be disappointing to the amateur collector. Many deposits have been exhausted long since and many of the mines that produced them are abandoned or inaccessible. Few active mines, moreover, will welcome the casual visitor. The collector should not give up hope of finding ore minerals, however. Some active mines are open to visitors and some inactive ones are open and reasonably safe to enter, but only if the collector is experienced in underground work and accompanied by another person. The best hunting grounds for the minerals of ore deposits, however, are the mine dumps. These are generally open to search and collecting on them is safe. The patient collector who is willing to break and examine many pieces of rock is also likely to be rewarded, not only with specimens of gangue minerals and wallrocks, but with some of the ore minerals as well.

In addition to the minerals that characterize the different mining districts, Colorado is noted for the remarkable assemblage of zeolite minerals in the lava flows of North and South Table Mountains, Jefferson County, the contact-metamorphic minerals of Italian Mountain, Gunnison County and elsewhere, and the vast number of rare minerals in the alkalic rocks of Iron Hill, Gunnison County. Colorado pegmatite bodies, considered as a unit, probably contain as many minerals of the rare earths and other uncommon species as any group of pegmatite bodies in North America, and they have also yielded many gem specimens of aquamarine, topaz, amazonstone, and other minerals.

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Nearly all mineral localities mentioned in the text that can be located with any degree of precision are shown on the map (pl. 1). Mining districts, abandoned or active, are all shown on the map, as are many individual mines. Indications of the principal metals produced by each district will give the knowledgeable collector some hints as to the principal ore minerals in each district. I have made no attempt to list directions to the districts or individual mines within them. I have assumed that the reader can find his way to the districts by using the maps and literature referred to in the report, and that he will depend on local inquiries and reference to detailed maps to find specific mines.

In addition to the metal mining districts, and with certain exceptions, plate 1 shows the location of the deposits most likely to be of interest to the collector. Among the exceptions are less important localities for some individual species; most of these are given in the descriptions of the species concerned. Another exception is that only a few of the dozens of reported localities for agate, petrified wood and the many other semiprecious forms of chalcedonic quartz are listed here in any form. Much more information on such deposits is given by Pearl (1958) in his book, "Colorado Gem Trails and Mineral Guide," and in the articles referred to by him.

The following pages list the most noteworthy mineral localities, other than mining districts, with directions for finding them. The locality descriptions are listed alphabetically under county names, which are also given alphabetically, and are keyed to plate 1 with locality numbers, for example, Chaffee County: *Locality 3*.—Mount Antero. Locations are given by section, township, and range where these are known. Means of access from well-known towns or highways are given in sufficient detail to enable the collector to find a given deposit or to at least place him close to it. Inquiry of local inhabitants, however, is highly recommended for exact directions to deposits as well as information on land ownership, permission to collect minerals, and other matters.

Many of the locality descriptions given in this section have been taken directly from the source literature; many others have been taken without much change from the many excellent and extremely detailed descriptions in "Colorado Gem Trails and Mineral Guide" (Pearl, 1958). Still others have been generously supplied by John W. Adams, Glenn R. Scott and others of my colleagues.

For each locality the principal minerals are listed alphabetically. Descriptions of the minerals and their modes of occurrence are not given here, however. These facts, and references to the pertinent literature, are to be found under the specific names in the main part of the report—the section on descriptions of mineral occurrences.

The concentrations of localities in Jefferson County and parts of El Paso and Douglas Counties partly reflect the geologic environments, but most of them merely reflect the closeness of these areas to centers of population. This relation has a lesson for the mineral collector—for the same reason that more collecting localities have been found within easy reach of the larger cities, likewise these deposits have probably been picked over by more collectors than those that are less accessible.

NOTEWORTHY MINERAL LOCALITIES

BOULDER COUNTY

Locality 1.—Gold Hill district, Copper King mine. Bravoite, cobaltite, garnierite, morenosite, pentlandite, polydymite, and violarite.

The Copper King mine is three-fourths mile southwest of Gold Hill and 7 miles northwest of Boulder.

Locality 2.—Jamestown district, cerite deposits. Allanite, cerite, epidote, fluorite, monazite, tornebohmite, and uraninite.

Cerite deposits are 2 miles N. 42° E. of Jamestown, near the north edge of a small stock of Silver Plume granite.

CHAFFEE COUNTY

Locality 1.—Browns Creek area, California mine. Beryl, brannerite, ferrimolybdite, fluorite, jarosite, molybdenite, quartz (clear to smoky), and rutile.

The mine is 2 miles southwest of Mount Antero, at an altitude of 12,500 feet. It can be reached by road and trail up Browns Creek from U.S. Highway 285 near Nathrop or by the Baldwin Gulch trail from Chalk Creek.

Locality 2.—Turret district, Calumet mine. Beryl, columbite, corundum (var. sapphire), diopside, epidote, essonite, fluorapatite, garnet, graphite, hematite, magnetite, muscovite, quartz (sagenitic), wernerite.

The Turret district, which includes the Calumet iron mine, several very old gold mines, and many pegmatite bodies, comprises most of T. 51 N., R. 9 E., and the first tier of sections in T. 50 N., R. 9 E. The Calumet mine is on the east wall of Railroad Gulch; most of the pegmatite bodies are along or near the same stream. The area is 12 miles north of Salida and can be reached by following county roads 180, 190, and 31 (largely unimproved) from a point just north of Salida. See Hanley and others (1950) and Pearl (1958) for index maps.

Locality 3.—Mount Antero. Bertrandite, beryl (aquamarine), bismutite, brannerite, cyrtolite, fluorite, garnet (spessartite), phenakite, quartz (smoky and rock crystal), and topaz.

The famous Mount Antero gem locality covers a fairly large area in E½, T. 51 N., R. 6 E., and W½, T. 51 N., R. 7 E., within about 500 feet of the summits of Mount Antero (altitude 14,269 feet) and nearby White Mountain (altitude 13,900). The minerals occur in many small miarolitic cavities in granite. Blasting is commonly necessary, especially as the locality has been picked over by collectors for many years. The deposits can best be reached by road and trail from State Route 162, which follows Chalk Creek from near Nathrop on U.S. Highway 285 or from U.S. 285 near the mouth of Browns Creek, 3.6 miles south of Nathrop.

Locality 4.—Nathrop (Ruby Mountain). Garnet (spessartite), quartz, sanidine, and topaz.

The Nathrop locality is in NW¼, sec. 12, T. 15 S., R. 78 W., near Nathrop on U.S. Highway 285. Three low hills of rhyolite—Dorothy Hill west of the

Arkansas River and Ruby and Sugarloaf Mountains east of the river—yield gem crystals from lithophysae. The eastern hills can be most easily reached by crossing the railroad trestle just north of Nathrop. See Pearl (1958) for index map.

Locality 5.—Sedalia mine. Almandite, amphibole, cerussite, chalcocite, chlorite, chrysoprase, corundum, cuprite, gahnite, garnet, glaucophane, magnetite, malachite, staurolite, and willemite.

The old Sedalia copper mine, famed as the source of "Salida" garnets, is in sec. 16, T. 50 N., R. 9 E., 4 miles north of Salida. Follow county road 180 from a point just north of Salida for 4 miles where mine dumps are visible on hills to the east. Take the next right turn, cross the tracks and turn back south about one-half mile. The best surface collecting is in outcrops near the highest mine dumps. See Pearl (1958) for index map and road log.

Locality 6.—Trout Creek Pass area, Yard and Luella mines. Allanite, biotite, bismutite, euxenite, fluorite, gadolinite, monazite, muscovite, and xenotime.

The Trout Creek Pass pegmatite area is 5 to 7 miles west of Trout Creek Pass and 10 miles by road (U.S. Highway 24) east of Buena Vista. The Yard mine is in sec. 26, T. 13 S., R. 78 W., 4 miles north of U.S. Highway 24. The Crystal No. 8 (Luella) mine is in sec. 17, T. 14 S., R. 77 W., just south of U.S. Highway 24. The Clora May mine, about one-fourth mile south of U.S. Highway 24, is in sec. 11, T. 14 S., R. 77 W.

CLEAR CREEK COUNTY

Locality 1.—Beaver Brook (Brandt) pegmatite. Allanite, amazonstone, beryl, gadolinite, garnet, monazite, topaz, and zircon.

The Beaver Brook, or Brandt pegmatite, is in sec. 12, T. 4 S., R. 72 W., on the south bank of Beaver Brook. Turn south from U.S. Highway 40 at the east foot of Floyd Hill and follow the road up Beaver Brook about one-fourth mile to Beaver Brook School. Pegmatite is on the opposite side of the creek from the school.

Locality 2.—Floyd Hill pegmatite bodies. Allanite, beryl, muscovite, and titanite.

The Floyd Hill beryl deposit is in sec. 12, T. 4 S., R. 72 W. It is close to the north side of U.S. Highway 40, at the east foot of Floyd Hill and a few hundred feet west of the Clear Creek–Jefferson County line. The allanite locality is in the SE¼ sec. 34, T. 3 S., R. 72 W. on U.S. Highway 6, in coarse granite about 1 mile east of the junction with U.S. Highway 40.

Locality 3.—Grover pegmatite. Bertrandite, beryl, columbite, monazite, muscovite.

The Grover mine is at the common corner of secs. 9, 10, 15, and 16, T. 4 S., R. 72 W., at the top of a small ridge on the north side of Beaver Brook. It can be reached from U.S. Highway 40 via the road up Beaver Brook.

Locality 4.—McManus Gulch. Calcite, garnet (grossularite), hornblende, and vesuvianite.

This locality is in sec. 5, T. 4 S., R. 72 W., about 2 miles east of Idaho Springs. McManus Gulch empties into Clear Creek from the south just west of Gem Power Plant. Walk up the gulch about three-fourths mile, thence up a steep trail on the east side of the gulch. A calcium silicate body is exposed about halfway up the hill and a short distance west of the trail.

Locality 5.—Santa Fe Mountain prospect. Beryl and quartz (rose).

This pegmatite prospect, 3 miles southeast of Idaho Springs, is in sec. 8, T. 4 N., R. 72 W., at the top of a ridge that extends northward from Santa Fe

Mountain. It can be reached from U.S. Highway 6 and 40 by an abandoned logging road up Sawmill Gulch and a foot trail.

CONEJOS COUNTY

Locality 1.—King mine. Turquois.

From Manassa, which is 3 miles east of U.S. Highway 285, follow State Route 142 eastward 6.6 miles; turn south 0.3 mile to a cabin at mine dumps near the foot of large hill.

DELTA COUNTY

Locality 1.—Gunnison Forks sulfur deposit. Gypsum, marcasite, pickeringite, potash alum, and sulfur.

The deposit is 14.4 miles east of Delta and one-half mile south of State Route 92.

DOUGLAS COUNTY

Locality 1.—Devils Head Mountain. Albite, allanite, amazonstone, cassiterite, cyrtolite, gadolinite, quartz (smoky and rock crystal), samarskite, and topaz.

Devils Head is an isolated peak in the Rampart Range. It is easily reached from Sedalia on U.S. Highway 85, via State Route 67 (the Jarre Canyon road) and the Rampart Range road; road distance from Sedalia is 21.5 miles. It can also be reached from Colorado Springs by way of U.S. Highway 24 to Woodland Park, thence along the Rampart Range road. The most productive gem pockets are south of Devils Head peak, at the top of a ridge below the highway. Nearby pegmatite deposits are on White Quartz Mountain, and in Long Hollow, 7 miles south of Devils Head.

Locality 2.—Perry Park. Perry Park, well known to collectors for its satin spar, much of which is cut into ornamental material, is 10 miles northwest of Palmer Lake. It can be reached easily from either Larkspur or Palmer Lake, and is about 1 mile west of the junction of the roads westward from these towns.

Locality 3.—Pine Creek pegmatite area. Albite, cassiterite, fluorite, microcline (amazonstone), and quartz (smoky).

Follow State Route 67 (Jarre Canyon road) 13 miles westward from Sedalia on U.S. Highway 85 to the Pine Creek store, thence down the Pine Creek road 2 miles, where a small adit and dump can be seen above the stream. Several outcrops can be found nearby, and some specimens may be found in soil.

EL PASO COUNTY

Locality 1.—Austin Bluffs. Agate, carnelian.

Austin Bluffs, in secs. 20, 21, 28, and 29, T. 13 S., R. 66 W., is known as a source of cherry-red carnelian and rich red and brown mottled agate. The most accessible collecting locality is along the southwest side of the bluffs, 4 miles north of the center of Colorado Springs and 1 mile east of U.S. Highway 85–87.

Locality 2.—Crystal Park area. Amazonstone, bastnaesite, fluocerite (tysonite), phenakite, quartz (clear and smoky), topaz, and zircon.

Crystal Park, one of the oldest and best-known collecting localities for Pikes Peak minerals, is famous as a source of gem topaz and phenakite, amazonstone, smoky and clear quartz, zircon, columbite, and other minerals. The specimens occur in many small pegmatite bodies in granite.

Crystal Park is in sec. 18, T. 14 S., R. 67 W., 2 miles southwest of Manitou Springs. It is reached by a toll road that leaves U.S. Highway 24 at a point 2.1 miles west of 25th Street in Colorado Springs. Pegmatite bodies are present along the slopes of Cameron Cone from a point more than 1 mile northwest of Crystal Park southeastward as far as Bear Creek.

Locality 3.—Deadmans Canyon pegmatite. Fluorapatite, muscovite, triplite.

This pegmatite deposit is in sec. 9, T. 16 S., R. 67 W. It can be reached from Colorado Springs via State Route 115 to the mouth of Deadmans Canyon. The Johnny feldspar mine is on this or a nearby deposit.

Locality 4.—Garden of the Gods and vicinity. Celestite, gypsum, pickeringite, rhodochrosite, and strontianite.

This well-known scenic attraction is 4½ miles northwest of Colorado Springs and northeast of Manitou.

Locality 5.—St. Peters Dome. Amazonstone, arfvedsonite, astrophyllite, chlorite, columbite, cryolite, cyrtolite, elpasolite, fayalite, fluorite, gearksutite, kasolite, pachnolite, pyrochlore, prosopite, quartz (smoky and clear) ralstonite, riebeckite, rutile, thomsenolite, topaz, weberite, xenotime, and zircon.

St. Peters Dome is in sec. 17 (unsurveyed), T. 15 S., R. 67 W., 7½ miles airline southwest of Colorado Springs. It has long been known as a source of rare fluorine minerals, some of them new to science. The locality is easily reached from Colorado Springs via the Gold Camp road (State Route 336). More than 1,000 small pegmatitic deposits exist in and near the dome. Pearl (1958) gives explicit directions for finding some of those that have produced good specimens.

Locality 6.—Stove Mountain. Amazonstone, bastnaesite, fergusonite, fluocerite (tysonite), fluorite, genthelvite, lanthanite, phenakite, quartz (smoky), topaz, and zircon.

Stove Mountain, also called Cookstove Mountain, is in secs. 5 and 8, T. 15 S., R. 67 W. It is a little more than 1 mile northwest of St. Peters Dome and can be reached easily from Colorado Springs and Broadmoor via the Gold Camp road (State Route 336).

FREMONT COUNTY

Locality 1.—Cotopaxi mine area. Amphibole, chalcopyrite, gahnite, garnet, samarskite(?), sphalerite, and uraninite.

The old Cotopaxi copper mine, noted as a source of gahnite, is three-fourths mile northwest of Cotopaxi, which is on U.S. Highway 50, 25 miles east of Salida. Mine dumps along the gulch at the west edge of town, near the cemetery, are the best collecting places. The Cotopaxi feldspar mine, which contains uraninite, samarskite(?) and other minerals, is 4 miles north of Cotopaxi, in sec. 8, T. 48 N., R. 12 E.

Locality 2.—Curio Hill. Banded agate.

Curio Hill (Specimen Ridge), known as the source of some of the finest banded agate in Colorado, is a low limestone ridge 7 miles south of Canon City. The agate occurs in the limestone itself and in surface debris. The locality can be easily reached on State Route 143 from Canon City.

Locality 3.—Devils Hole pegmatite. Beryl, columbite-tantalite, microcline, muscovite, and quartz (rose).

One of the more productive beryl and columbite-tantalite deposits in Colorado, the Devils Hole pegmatite can be reached from U.S. Highway 50 by following a steep mine road 6.1 miles northward from Texas Creek.

Locality 4.—Eight Mile Park pegmatite district. Albite, beryl, beyerite, biotite, bismuth carbonate minerals, cerussite, chalcocite, chlorite, columbite-tantalite, fluorapatite, garnet (spessartite), lepidolite, monazite, montebrasite, muscovite, natromontebrasite, quartz (rose), triplite and tourmaline.

Eight Mile Park, 5 miles northwest of Canon City, also described as the Royal Gorge area, comprises an area of about 10 square miles in T. 18 S., R. 71 W. It is easily reached via U.S. Highway 50 and the Royal Gorge road from Canon City. The Mica Lode mine, which has produced much feldspar, mica, and beryl, is in NE¼SW¼ sec. 14, T. 18 S., R. 71 W. The Meyer's mine is just east of the Mica Lode mine and also in sec. 14. The School Section mine is in the southwestern part of Eight Mile Park, in sec. 16, T. 18 S., R. 71 W. Pearl (1958) gives detailed road logs to these and other pegmatite deposits.

Locality 5.—Garden Park. Agate, barite, celestite, goethite, millerite(?), and quartz geodes.

The Garden Park area, and the nearby badlands along Felch Creek, is well known as a source of silicified dinosaur bones, banded agate, and quartz or agate geodes. The area is about 8 miles north of Canon City. Follow the Shelf road up Fourmile Creek and northward from Canon City to the mouth of Felch Creek. Beds with dinosaur bones as well as nearby deposits of alabaster and satin spar, are just west of Fourmile Creek. The Felch Creek geode locality is about 1 mile east of this point.

Locality 6.—Grape Creek area. Corundum, dumortierite, garnet (almandite), and sillimanite.

The exact locations of these deposits are not known. The corundum-dumortierite-bearing pegmatite is on a ridge near Grape Creek, 7 miles southwest of Canon City; sillimanite is abundant in nearby rocks. The almandite garnet locality is described as on Grape Creek, 2 miles S. 75° W. of Canon City.

Locality 7.—Iron Mountain. Ilmenite, magnetite, olivine, and spinel.

The Iron Mountain deposit is on the north side of Pine Creek, a tributary of Grape Creek, 10½ miles southwest of Canon City and 15 miles north of Silver Cliff. Means of access are not known, but it probably can be reached from the Copper Gulch road between the Royal Gorge and Westcliffe.

Locality 8.—Micanite-Guffey area (Park County loc. 6). Columbite-tantalite, cordierite, euxenite, fluorapatite, kyanite, microcline, monazite, muscovite, scheelite, sillimanite, spinel, and vesuvianite.

The Micanite-Guffey area occupies parts of T. 15 S., Rs. 72 and 73 W. in Park County and T. 16 S., R. 73 W. in Fremont County. Most of the pegmatite deposits are along Mac Gulch, a tributary to Currant Creek. State Route 9 (the Guffey road) passes through most of the area. The Famous Lode mine is in sec. 18, T. 15 S., R. 72 W., 1.5 miles east of Guffey. The Copper King prospect is in sec. 21, T. 15 S., R. 73 W., on Thirty-one Mile Creek, 3 miles southwest of Guffey.

Locality 9.—Pine Creek area, Gem mine. Annabergite, chalcocite, niccolite, and silver.

The exact location of this old mine is not known. It is on or near Pine Creek, an eastward-flowing tributary of Grape Creek. It has also been described as in Grape Creek Canyon in Custer County but according to Cross (1884) this location is erroneous.

Locality 10.—Pine Ridge pegmatite. Fluorite, gadolinite.

The Pine Ridge pegmatite, principally of quartz, microcline, muscovite and bluish-green plagioclase, is in sec. 20, T. 49 N., R. 12 E. It is 7 miles north of

Cotopaxi and can be reached via a road up Red Gulch from that town. The Cotopaxi feldspar mine (Fremont County, loc. 1) is near the same road.

GILPIN COUNTY

Locality 1.—Evergreen mine. Augite, bornite, chalcopyrite, garnet, and wollastonite.

The Evergreen mine is in the valley of Pine Creek, one-half mile south of Apex. It is easily reached via the Apex road from Central City.

GRAND COUNTY

Locality 1.—Monarch Valley. Beryl, garnet, and tourmaline.

The Green Ridge pegmatite is described as being a few hundred feet north of the junction of Arapahoe Creek with the Colorado River. This locality is possibly now flooded by Lake Granby; other pegmatite bodies exist in the area, however.

GUNNISON COUNTY

Locality 1.—Comet prospect. Beryl, fluorapatite, and muscovite.

The Comet pegmatite prospect is in sec. 19, T. 12 S., R. 83 W., 34 miles north-northeast of Gunnison. It is on the Old Taylor Pass road northwest of Taylor Park.

Locality 2.—Iron Hill (Powderhorn) district. Aegirite, amphibole (vars. soda-tremolite and glaucophane), bastnaesite, brugnatellite, calcite, cancrinite, cebollite, cerite(?), diopside, dolomite, fluorite, ("gunnisonite"), garnet, hastingsite, juanite, melilite, monticellite, natrolite, nephilite, olivine, perovskite, pyrochlore, spinel, synchisite, thorite, thorogummite(?), titaniferous vesuvianite, wollastonite, and xenotime(?).

A remarkable complex of alkalic igneous rocks and carbonate bodies, about 12 square miles in area, the Iron Hill district has produced a large number of minerals, several of them new. Thorite and other rare-earth minerals are also widespread in veins in and near the alkalic complex. The Iron Hill complex, chiefly in T. 46 N., R. 2 W., is on Beaver Creek, a tributary to Cebolla Creek. It is 3 miles southeast of Powderhorn, which is 20 miles south of Iola, on U.S. Highway 50, and can be reached via State Route 149.

Locality 3.—Italian Mountain. Adularia, albite, ankerite, anorthite, chabazite, chlorite, diopside, epidote, fluorapatite, garnet, graphite, heulandite, lazurite, magnetite, mizzonite, sahlite, scolecite, stilbite, talc, thomsonite, titanite, vesuvianite, and wollastonite(?).

The Italian Mountain locality is one of the richest and least known places in the State for contact-metamorphic minerals. It can be reached from Gunnison via State Route 135 (the Gothic road) 19 miles to the mouth of Cement Creek, thence 12 miles up Cement Creek on a poor secondary road.

The Italian Mountains are about 1 miles northeast of (and 2,000 feet above) the end of the road. The metamorphic minerals are abundant in a tactite zone around two bodies of intrusive quartz monzonite, particularly in the wedge between the bodies.

Locality 4.—Quartz Creek (Ohio City) district. Albite (var. cleavelandite), allanite, amblygonite, beryl, betafite, columbite-tantalite, cookeite, gahnite, lepidolite, lithiophyllite-triphylite, microlite, monazite, muscovite, prochlorite, pyrochlore, samarskite, topaz, and tourmaline.

This district contains scores of pegmatite bodies, many of them rich in lepidolite, topaz, beryl and other minerals. It is in T. 49 and 50 N., R. 3 E. The deposits are along Quartz Creek and can be reached from Parlin, on U.S. Highway 50, via State Route 162 toward Ohio City. A fee is charged by owners of some of the best collecting localities.

Locality 5.—Vulcan district, Good Hope mine. Berthierite, coloradoite, copper, opal, petzite, pyrite, rickardite, roscoelite, selenium, sulfur, sylvanite, tellurite, tellurium, tetradymite(?), and weissite.

The Good Hope mine, type locality of rickardite and weissite, is at Vulcan, a ghost town not shown on most modern maps. Considered by some as part of the Cebolla mining district, it is in sec. 7, T. 47 N., R. 1 W., 10 miles southeast of Iola. A county road that branches from State Route 149 about 4 miles south of Iola leads to the town.

JACKSON COUNTY

Locality 1.—Northgate district. Fluorite and ilsemannite.

The highly productive Northgate fluorspar district is about 4 miles northwest of Northgate, not far from State Route 127.

JEFFERSON COUNTY

Locality 1.—Augusta mine. Chalcocite, fluorite, sphalerite, and willemite.

The Augusta mine is on Cub Creek, one-half mile south of the town of Evergreen.

Locality 2.—Bergen Park area, Creswell mine. Actinolite, allophane, beryl, fluorapatite, gahnite, galena, stilbite, and titanite.

Bergen Park is a well-known picnic ground just south of U.S. Highway 40 and 7 miles (airline) southwest of Golden. The Creswell mine, which contains gahnite and other minerals, is one-fourth mile west of Bergen Park in the NW¼ sec. 20, T. 4 S., R. 71 W. It is on a county road that leads toward Idaho Springs. A small shaft and several dumps can be seen on the north side of the road. One of the several other beryl-bearing pegmatite bodies that are known in the Bergen Park area is 3 miles northwest of the park on U.S. Highway 40.

Locality 3.—Bigger pegmatite mine. Bertrandite, beryl, bismuthinite, bismutite, columbite, feldspar, monazite, muscovite, and zircon.

The Bigger mine is in sec. 3, T. 6 S., R. 70 W., on the low divide between South Turkey and Deer Creeks. Follow U.S. Highway 85 southwestward from Morrison to the old Turkey Creek (Tinytown) road (State Route 8), then turn southeastward on State Route 124 toward Deer Creek. Continue on 124 for 0.7 mile where a private road turns off to the right (southwest) to the nearby mine.

Locality 4.—Burroughs mine. Allanite, beryl, bismuthinite, bismutite, columbite-tantalite, euxenite, garnet, monazite, triphylite, and xenotime.

The Burroughs feldspar mine is in the NE¼ sec. 27, T. 4 S., R. 71 W. It is in Kerr Gulch, between the Bergen Park road (State Route 68) and the Bear Creek Canyon road (State Route 74). At a point on the Kerr Gulch road 2.1 miles south of State Route 68, walk up the hill (east) to a large opencut in a pegmatite dike.

Locality 5.—Centennial Cone pegmatite. Bertrandite, beryl (aquamarine), monazite, quartz (smoky), and samarskite(?).

The deposit is in or near sec. 32, T. 3 S., R. 71 W. Centennial Cone is a prominent hill on ranch land owned (1951) by Frank Termantozzi of Golden. The locality is 15 miles west of Golden; see the owner for directions and permission. The pegmatite is on the northeast flank of the cone, in sec. 32, T. 3 S., R. 71 W., about one-fourth mile up the hill from an old log barn.

Locality 6.—Cressman Gulch pegmatite. Beryl, columbite, and fluorapatite.

This prospect is in secs. 17 and 18, T. 3 S., R. 70 W. It is in Cressman Gulch, the first gulch north of Golden Gate Canyon. From the brickyards north of Golden follow an unimproved road northward to a point opposite the mouth of the gulch, thence follow an old road, on foot, 0.8 mile westward up the gulch to the pegmatite outcrop.

Locality 7.—Critchell area, Black Knight vein. Autunite, becquerelite, fourmarierite, pitchblende, uranophane.

Several pegmatitic dikes and veins, some of them with rare-earth minerals, are in the general vicinity of Critchell. This is on the Phillipsburg-Deermont-Conifer county road, about 5 miles east of Conifer and U.S. Highway 285. The Critchell mine, which explores a pegmatite dike, is one-fourth mile northeast of Critchell, on the north side of the road to Deer Creek. The Black Knight and several other vein deposits are 2 miles south-southwest of Critchell.

Locality 8.—Drew Hill pegmatite. Beryl, chrysoberyl, corundum, fluorapatite, tourmaline, rutile.

The Drew Hill prospect is in or near sec. 34, T. 2 S., R. 71 W., about 10 miles northwest of Golden. Follow the Golden Gate Canyon road from Golden to the Crawford Gulch road. Follow this road northward about 6 miles where the Drew Hill pegmatite appears on the north side of the road. This pegmatite has been visited by many collectors, and chrysoberyl is difficult or impossible to find. There are, however, several other pegmatite bodies in other parts of the hill, that have also yielded specimens.

Locality 9.—F.M.D. and Malachite mines. Amphibole, chalcopyrite, pyrite, pyrrhotite, sphalerite.

The F.M.D. mine is on the line between secs. 24 and 25, T. 4 S., R. 71 W. From a point on State Route 74 about 1½ miles west of Idledale, follow a secondary road northwestward about one-half mile up Cold Spring Gulch, thence turn north and continue about 1 mile up a tributary stream. The Malachite mine is southeast of the F.M.D., in NE¼ sec. 30, T. 4 S., R. 70 W. It is one-half mile north of State Route 74, opposite a point about 1 mile west of Idledale.

Locality 10.—Genessee Mountain deposit. Allanite, epidote, garnet, grossularite, scheelite, titanite, vesuvianite.

The Genessee Mountain deposit is on U.S. Highway 40, one-half mile west of its intersection with the Lookout Mountain road. A deep road cut exposes a large pink granite pegmatite. Calcium-silicate rock, containing the above minerals, is exposed on the north side of the highway.

Locality 11.—Guy Hill (Ramstetter Ranch) pegmatite area. Beryl, bismuthinite, bismutite, chrysoberyl, garnet, sillimanite, topaz, tourmaline, zircon.

The Guy Hill, or Ramstetter Ranch, prospect is in or near sec. 15, T. 3 S., R. 71 W. Follow the Golden Gate Canyon road 7 miles westward from Golden to the foot of Guy Hill where the hairpin curves start. Leave the highway and follow an unimproved road northward about 850 feet where a prospect pit in pegmatite is on the west side of the road.

A second chrysoberyl-bearing pegmatite outcrops along the Golden Gate Canyon road about one-fourth mile east of the better known Guy Hill deposit just described.

Locality 12.—Leyden mine. Carnotite and coffinite with coal.

The old Leyden coal mine is on the Leyden road, 8 miles north of Golden and one-fourth mile east of the road to Boulder.

Locality 13.—Robinson Gulch pegmatite. Chrysoberyl, tourmaline.

The Robinson Gulch prospect is in sec. 16, T. 3 S., R. 71 W. Follow the Golden Gate Canyon road from Golden 11 miles to Guy Gulch on the west side of Guy Hill. Turn south on the Robinson Gulch road; the pegmatite is exposed at the edge of the road just south of a bridge over Guy Gulch.

Locality 14.—Roscoe pegmatite. Beryl, fergusonite, gadolinite, molybdenite, monazite, tengerite(?), uraninite, xenotime, yttrotantalite.

The Roscoe dike is in sec. 5, T. 4 S., R. 71 W. It is exposed by a road cut on the Clear Creek Canyon highway (U.S. Highway 6), 3 miles east of the fork between U.S. Highway 6 and the Black Hawk road (State Route 119). Much of the deposit has been removed by excavation for the highway but several smaller dikes crop out on the hill above the road cuts.

Locality 15.—Schwartzwalder mine. Autunite, johannite, metatorbernite, pitchblende, pyrrhotite, torbernite.

The Schwartzwalder mine is in the SE¼ sec. 25, T. 2 S., R. 71 W., close to Ralston Creek and just west of Ralston Buttes. In 1959 neither the mine nor the immediate vicinity were open to visitors.

Locality 16.—South Platte area. Allanite, cookeite(?) cyrtolite, doverite(?), fergusonite, fluorapatite, gadolinite, monazite, pitchblende, sphene, thorite, xenotime, yttrian fluorite, yttrotantalite.

In the area between the towns of Buffalo Creek and South Platte, near the highway to Deckers, there are several pegmatitic deposits, some of them characterized by rare-earth minerals. One unnamed cyrtolite-bearing deposit is in SE¼NE¼ sec. 33, T. 7 S., R. 70 W. Among others are the Big Bertha and the White Cloud mines.

Locality 17.—Swede Gulch pegmatite. Allanite, beryl, cyrtolite, microlite, topaz.

Follow the Swede Gulch road 1½ miles north from Kittredge, which is on the Bear Creek Canyon road (State Route 74). At this point a secondary road turns westward one-half mile to the mine.

Locality 18.—Table Mountains. Analcite, apophyllite, aragonite, calcite, chabazite, chevkinite, halloysite, laumontite, levynite, mesolite, mordenite (ptilolite), natrolite, petrified palm wood, scolecite, stilbite, thomsonite, wavellite(?).

Both North and South Table Mountains, just east of Golden, have long been famous as sources of zeolites, which occur as cavity filling in the lava flows. Most good specimens have come from North Table Mountain. Some specimens can be found in the flows themselves and even in blocks of rubble along the slopes, but fine specimens can usually be found only by blasting or by searching fresh quarry faces.

Locality 19.—Van Bibber Creek pegmatite. Beryl.

This beryl-bearing pegmatite body is in Van Bibber Creek (also called Dry Creek on some maps), about 6 miles northwest of Golden. From the brickyards north of Golden follow an unimproved road northward along the west side of hogback to near the mouth of a gulch. About one-half mile up the gulch, the pegmatite crops out at a sharp turn in the streambed.

LAKE COUNTY

Locality 1.—Alicante district, John Reed mine. Pyrite, rhodochrosite.

The old Alicante district is 10 to 12 miles northeast of Leadville, a little south of Climax, and east of State Route 91. The John Reed mine, famous as a source of beautiful rhodochrosite, has been long abandoned, but a little material has recently been found on the dump.

Locality 2.—Chalk Mountain. Quartz (smoky), sanidine, topaz.

Chalk Mountain, close to the common corner of Lake, Eagle, and Summit Counties, is just west of Fremont Pass on State Route 91; its 12,000-foot summit can be reached in a 1-hour walk from the highway. The north slope is the easiest to ascend.

LARIMER COUNTY

Locality 1.—Crystal Mountain district. Autunite, bertrandite, beryl, bismuthinite, bismutite, columbite-tantalite, fluorapatite, "gummite," lithiophilite-triphylite, muscovite, spodumene, triplite, torbernite, uraninite.

The Crystal Mountain pegmatite district, about 6 square miles in area, is in T. 7 N., R. 71 and 72 W., 18 miles airline and 45 miles by road west of Fort Collins. The deposits are south and east of Crystal Mountain, a prominent landmark. The district can be reached from Fort Collins by the Buckhorn Creek road from Masonville and a ranch road through the Turner and Reynolds Ranches.

Locality 2.—Hyatt beryl mine. Beryl, bismuthinite, "gummite," lithiophilite-triphylite, muscovite, purpurite, uraninite.

The Hyatt mine is in NE¼NW¼ sec. 28, T. 6 N., R. 71 W. It is about 1 mile north of the North Fork Big Thompson River. It can be reached from Drake, on U.S. Highway 34 via a narrow mountain road through the Hyatt Ranch to the mine workings, 1.5 miles map distance north-northwest of Drake.

Locality 3.—Prairie Divide district, Copper King mine. Amphibole (vars. actinolite, anthophyllite, and cummingtonite), coffinite, monazite, phlogopite, pitchblende.

The Copper King mine is near the southwestern edge of Prairie Divide, in sec. 8, T. 10 N., R. 72 W. From Fort Collins follow U.S. Highway 287 for 23.3 miles. Turn west on a gravel road for 12.4 miles to the road fork. Thence take a sharp left (southwestward) turn on the road to Red Feather Lakes and proceed 5.3 miles to the Copper King mine. The monazite listed is not at the Copper King mine; it is in several pegmatite bodies in the general vicinity of the mine.

Locality 4.—Red Feather Lakes. Amethyst.

The Red Feather Lakes deposit, discovered by Major R. G. Coffin, is a source of fine amethyst quartz crystals, some of gem quality. It is about 5 miles west of the small town of Red Feather Lakes and can be approached from Fort Collins via U.S. Highway 287 and State Route 200. Inquiries should be made at Red Feather Lakes, which can also be reached via the route to the Copper King mine on Prairie Divide (Larimer County, loc. 3).

Locality 5.—Specimen Mountain. Agate, allophane, chalcedony, nontronite, onyx, opal, sanidine, tridymite, topaz.

Specimen Mountain, best known for its opal, agate and onyx, is on the Continental Divide, in the northwest corner of Rocky Mountain National Park. Follow the Trail Ridge road (U.S. Highway 34) 31 miles westward from Estes Park to Milner Pass, thence follow a marked trail northward 1½ miles to Specimen Mountain. Note.—collecting is not permitted within the National Park.

Locality 6.—Wisdom Ranch pegmatite. Beryl, chrysoberyl, garnet.

This prospect, not far from the Crystal Mountain district, is in the S½ sec. 5, T. 7 N., R. 71 W., 15.5 miles airline and 29 miles by road west of Fort Collins. It can be reached from Bellvue, northwest of Fort Collins by a 15-mile dirt road.

MESA COUNTY

Locality 1.—Opal Hill. Opalized wood.

Opal Hill, a source of opalized wood suitable for cutting, is just west of the Fruita golf course, 2 miles south of Fruita and one-fourth mile west of the road to Colorado National Monument.

Locality 2.—Pinon Mesa. Agate, petrified wood.

Pinon Mesa, a source of superb banded and moss agate, chalcedony, and petrified wood, is on the south side of the Colorado River and extends westward into Utah. Among many collecting localities is one 3½ miles south of Glade Park.

MINERAL COUNTY

Locality 1.—Wagon Wheel Gap. Barite, beidellite, carnelian agate, creedite, fluorite, gearksutite, halloysite.

This fluorspar mine is 1.7 miles by road south of the town of Wagon Wheel Gap, on State Route 149. The mine may be inaccessible, but barite crystals abound on the surface and other minerals may be found on the dumps.

MOFFAT COUNTY

Locality 1.—Breeze Mountain. Analcite, olivine, stilbite.

Breeze Mountain is about 4½ miles southeast of Craig and south of State Route 394.

Locality 2.—Fortification dike. Analcite, thomsonite.

This dike is on Fortification Creek, 18 miles north of Craig, near State Route 789.

MONTROSE COUNTY

Locality 1.—Cashin mine. Amalgam, bornite, chalcocite, covellite, cuprite, native copper and silver, domeykite, luzonite, uraninite.

The Cashin mine is 4 miles above the mouth of La Sal Creek, a tributary of Gypsum Creek, and about the same distance south of Paradox.

PARK COUNTY

Locality 1.—Alma district, Sweet Home mine. Fluorite, huebnerite, rhodochrosite.

The old Sweet Home mine is 3 miles northwest of Alma, on the slope of Mount Bross and on the north side of Buckskin Gulch. Cleavage pieces of bright-red rhodochrosite are reportedly abundant on the dump of this and several nearby mines, but crystals are rare.

Locality 2.—Badger Flats (Lake George) area. Bertrandite, beryl, cassiterite, topaz, wolframite.

The Boomer mine is in sec. 21, T. 11 S., R. 72 W. Other principal mines and prospects in the Badger Flats area are in this and the adjoining section 22 to the east. Follow U.S. Highway 24 westward about 7 miles from Lake George. Turn north near Round Mountain on a county road that leads toward Tarryall. At about 2½ miles, just past the Badger Flats airstrip turn eastward about 1½ miles on the mine road.

Locality 3.—Garo. Calciovolborthite, carnotite.

These small uranium deposits are one-half mile south of Garo, which is 9 miles southeast of Fairplay on State Route 9.

Locality 4.—Hartsel area. Barite.

The Hartsel barite mine, known for its beautiful blue crystals, is 2 miles south of Hartsel in sec. 18, T. 12 S., R. 75 W. and just south of U.S. Highway

24. Another locality is described as 4 miles southwest of Hartsel, but this may represent the same deposit. Several agate and chalcedony localities are known in the general vicinity of Hartsel. One of these is along U.S. Highway 24 just west of Hartsel. Others are on the so-called Agate plateau between Hartsel and Guffey along State Route 9, and on Thirty-one Mile Mountain, about 8 miles west of Guffey.

Locality 5.—Meyers Ranch pegmatite mine. Beryl, beyerite, bismutite, columbite.

The Meyers Ranch pegmatite mine, which could be considered a northwestward extension of the Micanite-Guffey area, is in sec. 31, T. 14 S., R. 73 W. It is about 5 miles northwest of Guffey and near State Route 9.

Locality 6.—Micanite-Guffey area. See Fremont County locality 8, Micanite-Guffey area.

Locality 7.—South Park analcite basalt. Analcite, natrolite, stilbite, thomsonite.

Analcite diabase and analcite syenite outcrop as low ridges on the floor of South Park in secs. 20, 21, T. 11 S., R. 75 W., 3 miles north of Hartsel and 6 miles southeast of Garo. One large sill, several minor ones, and a small dike are exposed.

Locality 8.—South Park salt works. Anhydrite, carnallite, chalcedony, halite, moss agate.

The site of the old salt works, long abandoned, is 1 mile northeast of Antero Junction, at the intersection of U.S. Highway 24 and U.S. 285. An unimproved road leads northward from U.S. Highway 24 just east of Antero Junction. In addition to halite, many forms of agate and chalcedony can be found near the salt works, along Agate Creek to the east and in other parts of the area between Hartsel and Antero Junction.

Locality 9.—Teller pegmatite. Allanite, bastnaesite(?), gadolinite, molybdenite, monazite, xenotime, yttrian fluorite.

The Teller pegmatite is in the NE¼ sec. 31, T. 12 S., R. 71 W., one-half mile south of Lake George on the county road to Eleven Mile Canyon Reservoir. The rare-earth minerals occur in association with varicolored fluorite in the northern part of a microcline pegmatite.

Locality 10.—Unnamed epidote locality, Elk Creek region. Epidote, garnet, hematite.

The exact locality is not known. It is in the Elk Creek drainage basin in northeastern Park County, at an estimated altitude of 10,500 feet. The Pegmatite Points are north of the deposit and Bandit Peak is to the west. Apparently the epidote is in schist near its contact with Pikes Peak granite.

RIO GRANDE COUNTY

Locality 1.—Del Norte area. Plum agate, varicolored chalcedony and opal.

The Old Woman Creek area, noted for different kinds of agates, is 10 miles northwest of Del Norte, at the base of the Twin Mountains.

ROUTT COUNTY

Locality 1.—Fish Creek district. Autunite, uranophane.

The small Fish Creek district is in sec. 12, T. 6 N., R. 84 W., about 5 miles east of Steamboat Springs.

SAGUACHE COUNTY

Locality 1.—Hall turquois mine. Hematite, pyrite, turquois.

The Hall mine, one of the three Colorado mines that have produced turquois, is in T. 47 N., R. 8 E., 8 miles northwest of Villa Grove and 5 miles east of Bonanza.

Follow U.S. Highway 285 northwestward 2.7 miles from Villa Grove. Turn west on a secondary road 2.7 miles to the boundary of the Cochetopa National Forest and continue 1.8 miles to two cabins that are one-fourth mile below the turquois mine.

Locality 2.—Los Ochos mine. Autunite, johannite, torbernite, uraninite, uranophane.

The Los Ochos mine is south of the old Cochetopa mining district, in sec. 4, T. 47 N., R. 2 E. Follow State Route 114 southward from its junction with U.S. Highway 50 west of Parlin for 12 miles, thence turn east 2 miles to the mine.

SAN JUAN COUNTY

Locality 1.—Silverton district, Sunnyside mine. Alabandite, alleghanyite, common sulfides, friedelite, helvite, rhodochrosite, rhodonite, tephroite.

The Sunnyside mine is 3 miles northwest of Eureka and 7 miles north-northeast of Silverton, at altitudes of 11,000 to 13,000 feet. The best reported collecting, however, is from waste piles near the Sunnyside mill at Eureka, 9 miles northeast of Silverton on State Route 110.

TELLER COUNTY

Locality 1.—Black Cloud pegmatite. Bastnaesite, fluocerite (tysonite).

The Black Cloud pegmatite mine is on the line between secs. 9 and 10, T. 13 S., R. 70 W. It is about 600 feet north of U.S. Highway 24 between Florissant and Divide about 3 miles west of Divide and about 5 miles east of Florissant.

Locality 2.—Crystal Peak (Florissant, Topaz Butte). Albite, amazonstone, cassiterite, goethite, phenakite, quartz (smoky and amethyst), topaz.

These deposits, worked intermittently since 1865, were the source of much of the "Pikes Peak" amazonstone, topaz, and other minerals in collections throughout the world. Known also as Topaz Butte, "Florissant," and other names, the productive area is a rectangle of about 3 square miles centering on Crystal Peak and about 4 miles north of Florissant. The original diggings are open to collectors for a fee, and there is still much other good collecting ground. The deposits can be reached from Florissant which is on U.S. Highway 24 by driving northward about 5 miles on State Route 143, thence westward 1 mile toward Lake George on the Lake George-Westcreek road.

WELD COUNTY

Locality 1.—"Sterling area." Barite.

The "Sterling" barite locality, not shown on plate 1, is actually 26 miles west of Sterling. It is 5 miles northeast of Stoneham, Weld County, which is on State Route 14. The clear-blue crystals of barite are said to be among the finest in the United States.

AVAILABLE MAPS AND REPORTS

The serious mineral collector will learn to plan his collecting trips far ahead, and to learn all he can from the literature as to the geologic settings and accessibility of the deposits he hopes to find. In seeking the deposits, or even their general vicinity, the collector should learn to depend on maps. In addition to plate 1 of this report, the following kinds of maps will be found helpful:

1. Road maps which are distributed free by most filling stations. Known and used by everyone, these maps show the locations of cities and towns, numbered Federal and State highways and some county and secondary roads. They are of most use in helping the collector get to the general vicinity of a deposit.
2. Topographic quadrangle maps, published by the U.S. Geological Survey. These maps, commonly on scales of 1:62,500 (about 1 inch=1 mile) or 1:24,000 (1 inch=2,000 feet), show the shape of the land in great detail as well as roads, trails, mines, and many other features. They are indispensable for serious collecting trips. A folder that describes topographic maps and symbols, and an index map of Colorado that shows the areas covered by standard quadrangle maps as well as many maps of special areas can be obtained free on application to the U.S. Geological Survey, Federal Center, Denver, Colo.
3. Maps of most national forests, most of them without topographic contours but showing roads, trails, campgrounds and other features in detail, are available from local foresters' headquarters or from the U.S. Forest Service in either Washington, 25, D.C., or Federal Center, Denver, Colo.
4. Map showing metallic mineral deposits of Colorado, prepared by R. P. Fischer and others, 1946, reprinted 1956: U.S. Geol. Survey Missouri Basin Studies No. 8. On a scale of 1:1,000,000 (about 1 inch=16 miles), this map shows all mining districts, and many individual mines, with generalized indications of the value and kind of metals produced. A reprint, on a slightly smaller scale, is included in the report by Vanderwilt and others (1947), described below. Much of the information on the map is also shown on plate 1 in this report.
5. Map showing construction materials and nonmetallic mineral resources of Colorado, prepared by D. M. Larrabee and others, 1947: U.S. Geol. Survey Missouri Basin Studies No. 10. On a scale of 1:500,000 (about 1 inch=8 miles), this map shows in colors the distribution of limestone, dolomite, gypsum and other rocks that have actual or potential use in industry. It also shows locations of hundreds of mines and quarries and occurrences of many nonmetallic minerals, such as barite, fluorite, and the pegmatite minerals. A reprint of this map is included in the report by G. O. Argall, Jr. (1949), listed below.
6. Preliminary geologic map showing the distribution of uranium deposits and principal ore-bearing formations of the Colorado

Plateau region, by W. I. Finch, 1955: U.S. Geol. Survey MF 16. On a scale of 1:500,000, this map shows the locations of hundreds of uranium prospects and mines in western Colorado. Some of the information shown is incorporated on plate 1 of this report.

7. Map showing uranium deposits and principal ore-bearing formations of the central Cordilleran foreland region, by T. L. Finnell and L. S. Parrish, 1958: U.S. Geol. Survey MF 120. On a scale of 1:750,000 (about 1 inch=12 miles), this map shows locations of many uranium deposits and mines in Colorado and several neighboring States. Some of its information is shown on plate 1 of this report.

All the maps noted above as published by the U.S. Geological Survey can be purchased by mail from that organization at the Federal Center, Denver, Colo., or over the counter from that office, or from the Survey's Public Inquiries Office, New Customs Building, Denver, Colo.

The maps listed above are most useful for planning purposes. In addition, nearly all the source books and articles listed in the bibliography contain maps or descriptions of exact locations and means of access to the mineral deposits or occurrences described in them. Among the hundreds of such references, a few books are particularly useful in providing background information of the kind needed by collectors. Among these are the following:

"Mineral Resources of Colorado" (Vanderwilt and others, 1947).

This book contains a useful summary of the geology of Colorado, as well as facts on location, history, and production of each important mining district.

"Colorado Gem Trails and Mineral Guide" (Pearl, 1958).

Aimed primarily at the amateur mineralogist, Pearl's book provides delightful descriptions of many of the best-known mineral localities, with detailed directions for finding them. Many localities for the quartz family of minerals that appear in Pearl's book are not repeated in this report.

"Pegmatite Investigations in Colorado, Wyoming, and Utah" (Hanley and others, 1950).

This report contains fine technical descriptions of all the more important pegmatite deposits, with many useful references to the literature, detailed maps of many deposits, means of access, and a spot map (scale 1:500,000) showing virtually all important pegmatites.

"Occurrence of Nonpegmatite Beryllium in the United States" (Warner and others, 1959).

The contents of this report are explained by its title, but it is of special interest to collectors because it contains brief but usable descriptions of nearly all the contact-metamorphic deposits in Colorado. Many of these deposits, also called lime or calcium silicate, skarn, tactite, and other names, are rich sources of rare and unusual minerals.

"Geology and Ore Deposits of the Front Range, Colorado" (Lovering and Goddard, 1950).

This report is a thorough scientific summary of the ore deposits and general geology of the Front Range, but it contains an abundance of useful background information on an area that is likely to be visited by more collectors than any other part of the State.

"Contributions to the Geology of Uranium and Thorium by the U.S. Geological Survey and the Atomic Energy Commission for the United Nations International Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland, 1955" (Page and others, 1956).

Although only one among hundreds of available books and reports on the geology and mineralogy of radioactive raw materials, this report contains information on many Colorado deposits that are not described elsewhere or whose descriptions are scattered through a variety of publications.

Mining districts have undergone many changes of name and boundaries through the years. In general, the usage in this report follows that of the authors quoted, or relies on easily understood generalizations in reference to well-known geographical centers. Thus terms like Central City, Georgetown, Idaho Springs, Ouray and Telluride districts are used in place of the multiplicity of local names of mining districts.

DESCRIPTIONS OF MINERAL OCCURRENCES

The occurrences of all the natural inorganic minerals that are known in the State are listed in the following pages. Organic compounds, and the minerals and metals of the many meteorite falls that have been recorded, are arbitrarily excluded.

The essential minerals, and most of the accessory ones, in igneous, metamorphic, and sedimentary rocks are listed, and a few exemplary occurrences are noted for most of them, but no attempt is made to catalog all the occurrences of such rock-forming minerals. Even if such treatment were feasible, it would require a mass of petrologic and petrographic descriptions out of all proportion to their possible interest or use to the mineralogist or mineral collector.

For each species, the commonly accepted chemical composition is given beneath the species name. The crystallographic, optical and other physical properties of minerals are not listed, because the professional and the advanced amateur will know more facts than space permits here. Others need more information than can be given, and are referred to the standard texts and reference works for complete descriptions of the minerals and for the means of identification.

Excluding the scores of varietal names (distinct from real varieties), as well as names of mineral groups, the descriptions include the following classes of minerals:

Class	*Number described*
Type species	42
Other species	403
Total valid species known in Colorado	445
Subspecies	21
Named varieties	96
Discredited "type" species	20
Total	582

Except for very recently described minerals, which are taken directly from the original literature, the nomenclature, classification, and preferred chemical formulas as used here are taken from Palache and others (1944—elements, sulfides, sulphosalts, and oxides; 1951—halides, nitrates, borates, carbonates, sulfates, phosphates, arsenates, tungstates, molybdates, etcetera); and Ford (1932), used for silicates only).

All minerals are listed alphabetically. Accepted type minerals—those first found in Colorado—are indicated by a dagger (†) next to the name. Discredited species names are indicated by an asterisk (*). Many names other than accepted species are also included alphabetically, but except for a few that require some general discussion, or that are more conveniently treated as groups, the reader is referred directly to descriptions under a species name.

Insofar as possible, the descriptions of occurrences are mere abstracts of descriptions by the cited authors, without interpretation or extrapolation by me. To avoid errors in "translation," most measurements are given as originally reported. Similarly, many names of mines, mining districts, and other places, as well as the names of some geologic formations, are given as used by original authors.

The descriptions of most species begin with a brief general statement as to their distribution, mode of occurrence, and importance. Except for unique occurrences, and for most of the uranium and vanadium minerals, these general statements are followed by brief descriptions of the principal known occurrences. These are arranged by counties, listed alphabetically, then by districts, mines, or other localities. If a locality and the means of access to it are listed in the section on mineral localities and shown on plate 1, the reference number is shown after the locality name, thus *Douglas County.*—Devils Head (loc. 1).

ACANTHITE

Ag_2S

[*See also* Argentite]

Acanthite, the orthorhombic(?) form of silver sulfide, was reported from several districts late in the 19th century. Inasmuch as all argentite is believed to form by inversion of acanthite, and as the crystals of the two minerals are closely similar, all distinctions between acanthite and argentite are tenuous.

Clear Creek County.—Silver Plume district, Pelican Dives mine. Parallel-acicular, greenish-gray crystals of acanthite coat crystals of argentite and are themselves coated with pyrite crystals (Draper, 1897).[1]

Georgetown district, Little Emma mine. Acanthite occurs sparingly, in crystals ¼ to ¾ inch long (Randall).

Dolores County.—Rico district, Enterprise mine. Acanthite is iron black with brilliant metallic luster and less sectile than argentite. The crystals (6 by 0.5 mm) have a decidedly orthorhombic appearance and are acutely terminated. All are deeply striated, and some of the better ones show striations on the basal pinacoid. Associated with the acanthite are rounded "nuggets" of silver sulfide which Chester (1894) believes to be massive acanthite, rather than argentite. Stephanite, polybasite, tetrahedrite, pyargyrite, and the common sulfides are associated, all set in bright-pink rhodochrodite (Chester, 1894).

Summit County.—Argentine district, Double Header lode. Acanthite is reported (Randall).

ACMITE (AEGIRITE)

[*See* Pyroxene group]

ACTINOLITE

[*See* Amphibole group]

ADULARIA

[*See* Feldspar group, orthoclase species]

AEGIRINE

[*See* Pyroxene group, acmite species]

AEGIRITE

[*See* Pyroxene group, acmite species]

AGATE

[*See* Quartz]

[1] Draper, M.D., 1897, Minerals of Clear Creek County: Unpub. thesis, Colorado School Mines, Golden, Colo.

AGUILARITE

Ag_4SeS

Hinsdale County.—White Cross district, Golden Fleece mine. Aguilarite is intergrown with krennerite in specimens of ore from this mine. It is possibly slightly later than the krennerite. (W. H. Brown, 1926.)

AIKINITE

$PbCuBiS_3$

[*See also* Alaskaite]

Aikinite has been reported from several widely scattered mining districts in the State. As with all other bismuth sulfosalts, identifications based on chemical analyses alone, particularly the older ones, are tenuous. As noted under alaskaite, some of the material attributed to that mineral may be aikinite and matildite.

Clear Creek County.—Lawson district, Little Giant mine. Small acicular crystals with a golden tarnish were found in ore from this mine. They are doubtfully ascribed to aikinite (Randall).

Hinsdale County.—Lake City district, Gladiator mine. Aikinite containing 5 percent silver was reported from this mine (Randall).

Lake County.—Leadville district, Greenback mine. Aikinite containing blebs of native silver was identified in a polished section of ore from this mine. It was associated with chalcopyrite of the last, or bismuth, stage of mineralization. (Chapman and Stevens, 1933; Chapman, 1941.)

La Plata and Montezuma Counties.—La Plata district. Aikinite is reported to occur in moderate quantities as an ore of lead and bismuth (George, 1913; Schrader, Stone, and Sanford, 1916). The only positive identification known is that of Galbraith (1949) who found that a mineral from the Comstock mine, formerly thought to be cosalite, was actually aikinite.

Ouray County.—Red Mountain district, Dunmore mine. Silver-bearing aikinite has been identified in ore from this mine, 4 miles south of Ouray. It is one of the ore minerals in a shoot of copper ore in a hematite chimney. Associated minerals are chalcopyrite, barite, rhodochrosite, and some chlorite. (Kelley, 1945; Kelley and Silver, 1946.)

San Juan County.—Silverton district. Beautiful acicular crystals of aikinite are reported from many mines (Randall).

ALABANDITE

MnS

Boulder County.—Nederland district, Forest Home mine. Alabandite occurs as a thin powdery coating on crystals of ferberite in this mine. (Lovering and Tweto, 1953.)

Mineral County.—Creede district. Although not positively identified, the presence of alabandite in ores from this district is suspected, because the ores give off hydrogen sulfide when treated with hydrochloric acid. Only alabandite, pyrrhotite, and some sphalerite are known to produce hydrogen sulfide; there is no pyrrhotite in these ores and the little sphalerite present does not generate hydrogen sulfide. (W. H. Emmons and Larsen, 1923.)

Park County.—Quartzville district. Alabandite was reported by Endlich (1874) and by J. A. Smith (1883); neither report has been confirmed since.

Alma district. Rare granular masses of alabandite are mentioned by G. M. Butler (1912).

San Juan County.—Silverton district, Sunnyside mine (loc. 1). In ore from this mine, 7 miles north-northeast of Silverton, alabandite is widely distributed as minute grains and veinlets, mostly microscopic, through friedelite, alleghanyite, and rhodonite. (Burbank, 1933).

Summit County.—Montezuma district, Queen of the West mine. At the head of Peru Creek, just north-northwest of Argentine Pass, was a 1- to 6-inch vein of alabandite with rhodochrosite. Small cavities contained small crystals of dolomite and pyrite. Most of the alabandite was massive, but one crystal showing cube and tetragonal trisoctahedron was seen. (W. B. Smith, 1886b; Lovering, 1935.)

ALABASTER

[*See* Gypsum]

ALASKALITE†

$Pb(Ag,Cu)_2Bi_4S_8$(?)

[*See also* Aikinite *and* Matildite]

Alaskaite was named for the Alaska mine in the Silverton district. It has since been reported from the Sultan mine, which adjoins the Alaska, from the Lillian mine at Leadville, and from Bolivia. Mineralogists have disagreed as to its chemical composition and even as to the validity of the species. The most recent and most detailed work by R. M. Thompson (1950) indicates clearly that the type material from Silverton, as well as that from Bolivia, represented mixtures of matildite, aikinite, and other minerals and that the name alaskaite should be dropped. As 2 of the 3 reported occurrences in Colorado have not been restudied, they are described here, although all 3 may represent mixtures of other minerals.

Lake County.—Leadville district, Lillian mine. Chapman (1941) found a mineral in ore from the Lillian mine on Printer Boy Hill which he first believed to be bismutoplagionite (galenobismutite) but later microscopic studies convinced him it was alaskaite. It occured as residual modules in a mass of cerussite, with hematite and other carbonate and oxide minerals. A little native gold, partly contemporaneous with the alaskaite(?) and partly of supergene origin, was also present.

San Juan County.—Silverton district, Alaska mine. Alaskaite(?) was first described by Koenig (1881d, 1883) from the Alaska mine on Poughkeepsie Gulch, one-third of a mile from Lake Como. This mineral, or mixture of minerals, was the chief ore mineral in a shoot that yielded about $90,000 in silver; some pieces of ore assayed as much as 3,000 ounces of silver to the ton. Associated minerals were tetrahedrite and chalcopyrite in a quartz-barite gangue. Sphalerite and galena were locally abundant and both rhodonite and rhodochrosite were present. The alaskaite(?) formed small foliated masses, some with smooth cleavage planes. Koenig (1881d, 1885b) made several analyses of impure material. See also Liweh (1885), Koenig (1888), and de Gramont (1897).

As noted above, R. M. Thompson (1950) restudied 3 specimens of Koenig's type material and 2 specimens from Bolivia. As a result of studying polished sections and X-ray powder patterns he concludes that the supposed alaskaite is actually a mixture of matildite and aikinite, with other minerals.

Silverton district, Sultan mine. W. H. Brown (1927) identified what he thought was alaskaite from the Sultan mine, which adjoins the Alaska mine. By a microscopic study of polished sections of the ore, he found the alaskaite(?) to be intimately intergrown with chalcopyrite and other minerals. The alaskaite(?) was in particles less than 0.5 cm long, molded around crystals of quartz and pyrite. Pyrite, sphalerite, and tetrahedrite were corroded by the alaskaite(?) which was in turn cut by veinlets of covellite.

ALBITE

[*See* Feldspar group, plagioclase series]

"ALKALI"

The familiar white to gray incrustations that coat soils and rocks in most of the drier parts of the State, particularly in and around intermittent ponds and lakes, are popularly termed "alkalis." They are made up of minerals that may be locally admixed with organic matter. The "alkalis" are of great interest to agriculturalists and livestock growers, but the little attention that has been given to them by scientists seems to have been along chemical rather than mineralogic lines. Thus Headden (1918) describes the origin and chemical character of alkalis in the soils of Colorado, and concludes that these widespread materials are not as injurious to plants or animals as is commonly supposed. Headden finds that the "white alkalis" commonly contain Na_2SO_4, $CaSO_4$, $MgSO_4$, and NaCl, whereas the "black alkalis" contain Na_2CO_3 and $NaHCO_3$; no doubt most of these are the common hydrous forms that are well known in the household as well as to mineralogists.

ALLANITE

$(Ca, Ce, La, Th)_2(Al, Fe)_3(SiO_4)_3(OH)$

The rare-earth mineral allanite is widespread and locally abundant in pegmatite bodies and as an accessory mineral in igneous and metamorphic rocks. Only a few of its Colorado occurrences as an accessory mineral are described below. The mineral is of added interest to Colorado mineral collectors because Hillebrand's description of it from the Tenmile district, Summit County (Iddings and Cross, 1885), was the first published report to draw attention to the widespread occurrence of allanite as an accessory rock-forming mineral.

Boulder County.—Jamestown district (loc. 2). Jet-black brittle crystals, both bladed and tabular and up to 2 by 5 mm in size are associated with cerite in small deposits near the north border of a stock of Silver Plume granite. Allanite forms narrow veinlets along the borders of cerite masses and is also intergrown with the cerite (*see* for more details) and other minerals (Goddard and Glass, 1940—analysis; *see also* Goddard, Lovering, and Fairchild, 1935).

Chaffee County.—Trout Creek Pass (loc. 6). Bladed crystals of allanite associated with other rare-earth minerals, have been found in several pegmatite bodies, notably the Crystal No. 8. (Heinrich, 1948a; Hanley and others, 1950.)

Clear Creek County.—Georgetown district. Allanite is an accessory mineral in magnetite- and biotite-bearing pegmatite bodies that cut quartz monzonite. Black glassy crystals as much as 3 inches long are especially well developed near the head of Maxmilian Gulch. They are also present in pegmatite on the northeast side of the road to the Humboldt mine. (Spurr and Garrey, 1908.)

Beaver Brook. At Beaver Brook (loc. 1) small black grains are associated with magnetite and zircon.

Floyd Hill (loc. 2). Rough crystals of allanite, ⅜ inch thick and more than 1 inch long, occur in coarse granite along U.S. Highway 6, 0.95 mile east of the junction of U.S. Highways 6 and 40 at Clear Creek. (J. W. Adams, written communication.)

Douglas County.—Devils Head Mountain (loc. 1). Pitch-black glossy crystals of allanite are associated with gadolinite in decomposed granite. Eakins (1886) gives a chemical analysis and description of the optical properties.

Eagle County.—Allanite is an accessory in quartz porphyry along the Eagle (Colorado) River. (Iddings and Cross, 1885.)

Gunnison County.—Italian Mountain (loc. 3). Allanite is a very rare accessory mineral in the quartz monzonite. (Whitman Cross and Shannon, 1927.)

Quartz Creek (Ohio City) district (loc. 4). Several pods of allanite-bearing rock, each a few feet thick and as much as 10 feet long, occur in the Black Wonder pegmatite. They consist of quartz and albite with scattered prismatic crystals of allanite as much as 2 inches long. (Staatz and Trites, 1955.)

Jefferson County.—Small quantities of allanite are known in several places in this county. At the Burroughs mine (loc. 4), radiating altered crystals as much as 8 inches long are associated with euxenite. Allanite is also present in the Genessee Mountain dike (loc. 10; see garnet) and with beryl in Swede Gulch (loc. 17). (G. R. Scott, written communication.)

Allanite is widespread in the South Platte area of Jefferson County (loc. 16). Schlieren hundreds of feet long but no wider than 4 inches are very rich in allanite, which makes up a large percentage of the rock (Vance Haynes, written communication). In the White Cloud mine, euhedral crystals of allanite and gadolinite occur in parts of the pegmatite core. (Haynes, 1958.)

Larimer County.—Allanite is an accessory mineral in gneiss of the Medicine Bow Range (Randall).

Park County.—Chestnut-brown crystals of allanite are present in the porphyry of Mount Silverheels and Mosquito Gulch. (Iddings and Cross, 1885.)

Teller pegmatite (loc. 9). This pegmatite, rich in rare-earth minerals, contains glossy black masses of allanite in irregular lumps that are as large as walnuts. Glass, Rose, and Over (1958) record a spectrographic analysis.

Summit County.—Tenmile district. Allanite is exceptionally abundant in the biotite porphyry of this district. Prismatic crystals may be seen in numbers in all hand specimens of the porphyry, and few thin sections lack any of it. Hillebrand's partial analysis of material from this district proved its identity as allanite and first called attention to the widespread occurrence of this mineral as an accessory rock-forming mineral. (Iddings and Cross, 1885; S. F. Emmons, 1898.)

Breckenridge district. Small anhedral crystals of allanite are present, but nowhere abundant in the porphyries. (Ransome, 1911.)

Front Range, general.—Allanite is locally abundant as an accessory mineral in the oldest Precambrian granites. It is deep brown and often intergrown with titanite and monazite. In the Pikes Peak batholith it forms clusters of rose-red to greenish-gray grains. It is rare in most of the Sherman granite but more abundant in coarse red phases of the southern half. In the youngest Precambrian granites it is more abundant along borders of granite masses and forms thin lenses between the lamellae of biotite. (Boos, 1935.)

ALLEGHANYITE

$Mn_5(SiO_4)_2(OH)_2$

San Juan County.—Silverton district (loc. 1). The second authenticated occurrence of alleghanyite in the United States is in the Sunnyside vein but even there it was found in only five of the specimens studied by Burbank (1933). It is somewhat more abundant than tephroite, with which it is commonly associated, but much less abundant than rhodonite. On polished surfaces of the manganese silicate vein material it is a darker grayish pink than the lighter pink of rhodonite or the greenish-gray of tephroite.

ALLOPHANE

$Al_2SiO_5.nH_2O$

[*See also* Clay minerals]

The amorphous clay mineral allophane, a varicolored decomposition product of silicates, is probably far more widespread in the oxidized parts of many ore deposits than has been reported. In addition to those localities given below, it is reported from the Franklin mine in Gilson Gulch; this locality is not known to me. (Endlich, 1878; J. A. Smith, 1883.)

Boulder County.—Sugar Loaf district.—Reported from Fowler and Wells' Ranch. (Endlich, 1878.)

Nederland tungsten district. Allophane is a minor constituent of clay assemblages (mostly beidellite, dickite and cimolite) in many tungsten veins. (Lovering and Tweto, 1953.)

Dolores County.—Rico district. A soft mass of pale-blue allophane mixed with kaolinite was found in a cavity in limestone in the M. A. C. prospect, adjoining the Puzzle mine. (Ransome, 1901a.)

Gilpin County.—Central City district. Allophane was associated with native silver in the Cincinnati mine. (J. A. Smith, 1883.)

Jefferson County.—A thin bluish crust on limonite from near Bergen Ranch was analysed by F. A. Genth and found to contain 33.85 percent Al_2O_3 and 5.40 percent CuO, corresponding to a 5:1 mixture of allophane and chrysocolla (Randall).

Blue incrustations of allophane occur with apatite, titanite, and many other minerals in the Cresswell mine at Bergen Park (loc. 2). See also apatite. (J. W. Adams, written communication.)

Larimer County.—Dendritic masses of allophane and nontronite occur in chalcedony on Specimen Mountain. (Wahlstrom, 1941.)

San Juan County.—Silverton district. Soft white material in a fissure in the Silver Ledge mine was analysed by Hillebrand and calculated to be a mixture of allophane, aluminite, gibbsite, and alunite. No specific identifications were made. (Ransome, 1901b.)

ALMANDITE

[*See* Garnet]

ALTAITE

PbTe

Small amounts of the lead telluride, altaite, occur in many of the telluride-bearing ores in the State. It is commonly intimately mixed with other tellurides and is nowhere known to be abundant.

Henryite, (Pb,Fe)Te, a supposed new iron-lead telluride mineral was first described by Endlich (1874) from the Red Cloud mine, Gold Hill district, Boulder County. Genth (1874) restudied the type material from the Red Cloud mine and found it to be a physical mixture of altaite and pyrite, thus discrediting henryite as a valid species. The name did not die immediately for it was later reported by Endlich (1878) from the Cold Spring tungsten mine and from all the telluride-bearing mines of the Gold Hill, Ward, Sugar Loaf, and Sunshine districts of Boulder County.

Boulder County.—Gold Hill district. In the Red Cloud mine, altaite is commonly intermixed with native tellurium and sylvanite, associated with pyrite, siderite, and quartz. Most of it forms granular masses with indistinct cubic cleavage but in places it forms indistinct cubic crystals lightly coated with galena; more rarely it forms large cleavage masses with one cleavage cube five-eighths inch in diameter seen. (Genth, 1874—analysis.) Both Endlich (1874) and J. A. Smith (1883) note the occurrence of altaite in the Slide, Cold Spring, Prussian, and Red Cloud mines, with fine crystals from the Slide. Goddard (1940) found altaite in many ores of the district but greatly subordinate in amount to petzite and other tellurides.

Magnolia district. Sylvanite is the chief ore mineral in the telluride veins of this district, but other tellurides, including a little altaite, commonly accompany it. (Wilkerson, 1939a, b.)

Nederland district. Telluride minerals, intimately intergrown and including altaite, characterize the eastern half of this district (see sylvanite). (Lovering and Tweto, 1953.)

Clear Creek County.—Idaho Springs district. Altaite is the most abundant mineral in a polished section of high-grade ore from the Jewelry Shop mine, one-half mile west of Idaho Springs, that was studied by M. N. Short. It was associated with coloradoite, petzite, krennerite, gold, galena, and sphalerite in a gangue of kaolin, pyrite, sericite, carbonate, barite, and opal. (Lovering and Goddard, 1950.)

Lake County.—Leadville district. Altaite is a minor constituent of ores of the fourth, or bismuth, stage of mineralization and has been found in specimens from the Greenback, Tucson, and Louisville mines on Iron Hill and the Garbult mine on Breese Hill. One specimen contained inclusions of galena. (Chapman and Stevens, 1933; Chapman, 1941.)

Saguache County.—Bonanza district. Ores from the Empress Josephine mine contain altaite, usually forming shells around galena and in contact with other tellurides. (Burbank, 1932.)

ALUM

[*See* Potash alum]

ALUMINITE

$Al_2O_3.SO_3.9H_2O$

Aside from an occurrence in Mount Vernon Canyon, Jefferson County, listed by Endlich (1878), only one occurrence of aluminite has been reported. Possibly it occurs as a postmining efflorescence in many sulfide-bearing mines.

San Juan County.—Silverton district, Silver Ledge mine. A large quantity of soft white material, which assumed a faint green tinge when wet, was found in a fissure in this mine. Recalculation of his chemical analysis led Hillebrand to believe the material was a mixture of allophane, aluminite, gibbsite, and alunite; these constituents were not specifically identified. (Ransome, 1901b—analysis)

ALUNITE

$KAl_3(SO_4)_2(OH)_6$

Alunite, commonly formed by solfataric action on volcanic rocks, is widespread in Colorado and occurs in enormous quantities locally. It also occurs as a vein mineral in a few places. During World War I, when German supplies of potash were cut off, the Colorado alunite was regarded as a possible source of potash, but later development of the great potassium-salt deposits of New Mexico led to cessation of interest in alunite. Brief descriptions of most Colorado occurrences are given by B. S. Butler and Gale (1912).

As pointed out by Hillebrand and Penfield (1902) alunite and natroalunite, $(NaAl_3(SO_4)_2(OH)_6$, form an isostructural series from the pure-potassium end to the pure-sodium end of the series. Any specimen that contains more sodium than potassium is called natroalunite. On this basis, the material from Red Mountain, Ouray County, and from the Rosita Hills, Custer County, described below, should actually be called natroalunite. For lack of exact chemical information on many deposits, however, all of the alunite and natroalunite occurrences in the State are grouped together.

Conejos and Rio Grande Counties.—Platoro and Summitville districts. Alunite was first mentioned by Endlich (1878) from these districts. Patton (1917) describes tabular crystals, 0.008 to 0.012 mm long and 0.004 mm wide. They are intimately associated with quartz in most places, as well as with fine-grained kaolin, sericite, and minute prismatic grains of rutile or brookite. He gives a chemical analysis of the alunite rock, indicating that it contains 32.8 percent alunite.

The alunitized material is most abundant in a zone of alteration near Lookout Mountain. Steven and Ratté (1960) give excellent descriptions of the alunite. They find that it contains significant amounts of sodium but not enough to call it natroalunite.

Custer County.—Rosita Hills. The first recorded occurrence of alunite in the United States was from the Rosita Hills (Whitman Cross, 1891a, 1896). About one-third of the altered rhyolite at the top of Democrat Hill is alunite which was later described by Hillebrand and Penfield (1902) as natroalunite. The alunite rock is hard, somewhat porous, light pink to white, and weathers to rounded masses. It resembles granite, but contains tablets and irregular grains of alunite with interstitial quartz; cavities contain alunite, quartz, and kaolin. On Mount Robinon, also in the Rosita Hills, a broad dike of rhyolite is altered in most places to a quartz-alunite rock, but locally to quartz-diaspore and elsewhere to kaolin. This alunite, in contrast to that of Democrat Hill, contains very little sodium. Eakins (1892) gives an analysis of natroalunite from Knickerbocker Hill.

Dolores County.—Rico district. The Calico Peak porphyry of this district is almost pure alunite with a little kaolin and quartz; it contains no diaspore. There is much sodium in the alunite that replaces the igneous rocks, but veins of the same mineral that traverse the altered rocks are much higher in potassium. There is a little free sulfur in porous areas that represent original feldspar phenocrysts. Whitman Cross and Spencer (1900) think the alunite is a product of solfatarism during the waning stages of igneous activity.

Eagle County.—Red Cliff district. Friable white alunite is associated with zinc carbonate ore in the zinc stope of the Eagle No. 2 ore shoot of the Eagle mine. (R. D. Crawford and Gibson, 1925.)

Hinsdale County.—Carson Camp. With quartz and pyrite, alunite is a wall-rock alteration product near the ore-bearing veins. (E. S. Larsen, Jr., 1911.)

San Cristobal quadrangle. In addition to those near Carson Camp, many of the volcanic rocks along the Middle Fork of the Piedra River, on Red Mountain, and elsewhere are partly altered to alunite-quartz rock. The famous Slumgullion mudflow is comprised of greatly altered andesitic rocks containing large amounts of alunite which lines cavities or is scattered through masses of opal. (E. S. Larsen, Jr., 1913.)

Lake County.—Leadville district. Alunite has not been seen or positively identified in this district, but analyses of claylike material, mixed with sericite and other minerals, indicate its presence. (S. F. Emmons, Irving, and Loughlin, 1927.)

Mineral County.—Creede district. The Denver Museum of Natural History has a specimen of alunite labeled "Creede."

Ouray County.—Red Mountain district. Alunite is an alteration product of the rocks of Red Mountain (Whitman Cross, Howe, and Irving, 1907). In the National Belle mine in this district an aggregate of minute crystals, clearly associated with enargite, fills pockets and seams in the ore. A chemical analysis by Hurlburt (1894) shows the mineral to be a little closer to natroalunite than to alunite.

Saguache County.—Bonanza district. Alunite was first mentioned by Endlich (1878) from Tracey Creek in the Bonanza district, and from Beidell, but appears not to have been studied in detail until the work by Burbank (1932). It is associated with silicified rocks and is most abundant on top of a broad flat mountain south of Porphyry Peak, where rhyolites are completely altered to tough jasperlike masses of quartz, alunite, rutile, and other minerals. It is not found as a wallrock alteration mineral, but a small amount is present in an area of solfataric alteration near Greenback Gulch.

San Juan County.—Silverton district. Alunite was found in the Mystery Lode on Anvil Mountain. (Ransome, 1901b.)

Teller County.—Cripple Creek district. Alunite is confined to the oxidized zone of the ore deposits. On level 5 of the Last Dollar mine it follows a vein fissure as a rather hard and compact fine-grained substance resembling kaolin; it is also known in the Modoc mine and probably occurs in others. (Lindgren and Ransome, 1906.)

ALUNOGEN

$Al_2(SO_4)_3 \cdot 16H_2O$

Like potash alum, aluminite, and other secondary sulfates, alunogen is probably much more widespread than is indicated by the literature.

Delta County.—Doughty Springs. Three varieties of alunogen—massive, micaceous, and fibrous—occur as coatings on sandstone and fill small cavities in the rock. The mineral occurs both at the hot springs and in Alum Gulch across the river from the springs. It is not genetically connected with the present-day hot springs. Headden (1905a; b) gives analyses.

Huerfano County.—Alunogen was noted by Randall but the locality is not known.

Teller County.—Cripple Creek district. Separate samples of an admixture of alunogen and epsomite were analyzed by W. O. Hotchkiss and R. M. Chapman; no details other than the analytical results are available (Hobbs, 1905).

AMALGAM

Ag, Hg

[*See also* Gold amalgam]

The solid solution of silver and mercury, in widely varying proportions, is called amalgam. Some can be classed as mercurian silver; other examples approach the composition of moschellandsbergite (Ag_2Hg_3) which is the only definite mineral species in the series that is recognized by modern mineralogists. Moschellandsbergite has not been reported from Colorado, but amalgams, none of them studied or analyzed in detail, have been found in many of the telluride ores of Boulder and La Plata Counties. Some specimens contain gold as well as silver and hence can be classed as gold amalgams.

Boulder County.—The first reported occurrence of amalgam in Colorado was from the Forest mine, where it occurred in very small quantity. It was nearly as liquid as native mercury, but contained a little silver (Endlich, 1874). Later, Endlich (1878) reported amalgam associated with coloradoite from the Keystone mine, Magnolia district. Still later, J. A. Smith (1883) reported it from the American and several other mines in the Sunshine district and from the Smuggler mine at Balarat. In all these occurrences it was associated with coloradoite.

La Plata County.—La Plata district. Native amalgam is reported from nearly all the veins that contain native mercury. It is a supergene mineral and may be derived from the breakdown of cinnabar and the telluride minerals. From the relative abundance of gold and silver in the district, Galbraith (1949) believes the amalgam probably contains more gold than silver. W. H. Emmons (1905) identified amalgam in the Neglected mine, where it was associated with sylvanite, gold, and pyrite.

Montrose County.—Cashin mine (loc. 1). Nuggets of native amalgam that contain some arsenic occur in the copper ore of this mine. The nuggets are surrounded by shells of uraninite(?). (Theodore Botinelly, written communication.)

AMAZONITE

[*See* Feldspar group, microcline species]

AMAZONSTONE

[*See* Feldspar group, microcline species]

AMBLYGONITE

$(Li,Na)Al(PO_4)(F,OH)$

[*See also* Montebrasite *and* Natromontebrasite]

Minerals of the amblygonite series are basic phosphates of aluminum, sodium, and lithium; members range from amblygonite, which contains more lithium and fluorine than sodium and hydroxyl, through montebrasite, with more hydroxyl than fluorine, to natromontebrasite with more sodium and hydroxyl than lithium and fluorine. All three species are known in Colorado, each in only a single place.

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). The Bazooka prospect, at the head of Wood Gulch, and 2¾ miles due south of Ohio City, is the only deposit in this lithium-bearing district to yield amblygonite. In one pod the pegmatite contains about 12 percent spodumene and 5 to 10 percent amblygonite, the latter in scattered anhedral crystals as much as 3 inches in size. Some lepidolite, cookeite, microlite, and prochlorite are present in the rock, which is made up largely of quartz and albite. Staatz and Trites (1955) failed to find the amblygonite described by Hanley and others (1950).

AMIANTHUS

[*See* Amphibole group *and* Serpentine]

AMPHIBOLE GROUP

Next to the pyroxenes, the amphiboles are the most common rock-forming ferromagnesian minerals in most igneous and metamorphic rocks. In addition, several members of the group occur in ore deposits, particularly those formed by contact metamorphism.

The members of the group are classified primarily as to crystal form and secondarily as to chemical composition. The species, subspecies, and varieties known to occur in Colorado are listed below:

Members of the amphibole group that occur in Colorado

Species and subspecies	Chemical composition
ORTHORHOMBIC SECTION	
Anthophyllite	$(Mg,Fe)_7Si_8O_{22}(OH)_2$
MONOCLINIC SECTION	
Amphibole	
Cummingtonite	$(Mg,Fe)_7Si_8O_{22}(OH)_2$.
Grunerite	$(Fe,Mg)_7Si_8O_{22}(OH)_2$.
Tremolite	$Ca_2Mg_5Si_8O_{22}(OH)_2$.
Actinolite	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$.
Hornblende	Complex silicate, with Al, Fe, Mg, Ca, and alkalies.
Glaucophane	$Na_2(Mg,Fe^{+2})_3(Al,Fe^{+3})_2Si_8O_{22}(OH)_2$
Riebeckite	$Na_2Fe_3{}^{+2}Fe_2{}^{+3}Si_8O_{22}(OH)_2$
Crossite	$Na_2(Mg,Fe^{+2})_3AlFe^{+3}Si_8O_{22}(OH)_2$.
Hastingsite	$Ca_2Na(Fe^{+2},Mg)_3(Al,Fe^{+3})_2Si_8O_{22}(OH)_2$.
Magnesiohastingsite	
Arfvedsonite	$Na_3Fe_4AlSi_8O_{22}(OH)_2$.
Kataphorite	
Barkevikite	

In the descriptions below, which should be taken as a sampling of occurrences rather than a complete catalog, the species and subspecies appear in the same order as in the classification above. These are followed by a section on "Amphibole, undivided," including examples of occurrences in which the mineral was called amphibole by the original authors, either for lack of detailed study or because two or more kinds are present. Probably most such occurrences are of the amphibole species, as distinct from the group. Asbestos is a variety of amphibole that is distinguished by its physical properties; it may represent any one of the subspecies. It is included under the heading of "Amphibole, undivided" for lack of more detailed information.

Amphibole species ANTHOPHYLLITE

$(Mg,Fe)_7Si_8O_{22}(OH)_2$

Anthophyllite, the orthorhombic amphibole, is probably widespread as a rock-forming mineral, especially in the crystalline schists, but is not as abundant as many of the other amphiboles. Only a few occurrences are worth mentioning here.

Boulder County.—North Boulder Creek. (Endlich, 1878.)

Chaffee County.—Monarch district. A quartz-epidote-anthophyllite rock crops out west of a small quartz monzonite stock west of Cree Camp. The rock is very tough and olive green in color, but the weathered surface is black. Quartz and anthophyllite, in equal quantities, make up the bulk of the rock, which also contains small yellowish-green grains of epidote and a little calcite. (R. D. Crawford, 1913.)

Fremont County.—Present in the Guffey area. (Bever, 1953.)

Gunnison County.—Gold Brick district. Anthophyllite schist can be found on several mine dumps in Jones and Dutch Flat Gulches. The mineral forms gray radial aggregates with cleavage faces as much as 1 inch long; green chlorite and a little quartz are interstitial to the anthophyllite. In some specimens from Dutch Flat anthophyllite is subordinate to andalusite, which poikilitically incloses biotite and anthophyllite. One specimen shows coarsely crystallized light-gray anthophyllite in dominant dark-gray andalusite. (R. D. Crawford and Worcester, 1916.)

Larimer County.—Prairie Divide district, Copper King mine. Much of the amphibole skarn associated with uranium-bearing massive sulfides consists chiefly of anthophyllite. Generally the anthophyllite skarn is barren, whereas cummingtonite skarn contains mineral deposits. The anthophyllite occurs as sheaves of curved fibers, some as much as 1 inch long, but most of them shorter. Cummingtonite is intergrown with it, as is phlogopite. (Sims, Phair, and Moench, 1958.)

Park County.—The wallrocks of the Copper King pegmatite prospect comprise a series of actinolite and anthophyllite schists. These are impregnated with bornite and chalcopyrite. (Hanley, Heinrich, and Page, 1950.)

Amphibole subspecies **CUMMINGTONITE**

$(Mg,Fe)_7Si_8O_{22}(OH)_2$

Larimer County.—Prairie Divide district, Copper King mine. The amphibole skarn that encloses the uranium-bearing massive sulfide deposits of this mine is composed partly of cummingtonite skarn; other kinds are anthophyllite skarn and actinolite skarn. The cummingtonite, which is associated with sulfides, magnetite, mica, and quartz, occurs as euhedral to subhedral blades, some as much as 6 inches long. (Sims, Phair, and Moench, 1958.)

Amphibole subspecies **GRUNERITE**

$(Fe,Mg)_7Si_8O_{22}(OH)_2$

Jefferson County.—Grunerite is a constituent of an amphibolite-bearing layer in garnetiferous schist at the Schwartzwalder mine. (D. M. Sheridan, written communication.)

Amphibole subspecies **TREMOLITE**

$Ca_2Mg_5Si_8O_{22}(OH)_2$

Chaffee County.—Monarch district. Large quantities of tremolite occur with pockets of galena south of Greens Gulch. It is also present as a microscopic constituent of some quartzite and is in some marble and limestone. (R. D. Crawford, 1913.)

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Front Range, general.—Garnet, magnetite, hematite, tremolite, epidote, and fine-grained quartz formed early in the period of mineralization near the quartz monzonite porphyry stocks that are related to centers of mineralization. (Lovering and Goddard, 1950.)

Gunnison County.—Iron Hill (loc. 2). Sodic tremolite and glaucophane are the chief amphiboles in the alkalic rocks of Iron Hill, although they are greatly subordinate to pyroxene, melilite, and other minerals. Nearly everywhere associated with aegirite, they are the only amphiboles in hydrothermally metamorphosed limestone and in several other geologic settings. (E. S. Larsen, Jr., and Goranson, 1932; E. S. Larsen, Jr., and Jenks, 1942.)

Tomichi district, Iron King mine. Microscopic amounts of tremolite are in the serpentine of this mine. (R. D. Crawford, 1913.)

La Plata County.—La Plata district, Camp Bird prospect. The vein in the Camp Bird prospect near Diorite Peak contains an abundance of clear to white rodlike crystals of tremolite, intimately intergrown with pyrite and chalcopyrite in quartz gangue. Ankerite, calcite, and barite are present. (Galbraith, 1949.)

Amphibole subspecies **ACTINOLITE**

$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$

Actinolite, the calcium-magnesium-iron amphibole, is widespread, particularly in contact-metamorphic deposits. Only a few occurrences are given here; others that probably include actinolite as one of the species, are given under "Amphibole, undivided."

Boulder County.—Asbestiform actinolite was reportedly associated with lead, zinc, copper, and iron minerals in veins at the head of North Boulder Creek and in the Partridge Lode on Coal Creek. (J. A. Smith, 1883.)

Chaffee County.—Monarch district. Radiating tufts of actinolite associated with magnetite occur at a contact between granite and limestone on the southwest slope of Missouri Hill. At Cree Camp, in the same district, a large specimen of dark-green quartz associated with garnet and epidote was found in a moraine. The green color of the quartz was due to inclusions of both acicular and short stout crystals of actinolite with frayed ends. (R. D. Crawford, 1913.)

Custer County.—Actinolite occurs in a dike at the north base of the Rosita Hills associated with acmite and riebeckite. (Whitman Cross, 1890.)

Gunnison County.—Light-blue and bluish-green actinolite was reported from Mount Ouray (Randall).

Jefferson County.—Crystallized actinolite is reported from Bergen's Ranch, probably near what is now know as Bergen Park. (Hollister, 1867; Endlich, 1878; J. A. Smith, 1883.)

Ouray County.—Actinolite is a constituent of magnetite-pyrite replacement ores associated with chalcopyrite, garnet, epidote, quartz, and calcite (Whitman Cross, Howe, and Irving, 1907).

It is also associated with small gem-quality garnet crystals in amygdules on Mount Sneffels, where it forms a microscopic intergrowth of actinolite with quartz. (Eckel, 1932.)

Park County.—I have observed actinolite as an important gangue mineral in the Lone Chimney (Betty) and other mines near Guffey and in the Isabella mine near Currant Creek.

Teller County.—Actinolite is abundant in schist in a railroad cut west of Victor (Randall).

Amphibole subspecies HORNBLENDE

Complex silicate, with Al,Fe,Mg,Ca, and alkalies

Hornblende, whether the green common hornblende or the brown basaltic hornblende, is probably the most common subspecies of amphibole in rocks, and most of the material described simply as amphibole is to be ascribed to this subspecies.

Gunnison County.—Wildcat Gulch. Long slim crystals of green hornblende are in a 2-foot pegmatite dike near the west border of an augite-syenite body. The dike also contains quartz, pink microcline, and a few large brown crystals of titanite. (Hunter, 1925.)

San Juan Mountains, general.—Hornblende is one of the chief mafic minerals of the lava flows in the San Juan Mountains, but it is somewhat subordinate to diopside and biotite, both in absolute amount and in the number of lava flows that contain it. It is absent in basaltic rocks and andesites that are close to basalt in composition. Both biotite and hornblende are less abundant in andesite than they are in latite-andesite; they occur in most of the quartz latite but are rare in the rhyolite. Hornblende is somewhat less common in the granular rocks than in lava flows and is rare as a hydrothermal mineral. E. S. Larsen, Jr., and others (1936) give several analyses.

Amphibole species GLAUCOPHANE

$Na_2(Mg,Fe^{+2})_3(Al,Fe^{+3})_2Si_8O_{22}(OH)_2$

Glaucophane is probably a constituent of some schists and other metamorphic rocks, but such occurrences have not come to my attention. Only two localities are noted here.

Chaffee County.—Sedalia mine (loc. 5). A bluish-gray mineral that is either glaucophane or a very similar amphibole is among the many minerals—garnet, hornblende, staurolite, corundum and others—that make up the gangue of this deposit whose chief ore mineral is chalcocite. (Lindgren, 1908.)

Gunnison County.—Iron Hill (loc. 2). Soda-tremolite and glaucophane are the chief members of the amphibole group of minerals in the alkalic and related rocks of Iron Hill. Nearly everywhere they are associated with aegirite. (E. S. Larsen, Jr., and Jenks, 1942.)

Amphibole species RIEBECKITE

$Na_2Fe_3^{+2}Fe_2^{+3}Si_8O_{22}(OH)_2$

The sodium-iron amphibole riebeckite is a rock-forming mineral commonly associated with alkalic rocks. It has been found in two localities in Colorado; in one of these it was first described as arfvedsonite. The blue fibrous variety crocidolite, or blue asbestos, has been reported from the other locality.

Boulder County.—Wallstreet district, Rex No. 1 mine. A mineral in the Rex No. 1 tunnel, first thought to be pitchblende by the local miners, was shown to be the crocidolite variety of riebeckite. It had a delicate display of colors. (Wood, 1910.)

Custer County.—Rosita Hills. Dark-blue riebeckite of secondary origin was reported. (Koenig, 1877; Whitman Cross, 1890; 1896; Clarke and Steiger, 1902—all give analyses.)

El Paso County.—St. Peters Dome. The mineral at this locality was first described as arfvedsonite by Koenig (1877), who gave a chemical analysis. It occurred as large imperfect black crystals as much as 4 inches long, in masses of quartz in granite associated with astrophyllite and zircon. Later, reexamination of Koenig's type material convinced Lacroix (1899) that the optical properties were those of riebeckite and the mineral has been so described since.

In the Colorado Springs quadrangle, especially near St. Peters Dome, riebeckite is present in the Mount Rosa granite and associated pegmatite bodies. Quartz, microcline, and riebeckite are the essential minerals in the granite; some of the riebeckite occurs as small subhedral crystals, but most is in irregular masses. Riebeckite is the most abundant dark silicate in the pegmatite and comprises as much as 15 percent of the rock. It forms black to bluish-black prismatic crystals as large as 2 by 12 inches which display uncommonly conspicuous cleavage. (Finlay, 1916; Kunitz, 1930—analysis; Boos, 1935; Landes, 1935; Berman, 1937; Steven, 1949; Coleman, 1951—includes new analysis.)

Amphibole species CROSSITE

$Na_2(Mg,Fe^{+2})_3AlFe^{+3}Si_8O_{22}(OH)_2$

Crossite is considered by some as a species of the amphibole group, intermediate in composition between glaucophane and riebeckite, and by others as a variety of riebeckite. It has been noted from two localities. It is possibly present as a rock-forming mineral in other alkalic volcanic rocks.

Custer County.—Silver Cliff and Rosita districts. Crossite is noted as a secondary growth on brown hornblende and on pyroxene. (Whitman Cross, 1890.)

Teller County.—Cripple Creek district. A blue amphibole in some of the volcanic rocks is allied to crossite. (Whitman Cross and Penrose, 1895.)

Amphibole species HASTINGSITE

$Ca_2Na(Fe^{+2},Mg)_3(Al,Fe^{+3})_2Si_8O_{22}(OH)_2$

The hastingsites are a group of amphiboles low in silica with calcium, ferrous iron, magnesium, aluminum, and smaller amounts of alkalies. The chemical and optical properties of a variety that is high in magnesium called magnesiohastingsite occurs in metamorphosed limestone at Iron Hill, Gunnison County; it is associated with nepheline rocks. (Billings, 1928.)

Amphibole species ARFVEDSONITE

$Na_3Fe_4Al(OH)_2Si_8O_{22}$

The first and best known occurrence of arfvedsonite in Colorado—that at St. Peters Dome—has since been discredited and the mineral found to be riebeckite, which see. Three other localities of this amphibole that is high in iron and soda still stand in the literature, however.

Boulder County.—Jamestown district. Arfvedsonite, as one of a large number of gangue minerals, is intergrown with deep-violet fluorite in several small fluorspar veins. (Goddard, 1946.)

Custer County.—Rosita district. Dark-brown barkevikite, a mafic variety of arfvedsonite, is in a dike at the north edge of the Rosita Hills. It is associated with blue riebeckite and green aegirite. (Whitman Cross, 1890; 1896.)

Teller County.—Cripple Creek district. The variety kataphorite, intermediate between arfvedsonite and barkevikite, is present in the alkalic rocks. (Lindgren and Ransome, 1906.)

AMPHIBOLE, UNDIVIDED

Boulder County.—Camp Albion, Snowy Range mine. Fibrous sheetlike masses of asbestos, which seems, from chemical analysis and optical properties, to be an alkalic amphibole, occur in the central part of the banded vein. Other minerals are pyrite, galena, sphalerite, calcite, feldspar, quartz, and pyroxene. Some of the light-gray asbestos fibers are 2 inches long. (Hollister, 1867; Wahlstrom, 1934; 1940.)

North Boulder Creek. Amianthus, a fine silky variety of either amphibole or serpentine, is reported here. (Endlich, 1878.)

Chaffee County.—Sedalia mine (loc. 5). The Sedalia ore deposit, famous for the large "Salida" garnets, consists of ore and gangue minerals intergrown in a bluish-gray amphibolite; amphibole is thus the most abundant gangue mineral. Chalcocite is the most important ore mineral; others are copper carbonates, cuprite, sulfides of copper, lead, zinc and iron, spinel, corundum, quartz, garnet, biotite, glaucophane(?), staurolite, labradorite, asbestos, talc, and chlorite. (Lindgren, 1908.)

Calumet iron mine (loc. 2). The variety byssolite, which forms fibers in sagenitic quartz is described from here (Randall); but W. B. Smith (1887a, b) and Pearl (1958) say the mineral has been found to be epidote.

Fremont County.—Cotopaxi mine (loc. 1). Dark-green amphibole is one of the gangue minerals in this deposit that is more famous for the occurrence of gahnite than for its production of copper. (Genth, 1882; Lindgren, 1908.)

Gunnison County.—Taylor Peak and Whitepine districts. Amphibole is among the contact-metamorphic silicate minerals here; it is especially abundant at or very close to the contact between sedimentary and igneous rocks. (Harder, 1909.)

San Miguel County.—Telluride district. Amphibole is a gangue mineral in the Japan mine, but has not been found in other ore deposits. (Whitman Cross and Purington, 1899.)

Summit County.—Breckenridge district. A dark-green amphibole occurs in garnet-rich sedimentary rocks of Gibson Hill. It also occurs as small needles in the ore of the Sultana and nearby mines. (Ransome, 1911.)

Several amphibole minerals, notably actinolite and tremolite, occur in metamorphosed limestone near the iron deposits, and the rocks immediately above and below the corundum deposit are amphibolites. (Behre, Osborn, and Rainwater, 1936.)

ANALCIME

[*See* Analcite]

ANALCITE

$NaAlSi_2O_6 \cdot H_2O$

Analcite, or analcime, is one of the most common zeolite minerals; it is a widespread constituent of volcanic rocks throughout Colorado, and has also been found in the Green River shales. It is possibly present in other sedimentary rocks.

Clear Creek and Gilpin Counties.—Analcite is present, but not abundant, in an aegirite-bearing alkalic stock on the south side of Clear Creek, east of the mouth of Soda Creek (see acmite). It is largely confined to the groundmass. (Spurr and Garrey, 1908.)

Garfield, Mesa, and Rio Blanco Counties.—Analcite is an abundant original constituent of parts of the Green River formation that covers wide areas in western Colorado. W. H. Bradley (1929) notes the following localities particularly, but it is probably present elsewhere: Garfield County, sec. 26, T. 3 S., R. 99 W.; Mesa County, near De Beque and along the Book Cliffs on the north side of Grand Valley; Rio Blanco County, sec. 24, T. 1 N., R. 104 W., sec. 9. T. 1 N., R. 103 W., and sec. 26, T. 1 N., R. 100 W. The crystals vary in size but their maximum diameter is 2 mm. Nearly all are euhedral, but many are rough and uneven. All are opaque and dull gray and some are darkly stained with iron oxide. The crystals are full of tiny inclusions and fragments of other minerals. The matrix of the analcite crystals is chalcedony or opal; some beds are comprised almost entirely of analcite. Bradley believes the analcite and associated apophyllite were precipitated on the lake floor by reaction between salts in the lake water and solution products from tuffaceous debris.

Gunnison County.—Iron Hill (loc. 2). Analcite is one of the most abundant alteration products of nepheline in the alkalic rocks of Iron Hill (see melilite). Locally it makes up nearly half of the ijolite rock. (E. S. Larsen, Jr. and Jenks, 1942.)

Jefferson County.—Table Mountain (loc. 18). Next to thomsonite, analcite is the second most abundant zeolite in the classic Table Mountain zeolite locality, just east of Golden. Most of it is milky white, but there are some clear glassy crystals from 1 mm to 2½ inches in diameter. Most of the analcite crystals rest on chabazite or thomsonite, but a few minute ones are on hairlike fibers of mesolite. (Patton, 1900—analyses and crystallography; see also Whitman Cross and Hillebrand, 1882a, 1885b; Klein, 1884; Clarke and Steiger, 1900—analysis.)

Las Animas County.—Apishapa quadrangle. White grains of analcite, probably vesicle fillings, occur in olivine-bearing augite vogesite dikes, the most abundant kind of dike in the quadrangle. (Whitman Cross, 1915.)

Moffat County.—Fortification Dike (loc. 2). Coarse-grained analcite syenite occurs locally near the center of Fortification Dike, a prominent feature on Fortification Creek, 18 miles north of Craig. The analcite, comprising about 10 percent of the rock, occurs as brownish-gray grains that replace feldspars or fill the angular spaces between feldspar crystals. In addition, oligoclase-orthoclase, augite, hornblende, and biotite are the chief rock-forming minerals. Thomsonite, less abundant than analcite, fills some of the interstices between feldspar phenocrysts. It is radially fibrous and slightly younger than analcite. (C. S. Ross, 1926.)

Breeze Mountain (loc. 1). An analcite basalt on Breeze Mountain, 4½ miles southeast of Craig, is a dark-gray rock with phenocrysts of olivine, augite, and biotite. Analcite and stilbite, comprising about 5 and 3 percent of the rock, respectively, are interstitial to the feldspars. (C. S. Ross, 1926.)

Park County.—South Park (loc. 7). Analcite basalt crops out as a low ridge on the floor of South Park, in secs. 20 and 21, T. 11 S., R. 75 W., 3 miles north of Hartsel and 6 miles southeast of Garo. Similar rocks were penetrated at depth in an oil well in sec. 16 of the same township. Analcite is an alteration product of the feldspars. In the syenite, where it is associated with thomsonite, natrolite, and stilbite, it lines cavities from 0.5 to 1 cm in diameter and is massive, with traces of cubic cleavage. In the diabase the analcite is fine grained. (Jahns, 1938.)

Teller County.—Cripple Creek district. Analcite occurs in phonolite, trachytic phonolite, and basalt as a minor constituent. Some of it is primary and some secondary. In many places it surrounds crystals of nepheline. Lindgren and Ransome, 1906.)

ANATASE

TiO_2

Anatase, or octahedrite, although less abundant than rutile, is widespread as an accessory mineral in many igneous rocks. These occurrences are not given here.

Boulder County.—In the trachyte at Sunset, anatase occurs as bright-yellow megascopic crystal grains packed together in groups. It is an alteration product of titanite. (Breed, 1899.)

Gunnison County.—Cebolla district. The outstanding occurrence of anatase in Colorado is in the Cebolla district, one-half mile northeast of the Lot mine, a few miles northeast of the mouth of Powerhorn Creek, and a few miles north of Iron Hill. There anatase forms veinlets on joint planes in a dioritic dike that cuts Precambrian rocks. Well-formed crystals as much as 1 cm in diameter are abundant. They range in habit from pyramidal to tabular or prismatic, and in color from deep blue to nearly black. The lighter colored crystals are translucent and some would make beautiful gems. (E. S. Larsen, Jr., and Hunter, 1914.)

ANDALUSITE

$AlSiO_5$

Andalusite has been noted in only four counties. As a constituent of metamorphic rocks, particularly of the sillimanite-bearing schists, it is possibly more widespread than reports indicate.

Clear Creek County.—Andalusite is a rare accessory constituent in biotite-sillimanite schist. (Spurr and Garrey, 1908.)

Gunnison County.—Gold Brick district. In some of the schist found in mines on Dutch Flat Gulch, dark-bluish-gray andalusite in anhedral masses is the dominant mineral. It is associated with small aggregates of biotite or anthophyllite and a little quartz. In the same district, and about 1 mile north of Lookout Mountain, there is a streak of coarse andalusite-quartz rock that is parallel to the schistosity of inclosing mica schist. Andalusite is reddish pink, in prismatic crystals that lack terminations but are as much as 1 by ⅜ inch or larger. These inclose all other minerals of the rock micropoikilitically. (R. D. Crawford and Worcester, 1916.)

Jefferson County.—Andalusite occurs in bladelike porphyroblasts as much as 10 inches long in quartz-mica schist in the area between Belcher Hill and Ralston Creek. Andalusite also occurs in small knots in schist layers of the Coal Creek quartzite (Fraser, 1949) in the northwest corner of the Ralston Buttes quadrangle. (D. M. Sheridan, written communication.)

Larimer County.—Pink and white to gray cleavage masses of andalusite are associated with penninite, one of the chlorite minerals, and sillimanite in the following localities: one quarter of a mile below the Empire copper mine; 6 miles above Masonville in Buckhorn Gulch; 2 miles above Masonville in boulders along Buckhorn Gulch; and in place, with white quartz, about 4 miles southeast of Crystal Mountain. (R. G. Coffin, written communication.)

ANDESINE

[*See* Feldspar group, plagioclase series]

ANDRADITE

[*See* Garnet]

ANGLESITE

$PbSO_4$

Anglesite is commonly an intermediate product in the alteration of galena to cerussite, and was a constituent in the oxidized parts of virtually all the lead-producing mines in the State. In some mines it was abundant and an important ore mineral. It is still found in the near-surface parts of many deposits, but as most mines have long since exhausted the oxidized ores it is far less abundant, and less noticed in the recent literature, than it was in the earlier days of mining. Only the most important or interesting occurrences are given here.

Chaffee County.—Monarch district. Fine large masses of anglesite were once characteristic of the ore from the Monarch mine (Dana, 1892). In the summer of 1909, Thomas Penrose found a small group of anglesite crystals in the Little Wonder mine near the center of a mass of galena that weighed several hundred pounds. The crystals, as much as 2 inches long, had dull surfaces but the interior parts were water clear. (R. D. Crawford, 1913.)

Sedalia mine (loc. 5). Anglesite, with secondary copper minerals, characterized the outcrops of this deposit, but it is more noted for its large garnet crystals than for metal production. (Schrader, Stone, and Sanford, 1916.)

Winfield. The ores from the little-known camp of Winfield, on the slope of Mount Harvard, contained a little anglesite, significant only because it was closely associated with bismuthinite. (E. P. Chapman, written communication.)

Dolores County.—Rico district. Earthy anglesite, mixed with other oxidation products such as limonite and jarosite, was an abundant constituent of the near-surface ores. (Ransome, 1901a.)

Eagle County.—Gilman (Red Cliff) district. Anglesite was the most prominent oxidation product of galena, although there was some coarse sand-cerussite.

In the Black Iron mine, Emmons noted a complete series of alteration products. The primary ore was a mixture of galena and pyrite. The galena altered completely to anglesite before the pyrite was more than slightly pitted, leaving a friable mass of pyrite. In the zone outside this mass of pyrite and anglesite there were large masses of melanterite. Still farther out from the primary nucleus the melanterite was altered to a mixture of jarosite, native sulfur, anglesite, and other sulfates. The final product was limonite. (S. F. Emmons, 1886a ; R. D. Crawford and Gibson, 1925.)

Gunnison County.—Redwell Basin, Daisy mine. The external crystallography of anglesite crystals in a U.S. National Museum specimen from this locality is described by Shannon (1920). The specimen consists of ocherous and cellular limonite with many crystals in cavities and on the surface of the limonite. The larger crystals, with maximum diameters of 7 mm, are tabular; the smaller ones are more perfect and are prismatic. Redwell Basin is on the northwest slope of Mount Emmons and about 3 miles, airline, from Irwin. (S. F. Emmons, Cross, and Eldredge, 1894.)

Lake County.—Leadville district. As an intermediate product between galena and cerussite, anglesite forms crusts on nodules of partly altered galena. It was never as abundant nor valuable a mineral as cerussite. (S. F. Emmons, Irving, and Loughlin, 1927.)

Mineral County.—Creede district. Anglesite was abundant in the oxidized ore—even more so than cerussite—and extended as deep as 1,000 feet beneath the surface in the Park Regent mine. Some of it formed massive bodies in siliceous gangue and some occurred as beautiful glassy crystals in cavities of galena. (W. H. Emmons and Larsen, 1923.)

Pitkin County.—Aspen district. Anglesite, with cerussite and the secondary silver sulfide minerals, was a very abundant constituent of the rich oxidized lead-silver ores. It was associated with limonite, cuprite, minium, and a little melaconite. (Spurr, 1898.)

ANHYDRITE

$CaSO_4$

Considering the amount of gypsum in the State, the apparent paucity of anhydrite is somewhat surprising.

Eagle County.—Gypsum. Anhydrite is abundant on the dump of the Iron Nellie mine, 2 miles north of Gypsum. It is gray and massive and is genetically associated with the widespread gypsum deposits in the area, rather than with the pyrite of the ore with which it is found. (Burchard, 1911; Rogers, 1915; R. W. Stone, 1920.)

Jefferson County.—Elk Creek. A pegmatite dike on Elk Creek, near the mouth of Tarryall Creek and 5 miles from the old St. Louis Ranch, contains rare anhydrite. The principal minerals in the dike are microcline (var. amazonite), orthoclase, smoky quartz, and specular hematite. The anhydrite is transparent and a beautiful wine-red color. (Hollister, 1867; Endlich, 1878; J. A. Smith, 1883.)

Park County.—Crystallized anhydrite is reported from the old salt works in South Park (loc. 8). (Endlich, 1878.)

San Miguel County.—Iron Springs district. Small quantities of anhydrite and fluorite are present in some of the veins in this district. The chief gangue minerals are quartz with calcite, mixed carbonates, and barite. (Varnes, 1947a.)

ANKERITE

$Ca(Fe,Mg)(CO_3)_2$

[*See also* Carbonate minerals (mixed)]

Ankerite is distinguished from dolomite in that it contains more iron than magnesium. It occurs as a gangue mineral in many ore deposits, particularly those in limestone and dolomite country rocks. In addition to the occurrences given below, much of the material described as "Carbonate minerals (mixed)" is probably ankerite or at least close to it in composition.

Chaffee County.—Monarch district. Brown coarsely crystalline iron-bearing dolomite or ankerite is in the ore of the Rainbow-Eagle Bird mine. A black to bluish gray variety forms the walls of several ore bodies on Monarch Hill. (R. D. Crawford, 1913.)

Custer County.—Silver Cliff district, Bull Domingo mine. Ankerite and dolomite are gangue minerals in this mine where they form shells around nuclei of galena and sphalerite in replaced boulders of a breccia pipe. (S. F. Emmons, 1896.)

Gunnison County.—Italian Mountain (loc. 3). Warped crystals of ankerite covered by calcite crystals line a few cavities in dark-gray limestone. (Whitman Cross and Shannon, 1927.)

Gold Brick district. Small curved light-gray rhombs of ankerite are associated with pale-yellow sphalerite crystals in the Sandy Hook mine. In the Cortland mine flat rhombs occur with pyrite and quartz; in the Grand Prize mine they are intergrown with arsenopyrite. A sample from a 2-inch vein of cream-white ankerite from the Raymond mine was shown by analysis to contain 3.02 percent MnO. (R. D. Crawford and Worcester, 1916.)

Lake County.—Leadville district. The only recorded occurrence of ankerite is in the Mikado mine where it lines cavities in sphalerite. It is possibly much more abundant elsewhere but has not been recognized because of its similarity to other carbonate minerals. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata and Montezuma Counties.—La Plata district. Ankerite is abundant in some places. It fills open spaces in quartz and replaces pyrite; it is in turn replaced by chalcopyrite, bornite, and tetrahedrite. (Galbraith, 1949.)

Ouray County.—Ouray district, Mineral Farm mine. Ankerite, which contains about twice as much calcium as iron and magnesium, occurs in a replacement deposit in this mine. (Burbank, 1940.)

Park County.—Alma district. Along Platte Gulch in the northern part of the district small amounts of ankerite are widespread in most veins and abundant in others. The fresh mineral is white but it weathers buff to dark brown. (Behre, 1953.)

Park and Summit Counties.—Montezuma district. Ankerite, which contains so much iron and manganese that it might be called impure siderite, is a common gangue mineral in many galena-sphalerite veins and is also abundant as a wallrock alteration mineral in many places. In the veins, most of it occurs as light-pinkish-brown compact aggregates with curved cleavage faces. Much of the ankerite is later than the sulfides, but in some veins it becomes more abundant toward the bottoms of the ore shoots and may have preceded the ore minerals. (Lovering, 1935.)

Teller County.—Cripple Creek district. Ankerite is a constituent of the wallrocks in the Gold King and other mines. (Lindgren and Ransome, 1906.)

Front Range ore deposits, general.—Carbonates accompanied and succeeded the ore stage in most deposits. Replacement of wallrocks by siderite and ankerite is very common near strong lead-zinc-silver veins, but rare near gold veins. Calcite is the chief postore carbonate mineral. (Lovering and Goddard, 1950.)

ANNABERGITE

$Ni_3(AsO_4)_2 \cdot 8H_2O$

Annabergite has been reported from only 3 localities in the State; 2 of these occurrences are well authenticated, but the exact locations of all 3 are doubtful.

Fremont County.—Pine Creek, Gem mine (loc. 9). Annabergite, as crystalline coatings or pale-green to rich apple green minute globular aggregates, occurs as an alteration of niccolite. The mineral is closely associated with fine needles of aragonite. (Genth, 1886—analysis.)

Custer County.—Near Rosita-Silver Cliff district. Randall reports annabergite from mines near this district and also from a locality 6 miles west of Rosita.

Dana (1892) lists annabergite from the Verde mine, on the east slope of the Sangre de Cristo Mountains, where it was associated with chalcopyrite, tetrahedrite, and pyrite. The Verde mine, whose location is not known, may be the one referred to by Randall as west of Rosita.

ANORTHITE

[*See* Feldspar group, plagioclase series]

ANORTHOCLASE

[*See* Feldspar group]

ANTHOPHYLLITE

[*See* Amphibole group]

ANTIGORITE

[*See* Serpentine]

ANTIMONY

Sb

Native antimony is reported only as minute crystals in ores of the Gold Hill district, Boulder County. (Endlich, 1878.)

ANTRIMOLITE

[*See* Mesolite]

APATITE

[*See* Fluorapatite]

APHROSIDERITE

[*See* Chlorite group]

APOPHYLLITE

$KF \cdot Ca_4(Si_2O_5)_4 \cdot 8H_2O$

In addition to the Table Mountain locality where it is associated with the true zeolites, apophyllite has been reported only from Hunts Peak, in Fremont County, and from basalt flows near the San Luis Valley. (J. A. Smith, 1883; George, 1913.) It is probably present in other zeolite localities but either has not been identified, or recorded occurrences have escaped me.

Jefferson County.—Table Mountain (loc. 18). In their original descriptions of the zeolites of Table Mountain, Whitman Cross and Hillebrand (1882a, 1882b, 1885) say that apophyllite occurs in well-formed white crystals, some of them with a greenish tint; the larger crystals occurred in smaller cavities in the basalt, whereas larger cavities contained smaller crystals.

Patton (1900) found apophyllite to be very rare, as snow-white opaque crystals ¼ to ½ inch long, always imbedded in analcite.

Two places on North Table Mountain have recently yielded good crystals. One of these is at the head of an old rock haulageway on the west side of the mountain, in broken rock near the mouth of an old tunnel. The other site is in a small quarry one-half mile west of the big quarry on the south side of North Table Mountain. (J. W. Adams, written communication.)

AQUAMARINE

[*See* Beryl]

ARAGONITE

$CaCO_3$

Aragonite, the orthorhombic form of calcium carbonate, occurs in several veins and a few caves. It is probably far more widespread than the literature indicates.

Clear Creek County.—In mines in the Idaho Springs and Georgetown districts. (Endlich, 1878; J. A. Smith, 1883.)

Del Norte County.—In trachyte. (Endlich, 1878.)

El Paso County.—Manitou. The beautiful white stalactites, stalagmites, and encrustations of the caves at Manitou are largely aragonite (Randall).

Gunnison County.—Snowmass Mountain area. A small amount of aragonite occurs as radiating needles on chalcocite, and in cavities in calcite in the Black Queen mine. (Vanderwilt, 1937.)

Jefferson County.—Table Mountain (loc. 18). Aragonite is associated with zeolites in cavities in the basalt flows. (Endlich, 1878; Whitman Cross and Hillebrand, 1882a; 1885.)

Lake County.—Leadville district. Even more than calcite, aragonite is largely confined to the oxidized ores or to the walls of mine workings. It forms radiating columnar aggregates and, although associated with oxidized zinc ores, has not been found in contact with zinc minerals. The zinc-bearing variety, nicholsonite, is described separately below. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata and San Miguel Counties.—I have noted beautiful cave pearls as much as 1 inch in diameter and made up of concentric layers of aragonite in "nests" of aragonite on the floors of old mines and beneath water drips in both the La Plata and Rico districts. They are probably present in many other mining districts but have not been recorded. The best known occurrence of cave pearls is in the lower levels of the Carlsbad Caverns, N. Mex. (Hess, 1929; Davidson and McKinstry, 1931.)

Larimer County.—Aragonite has been found in many localities in Larimer County by R. G. Coffin (written communication). The distribution of the geologic units in which he found the mineral suggests that equally alert observers would find it in several other counties.

The Lykins formation contains pseudohexagonal yellow to red tablets of aragonite as much as 3 inches in diameter in the following localities: east of Owl Canyon, Campbell Spring Draw, Sand Creek, and Boxelder Creek. One of these crystals was found on X-ray examination to be dolomite; apparently it was a pseudomorph after aragonite. (A. J. Gude, oral communication.)

White incrustations of aragonite line caves in the Ingleside formation.

Brown compact "Mexican onyx" occurs east of the Pinon Pines district in the gypsum of the Lykins formation.

White to yellow compact onyx occurs in caves in the Ingleside formation at the Ingleside quarries, at Pinon Pines, and in Owl Canyon.

Large bivalve shells of the Niobrara formation are composed of aragonite.

Park County.—Beautiful snow-white and cream-colored aragonite is reported from a cave, whose location is "secret." (Randall.)

Rio Grande County.—Aragonite is reported "above Fir Creek." (Endlich, 1878.)

Hot-springs localities.—The deposits around many of the hot springs in the State, such as those at Pagosa Springs, Archuleta County; Poncha Springs, Chaffee County; Glenwood Springs, Garfield County; Steamboat Springs, Routt County, and many others, are almost certainly composed largely of aragonite. The chemistry of the spring water has been studied extensively, but no one seems to have been interested in the solid deposits of mineral matter. (George and others, 1920.)

Aragonite varieties NICHOLSONITE* and TARNOWITZITE

Zincian and plumboan aragonite

The zinc- and lead-bearing varieties of aragonite, both ill defined, are called nicholsonite and tarnowitzite, and have been described in two localities:

Garfield County.—Near Glenwood Springs, Maid of Erin claim. Nicholsonite occurs in this claim, at the head of East No Name Creek, 7 miles north of Glenwood Springs. The mineral, whose zinc content varies in different layers, occurs in the upper part of the Leadville limestone with hemimorphite and smithsonite. All three minerals are oxidation products of a lead-zinc deposit. (E. P. Chapman, Jr., written communication.)

Lake County.—Leadville district. In addition to normal aragonite, the zincian and plumboan varieties have each been described from this district. G. M. Butler (1913), who named the material nicholsonite, describes it from the oxidized manganese-iron ore in the Blue limestone; it contained as much as 10 percent zinc. Some of Butler's original material was studied spectrographically by Faust (1950) ; he found it to contain no zinc, but 0.19 percent SrO. E. P. Chapman, Jr. (written communication) found what he identified as tarnowitzite in the Evelyn mine, in the south drift of the 900-foot level, near the top of an incline. It contained 3 to 10 percent lead and was darker than hemimorphite with which it was associated in low-grade carbonate ore.

ARFVEDSONITE

[*See* Amphibole group]

ARGENTIAN GOLD

[*See* Gold]

ARGENTIAN TETRAHEDRITE

[*See* Tetrahedrite]

ARGENTITE

Ag_2S

[*See also* Acanthite]

Argentite is one of the more important sources of silver in many mining districts. In addition to its widespread occurence in megascopic masses and crystals, argentite in microscopic intergrowth is probably responsible for much of the silver in silver-bearing galena, arsenopyrite, and other minerals. Much of it is primary, but some is of undoubted secondary origin. Probably some, if not all, of the material described as acanthite is actually argentite; this is discussed under acanthite.

Boulder County.—Caribou district. Argentite is reported by Endlich (1878), and H. D. Wright (1954).

Chaffee and Gunnison Counties.—Tincup, Monarch, and Tomichi districts. Argentite is locally important among the oxidation products of galena and sphalerite in the bed-replacement ores. It is rare in the quartz-pyrite veins (Dings and Robinson, 1957). The high-grade ore from the lowest level of the Madonna mine, Monarch district, contains much argentite as small grains. Nearly pure, well-crystallized argentite has been seen in the Moose mine in the same district. (R. D. Crawford, 1913.)

Winfield. Argentite is reported with bismuthinite by E. P. Chapman, Jr. (written communication).

Clear Creek County.—Georgetown and Idaho Springs districts. Argentite is widespread and abundant. In places it occurs as cubes as much as ½ inch in diameter, elswhere as incrustations or fernlike branching and reticulated aggregates. In the Pelican-Dives mine it is altered to acanthite (Draper, 1897).[2] According to Randall (1932), some wallrocks, for example granite in the Mendota mine and dike rocks in the Seven-Thirty mine at Georgetown, contained from 1 to 5 percent argentite. Much of this material is said to have been thrown over the dumps. A 1-ton shipment of galena-argentite ore from the Equator

[2] Draper, op. cit.

and Terrible lodes at Georgetown yielded $2,600 in silver and lead. (Endlich, 1878.)

Silver Plume district. The J. S. Randall collection contained a specimen of cuprian argentite, formerly called jalpaite, found in 1892 in the Pay Rock mine at Silver Plume. It was somewhat harder than argentite and less sectile and malleable. Three assays by Robert Neuman showed 13.4 percent copper and traces of lead and iron, in addition to the silver and sulfur that characterize argentite. (Randall).

Custer County.—Silver Cliff-Rosita district. Argentite was a very important product of many of the mines. In the Twenty-six mine a 4-inch specimen across a vein showed the following succession of zones from each wall: zone 1, a band of mixed barite and calcite; zone 2, a sheet of banded country rock containing a zone of argentite; zone 3, the center of the vein filled with crystalline barite. In places the band of country rock (zone 2) was completely replaced by argentite. (S. F. Emmons, 1896.)

Eagle County.—Gilman (Red Cliff) district. Argentite is reported by R. D. Crawford and Gibson (1925).

Gunnison County.—Gold Brick district, Cortland mine. A specimen from this mine shows massive argentite containing wire silver, galena, and sphalerite. (R. D. Crawford and Worcester, 1916.)

Irwin (Ruby) district. In the Bullion King mine, the most valuable ore minerals were argentite, proustite, and pyrargyrite. These were associated with sphalerite, pyrite, quartz, and a little galena. In the Forest Queen mine, the chief ore is arsenopyrite and the rich silver minerals, which cement fault breccia. (S. F. Emmons and others, 1894.)

Elk Mountains. Argentite is reported by Hillebrand (1884).

Hinsdale County.—Lake City. Argentite is reported by Irving and Bancroft (1911).

Lake County.—Leadville district. Despite the enormous production of silver from this district, primary silver minerals are seldom apparent in the ore; most of the silver is concealed in or among the base-metal sulfides, probably as argentite. In the silver-bismuth ore, however, as in large cavities in quartzite of Cambrian age in the Tucson mine, spongy argentite is intergrown with galena and bismuthinite in an outer crust that covers coarsely crystalline galena; argentite also occurs in the oxidized ores as specks in cerussite and in residual nodules of galena. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata County.—La Plata district. Argentite is reported by Galbraith (1949).

La Plata and San Juan Counties.—Needle Mountains. Argentite is reported by Whitman Cross, Howe, Irving, and Emmons (1905).

Mineral County.—Creede district. Argentite was abundant in the ores mined during the early days of the district; much of it was probably in the argentiferous galena. (W. H. Emmons and Larsen, 1923.)

Montrose County.—Cashin mine. Argentite is reported by W. H. Emmons (1906b).

Ouray County.—Ouray district. Argentite is widespread but not very abundant. In the American Nettie mine, one or two pockets of rich ore near the top of the ore body contained a mixture of native sulfur with porous black argentite. (Downer, 1901.)

Park County.—Horseshoe and Sacramento districts. Argentite is reported by R. D. Butler and Singewald (1940).

Park and Summit Counties.—Montezuma district. Argentite is not abundant, but is present in many mines. In the silver ores at the north end of Glacier Mountain, it is associated with galena, miargyrite, and pyrargyrite in a gangue of ankerite. In the banded proustite-bearing vein of the California (Bell) mine massive and finely granular argentite, partly altered to native silver, was 2 to 3 inches wide in places. (Lovering, 1935.)

Pitkin County.—Aspen district. Argentite comprised a large part of the rich silver ores of this camp. It was a late primary mineral associated with tennantite, pearceite, and others; some of it was probably also in the supergene ores. (Bastin, 1925; Spurr, 1898.)

Saguache County.—Bonanza district. Argentite is uncommon in the richer silver ores. Where present, it is associated with covellite and stromeyerite and seems to be an alteration product of the latter mineral (Burbank, 1932). Supergene argentite is reported from the Eagle vein (Wuensch, 1923).

San Juan County.—Silverton district. Argentite is not widespread nor abundant in the district as a whole. In the Ridgeway, Polar Star, and Palmetto mines, however, it formed some rich ores. (Ransome, 1901b.)

San Miguel County.—Rico district. Black rounded masses of argentite are interstitial to proustite, polybasite, and stephanite in the richer silver ores of Newman Hill. (Ransome, 1901a.)

Dunton district. In the primary ores, argentite forms irregular microscopic inclusions in sphalerite; it is locally abundant. In the secondary sulfide zone, argentite occurs as small well-formed crystals with ruby-silver minerals. (Bastin, 1923.)

ARSENIC

As

Native arsenic is reported only from the Leadville district, Lake County, where it was said to occur as very brittle nodules in "a silver-gold mine 5 or 6 miles west of Leadville." (S. F. Emmons, Irving, and Loughlin, 1927.)

ARSENOPYRITE

FeAsS

Arsenopyrite is fairly widespread and locally rather abundant in the mining districts of the State. In some places it contains significant amounts of gold or silver, and hence is an economically important mineral.

Boulder County.—Nederland tungsten district. Small amounts of arsenopyrite, associated with marcasite and ferberite, occur in ores of the Beddig and Grand Republic mines. (Lovering and Tweto, 1953.)

Conejos County.—Platoro district, Mammoth mine. Arsenopyrite is associated with quartz, petzite, argentite, pyrargyrite, and proustite. (Patton, 1917.)

Eagle County.—Gilman (Red Cliff) district. Minute amounts of arsenopyrite are associated with pyrite. R. D. Crawford and Gibson, 1925.)

Jefferson County.—Bergen Park, Park lode. This lode, which yielded silver and copper, contained some arsenopyrite. (Endlich, 1878.)

Gilpin County.—The Rio Dolores mine in the Nevada district was reported by Endlich (1878) to contain both arsenopyrite and franklinite. In other parts of the county arsenopyrite was rare, but some of it was rich in silver or gold.

In the Burroughs, Kansas, Illinois, California, and Kent County mines it occurred in both massive and crystallized form, contained much more silver than gold, and was associated with chalcopyrite and pyrite. (J. A. Smith, 1883.)

Gunnison County.—Ruby (Irwin) district. In the Forest Queen mine, arsenopyrite is abundant and intergrown with rich silver minerals. It makes up the chief ore as a cement in the fault breccia. It is commonly present in many other mines in the district. (Endlich, 1878; S. F. Emmons and others, 1894.)

Gold Brick district. Small well-formed crystals of arsenopyrite are associated with ankerite and quartz in the Grand Prize mine. Small crystals and grains are also in the Cortland vein associated with ruby- and brittle-silver minerals, galena, and quartz. (R. D. Crawford and Worcester, 1916.)

Lake County.—Leadville district. Arsenopyrite is widespread and locally abundant, and was formed during the mesothermal period of mineralization. In the Tucson mine a lens of the mineral 5 by 3 by 1 foot was parallel to the pitch of the ore shoots. Most of the material occurs as orthorhombic prisms with bases but no pyramids. (S. F. Emmons and others, 1927.)

On the dump of the First National mine in Iowa Gulch and in the Leadville Deep Mines Co. workings in Empire Gulch, Chapman (1941) reports arsenopyrite as large irregular areas and grains, intergrown with carbonates, along the sides of veins that contain galena, sphalerite, pyrite, chalcopyrite, and quartz. Arsenopyrite and galena, with some sphalerite, are curiously intergrown suggesting contemporaneity.

La Plata and Montezuma Counties.—La Plata district. Arsenopyrite is widespread but nowhere abundant. It is commonly associated with pyrite that contains tellurides of gold and silver. (Galbraith, 1949.)

Park and Summit Counties.—Montezuma district, Silver Wave mine. Arsenopyrite was seen only in this mine in barren quartz between two ore shoots on the fifth level. It formed small grains disseminated through the quartz. (Lovering, 1935.)

San Miguel County.—Telluride and Mount Wilson districts. Coarsely crystallized arsenopyrite, with crystalline quartz and a little calcite, galena and sphalerite, is associated with gold in the Mount Wilson area; it is the most abundant metallic mineral in the Tam O'Shanter, Archean, and Special Sessions mines. It has also been seen in the Yankee Boy, Smuggler, and Virginius veins. (Purington, 1898; Whitman Cross and Purington, 1899.)

Hurst (1922) found slender crystals of arsenopyrite as a wall rock-alteration mineral in the Smuggler Union mine.

ASBESTOS

[*See* Amphibole group *and* Serpentine]

ASTROPHYLLITE

$K_2(Fe^{+2}, Mn)_4Ti(Si_2O_7)_2(OH)$

El Paso County.—St. Peters Dome (loc. 5). This is one of the few known localities in the world. Long narrow brass-yellow to deep-bronze blades are imbedded in quartz and feldspar or are associated in veins with arfvedsonite and zircon. Individual blades are as much as 15 cm long. J. A. Smith (1883) and Eakins (1891a, b) also describe astrophyllite from Cheyenne Mountain; it is not known whether they refer to the St. Peters Dome locality or to a different one. (Koenig, 1877—analysis and crystallography; Lacroix, 1889; Eakins, 1891a; b—analyses.)

ATACAMITE

$Cu_2(OH)_3Cl$

Atacamite is reported only from the silver lodes on Kendall Mountain near Howardsville, Silverton district, San Juan County. (Endlich, 1878.)

AUGITE

[*See* Pyroxene group]

AURICHALCITE

$(Zn, Cu)_5(OH)_6(CO_3)_2$

Aurichalcite has been reported in very small quantities from the oxidized ores of only three places: Salida, Chaffee County; Central City district, Gilpin County, where it coated sphalerite in the Jones mine (J. A. Smith, 1883); and at Leadville in Lake County.

At Leadville it formed rare needles in cavities and veins, associated with calamine and chalcedonic quartz. It was found only in the copper-gold belt of the district, particularly in the Ibex mine. (S. F. Emmons, Irving, and Loughlin, 1927.)

AUTUNITE

$Ca(UO_2)_2(PO_4)_2 \cdot 10\text{–}12\ H_2O$

Clear Creek County.—Freeland-Lamartine district. Autunite is associated with torbernite and dumontite(?) in vugs, fractures, or gouge in the oxidized parts of several veins. No commercial deposits of uranium are known and these minerals are seldom visible in the ore. (J. E. Harrison and Wells, 1956; Sims and Tooker, 1956.)

Robineau claims. Autunite was reported from these claims, on the ridge between Clear Creek and Silver Creek, by J. S. Randall in 1886. This mineral was not found by R. U. King and Granger (1952), however, when they examined the torbernite-bearing ores.

Fremont County.—Along Tallahassee Creek, in T. 17 S., Rs. 72 and 73 W., small amounts of autunite were reported from several deposits. The autunite is disseminated in gravel deposits that are overlain by tuff. (Heinrich and Bever, 1957.)

Jefferson County.—Autunite and torbernite and metatorbernite were common constituents of the oxidized vein material from the Schwartzwalder uranium mine (loc. 15) south of Ralston Creek. They are very rarely present, however, in other deposits in the Golden Gate Canyon and Ralston Creek drainage areas. (J. W. Adams, Gude, and Beroni, 1953.)

The Black Knight vein, 2 miles south-southwest of Critchell (loc. 7), contains autunite associated with pitchblende, uranophane, becquerelite, and fourmarierite. (Vance Haynes, written communication.)

Lake County.—St. Kevin district. A uranium mineral, probably autunite, is disseminated in fine-grained silicified rock of the northeastern part of the district. (Pierson and Singewald, 1954.)

Larimer County.—Crystal Mountain district (loc. 1). Minute quantities of autunite as flakes and scales, are present as an alteration product of uraninite in several deposits. (Hanley, Heinrich, and Page, 1950; Thurston, 1955.)

Routt County.—Fish Creek district (loc. 1). Autunite and uranophane occur along the contacts between granitic rocks and biotite schist. (Beroni and Derzay, 1955.)

Saguache County.—Cochetopa district, Los Ochos mine (loc. 2). Small quantities of autunite and uranophane with even less torbernite occur as alteration products of pitchblende. (Derzay, 1956.)

San Miguel County.—Placerville district. Autunite occurs in veins 1½ miles northwest of Placerville, associated with chalcopyrite, chalcocite, gold, erythrite, vanadiferous asphalt, and mariposite. (Hess, 1913b.)

AZURITE

$Cu_3(OH)_2(CO_3)_2$

Azurite, the beautiful dark-blue carbonate of copper, is widespread in the oxidized parts of nearly all ore deposits that contain copper. Commonly associated with the green carbonate malachite, it forms stains and crusts or rarely crystals. Nowhere has it been reported in great enough abundance to form an important ore of copper and nowhere has it yielded such beautiful specimen material as that from such classic localities as Bisbee, Ariz., and Siberia. It is, however, of some value as an indication of the presence of copper minerals. The number of occurrences given below, although incomplete, indicates its wide distribution in Colorado.

Boulder County.—Ward district, Copper Rock mine. With malachite. (Worcester, 1920.)

Caribou district. With malachite as alteration product of tetrahedrite. (Endlich, 1878.)

Chaffee County.—Monarch district, Lilly and Major mines. Massive and rather abundant, with malachite. (R. D. Crawford, 1913.)

Sedalia mine (loc. 5). (Lindgren, 1908; J. W. Adams, written communication.)

Clear Creek County.—Trail Creek (Freeland-Lamartine district). Champion, Kelley, and Tennel mines. (Hollister, 1867; Bastin and Hill, 1917.)

Custer County.—Rosita-Silver Cliff and other deposits of Wet Mountain Valley; Rosita, Zoo, Markheart, and Greenhorn mines. (Endlich, 1878; Charlton, 1890.)

Fremont County.—Eight Mile Park pegmatite bodies (loc. 4). Heinrich, 1948b.)

Red Gulch deposits. (Lindgren, 1908.)

Gilpin County.—Black Hawk district, Running lode and others. (Hollister, 1867; Bastin and Hill, 1917.)

Gunnison County.—Gold Brick district, near Lamphier Lakes. As stains with malachite, limonite, and molybdenite in a pegmatite dike. (R. D. Crawford and Worcester, 1916.)

Tomichi district, Victor and Iron King mines. (R. D. Crawford, 1913.)

Hinsdale County.—Lake City district. (Irving and Bancroft, 1911.)

Jefferson County.—Cressman Gulch (loc. 6), first gulch north of Golden Gate Canyon. As coatings in a pegmatite quarry. (J. W. Adams, written communication.)

Lake County.—Leadville district. Rare. (S. F. Emmons and others, 1927.)

La Plata County.—La Plata district. (Galbraith, 1949.)

Larimer County.—Empire Copper mine; Prairie Divide; North Fork, Thompson River Canyon; Upper Redstone Canyon. (R. G. Coffin, written communication.)

Moffat County.—Blue Mountain. With carnotite. (Gale, 1908.)

Montrose County.—Cashin mine (loc. 1). (W. H. Emmons, 1906b.)

Park and Summit Counties.—Montezuma district. (Lovering, 1935.)
Fairplay. (Endlich, 1878.)

Routt County.—Hahns Peak district. (Gale, 1906; George and Crawford, 1909.)

San Juan County.—Silverton district, Kendall Mountain, near Howardsville. Small very brilliant crystals. (Endlich, 1878.)

Needle Mountains area. (Whitman Cross, Howe, Irving, and Emmons, 1905.)

Summit County.—Breckenridge district. With cerussite in Dunkin workings on the south slope of Nigger Hill. (Ransome, 1911.)

BARITE

$BaSO_4$

Barite is so widespread as a minor or major gangue mineral in ore deposits that it would be pointless to attempt a complete list of its occurrences. A few of its more important occurrences in mines are noted here, but emphasis is on the localities that have yielded good crystals or attractive specimens to collectors.

Boulder County.—Jamestown district. The dump of the Argo mine yields clusters of grayish-blue crystals of barite. (G. R. Scott, written communication.)

Custer County.—Silver Cliff and Rosita districts. Barite is very abundant in these districts and elsewhere in the Wet Mountain Valley; large amounts have been mined and shipped intermittently from veins of solid barite that are several feet wide. In the Humboldt-Pocahontas mine the ore was chiefly barite and tetrahedrite, with chalcopyrite and pyrite, and small amounts of galena, stephanite, and other silver-antimony minerals. The barite occurs as fine tabular crystals in many places. (Whitman Cross, 1896.)

Douglas County.—Castle Rock area. Well-shaped crystals as much as 3 inches long, some of them blue, occur in cavities in the rhyolite that caps buttes between Palmer Lake and Sedalia. (Richardson, 1915.)

Hinsdale County.—Carson Camp district. Barite is the most abundant gangue mineral; it is associated with enargite and lesser amounts of pyrite, chalcopyrite and famatinite. Galena and sphalerite are the next most abundant. (E. S. Larsen, Jr., 1911.)

Jefferson County.—Clear Creek quarry. In the rock quarry at the mouth of Clear Creek Canyon on the north side of the creek barite occurs in a high-angle fault zone. Sharp yellow-brown crystals as much as 2 inches long are associated with nailhead crystals of calcite. (J. W. Adams, written communication.)

Mineral County.—Creede district. Barite is abundant in several mines, especially near the surface. In the Bachelor and Commodore mines, however, it extends to the lowest levels. Commonly white at depth but pink near the surface, it is probably of both primary and secondary origin. (W. H. Emmons and Larsen, 1923.)

Wagon Wheel Gap (loc. 1). Translucent crystals of barite as much as 2 inches long are perched on botryoidal masses of fluorite. The ridge east of the hot springs is strewn with many tons of large stout crystals that exhibit several crystal forms. (W. H. Emmons and Larsen, 1913.)

Park County.—Near Hartsel (loc. 4). A barite mine 4 miles southwest of Hartsel yields perfect blue crystals, singly and in groups, as much as 3 inches long. Because the depth of color increases with exposure to sunlight the prettiest specimens are to be found on the dump. (J. W. Adams, written communication.)

In the same or a nearby deposit, described as 2 miles southwest of Hartsel, in the SE¼ sec. 18, T. 12 S., R. 75 W., barite occurs as vertical veins 1 to 2 feet thick, and irregular layers in limestone. The barite crystals occur as a porous aggregate mixed with iron-stained clay; they are a slightly opaque blue, grading inward to white. (Howland, 1936.)

Park and Summit Counties.—Montezuma district. Barite is abundant in the lead-zinc ores, especially those rich in gray copper. Some barite also occurs in quartz monzonite porphyry, interstitial to quartz and orthoclase, where it seems to be a late accessory magmatic mineral. Beautiful specimens of coarsely crystalline barite, crusted with quartz, sphalerite, and galena, have been taken from the St. Johns mine. (Lovering, 1935.)

Pitkin County.—Aspen district. Barite is a common gangue mineral at Aspen, but only in the Smuggler mine has it been found as good crystals. There, cavities in the oxidized ore are lined with beautifully formed wine-yellow crystals, many containing zonal inclusions. Kemp (1889) gives many optical and crystallographic data.

In the rich polybasite ores of the Smuggler and Mollie Gibson mines, flesh-colored barite occurs as interlocking tabular crystals with interstitial polybasite. One of the chief ores on Smuggler Mountain is "crisscross spar," consisting of granular barite with narrow seams of tennanite and tetrahedrite. (Spurr, 1898.)

Pueblo County.—Nepesta quadrangle. Two localities are noted: one on the east side of Chicosa Creek in T. 22 S., R. 60 W., the other 3 miles west of Fowler in T. 22 S., R. 62 W. At both localities limestone lenses in the upper Apishapa shale contain ramifying cavities partly or entirely filled with pale-blue barite crystals. (Fisher, 1906.)

Apishapa quadrangle. On the upland in the northeastern part of the quadrangle weathering of the Apishapa shale has left the surface strewn with fragments of translucent to transparent crystals. Also, concretions near the top of the Carlile shale contain a few nice crystals of barite and calcite. (Stose, 1912.) North of Pueblo some baculites fossils are replaced by barite. (G. R. Scott, written communication.)

Weld County.—"Sterling area" (loc. 1). This locality for blue barite crystals, known throughout the mineralogical world, was known at least as early as 1878 when it was mentioned by Endlich. Although commonly described in the literature as near Sterling, in Logan County, it is actually near Stoneham, in Weld County, 25 miles west of Sterling. The country rock is altered volcanic ash, which contains crystals of barite ½ to 4 inches long. They are grayish blue to light blue, all translucent, and some as clear and fine in color as aquamarine gems. Many loose crystals can be found on the hill slopes; others are in crystal-filled cavities in the tuff, and still others are in calcite veins. (Ellermeier, 1948a; Pearl, 1958.)

BARKEVIKITE

[*See* Amphibole group, subspecies arfvedsonite]

BASSETITE

$Fe(UO_2)_2(PO_4)_2 \cdot 8H_2O$

Boulder County.—Yellowish-green crystals identified by X-ray pattern as bassetite occur in the Fairday uranium vein deposit on Overland Mountain. The mineral coats fractures and is associated with uraninite and coffinite. (W. N. Sharp, oral communication, 1959.)

BASTNAESITE

$(Ce,La)(CO_3)F$

Bastnaesite, a rare fluocarbonate of the cerium group of rare earths has been found as an alteration product of other cerium minerals in five widely separated localities.

Boulder County.—Jamestown district (loc. 2). Bastnaesite identified by microscopic means has been seen in only a few of the coarser specimens of cerite from Jamestown, but it is probably present in all the cerite. Other associated minerals of interest are allanite, tornebohmite, monazite, and uraninite. (Goddard and Glass, 1940.) Foster (1949) and Donnay and Donnay (1953) used some of the material collected by Goddard and Glass in general studies, but added no new data on the occurence itself.

El Paso County.—Bastnaesite has apparently been found in at least three different places in the Pikes Peak region, but some of the locality descriptions are vague. The first discovery listed simply as "near Pikes Peak," was by Allen and Comstock (1880). Their material, of which they give chemical analyses, consisted of 12 fragmental and whole crystals as much as 1 inch in diameter, mostly free but some attached to feldspar. The central parts of the crystals consisted of "tysonite," described as a new mineral by Allen and Comstock but since found to correspond to fluocerite, altered on the outer parts to bastnaesite. Dana (1884), who described the crystallography of the tysonite (fluocerite), and Hillebrand, (1899; 1900) who provided new analyses of both minerals, narrowed this original locality to "west of Cheyenne Mountain." Writing in 1929, Over states that although the original bastnaesite-tysonite locality is lost, it was at the base of Stove Mountain, (loc. 6) just west of Cheyenne Mountain and 6 miles southwest of Broadmoor.

G. R. Scott (written communication) has since recovered what he thinks is the original location below the road at Fairview. From a pocket of iron-stained kaolinite he collected about 15 translucent amber crystals of bastnaesite three-eighths inch in diameter and as much as 1 inch long. Some of the crystals penetrate crystals of hematite after siderite and are associated with smoky quartz, microcline-perthite, small crystals of columbite, and crystals of an unknown radioactive mineral.

Hidden (1891) describes a second locality for bastnaesite and tysonite (fluocerite) and gives additional analyses. His locality is "near Manitou," which is probably the same as the Crystal Park (loc. 2) occurrence described by Kunz

(1890b). Hidden's material consisted of a group of hexagonal tabular crystals weighing 6 kilograms. The individual crystals, which were nearly 2 inches in diameter, were clear deep-brown bastnaesite; the interiors were wax-yellow unaltered tysonite (fluocerite). Hidden also notes a white earthy mineral that he thought might prove to be a mixture of bastnaesite and lanthanite. The specimen described by Kunz was a single crystalline cleavage mass of tysonite (fluocerite), weighing fully 6 kilograms and covered with bastnaesite.

Bastnaesite is associated with the remarkable crystal of genthelvite described by Scott (1957). This was from a miarolitic cavity in granite on the northeast spur of Stove Mountain (loc. 6) in the NE¼NW¼NW¼ sec. 4, T. 15 S., R. 67 W. This is almost certainly a different locality from the original one of Allen and Comstock.

Glass and Smalley (1945) record a new optical study of an old specimen, probably from one of the above localities. They describe it as a crystalline mass, nearly fist sized, composed of reddish-brown laminated bastnaesite in parallel growth with grayish-buff tysonite (fluocerite). See also Donnay and Donnay (1953.)

Gunnison County.—Powderhorn district. Small quantities of bastnaesite have been identified by X-ray means among other rare-earth minerals in a single thorium prospect in this district. See "Thorite." (Olson and Wallace, 1956.)

Park County.—The Teller pegmatite (loc. 9), which is rich in xenotime and gadolinite, contains a very fine grained high-index carbonate that is doubtfully referred to as bastnaesite by Glass, Rose, and Over (1958).

Teller County.—Bastnaesite has been identified in material from the Black Cloud pegmatite (loc. 1) between Florissant and Divide; it is associated with fluocerite. (Haynes, 1958.)

BAUXITE

Chaffee County.—Buena Vista. Bauxite is a rock commonly composed of the minerals gibbsite, boehmite, or diaspore. Only one poorly substantiated occurrence has been recorded. An extensive bed of bauxite, containing 61.32 percent Al_2O_3, 5.57 percent SiO_2, 3.39 percent Fe_2O_3, and 29.14 percent H_2O is reported from near Buena Vista. (Ohly, 1901.)

BECQUERELITE

$7UO_3 \cdot 11H_2O$(?)

Becquerelite has been identified in ore from the Black Knight vein 2 miles south-southwest of Critchell, Jefferson County (loc. 7). It is associated with pitchblende, uranophane, autunite, and fourmarierite. (Haynes, 1958.)

BEEGERITE†

$Pb_6Bi_2S_9$

Aside from occurrences in Siberia and Switzerland, beegerite, which was first found in Colorado, seems to be largely confined to this State. It is essentially a lead-bismuth sulfide, with some copper and silver possibly substituting for lead.

Ouray County.—Ouray district, Old Lout mine. A fine granular lead-gray mineral identified as beegerite is associated with pyrite, chalcopyrite, barite, and quartz. In addition to the essential elements, Genth's (1886) analysis shows appreciable quantities of silver, iron, and copper; the latter two he considers to be chalcopyrite impurities. (Genth, 1886; Koenig, 1885a; b.) Harcourt (1942) found that a specimen of supposed beegerite from this type locality was actually a mixture of schirmerite and matildite.

Park County.—Montezuma district, Baltic Lode. The Baltic lode on Revenue Mountain near the head of Geneva Gulch is the type locality for beegerite. Koenig (1881d) describes it as brilliant metallic light- to dark-gray cubic crystals, with cubic cleavage. He gives an original analysis by Genth, which shows a little copper but no silver, although the Baltic lode produced much silver. Lovering (1935) found beegerite as light-gray masses intergrown with quartz, and as small well-defined isometric(?) crystals.

Summit County.—Treasury Vault mine. Beegerite forms small particles and patches as much as 10 mm in diameter disseminated through quartz and associated with pyrite, a little chalcopyrite, and a yellowish earthy coating that may be bismite. The analysis agrees with that for argentian beegerite. (Genth, 1886.)

BEIDELLITE†

$Al_2(AlSi_3)O_{10}(OH)_2(H_2O)_4Na_{0.32}$

[*See also* Montmorillonite *and* Clay minerals]

Beidellite, one of the clay minerals, was first identified in Colorado and named for its type locality, Beidell. Since then, it has only been reported from three other mining districts, but is probably much more widespread. It is currently considered to be an aluminian montmorillonite.

Boulder County.—Nederland district. Beidellite is probably the most abundant clay mineral in the tungsten veins, where it occurs chiefly as fillings in vuggy openings near the tops of ferberite ore shoots. It is also the most common clay mineral in the late silver ores of the district. (Lovering and Tweto, 1953.)

Mineral County.—Wagon Wheel Gap (loc. 1). Beidellite is a constituent of the vein matter in the fluorite-barite deposit. (Ross and Shannon, 1925b.)

Ouray County.—Ouray district. Beidellite occurs as an early gangue mineral in the tetrahedrite-bearing veins of the Virginius, Terrible, and other mines south of Stony Mountain. Moehlman (1936b) believes that it was formed by alteration of the fault gouge.

Saguache County.—Beidell. Beidell, a mining camp that is not shown on modern maps, is the type locality of beidellite. E. S. Larsen Jr. and Wherry (1916) first described it as leverrierite, but later studies showed them that it was a new mineral which they called beidellite. (E. S. Larsen Jr. and Wherry, 1925; Ross and Shannon, 1925b.) Grim and Rowland (1942) found that beidellite from the type locality, Wagon Wheel Gap, and elsewhere was a mixture, and urged that the name be dropped. Ross and Hendricks (1945), however, redefine the species and believe it should be retained.

It was abundant on the dumps of the Buckhorn and Esperanza mines and was also found in several other old gold-silver mines. It was reported to occur as irregular bodies several feet across, associated with manganese oxides and a little quartz. The cited references give complete descriptions of the optical and chemical properties of the mineral.

The site of the abandoned mining town of Beidell is in T. 43 N., R. 6 E. near the head of Beidell Creek and on a divide between that stream and Lime Creek. It is 8 miles, airline, northwest of La Garita and probably can be reached by a trail up Beidell Creek.

BENJAMINITE

$Pb(Cu,Ag)Bi_2S_4(?)$

[*See also* Cosalite]

San Juan Mountains.—Shannon (1925) who first described and named this mineral of somewhat uncertain composition, found that most of the published analyses of cosalite from the San Juan Mountains were suspiciously like those for benjaminite; he felt that possibly all of the cosalite occurrences should be ascribed to benjaminite. No further studies of specimens from the San Juan Mountains have come to my attention.

BENTONITE

[*See* Montmorillonite]

BERTHIERITE

$FeSb_2S_4$

Gunnison County.—Vulcan district (loc. 5). The relatively rare iron-antimony sulfide berthierite, has been reported only once from Colorado. Rickard (1903) notes a single specimen from the Good Hope mine, which is better known as the type locality of the copper telluride minerals rickardite and weissite. The specimen contained fine needles of berthierite that resembled stibnite.

BERTRANDITE

$Be_4Si_2O_7(OH)_2$

Bertrandite, which is near phenakite in composition but also contains water, has been found as scattered crystals in several beryl-bearing pegmatite bodies, notably those of Mount Antero. It is abundant in the Badger Flats area of Park County.

Chaffee County.— Mount Antero (loc. 3). The finest locality in North America for bertrandite, as well as for gem aquamarine and phenakite, is Mount Antero. The first description of bertrandite known to me is that of Penfield (1888), who includes an analysis and description of the crystallography. Penfield's specimens consisted of small (5 mm) rectangular blades attached to quartz and associated with beryl and phenakite. Many of the crystals were hemimorphic. Penfield (1889) further described additional material including one crystal 25 by 8 by 3 mm and cited proof of the hemimorphic nature of the crystals by use of a pyroelectric test. He heated a crystal in an air bath to 100° C., cooled it, and dusted it with red lead oxide and powdered sulfur. The flat basal plane was electrically positive and became coated with the yellow sulfur, whereas the rounded basal plane was negatively charged and was coated with red lead oxide.

Again in 1890 Penfield wrote on the occurrence, made corrections in his earlier crystallographic descriptions, and described the paragenesis of the beryllium minerals.

Crystals of bertrandite, as much as 27 by 6 mm, perched on etched crystals of blue beryl are described by Kunz (1888). Switzer (1939b) gives new crystallographic data on platy, colorless, hemisymmetric crystals as much as 1 cm long. He found that twinned crystals, heart shaped in cross section, were relatively common.

Clear Creek County.—Grover mine (loc. 3). Very small sharply defined crystals of bertrandite are associated with beryl, columbite, monazite, and fluorite in the intermediate zone of a quartz-muscovite-albite pegmatite body. (Hanley, Heinrich, and Page, 1950.)

Jefferson County.—Centennial Cone (loc. 5). On the northeast flank of Centennial Cone microscopic pinkish blades and plates of bertrandite, with bright cleavage faces, occur sparingly in aggregate pseudomorphs after beryl. The bertrandite is intergrown with quartz, sericite, and albite. (Waldschmidt and Adams, 1942.)

Bigger mine on Turkey Creek (loc. 3). Well-formed crystals of bertrandite occur in altered beryl. (J. W. Adams, written communication.)

Larimer County.—Crystal Mountain district (loc. 1). Colorless twinned crystals of bertrandite were found in a single tiny miarolitic cavity in the Hyatt pegmatite. Other minerals are beryl, quartz, sericite, apatite, fluorite, and tourmaline. (Thurston, 1955.)

Park County.—Badger Flats area (loc. 2). Bertrandite is sufficiently abundant to be an important ore of beryllium in the Boomer and nearby mines and prospects. It occurs as small hard white grains interstitial to crystals of altered beryl. Some bertrandite is also imbedded in crystals and grains of beryl but it is inconspicuous there. (W. R. Griffitts, oral communication.)

BERYL

$Be_3Al_2(SiO_3)_6$

Scattered crystals of beryl, the chief source of the metal beryllium, are to be found in a great many pegmatite bodies in different parts of Colorado. In only a few districts, however, is the beryl sufficiently concentrated to be mined for that mineral rather than as a minor byproduct from the production of feldspar, mica, or other minerals. The pegmatite areas that seem to be most promising as commercial sources of beryl are the Crystal Mountain and Hyatt deposits, Larimer County, and the Eight Mile Park and Devils Hole deposits, in Fremont County.

In addition to its occurrence in pegmatite dikes, beryl is a vein mineral in two districts: the Badger Flats area, Park County, and the Browns Canyon area, Chaffee County. The former area has the largest production and the largest apparent reserves of any beryl deposit in the United States. In both areas the deposits are transitional between pegmatite dikes and hydrothermal veins.

In addition to the occurrences of common beryl just noted, Mount Antero and the surrounding area in Chaffee County has long been known as a rich source of crystals of the beautiful light-blue gem variety, aquamarine; hundreds of gems have been recovered from this locality. This locality is at an altitude of more than 14,000 feet; hence it is famed as one of the highest known gem localities in the world, exceeded in height only by the sapphire deposits of Kashmir. (Gaines, 1957.)

All the deposits named above are described below, as well as a few others that are easily accessible or may be of special interest to collectors. Many other localities, in which beryl is present but very sparsely distributed, are listed by Hanley, Heinrich, and Page (1951), to which the reader should refer for much more information on the occurrences of beryl and other minerals in Colorado pegmatite bodies than can be given here.

Chaffee County.—Browns Creek area (loc. 1). Several beryl-bearing veins crop out on the face of Mount Antero (Switzer, 1939 a, b), but the best known example of a transitional phase between pegmatite dikes and hydrothermal veins is the deposit exposed in the California mine. This is at an altitude of 12,500 feet, on the south slope of the divide between Browns Creek and Baldwin Gulch. The vein is of quartz and about 2 feet wide. Most of the quartz is massive and milky white, but colorless to dark smoky crystals as much as 12 inches long occur in vugs. Small pockets in the vein contain crystals of colorless to bluish-green beryl from 1 to 5 cm long. A few doubly terminated aquamarine crystals have been found. Other minerals in the vein are sericite, molybdenite, molybdite, and fluorite. Some molybdenite ore has been produced and a little of this mineral occurs as inclusions in a few beryl crystals. One crystal of brannerite was found on the dump. (Landes, 1934; Adams, 1953.)

Mount Antero area (loc. 3). Mount Antero and nearby White Mountain is one of the best known mineral localities in the country, at least among students of the literature. The area is at an altitude of more than 14,000 feet and until recently has been so inaccessible that only the most active and avid collectors have ever seen the deposits. It is generally known as the finest locality in North America for gem aquamarine and for excellent crystals of phenakite and bertrandite. Specimens from here are in most museums and many gems have been cut from this material.

Near the peaks of Mount Antero and White Mountain the granitic stock that makes up these mountains contains many pegmatite bodies that are characterized by large miarolitic cavities; these cavities contain the gem-quality crystals. The cavities are found through a vertical zone of only 500 feet; below this, for a range of 2,500 feet, the pegmatite bodies are relatively coarse grained schlieren, at most only a few inches wide and a few feet long. These are so rich in common beryl as to be almost monomineralic. The dominant minerals in both the cavity and schlieren deposits are smoky quartz, perthitic microline, albite, beryl, muscovite, and fluorite. Accessory minerals are phenakite, topaz, garnet, epidote, bertrandite, calcite, biotite, magnetite, limonite, and sulfur. Topaz or gem-quality crystals of other minerals may be dominant in a single cavity. Cyrtolite was reported by Genth (1892b), but has not been found since. Brannerite(?) is sparingly present. (Adams, 1953.)

The beryl crystals in cavities, most of which are clear and of gem quality, range in color from light blue to pale and deep aquamarine green, and from very small to as much as 6 cm in length. A very few 7-inch crystals have been found, but these were fractured. Many of the crystals are deeply etched. Among the many descriptions of the locality are the following: R. C. Hills (1886, 1889), R. T. Cross (1887), Kunz (1888, 1890a), Penfield (1887, 1888, 1890), Penfield and Sperry (1888), Sterrett (1909), Over (1928, 1935), Switzer (1939a, b), and Pearl (1958).

Clear Creek County.—Beaver Brook pegmatite (loc. 1). In addition to crystals of topaz, this pegmatite body contains well-formed crystals of blue beryl, associated with green amazonstone and the common pegmatite minerals. (J. W. Adams, written communication.)

Floyd Hill beryl pegmatite (loc. 2). The soil near an outcrop of white pegmatitic quartz contains hundreds of beryl crystals as much as 6 inches long. Most are greenish blue but some are light blue and a few are cloudy aquamarine. Some of the crystals are fractured and recemented with quartz. (G. R. Scott, written communication.)

Fremont County.—Devils Hole mine (loc. 3). The Devils Hole mine, one of the more productive beryl deposits in the State, yields euhedral crystals, ranging from one-fourth inch to as much as 2 feet in diameter. Most are greenish blue to pale blue, but the color ranges from bluish white to deep brown. Columbite-tantalite in well-formed crystals, muscovite, rose quartz, and gigantic crystals of microcline add to the interest and value of the deposit. A few gemstones have been cut from the beryl. (Sterrett, 1909, 1923; Landes, 1935; Hanley, Heinrich, and Page, 1950.)

Eight Mile Park district (lo. 4). Many pegmatite bodies are known in this district. Many have been explored or actually developed, but those worked by the Mica Lode, Meyers, and School Section mines are the most productive and seem to have the largest reserves of beryl and other minerals. The beryl crystals, commonly subhedral, range from less than 1 inch in diameter to a few as much as 1 foot in diameter by 6 feet in length. They are commonly blue green but some are deep to pale blue, light green, and bright lemon yellow. White to pale-orange specimens have been found on the Mica Lode mine dump and light-red crystals occur in the Border Feldspar No. 2 prospect. The crystals are chalky to glassy and small parts of some of them are of gem quality. Triplite, bismuth carbonate minerals, and columbite-tantalite are associated with the beryl of the Mica Lode mine and elsewhere; columbite, red and green tourmaline, and natromontebrasite occur in the Meyers mine. (Headden, 1905b; Sterrett, 1909, 1923; Landes, 1935, 1939; Heinrich, 1948b; Hanley, Heinrich, and Page, 1950.)

Grand County.—Monarch Valley (loc. 1). The Green Ridge pegmatite outcrops a few hundred feet north of the junction of Arapahoe Creek with the Colorado River. It contains crystals of beryl as much as 6 inches across and several feet long, associated with feldspars and biotite and a little tourmaline, garnet, and magnetite. (Ives, 1941.)

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). Beryl is widely distributed in the district and has been found in 232 of the pegmatite bodies examined. It ranges in size from tiny crystals to some that are 2 feet in diameter. The color varies also: brown, white, gray, greenish white, pale green, greenish gray, and pale blue green have all been observed. A little pale-pink beryl, distinguishable in hand specimen only by its characteristic luster, was found in the Brown Derby deposit. (Eckel, 1933a; Staatz and Trites, 1955.)

Jefferson County.—Bigger mine (loc. 3). Light-greenish-blue to green beryl occurs in huge crystals nearly 3 feet in diameter and as much as 10 feet long. Large quantities of feldspar, a little mica, and some beryl have been produced.

Among the associated minerals are bismuthinite, bismutite, columbite, monazite, tourmaline, and zircon. Well-formed crystals of bertrandite have been found in altered beryl on the dump. (Sterrett, 1923; Hanley, Heinrich, and Page, 1950; J. W. Adams, written communication.)

Centennial Cone (loc. 5). Well-developed crystals, from ½ to 4 inches across and as much as 20 inches long, are relatively abundant in the pegmatite. They range in color from light yellow green through pale green to pale blue green. Commonly the crystals have many rectangular and diamond-shaped hopperlike pits in the prism faces; these are lined with small crystals of monazite, albite, garnet, and samarskite(?). Bertrandite has also been found here. (Waldschmidt and Adams, 1942; Hanley, and others, 1950; J. W. Adams, written communication.)

Cressman Gulch (loc. 6). Opaque rough crystals of light-green beryl, few more than 1 foot long and most of them very small, are relatively abundant in the pegmatite dike. Apatite occurs in small subhedral to euhedral crystals. (Hanley and others, 1950.)

Roscoe pegmatite (loc. 14). Beryl occurs as small crystals in this deposit, but the much rarer mineral gadolinite is of greater interest. The Roscoe dike and other smaller dikes on the hill above it also contain xenotime, fergusonite, monazite, yttrotantalite(?), uraninite, and a little molybdenite. (Vance Haynes, written communication.)

Swede Gulch pegmatite (loc. 17). Beryl, mostly altered to micaceous minerals, occurs in rough crystals as much as 1½ by 8 inches in size. Allanite, cyrtolite, muscovite, garnet, and feldspar are associated. (G. R. Scott, written communication.)

Van Bibber Creek pegmatite (loc. 19). Large coarse crystals of light-blue beryl occur in pegmatite. (J. W. Adams, written communication.)

Larimer County.—Crystal Mountain district (loc. 1). This district, an area of about 6 square miles, contains some of the richer beryl deposits in the State. Beryl is widely distributed in at least 350 pegmatite bodies, where it comprises from traces to as much as 2 percent of their bulk. Most of it is dull greenish gray to light bluish green but white, yellow, and blue varieties occur. It usually forms euhedral tapered crystals, but anhedral grains occur in many places. One crystal in the Big Boulder prospect was 6 or 7 feet long and 1.8 feet in diameter but most crystals are much smaller. Tantalite, spodumene, tourmaline, uranium minerals, and muscovite are among the associated minerals. (Sterrett, 1923; Hanley, Heinrich, and Page, 1950; Thurston, 1955.)

Hyatt beryl mine (loc. 2). The Hyatt mine, which was not discovered until 1936, is another of the few productive beryl deposits in the State that seems to have reasonably large reserves. The main pegmatite body, at least 350 feet long and 60 feet wide, is estimated to contain from 1 to 3 percent beryl in its wall and intermediate zones. In the wall zone the euhedral crystals of bluish-green to blue beryl are small with an average size of only 6 mm. In the intermediate zone, however, the crystals are as much as 1 foot in diameter and 4 feet long. They occur in clusters. Most of the crystals are fractured subparallel to the basal cleavage, and the fractures are healed by quartz or by fine-grained pegmatite. Lithiophyllite-triphylite, purpurite, uraninite, and bismuthinite are associated. (Hanley, Heinrich, and Page, 1950.)

Park County.—Badger Flats area (loc. 2). The Boomer mine and nearby mines and prospects in this area are notable not only because the beryl occurs in veins rather than in pegmatite dikes, but also because together they were the largest beryl producers in the United States in 1959, and have the largest apparent reserves. Much of the beryl occurs as anhedral and subhedral grains as much as 1 inch across. Muscovite, quartz and fluorite are commonly interstitial to the beryl. Prismatic crystals of beryl, most of them poorly terminated, are particularly well developed where they are in a matrix of siderite or where they line vugs in the veins. The prisms range from 1/16 to 1 inch in diameter and from ½ to 2 inches in length. Much of the beryl is partly or completely altered to sericite.

Bertrandite, which is locally abundant, wolframite, cassiterite, topaz, and some galena are associated with the beryl in most places. (W. R. Griffitts, written communication.)

BETAFITE

Niobate-titanate of uranium and other heavy metals

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). Small amounts of betafite were found in the Brown Derby No. 1 mine (Hanley, Heinrich, and Page, 1950). It was associated with monazite, gahnite, and columbite tantalite. The mineral was not observed by Staatz, and Trites (1955) and is probably very rare.

BEYERITE

$Ca(BiO)_2(CO_3)_2$

Fremont County.—Mica Lode and School Section pegmatites in Eight Mile Park (loc. 4).

Park County.—Meyers Ranch pegmatite (loc. 5). This rare calcium-bismuth carbonate was found at the three listed localities by Heinrich (1947). It is somewhat more abundant in the Mica Lode mine deposit than in the others, but is rare in all three. It is intimately associated with bismutite. Crystals are bright yellow, but massive beyerite ranges from white through grayish green to gray in color. Heinrich gives X-ray powder data and chemical analyses.

BINNITE

[*See* Tennantite]

BIOTITE

$K(Mg, Fe^{+2})_3(AlSi_3)O_{10}(OH, F)_2$

Biotite, the black mica, is a common constituent of many igneous and metamorphic rocks. None of these occurrences is described here. It is also widespread, but nowhere very abundant, in some pegmatite bodies, contact-metamorphic zones, and in a few hydrothermal veins.

Chaffee County.—Turret district. (loc. 2). A hydrated brown biotite, that exfoliates when heated as do the vermiculites, is abundant in veins between bodies of gray-green and black schist. It forms solid masses of crystals, each 2 to 3 inches in diameter, in shoots that are as much as 40 feet long. The mica is greenish to brownish black; the folia are flexible and inelastic. (Sterrett, 1923.)

Trout Creek Pass region (loc. 6). Biotite is a common accessory mineral in the Yard pegmatite, and locally forms books as much as 1 by 2 by 3 feet in size. These are associated with tabular bodies of muscovite on the margins of the quartz-microcline core; euxenite, monazite, and fluorite are present in some quantity as pods. (Heinrich, 1948a.) In the Crystal No. 8 mine it occurs in minor amounts in the border zone and in the core of the pegmatite. In the Clora May, biotite forms books as much as 2 feet in diameter; it is most abundant at the outer edges of the core. (Hanley, Heinrich, and Page, 1950.)

Sedalia mine (loc. 5). Biotite is a minor constituent of the amphibolite that contains a variety of copper minerals as well as spinel (gahnite?), corundum, the famous "Salida garnets," and other minerals. (Lindgren, 1908.)

El Paso County.—"Pikes Peak." The high-iron variety of biotite called siderophyllite was first found and described from this locality. It occurs as hard black well-formed crystals, associated with amazonstone and astrophyllite. Some of it is bronzy black, resembling phlogopite on the outer parts of the crystals, altered to soft rotten material toward the center. (Lewis, 1880—type description, with analysis; Clarke, 1887—analysis.)

Fremont County.—Cotopaxi mine (loc. 1). Biotite is an abundant gangue mineral in this deposit that yielded copper but is best known as a locality for gahnite. (Lindgren, 1908.)

Eight Mile Park (loc. 4). Biotite is widespread in all the pegmatite bodies, and is very abundant in some of the marginal ones. In the Border Feldspar No. 1 it forms blades as much as 6 feet long and 1½ feet wide parallel to the walls. Much of the biotite is altered to chlorite. (Heinrich, 1948b.)

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). Biotite is widespread in the lithium-bearing pegmatite bodies, especially those west of Ohio Creek, but is nowhere abundant. (Staatz and Trites, 1955.)

Jefferson County.—F. M. D. mine (loc. 9). Biotite is intergrown with hornblende, and with chalcopyrite and other copper minerals in this supposedly Precambrian copper deposit. (Lindgren, 1908.)

Pitkin County.—Snowmass area. A manganiferous biotite, probably the variety manganophyllite, is associated with braunite. (Rogers, 1946.)

San Miguel County.—Ophir district. Biotite is a minor constituent of the vein matter in the Badger mine. (Whitman Cross and Purington, 1899a.)

Teller County.—Cripple Creek district. In addition to its presence in gneiss, granite, and volcanic country rocks, dark-brown biotite is associated with pyrite as a vein mineral in the Dolly Varden vein, cut by the Ophelia Tunnel. Lindgren and Ransome, 1906.)

BISMITE

Bi_2O_3

Bismite, or bismuth ochre, is uncommonly rare as compared with the distribution of primary bismuth minerals or other oxidation products such as bismutite. Its apparent rarity may be due more to its similarity to limonite and other oxidation products than to actual scarcity. Inasmuch as X-ray data are needed to distinguish bismite from the much more common bismutite, all "bismite" occurrences may refer to bismutite.

Larimer County.—According to Randall bismite was reported from the mountains west of Fort Collins or near Cummins City in North Park. Other bismuth minerals are known in both places.

Park and Summit Counties.—Montezuma district. Canary-yellow bismite occurs in the oxidized zone of the bismuth-silver ores. The most important occurrence is the Missouri mine in Hall Valley, where it formed a noteworthy part of the ore for many years. Associated with bismutite and a little malachite, it was found as much as 200 feet below the present glaciated surface. Because the bismuth minerals oxidize more easily than chalcopyrite, fresh chalcopyrite occurs in ores where bismuthinite and emplectite are completely oxidized. (Lovering, 1935.)

The beegerite from the Treasury Vault mine is coated with a yellowish earthy material, probably bismite. (Genth, 1886.)

BISMUTH

Bi

Native bismuth has been reported widely, but nowhere does it seem to be as abundant as bismuthinite or its oxidation products.

Boulder County.—Sugarloaf district, Las Animas mine. Bismuth is associated with bismuthinite and bismutite. (Burkart, 1874; Endlich, 1878.)

Chaffee County.—Clear Creek district. Silver occurs in sooty chalcocite, intimately associated with native bismuth and bismuthinite with argentite, in galena. Neither bismuth nor bismuthinite contain much, if any, silver where associated with molybdenite, but if alone in quartz they are commonly very rich in silver. (Chapman, 1935.)

Fremont County.—Some native bismuth was reportedly shipped from Feldspar Siding in Fremont County; no details are available. (George, 1927.)

Gilpin County. Central City district. Native bismuth is present in small quantities in nearly all the pyritic ores; it is also sparingly present in some of the galena-sphalerite ores. (Bastin and Hill, 1917.)

Jackson County.—North Park. Particles of bismuth occur on bismutite in ore from Cummins City. This locality is not now known. (Pearce, 1883.)

Jefferson County.—Native bismuth occurs in the pitchblende vein deposit at the Mena mine in the Ralston Creek district (Sheridan and others, 1958).

Lake County.—Leadville district. Extensive deposits of "bismuth" are reported from Leadville; probably these refer to bismuth in bismuthinite or bismutite rather than the native element. (George, 1927; Willy, Morgan, and Ionides, 1932.)

San Miguel County.—Ophir district, Santa Cruz mine. Native bismuth and bismuthinite are probably present with schirmerite in chalcopyrite-galena ore of this mine. (Hillebrand, 1883.)

Summit County.—Breckenridge district. Native bismuth and bismuthinite were found in early placers on French Gulch. (Burkart, 1874; Endlich, 1878.)

BISMUTHIAN ULLMANNITE

[*See* Ullmannite]

BISMUTHINITE

Bi_2S_3

Bismuthinite, commonly altered to bismutite and other oxidation products and less commonly associated with native bismuth, is rather widely distributed as a vein mineral in several mining districts; it is also present in many pegmatite bodies, but in small quantities. Bismuth has been produced commercially in the State, but the total production is probably to be measured in hundreds of pounds rather than in tons.

Boulder County.—Sugarloaf district, Las Animas mine. Stout columnar aggregates of bismuthinite largely altered to bismutite pseudomorphs were characteristic of ore in this mine. (Burkart, 1874; Genth, 1874; Endlich, 1878.)

Ward district. Contains copper and iron. (Endlich, 1878.)

Chaffee County.—Granite district. (Endlich, 1878.)

Clear Creek (Winfield) district. Bismuthinite, associated with native bismuth, is likely to be very rich in silver if alone in quartz, but is barren of silver where molybdenite is present. The mineral has been found in polished sections of ore from the Banker, Douglas platt, Mike Rabbit, and other mines. In the Banker mine it is the most abundant mineral in the specimens examined, associated with pyrite, galena, polybasite, and a little molybdenite. In the Mike Rabbit mine, on the South Fork of Clear Creek 2½ miles above Winfield, the order of prominence as seen under the microscope is pyrite, specular hematite, chalcopyrite, bismuthinite, quartz, carbonate, bornite, sphalerite, and chalcocite. One specimen from this mine also contains emplectite. (Chapman, 1935.)

Gilpin County.—Central City district, Alice mine. Argentiferous bismuthinite occurs locally in ore from this mine. (Bastin and Hill, 1917.)

Jackson County.—North Park. Reported from Cummins City in North Park. This locality is now unknown. (Pearce, 1883.)

Jefferson County.—Reported from near Guy Hill (loc. 11), in a quartz vein with bismutite (Randall). This may possibly be the same locality as that reported as "near Golden" by Hillebrand (1885a) who found molybdenite associated with bismuthinite. It is probably the Guy Hill locality for chrysoberyl (J. W. Adams, written communication.)

Burroughs mine (loc. 4). Bismuthinite, largely altered to bismutite, is associated with euxenite (p. 135) and other minerals. (G. R. Scott, written communication.)

Bigger mine (loc. 3). Bismuthinite, bismutite, and other alteration products occur in rounded to thin-bladed masses in quartz, which is typically shattered near masses of bismuthinite. Other minerals of interest are beryl, columbite, and monazite. (Hanley and others, 1950.)

Lake County.—Leadville district. Bismuth in small quantities is a common constituent of both primary and secondary ores. Most of the bismuth is in the form of bismuthinite associated with argentite, occurring as microscopic inclusions in galena. Other bismuth minerals that have been reported from Leadville—kobellite, lillianite, and schapbachite—have since proved to be mixtures of bismuthinite and other minerals, at least in part. (S. F. Emmons and others, 1927.) In a more recent study Chapman (1941) found small amounts of the mineral intergrown with argentite in ore from the Lillian mine. It belongs to the bismuth (fourth and last) stage of mineralization.

La Plata County.—La Plata district. Bismuthinite was reported from the Comstock mine (Endlich, 1878.). It was not found by Whitman Cross, Spencer, and Purington (1899) nor by Galbraith (1949).

Larimer County.—Head of Big Thompson Creek. Reported with molybdenite in a pink quartz vein. (Hillebrand, 1885a.)

Hyatt beryl mine (loc. 2). Bismuthinite and bismutite occur in the inner intermediate zone of the Hyatt pegmatite. In one place it forms the matrix for large grains of perthite and quartz. Among the associated minerals of interest are beryl, lithiophyllite, and several uranium minerals. (Hanley, Heinrich, and Page, 1950; Thurston, 1955.)

Ouray County.—Ouray district, American Nettie mine. Small amounts of bismuthinite are associated with pyrite, chalcopyrite, tetrahedrite, sphalerite, and galena in ore from this mine. Tetradymite, argentite, and sulfur are also present. (Downer, 1901.)

Red Mountain district, Indiana mine. Reported by Endlich (1878).

Park and Summit Counties.—Montezuma district. Bismuthinite is the chief primary bismuth mineral in the bismuth-silver veins in the south half of the district. It commonly forms shiny lead-gray specks disseminated through pyrite-bearing quartz. Associated minerals are chalcopyrite, emplectite, and possibly schapbachite. (Lovering, 1935.) The cuprobismutite first reported by Hillebrand (1884) from the Missouri mine in Hall Valley was thought by Palache (1940) to be a mixture of emplectite and bismuthinite, but later work by Nuffield (1952) showed cuprobismutite to be a valid species.

San Juan County.—Silverton district. In the Neigold claim on the south slope of Galena Mountain, bismuthinite forms rare slender prismatic crystals with specular hematite in quartz. (Ransome, 1901b.)

San Juan and Ouray Counties.—Red Mountain district. T. E. Schwartz (1889) notes bismuthinite as abundant.

Summit County.—Breckenridge district. Bismuthinite is present in many of the moderate-temperature deposits. In the Arctic vein at the head of the Blue River it occurs with pyrite and gold in quartz. It is also reported from the Wire Patch, Cashier, and I. X. L. mines. In the latter it occurs with a very compact iron sulfide (probably marcasite), some pyrite, and quartz. (Hillebrand, 1884; Ransome, 1911; Lovering, 1934.)

BISMUTITE

Bi_2CO_5

Bismutite, the bismuth carbonate, is almost coextensive with bismuthinite, from which it is most commonly derived during oxidation. Judging by the literature, bismutite is actually more widely distributed than bismuthinite; this is true because much primary bismuthinite has been completely oxidized, but probably almost all bismutite specimens would show at least a little bismuthinite on microscopic examination.

In the following listing, most of the bismuthinite localities are omitted, but all can be assumed to contain some bismutite.

Chaffee County.—Mount Antero area (loc. 3). One of the earlier and better documented descriptions of a bismutite occurrence was that of Mount Antero material by Genth (1892a), who gives two chemical analyses. Phenakite, orthoclase, muscovite, and hematite were associated minerals. One fragment of a crystal, that was pseudomorphic after bismuthinite, was dark-greenish gray; all other specimens were grayish or greenish, in bundles of deeply striated crystals.

Trout Creek Pass area, Yard pegmatite (loc. 6). Bismutite is reported to be locally abundant in this euxenite-bearing deposit and 800 pounds was said to have been shipped. The small amount seen by Heinrich (1948a) was in quartz and ranged from gray through brown to green in color. The Luella pegmatite, 3 miles southeast of the Yard, contains the same minerals. (See also Hanley, Heinrich, and Page, 1950.)

The following are other localities for bismutite in pegmatite bodies listed by Heinrich (1947): Park County—Meyers Ranch, and Rosemont; Fremont County—School Section, Mica Lode mine, Devils Hole, and Border Feldspar No. 1; Gunnison County—Wood Gulch; Jefferson County—Burroughs, and Bigger. The Meyers Ranch, School Section, and Mica Lode mines all contain beyerite; the others are all noted under beryl.

Frondel (1943) restudied a large number of museum specimens of bismuth. He found some to be mislabeled, but listed specimens from the following localities as certainly containing bismutite: Chaffee County—Salida; Lake County—Lillian mine at Leadville; La Plata County—Las Animas River; San Miguel County—Telluride.

BOLE

[*See* Halloysite]

BOOTHITE

[*See* Chalcanthite]

BORNITE

Cu_5FeS_4

Bornite, popularly called peacock copper ore, is widespread as both a primary and secondary mineral in copper-bearing veins, but is rarely as abundant as chalcopyrite. It has also been found in very small quantities in a few pegmatite dikes. Not all of its known minor occurrences are given here.

Boulder County.—Ward district. Pyrite, both massive and as large crystals, chalcopyrite, bornite, and a little chalcocite in that order of abundance, occur in veins of coarsely crystalline milky quartz. (Walker, 1935.)

Chaffee County.—Monarch district, Highland claim. Small quantities of bornite occur in pegmatitic quartz on this claim. (R. D. Crawford, 1913.)

Clear Creek County.—Georgetown and Idaho Springs districts. Bornite is occasionally seen in ores from several mines, and some very good specimens have been collected. In the Plutus mine, Idaho Springs district, blebs of stromeyerite are distributed through a matrix of bornite. (Pearce, 1888; Bastin and Hill, 1917; Spurr and Garrey, 1908.)

Eagle County.—Gilman (Red Cliff) district. In ore from the Eagle mines, bornite forms microscopic veinlets in chalcopyrite. Most of it is probably secondary, but a little is intergrown with the chalcopyrite and may be contemporaneous with it. (R. D. Crawford and Gibson, 1925.) The Denver Museum of Natural History has a beautiful large specimen of crystalline bornite on pyrite.

Fremont County.—Guffey area, Betty mine. Significant quantities of bornite, with pyrite, sphalerite, and a little covellite are associated with abundant malachite. (Bever, 1953.)

Pine Creek, Gem mine (loc. 9). Small amounts of bornite, pyrite, chalcopyrite, and native silver are associated with niccolite and annabergite. (Genth, 1882; Whitman Cross, 1884a.)

Gilpin County.—Evergreen mine (loc. 1). Bornite is a minor and sporadic constituent of the galena-sphalerite ores of the Central City district. More important, it is a prominent constituent of the ore of the Evergreen mine, one of the few ore deposits in Colorado that is thought to be of Precambrian age.

The Evergreen deposit, outside the Central City district proper, is in the valley of Pine Creek, one-half mile south of Apex. It is confined to dikes and igneous breccia that cut the Idaho Springs formation. Chalcopyrite and bornite are the chief ore minerals; they form small irregular masses in the monzonitic dikes but are much more abundant in the breccia along the dike walls. The two minerals are in contemporaneous intergrowth and are commonly associated with garnet, which is rare elsewhere. Chalcocite is inconspicuous but is intergrown with the chalcopyrite and bornite of some specimens. In addition to the ordinary rock-forming and accessory minerals of the dikes, wollastonite is abundant. The Denver Museum of Natural History has beautifully iridescent specimens of massive bornite from this mine. (Ritter, 1908; Rogers, 1914; Bastin and Hill, 1917.)

Gunnison County.—Gold Brick district, Bornite claim. Bornite fills fractures in quartz in a vein on this claim on the southeast shoulder of Henry Mountain. (R. D. Crawford and Worcester, 1916.)

Larimer County.—North Fork, Big Thompson River. On Redstone Divide, bornite occurs as granules and small isolated masses associated with fluorite and malachite. (R. G. Coffin, written communication.)

Moffat County.—Blue Mountain. Bornite, with malachite, azurite, and several other copper minerals, is a minor constituent of the carnotite-bearing ores of Blue Mountain, near Skull Creek, 15 miles north of Rangely. (Gale, 1908.)

Montrose County.—Cashin mine (loc. 1). This well-known red-bed copper deposit in sandstone contains bornite, together with covellite, chalcocite, native copper and silver, cuprite, azurite, and malachite. Gangue minerals are kaolin, crushed sandstone, calcite, barite, and quartz. (W. H. Emmons, 1906b; Fischer, 1936.)

Pitkin County.—Aspen district. Bornite is rare in the Aspen ores. With galena, sphalerite, pearceite, argentite, and calcite it cuts the older tennantite as replacement veinlets. (Spurr, 1898; Bastin, 1925.)

Routt County.—Hahn's Peak district. Chalcopyrite, with less bornite and chalcocite, is present in the mines on Farwell Mountain, in the Snowbird mine north of Columbine, and in the Slavonia area near the head of Elk River. (George and Crawford, 1909.)

Saguache County.—Bonanza district. Bornite is present in the Rawley, Joe Wheeler, and St. Louis veins and probably occurs in small quantities in others. It is not as abundant as chalcopyrite, but is much more abundant than enargite. In vugs it forms rounded crystals with imperfect curved faces, associated with crystals of chalcopyrite and tennantite. (Burbank, 1932.)

San Juan County.—Silverton district. Bornite, some of it rich in silver, was abundant in the ores mined during the early days of the Red Mountain area. Commonly associated with chalcocite and chalcopyrite, some of the bornite contained embedded crystals of barite. (Ransome, 1901b.)

BOULANGERITE

$Pb_5Sb_4S_{11}$

Gunnison County.—Ruby-Elk Mountain district, Domingo mine. The Domingo and nearby mines, near the north end of the Ruby Range, on the divide between

Baxter Basin and Dark Canyon, have yielded the only specimens of boulangerite in the State; these specimens have had a bewildering history.

A mixture of boulangerite and other minerals was first described as a new but unnamed mineral by Eakins (1888a, b); Groth (1889) named it domingite. Eakins (1890a) promptly renamed it warrenite, but both of these new names were used interchangeably for some years. Eakins' material, of which he gives an analysis and a formula of $3(Pb,Fe)S \cdot 2Sb_2S_3$, consisted of aggregates of small acicular crystals, forming mottled woollike masses in cavities of siliceous gangue. The supposed mineral was dull grayish black, partly iridescent.

L. J. Spencer (1907) examined a different specimen of warrenite from the same mine. This one was in rhodochrosite which contained a few specks of tetrahedrite, pyrite, and arsenopyrite. Spencer concluded from his study of the specimen and Eakins' analysis that the woollike mineral was jamesonite and that the names warrenite and domingite should be discarded. Spencer's conclusions were confirmed by Schaller (1911b) who gave new analytical data. But the discrediting of Eakins' wooly mineral was not yet complete! Robinson (1949) reexamined some of the original warrenite material using modern mineralogic methods. He found one specimen to consist of boulangerite; most other specimens proved to be owyheeite and several others were jamesonite.

As if to further add to the confusion, in the same reports in which he described warrenite, Eakins (1888a, b, 1890a) also described and analysed another lead sulfantimonide, associated with pyrite and sphalerite. He identified this mineral, which was from the mines of Baxter Basin, not far from the "warrenite" locality of the Domingo mine, as freieslebenite. This too was soon discredited when mineralogists showed that Eakins' analysis was obviously that of boulangerite (L. J. Spencer, 1907). Thus from a supposedly new mineral, which bore 2 names, have come authenticated occurrences for 3 minerals—boulangerite, jamesonite, and owyheeite.

BOURNONITE

$PbCuSbS_3$

Although one of the most common of the sulfosalts, bournonite has been reported from only three places in Colorado.

Clear Creek County.—Georgetown district, Terrible mine. Small crystals. (Endlich, 1878.)

Eagle County.—Gilman district. Bournonite is among the minerals found in extremely small amounts in copper-silver chimney deposits associated with replacement bodies in limestone. The galena in pyrite-chalcopyrite ore contains inclusions of hessite, petzite, and gold. Vugs in the ore contain tiny crystals of freibergite, polybasite, stromeyerite, bournonite, and schapbachite. (Tweto and Lovering, 1947.)

San Juan County.—Silverton district. Arsenian bournonite occurs at the Zuni mine in small vertically striated prisms with pyrite and zunyite (Hillebrand, 1884; Ransome, 1901b). The mineral is also reported as widely associated with galena in the mines of Bear and Anvil Mountains (Randall). One polished section of ore from the Yankee Girl mine at Red Mountain showed many microscopic residual areas of probable bournonite; it was largely replaced by stromeyerite and chalcocite. (Bastin, 1925.)

BRANNERITE

Complex uranium titanium oxide

Chaffee County.—Browns Creek area, California mine (loc. 1). A single specimen of brannerite, a mineral which has been reported from only a few localities in the United States, was found on the dump of the lower adit of the California mine. This mine is opened on a quartz vein that contains beryl, molybdenite, fluorite, and other minerals (Landes, 1934). The brannerite specimen, which was a black incomplete prismatic crystal 5 mm in diameter, was found by Adams (1953). Its identity was confirmed by quantitative spectrographic analyses and X-ray powder patterns.

Gilpin County.—Crystals of brannerite from an unknown locality in Gilpin County have been identified by Vance Haynes (written communication.)

BRAUNITE

$3Mn_2O_3 \cdot MnSiO_3$

Braunite, a comparatively rare mineral in the United States, has been found only once in Colorado, but the occurrence is well authenticated. It is in a prospect one-half mile northwest of Snowmass post office, Pitkin County, in the Maroon formation and 250 feet above the Roaring Fork River. The braunite is massive, black, and metallic, with cavities that contain minute pseudooctahedral crystals that are so characteristic of this species. It is very slightly magnetic. Associated minerals are calcite, barite, a pleochroic biotite that is probably manganophyllite, muscovite, quartz, microcline, and plagioclase. The deposit and the braunite are probably of hydrothermal origin. (Rogers, 1946—includes crystallography.)

BRAVOITE

$(Ni,Fe)S_2$

[*See also* Polydymite]

Boulder County.—Gold Hill district (loc. 1). Bravoite is one of the rare nickel minerals in ore from the Copper King mine. With a little niccolite and pyrite it replaces and veins the older minerals; it is intimately associated with violarite. (Goddard and Lovering, 1942.)

BRITTLE SILVER

[*See* Stephanite]

BROCHANTITE

$Cu_4(SO_4)(OH)_6$

Brochantite, one of the oxidation products of primary copper minerals, has only been reported twice. Like other sulfate minerals of the oxidized zone it is possibly much more widespread than the record indicates.

Chaffee County.—Monarch district. Large quantities of very pure brochantite were found in the oxidized parts of some of the copper-bearing deposits. It formed small crystals and aggregates of crystals, mixed with iron oxide minerals. (R. D. Crawford, 1913.)

Moffat County.—Blue Mountain district. Blue Mountain, which is near Skull Creek, 15 miles north of Rangely, was one of the earlier localities at which carnotite was discovered. It occurred in Jurassic sandstone, associated with malachite, azurite, a copper selenide, a copper vandate, and brochantite. (Gale, 1908.)

BROMYRITE

AgBr

[*See also* Cerargyrite]

Cerargyrite, silver chloride, and bromyrite, silver bromide, form a complete isomorphous series. None of the three reports of occurrences of bromyrite contain sufficient data to determine their place in the series.

Lake County.—Leadville district. Both crystallized and massive bromyrite, as well as iodobromite (iodian bromyrite) were reported from the oxidized ores worked in the early days of the district (S. F. Emmons, 1886b). Later workers have not noted these minerals.

Mineral County.—Creede district. The Denver Museum of Natural History displays a specimen, labeled bromyrite, of greenish-white powder that fills vugs and cracks in volcanic rock.

Park and Summit Counties.—Montezuma district. Bromyrite is reported from the oxidized zones of the Baker and other rich silver veins.

BRONZITE

[*See* Pyroxene group, enstatite species]

BRUCITE

$Mg(OH)_2$

Brucite has been reported only once. This was from James Creek, Boulder County. The discovery was made in 1866 by J. A. Smith. (Hollister, 1867; J. A. Smith, 1883.)

BRUGNATELLITE

$Mg_6Fe^{+3}(CO_3)(OH)_{13}\cdot 4H_2O$

Brugnatellite, a mineral whose composition is close to that of pyroaurite, has been found only in the uncompahgrite rock of Iron Hill in Gunnison County (loc. 2). There, micaceous masses of nearly colorless brugnatellite occur as alteration products of melilite in small amounts and in few places. It forms veinlike streaks and is so soft that it may be more common than exposures indicate. It is probably of very late hydrothermal origin. (E. S. Larsen, Jr., and Goranson, 1932; E. S. Larsen, Jr., and Jenks, 1942.)

BYSSOLITE

[*See* Amphibole group, Epidote, *and* Serpentine]

BYTOWNITE

[*See* Feldspar group, plagioclase series]

CALAMINE

[*See* Hemimorphite]

CALAVERITE

$AuTe_2$

Calaverite, the gold telluride, is one of the group of telluride minerals for which several Colorado mining camps are famous. Calaverite and krennerite are the principal ore minerals at Cripple Creek, hence are the basis for a large part of the great production of gold from there. As noted in the introduction, both calaverite and krennerite are among the most valuable minerals in the State, together having produced about $400 million worth of gold. Calaverite is not as widespread as some of the other tellurides, being known from only four districts.

Boulder County.—Calaverite, although much less abundant than sylvanite, has been known since the earliest days of mining in several camps in Boulder County. At Gold Hill, it occurred with sylvanite and quartz in the Red Cloud mine. (Genth, 1874—analysis; Endlich, 1874, 1878.) Good crystals of calaverite came from the Sunshine district; it was also present in ores of the Slide, Cold Spring, Mountain Lion, and Keystone mines in other districts (Genth, 1877; Endlich, 1878; J. A. Smith, 1883). In the eastern part of the Nederland tungsten district, where tellurides are relatively abundant, as well as in several of the tungsten deposits, calaverite is intimately associated with other tellurides. (Lovering and Tweto, 1953.) In the Magnolia district, sylvanite is the chief telluride ore mineral, but it is commonly accompanied by some calaverite or other tellurides. (Wilkerson, 1939 a, b.)

Costilla County.—Grayback district. Small particles of calaverite are sometimes found in gold placer deposits. The mineral must have been derived from veins on Grayback Mountain but none has been found in place. (Patton, 1910.)

La Plata and Montezuma Counties.—La Plata district. Calaverite is present in small amounts in many deposits, commonly intergrown with hessite, krennerite, petzite, and coloradoite. (Galbraith, 1949.)

Teller County.—Cripple Creek. Calaverite is the principal source of gold in the famous deposits of Cripple Creek; it is perhaps even more abundant than is recognized by many local miners, who tend to identify silvery calaverite as sylvanite. One of the world's classic localities for calaverite, Cripple Creek has given rise to an extensive literature on its mineralogy and crystallography. It was first reported from here by Knight (1894).

It commonly occurs as slender, deeply striated prisms, elongated on the axis of symmetry. Most crystals are very small, but some as much as 1.5 cm long are found. Massive calaverite is rarer than the crystallized kind, but it has been noted in the Blue Bird mine. The crystals are commonly perched on crusts of quartz crystals; more rarely they are on crusts of fluorite or dolomite or are in chalcedony. Fine crystals were found with fluorite in vugs in the Conundrum mine. (Lindgren and Ransome, 1906.)

In the Cresson mine, the walls of a large chamber were lined with a white porous material, largely celestite, that was so heavily impregnated with calaverite that the ore was worth $10,000 to $16,00 per ton. (Patton, 1915b.)

Calaverite and other tellurides belong to the second stage of mineralization at Cripple Crek. In the first stage fluorite, adularia, and quartz were deposited. The same minerals were formed in the second stage but were then accompanied by small white rhombs of dolomite, slender prisms of celestite, as well as the tellurides and a little free gold, roscoelite, and the common sulfides. The third or last stage of mineralization produced quartz, chalcedony, calcite, and a little cinnabar. (Loughlin, 1927; Loughlin and Koschmann, 1935.)

For other details of calaverite occurrences at this camp, see Duce (1917), Goldschmidt (1931—exhaustive crystallographic study); Hillebrand (1895 a, b; 1900—analyses); Penfield (1895—crystallography); Penfield and Ford (1901—elaborate crystallograpyh and analyses); G. F. H. Smith and Prior (1902—crystallography).

CALCIOVOLBORTHITE

$CuCa(VO_4)(OH)$

Calciovolborthite was reported from three localities many years ago during a period of emphasis on vanadium-bearing minerals. It has only been reported once more recently despite the greatly increased efforts of government and industry to find uranium and vanadium deposits, and despite the fact that its calcium-free analogue, volborthite, has been identified in several places.

Custer and Huerfano Counties.—Reported by Hess (1913a): "Black carbonaceous shales from Pass Creek, 9 miles south of Malachite, contain golden-yellow and yellowish-green minerals which appear to belong to the volborthite and calciovolborthite series. Similar deposits are reported a few miles southeast of Silver Cliff, Custer County."

Montrose County.—Paradox Valley. Saffron-green rosetted crystals of calciovolborthite occur on white sandstone near Uranium post office. (Schrader, Stone, and Sanford, 1916.)

Park County.—Garo district (loc. 3). Calciovolborthite occurs in the vanadium-uranium deposits (G.B. Gott, written communication).

CALCITE

$CaCO_3$

Calcite is one of the most abundant and widespread minerals in Colorado. It is the principal mineral in all limestone and marble, and in this form has wide use in cement manufacture, as a smelter flux, in the sugar-refining industry, as a building stone, and as a source of agricultural lime. The general distribution of the limestone and marble can be determined from the geologic map of Colorado, published by the U.S. Geological Survey in 1935, and is shown specifically on the map of construction materials and nonmetallic resources by Larrabee, Clabaugh, and Dow (1947). The best known marble deposit in the State, the Yule, in Gunnison County, is described by Vanderwilt (1937).

In addition to its abundance in all the limy sedimentary rocks, calcite is very widespread as a vein mineral in innumerable ore deposits, where it is of both primary and secondary origin, in cave and hot-spring deposits, and even in some soils. Only a few of the more important or more interesting occurrences are given here.

Chaffee County.—Monarch and Tomichi districts. Coarsely crystallized calcite is common along the borders of many ore bodies and is regarded as a favorable indication of ore. White and blue marble, some of it dolomitic, is probably the most abundant product of contact metamorphism. Among the special types known are: wollastonite-bearing marble in the Garfield quarry; black graphitic marble in a few places; olivine-bearing marble, partly serpentinized, on Mount Stella; diopsidic marble on Missouri Hill; and ophicalcite, or serpentine-bearing marble in Taylor Gulch. (R. D. Crawford, 1913.)

Gunnison County.—Snowmass Mountain district. Calcite is the chief gangue in some deposits, but is absent in others. In the form of scalenohedrons it lines cavities and vugs in the vein matter. (Vanderwilt, 1937.)

Jefferson County.—South Table Mountain (loc. 18). Calcite in "dogtooth" crystals is associated with zeolites in some cavities in the lava cap of South Table Mountain. They exhibit orange thermoluminescence. (J. W. Adams, written communication.)

Clear Creek Quarry. The quarry in Precambrian rocks at the mouth of Clear Creek Canyon, just northwest of Golden exposes a high-angle fault that contains "nailhead" crystals of calcite and sharp yellow-brown crystals of barite. (J. W. Adams, written communication.)

Lake County.—Leadville district. Calcite is rare as a primary mineral, but is abundant in the oxidized ores. Most of it forms small crystals in cavities, but large and beautiful rhombohedra occur on cerussite ore in the Evening Star mine. It is commonly the last mineral to form in the oxidized ores. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata County.—An interesting development of thin calcite shells around gas bubbles in a hot spring is described by Eckel (1939).

Larimer County.—A vein of yellow calcite is in Benton shale near the head of Fossil Creek, a few miles from Fort Collins. After insolation, some specimens continue to phosphoresce for 2½ hours. Headden (1923) gives a partial analysis. Other luminescent calcites from the county are described by Headden (1906, 1924).

R. G. Coffin (written communication) lists dozens of interesting occurrences of calcite in different parts of Larimer County. Similar lists could probably be assembled for most other counties. For examples, in the Ingleside formation he finds pink, white, and creamy compact marble as well as yellow to pink dolomite. In cavities in the same formation he finds dogtooth and nailhead crystals, Iceland spar in large scalenohedra, and golden-yellow radiating crystals.

Las Animas County.—Apishapa River. Handsome crystals, some of Iceland-spar quality, occur in geodes in limestone. (Schrader and others, 1916.)

Mesa County.—Fruita. Aurand (1920b) states: "Onyx occurs in several areas west of Fruita, near the Colorado-Utah line. Some of it takes a high polish and is suitable for ornamental purposes."

Park and Summit Counties.—Montezuma district. Calcite is most abundant as supergene veinlets cutting the ore near the surface but it is also present as late hypogene veinlets or well-formed crystals in vugs. It is less abundant than ankerite. As in many other districts, ground water dissolves and reprecipitates much calcite in the mine workings. (Lovering, 1935.)

Pueblo County.—In the Apishapa quadrangle, calcite and barite of good specimen grade occur sparingly in concretions near the top of the Carlile shale (Stose, 1912). North of Pueblo, in the Pierre shale, calcite and barite crystals occur. (G. R. Scott, written communication.)

Routt County.—Aurand (1920) stated: "A small deposit of onyx marble is on the south side of the Yampa River, southwest of Steamboat Springs. The blocks of marble are somewhat limited in size, but the material is well suited for ornamental work and has been used for that purpose." See also H. A. Lee (1903).

San Juan County.—Silverton district. Calcite is less important than barite, but is widespread in the wallrocks and veins. In places it is the principal vein mineral and contains sphalerite, with some pyrite, chalcopyrite, and gold. In the Camp Bird vein it is associated with fluorite and quartz. (Ransome, 1901b.)

Summit County.—Breckenridge district. Nearly pure calcite, with garnet, epidote, and the common sulfides, occurs in metamorphosed limy sedimentary rocks. Stalactitic crusts that are later than siderite, are known in the Little Sallie Barber mine. As a rule calcite is unimportant as a gangue mineral, but in the deeper parts of narrow gold veins on Farncomb Hill it is the principal gangue. (Ransome, 1911.)

Tenmile district. Quartz, barite, and calcite are the common gangue minerals; quartz is much more abundant than the others except in deposits that occupy shear zones, such as the Queen of the West group, where calcite is the only common gangue. Here it often forms solid veins 1 to 2 feet thick, of crystalline calcite with curved faces. (S. F. Emmons, 1898.)

CALEDONITE

$Cu_2Pb_5(SO_4)_3(CO_3)(OH)_6$

Caledonite, one of the rarer sulfates of lead and zinc, was reported many years ago from the oxidized zones of several districts. It has not been reported since.

Clear Creek County.—Idaho Springs district. Caledonite was found occasionally in the surface workings of the mines on Red Elephant Mountain (Randall). It was also abundant in the Freeland mine on Trail Creek. (Endlich, 1878.)

Gilpin County.—Black Hawk district. The mineral was noted in the near-surface deposits of the Running Lode (Randall).

CANCRINITE

$(Na_2Ca)_4(AlSiO_4)_6(CO_3SO_4)\cdot 1\text{–}3H_2O$

Gunnison County.—Iron Hill (loc. 2). Cancrinite, some of it the sulfatic variety, in which nearly half the CO_2 is replaced by SO_3, has been reported only in the alkalic rocks of Iron Hill, 20 miles south of Iola and 25 miles southwest of Gunnison.

Cancrinite is both abundant and widespread at Iron Hill, chiefly as an alteration product of nepheline, more rarely in veinlets. Most of it is normal cancrinite and forms granular aggregates, but one veinlet in coarse-grained melilite rock was found in which coarse cleavage fragments of sulfatic cancrinite as much as 10 cm in diameter enclosed monticellite (olivine), melanite, a little idocrase (vesuvianite), and other minerals. Cancrinite is also found as a reaction product in contact-metamorphosed limestone and probably as a primary mineral in cancrinite syenite. (E. S. Larsen and Steiger, 1916; E. S. Larsen and Foshag, 1926; E. S. Larsen and Jenks, 1942.)

CARBONATE MINERALS (MIXED)

Below are most of the occurrences of carbonate gangue minerals that cannot be accurately described as mineral species, such as manganosiderite, dolomite, and ankerite, or the pure end members among the carbonate minerals—calcite, magnesite, siderite and rhodochrosite.

Clear Creek County.—Georgetown and Idaho Springs districts. In the lead-silver ores, mixed carbonates that contain Ca, Fe, Mg and Mn are common and are locally abundant; like quartz the carbonates were formed throughout the period of mineralization. In the pyritic gold ores, carbonates are commonly much subordinate to quartz, though in the Griffith mine they exceed pyrite. The variety mesitite ($2MgCO_3 \cdot FeCO_3$), now called ferroan magnesite occurs in yellowish-white masses and yellow rhombohedral crystals in the Colorado Central mine. (Spurr and Garrey, 1908.)

Hinsdale County.—Lake City district. Mixed carbonates are present but unimportant. (Irving and Bancroft, 1911.)

Ouray County.—Ouray district. Mixed carbonate, with barite and quartz, forms the gangue in many veins and replacement deposits. (Whitman Cross, Howe, and Irving, 1907.)

Pitkin County.—Aspen district. Mixed carbonate ranging from calcite to dolomite, with some iron-bearing varieties, is widespread but nowhere very abundant. It forms coarse white masses in veinlets and as the matrix of breccia; medium-grained gray to white carbonate fills fracture zones near ore bodies. (Vanderwilt, 1935.)

Saguache County.—Orient iron mine. A carbonate, shown by analysis to be very close to ankerite in composition, forms masses on the fringes of the limonite ore body. J. B. Stone (1934) thinks that the ore must have been derived from carbonates higher in iron than any now present—probably close to siderite in composition. He thinks the ankerite could not have been the source of the ore because there are no signs of large changes in volume.

Summit County.—Breckenridge district. Pure siderite is not known to exist and pure calcite is very rare. But mixtures, most of them probably near siderite or ankerite, are present in subordinate amounts in most lead-zinc ores. Mixed carbonates are characteristic of the altered wallrocks near sphalerite veins. They range from white to pale buff, brown, or pink, and contain Fe, Mn, Mg and Ca in varying proportions. (Ransome, 1911.)

CARMINITE

$PbFe_2(AsO_4)_2(OH)_2$

A single specimen of this rare basic arsenate of lead and ferric iron from an unknown locality in Colorado is in the U.S. National Museum collection. It was analysed and described by Foshag (1937) in a general study of the species.

CARNALLITE

$KMgCl_3 \cdot 6H_2O$

Carnallite is reported from the old salt works in South Park, near Hartsel, Park County (loc. 8). (Endlich, 1878; J. A. Smith, 1883.) It is almost certainly present in the bedded salt deposits in Paradox Valley and elsewhere.

CARNELIAN

[*See* Quartz]

CARNOTITE†

$K_2(UO_2)_2(VO_4)_2 \cdot 3H_2O$

Carnotite was first described from Montrose County, Colo., and was soon thereafter found in several other localities in Colorado and Utah. For many years it was almost as important as a mineralogical curiosity as it was a source of vanadium and uranium. The coming of nuclear fission during and after World War II resulted in a worldwide intensive search for sources of uranium. All the earlier known occurrences of carnotite were reexamined as a first step in the search, thus emphasizing the practical value of pure mineralogical research. Later many new deposits were found and explored. As a byproduct of the search, mineralogists have discovered a great many new uranium and vanadium minerals, some of which were classed as carnotite in the earlier days of less complete knowledge. The literature on the mineralogy, geology, and origin of the uranium minerals of Colorado is already vast, and is still growing constantly. The few references given here, especially to Weeks and Thompson (1954), as well as U.S. Geological Survey Professional Paper 300 (Page and others, 1956) and the bibliography by Margaret Cooper (1954) should serve to guide the reader to other pertinent literature. Although it contains few facts on individual occurrences, the work of Frondel (1958) is essential to a serious student of this subject.

Early literature

Dolores County.—Carnotite reported along Dolores River. (Schrader and others, 1916.)

Eagle County.—Brush Creek. Carnotite reported in silver, gold and vanadium-bearing sandstone. (Schrader and others, 1916.)

Garfield County.—Carnotite reported, no locality. (Schrader and others, 1916.)

Jefferson County.—Leyden mine (loc. 12). This locality was the first in which the mineral carnotite was seen but the species was established on the basis of material from Montrose County. Berthoud (1875) described an unknown uranium-bearing mineral in the coal of the Laramie formation. Fleck (1916) says the identity of the mineral with carnotite was established in 1904.

In the Leyden coal mine, carnotite occurs as yellow incrustations in fractured and partly silicified coal of the Laramie formation. There is much vuggy quartz in the coal. (Wilson, 1923.)

Mesa County.—Gateway district. Carnotite reported as impregnations in sandstone along Dolores River. (Schrader and others, 1916.)

Moffat County.—Blue Mountain district. Blue Mountain is near Skull Creek, 15 miles north of Rangely. Carnotite occurs as films or thin crusts of powdery or amorphous material in Jurassic sandstone. It is associated with malachite, azurite, brochantite(?), an unknown copper selenide, a copper vanadate, and other vanadium and uranium minerals similar to those in Paradox Valley. (Gale, 1908.)

Montrose County.—The type description for carnotite was based on material from Montrose County, locality not specified. The physical and chemical properties were described by Friedel and Cumenge (1889); the radioactivity of the type specimen was determined by the Curies themselves.

La Sal Creek. Carnotite was the only uranium-vanadium mineral noted by Hillebrand and Ransome (1900). The deposits are very superficial, never extending more than 20 feet below the surface.

Roc Creek. Carnotite occurs with a few impregnations of azurite and malachite. No roscoelite was seen. (Hillebrand and Ransome, 1900.)

Park County.—Garo (loc. 3). An occurrence of uranium-bearing minerals was described near Garo by Fleck (1909). Carnotite has since been identified, mixed with several other uranium-vanadium minerals (J. W. Adams and G. B. Gott, written communications).

The deposit is one-half mile south of Garo, 9 miles southeast of Fairplay on State Route 9. Small pits and trenches near the road expose sandstone that is locally rich in carnotite.

Rio Blanco County.—Carnotite occurs as coatings on silicified wood and as sparse impregnations in Dakota sandstone near Coal Creek Valley, 14 miles northeast of Meeker. (Gale, 1907.)

San Miguel County.—Placerville. Small quantities of minute carnotite crystals coat joints in roscoelite-bearing sandstone. (Hillebrand and Ransome, 1900.)

Southwestern Colorado, general.—Huleatt and Keating (1921) [3] who describe the distribution of carnotite deposits, believe them to be derived from pitchblende that was deposited contemporaneously with the enclosing rocks. They stress the fact that many petrified logs are very rich in carnotite, particularly at the heart, with the remainder of the tree replaced by yellow vanadium oxides.

Coffin (1921) describes the close relationship between carnotite and petrified wood. He characterizes the average ore as a yellow powder of microscopic crystals in cavities, seams, or disseminated in sandstone. It is mixed with calcite and gypsum in cavities or coats crusts of tiny calcite crystals; it is invariably associated with other vanadium minerals.

The different theories of the origin of carnotite are discussed by Notestein (1918), who also records the results of his efforts to precipitate carnotite.

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[3] Huleatt, W. P., and Keating, P. H., 1921, The Carnotite Industry in Colorado: Unpublished thesis, Colorado School of Mines, Golden, 1921.

Modern literature

Summarizing the detailed mineralogical observations made by themselves and many other workers, Weeks and Thompson (1954) describe the carnotite of western Colorado as occurring chiefly disseminated in sandstone or locally as pure masses, especially around petrified wood. It is associated with tyuyamunite, metatyuyamunite, hewettite, rauvite, and corvusite. Weeks and Thompson have positively identified carnotite in most of the vanadium-uranium mines in the following Colorado districts: Mesa County, Gateway; Montrose County, Paradox, and Uravan; Montrose and San Miguel Counties, Bull Canyon; San Miguel County, Gypsum Valley; San Miguel and Dolores Counties, Slick Rock. Dwornik and Ross (1955) show an electron micrograph of carnotite from the Yellow Bird group of claims, Montrose County. See also McKelvey, Everhart, and Garrels (1955).

The mineral associations in the Bitter Creek mine, Uravan district, Montrose County, are described here as typical of most of the Colorado Plateau uranium deposits. The mine is 6 miles south of Uravan in SW¼SW¼ sec. 1, T. 46 N., R. 17 W. It is in the Salt Wash sandstone member of the Morrison formation. Mineralogically, there are three gradational zones downdip from the surface. Zone 1 is comprised of abundant dark-gray vanadiferous clay (not identified) with carnotite, tyuyamunite, metatyuyamunite, and a little rauvite. Zone 2 contains abundant corvusite, with montroseite, unidentified uranium oxides, rauvite, a little hewettite, and vanadiferous clay. Pascoite coats the other minerals. Zone 3 consists of nodules, bands and disseminations, some of very high grade, of abundant montroseite with less corvusite, unidentified uranium oxides, and locally a little hewettite. Pyrite is abundant in this zone, and there is some chalcopyrite and barite. (Heyl, 1957.)

CASSITERITE

SnO_2

Cassiterite, the chief ore of tin, has been found in extremely small quantities in several places in the State. Because tin is so scarce in the United States, which makes us dependent on foreign supplies, excitement has usually accompanied each discovery of cassiterite. Except at Climax, nowhere in Colorado does there seem to be even a remote possibility of finding commercial deposits of tin.

Douglas County.—Devils Head (loc. 1). In the Topaz prospect, in sec. 21, T. 9 S., R. 69 W, topaz and a little cassiterite with ferruginous mud occur in pockets in quartz-microperthite-cleavelandite pegmatite The cassiterite occurs as imperfect crystals, ½ to ¾ inch in diameter. (Peacock, 1935a; Hanley and others, 1950.)

Pine Creek (loc. 3). Two ½-inch irregular masses of cassiterite, with amazonstone and quartz, were found in a pegmatite body by G. R. Scott (written communciation).

El Paso County.—St. Peters Dome (loc. 5). Small crystals of cassiterite are present but very rare. (Pearl, 1958.)

Garfield County.—Cassiterite was reported from near Carbondale. (Schrader and others, 1916.)

Jefferson County.—Near Golden. A large deposit of tin ore from which specimens were reported to yield as much as 12 percent tin, was reported about 3 miles from Golden. The reports were never substantiated by production of tin. (Rolker, 1894.)

Lake County.—Climax. The molybdenite ore from Climax contains small quantities of cassiterite, topaz, and other minerals. Because the tonnages of rock mined and milled at Climax are so enormous, it has been possible to recover the cassiterite in salable quantities as a byproduct. (Cooley, 1953.)

Larimer County.—Arapahoe Peaks. A few pounds of greisenlike rock from the vicinity of Arapahoe Peaks contained scattered grains of cassiterite. (George, 1927.)

Park County.—Badger Flats area (loc. 2). Cassiterite is widespread, but in concentrations of 100 ppm or less in much of the greisen and vein material in this district, which is notable for its beryl-rich veins. Well-formed shiny dark-brown crystals as much as one-eighth inch long occur in cavities in quartz in the Mary Lee prospect and perhaps elsewhere. (W. R. Griffitts, written communication.)

Teller County.—Florissant (Crystal Peak) (loc. 2). Small extremely rare crystals of cassiterite perched on amazonstone have long been known from the vicinity of Florissant. At one time, Randall's collection included a fine specimen whose identity had been established by Whitman Cross, (Randall).

Other reported localities.—Cassiterite has been reported in newspapers from the Atlantic Cable mine at Rico, from near Badito in Huerfano County, from a locality 12 miles from Durango, and from near Walsenburg. None of these reports have been substantiated.

CEBOLLITE†

$Ca_5Al_2Si_3O_{12}(OH)_4$(?)

Cebollite, one of Colorado's type minerals, has only been found as an alteration product of melilite in the alkalic rocks of Iron Hill, Gunnison County (loc. 2). It was named for nearby Cebolla Creek. Colorless in thin section and minutely fibrous in habit, it is related to fractures in the melilite of the uncompahgrite rock; the fibers form along walls of the fractures, their long axes nearly perpendicular to the elongation of the fractures. The cebollite, which itself alters to juanite, another type mineral, is associated with a colorless granular isotropic mineral that resembles garnet but has a low index of refraction. (E. S. Larsen and Schaller, 1914; E. S. Larsen and Goranson, 1932; E. S. Larsen and Jenks, 1942.)

CELESTITE

$SrSO_4$

Boulder County.—Jamestown district. A few small irregular veinlets of calcite in the Skunk Tunnel contain colorless to pale-blue crystals of celestite in rare vugs. (E. N. Goddard, written communication.)

El Paso County.—Garden of the Gods area (loc. 4). Lenticular masses of celestite, many of them geodal, occur in the red sandstone of Triassic age in and near the Garden of the Gods. The perfectly formed crystals are blue and transparent. More rarely the celestite occurs in blue fibrous masses or as colorless crystals. (Finlay, 1916.)

The Garden of the Gods locality is said to have been exhausted by collectors, but good light-blue crystals can still be found in Red Rock Canyon, 2 miles south of the Garden of the Gods. (Over, 1929.)

Fremont County.—Garden Park (loc. 5). In a thin siliceous layer in the Morrison formation are quartz geodes that are lined with yellow massive and crystalline calcite, clear to amber barite, and crystals of celestite. The latter are blue, milky, or clear with pink flecks. (Scott, 1949.)

Otero County.—Apishapa Creek. Beautiful azure-blue crystals of celestite are reported. (J. A. Smith, 1883.)

San Miguel County.—Rico district. In the Enterprise blanket ore deposit of Newman Hill, solution cavities contain a pulverulent mixture of celestite and dolomite. These minerals, which occur in very small quantities in a gypsum bed, have been concentrated by hydrothermal solution and removal of the gypsum. (Ransome, 1901a.)

Teller County.—Cripple Creek district. Aside from Rico, Cripple Creek is the only mining district in the State whose ores are reported to contain celestite. Slender prisms of the mineral were formed during the second, or telluride, stage of mineralization. Locally celestite and roscoelite are guides to rich ore. (Loughlin and Koschmann, 1935.) In the Iron Clad mine there was a vein of white granular celestite about 1 foot wide. The grains were coated with a white impalpable powder that when analyzed proved to be an unnamed basic hydrous strontium sulfate. (Lindgren and Ransome, 1906.) In the Cresson mine, the walls of a large chamber were lined with white porous celestite that contained so much calaverite as to be worth from $10,000 to $16,000 per ton. (Patton, 1915b.)

CERARGYRITE

AgCl

[*See also* Bromyrite]

Cerragyrite has been found in the oxidized parts of nearly all the silver-bearing deposits in Colorado. It is nowhere as abundant as cerussite, but as noted earlier, it is one of the most valuable minerals in the State, having yielded an estimated $145 million in silver.

Boulder County.—Gold Hill district. This mineral occurs as rare scaly coatings on quartz in the surface ores. (Endlich, 1874; 1878.)

Caribou district. Occurs as small compact masses in the Wade Hampton mine. (Endlich, 1878.)

Chaffee and Gunnison Counties.—Monarch, Tomichi, and Tincup districts. Cerargyrite is of local importance with other oxidation products of galena and sphalerite in the bed replacement ores of all three districts. It is rare in the quartz-pyrite veins. (Dings and Robinson, 1957.) Copper-stained cerargyrite is reported from the Little Charm and Mountain Chief mines, Monarch district. It was also abundant in the lowest level of the Madonna mine, where it is earthy and not conspicuous to the unaided eye. (R. D. Crawford, 1913.)

Clear Creek County.—Georgetown and Idaho Springs districts. It occurred as crusts on surface ores of the veins in Lincoln and adjacent mountains. (Endlich, 1878; Spurr and Garrey, 1908.)

Custer County.—Rosita Hills and Silver Cliff districts. In the Silver Cliff and other mines in rhyolite, most of the silver values were in cerargyrite, which occurred as flakes or granules along cracks in manganese-stained rhyolite. Large masses of this ore that were quarried from the surface yielded 30 to 50 ounces of silver per ton. Sulfur and antimony are present in the cerargyrite ore. In the Silver Bar and Kate mines cerargyrite forms films or flakes in breccia; manganese is less abundant here than in most deposits but some barite and fluorite are present. (S. F. Emmons, 1896.)

Eagle County.—Gilman (Red Cliff) district. Much of the silver from the oxidized bodies mined in the early days was in cerargyrite. Other silver minerals present are native silver, argentite, freibergite, and hessite. (R. D. Crawford and Gibson, 1925; Tweto and Lovering, 1947.)

Brush Creek. Deposits in gray crossbedded sandstone on Brush Creek, 7 miles southeast of Eagle produced 131,134 ounces of silver between 1913 and 1920. One 30-ton lot of ore produced in 1913 yielded $5,000 worth of silver, all of it as manganese- and copper-stained cerargyrite. The sandstone also contains some carnotite and probably mariposite. (Hess, 1933; Schrader, Stone, and Sanford, 1916.)

Gilpin County.—Central City and Black Hawk districts. Cerargyrite is rarely present in these districts. (Bastin and Hill, 1917.)

Lake County.—Leadville district. Cerargyrite, with embolite and a little iodyrite are present throughout the district and were locally abundant. The chloride-bromide ore is largely basic ferric sulfate, stained by carbonates of copper, and containing enough of the silver halides to assay high silver values. Individual lumps of cerargyrite seldom weigh more than 1 pound, but one of 100 pounds has been reported. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata and Montezuma Counties.—La Plata district. Cerargyrite is probably present in the richer oxidized silver ores of some of the mines. It has been reported together with embolite and bromyrite, but none of these were identified by Galbraith (1949).

Mineral County.—Creede district. It was noted in oxidized ores of the Mollie S and Amethyst mines. (W. H. Emmons and Larsen, 1923.)

Ouray County.—Ouray district. Cerargyrite is present in barite-quartz gangue in some of the replacement deposits in limestone where it is associated with chalcocite. (Whitman Cross and others, 1907.)

Saguache County.—Bonanza district. The rich oxidized silver ores probably contain cerargyrite or embolite, but neither was recognized by Burbank. A body of cerargyrite was reported at the outcrop of the Eagle vein in Eagle Gulch. (Burbank, 1932.)

Summit County.—Breckenridge district. Small quantities occurred as impregnations of rhyolite. (Schrader, Stone, and Sanford, 1916.)

Tenmile district. With cerussite, it is fairly widespread. It is the principal silver mineral of the shallow oxidized ores and is commonly associated with wad. (S. F. Emmons, 1898.)

CERGADOLINITE

[*See* Gadolinite]

CERIAN FLUORITE

[*See* Fluorite]

CERITE

Cerite, an uncommon and complex calcium cerium silicate with other rare earths, has been found in two widely separated localities, and in abundance at one of them.

Boulder County.—Jamestown district (loc. 2). Small deposits of cerite are 2 miles N. 42° E. of Jamestown, near the north border of a small stock of Silver Plume granite. Cerite-bearing rock, with 75 percent cerite forms irregular lenses ¼ to 15 inches wide and 6 inches to 6 feet long in narrow aplite-pegmatite zones along the borders of schist bodies. Narrow veinlets of black allanite (first called gadolinite in apparent error by Goddard, Lovering, and Fairchild, 1935) border the cerite rock, and minute grains of pyrite and uraninite are locally present. The cerite rock is an intimate intergrowth of cerite with allanite, brown epidote, tornebohmite, fluorite, monazite, uraninite, and quartz; the cerite itself occurs as small grains, gray to pinkish brown to grayish lavender. Chemical analyses and calculation of the ratio between lead and uranium plus thorium give an age of 940 million years. (Goddard and Glass, 1940.) Hanson and Pearce (1941) made further studies of the material described by Goddard and Glass; their chemical analyses showed a higher alumina content and a somewhat different chemical formula than had earlier been ascribed to cerite.

Rusty Gold cerite prospect. This prospect is in sec. 17, T. 2 N., R. 71 W., on Central Gulch, 2 miles northeast of Jamestown. Cerite and associated minerals occur in irregular grayish-brown masses composed of extremely fine grains. Cerite and other rare-earth minerals make up 2 to 5 percent of the core of the pegmatite. (Hanley, Heinrich, and Page, 1950.)

Gunnison County.—Powderhorn district loc. 2). Bastnaesite, synchisite, and a mineral that gives the same X-ray pattern as the cerite from Jamestown in Boulder County occur in some of the carbonate veins near Iron Hill (see thorite). None of them are abundant. (Olson and Wallace, 1956.)

CERUSSITE

$PbCO_3$

Cerussite is nearly coextensive with galena-bearing ores; in some mines and districts it is very abundant and has yielded about $50 million worth of lead. Only its more important occurrences are noted here.

Chaffee County.—Sedalia mine (loc. 5). Cerussite occurs in some quantity with chalcocite, the chief ore mineral, and many other minerals. (Lindgren, 1908.)

Winfield district. It is rarely present, associated with bismuthinite. (E. A. Chapman, Jr., written communication.)

Chaffee and Gunnison Counties.—Monarch, Tomichi and Tincup districts. Cerussite, with free gold, is the chief ore mineral in the oxidized zones of the replacement ores in all three districts. It is white to dark gray and occurs as patches, seams, and crystals as much as one-half inch long in cavities. Much of the cerussite ore contains some residual galena. Cerussite is also widespread but less abundant in the oxidized parts of the more productive quartz-pyrite veins of these districts and the Chalk Creek district. (Dings and Robinson, 1957.) R. D. Crawford (1913), who saw more of the oxidized ores than Dings and Robinson, gave more details, especially as to specific localities.

Clear Creek County.—Idaho Springs district. Beautiful clear crystals of cerussite line vugs in brecciated galena in the Brighton mine near Idaho Springs. Large amounts of cerussite have been produced from the Freeland and other mines in this and the Georgetown district. (Spurr and Garrey, 1908.)

Custer County.—Oak Creek (Ilse), Terrible mine. Cerussite and phosgenite are the only ore minerals in the Terrible mine at Ilse. The cerussite fills interstices of shattered and altered rocks along fault zones and is probably derived from the oxidation of galena bodies which are either completely altered or as yet uncovered. It is both crystalline and massive and grayish white to light translucent amber in color. An analysis by Warren (1903) showed an appreciable amount of strontium isomorphous with the lead—the first recorded occurrence of this kind of isomorphism. (Charlton, 1890; Warren, 1903; Brinsmade, 1907; Hunter, 1914; Waldschmidt, 1923.)

Eagle County.—Gilman (Red Cliff) district. Cerussite was widespread and abundant in the early days of mining, but less so than anglesite. Most of it was soft and earthy, but some small groups of crystals with adamantine luster were found. (R. D. Crawford and Gibson, 1925; Tweto and Lovering, 1947.)

Fremont County.—Eight Mile Park (loc. 4). Cerussite pseudomorphic after crystals of fremontite (natromontebrasite) are listed by Frondel (1935) as from "Canyon City." Heinrich (1948b) believes these must have come from the Meyers pegmatite quarry in Eight Mile Park.

Gilpin County.—Copper-stained cerussite was the chief ore mineral in the Boss mine, Quartz Valley district; it was associated with other oxidation products of galena in altered gneiss. It was also present in the Pleasant View, Gunnell, J. P. Whitney, and other mines (Endlich, 1878).

Gunnison County.—Gold Brick district. Gray to white crystals occur in small quantity in several mines. Massive cerussite was found on the dump of a mine three-quarters of a mile east of the Sacramento mine, associated with calamine in quartzite. (R. D. Crawford and Worcester, 1916.)

Lake County.—Leadville district. Most of the lead in the rich oxidized ores at Leadville is in the form of cerussite. It is most abundant in blanket deposits but also occurs in lodes. All of it contains silver in variable amounts as inclusions of either argentite or admixed silver halides. There are three types of cerussite ore. The first consists of large crystals, embedded in manganese and iron oxides or clay. The crystals form radiating clusters or druses in cavities. The second type, sand carbonate, consists of aggregates of small crystals, loosely consolidated, in very extensive bodies. The third type, hard carbonate, consists of cerussite disseminated through masses of dense silica. It contains more silver than the other types (S. F. Emmons and others, 1927.)

Mineral County.—Creede district. It is fairly abundant in the Amethyst, Holy Moses, and other mines, where it forms the outer shells of galena altered to anglesite. It apparently has a narrower vertical range than anglesite. (W. H. Emmons and Larsen, 1923.)

Park and Summit Counties.—Montezuma district. Cerussite is a common mineral in the near-surface ores. In many ores the galena seems to alter directly to cerussite without going through the anglesite stage, but some sulfate is probably always formed. It is found in open spaces, commonly as well-formed crystals 2 to 10 mm long, as much as 200 feet beneath the surface. (Lovering, 1935.)

Park and Lake Counties.—Weston Pass district. Cerussite is moderately abundant as crystals and dense brown masses. It is much less abundant in the nearby Alma district. (Behre, 1932.)

Pitkin County.—Aspen district. Cerussite and anglesite were the principal ore minerals of lead in the oxidized ores, especially those of Tourtelotte Park. Locally very abundant as "sand carbonate," they were associated with limonite, cuprite, minium, and a little melaconite. (Spurr, 1898.)

Routt County.—Hahns Peak district. The ore of the Tom Thumb mine consists of galena and sandy cerussite, but it is rare elsewhere in the district. (Gale, 1906; George and Crawford, 1909.)

Saguache County.—Bonanza district. Small amounts of cerussite occur near the outcrops throughout the district. In the Bonanza vein, cerussite followed anglesite and covellite as shells on massive galena (Burbank, 1932.)

San Miguel County.—Telluride district. Massive cerussite occurs in replacement deposits at Sawpit, between Telluride and Placerville. In the Alta mine, fine crystals occur in cavities in quartz and galena. (Whitman Cross and Purington, 1899; W. E. Adams, 1900.)[4]

Summit County.—Breckenridge and Tenmile districts. Cerussite formed an important part of the early lead-silver ores. Most of it, mixed with cerargyrite, wad, and other materials, was soft and earthy. (S. F. Emmons, 1898; Ransome, 1911.)

CEYLONITE

[*See* Spinel]

CHABAZITE

$(Ca,Na_2)Al_2Si_4O_{12}\cdot 6H_2O$

Chabazite, one of the commoner zeolites, has been reported from only three localities in the State; it is probably present elsewhere in basalts and related rocks.

Gunnison County.—Italian Mountain (loc. 3). Chabazite is widespread in this area of complex and unusual petrology. It is most common in cavities of vesuvianite and an almost invariable associate of that mineral. It forms white crystals, many of them perfectly developed. Most crystals are simple rhombs but a few are twinned. Some stilbite and scolecite, both probably earlier than chabazite, accompany it in some cavities. (Whitman Cross and Shannon, 1927.) It is also noted from Uncompahgre Peak by Endlich (1878).

Jefferson County.—Table Mountains (loc. 18). North and South Table Mountains on the east edge of Golden are classic localities for most of the zeolite minerals and specimens from there are in many museums. Chabazite is the most common zeolite and also the oldest. In most places it forms thin white to pink crusts of simple or twinned rhombs; many crystals are as much as 1 cm in diameter. In one quarry on the east side of North Table Mountain, the crystals are only 5 to 10 mm in size, but are very complicated twins. (Whitman Cross and Hillebrand, 1882a—analyses; 1885; Patton, 1900; see also Waldschmidt, 1939, for a general description and summary of published data.)

[4] Adams, W. E., Report on the Alta group of mines, San Miguel County, Colo.: Unpublished thesis, Colorado School of Mines, Golden, 1900.

CHALCANTHITE

$CuSO_4 \cdot 5H_2O$

Chalcanthite, a hydrous sulfate of copper, is widespread in the oxidized parts of many copper-bearing deposits and as a postmining efflorescence on the walls of stopes and other mine workings. In a few places it has been found in sufficient quantity to be of commercial value as copper ore. It is easily soluble in water, hence is more abundant in dry mines than in wet ones. Only a few of the representative reported occurrences are given here.

Boothite, which differs from chalcanthite primarily in containing 7 molecules of water of crystallization instead of 5, has not been reported in Colorado. Because it is commonly formed and remains stable only at lower temperatures than chalcanthite, I strongly suspect that some or all of the "chalcanthite" reported from mines that contain perpetual ice may be boothite.

Clear Creek County.—Idaho Springs and Georgetown districts. Chalcanthite was reported as encrustations on mine walls in the Whale, Centennial, and several other mines. (Endlich, 1878; J. A. Smith, 1883.) Large quantities, of prospective importance as a source of copper, are reported to occur in veins with tetrahedrite, galena, chalcopyrite, sphalerite, barite, and other minerals. (Williams, 1888.)

Eagle County.—Gilman (Red Cliff) district. Chalcanthite is common on mine walls in this district. In the Ground Hog mine it also fills a few narrow fissures in quartzite. (R. D. Crawford and Gibson, 1925.)

Lake County.—Leadville district. Chalcanthite is present in large quantities and is commercially important in the Ibex mine. It is most abundant near the tops of sulfide ore bodies and in partly oxidized ores where it forms scattered fibrous masses mixed with oxides and residual sulfides. It also occurs as stalactites in old mine workings. (S. F. Emmons and others, 1927.)

Larimer County.—Empire copper mine. Chalcanthite occurs as crusts and small crystals. (R. G. Coffin, written communication.)

Park and Summit Counties.—Montezuma district. Chalcanthite is reported from the upper parts of several copper-lead-zinc veins and is very abundant in the Pennsylvania mine. It is not rare in drifts and old stopes in moderately dry mines. Well-crystallized chalcanthite coats walls of the fifth level, Silver Wave mine. (Lovering, 1935.) This level is filled with ice and ice crystals the year round, hence this is one of the suspected occurrences of boothite

San Miguel County.—Mount Wilson district, Silver Pick and Special Session mines. Both of these mines contain perpetual ice, and fairly abundant postmining chalcanthite. As noted above, further study might show this to be boothite. (Purington 1898; Whitman Cross and Purington, 1899.)

Telluride district. The chalcopyrite in most of the mines is largely replaced by chalcanthite in many places. This is probably due to insufficient circulation of water to transport the copper, although there is sufficient water to alter the sulfides to sulfates. The chalcanthite loses part of its water of crystallization soon after exposure by mining and turns to a white powder. (Purington, 1898; Whitman Cross and Purington, 1899.)

CHALCEDONY

[*See* Quartz]

CHALCOCITE

Cu_2S

Chalcocite is present as small masses, veinlets, or sooty coatings on other minerals in nearly all the copper-bearing ore deposits. In some places it is richly argentiferous, and probably large amounts of both copper and silver were produced from chalcocite ores in the early days of some districts. It is, however, abundant in only a few places. Most chalcocite is in the zone of secondary sulfide enrichment, but some is probably of primary origin. In addition to the few more interesting examples described below, chalcocite has been reported from the following districts, among others: Boulder County—Sugar Loaf and Ward; Chaffee County—Poncha Springs, Monarch and Tomichi; Clear Creek County—Idaho Springs; Costilla County—Grayback; Eagle County—Red Cliff; Hinsdale County—Lake City; La Plata and Montezuma Counties—La Plata; Larimer County—Pearl and Redstone Divide; Ouray County—Ouray and Red Mountain; Park County—Alma and Platte Gulch; Park and Summit Counties—Montezuma; Pitkin County—Aspen; Rio Grande County—Summitville; Routt County—Hahns Peak; San Juan County—Silverton; San Miguel County—Telluride; and Teller County—Cripple Creek.

Chaffee County.—Sedalia mine (loc. 5). The ore in this deposit, believed to be of Precambrian age, consists principally of cuprite, chalcocite, and copper carbonates, with residual chalcopyrite and other sulfides, intergrown with the minerals of amphibolite rock. These include the well-known "Salida" garnets, as well as spinel, corundum, and many others. (Lindgren, 1908.)

El Paso County.—The Blair Athol copper mine, near the Garden of the Gods, works a typical "red bed copper deposit." I have observed chalcocite scattered as rounded blebs through a red sandstone, whose color is characteristically bleached in the immediate vicinity of the copper minerals. The chalcocite is partly altered to azurite and malachite,

Fremont County.—Eight Mile Park (loc. 4). Chalcocite is intergrown with spessartite garnet in a 6-foot pod in the Mica Lode pegmatite quarry. It also occurs in the School Section pegmatite, where it is partly altered to covellite and copper carbonates. Small bodies of chalcocite ore of this character have been mined intermittently from these and other pegmatite bodies. (Heinrich, 1948b.)

Red Gulch deposits. Chalcocite, with some malachite and azurite, is the chief ore mineral in these deposits, which are 9 miles north of Cotopaxi. The chalcocite, which contains a little silver, occurs as intergrowths and nodules that replace shaly coal; younger barite cuts both coal and chalcocite. (Lindgren, 1908.)

Gem mine (loc. 9). Most of the copper in the near-surface ore of the Gem mine, best known for its content of niccolite, was in the form of chalcocite. (Whitman Cross, 1884; Genth, 1886.)

Jefferson County.—Augusta lode (loc. 1). The chief ore minerals in this Precambrian deposit, which is on Cub Creek, one-half mile above Evergreen, are yellow sphalerite and chalcocite. They occupy parts of a crustified quartz-fluorite vein in red granite. (Lindgren, 1908; Patton, 1915a.)

Lake County.—Leadville district. Chalcocite does not occur in the primary ores, but is very abundant in the enriched sulfide zone, especially as thin sooty films that coat cracks and fissures of chalcopyrite, pyrite, and other minerals. Probably most of the copper from Breece Hill and the Tucson Maid fault was in the form of chalcocite. In the lower levels of the Penn mine and the 10-level of the Ibex, chalcocite stringers in the central cavernous parts of the lodes contained 8 to 10 percent copper, with high silver values. (S. F. Emmons and others, 1927.)

Montrose County.—Cashin mine (loc. 1). Chalcocite, covellite, bornite, cuprite, azurite, and malachite, with some native copper and native silver, are all ore minerals in this deposit. The gangue consists of quartz, kaolin, barite, and calcite. (W. H. Emmons, 1906b.)

Sunrise mine. In this mine, 4 miles northeast of Paradox, ore from the lower levels is almost solid chalcocite, with a little chalcopyrite, covellite, and bornite. The ore occurs both as massive vein fillings and as a replacement of calcite vein matter. (Fischer, 1936.)

Saguache County.—Bonanza district. Both primary and secondary chalcocite are present, but in small amounts. Graphic intergrowths with bornite in the Rawley mine suggest primary origin for the chalcocite. It also fills cracks in sulfide ores, associated with late chalcopyrite, and is partly altered to covellite. Sphalerite is coated by chalcocite and covellite near the surface (Burbank, 1932.)

CHALCOPHANITE

$(Mn, Zn)O \cdot 2MnO_2 \cdot 2H_2O$

Lake County.—Leadville district. Chalcophanite, containing enough zinc to constitute an ore mineral, is associated with hetaerolite here as at Franklin Furnace, N.J. Some of it occurs as druses of minute tabular rhombohedral crystals that coat botryoidal surfaces and fill cracks in hetaerolite. Some of it occurs as foliated crusts that coat smithsonite and are themselves coated by hemimorphite. (Ford, 1914; S. F. Emmons, Irving, and Loughlin, 1927.)

Park and Lake Counties.—Weston Pass district. Chalcophanite, or a closely similar mineral, forms black coatings on smithsonite in the rich oxidized ores. (Behre, 1932.)

CHALCOPYRITE

$CuFeS_2$

Chalcopyrite is nearly as ubiquitous as pyrite in the State's mining districts. It is the most abundant primary copper mineral in nearly all deposits and is probably the source of more of the $88 million worth of copper produced to date (1959) than all the other copper minerals together. In many places, moreover, it contains appreciable amounts of gold, either as minute inclusions or in solid solution; in the La Plata district it contains some platinum. A few of the more important or interesting localities are noted below. In addition to these, chalcopyrite has been noted in appreciable quantities in the following districts, among others: Boulder County—Caribou, Gold Hill, Nederland, and Ward; Chaffee County—Sedalia mine and Cleora, Cotopaxi, and Monarch districts; Clear Creek County—Georgetown, Empire, and Idaho Springs; Costilla County—Grayback; Custer County—Silver Cliff and Rosita; Dolores County—Dunton and Rico; Eagle County—Red Cliff; Fremont County—Gem Nickel mine; Gilpin County—Central City; Gunnison County—Elk Mountains and Gold Brick; Hinsdale County—Carson Camp, Lake City, and Lake Fork; Jefferson County—Malachite mine on Bear Creek; Lake County—Climax; Larimer County—Pearl, Empire, and others; Mineral County—Creede; Ouray County—Ouray and Red Mountain; Park County—Tarryall, Alma, and Platte Gulch; Pitkin County—Aspen; Routt County—Hahns Peak; San Miguel County—Telluride and Mount Wilson; San Juan County—Silverton; Summit County—Breckenridge; and Teller County—Cripple Creek.

Clear Creek County.—Most of the gold in many mines in Clear Creek County is contained in chalcopyrite. Good tetrahedral sphenoidal crystals of chalcopyrite, crusted by other minerals and some of them perched on tetrahedrite, have been collected from the Freeland mine, near Idaho Springs. (Draper, 1897).[5]

Custer, Huerfano, and Fremont Counties.—The Rita Alto mine, near the common corner of these counties, is a relatively minor producer of copper, but is noteworthy because the only ore minerals are chalcopyrite and chrysocolla. Both occur as impregnations in sandstone. (Bagg, 1908.)

Gilpin County.—Chalcopyrite is the principal copper mineral in most ore deposits in the county and commonly comprises more than 5 percent of the ores by weight.

In the Evergreen mine (loc. 1), one of the few mines in the State that are predominantly copper mines, chalcopyrite and bornite are the ore minerals. They are commonly associated with garnet and are intergrown with the rock-forming minerals of wollastonite-bearing dikes or breccia along the dike walls. A little secondary chalcopyrite also occurs in vugs. (Endlich, 1878; Bastin and Hill, 1911; 1917.)

Jefferson County.—The Malachite and the nearby F. M. D. mine, on Bear Creek east of Evergreen (loc. 9) both develop copper deposits that are believed to be of Precambrian age. In the F. M. D. mine the deposits are in a dark-green amphibolite schist. Pyrite and chalcopyrite are intimately intergrown with ragged green prisms of hornblende and books of biotite with an interstitial mosaic of labradorite. A little zinciferous siderite and secondary pyrite are present in fractures. The Evergreen deposit is similar to the F. M. D., but the ore consists of masses of chalcopyrite, dark-brown sphalerite, and pyrrhotite, intergrown in apparent contemporaneity with augite and labradorite. (Lindgren, 1908.)

Lake County.—Leadville district. Chalcopyrite occurs in comparatively small quantity as interstitial grains and small masses in the sulfide ores, where it is associated with other minerals deposited at high and moderate temperatures. On Breece Hill it occurs with pyrite as irregular patches and streaks in magnetite. In the blanket ores it forms minute inclusions in sphalerite. In some

[5] Draper, M. D., 1897, op. cit.

mines, notably those of Iron Hill, it is more abundant where oxidation is strongest but this is probably due to greater permeability of ores that contain much primary chalcopyrite than to secondary concentration of this mineral. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata and Montezuma Counties.—La Plata district. Chalcopyrite is present in small amounts in most telluride and other ores in the district. It is the most abundant sulfide mineral in the vicinity of Copper Hill and Bedrock Gulch. One comparatively small body of rich chalcopyrite ore on Copper Hill produced more than 200,000 pounds of copper. Of greater interest to the mineralogist, although apparently not of much commercial value, this chalcopyrite contained appreciable quantities of platinum. (G. M. Schwartz, Varnes, and Eckel, 1949.)

Park and Summit Counties.—Montezuma district. Chalcopyrite is the most abundant copper mineral in the district. In some veins, such as the Waldorf, it forms well-developed crystals, but is much more commonly present as blebs and blades in sphalerite or as masses that vein or replace pyrite. There are two or more generations of chalcopyrite in many veins. The earlier generation is medium to coarse grained and shows twinning in polarized light, whereas the later generation is fine grained and untwinned. (Lovering, 1935.)

Saguache County.—Bonanza district. Chalcopyrite is one of the more abundant copper minerals and is present in some amount in all sulfide veins. Most of it is massive, intergrown with granular pyrite and other sulfides, but it also forms small crystals in vugs. In the Rawley mine ore pyrite, chalcopyrite, and bornite occur in that order of abundance. Much of the chalcopyrite is intergrown with pyrite on a microscopic scale. It reportedly contains valuable amounts of both gold and silver but part of this is due to the presence of intergrown argentiferous tennantite. (Burbank, 1932.)

CHEVKINITE

Titanosilicate of cerium metals

Chevkinite, a titanosilicate of the cerium earths, occurs in extremely small quantities in the rhyolitic Pearlette ash bed of Pleistocene age near Golden. It is possibly present in other igneous rocks. It forms slender dark-brown prismatic crystals with an average size of 0.03 by 0.17 mm. (Powers, Young, and Barnett, 1958.)

CHLOANTHITE

$(Ni,Co)As_{3-x}$

Chloanthite has been reported as from "the Arkansas River." No details are available. (Endlich, 1878.)

CHLORITE GROUP

[*See also* Clay minerals]

The chlorite group is commonly separated by mineralogists into three related mineral species: clinochlore ($H_8Mg_5Al_2Si_3O_{18}$), penninite ($H_8(Mg,Fe)_5Al_2Si_3O_{18}$), and prochlorite ($H_8(Fe,Mg)_5Al_2Si_3O_{18}$).

Two other species in the chlorite group have been reported from Colorado. These are cookeite ($LiAl_4(AlSi_3)O_{10}(OH)_8$) and thuringite (approximately $(Fe^{+2},Mg)_3Fe^{+3},Al)_3(Al,Si)_4O_{10}(OH)_8$).

Chlorite minerals are widespread and locally abundant in the more mafic rocks, as vein minerals in places, and especially in the altered wallrocks of many ore deposits. In addition finely divided chloritic minerals are constituents of many clays. Surprisingly few workers have attempted to determine the mineral species, commonly limiting their descriptions to the occurrence of "chlorite" or of "chloritic material." However, it is certain that all five of the above species are present in Colorado. The few reports of occurrences of the individual species are summarized below, followed by a section on "Chlorite, undivided."

Chlorite species **PROCHLORITE**

$H_4Mg_2Al_2SiO_9$

[*See also* Chlorite group]

Prochlorite, one of the chlorite group of minerals, has been reported from only one place, but is much more abundant than this. In the Bazooka prospect, Quartz Creek (Ohio City) district, Gunnison County (loc. 4), it is present with lepidolite and cookeite in quartz-albite pegmatite. (Hanley, Heinrich, and Page, 1950.)

Chlorite species **COOKEITE**

$LiAl_4(AlSi_3)O_{10}(OH)_8$

Cookeite, a micaceous mineral allied to the chlorites, has been reported only from the Bazooka prospect in the Quartz Creek (Ohio City) district, Gunnison County (loc. 4). There it is associated with lepidolite, microlite, and prochlorite in quartz-albite pegmatite. (Hanley, Heinrich, and Page, 1950.)

Chlorite species **THURINGITE**

Approximately $(Fe^{+2},Mg)_3(Fe^{+3},Al)_3(Al,Si)_4O_{10}(OH)_8$

Thuringite, an iron-rich member of the chlorite group, is reported only from the Creede district, Mineral County.

At Creede, thuringite is very abundant as a primary vein mineral. The vein worked by the Solomon and Ridge mines is almost entirely thuringite, with a little quartz, fluorite, galena, and sphalerite. The Amethyst vein is largely amethyst quartz with some galena and sphalerite but even here there are some streaks and bodies of thuringite. In all occurrences it is a vein filling rather than replacement material. It is olive green, soft, and friable, and varies from fibrous to platy to finely crystalline in texture. (E. S. Larsen and

Steiger, 1917—analyses and optical properties; see also W. H. Emmons and E. S. Larsen, Jr., 1923.)

CHLORITE UNDIVIDED

Chaffee County.—Sedalia mine (loc. 5). The well-known large "Salida" garnets which are more characteristic of the Sedalia mine than chalcocite and other copper minerals for which it was worked, are invariably coated with a chloritic alteration product. This was classed as the variety aphrosiderite by Penfield and Sperry (1886), who include an analysis in their description.

Monarch district, Garfield mine. A pale-green chloritic mineral occurs in very small quantity in narrow veinlike streaks in some sulfide ores of this mine. (R. D. Crawford, 1913.)

Dolores County.—Rico district. Chlorite is abundant in mines in the metamorphosed Devonian limestones; it is massive and cryptocrystalline. It also occurs with serpentine in the Black Wonder and several other mines. (Ransome, 1901a.)

El Paso County.—St. Peters Dome (loc. 5). Chlorite is associated with cryolite and other fluorine-bearing minerals. (J. W. Adams, written communication.)

Fremont County.—Eight Mile Park (loc. 4). Secondary chlorite is very abundant in the School Section pegmatite, where it is an alteration product of biotite. This type of occurrence is characteristic of many pegmatite bodies in the State. Chlorite also occurs as primary fibrous aggregates, one-half inch long, in injection gneiss. (Heinrich, 1948.)

Gunnison County.—Taylor Peak and Whitepine districts. Chlorite is abundant as a gangue mineral in the contact-metamorphic iron deposits of these districts. Some serpentine is also present in places. It impregnates the sedimentary rocks that form the walls of the ore bodies. (Harder, 1909.)

Italian Mountain (loc. 3). Several varieties or species of chlorite are present. Most of it forms minute smoky-gray globules and aggregates on crystals of epidote, adularia, and titanite on specimens of andradite garnet. Some of it is in scales 3 mm in diameter and blackish green in color. Apparently the chlorite was the last mineral to form except pyrite. One specimen, probably of penninite, shows many pale apple-green plates 1 cm in diameter embedded in calcite. (Whitman Cross and Shannon, 1927.)

Lake County.—Leadville district. Chlorite is the most common alteration product of the dark silicate minerals of intrusive porphyritic rocks and Precambrian granites. The chloritic alteration extends farther from the ore deposits than the sericite-quartz kind. The chlorite found in the sedimentary rocks may also represent wallrock alteration, but it is more probably a primary mineral in these rocks. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata and Montezuma Counties.—La Plata district. Chlorite is widespread as a wallrock alteration product, particularly in the porphyritic rocks. A litttle chlorite is intergrown with garnet and sulfide minerals in the Silver Falls mine; in the Peerless mine it is closely associated with pyrite and arsenopyrite. (Galbraith, 1949.)

Saguache County.—Bonanza district. Chlorite is very common as a wallrock alteration product near veins, but is rare in the veins themselves. Small amounts occur in a few small veins on Alder Creek, where it is associated with epidote, calcite, pyrite, and chalcopyrite. (Burbank, 1932.)

San Miguel County.—Chlorite is rare even in the wallrocks, but it has been seen in the Lakeside mine, Mount Wilson district, in the Single Standard and

Badger mines at Ophir and in the Smuggler mine, Telluride district. (Purington, 1898.)

In the Smuggler mine, a wide but variable propylitic zone occurs beyond a narrow sericitized fringe along veins. Chlorite, calcite, and pyrite characterize the propylitic zone. The presence of chlorite so close to the veins suggests that solutions bearing alkaline carbonates and CO_2 did not permeate the walls, as chlorite is unstable in their presence. (Hurst, 1922.)

San Juan County.—Silverton district. In the mines of Silver Lake Basin chlorite occurs as nests in vein quartz. It is thought by miners to be an indication of good ore. (Ransome, 1901b.)

Summit County.—Breckenridge district. Chlorite is a common alteration product of the femic-porphyry bodies and gives the greenish colors that characterize their outcrops. It is not common in the ore deposits but is a constituent of contact-metamorphosed sedimentary rocks. In the Senator mine it is a vein constituent, with quartz, pyrite, hematite, and carbonate. In the Sultana and Fox Lake mines it is an abundant microscopic vein mineral, with quartz, pyrite, hematite, and magnetite. (Ransome, 1911.)

Teller County.—Cripple Creek. Chlorite is an abundant alteration product of the volcanic rocks. (Lindgren and Ransome, 1906.)

CHLOROPAL

[*See* Nontronite]

CHROME MICA-CLAY

[*See* Mariposite]

CHROMITE

$(Mg,Fe^{+2})(Cr,Al)_2O_4$

Chromite is a common accessory mineral in many igneous rocks, particularly in the more basic ones. Only one occurrence of chromite in larger masses than microscopic grains has been reported. This is on Mount Silverheels, not far from Fairplay in Park County. The report has not been verified since. (Endlich, 1878; J. A. Smith, 1883.)

CHRYSOBERYL

$BeAl_2O_4$

Clear Creek County.—Chrysoberyl occurs in 6-inch crystals in pegmatite near Squaw Pass campground on the Bergen Park-Echo Lake road. (G. R. Scott, written communication.) Chrysoberyl, intergrown with beryl, has been found in a pegmatite body on Sante Fe Mountain (loc. 5) (J. W. Adams, written communication).

Douglas County.—In an old mica prospect, located only as "6 miles west of Sedalia" (Schrader, Stone, and Sandford, 1916), greenish-yellow chrysoberyl in tabular masses occurs in a gangue of quartz, feldspar, and mica. The chrysoberyl is of good color and some is translucent but there are no good crystals. It is associated with black tourmaline and brown garnet. This discovery, made in 1893, was the first known locality west of New York. (Bixby, 1894; Randall.)

Jefferson County.—Guy Hill (loc. 11). Chrysoberyl occurs in thin twinned crystals, most of them pseudohexagonal, as much as 4 inches in diameter, as well as in single well-formed crystals. Associated minerals, none of collecting quality, are bismuthinite, bismutite, beryl, garnet, black tourmaline, and topaz. (J. W. Adams, written communication.) A second locality is just northeast of Guy Hill, where a pegmatite is exposed in a cut on the Golden Gate Canyon road. It contains abundant thin crystals of chrysoberyl (both single and twinned), garnet, black tourmaline, and minute crystals of zircon. (G. R. Scott, written communication.) The chrysoberyl occurrence described by Seaman (1935a) is probably at or near 1 of these 2 localities.

Robinson Gulch (loc. 13). Chrysoberyl, with poor quality black tourmaline, occurs in a white feldspar pegmatite. (J. W. Adams, written communication.)

Drew Hill (loc. 8). Chrysoberyl occurs in exceptionally large crystals and irregular masses in a pegmatite halfway up the side of Drew Hill. This is on the east side of the Crawford Gulch road, 6 miles north of its junction with the Golden Gate Canyon road. The chrysoberyl is found especially along the contact of large segregations of quartz and pink feldspar. Twinned crystals, the largest 2.54 by 14 by 12 cm, are associated with massive quartz; untwinned crystals are in feldspar or in quartz-muscovite intergrowths.

About 100 yards from the peak of Drew Hill, along the crest of the ridge, dark-green crystal fragments of chrysoberyl occur in float from a 3-foot eastward-trending pegmatite body. A similar occurrence is also reported on the northeast slope of Drew Hill. (J. W. Adams, written communication.) Chrysoberyl has also been found in a pegmatite near the Crawford Gulch road at the middle of the west side of sec. 2, T. 3 S., R. 71 W. (D. M. Sheridan, written communication.) Several hundred olive-green crystals, the largest 5 by 5 by 2½ inches, have been taken from this locality. These are among the largest known crystals of chrysoberyl in the world (Waldschmidt and Gaines, 1939; Hanley, Heinrich, and Page, 1950).

Larimer County.—Wisdom Ranch (loc. 6). Chrysoberyl is abundant enough to have economic value as a source of beryllium in the Wisdom Ranch beryl prospect, in S½ sec. 5, T. 7 N., R. 71 W., 15.5 miles west of Fort Collins. Brown garnet in masses as much as 12 inches across is intergrown with quartz, beryl, chrysoberyl, and albite. The chrysoberyl is yellowish green to dark green, in plates as much as 3 inches by 13 mm. It is commonly associated with light-pink albite (Hanley, Heinrich, and Page, 1950).

Crystal Mountain district (loc. 1). Chrysoberyl is less abundant here than in the Wisdom Ranch prospect but 4 of the pegmatites contain asparagus-green to yellowish-green plates, masses and imperfect crystals, 0.05 to 0.1 inch by 0.2 to 0.6 inch. (Thurston, 1955.)

CHRYSOCOLLA

$CuSiO_3 \cdot 2H_2O$

Chrysocolla is present in the oxidized parts of a few scattered ore deposits but it is rare in most places and is reported as an ore mineral in only one minor deposit. It is more widely distributed than indicated by the literature but has not been considered worth mentioning by many authors.

Chaffee County.—Monarch district. Sky-blue chrysocolla coats walls of small cavities in the Lilly mine and fills fissures in other copper ores. (R. D. Crawford, 1913.)

Sedalia mine (loc. 5). Small amounts have been found on the dump. (J. W. Adams, written communication.)

Clear Creek County.—Idaho Springs district. Small amounts in beautiful botryoidal masses are reported from the Champion lode on Trail Creek and from the Kelley lode. (Hollister, 1867.)

Custer, Fremont, and Huerfano Counties.—Small shipments of 10-percent copper ore, consisting of chrysocolla and chalcopyrite in fractures in sandstone, have been shipped from deposits on Rita Alto Peak. This is the only place in Colorado where the mineral has been considered as an ore. (Bagg, 1908.)

Gunnison County.—Gold Brick district. A small quantity of chrysocolla is associated with malachite in quartzite three-quarters of a mile southeast of the Gold Links tunnel. (R. D. Crawford and Worcester, 1916.)

Snowmass Mountain district. Although chrysocolla is not an ore mineral, it is particularly abundant in veins on the east face of Crystal Peak and in the North Pole mine. (Vanderwilt, 1937.)

Jefferson County.—Chrysocolla is associated with cuprite at Pine Grove, and is also a minor constituent of the copper lodes on Bear Creek. (Randall; Schrader and others, 1916.)

Lake County.—Leadville district. Bluish-green to deep-green chrysocolla is rare throughout the district but more abundant than malachite or azurite. It fills irregular cavities in masses of limonite and manganese oxides. (S. F. Emmons and others, 1927.)

Mineral County.—Creede district. It is present, but rare in oxidized ores of the Mollie S and the Monte Carlo mines. (W. H. Emmons and Larsen, 1923.)

Park and Summit Counties.—Montezuma district. Chrysocolla is rare in the oxidized zone, with limonite. (Lovering, 1935.)

Saguache County.—Allen's copper mine, at the head of the San Luis Valley, is reported to contain chrysocolla. (Endlich, 1878.)

Summit County.—Breckenridge district. A very small amount of chrysocolla has been noted in oxidized lead-silver ore from workings on Nigger Hill. (Ransome, 1911.)

Teller County.—Cripple Creek. It has been identified only on the seventh level of the Iron Clad mine, where it resulted from oxidation of tetrahedrite; it may also be present elsewhere. (Lindgren and Ransome, 1906.)

CHRYSOLITE

[*See* Olivine]

CHRYSOPRASE

[*See* Quartz]

CIMOLITE

$2Al_2O_3 \cdot 9SiO_2 \cdot 6H_2O$ (?)

[*See also* Clay minerals]

Boulder County.—Nederland tungsten district. A clay mineral, tentatively identified as cimolite, is nearly as abundant as beidellite in the tungsten-bearing veins. Cimolite, also spelled kimolite, is possibly a mixture of two or more clay minerals. (Lovering and Tweto, 1953.)

CINNABAR

HgS

Cinnabar has been found in a few localities but nowhere in sufficient quantity to be of commercial interest as an ore of quicksilver. In addition to the authenticated occurrences given below it has been reported by local newspapers as occurring in quantity at Silver Cliff, Custer County; on Kiowa Creek, Elbert County; on the Laramie River, Larimer County; and from other places.

Boulder and Clear Creek Counties.—Small quantities of cinnabar are reported from different parts of these counties. (George, 1913; Randall.) The Denver Museum of Natural History has a specimen of coloradoite from Boulder County coated with red specks of cinnabar.

La Plata County.—La Plata district. A little hypogene cinnabar, contemporaneous with native gold, occurs in the Bessie G, Durango Girl, and possibly other mines. (W. H. Emmons, 1905; Galbraith, 1949.)

Saguache County.—Cochetopa Creek. A deposit of cinnabar, of possible commercial grade, is in T. 47 N., R. 2 E., on Cochetopa Creek about 20 miles south on State Route 114 from its junction with U.S. Highway 50. Quartz and pyrite are associated with the cinnabar in breccia. (Vanderwilt, 1947.)

Teller County.—Cripple Creek. Cinnabar is locally present in several mines and is probably related to the third stage of mineralization. This stage consists of quartz, chalcedony, pyrite, calcite, and minute grains of fluorite and cinnabar. These minerals frequently conceal the rich telluride minerals of the second stage. In the Dante mine it is closely associated with pyrite in collapse breccia; locally it forms small botryoidal druses in vugs, but even some of these cover pyrite. One small specimen suggests complete replacement of a sphalerite crystal by cinnabar. Although it is widespread in the district it is too rare to be of interest except to mineralogists. (Loughlin, 1927; Loughlin and Koschmann, 1935.)

CLAUSTHALITE

PbSe

Colorado Plateau.—As described by Coleman and Delevaux (1957) the element selenium is widespread and relatively abundant in the uranium deposits in Jurassic sandstones of the Colorado Plateau; it is very rare in uranium deposits in rocks of Triassic age. Some of the selenium is in solid solution in pyrite, marcasite, galena, chalcocite, and chalcopyrite, where it substitutes for sulfur. Much of it, however, is in the form of definite selenide minerals, all of them closely associated with the sulfides. Chief among these selenides are clausthalite, the selenide of lead, and galena-clausthalite, which represents an isomorphous series between galena (PbS) and clausthalite (PbSe).

In the Rifle and Garfield vanadium mines, Rifle district, Garfield County, a persistent band of sulfides contains clausthalite-galena in variable amounts; the band can be traced for several thousand feet along the strike.

An exceptional concentration of clausthalite occurs in the Corvusite mine, Montrose County. A wide band of clausthalite formed a semicircular band around a petrified log that was 18 inches in diameter and 10 feet long. Chalcocite nodules in the Cougar mine, Slick Rock district, San Miguel County, contain clausthalite and digenite intergrown with the chalcocite; in some nodules eucairite is also present. Coleman and Delevaux (1957) also note galena-clausthalite from the Bear Creek mine, Placerville district, Montrose County; they find selenium present in sulfides, but not as clausthalite, in several other ores of the Colorado Plateau.

San Juan County.—As noted under umangite, an occurrence of zorgite, since shown to be a mixture of clausthalite and umangite has been reported from the Pearl lode on Minnesota Gulch. The identification has not been definitely established.

CLAY MINERALS

Clay, which is composed largely of clay minerals, is enormously abundant in Colorado. Most shales and other fine-grained sedimentary rocks consist partly or entirely of clay that is consolidated to greater or lesser degree. Most soils contain large proportions of clay minerals. The wallrocks of many ore deposits are partly altered to clay and there is also much clay in many veins.

Clay suitable for manufacture of brick, pottery, fire clay, and other uses, is very abundant in many parts of the State and a large industry is built on this resource. Few studies have been made of the mineralogy of the commercial clays and they are treated here as rocks rather than minerals. Among the most useful reports on their distribution and technologic character are the following: Aurand (1920b); G. M. Butler (1914); Larrabee and others (1947); Vanderwilt (1947, p. 232–240); and Waagé (1952, 1953).

The study of clay minerals, as distinct from clay, is a comparatively new and rapidly advancing branch of the science of mineralogy. It is also a difficult one, for by definition clay minerals are microscopic or submicroscopic in particle size and require very exacting microscopic, X-ray, chemical, and other techniques for their identification.

Knowledge of clay mineralogy is advancing rapidly and no classification or list of accepted species seems likely to be acceptable to all clay mineralogists for very long. The following minerals, each described from one or more places in Colorado, are commonly treated as species: allophane, beidellite, cimolite, dickite, halloysite, illite group, kaolinite, montmorillonite, nacrite, nontronite, and sauconite. Vermiculite and members of the chlorite and mica groups occur in finely divided form in many soils and clays. For this reason, they too must be considered as clay minerals.

Further information on the clay minerals can be found in the following references, among many others: Grim (1953); Kerr and Hamilton (1949); Ross and Kerr (1931); Ross and Hendricks (1945).

CLEAVELANDITE

[*See* Plagioclase series, albite species]

CLINOCHLORE

[*See* Chlorite group]

CLINOENSTATITE

[*See* Pyroxene group]

CLINOZOISITE

$HCa_2Al_3Si_3O_{13}$

At Allens Park, Boulder County, clinozoisite occurs in very small amounts, irregularly distributed in calcium silicate rock, with wollastonite. Other minerals are grossularite, diopside, calcite, vesuvianite, and quartz. (Dings, 1941.)

COBALTITE

CoAsS

Boulder County.—Gold Hill district (loc. 1). The unusual nickel ore in the Copper King mine contains polydymite as the main ore mineral. In the lower level of the mine the polydymite is veined by violarite, which is in turn cut by veinlets of pyrite, cobaltite, and pentlandite. (Goddard and Lovering, 1942.)

COFFINITE†

$U(SiO_4)_{1-x}(OH)_{4x}$

Coffinite is one of the many new minerals that have been discovered as a result of the intensive search for uranium during the postwar years. It is a black mineral with high adamantine luster, commonly associated with black organic matter and uraninite; doloresite is also associated in most ores. In many ores coffinite and uraninite are the most abundant minerals.

The mineral was first found in high-grade ore from the La Sal No. 2 mine in Mesa County; later it was identified in more than 25 other uranium mines in Mesa, Montrose, and San Miguel Counties. It has also been found with pitchblende in the Copper King mine on Prairie Divide, Larimer County (loc. 3), and with carnotite in the old Leyden coal mine, Jefferson County (loc. 12). (Stieff and others, 1955; 1956; Stern and others, 1957; Sims, 1958.)

Coffinite has been identified by X-ray methods in material from a uranium-bearing vein in the Fairday mine, Overland Mountain, Boulder County (W.N. Sharp, written communication).

COLORADOITE†

HgTe

Coloradoite, among the first new minerals to be discovered in Colorado, was first identified in the telluride ores of Boulder County. Later it was found in three other telluride districts—Cripple Creek, La Plata, and Vulcan.

Boulder County.—The type description of coloradoite was based on impure specimens from the Keystone and Mountain Lion mines in the Magnolia district and from the Smuggler mine in the Ballerat district. It was a very rare mineral in both districts. In the Magnolia district it was closely intermixed with native tellurium and quartz; in the Smuggler mine it was mixed with native gold, sylvanite, tellurium, and tellurite. Most was massive and somewhat granular, but some had a columnar structure believed due to admixture with sylvanite. The original analyses showed appreciable contents of gold, silver, and several other elements, all due to admixture of other minerals (Genth, 1877).

More recently, coloradoite has been seen with sylvanite in ores from the Magnolia district (Wilkerson, 1939 a, b) and in very small amounts with other tellurides in the Gold Hill district (Goddard, 1940). The Denver Museum of Natural History has a specimen from the Grey Eagle lode in which coloradoite is disseminated in quartz, the whole specimen coated with tiny specks of cinnabar.

Gunnison County.—Vulcan district (loc. 5). X-ray powder diffraction data on a specimen of coloradoite from this district are reported by Harcourt (1942).

La Plata and Montezuma Counties.—La Plata district. Among the tellurides, coloradoite is second only to hessite in abundance in ores from this district. It occurs in contemporaneous intergrowth with the other tellurides and is locally replaced by hypogene native gold. It is the source of the supergene native mercury that is found in a few places. (Galbraith, 1949.)

Teller County.—Cripple Creek district. Newspaper reports of the occurrence of small amounts of coloradoite, associated with native mercury in the Moon Anchor mine and from the Clara D claim on Gold Hill, have not been further substantiated.

COLUMBITE

(Fe,Mn) $(Cb,Ta)_2O_6$

[*See also* Tantalite]

Columbite, all of it containing some tantalum, has been found in a few pegmatite bodies and a few hundred pounds have been produced as a byproduct of mining other minerals. Nowhere are any sizeable deposits known.

Boulder County.—New Girl prospect. Columbite, containing 4 percent Ta_2O_5 and 75 percent Cb_2O_5, occurs as large bladed crystals associated with small irregular concentrations of albite in this beryl-bearing dike. (Hanley and others, 1950.)

Beryl Nos. 1 and 2 prospects. Columbite-tantalite occurs in isolated pods of quartz and plagioclase. (Hanley, Heinrich, and Page, 1950.)

Clear Creek County.—Grover mine (loc. 3). Columbite occurs in masses as large as 2 by 6 inches. (Hanley, Heinrich, and Page, 1950.)

Chaffee County.—Turret district, Rock King prospect (loc. 2). Small grains of columbite are associated with beryl on the selvages of quartz bodies in this prospect. (Hanley, Heinrich, and Page, 1950.)

El Paso County.—The earliest reported occurrence of columbite in the State was from "Pikes Peak," probably the St. Peters Dome area (loc. 5). It is associated with amazonstone, smoky quartz, zircon, and other minerals; some of the prismatic crystals penetrate the amazonstone and zircon. Some masses weigh several pounds. Small amounts are also associated with cyrtolite. (J. L. Smith, 1877.)

Fremont County.—Eight Mile Park (loc. 4). An unnamed hill 7 miles west of Canon City, which Heinrich (1948a) feels sure is the Meyers Quarry lepidolite locality in Eight Mile Park, contained masses of columbite weighing as much as 600 pounds. They are in pegmatite with red, green, and black tourmaline. Analysis showed the mineral to contain more manganese than usual, 22 percent Ta_2O_5, and 56 percent Cb_2O_5. (Headden, 1905b; Sterrett, 1923.) Small specimens of columbite were found by Heinrich (1948b) in the Meyers quarry, Mica lode, and School Section deposits in this district.

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). Wedge-shaped tabular crystals of columbite have been found in 29 of the pegmatite dikes in the district. In the Brown Derby No. 1 it comprises 1.4 percent of the rock in a small body 20 feet long and 1 foot wide, but it is rare elsewhere. Specimens studied range from nearly pure manganocolumbite to niobium-rich tantalite but most of them are toward the columbite end of the series. (Eckel, 1933a; Hutchinson, 1955; Staatz and Trites, 1955.)

Powderhorn district (loc. 2). A very large body of columbite-bearing material, presumably in the carbonatite rocks of Iron Hill, is reported by Wagner (1958); the grade is not reported but is probably low.

Jefferson County.—Cressman Gulch (loc. 6). Some columbite is present in the pegmatite dike. (J. W. Adams, written communication.)

Bigger mine (loc. 3). Columbite occurs in bladed crystals and anhedral masses associated with beryl and muscovite. (Hanley, Heinrich, and Page, 1950.)

Burroughs mine (loc. 4). Columbite-tantalite is commonly intergrown with euxenite in the pegmatite at this mine. (J. W. Adams, written communication.)

General. Boos (1954) lists the mineral assemblages of 23 pegmatite bodies in the Denver Mountain Parks area. Several of these contain tantalite or columbite or minerals intermediate between them.

Larimer County.—Crystal Mountain district (loc. 1). Columbite is widely scattered as clusters of tabular crystals, but is of negligible importance everywhere. One block of rock from the Buckhorn Mica mine contains more columbite-tantalite than all the rest of the district. (Thurston, 1955.)

COLUSITE

$Cu_3(As,Sn,V,Fe,Te)S_4$

Ouray County.—Red Mountain district. Colusite is a rare complex sulfide of copper and arsenic related to tennantite, but with vanadium, tin, and tellurium substituting for arsenic. It is reported as a mineralogical curiosity, with enargite, in ore from the Red Mountain district. (Burbank, 1947; Nelson, 1939.)

COMMON SCAPOLITE

[*See* Scapolite group (wernerite)]

COOKEITE

[*See* Chlorite group]

COPIAPITE

$(Fe,Mg)Fe_4^{+3}(SO_4)_6(OH)_2 \cdot 20H_2O$

Eagle County.—Gilman (Red Cliff) district. Although this is the only reported occurrence of copiapite, it is probably present in many other mines in the State as one of the oxidation products of iron sulfides and as a postmining efflorescence.

A mineral identified as either copiapite or coquimbite was found in the Ground Hog lode on Battle Mountain. It cemented nuggets of gold and itself contained some gold. (Guiterman, 1891.)

COPPER

Cu

Native copper is very widely distributed in the oxidized zones of many copper-bearing deposits. Locally it forms large masses, but is of little commercial importance in most places.

Boulder County.—Beautiful microscopic crystals, as veins in gangue minerals have been taken from the Ni Wot and other mines. (J. A. Smith, 1883.)

Chaffee County.—Monarch and Tomichi districts. Copper occurs near the surface in the Lilly mine; it has also been reported from the Columbus mine at Monarch and the Morning Glim mine at Tomichi. (R. D. Crawford, 1913.)

Clear Creek County.—Nuggets weighing 1 to 2 pounds were reportedly found in the soil at Idaho Springs. Small flakes, wires, and dendritic coatings occur in the Centennial mine and in the Pittsburg mine at Empire. Mine rails are replaced by copper in some places. (Spurr and Garrey, 1908.)

Custer County.—Oro Verde district. Native copper is finely disseminated through gangue in low-grade veins in conglomerate of Carboniferous age. A copper sulfide that contains some silver is associated. Production has been negligible from here and from other scattered occurrences of native copper in the Sangre de Cristo Mountains. (H. A. Lee, 1903; Charlton, 1890.)

Dolores County.—Rico district, California prospect. Small crystalline sheets or skins of native copper have been found only in this prospect near the head of Iron Draw. (Ransome, 1901a.)

Gilpin County.—A few very fine specimens of dendritic copper occurred in the Gregory lode and in the Narragansett mine. (Endlich, 1878; J. A. Smith, 1883.)

Gunnison County.—Vulcan district (loc. 5). Some native copper has been found as deep as the lowest level of the Good Hope mine. (Rickard, 1903.)

Anthracite-Crested Butte district. Small amounts occur throughout the district. A little copper is known in the coal-bearing sandstone in Redwell Basin at the east end of Scarp Ridge. (S. F. Emmons, Cross, and Eldridge, 1894.)

Hinsdale County.—Lake City district. A 150-pound mass was found in the Excelsior mine; smaller masses occur elsewhere in the district. (Irving and Bancroft, 1911.)

Jefferson County.—Native copper was reported in great abundance from veins near Golden (probably the Evergreen and other nearby mines). (Randall; Schrader, Stone, and Sanford, 1916.)

Lake County.—Leadville district. Copper is occasionally found in the oxidized ores, associated with clays on which it is precipitated from sulfate solutions. On the fifth level of the Ibex mine, branching irregular masses, some of great size, ramify through moist clay. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata and Montezuma Counties.—La Plata district. Near the head of Bedrock Gulch and on the divide between it and the East Mancos River, native copper, with other copper minerals, occurs as leaves in seams and cracks in monzonite porphyry. (Toll, 1908.) Small nodules of native copper with pyrrhotite(?) are fairly abundant in a modern swamp deposit on the west side of the La Plata River just below the town of La Plata, where they are precipitated by the organic ooze from copper-bearing surface water. (Galbraith, 1949.)

Montrose County.—Cashin mine (loc. 1). Large amounts of copper in irregular masses, one weighing 500 pounds, occur in kaolin and associated with covellite, chalcocite, bornite, cuprite, azurite, malachite, and native silver. The gangue minerals are kaolin, quartz, and barite. (W. H. Emmons, 1906b.)

Park and Summit Counties.—Montezuma district. Native copper is reported from many mines. Near the south breast of F level, Pennsylvania mine, acid mine water has replaced the iron rails with spongy native copper. In Hand Cart Gulch native copper, thought to be "red gold," was recovered from placers as early as 1861. This copper was probably precipitated from copper-bearing water by organic matter. (Lovering, 1935.)

Routt County.—Hahns Peak. Both native copper and silver have been found in veins near the Columbine-Snowbird mine. (George and Crawford, 1909.)

Saguache County.—Bonanza district. Small masses and thin sheets occur along joints in the upper levels of the Rawley mine. The mineral is probably widely distributed elsewhere in small amounts adjacent to copper ores and near the surface. (Burbank, 1932.)

San Juan County.—Silverton district. Copper is rare and only in the oxidized ores. In the Tom Moore mine it occurs in stringers of quartz that contain crystals of hubnerite. (Ransome, 1901b.)

San Miguel County.—Telluride district. Native copper is rarely present in the gold veins. In the Smuggler mine it forms thin arborescent films on fracture planes of gray quartz and has been found as far as 1,845 feet below the surface. (Purington, 1898; Hurst, 1922.)

Teller County.—Cripple Creek. Copper was seen in a specimen from an altered basalt dike on Tenderfoot Hill, and a seam of partly crystallized copper has been reported from Mineral Hill. It is probably derived from oxidation of tetrahedrite. (Lindgren and Ransome, 1906.)

COQUIMBITE

$Fe_2(SO_4)_3 \cdot 9H_2O$

Eagle County.—Gilman (Red Cliff) district. A hydrous ferric sulfate, identified as either coquimbite or copiapite, was found in the Ground Hog lode on

Battle Mountain. It cements nuggets of gold and itself contains some gold, although it yields no gold on panning. (Guiterman, 1891.)

Coquimbite is also reported on the walls of a crosscut in the Eagle No. 2 mine. It formed aggregates of poor crystals, predominately green, but bluish-green locally. Some of the material contains a little copper. (R. D. Crawford and Gibson, 1925.)

CORDIERITE

$Mg_2Al_4Si_5O_{18}$

Chaffee County.—Monarch district. Cordierite hornfels derived by alteration of shale is one of the most abundant contact-metamorphic rocks in the district. This is a very hard dense rock, predominantly dark gray but blue or pink in many places. Cordierite, which is crowded with inclusions, comprises as much as one-third of the rock locally; quartz and biotite are the other principal constituents. The hornfels is especially abundant on the south slope of Syncline Hill. It also crops out near a porphyry dike 1 mile east of Boss Lake and in several shale beds east of Kangaroo Gulch. (R.D. Crawford, 1913.)

Fremont and Park Counties.—Cordierite is reported 6 miles from Canon City. (Schrader and others, 1916.)

Micanite area (loc. 6). This cordierite locality has been known for many years and studied by several workers. In the Climax mica claim, sec. 5, T. 16 S., R. 72 W., on the west side of a small tributary to Mac Gulch, cordierite occurs in crystals and masses, some nearly 1 yard across, in contact with feldspar, mica, and quartz. Part of the mineral is fresh and glassy with gray to dark-violet-blue colors, but much is altered to pinite (a variety of muscovite). (Sterrett, 1923.) The cordierite-bearing dike is 460 feet long and 300 feet wide. Cordierite occurs along the hanging wall of the massive quartz core. Much muscovite, with a few crystals of fluorapatite, microcline, and quartz are associated. (Heinrich, 1950.)

Cordierite and quartz occur as granular aggregates as much as 4 inches across, interstitial to anthophyllite near the Lone Chimney, or Betty mine, near Guffey. It is on the north side of Thirty-one Mile Creek, about two-thirds of a mile south of the mine. (Bever, 1953; Heinrich and Bever, 1957.)

At a point 2.8 miles east of Texas Creek on U.S. Highway 50 a micaceous schist contains porphyroblasts of cordierite ⅛ to 5 inches in diameter. Quartz, iron ore, and a little muscovite, biotite, and green tourmaline are associated. (Travis, 1956.)

Gunnison County.—Gold Brick district. A large body of cordierite-bearing mica schist is exposed in the northern part of the district especially between Henry Mountain and Lamphier Lakes. Cordierite, in very dark gray elongate subhedrons or pseudophenocrysts as much as 2½ inches long, comprise one-third of the rock in places. The cordierite, which is fresh and glassy in some places but partly replaced by a black mineral in others, contains many inclusions of apatite, magnetite, and other minerals. (R. D. Crawford and Worcester, 1916.)

Jackson County.—Pearl district. Near the copper deposits of this district is a belt of nodular mica schist. The ellipsoidal nodules, 1 to 4 inches long, are largely fresh or altered cordierite. (A. C. Spencer, 1903; Read, 1903.)

Jefferson County.—Porphyroblasts of cordierite ¼ by ¾ inch occur in a schist layer in the Coal Creek quartzite that crops out on the south slope of Blue Mountain. (D. M. Sheridan, written communication.)

CORRENSITE

[*See* Vermiculite]

CORUNDUM

Al_2O_3

Chaffee County.—Corundum is reported from three localities in the county—Chalk Creek, Sedalia mine, and Turret. The Chalk Creek locality, 8 miles south of Buena Vista, where the sapphire variety is reported (Schrader, Stone and Sanford, 1916), is not substantiated by other workers and may have been given in error for the Turret locality.

Sedalia mine (loc. 5). Corundum is present in small amounts in the amphibolite schist which has yielded large amounts of copper principally in the form of chalcocite. Among the associated minerals are gahnite, the large "Salida" garnets, and staurolite. (Lindgren, 1908.)

Calumet mine at Turret (loc. 2). The presence of a sapphire-bearing schist was first reported by W. B. Smith (1887a). The gem-quality corundum, ranging from pale to deep blue in color, occurs as small rough rhombohedral plates in feldspar-quartz-muscovite schist. Locally it comprises as much as 40 percent of the corundum-bearing ledge, which is only about 1 foot thick. It extends northward up the mountainside for 800 or more feet and dips 30° E. Just below the ledge is a body of limestone partly altered to essonite garnet. The corundum crystals are thin rhombohedral plates 1 to 5 mm in diameter. They have not been sold as gems but some corundum was mined and marketed in 1893–95 for use as an abrasive. (Pratt, 1906; Pearl, 1941d, 1958; Ellermeier, 1947a; 1948b.)

Clear Creek County.—On the ridge between Devils Canyon and Barbour Fork of Soda Creek 1 mile east of the mouth of Eclipse Gulch, boulders of schist contain 30 to 50 percent corundum. The barrel-shaped crystals, ½ to ¾ inch long, are skeletons filled with biotite, muscovite, quartz, and feldspar. Large plates of contemporaneous muscovite enclose grains of corundum in parallel orientation. The corundum-bearing rocks contain no sillimanite, which is abundant elsewhere. (Spurr and Garrey, 1908; Pratt, 1906.)

Fremont County.—Corundum, some of it gem quality, occurs in a pegmatite on the ridge between the Rocky Mountain Boy and Joker claims on Grape Creek, 7 miles southwest of Canon City. Fragments and particles are thickly scattered through the quartz-plagioclase-mica rock. No well-formed crystals have been found, but there are some roughly hexagonal prisms. The mineral is transparent to translucent and ranges from nearly colorless through pale blue or green to deep blue. Dumortierite and sillimanite are present. (Pratt, 1906; Finlay, 1907.)

Jefferson County.—Golden Gate Canyon (loc. 8). In a continuation of the Drew Hill chrysoberyl-bearing pegmatite, many tiny grains of highly fluorescent corundum occur in a band of pink feldspar and mica. Tourmaline, crystals of rutile as much as 1 inch in length, and a little epidote and apatite are also present. (E. E. Parshall, oral communication.)

Routt County.—Hahns Peak. Bluish-gray corundum occurs near Hahns Peak.

CORVUSITE†

$V_2O_4 \cdot 6V_2O_5 \cdot nH_2O$

The material on which the type description and analyses were based was collected from the east side of the La Sal Mountains, Utah, 10 miles west of Gateway, Mesa County, Colo. As this locality is just beyond the Colorado-Utah boundary, and as other material used in the type description came from Gypsum Valley, San Miguel County, it seems fair to claim corvusite as a new mineral from Colorado. (Henderson and Hess, 1933.)

Corvusite impregnates sandstone and siltstone and is commonly an alteration product of montroseite and other vanadiferous minerals; it alters to navajoite in some places. Common associates are carnotite, tyuyamunite, rauvite, and hewettite. Shrinkage cracks are partly filled with gypsum and fervanite.

The mineral has been positively identified, and in abundance, in the following districts: Mesa County—Gateway; Montrose County—Uravan and Paradox; Montrose and San Miguel Counties—Bull Canyon; San Miguel and Dolores Counties—Slick Rock. (Weeks, Cisney, and Sherwood, 1953; Weeks and Thompson, 1954.)

COSALITE

$Pb_2Bi_2S_5$

Cosalite has been reported from a few localities in southwest Colorado. Some of the analyses show so much silver and copper that they may partly represent aikinite, benjaminite, or other minerals but there seems to be little doubt as to the existence of cosalite itself.

La Plata County.—La Plata district, Comstock mine. Cosalite was analysed and described by Hillebrand (1884) and Whitman Cross and Hillebrand (1885) from this mine. It formed irregular masses rarely 1 inch long in a quartz vein with pyrite, sphalerite, sylvanite(?) and native gold. None was found by Galbraith (1949). George (1913) states that Hillebrand's material "is clearly aikinite." Shannon (1925), on the other hand, suggests that this and some other analyses of supposed cosalite are suspiciously like those of benjaminite.

Ouray County.—Poughkeepsie Gulch, Gladiator mine. Cosalite occurs in this mine, as small irregular masses with galena, bismuthinite, chalcopyrite and pyrite in a quartz gangue. In some specimens, small particles of bismuthinite occupy the centers of masses of cosalite, which is surrounded by a fringe of galena. (Genth, 1886—analysis; Koenig, 1885b—analysis; Bastin, 1923.)

San Juan County.—Silverton district, Yankee Girl mine. Argentiferous cosalite occurs in ore from this mine on Red Mountain; it is associated with barite and chalcopyrite (Pearce, 1884b—analysis.)

COVELLITE

CuS

Covellite, commonly in the zone of secondary enrichment, is widespread in copper-bearing ores associated with other copper minerals. It is comparatively rare in most districts and is more commonly recognized by microscopic examination of polished sections of ores than in hand specimens. In addition to the three occurrences worth describing below, it has been reported from the following districts, among others: Winfield, Chaffee County; Silver Cliff, Custer County; Red Cliff, Eagle County; Central City, Gilpin County; Lake City, Hinsdale County; Leadville, Lake County; La Plata, La Plata and Montezuma Counties; Wagon Wheel Gap, Mineral County; Genesee and Red Mountain, Ouray County; Montezuma, Park and Summit Counties; Aspen, Pitkin County; Bonanza, Saguache County; Silverton, San Juan County.

Montrose County.—Cashin mine (loc. 1). Richly argentiferous covellite, which makes beautiful ore specimens, is associated with chalcocite, bornite, native copper, cuprite, azurite, and malachite in a quartz-kaolin-barite-calcite gangue. Some specimens of massive covellite are comprised of coarsely crystalline material, cut by veinlets or masses of finely crystalline covellite. The two varieties are often cut by bands of chalcopyrite or luzonite. (W. H. Emmons, 1906b; Rogers, 1911; Fischer, 1936.)

Pitkin County.—Mount Sopris, M. & J. claim. Ore from this claim, on Bulldog Creek 20 miles west of Aspen, contains galena, covellite, bornite, stromeyerite, argentite, and other minerals as stringers and small masses in a matrix of recrystallized sandstone. The most abundant mineral, galena, is peripherally replaced by covellite and cerussite. In pseudoeutectic intergrowths of galena and stromeyerite, covellite replaces stromeyerite. Some specimens also show graphic intergrowths of covellite and cerussite. (G. M. Schwartz and Park, 1930.)

Rio Grande County.—Summitville district. Covellite is the most abundant secondary copper mineral in the district. It occurs as encrustations and fillings in vuggy quartz and ranges in grain size from powdery coatings to aggregates of bladed crystals. In the Chandler and Golconda tunnels it forms solid masses 3 to 6 inches thick. Several tons of nearly pure covellite was shipped in 1902. Many of the beautifully bladed crystals and rosettes are lightly coated with chalcocite. (Patton, 1917; B. S. Butler, written communication, 1930; Steven and Ratté, 1960.) Roberts and Ksanda (1929), who made an X-ray study of specimens from this district, found several percent of chalcopyrite between the thin hexagonal plates of covellite.

CREEDITE†

$Ca_3Al_2F_4(OH,F)_6(SO_4)\cdot 2H_2O$

Creedite, an extremely rare mineral that is known in very few localities in the world, was first found in the fluorite-barite mine at Wagon Wheel Gap, near Creede in Mineral County (loc. 1). The vein is in Tertiary lava flows and tuffs of predominantly rhyolitic and quartz latitic composition. Coarsely crystallized barite and fluorite are abundant. Gearksutite, another rare fluoride mineral, characterizes the lower levels whereas creedite is in the upper parts of the mine. Creedite, a colorless to delicate-purple color with vitreous luster, has two modes of occurrence. In one, it occurs in cavities of banded fluorite or as embedded radial masses of crystals in white sugary-textured barite. In the other, it forms loose doubly terminated crystals embedded in white halloysite. (E. S. Larsen, Jr. and Wells, 1916—analysis; Foshag, 1921—analysis and crystallography; E. S. Larsen Jr. and Wherry, 1917—halloysite analysis; Fleischer, 1952—new X-ray and differential thermal analysis data.)

CRISTOBALITE

SiO_2

Cristobalite, one of the high-temperature forms of silica, is fairly widespread in volcanic rocks in some parts of the State. Only two general localities are noted here, but they illustrate its mode of occurrence.

Grand County.—In a rhyolite flow in sec. 10, T. 3 N., R. 76 W., 3 miles west of Grand Lake, cristobalite, generally accompanied by tridymite is present in a few lithophysae (Spock, 1928).

San Juan Mountains, general.—Cristobalite that can be determined by microscopic means is fairly widespread in lava flows of the San Juan Mountains, but it rarely comprises more than a small fraction of 1 percent of the rock. On the other hand, X-ray methods have shown that cristobalite is the chief mineral of most spherulites and the submicroscopic parts of rhyolites and, as such, is nearly as abundant as tridymite. Cristobalite is the most common silica mineral in vesicles of basaltic lava and is present in a quarter of the lava flows examined. It is less common in andesite and very rare in cavities in rhyolite. In all of these it forms spherulites perched on the walls of gas cavities. It tends to be concentrated in the denser parts of the groundmass in most rocks. (E. S. Larsen, Jr., 1930; E. S. Larsen, Jr., Irving, Gonyer and E. S. Larsen 3d, 1936.)

In Ouray County, 2 miles west of Red Mountain an altered amygdaloidal lava contains rosettes of quartz on the walls of vesicles; these are due to inversion from cristobalite. (Moehlman, 1935.)

CROCIDOLITE

[*See* Amphibole group, riebeckite species]

CROOKESITE

[*See* Thallium minerals]

CROSSITE

[*See* Amphibole group]

CRYOLITE

Na_3AlF_6

El Paso County.—St. Peters Dome (loc. 5). Cryolite has been found in two localities in the state. The best known is that at St. Peters Dome west of Cheyenne Mountain. Here it occurs in small masses in quartz-feldspar pegmatite and veins associated with astrophyllite, riebeckite, and fine zircon crystals. It ranges from pink or rose to gray in color and appears massive except under the microscope where it is seen to be complexly twinned. The deposit in the Eureka tunnel was once worked for a mixture of cryolite and thomsenolite, which was used in the manufacture of glass bottles. (Whitman Cross and Hillebrand, 1883; 1885—analysis.) It is partly altered to other rare fluorine minerals, such as pachnolite and prosopite, in almost all places and is locally replaced by chalcedony. (Pearl, 1958; see also Landes, 1935.) Much of the material that was earlier thought to be cryolite has been shown to be weberite (which see).

A drill core from the Green River formation in northwestern Colorado contains a ¼-inch bed of cryolite. Dawsonite is present in the same core, but not directly associated with the cryolite. (Charles Milton, written communication.)

CUMMINGTONITE

[*See* Amphibole group]

CUPRIAN ARGENTITE

[*See* Argentite]

CUPRIAN MELANTERITE

[*See* Melanterite *and* Pisanite]

CUPRITE

Cu_2O

Cuprite is fairly widespread in oxidized copper-bearing ores and in a few places has been of some economic importance. The following localities illustrate its mode of occurrence.

Chaffee and Gunnison Counties.—Monarch and Tomichi districts. In minable quantities in the Lily mine, Monarch district. The Iron King mine, Tomichi district, yielded 2 tons of rich copper ore from a single small pocket of cuprite. (R. D. Crawford, 1913; Dings and Robinson, 1957.) It is also reported at Poncha Springs. (Schrader, Stone, and Sanford, 1916.)

Custer County.—Cuprite is reported from Markheart's mine. (Charlton, 1890.)

Fremont County.—Reported as one of the important copper minerals in the Sedalia mine. (Schrader, Stone, and Sanford, 1916.)

Jefferson County.—Fine specimens were found from the Malachite mine on Bear Creek (loc. 9); also found in several other copper deposits. (Hollister, 1867.)

La Plata County.—Occurs as veins and veinlets that cut metamorphic rocks close to the syenite stock along Bedrock Creek, especially in the Copper Age mine. (Galbraith, 1949.)

Montrose County.—A little cuprite is associated with chalcocite and other copper minerals in the Cashin mine. (W. H. Emmons, 1906b.)

Park County.—Good specimens were found from the Sweet Home mine on Buckskin Gulch (loc. 1). (Endlich, 1878; J. A. Smith, 1883.)

Pitkin County.—Cuprite was found in oxidized ores at Aspen, but not abundant. (Spurr, 1898.)

San Miguel County.—Massive cuprite was reported from the Dolores River. (Endlich, 1878.)

CUPROBISMUTITE†

$CuBiS_2$

Like many of the bismuth sulfosalts, cuprobismutite was not readily recognized as a valid mineral species. It was first described as a new mineral from the Missouri mine in Hall Valley, Park County, by Hillebrand (1884; Whitman Cross and Hillebrand, 1885). Later both Short (1931) and Palache (1940) restudied some of Hillebrand's type specimens and found them to be mixtures of emplectite and bismuthinite, thus discrediting cuprobismutite. Still later, Nuffield (1952) reexamined the type specimens and reviewed the work of Hillebrand, Short, and Palache. Basing his conclusions on X-ray studies and calculation of the unit cell, he concludes that cuprobismutite is a valid species, possibly dimorphous with emplectite. Hillebrand, who gives three analyses, describes the type material as small slender deeply striated crystals with a bronze-colored coating in a quartz gangue with chalcopyrite and wolframite. The crystals are embedded in compact dark bluish-gray material of the same composition except that it contains appreciable amounts of lead and silver. Palache's description of these specimens is similar, except that he saw irridescent plates and needles of emplectite in druses with thicker striated crystals of bismuthinite in a few of the druses.

CUPROSCHEELITE

[*See* Cuprotungstite]

CUPROTUNGSTITE

$Cu_2(WO_4)(OH)_2$

The old Grand View and Stockton mines in the Cleora mining district, 2 miles southeast of Salida, Chaffee County, contains scheelite in a quartz vein associated with some gold and copper minerals. With the scheelite is a mineral tentatively identified by G. O. Argall, Jr. (1943) as cuproscheelite. As cuproscheelite has been found to be a mixture of scheelite and cuprotungstite, there is at least mild presumptive evidence that the latter mineral is present in this district.

CYANITE

[*See* Kyanite]

CYANOTRICHITE

$Cu_4Al_2(SO_4)(OH)_{12}\cdot 2H_2O$

Cyanotrichite, known as velvet copper ore, is reported only from the Kelley lode on Trail Creek just west of Idaho Springs in Clear

Creek County. It is associated with azurite, cuprite, malachite, and other secondary minerals. (Hollister, 1867.)

CYRTOLITE

Uranium-thorium rare-earth-bearing zircon

[*See also* Zircon]

Cyrtolite, a variety of zircon containing uranium, thorium, and the rare earths, has been found in several places in the State. It is treated here as a valid species but may actually be a mixture of minerals in some of its occurrences.

Chaffee County.—Mount Antero (loc. 3). Cyrtolite occurs with muscovite, orthoclase, and quartz. It forms 10- to 15-mm bundles of radiating columnar crystals each terminated by rounded planes of the common pyramid of zircon. The cyrtolite is stained by greenish-brown uranium and iron oxides. (Genth, 1892b—analysis). O. I. Lee (1928) found hafnium in the cyrtolite from here.

Clear Creek County.—About 6 miles south of Idaho Springs, on the road to Mount Evans, a pegmatite contains cyrtolite, with uraninite(?) inclusions, allanite and biotite. (G. R. Scott, written communication.)

Douglas County.—Devils Head Mountain (loc. 1). Cyrtolite, or a closely related mineral, occurs with samarskite among the rare mineral assemblage at Devils Head. It occurs in peculiar pale-brown growths, 1 to 1¾ inches long, some with crystal faces on their upper parts. (Hillebrand, 1889—analysis.)

Jefferson County.—Near South Platte (loc. 16). In pegmatite bodies southwest of South Platte and southeast of Buffalo, cyrtolite occurs in crystalline masses as much as 8 inches in diameter. The mineral is commonly associated with biotite and forms curved tetragonal crystals that radiate from a base in the biotite and terminate in adjacent feldspar. Monazite crystals as much as 1 inch long, massive and finely crystallized fluorite, and an altered mica are associated. The cyrtolite is partly intergrown with thorite. (G. R. Scott, written communication.) The Big Bertha feldspar mine, west of Long Scraggy Peak, near Foxton, contains cyrtolite, xenotime, and doverite. (Vance Haynes, written communication.) In the White Cloud mine, euhedral crystals of cyrtolite and fergusonite are associated with biotite aggregates in the outer zone of the pegmatite. Yttrofluorite, gadolinite, doverite, and other rare-earth minerals are present. (Haynes, 1958.)

Swede Gulch (loc. 17). In the Swede Gulch pegmatite, chocolate-brown cyrtolite forms a row of radiating or columnar crystals. The prisms are about three-fourths of an inch long, with first-order pyramid faces. As is true of most minerals that contain uranium or thorium, the feldspar that surrounds the cyrtolite is shattered and stained. (G. R. Scott, written communication.)

DANALITE†

[*See* Genthelvite]

DAWSONITE

$NaAl(CO_3)(OH)_2$

Dawsonite, known in only a few places in the world, occurs in noteworthy quantity in a drill core from the Green River formation of the Piceance Basin in western Colorado. There it forms small but easily visible crystals in vugs in the shale. Authigenic albite is associated with the dawsonite; cryolite is present in the same core. Dawsonite has not yet been found in the Green River of Wyoming or Utah, whereas a large number of other new or rare minerals have been found in these States but not yet in Colorado (Charles Milton, oral communication).

DECHENITE

[*See* Descloizite]

DELRIOITE†

$CaO \cdot SrO \cdot V_2O_5 \cdot 3H_2O$

Delrioite, a new calcium-strontium vanadate, was first found as an efflorescence on sandstone on the dump of the Jo Dandy mine, Montrose County. It occurs as radial aggregates of pale-yellow-green fibrous acicular crystals. Metarossite occurs on the same dump. (M. E. Thompson and Sherwood, 1959.)

DESCLOIZITE

$(Zn,Cu)Pb(VO_4)OH$

Descloizite, formerly also called dechenite, has been reported from the Evening Star and Aetna mines at Leadville, Lake County, but in very small quantity. In various colors of yellow to deep brick red, it is associated with cerussite as incrustations on dark-brown siliceous gangue which is itself crusted on white quartz. (Iles, 1882b—analysis.) A specimen of montmorillonite from Montrose County was shown by the electron microscope to contain some descloizite. (Dwornik and Ross, 1955.)

DIAMOND

C

There are no authentic occurrences of diamonds in Colorado. Finds have been reported intermittently since 1870 or even earlier but no reports have been proved.

DIASPORE

$Al_2O_3 \cdot H_2O$

Custer County.—Stout white prismatic crystals and grains of diaspore occur in the cavities of eruptive rocks on Mount Robinson, between the Silver Cliff and Rosita districts. They are noticeable because of the bright luster on perfect cleavage planes and crystal faces. The mineral is associated with alunite, from which it is probably derived. (Whitman Cross, 1891b, 1896; Eakins, 1892; Clarke, 1903—all contain analyses.) Melville (1891) describes the crystallography of diaspore from the Rosita Hills.

San Juan County.—Silverton district. Diaspore occurs with kaolin as an alteration product of lava in the Polar Star mine on Engineer Mountain; it is also present in the National Belle mine on Red Mountain. (Ransome, 1901b.)

Saguache County.—Bonanza district. No diaspore occurs in the ore-bearing veins, but there is some in their intensely silicified wallrocks, where it is associated with kaolinite, sericite, and zunyite. (Burbank, 1932.)

DICKITE

$Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$

[*See also* Clay minerals, Kaolinite, *and* Nacrite]

Dickite, one of the clay minerals, has been reported from very few districts but is probably much more widespread than is thus indicated.

Boulder County.—Nederland tungsten district. Dickite is abundant in the altered wallrocks of the tungsten veins. It also occurs in the veins themselves, where it is disseminated through horn quartz or locally fills openings in coarse vuggy ferberite. (Lovering and Tweto, 1953.)

La Plata and Montezuma Counties.—La Plata district. Dickite is a widespread vein mineral and was the last mineral to form in the telluride deposits. It occurs as white pulverulent masses of microscopic platy crystals, often stained yellow or brown; locally it is dense and resembles massive alunite. A large dickite-filled vug that was rich in free gold was found in the Cumberland mine. (Galbraith, 1949.)

Ouray County.—Red Mountain district. Dickite is abundant in cavities in quartz in the National Belle and possibly other mines at Red Mountain. It is of commercial value in its own right since dickite from here is widely used as a reference standard by clay mineralogists. The mineral was earlier described as kaolinite by Hills (1884). Dick (1888) and Reusch (1887), described its crystallography and Whitman Cross and Hillebrand (1885) gave an analysis. Later, when Ross and Kerr (1930, 1931) described dickite as a new mineral, they recognized that the "kaolinite" of Red Mountain belonged to the new species.

DIGENITE

$Cu_{2-x}S$

Digenite, which can be considered as close to an isometric form of chalcocite, has been reported only from the Cougar mine, Slick Rock district, San Miguel County. There it is microscopically intergrown with clausthalite and some eucairite in chalcocite nodules. (Coleman and Delevaux, 1957.)

DIHYDRITE

[*See* Pseudomalachite]

DIOPSIDE

[*See* Pyroxene group]

DIPYRE

[*See* Scapolite group (mizzonite)]

DOLOMITE

$CaMg(CO_3)_2$

True dolomite contains nearly equal proportions of calcium and magnesium, but the mineral grades by increases in iron and manganese toward ankerite, $CaFe(CO_3)_2$, and kutnahorite, $CaMn(CO_3)_2$. The exact place of a given specimen in this rather complex relationship can only be determined by chemical analysis. Only those occurrences originally ascribed by authors to the species dolomite are listed here. Ankerite is described separately; kutnahorite has not been described as such from Colorado.

Dolomite is extremely abundant as an essential constituent of the dolomitic sedimentary rocks in many parts of the State. It is also present in greater or lesser quantity as a gangue mineral in many ore deposits.

Chaffee County.—Monarch district. Brown coarsely crystalline dolomite containing some iron or manganese is a gangue mineral in the Rainbow-Eagle Bird mine. A black to bluish-gray variety forms the walls of a few ore bodies on Monarch Hill. (R. D. Crawford, 1913.)

Custer County.—Silver Cliff and Rosita districts. In the Bull Domingo mine, boulders in a breccia pipe are coated with concentric shells of ore and gangue minerals. Of these, a shell of white dolomite follows an early layer of coarse silver-bearing galena, and is in turn followed by layers of ankerite or siderite and then calcite. (S. F. Emmons, 1896.)

Dolores County.—Rico district. Dolomite is not known as a gangue mineral in the district, but it is present in the gypsum of Newman Hill that forms the Enterprise blanket ore body; crystals of dolomite are mixed with celestite in the pulverulent residue from solution of the gypsum. (Ransome, 1901a.)

Eagle County.—Gilman (Red Cliff) district. Coarsely crystalline dolomite is widespread as a replacement of wallrocks and gouge along faults. Most is medium gray but some is mottled white and dark gray. Three analyses show the dolomite to be close to the theoretical composition of the species. (R. D. Crawford and Gibson, 1925.)

Gunnison County.—Iron Hill (loc. 2). Carbonates, predominantly dolomite, comprise a large part of the rocks of the Iron Hill alkalic complex. There are large masses of dolomitic marble thought by E. S. Larsen Jr. and Jenks (1942) to be of intrusive origin.

Lake County.—Leadville district. Dolomite, which grades into the much more abundant manganosiderite (ferroan rhodochrosite), occurs as small crystals that line vugs and as granular masses enclosing sulfides. (S. F. Emmons and others, 1927.)

Ouray County.—Ouray district. A specimen from the Camp Bird Extension, which shows the beginning of encrustation of dogtooth calcite by dolomite is described and illustrated by Patton (1903).

Park County.—Alma district. Iron-bearing dolomite is the most abundant gangue in the silver-lead ores; barite is also prominent in some mines. The deposits are bed replacements in limestone; sphalerite and galena are abundant, pyrite is less so, and chalcopyrite and richly argentiferous tetrahedrite occur in small amounts. Dolomite, which here contains much iron and some manganese, is also the most abundant gangue in the gold deposits in quartzite. (Q. D. Singewald and Butler, 1941.)

Horseshoe and Sacramento districts. Dolomite is widespread and abundant in both primary and secondary ores. (R. D. Butler and Singewald, 1940.)

Park and Lake Counties.—Weston Pass district. Dolomite, some of which probably approaches ankerite in composition, is common in vugs and bands in limestone; it is by far the most abundant gangue mineral. (Behre, 1932.)

Pitkin County.—Aspen district. Much of the dolomite at Aspen is of secondary origin, but it closely resembles the original dolomite in the primary ores. (Vanderwilt, 1935.)

Saguache County.—Bonanza district. Magnesian carbonates are very rare in most of the district. Dolomite, however, is a vein mineral in the E. D. vein in the extreme southern part of the district, where it is associated with calcite and siderite. (Burbank, 1932.)

Teller County.—Cripple Creek. A dolomitic carbonate, probably variable in composition, is widespread in veins and altered wallrocks. Some of it forms rhombohedral crystals and much of it is green, probably tinted by copper salts. In the Orpha May mine, opal preserves hollow negative pseudomorphs after dolomite. Small white rhombs of dolomite associated with fluorite are characteristic of the second period of mineralization. (Lindgren and Ransome, 1906; Loughlin, 1927.)

DOLORESITE†

$3V_2O_4 \cdot 4H_2O$

Doloresite, one of the many new minerals first discovered as a by-product of the Colorado Plateau uranium rush of 1946–55, was first found in the La Sal No. 2 mine, at the head of Lumsden Canyon, 3½ miles southwest of Gateway in Mesa County. After its discovery, it was also found in the Corvusite, Matchless, Arrowhead, Black Mama, and Lumsden No. 2 mines of Mesa County, in the Golden Cycle, J. J., and Peanut mines of Montrose County, and in mines in Utah and Arizona.

In its type locality, doloresite forms black concretionary masses, 1 by 2½ feet, intimately associated with coffinite. Elsewhere it also forms groups of radiating crystals, some of them in petrified wood. Remnant slivers of paramontroseite are commonly present. The mineral is everywhere mixed with other vanadium oxides.

The original description includes chemical and X-ray data. (Stern and others, 1957.)

DOMEYKITE

Cu_3As

Domeykite has been found in only one place in the State. This is in the well-known Cashin mine, Montrose County (loc. 1), where slabs of domeykite several inches in diameter are associated with native copper and silver, chalcocite, amalgam, and other minerals. (Theodore Botinelly, oral communication.)

DOMINGITE*

[*See* Boulangerite, Jamesonite, *and* Owyheeite]

DOUGHTYITE†

$Al_4(SO_4)(OH)_{10} \cdot 7H_2O$

Doughtyite was described as a new mineral by Headden (1905b) and was named for its type locality, the Doughty Hot Springs in Delta County. It occurs as a white precipitate in and around the springs and is formed by reaction between acidic and alkalic water. It has since been found to be probably identical with an equally ill-defined mineral called winebergite. Which name, if either, will finally be preferred is problematic. See also Headden (1905a).

DOVERITE

$YFCO_3 \cdot CaCO_3$(?)

Doverite, a fluocarbonate of calcium, yttrium, and other rare earths, was first described from New Jersey (W. L. Smith and others, 1955). As the validity of the species was still in doubt in 1959, two reported occurrences in Colorado are also doubtful. The second reported occurrence of doverite is in the White Cloud pegmatite mine near South Platte, Jefferson County (loc. 16). There it is the most abundant product of a late-stage fluoride and fluocarbonate mineralization in which primary pegmatite minerals were replaced. Yttrium analogues of bastnaesite and other cerium fluocarbonates await further study. Other minerals of interest in this pegmatite include cyrtolite, fergusonite, gadolinite, and allanite (Haynes, 1958).

Doverite has also been identified as one of the pegmatite minerals in the Big Bertha feldspar mine west of Long Scraggy Peak in Jefferson County near Foxton (also loc. 16). It is associated with xenotime and cyrtolite. (Vance Haynes, written communication.)

DUMONTITE

$Pb_2(UO_2)_3(PO_4)_2(OH)_4 \cdot 3H_2O$

Dumontite or a closely related mineral is present in the oxidized parts of several veins in the Freeland-Lamartine district, Clear Creek County. It is associated with torbernite and autunite. It has not been reported elsewhere. (Harrison and Wells, 1956; Sims and Tooker, 1956.)

DUMORTIERITE

$8Al_2O_3 \cdot B_2O_3 \cdot 6SiO_2 \cdot H_2O$

Dumortierite has been reported in only one deposit. This in is the corundum-bearing pegmatite on Grape Creek, 7 miles southwest of Canon City, Fremont County (loc. 6). The dumortierite, which is visible only under the microscope, occurs as faintly blue perfect pointed prisms, 1.0 by 0.03 mm. Locally it forms bundles of radiating needles or larger more massive columnar aggregates. (Finlay, 1907.)

DURDENITE

[*See* Emmonsite]

DUTTONITE†

$VO(OH)_2$

Duttonite was first found in the Peanut mine, Montrose County. It forms crusts and coatings on another vanadium oxide mineral along fractures in the country rock. Melanovanadite and native selenium are associated. (M. E. Thompson, Roach, and Meyrowitz, 1956b.)

DYSCRASITE

Ag_3Sb

Dyscrasite is noted in the ores from Poughkeepsie Gulch, near Silverton in San Juan County. It has not been reported since from anywhere in the State. (Endlich, 1878.)

ELECTRUM

[*See* Gold]

ELPASOLITE†

K_2NaAlF_6

Elpasolite, one of the very rare fluorine minerals, was first found in the "Pikes Peak region," El Paso County, the cryolite-bearing area of St. Peters Dome (loc. 5). It has never been reported elsewhere. The mineral occurs as colorless compact irregular masses in massive pachnolite; one specimen was covered with small rounded crystallike projections similar to cube and octahedron forms. On the basis of their analysis the discoverers, Whitman Cross and Hillebrand (1883, 1885), thought elpasolite was related to cryolite and were somewhat doubtful as to its validity as a species. Frondel (1948) restudied the original specimens with modern X-ray diffraction methods. He proves elpasolite to be distinct from cryolite and identical with the artificial compound K_2NaAlF_6. Frondel describes the mineral as indistinct aggregates of crystals as much as 0.5 mm in size, lining cavities in massive pachnolite. A little powdery gearksutite is later than the elpasolite.

EMBOLITE

Ag(Cl,Br)

[*See also* Cerargyrite *and* Bromyrite]

Embolite, intermediate between ceragyrite and bromyrite in composition, is no longer considered to be a mineral species. It is listed separately here because available data are insufficient to place the reported occurrences in the ceragyrite-bromyrite series.

In addition to the three districts mentioned below, embolite was reported in the early days of Colorado mining history from the oxidized ores of Gold Hill in Boulder County, Peru district in Clear Creek County, and from the Snake River. (Endlich, 1878.)

Dolores County.—Rico district. Embolite is present in ores of the Puzzle mine, where argentite is partly altered to it and native silver. (Ransome, 1901a.)

Lake County.—Leadville district. Embolite is present in the oxidized ores, mixed with ceragyrite and a little iodyrite; a chloriodide is also reported. Always light green, soft, and sectile, these halides occur as scales, plates, aggregates, or rough crystalline coatings on crevice walls. In the hard siliceous ores the halides are mixed with basic ferric sulfates, granular cerussite, and nodules of galena. Some of the cerussite contains 5 to 10 percent silver as embolite but large quantities of such ore are rare. (S. F. Emmons, Irving, and Loughlin, 1927.)

Saguache County.—Bonanza district. The rich oxidized silver ores possibly contain embolite with cerargyrite, but it has not been definitely identified. (Burbank, 1932.)

EMMONSITE

$Fe_2(TeO_3)_3 \cdot 2H_2O$(?)

Emmonsite, one of the few oxidation products of the telluride minerals and first described from Tombstone, Ariz. (Hillebrand, 1886), was found in the W.P.H., Moose, and Deadwood mines at Cripple Creek, Teller County; it has not been reported elsewhere in the State. In the W.P.H. mine it was 150 feet below the surface in granite and schist near their contact with porphyry. It formed small yellowish-green irregular masses, often mammillary, and was associated with very rich native gold and with tellurite. Hillebrand (1904, 1905) who analysed the mineral, felt that it contained too little water to be durdenite, another ferric tellurite that it resembled, and ascribed it tentatively to emmonsite. Frondel and Pough (1944) reviewed Hillebrand's data and concluded that it is emmonsite and represents a valid species. They also found durdenite to be identical with emmonsite, hence to be discarded as a species. (See also Lindgren and Ransome, 1906.)

EMPLECTITE

$CuBiS_2$

Chaffee County.—Winfield district. Polished sections of ore from the Mike Rabbit mine contain a mineral first thought by E. P. Chapman, Jr. to be klaprotholite but later identified by M. N. Short as emplectite. It occurs as inclusions in bismuthinite and as borders between chalcopyrite and other bismuth minerals. (E. P. Chapman, Jr., written communication.)

Jefferson County.—Golden Gate Canyon. Emplectite was tentatively identified in pitchblende ore from the Union Pacific mine. It is intergrown with chalcopyrite in irregular patches of tennantite and can be seen only with the ore microscope. (Adams and Stugard, 1956.)

Park County.—Montezuma district. Some of the cuprobismutite (which see) described by Hillebrand (1884) from the Missouri mine in Hall Valley is actually emplectite (Short, 1931; Palache, 1940). The mineral was also seen in other veins in Hall Valley by Lovering (1935).

EMPRESSITE†

Ag_5Te_3

Empressite was first recognized by R. D. George in samples from the Empress Josephine mine, Bonanza district, Saguache County. The first complete description, which established it as a new mineral species and named it for its type-locality mine, was by W. M. Bradley (1914). Bradley, who gives two chemical analyses, describes empressite as very fine granular and compact masses with metallic luster and pale-bronze color on conchoidal fracture faces. Galena and native tellurium are associated. Patton (1916), who includes two additional analyses by E. J. Dittus of the Colorado School of Mines, says that Dittus' analyses were made before publication of Bradley's paper; part of the credit for establishment of the species should apparently therefore go to Patton and Dittus.

Burbank (1932), who gives optical and microchemical properties of the material from the Empress Josephine mine, says that hessite and empressite are intergrown irregularly and probably contemporaneously; they are distinctly later that galena. Small amounts of altaite, sphalerite, galena, and chalcopyrite occur as microscopic specks in the tellurides along zones or streaks.

Specimens of the original empressite have also been studied by Schaller (1914), who felt that the mineral was actually muthmannite, by R. M. Thompson (1949), and by R. M. Thompson and others (1951). They studied the type material as well as a specimen from the Red Cloud mine, Boulder County (mislabelled as petzite), with X-rays, polished sections, and other means, and concluded that empressite is a valid species, with the composition AgTe. Donnay and others (1956), whose X-ray studies led them to believe that the formula for empressite should be Ag_5Te_3, have done the latest work on the mineral.

In addition to the previously mentioned occurrences in the Empress Josephine mine and in the Red Cloud mine of Boulder County only one other occurrence has been noted in Colorado. This too is in Saguache County. E. P. Chapman, Jr. (written communication) found it with other tellurides and native tellurium in ore from the Klondike mine, 10 miles west of the town of Saguache.

ENARGITE

Cu_3AsS_4

Enargite is fairly widespread and is a very important ore of copper in a few places. Locally it contains much silver. Most of its reported localities are described below. Burton (1868) reports on a chemical analysis of enargite from a quartz-pyrite vein in Colorado, but does not give the locality.

Chaffee and Gunnison Counties.—Tomichi district. Enargite and the gray copper minerals tetrahedrite and tennantite, occur in minor amounts in a few bed replacement deposits. They are rare in the quartz-pyrite veins. (Dings and Robinson, 1957.)

Clear Creek County.—Idaho Springs and Georgetown districts. Small quantities of enargite are present. (Spurr and Garrey, 1908.)

Gilpin County.—Central City and Blackhawk districts. Enargite is abundant in a few gold-pyrite veins, all confined to a small area within a radius of three-quarters of a mile of the Hazeltine mine in South Willis Gulch. In a few mines such as the Silver Dollar it is about as abundant as pyrite but is more commonly subordinate to pyrite. It is often closely associated with fluorite; tennantite is rare or absent in enargite-bearing veins. The mineral is rare in the galena-sphalerite ores, but there is a little in the Clay County mine and in the Gem vein where cut by the Argo lateral. (Bastin and Hill, 1917.) Enargite occurs both massive and as large imperfect crystals in the Prowers mine in Russell Gulch. All crystals are coated with quartz. Headden (1905b) gives a description of the crystals and an analysis.

Gunnison County.—Anthracite-Crested Butte district. Enargite occurs in quantity in the Forest Queen and several other mines. (S. F. Emmons, Cross, and Eldredge, 1894.)

Hinsdale County.—Carson Camp. Enargite is the principal ore mineral in this small copper-producing district. It is the earliest ore mineral, and is associated with much barite and a little pyrite, chalcopyrite, and famatinite. These minerals were followed by argentiferous galena and sphalerite and finally by marcasite. (E. S. Larsen, Jr., 1911.)

Lake County.—St. Kevin district, Haphazard mine. Enargite, which contains as much as 100 ounces of silver to the ton, is associated with covellite in this mine on Lake Creek. (Chapman, 1935.)

La Plata County.—La Plata district, Neglected and Tomahawk mines. Small quantities of enargite are intergrown with chalcopyrite and tetrahedrite in these mines. That in the Tomahawk is the pink variety, known as luzonite. (Galbraith, 1949.)

Ouray and San Juan Counties.—Red Mountain district. Enargite is a common mineral throughout the district and is the principal ore mineral of the National Belle mine (which is also known as a source of pure dickite), where it forms beautiful clusters of prismatic crystals, some of them crusted with malachite and quartz. In the Zuni mine (type locality of the mineral zunyite) the enargite contained 200 ounces of silver to the ton (Ransome, 1901b); the crystallography of enargite from the National Belle is described by Pirsson (1894.)

In the Genesee-Vanderbilt part of the Red Mountain district, crushed and distorted enargite is interlocked with pyrite, both growing out of a quartz gangue; crystals are rare. Covellite, with a little quartz and pyrite is interstitial to the enargite and pyrite. (Thornton, 1910—analysis.)

Ore from the dumps of the Yankee Girl chimney deposit shows tennantite and enargite intimately intergrown and probably contemporaneous; galena is closely associated and somewhat later than tennantite, which continued to form after enargite stopped. (Moehlman, 1936b.)

The Charter Oak mine at Red Mountain contains enargite with zunyite, pyrite, and native sulfur. Scorodite coats some of the enargite. (Penfield, 1893.)

Park County.—Montezuma district. Small blades of enargite occur in quartz gangue, associated with tetrahedrite, chalcopyrite, and a bismuth mineral in the Missouri mine in Hall Valley. (Whitman Cross, 1884.) No enargite was found in the district by Lovering (1935).

Rio Grande County.—Summitville district. Enargite occurs as tabular and prismatic black crystals and as sooty aggregates in many places; it is associated with pyrite, the most widespread metallic mineral (Steven and Ratté, 1960). The mineral is very abundant in the primary ores, and contains some gold and much of the silver. The largest crystals (3 mm in diameter) are the largest of any of the ore minerals. It does not oxidize as readily as pyrite and rich masses with much silver are found in the oxidized ores. (Patton, 1917.)

In the Ida mine, enargite that contains some free gold occurs in a coarse porphyry where it fills cavities left by alteration of feldspar phenocrysts. Therefore most of it is in the form of compact pseudomorphs after feldspar, but some cavities are lined with small shiny blue-black prismatic crystals. (Pirsson, 1894; Patton, 1917.)

Routt County.—Hahns Peak district, Homestake mine. The ore of this mine contains enargite with galena, chalcopyrite, sphalerite, barite, quartz, pyrite, and argentite(?). (E. P. Chapman, Jr., written communication.)

Saguache County.—Bonanza district. Enargite is a very minor constituent of the Rawley and Express veins, and is commonly noted only in polished sections of the ores. It is intimately intergrown with bornite and tennantite in pyritic ore of the Rawley vein; it alters to, or is replaced by tennantite. It contains both As and Sb, but As is in excess. (Burbank, 1932.)

San Juan County.—Silverton district, Lark mine. A chimmey-type deposit, 30 to 40 feet in diameter in this mine, in the Cement Creek area, contains enargite associated with galena and sphalerite ore. (Varnes and Burbank, 1945.)

General.—L. J. Spencer (1895) listed all the crystal forms then known on enargite. Included in his study are crystals from the following Colorado localities: mines near Black Hawk, Central City, and Russell Gulch (Prowers mine); Ida mine, Summitville district, Rio Grande County; National Belle mine, Red Mountain district, San Juan County; Missouri mine, Park County.

ENSTATITE

[*See* Pyroxene group]

EPIDOTE

$HCa_2(Al,Fe)_3Si_3O_{13}$

Epidote is a widespread and locally very abundant product of either local or regional metamorphism of calcareous rocks, both igneous and sedimentary. It is commonly, but not always, associated with other calcium silicate minerals; its pistachio-green color is so distinctive that it is easily recognized.

Epidote in a common constituent of the Precambrian rocks throughout the Front Range, particularly in metamorphic rocks near their contacts with intrusive bodies. Garnet, tremolite, and the iron oxides are common associates. (Lovering, 1930; Lovering and Goddard, 1950.) Epidote occurs in greater or less abundance in the following districts, among others: Georgetown, Clear Creek County; Rico, Dolores County; Grayback, Costilla County; Central City, Gilpin County; Taylor Peak and Whitepine, Gunnison County; Malachite mine, Genessee Mountain and elsewhere, Jefferson County; Leadville, Lake County; La Plata, La Plata and Montezuma Counties; Longs Gulch and elsewhere, Larimer County; Ouray, Ouray County; Beaver and Tarryall, Park County; Montezuma, Park and Summit Counties; Bonanza, Saguache County; Breckenridge and Kokomo, Summit County. A few specially noteworthy localities are described in more detail below.

Chaffee County.—Calumet iron mine (loc. 2). Perfect single crystals, dark pistachio-green in color, occur at the surface in the vicinity of the iron mine; they are associated with sagenitic quartz. Most of the crystals are in irregular cavities in a layer of soft limestone that contains calcite, pyroxene, and massive epidote. This layer is separated from the underlying body of magnetite ore by a bed of relatively unaltered limestone. The largest crystals are about 40 mm long; they are clustered about the bases of clear tapering quartz crystals that are 5 to 6 inches long and contain hairlike inclusions of epidote. (W. B. Smith, 1886b; Pearl, 1958.)

Fremont County.—Canon City. Pebbles of epidote from terraces along the Arkansas River, 2 miles south of Canon City, have been cut as cabochon gem stones. Most of the material is too coarsely crystalline and brittle for cutting but some good material has been found. The epidote ranges from light-pistachio-green to dark olive-green in color and contains a few patches of bright-red jasper. (Sterrett, 1909.)

Gunnison County.—Gold Brick district. A short distance northwest of Ohio City there is a streak of epidote rock several hundred feet long that is parallel to the enclosing schist and quartzite. It contains some quartz, but most of the rock is pure yellowish-green epidote. Crystals as much as 2 inches long occupy some of the many open cavities. (R. D. Crawford and Worcester, 1916.)

Italian Mountain (loc. 3). Epidote occurs as well-terminated crystals in cavities in anorthite, as imperfect green to greenish-yellow columnar or acicular masses on vesuvianite or on well-developed diopside crystals, as crystals interstitial to large grossularite garnets, and in calcite veinlets that cut hornfels and altered shale. The largest well-terminated crystals are about 1 by 2 cm in size. (Whitman Cross and Shannon, 1927—analyses.)

Monarch and Tomichi districts. Epidote is one of the most common products of contact metamorphism, but only in a few places does it make up the bulk of the rock. It is present in quantity on the west slope of Missouri Hill in the sedimentary rocks near their contact with quartz monzonite. Large bodies of epidote-quartz-chlorite rock, containing 80 to 90 percent yellow-green epidote, occur as blocks enclosed in quartz monzonite on the northeast shoulder of Taylor Mountain. West of Creek Camp there is a body of anthophyllite-quartz-epidote rock. (R. D. Crawford, 1913.)

Park County.—Elk Creek region (loc. 10). A fine collecting locality is on Epidote Hill, at an altitude of about 10,500 feet. The epidote, associated with quartz, garnet, and hematite, occurs in schist. The deposit yields fine pistachio-green crystals, ranging from microscopic sizes to 3 inches long. (Ellermeier, 1946b.)

EPIDOTE GROUP

[*See* Allanite, Clinozoisite, Epidote, Piedmontite, *and* Zoisite]

EPSOMITE

$MgSO_4 \cdot 7H_2O$

Epsomite, or natural epsom salts, is widespread as efflorescences on walls of coal mines, at different mineral springs, and in "alkali" deposits and dry "alkali" lakes in many parts of the State. It is probably also widespread as a postmining efflorescence in many metal mines, but it has only been specifically identified in a few.

Lake County.—Leadville district. Epsomite forms coatings and crystals on mine walls near the bottom of the oxidized zone. It is not rare, but is less abundant than other sulfates (S. F. Emmons, Irving, and Loughlin, 1927).

Park and Summit Counties.—Montezuma district. Epsomite is common in moderately dry inactive mines as thick crusts on the walls, commonly below stopes in veins that contain much ankerite gangue matter. The needlelike crystals, as much as 1 inch long, are perpendicular to the walls and are commonly associated with goslarite. (Lovering, 1935.)

Teller County.—Cripple Creek district. The mineral is present on the 1,000-foot level of the Portland mine, where it is mixed with manganese and alkalic sulfates. It is probably also present in other mines. (Lindgren and Ransome, 1906.) Hobbs (1905) gives a chemical analysis.

ERYTHRITE

$(Co\ Ni)_3(AsO_4)_2 \cdot 8H_2O$

Erythrite, or "cobalt bloom" has been found in two localities.

Gunnison County.—Elk Mountains. In the Luona and other mines on Teocalli and White Rock Mountains erythrite is an alteration product of loellingite (which see). (Hillebrand, 1884.)

San Miguel County.—Placerville. Erythrite occurs sparingly in a vein near the vanadium deposits at Placerville. It is associated with asphaltic material, chalcopyrite, chalcocite, azurite, malachite, galena, molybdenite, and molybdite. No primary source mineral is mentioned. (Hess, 1913b.) Uraninite, metatorbernite, jordisite, ilsemannite, and chrome mica-clay are also present in the Black King No. 5 claim. (Gruner and Gardiner, 1952.)

EUCAIRITE

CuAgSe

Eucairite, a very rare selenide of copper and silver, is reported in microscopic quantities in ore from the Cougar uranium mine, Slick Rock district, San Miguel County. There it is intergrown with clausthalite and digenite in some nodules of chalcocite. (Coleman and Delevaux, 1957.)

EUXENITE

$(Y,Ca,Ce,U,Th)(Cb,Ta,Ti)_2O_6$

Chaffee County.—Trout Creek Pass area (loc. 6). Masses of euxenite as much as 8 inches in diameter are reported from the Yard and Clora May mines, and fragments can be found on the dumps of the Crystal No. 8 mine. (Hanley and others, 1950.) A complete analysis of euxenite, with calculation of the lead-uranium ratio collected by J. W. Adams from the Crystal No. 8 mine, is given by Muench (1950).

Heinrich (1948a) describes in detail the occurrence of euxenite at the Yard pegmatite. Fluorite and rare-earth minerals, including many museum specimens of euxenite and of monazite are in tabular bodies of muscovite on the margins of a quartz-microcline core. The largest euxenite mass seen is 2.5 by 2 by 1.5 inches; monazite masses are even larger. Books of biotite up to 3 by 2 by 1 feet in size are present. The nearby Luella pegmatite has similar assemblages.

Badger Creek, near Trout Creek Pass. Euxenite, identified by X-ray means, is finely disseminated and fairly abundant in several dikelike bodies. The quartz cores of the dikes contain coarser crystals of euxenite with xenotime and an yttrium-bearing garnet. (Vance Haynes, written communication.)

Fremont County.—Colorado feldspar pegmatite. Euxenite, as one-half inch rounded masses or radiating blades and much of it altered, is associated with monazite and fluorite in a body of plagioclase and biotite. One mass of euxenite weighed 75 pounds. (Heinrich, 1948a.)

Jefferson County.—Burroughs mine, near Bergen Park (loc. 4). Euxenite in large lustrous black pieces, some with rough crystal faces 2 inches on a side, is associated with columbite, allanite, monazite, bismuthinite, bismutite, and garnet in pegmatite. Beryl crystals can be found around the rose-quartz core of the pegmatite. (G. R. Scott, written communication.)

Park County.—Guffey area (loc. 6). An unusually large concentration of euxenite is in the core margin of a small zoned pegmatite body 200 feet west of Mac Gulch, 3 miles southeast of Guffey. It forms bladed crystals 2 cm long associated with coarse biotite and magnetite, relatively abundant tantalite, and a little allanite, monazite, and radioactive ilmenite. (Bever, 1953; Heinrich and Bever, 1957.)

FAMATINITE

Cu_3SbS_4

The status of the minerals famatinite and luzonite (Cu_3AsS_4) has been the subject of controversy among mineralogists almost since they were first described. As a result of work by Gaines (1957) it is now established that there is a continuous solid-solution series between these two valid species; pure famatinite contains antimony whereas pure luzonite contains arsenic.

Famatinite has only been noted from Carson Camp, Hinsdale County, where it is associated with enargite and barite. It is much less abundant than enargite. (E. S. Larsen, Jr., 1911.)

In the absence of more specific data, the two reported localities for luzonite are described here in the probability that in both occurrences the mineral is part way between the end-member species.

Montrose County.—Cashin and nearby mines (loc. 1). Luzonite occurs as veinlets and replacement masses in the earlier sphalerite, galena, and chalcopyrite, and in rude colloform bands in covellite; it is most common in vugs, where dolomite crystals are commonly coated by small botryoidal masses of this mineral. None was seen with chalcocite or bornite, but intimate intergrowths of luzonite and chalcopyrite are common. (W. H. Emmons, 1906b.)

Park County.— Horseshoe district. Luzonite, probably of hypogene origin, occurs with quartz, barite, and sulfide minerals in a prospect near the Mudsill mine. Small irregular veinlets and masses of luzonite, with tiny threads of oxidation products, are interlaced with tennantite. (R. D. Butler and Singewald, 1940.)

FASSAITE

[*See* Pyroxene group, subspecies augite]

FAYALITE

Fe_2SiO_4

[*See also* Olivine]

Fayalite, an iron olivine, is reported from the Cheyenne Mountain area of El Paso County. As described and analysed from here by Hidden (1885) and by Hidden and Mackintosh (1891), it occurs in vugs in quartz and granite, in dark-brownish-black masses with two imperfect cleavages. It is locally abundant and some solid masses weigh as much as 10 pounds. It has not been reported in the literature since the work of Hidden and Mackintosh; according to J. W. Adams (written communication) however, fayalite has been collected by Edwin Over from several pegmatite bodies in the Stove Mountain-St. Peters Dome area (locs. 5 and 6). Adams thinks the original locality described by Hidden and Mackintosh was here rather than on Cheyenne Moutain.

FELDSPAR GROUP

Next to quartz, the feldspars are by far the most abundant minerals in the State. They are the most widespread and abundant silicates in nearly all igneous and most metamorphic rocks; they are also abundant in many clastic deposits such as arkose, and in some soils.

The members of the feldspar group are classified primarily as to crystal form and secondarily as to chemical composition. Those species and subspecies known to occur in Colorado are given below:

MONOCLINIC SECTION

Orthoclase	$KAlSi_3O_8$
Soda-orthoclase	$(K,Na)AlSi_3O_8$

TRICLINIC SECTION

Microcline	$KAlSi_3O_8$
Soda-microcline	$(K,Na)AlSi_3O_8$
Anorthoclase	$(Na,K)AlSi_3O_8$

PLAGIOCLASE FELDSPARS (TRICLINIC)

Albite	$NaAlSi_3O_8$
Oligoclase, Andesine, Labradorite, Bytownite	$nNaAlSi_3O_8$ $mCaAl_2Si_2O_8$
Anorthite	$CaAl_2Si_2O_8$

Since no attempt is made here to describe all the occurrences of rock-forming minerals, descriptions of the feldspars are much briefer than is warranted by their abundance or their petrologic importance. Because much orthoclase contains some sodium in isomorphous substitution for potassium, orthoclase and soda orthoclase are described together. The same is true of microcline and soda microcline. The plagioclase feldspars are a continuous series between the two end-member species, albite and anorthite. Intermediate members of the series are the subspecies oligoclase, andesine, labradorite, and bytownite. All these species and subspecies are present in Colorado rocks, but it seems advisable to group them all under the heading of the plagioclase series of feldspars.

Feldspar species ORTHOCLASE

$KAlSi_3O_8$

Orthoclase is probably the most abundant of all the feldspars in igneous and metamorphic rocks. It is dominant in granitic rocks and most pegmatite bodies and is present in varying amount in most other rocks.

As most orthoclase contains some sodium, thus grading toward soda orthoclase, the latter species is not treated separately here, although it is considered a valid species in the State's mineralogy. Very few occurrences of common orthoclase are noted. The variety adularia, which is pure or nearly pure potassium aluminum silicate, is described separately, as is the glassy high-temperature form of orthoclase, sanidine.

Chaffee County.—Mount Antero (loc. 3). Orthoclase occurs in a phenakite-fluorite-bearing quartz vein. (Switzer, 1939b.)

Lake County.—Climax district. Fine-grained secondary orthoclase is characteristic of the mineralized area at Climax, but the mineral can only be recognized under the microscope. The original microcline and orthoclase of the host rock are commonly recrystallized to this generation of orthoclase. It also occurs along the walls or central parts of many quartz veins. (B. S. Butler and Vanderwilt, 1933.)

Summit County.—Breckenridge and Tenmile districts. Orthoclase is most conspicuous as large phenocrysts in quartz monzonite porphyries. Some well-formed crystals, many of which can be easily removed from the altered matrix or can be found loose on the surface, are as much as 3 inches long. Some are short stout simple crystals but others are finely developed Carlsbad twins. (S. F. Emmons, 1898; Ransome, 1911.)

Feldspar species **ORTHOCLASE** variety **ADULARIA**

Adularia, the pure or nearly pure potassium aluminum silicate variety of orthoclase, is rather widespread as a primary constituent of many ore deposits; it is also found in a few pegmatite bodies.

Boulder County.—Nederland tungsten district. Adularia is relatively rare, but is present locally as small veinlets that seam ferberite and as crystals perched on ferberite and sulfides (Lovering and Tweto, 1953). Hess and Schaller (1914) describe a coating of adularia as much as 2 mm thick on the walls of the Black Hawk No. 2 vein, 1½ miles south of Nederland; it was beneath, and older than, most of the ferberite. In some of the mines of the Nederland and Eldora districts, intergrowths of roscoelite and pyrite are surrounded and invaded by fine-grained quartz with a few rhombic crystals of adularia. (Lindgren, 1907.)

Chaffee County.—Nathrop (loc. 4). Minute crystals of adularia are associated with spessartite garnet and topaz. (J. W. Adams, written communication 1958.)

Clear Creek County.—The wallrocks of many of the veins of the Georgetown and Idaho Springs districts are characterized by adularia. In Miller's mine on the Lamartine road, adularia forms nests and veinlets with quartz, pyrite, and sericite and also forms rims around altered feldspars. (Spurr and Garrey, 1908.)

Gunnison County.—Italian Mountain (loc. 3). Small white crystals of orthoclase, probably the variety adularia, rest on and apparently replace anorthite crystals. They are older than sphene and chlorite and probably older than epidote. Scattered white crystals of orthoclase also crust small green garnet in places. (Whitman Cross and Shannon, 1927.)

Snowmass Mountain. Adularia was found in a single thin section of a quartz-fluorite vein in the Mancos shale; it probably also occurs elsewhere. (Vanderwilt, 1937.)

Mineral County.—Creede district, Amethyst vein. Adularia and quartz form veinlets in the rhyolite wallrocks of this vein; no adularia has been found in the ore itself. (W. H. Emmons and Larsen, 1923.)

Ouray County.—Ouray district. Large anhedral masses and small rhombic crystals of adularia were among the first materials to form in the famous Camp Bird vein. The mineral has also been found in the Handicap and other veins cut by the Treasury tunnel. The adularia is corroded by later quartz, kaolin, carbonate minerals, and zoisite. (Moehlman, 1936b.)

Saguache County.—Bonanza district. Adularia occurs in some of the low-temperature quartz-rhodochrosite-fluorite veins in the southern part of the district; it is especially abundant in the Chloride mine. It also cuts altered wallrocks as small veinlets, especially in the latite that forms the walls of the Cocomongo vein. (Burbank, 1932.)

Teller County.—Cripple Creek district. Dense masses of adularia and quartz were among the earliest minerals deposited at Cripple Creek, although dark-purple fine-grained fluorite is the most conspicuous mineral of this early stage. (Lindgren and Ransome, 1906; Loughlin, 1927; Loughlin and Koschmann, 1935.)

Feldspar species ORTHOCLASE variety SANIDINE

The variety sanidine is characteristic of volcanic rocks that crystallized at high temperatures. It is relatively widespread in Colorado; a few of its occurrences are given below.

Boulder County.—West Sugarloaf Mountain. Sanidine comprises about 18 percent of the rock; it occurs as crystals as much as 1 cm long, and includes crystals of apatite. Much of it is intergrown with calcite and other minerals. Labradorite, calcite, biotite, magnetite, kaolin, quartz, sphene, and apatite are present in that order of abundance. (J. C. Blake, 1901.)

Chaffee County.—Nathrop (loc. 4). Sanidine, some of it in crystals, lines most of the lithophysae that contain the gem topaz and garnet crystals in rhyolite at this well-known locality. (Whitman Cross, 1886; Pearl, 1939b; 1958; Ellermeier, 1947b.)

Douglas County.—Castle Rock area. The rhyolite that caps buttes between Palmer Lake and Sedalia is porphyritic, with idiomorphic crystals of sanidine, less oligoclase, and rare microcline. Biotite also forms phenocrysts. Most of the sanidine crystals are perfectly formed, but some are partly resorbed. (Richardson, 1915.)

Gunnison County.—Ragged Mountain. The rhyolite on this mountain contains sanidine crystals as much as several inches long that have a striking satiny moonstone luster. The crystals are zoned, with outer parts lustrous and inner parts transparent. (Whitman Cross, 1885a; Edmondson Spencer, 1930.)

Lake, Eagle, and Summit Counties.—Chalk Mountain (loc. 1). The nevadite which makes up Chalk Mountain contains large phenocrysts of glassy sanidine of brilliant satiny luster and smoky quartz in a light-gray groundmass. Gem topaz crystals occur in cavities. (Whitman Cross, 1884; 1885a; Edmondson Spencer, 1930.)

Larimer County.—Specimen Mountain (loc. 5). Sanidine, as phenocrysts embedded in a dense groundmass, is the principal mineral of the quartz trachyte here. Tridymite is locally abundant in the groundmass. Opal, chalcedony, and topaz fill cavities in the rock. (Wahlstrom, 1941; 1944.)

San Juan Mountains, general.—Common orthoclase is only abundant in the San Juan tuff in the groundmass of the rocks. Sanidine, however, occurs as phenocrysts in half of the rhyolite and rhyolite quartz latite of the Potosi series and in most of the rhyolite in the Hinsdale formation. (E. S. Larsen, Jr. Irving, Gonyer and E. S. Larson 3d, 1936.) Heald (1950) includes a specimen from the Uncompahgre quadrangle in a general study of sanidine.

Feldspar species MICROCLINE

$KAlSi_3O_8$

The triclinic potassium feldspar microcline is probably almost as widespread and abundant as orthoclase, the monoclinic species. Intergrowths of microcline and albite, called perthite or microperthite, are also very abundant. Because most microcline contains some sodium, thus grading toward soda microcline, and because the latter species has not been generally distinguished from microcline, soda microcline is not described separately here, although it is present in the State.

Although common pink or white microcline is widespread and abundant as a constituent of many pegmatites and other igneous rocks, the chief interest in this mineral lies in the occurrences of the beautiful green variety amazonite, or amazonstone. Fine specimens have been found in abundance in several places, notably in the Pikes Peak region, and there are many who consider it the most outstanding of Colorado's gem materials. Only the amazonstone localities are given here.

Arapahoe County.—Deer Trail. Amazonstone crystals that are of gem quality but are chipped and broken along cleavage planes, have been found with rounded pebbles of clear quartz in gravel beds near Deer Trail, on U.S. Highways 40–287, 55 miles east of Denver. (Pearl, 1951a.)

Clear Creek County.—Beaver Brook (Brandt) pegmatite (loc. 1). the core of this pegmatite, which also contains beryl and topaz, is predominantly a pale amazonstone-variety microcline. (Hanley, Heinrich, and Page, 1950.)

Douglas County.—Devils Head Mountain (loc. 1). Large crystals of amazonstone, some as much as 1 foot in length, occur in the same cavities that yield good topaz and smoky-quartz crystals. Most of the amazonstone is inferior in color and quality to that from several other localities (J. A. Smith, 1883; Hanley, Heinrich, and Page, 1950; Pearl, 1958; J. W. Adams, written communication.)

Pine Creek (loc. 3). Amazonstone in deeply colored complete crystals has been found in the area. They are associated with smoky quartz, albite, and fluorite. (Reitsch, 1939; Pearl, 1958; J. W. Adams, written communication.)

El Paso County.—Crystal Park (lcc. 2). One of the most productive localities for gem amazonstone is that of Crystal Park. The crystals, with smoky and clear quartz and some topaz and phenakite, line miarolitic cavities in pegmatites. The well-developed amazonstone crystals range from a fraction of an inch to

3 or 4 inches square. The color ranges from gray to bright green and is often richer in one part of a crystal than another. (Koenig, 1876; Whitman Cross and Hillebrand, 1882c; 1885; Sterrett, 1909; Pearl, 1958.)

St. Peters Dome and Stove Mountain (locs. 5 and 6). Amazonstone occurs with smoky quartz, topaz, and many other minerals in cavities in pegmatite at both localities.

Jefferson County.—Indian Gulch. Amazonstone, and a single crystal of partly altered topaz, were found on the north side of the gulch. (G. R. Scott, written communication.)

South Platte area (loc. 16). Light-green crystals of amazonstone, allanite, cyrtolite, and clear octahedral crystals or purple cubic crystals of fluorite occur in several of the pegmatite bodies. (G. R. Scott, written communication.)

Park County.—Elk Creek. The first mention of amazonstone in Colorado is that of Hollister (1867), who reports it with orthoclase, smoky quartz, specular hematite, and rare anhydrite in what is now Park County, "5 miles from the old St. Louis Ranch." J. A. Smith (1883) gives this location as on Elk Creek, 5 miles above the Tarryall road crossing.

Teller County.—Crystal Peak area (loc. 2). The Crystal Peak area, variously known as Topaz Butte, Crystal Beds, and "Florissant area" and also placed in El Paso, Douglas, and Park Counties by some writers, is the most productive source of gem amazonstone in Colorado, if not in the United States. The locality was first described by Koenig (1876) who says that the amazonstone from near Florissant is of especially good quality. It occurs in drusy cavities in granite as fine crystals, singly or in groups, some very large. The largest reported single crystal was 18 inches long (R. T. Cross, 1883). Twinned crystals are numerous. W. B. Smith (1885, 1886a) says that the greatest number of gem crystals have come from this locality, but that a few crystals, with smoky quartz, have been found on Pikes Peak proper, and at the base of Pikes Peak on Bear Creek, at Crystal Park, at Specimen Rock, and at Cheyenne Mountain. Sterrett (1909, 1914) and Pearl (1958) give excellent descriptions of the locality. Rath (1876) describes crystals from "Pikes Peak" but does not give the locality.

Feldspar species **ANORTHOCLASE**

$(Na,Al)Si_3O_8$

Anorthoclase, the sodium equivalent of microcline, is a constituent of the phonolite in the Cripple Creek district and is present in andesitic rocks in many other places.

Feldspar **PLAGIOCLASE SERIES**

The plagioclase feldspars comprise a continuous series between albite, the sodium end-member species, and anorthite, the calcium end member. The intermediate subspecies include oligoclase, andesine, labradorite, and bytownite. They are widespread and abundant in virtually all igneous and metamorphic rocks as essential constituents. In many extrusive rocks, such as the lava flows of the San Juan Mountains, members of the plagioclase series make up most of the feldspar phenocrysts; elsewhere they are in the groundmass of the rocks. None

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of the intermediate subspecies are further described here. They can be found almost everywhere but their identity can only be established by chemical and microscopic means. Almost by definition, the kind of igneous rock will tell the kind of plagioclase that is dominant in it, for the more mafic the rock the closer are the feldspars to the anorthite end of the series.

Feldspar **PLAGIOCLASE SERIES** species **ALBITE**

$NaAlSi_3O_8$

In addition to its occurrence in the more silicic igneous rocks, both intrusive and extrusive, albite is widespread in many pegmatite bodies, some of it as the lamellar variety cleavelandite, and in a few contact-metamorphic deposits. In only one place, in Gilpin County, has it been described as a vein mineral. Authigenic albite occurs in the Green River formation and is possibly present in other sedimentary rocks. Perthite and microperthite, which are chiefly intergrowths of albite and microcline, also occur in many pegmatites and other igneous rocks. The following occurrences of albite are representative:

Douglas County.—Radiating groups of albite crystals are present in the Pine Creek (loc. 3) and Devils Head Mountain (loc. 1) pegmatite areas. (J. W. Adams, written communication; Hanley, Heinrich, and Page, 1950.)

Fremont County.—Eight Mile Park (loc. 4). White to red cleavelandite, as well as ordinary albite, is abundant in pegmatite. There is also some oligoclase, and andesine occurs in a few interior pegmatite bodies where they cut xenoliths of gabbro. (Heinrich, 1948b.)

Gilpin County.—Central City district, Rooks County mine. In this mine, between Apex and Tolland, small crystals of snowy-white feldspar, probably soda orthoclase, are implanted on octahedral crystals of pyrite in a vug. (Bastin and Hill, 1917.)

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). Pure-white lamellar cleavelandite is present in masses as much as several feet in diameter. It is associated with lepidolite and a little quartz in several of the pegmatites Massive and fine-grained sugary common albite is the dominant mineral in most of these bodies. (Eckel, 1933a; Staatz and Trites, 1955).

Italian Mountain (loc. 3). Albite is abundant and occurs in many mineral associations. In some places it forms small scattered imperfect white crystals in aggregates of large crystals of brown grossularite garnet; the crystals are zoned, ranging from albite to oligoclase and many of them are partly covered by minute crystals of heulandite. Elsewhere it forms small and almost perfect lustrous-white crystals in cavities in garnet-diopside rock. One large group of crystals consists of pale-pink crusts of drusy crystals along open cracks in the centers of feldspar veins in altered diorite. These crystals have a peculiar flat habit and are associated with chabazite, minute quartz crystals, and titanite. (Whitman Cross and Shannon, 1927.)

Teller County.—Near Florissant (loc. 2) and elsewhere, albite occurs with amazonstone. Locally it caps crystals of amazonstone, but more commonly it forms the light-colored base or matrix for the amazonstone. (Randall.)

Northwest Colorado.—Authigenic albite occurs in layers of the Green River formation that are richest in organic material. It forms sharply angular single rhomblike crystals, most of them greatly flattened. Their average length is 0.15 mm with a maximum observed length of 3 mm. (F. E. Moore, 1950.)

Feldspar PLAGIOCLASE SERIES species ANORTHITE

$CaAl_2Si_2O_8$

Anorthite is an essential constituent of the very mafic rocks and as such is probably rather widely distributed. Only one occurrence is noted here. Chemically, the anorthite molecule comprises a part of all the plagioclase feldspars, hence is present in virtually all igneous and most metamorphic rocks.

Gunnison County.—Italian Mountain (loc. 3). Anorthite is an important constituent of many specimens from this locality, but does not form particularly attractive specimens. In one place, translucent white anorthite is crusted with crystals of titanite and epidote; pyrite and chlorite are also present in cavities. (Whitman Cross and Shannon, 1927.)

FERBERITE

$FeWO_4$

[*See also* Huebnerite *and* Wolframite]

Ferberite, the iron end member of the wolframite series, is known and has even been mined in comparatively small quantities in Clear Creek and Gilpin Counties, but it is most abundant in the Nederland tungsten belt of Boulder County. This is the only large tungsten-producing district in the world in which ferberite is the principal ore mineral.

Boulder County.—Ferberite occurs in large quantity, locally as clean beautifully developed jet-black crystals. More commonly it forms small crystals coated with other minerals, including beidellite and other white clay minerals. Some of the ferberite contains manganese, thus grading toward wolframite. Marcasite, pyrite, and other sulfides are associated with ferberite.

In the main tungsten belt the ferberite occurs in crushed and brecciated zones as small veinlets or vug fillings. Other minerals include adularia, calcite, chalcedony, chalcopyrite, galena, goyazite, scheelite, tellurides, and quartz. (Hess and Schaller, 1914; Loomis, 1937; Lovering and Tweto, 1953.)

The Boulder County tungsten belt grades into the gold telluride deposits of the county. Thus, in the Logan mine at Gold Hill, ferberite is the chief ore mineral in a district that is best known for its tellurides; it is associated with dense horn quartz. (Goddard, 1940.) In the Magnolia district, which is primarily a gold and silver producer, there are several tungsten-bearing veins, in which ferberite occurs as blades 0.2 by 0.1 mm, associated with chalcedonic quartz, pyrite, sphalerite, and a little alunite. (Wilkerson, 1939a, b.)

FERGUSONITE

(Y, Er, Ce) (Nb, Ta) O_4

El Paso County.—Stove Mountain (loc. 6). Fergusonite, a rare-earth mineral of the multiple-oxide type, has been found on Stove Mountain. (Over, 1929.)

Jefferson County.—Roscoe dike (loc. 14). The Roscoe dike in Clear Creek Canyon, known for its crystals of gadolinite, contains euhedral crystals of fergusonite, ⅛ inch across and 1 inch long. (Vance Haynes, written communications.)

White Cloud mine (loc. 16). Euhedral crystals of fergusonite are associated with cyrtolite in biotite aggregates in the outer zone of this pegmatite, which also contains doverite and othere rare fluorine minerals. (Haynes, 1958.)

FERRIMOLYBDITE

$Fe_2(MoO_4)_3 \cdot 8H_2O$?

The mineral formerly known as molybdite was long ago shown to be hydrated ferric molybdate, not molydic oxide as earlier supposed. It was later renamed ferrimolybdite and the name molybdite was gradually dropped. The mineral occurs in small quantities at the outcrops of nearly all molybdenite deposits, where it is noticeable because of its yellow colors. It has been specifically recorded in the following districts.

Chaffee County.—Garfield quadrangle. In the Quartz Creek district, on the ridge north of North Quartz Creek and west of Cumberland Pass, there are quartz veins containing huebnerite and molybdenite. Ferrimolybdite is the chief molybdenum mineral in the upper parts of these veins. (Dings and Robinson, 1957.)

Monarch district (loc. 1). In the molybdenite-beryl veins of the California mine on Browns Creek, also known in the literature as "near Hortense," ferremolybdite occurs as lumps of yellow powdery material, made up of minute fibrous crystals, on near-surface vein materials and wallrocks. It is the only secondary mineral of importance. (Schaller, 1908; 1911b—analyses; R. D. Crawford, 1913; Landes, 1935.)

Gold Brick district. Very small amounts of this mineral coat molybdenite at a prospect near Upper Lamphier Lake. (R. D. Crawford and Gibson, 1925.)

Winfield district. A little ferrimolybdite is present with molybdenite. (E. P. Chapman, Jr., written communication.)

Gunnison County.—Tincup district. Ferrimolybdite occurs as a secondary mineral along fractures in the ores. (Goddard, 1936.)

Lake County.—Climax district. Ferrimolybdite is very conspicuous in parts of this, the world's largest known molybdenite deposit. Much of it is so finely crystalline as to appear earthy, but locally, beautiful clusters of fine silky needles grow from fissure walls. Most of the mineral is found close to the surface, but it occurs in oxidized fissures as much as several hundred feet beneath the surface. (Staples and Cook, 1931; B. S. Butler and Vanderwilt, 1933.)

San Juan County.—Silverton district. Reported from the Alice Cary lode by Endlich (1878). It is also abundant in the Sunnyside mine. (Randall.)

San Miguel County.—Placerville district. Ferrimolybdite occurs in a vein 1½ miles northwest of the Placerville vanadium deposits. It is associated with molybdenite, chalcopyrite, chalcocite, galena, vanadium minerals, and mariposite, with some asphaltic material. (Hess, 1913b.)

Telluride district. An analysis of material from this district is given by Schaller (1911b.)

Teller County.—Cripple Creek district. Ferrimolybdite, or some closely related mineral, occurs in a prospect on the north side of Battle Mountain, near the Comanche Plume tunnel. It forms bright-yellow capillary crystals in cracks and joints of weathered latite-phonolite. Little yellow tufts, probably of ferrimolybdite, and dark-blue coatings of ilsemannite occur as alteration products of molybdenite in a vein in the Ophelia tunnel. (Lindgren and Ransome, 1906.)

FERRIPHENGITE

[*See* Glauconite]

FERROAN RHODOCHROSITE

[*See* Rhodochrosite]

FERROAN MAGNESITE

[*See* Carbonate minerals (mixed)]

FERROAN SMITHSONITE

[*See* Smithsonite]

FERROAN SPHALERITE

[*See* Sphalerite]

FERROSELITE

$FeSe_2$

Ferroselite, the iron selenide that was first identified in Russia (Buryanova and Komkov, 1955) is reported in microscopic quantities in uranium-vanadium ore from the Virgin No. 3 mine, Montrose County. (Coleman and Delevaux, 1957.)

FERROTELLURITE*

"$FeTeO_4$"

Ferrotellurite, a supposed new mineral, was described by Genth (1877) from the Keystone mine, Magnolia district, Boulder County. It occurred as very delicate radiating tufts, or minute yellow crystals, coating vein quartz and associated with native tellurium. Genth gives no analysis and only a fragmentary description. Frondel and Pough (1944) on a review of the evidence, discredit the "species" with the conclusion that "it hardly seems worthy of further record in view of the complete lack of definitive characters." It is mentioned here because it is in the literature of Colorado minerals and because Genth's description of it means that some unidentified ferric tellurite was once present in the ore of the Keystone mine.

FERVANITE†

$Fe_4V_4O_{16} \cdot 5H_2O$

Fervanite, first thought to be selenite or satin spar colored yellow by carnotite, was first identified and analysed in Colorado from the Tiny mine in Gypsum Valley, San Miguel County. It was later found in many specimens of carnotite ore from the Colorado plateau region. In all cases it was associated with selenite, carnotite, hewettite or metahewettite, and the black vanadium minerals of the carnotite beds. (Hess and Henderson, 1931.)

More recently, fervanite has been positively identified not only in ore from its type locality in Gypsum Valley but in that from the Hummer mine, Bull Canyon district, Montrose County; from the Fox mine, Uravan district, Montrose County; and from the Polar Mesa mine in the Utah part of the Gateway district. In all these it forms coatings and fracture fillings with hewettite, metahewettite, steigerite, carnotite, and tyuyamunite. (Weeks and Thompson, 1954.)

FIBROFERRITE

$Fe(SO_4)(OH) \cdot 5H_2O$

An iron sulfate mineral, similar in megascopic appearance and chemical composition to fibroferrite, has been noted in the Black Iron mine, Gilman (Red Cliff) district, Eagle County. (Dana, 1892.)

FLORENCITE

$CeAl_3(PO_4)_2(OH)_6$

A uranium-bearing variety of florencite is disseminated in granite found in the dump of a mine just west of the St. Kevin district, Lake County. (Pierson and Singewald, 1954.) This rare mineral has not been reported elsewhere in the State.

FLUOCERITE

$(Ce,La,Nd)F_3$

Fluocerite has been found at several localities, two of them in El Paso County. Its first discovery, probably near the base of Stove Mountain (loc. 6), was by Allen and Comstock (1880) who called it a new mineral, tysonite; it has since been shown that tysonite is identical with fluocerite and the name "tysonite" has been dropped.

The second discovery was by Hidden (1891), who also called the mineral tysonite. This was probably from Crystal Park (loc. 2), near Manitou.

Details of the two occurrences, and additional references to the literature, are given under the heading "Bastnaesite," which is a prominent alteration product of the fluocerite from both places.

Douglas, Teller, and Park Counties.—South Platte-Lake George area. Fluocerite was noted in the rare-earth pegmatites of this area, which are richest in the Raleigh Peaks-Long Scraggy Peak sector of Douglas County. Xenotime is the most abundant of the rare-earth minerals. (Heinrich, 1958.)

Teller County.—Fluocerite occurs in the pegmatite at the Black Cloud mine (loc. 1) between Florissant and Divide. It is associated with bastnaesite. (Haynes, 1958.)

FLUORAPATITE

$Ca_5(PO_4)_3F$

Fluorapatite has been found by modern mineralogists to be the commonest species in the apatite series of minerals. For this reason, and because few detailed studies of Colorado specimens, such as would permit distinction between the different species and varieties, have been made, all the recorded occurrences of "apatite" are treated here as fluorapatite.

The mineral is one of the most widespread accessories in igneous rocks and is responsible for most of the phosphorus in most of them. These accessory occurrences are not described here. It is also found as a true vein mineral in some ore deposits, as a product of wallrock alteration near some of them, and as a constituent of many pegmatite bodies.

Boulder County.—Nederland tungsten district. Most of the fluorapatite in this district occurs as a normal accessory mineral in the igneous rocks, but minute crystals, apparently of hydrothermal origin, occur in the altered wallrocks of some tungsten veins. The sericitized rocks on the third level of the Dorothy mine contain as much as 5 percent fluorapatite. (Lovering and Tweto, 1953).

Chaffee County.—Turret district (loc. 2). Fluorapatite is an accessory mineral in the inner zone of a pegmatite at the Homestake mine. (Hanley, Heinrich, and Page, 1950.)

Clear Creek County.—Georgetown district. Green fluorapatite, which contains some manganese, and hence should be called manganian fluorapatite, occurs as irregular masses in muscovite pegmatite 1 mile southwest of Naylor Lake. (Spurr and Garrey, 1908.)

Eagle County.—Near Gypsum. Greenish-yellow crystals as much as one-half inch thick are reported in andesite. (Endlich, 1878.)

El Paso County.—Brown fluorapatite is intergrown with triplite in a single mass 2 feet in diameter in pegmatite at the south end of Deadmans Canyon (loc. 3). (Boucot, 1947.)

In the Johnny feldspar mine in sec. 10, T. 16 S., R. 67 W., 15 miles south-southwest of Colorado Springs, a little deep-green fluorapatite occurs with pale-green muscovite along the walls of quartz stringers. (Hanley, Heinrich, and Page, 1950.)

"Pikes Peak region." Staffelite, an early and now discarded name for carbonatian fluorapatite, was applied by Goldsmith (1878) to mamillary incrustations 4 to 6 mm thick on amazonstone from near Pikes Peak.

Fremont County.—Micanite district (loc. 8). Two much-fractured crystals of fluorapatite, 12 and 18 inches across, were seen in massive quartz, associated with cordierite. Both pink and green colors were present. (Sterrett, 1923.) Pale-green crystals, several inches long, occur in the Climax pegmatite with cordierite. (Heinrich, 1950.)

Eight Mile Park (loc. 4). This mineral is uncommonly abundant in the core-margin replacement units of the School Section pegmatite, where it forms dull gray-green to dark-purple blocky crystals as much as 8 inches in diameter. It is veined by albite and garnet. Fine-grained blue fluorapatite is also present in the Van Buskirk, Suzanna No. 4, and Meyers pegmatite quarry. Dark-brown specimens resembling triplite have been found on the dumps of the Mica Lode mine. (Heinrich, 1948b.)

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). Light-blue crystals, 0.25 to 0.5 inch long, have been found in three pegmatite bodies, but they are rare in all. (Staatz and Trites, 1955.)

Comet prospect (loc. 1). Pale-green fluorapatite, similar to beryl in appearance, occurs with muscovite and beryl in microcline-quartz-biotite pegmatite in sec. 19, T. 12 S., R. 83 W., 34 miles north-northeast of Gunnison. (Hanley, Heinrich, and Page, 1950.)

Italian Mountain (loc. 3). Small yellowish-white to colorless transparent crystals as much as 3 by 6 mm in size are interspersed with crystals of sahlite (pyroxene) in cavities in massive sahlite. It also occurs as transparent green crystals in calcite and as ill-defined brown masses as much as 2 cm long in sahlite rock. (Whitman Cross and Shannon, 1927.)

Jefferson County.—Cressman Gulch pegmatite (loc. 6). Reddish-brown fluorapatite is commonly associated with beryl. (J. W. Adams, written communication.)

Bergen Park, Cresswell mine (loc. 2). Small translucent crystals, blue to bluish green, with rough distorted crystals of titanite are associated with galena, allophane, pyroxene, and several other sulfides and silicates. J. W. Adams, written communication.)

Fluorapatite was found in pegmatite in the center of sec. 10, T. 3 S., R. 71 W., as pale-green prisms three-fourths inches long. (D. M. Sheridan, written communication.)

Larimer County.—Fort Collins. Beautiful nodular clusters of crystals were reported in clay. (J. A. Smith, 1883.)

Crystal Mountain district (loc. 1). Deep-green, blue-green, and lilac varieties of fluorapatite have been found in several pegmatite deposits as grains 0.1 to 0.6 inch in diameter. Although a rare accessory mineral in the pegmatites, fluorapatite is more abundant as a microscopic constituent of the country rocks. (Thurston, 1955.)

Big Boulder prospect. Some blue crystals are associated with beryl. (Hanley, Heinrich, and Page, 1950.)

Crystal Silica mine. Blue-green crystals that contain some manganese and have a streaked appearance like perthite are present in muscovite-beryl pegmatite. (Hanley, Heinrich, and Page, 1950.)

Glendevey. Near Glendevey, on the Laramie River, pink to red finely crystalline to fibrous fluorapatite is present. (R. G. Coffin, written communication.)

Saguache County.—Bonanza district. Fluorapatite occurs in a few widely spaced veins, intimately associated with quartz, carbonates, and sulfides. The colorless hexagonal and rectangular grains have very sharp crystal outlines. It also occurs sparingly in some altered and silicified wallrocks. (Burbank, 1932.)

San Miguel County.—It was noted in the Special Session mine (Mount Wilson) and the Carribeau mine (Ophir). (Whitman Cross and Purington, 1899.)

Teller County.—Cripple Creek district. Fluorapatite is abundant in the latite phonolite, in prismatic crystals crowded with liquid, solid, and gaseous inclusions. Fluorapatite also occurs in slender microscopic prisms with adularia in the Elkton mine. (Lindgren and Ransome, 1906.)

FLUORITE

CaF_2

Fluorite, which has many industrial uses, is present in greater or lesser amounts in dozens of ore deposits and many pegmatite bodies throughout Colorado. Fluorspar, the industrial name applied to the more or less impure ores of fluorite, has been mined in a small way from 10 districts and large amounts have been produced from 4 others: Jamestown district, Boulder County; Browns Canyon district, Chaffee County; Northgate district, Jackson County; and Wagon Wheel Gap, Mineral County. For descriptions of the fluorspar industry and resources, the reader should refer to Aurand (1920a), Cox (1945), Van Alstine (1947); and G. O. Argall, Jr. (1949).

Varieties of fluorite that contain yttrium and cerium are known in Colorado; these are described below at yttrian and cerian fluorite. In addition to these is the material originally called gunnisonite, since discredited as a species.

The name gunnisonite was tentatively proposed for an impure or altered fluoride from Iron Hill, Gunnison County (loc. 2). The analysis of the material led to a formula of $4CaO \cdot Al_2O_3 \cdot 2SiO_2 \cdot 16CaF_2$. (Clarke and Perry, 1882.) It was never proved to be a distinct mineral and the name has been dropped although it has been used as late as 1942 by E. S. Larsen, Jr., and Jenks (1942).

Comparatively few of the more interesting or more important deposits are given here.

Boulder County.—Jamestown district. Jamestown is one of the leading fluorspar-producing districts in the State. The commercial deposits consist of broad zones of brecciated granite that is cemented and partly replaced by fluorite. These zones are 10 to 70 feet wide and 50 to 350 feet long. There are also veins of fluorite from a few inches to 20 feet wide and 150 to 1,000 feet long, and fluorite is a gangue mineral in most of the metallic ores. Most of the fluorite is deep violet, but purple and wine-colored material is widespread and some is greenish white. The fluorite bleaches rapidly in sunlight, and nearly all is strongly thermoluminescent. Gangue minerals in the fluorspar deposits are clay minerals, quartz, sericite, pyrite, chalcedony, carbonates, and hematite. Arfvedsonite, garnet, adularia, and gearksutite occur in a few of the veins in small quantity (Goddard, 1946; see also Aurand, 1920a; Goddard, 1935; Van Alstine, 1947).

Ives (1935) described a specimen of clear colorless fluorite from the Jamestown district that encloses long slender needles of native tellurium and small rounded pieces of a dull-black mineral that contains uranium and copper. Specimens of fluorite from four different mines in the district were analysed by Bray (1942); he found each of them to contain 20 minor elements.

Chaffee County.—Mount Antero (loc. 3). Fluorite of octahedral habit is present in most of the pegmatite and miarolitic cavities on and near Mount Antero. The crystals, most of which are deep purple, range from 1 mm to 20 cm in size. Small colorless crystals with light-green coatings occur locally in the beryl-phenakite-bertrandite pegmatite. The octahedral crystals are twinned, a hitherto unknown crystal habit for this mineral. (Switzer, 1939a, b.) See also R. D. Allen (1952) for additional facts on chemistry and physical properties.

Morgan Ranch deposit. This deposit is 8½ miles north of Salida and close to the east bank of the Arkansas River. Veins of fluorite, ranging from a few inches to 4 feet in width, cut granite and the overlying lava flows. The fluorite is fine grained and porcelanic to sugar textured and is beautifully banded in shades of green, pink, purple, red, brown, and white. (B. S. Butler, written communication.)

Trout Creek Pass district (loc. 6). Abundant fluorite is associated with the euxenite, allanite, xenotime, and gadolinite of the Yard and Luella pegmatites. Based partly on his observations here, Heinrich (1948a) notes the close relationship existing between fluorite and the rare-earth minerals in many pegmatites of the United States.

Browns Canyon district. This district, which has produced large quantities of fluorspar, is 8 miles northwest of Salida and lies between the Arkansas River and U.S. Highway 285. The fluorite occurs as veins in granitic and volcanic rocks. Most of it is white and fine grained. It occurs as bands along faults and as large irregular masses that are botryoidal, mamillary, or even stalactitic.

Clear Creek County.—Georgetown district. Fluorite is a rare gangue mineral in the silver-lead deposits, but it is abundant in the deposits on McClellan Mountain. Similarly, although rare in most of the pyritic gold deposits, there are large quantities in the vein worked by the Big Chief mine and in several other veins in the gold belt along Leavenworth Mountain. The country rocks of the district contain fluorite in many places. Thus, in the pegmatite bodies it is a primary mineral contemporaneous with tourmaline; it fills miarolitic cavities in porphyritic granite near the bodies. In bostonite rocks it occurs as wedges between other minerals or replaces feldspars. It also occurs in the quartz monzonite where some is original and some formed after consolidation of the rocks. (Spurr and Garrey, 1908.)

Custer County.—Antelope Creek district. This district, which has produced large amounts of fluorspar, is 16 miles southeast of Westcliffe and 7 miles east of Rosita. The veins range from 20 inches to 4 feet in width and consist of finely fractured fluorite flanked by bands of brecciated silica that is cemented by fluorite. Brown fluorite predominates, but some is light green and violet blue. (Burchard, 1909; Aurand, 1920a.)

Douglas County.—Pine Creek (loc 3). The pegmatite bodies at Pine Creek contain cubic crystals of amber to yellow fluorite as much as 3 inches across.

The crystal surfaces are rough and iron stained but the interiors are fairly clear. (J. W. Adams, written communication.)

Kramer pegmatite mine. Deep-purple crystals of fluorite are associated with transparent albite crystals. (G. R. Scott, written communication.)

El Paso County.—St. Peters Dome (loc. 5). The St. Peters Dome area, 8 miles southwest of Colorado Springs, famous for the occurrence of cryolite and other rare fluorides, has also produced large amounts of fluorspar. Most of the fluorspar mineralization follows steep en-echelon shear joints and minor faults near Duffields and Cather Springs. The fluorite, intimately intergrown with quartz, is moderately to coarsely crystalline and purple, green, and white. Some deep-purple cubes are as much as 1 inch across. The common sulfides are present in small amounts and long bladed crystals of pink barite are locally abundant. Fluorite is also common in miarolitic pegmatite bodies in the area, where it is colorless to emerald green and commonly color banded along the octahedral cleavage planes (Steven, 1949; see also Aurand, 1920a; Landes, 1935; and Cox, 1945.)

Jackson County.—Northgate district (loc. 1). This district, one of the four major fluorspar producers in Colorado is on the southwest flank of the Medicine Bow Range; large reserves of ore are present. Fluorite occurs in fissure veins as reniform and botryoidal masses in fault breccia and as replacement bodies in breccia. Some of the commercial ore bodies are as much as 45 feet wide and 1,000 feet long. Chalcedony and a little pyrite and calcite are the gangue minerals. The comparatively rare molydenum mineral ilsemannite has been found here. (Van Alstine, 1947; Steven, 1954; Goldring, 1942.)

Jefferson County.—Cub Creek area (loc. 1). Several veins that contain fluorite with small amounts of lead, zinc, and copper minerals occur along Bear Creek and its tributaries in the vicinity of Evergreen. One of these is on the northwest side of Cub Creek, three-fourths of a mile southwest of Evergreen. This vein, 1 to 5 feet thick, contains banded fluorite that is amethyst to deep purple, pale to deep green, and greenish yellow. The vein can be traced for several miles and is opened at several places where it contains kidney-shaped bodies of metallic sulfides. (E. F. Burchard, 1909; Aurand, 1920a.)

The Augusta mine, possibly another opening of the same vein just described, is 1 mile south of Evergreen, on the east side of State Route 73. The outcrop yields specimens of massive banded green and purple fluorite, with a few clear colorless crystals of fluorite and small transparent yellow to brown prismatic crystals of willemite. Yellow sphalerite and chalcocite are also present. (Lindgren, 1908; J. W. Adams, written communication.)

Lake County.—Climax district. Fluorite is very widespread throughout the Climax deposit; it is more abundant in the higher grade molybdenite ore than elsewhere. In sericite-filled veins it forms octahedral crystals and irregular masses several inches in diameter; it is also present throughout the silicified rock. The green, red, and purple varieties are easily recognized, but there is also much colorless fluorite that is commonly overlooked. (B. S. Butler and Vanderwilt, 1931, 1933.)

La Plata County.—Needle Mountains district. Fluorite is more abundant in the Needle Mountains than anywhere else in the San Juan Mountains. It is green and alternates with layers of quartz crystals that are crusted on pink rhodochrosite. (Whitman Cross, Howe, Irving, and Emmons, 1905.)

Mineral County.—Wagon Wheel Gap (loc. 1). The Wagon Wheel Gap deposit, 1¼ miles south of the railroad station of the same name, is one of the larger fluorspar producers in the State. It is also of interest because it seems to be genetically related to present-day hot springs. The deposits occur in a series of sheeted veins; the fluorspar ranges from a few inches to 35 feet wide and has an average thickness of 6 to 8 feet in the main workings. Most of the fluorite is white and fine grained and forms botryoidal and mammillary masses; there are a few well-formed crystals in vugs. Barite in coarse crystals is abundant as are halloysite and the rare minerals creedite and gearksutite. Pyrite, quartz, chalcedony, and calcite are also present. (W. H. Emmons and Larsen, 1913; see also Lunt, 1915; Burchard, 1933; Aurand, 1920a; and Van Alstine, 1947.)

Ouray County.—Red Mountain district. Fluorite is widespread but not very abundant in most of the ore deposits of Ouray County. In the Barstow mine near Red Mountain, however, there is a deposit of very high grade material. It is in a 3- to 5-foot vein separate from the main Barstow gold vein. The fluorite is in coarsely crystallized masses in brown clay and ranges from pale to bright green. Some material of optical grade may have been present. (Cox, 1945.)

In the Grizzly Bear and Mickey Breen mines in Poughkeepsie Gulch, small bright-green crystals of fluorite are associated with rhodochrosite, quartz, and the common sulfides. (Aurand, 1920a.)

Park County.—Alma district. In the Kentucky Belle and Rainbow mines small cubes of fluorite occur as the chief gangue with chalcopyrite. In the Rhodochrosite mine, which has produced some excellent gem rhodochrosite, very clear deep-purple fluorite is associated with galena-chalcopyrite-tetrahedrite-rhodochrosite ore. (Aurand, 1920a.)

Teller County.—Cripple Creek district. Fluorite is a relatively abundant gangue mineral in most of the Cripple Creek deposits. It formed with adularia and quartz during the first stage of mineralization. These same minerals were deposited during the second stage but the fluorite is a lighter purple and the quartz is milky to smoky. Dolomite, celestite, and the telluride minerals characterize the second stage, and were accompanied by a little free gold, roscoelite, and the common sulfides. The third stage of mineralization is marked by quartz, chalcedony, calcite, and cinnabar. (Lindgren and Ransome, 1906; Loughlin, 1927.)

Fluorite variety CERIAN FLUORITE

An analysis of cerian fluorite from Colorado is recorded by Tschernik (1905). It is rich in yttrium and cerium, and is associated with topaz, feldspar, muscovite, and quartz. Tschernik also gives an analysis of the topaz.

Fluorite variety YTTRIAN FLUORITE

Yttrian fluorite, or yttrofluorite, is a variety of fluorite in which yttrium substitutes for part of the calcium. It is present in the White Cloud mine, Jefferson County (loc. 16), with doverite and other rare-earth minerals. Most of it is between the intermediate zone and the core of the pegmatite. (Haynes, 1958.)

An unidentified granular cleavable fluoride occurs with quartz, astrophyllite and danalite (genthelvite) in West Cheyenne Canyon, El Paso County (loc. 6). It contains much yttrium and erbium and smaller amounts of other rare earths. It is probably yttrian fluorite but may be closer to fluocerite. (Genth, 1892b—analyses.)

The Teller pegmatite in Park County (loc. 9) contains large lenses of varicolored fluorite in the northern part of the dike. Spectrographic analysis shows it to be yttrian fluorite. The pink and cream fluorite is rich in inclusions of xenotime, gadolinite and other rare-earth minerals. (Glass, Rose, and Over, 1958.)

The rare-earth pegmatite bodies of the South Platte-Lake George area, in Douglas, Teller, and Park Counties, generally contain yttrian fluorite. (Heinrich, 1958.)

FLUORSPAR

[*See* Fluorite]

FOURMARIERITE

$PbO \cdot 4UO_3 \cdot 5H_2O$ (?)

Fourmarierite has been identified in ore from the Black Knight vein 2 miles south-southwest of Critchell, Jefferson County (loc. 7). It is associated with pitchblende, uranophane, autunite, and becquerelite. (Haynes, 1958.)

FRANKLINITE

$(Fe, Zn, Mn)O \cdot (Fe, Mn)_2O_3$

Franklinite has been reported only once, in arsenopyrite from the "Rio Dolores" (possibly the Rico or Dunton districts). (Endlich, 1878.) The occurrence seems doubtful.

FREIBERGITE

[*See* Tetrahedrite]

FREIESLEBENITE

$Pb_3Ag_5Sb_5S_{12}$

[*See also* Boulangerite]

Freieslebenite has been doubtfully reported from only two localities. One of these—at the Domingo mine, Gunnison County—has been shown to be boulangerite. The only other report is that by Endlich (1878) from Cement Creek in the central part of the Silverton district, San Juan County. The mineral contained no silver, hence was probably wrongly ascribed to freieslebenite; it occurred as groups of acicular steel-grayish-black crystals.

FREMONTITE*

[*See* Natromontebrasite]

FRIEDELITE

$H_7(MnCl)Mn_4Si_4O_{16}$

The Sunnyside mine, Silverton district, San Juan County (loc. 1), is the second locality in the United States for the comparatively rare mineral friedelite. It forms fine-grained rose-red to brownish-red translucent masses, associated with alleghanyite, tephroite, and rhodonite. Burbank (1933) gives the optical properties.

FUCHSITE

[*See* Muscovite]

GADOLINITE

$Be_2FeY_2Si_2O_{10}$

Gadolinite, a comparatively rare silicate of yttrium and beryllium, has been found in several places in Colorado and has been produced commercially. In a discussion of gadolinite as a source of yttrium for the new Nernst gas-light mantle, Atkinson (1910) says, "Colorado has yielded small quantities of gadolinite, but it analysed considerably less [yttrium] than the Texan [gadolinite]."

Boulder County.—Jamestown district (loc. 2). Gadolinite is described by Goddard, Lovering, and Fairchild (1935) as bordering masses of cerite. Evidently the identification was in error, because a more thorough report on the cerite described allanite, but not gadolinite, as forming the borders of cerite rock. (Goddard and Glass, 1940.)

Chaffee County.—Trout Creek Pass (loc. 6). Gadolinite is present but rare in the pegmatite bodies (J. W. Adams, written communication.)

Clear Creek County.—Beaver Brook (loc. 1). A pegmatite body on Beaver Brook contains lustrous black masses of gadolinite as much as 3 inches in diameter; some have monazite in the core. Other interesting minerals are zircon, allanite, and garnet. (G. R. Scott, written communication.)

Douglas County.—Devils Head Mountain (loc. 1). Two specimens of gadolinite from the Devils Head pegmatite area were studied and analysed by Eakins (1886), whose description was the first report of this mineral in the United States. One specimen resembled a worn stone, which was black and somewhat lustrous on fresh surfaces. The other specimen was less dark, approaching a dull green; it occurred in angular fragments.

Fremont County.—Pine Ridge pegmatite (loc. 10). Black, resinous masses of gadolinite weighing as much as 20 pounds are associated with white plagioclase, gray fluorite, and green sericite as replacements of microline. (Heinrich, 1948a.)

Jefferson County.—Roscoe pegmatite (loc. 14). Gadolinite was first identified by me in the Roscoe dike, on Clear Creek Canyon, in 1932 from specimens collected by J. H. Johnson. Uncommonly well developed monoclinic crystals, black and vitreous, are in this collection; the largest partial crystal is 11 cm in diameter.

Vance Haynes (written communication) reports masses of gadolinite weighing as much as 10 pounds, in addition to many crystals. Xenotime, fergusonite, uraninite, beryl, and a little molybdenite and molybdite are associated. The gadolinite is high in cerium and may be classed as the variety cergadolinite.

White Cloud mine (loc. 16). The White Cloud mine, near South Platte, contains crystals of gadolinite and allanite in the outer parts of the pegmatite core. Other minerals in the dike are cyrtolite, fergusonite, yttrofluorite, and doverite. (Haynes, 1958.)

Park County.—A specimen of massive gadolinite from the upper canyon of the South Platte River was at one time in the Colorado Scientific Society mineral collection. (Randall.)

This is possibly the same locality as the Teller pegmatite (loc. 9), where xenotime and gadolinite are the most abundant rare-earth minerals. The gadolinite occurs as greenish-black crystals as much as 1½ inches long embedded in yttrian fluorite. It is also abundant as microscopic inclusions in the fluorite. Glass, Rose, and Over (1958) record a spectrographic analysis. (See also Heinrich, 1958.)

Washington County.—Gadolinite specimens were supposedly dug near Akron. They probably represent debris from deposits in the Rocky Mountains that were deposited on the plains. (Schrader, Stone, and Sanford, 1916.)

GAHNITE

$ZnAl_2O_4$

[*See also* Spinel]

Chaffee County.—Monarch district. The zinc spinel gahnite occurs in small quantity in the Bon Ton vein and in even less quantity in nearby garnetiferous schist. In the vein it is associated with quartz, feldspar, chalcopyrite, sphalerite, and galena. It forms grains and rhombic dodecahedrons as much as one-fourth inch in diameter. The mineral contains both magnesium and iron and is dark green. (R. D. Crawford, 1913.)

Sedalia mine (loc. 5). A spinel thought to be gahnite occurs as one of the gangue minerals (see amphibole). (Kunz, 1885; Lindgren, 1908.)

Fremont County.—Cotopaxi mine (loc. 1). The Cotopaxi mine, which has produced a little copper and zinc, is a well-known source of crystals of gahnite. The early literature places this mine in Chaffee County. The crystals, as much as 9 cm in diameter, are rough and some show both octahedral and dodecahedral faces; some are distorted and flattened. Some crystals contain inclusions of galena, chalcopyrite, and pyrite. Most are strongly altered to chloritic material but where fresh are dark bluish green. Genth (1882) gives an analysis.

The ore minerals are massive chalcopyrite and dark-brown sphalerite, intimately intergrown with quartz, abundant biotite, garnet, and amphibole; the wallrocks are granite gneiss, and the ore deposit itself is believed of probable Precambrian age. (Lindgren, 1908.)

Gilpin County.—Virginia Canyon. The Crystal mine contains zinciferous spinel (Endlich, 1878; J. A. Smith, 1883.)

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). Greenish-black to dark-green anhedral masses of gahnite, from 0.03 to 0.75 inch in diameter, were found in eight of the pegmatite bodies studied by Staatz and Trites (1955).

Jefferson County.—Bergen Park, Creswell mine (loc. 2). Beautiful green crystals as much as one-thirty second inch in size, are embedded in white recrystallized calcite. (G. R. Scott, written communication).

GALENA

PbS

Galena is one of the most valuable minerals in the State, not only because it is the source of nearly all the $317 million worth of lead that has been produced, but also because it has yielded a large part of Colorado's silver and some of its gold. Much of the silver in galena is in solid solution in the lead sulfide molecule; the remainder is present as argentite or other silver minerals that are microscopically intergrown with the galena. Gold is probably present as microscopic particles of free gold or tellurides. As a general rule fine-grained or "steel" galena is more likely to contain silver than the coarser kind. Argentiferous galena is seldom rich enough in silver to be an ore of that metal by itself; more commonly it merely adds to the silver content of ore that also contains visible silver minerals or argentiferous tetrahedrite-tennantite.

Only the more significant or interesting of the hundreds of galena occurrences in the State are given below.

Boulder County.—Camp Albion. Galena occurs in high-temperature veins with pyrite, chalcopyrite, sphalerite, and a little molybdenite; the gangue minerals are quartz, fluorite, feldspar, calcite, sodic asbestos, and diopsidic aegirine. In the Snowy Range mine, where it is most abundant, the galena has closely spaced octahedral parting planes. Microscopic study of polished sections shows that laminae of tetradymite parallel to the crystallographic directions are responsible for the parting. (Wahlstrom, 1934; 1937—analyses.)

Ward district. Galena is rare in most of the district, but in the White Raven mine, which produced large amounts of lead and zinc, it is relatively abundant. Most of it occurs as well-formed crystals as much as three-fourths inch across; in the oxidized zone some of these are coated with wire gold. Many of the crystals are distorted and tabular or elongated; their surfaces are dull or etched. (Worcester, 1920; Wahlstrom, 1935.)

Chaffee and Gunnison Counties.—Garfield quadrangle. Argentiferous galena, some of it very rich in silver, is one of the chief ore minerals in the bedded replacement deposits in the Tincup district and also in the Monarch and Tomichi districts. With sphalerite, it occurs in commercial amounts in the pyritic quartz veins of these districts and in the Mary Murphy mine. (Goddard, 1936; Dings and Robinson, 1957.)

Clear Creek County.—Georgetown district. Sphalerite and galena are the principal ore minerals in the silver-lead ores; they are intergrown to form the main mass of the vein matter. The galena contains some silver, but most of the silver is in other minerals. Galena, which contains some gold, is also widespread in the gold-pyrite deposits, but is seldom abundant. The Waldorf mine in the Argentine district contains very large and abundant crystals of galena on the walls of quartz-lined geodes. (Spurr, and Garrey, 1908.)

Custer County.—Silver Cliff and Rosita districts. Lead, as galena, is the third metal in economic importance in these districts, but only the Bull Domingo mine has produced very much galena. In this mine, as in the Bassick, the ore is in a breccia pipe with rounded boulders of gneiss, granite, and syenite. The ore minerals occur as concentric shells, ½ to 1 inch thick, on the boulders. The inner shell is composed of galena or alternations of galena and sphalerite with the galena well crystallized and the sphalerite amorphous or fibrous. This shell is thinly coated with dull lusterless crystals of galena, which are surrounded by shells of white dolomite, ankerite or siderite, light-colored calcite, and finally white or yellow botryoidal chalcedony. Most of the silver produced by the mine is in the galena. The coarse-grained galena contains an average of 68 ounces of silver to the ton; fine-grained galena contains less silver than the coarse-grained mineral. (S. F. Emmons, 1896.)

Dolores County.—Rico district. Galena occurs in moderate amounts in most of the mines, but it is nowhere sufficiently abundant to be an ore of lead. It is all argentiferous, but is not silver ore unless associated with argentite, freibergite, proustite, or pyrargyrite. (Ransome, 1901a.)

Eagle County.—Gilman (Red Cliff) district. Galena together with sphalerite, which is much more abundant, are the chief ore minerals in the district. They occur in pyrite with carbonates and chalcopyrite. The galena ranges from coarsely crystalline to the "steel" variety. (R. D. Crawford and Gibson, 1925; Borcherdt, 1931.)

Lake County.—Leadville district. Large amounts of galena occur in the primary ores, particularly in the western part of the district, although it is not as abundant as either pyrite or sphalerite. Most of it occurs as granular masses of small crystals, commonly cubes modified by octahedrons, but there are some crystals ¾ to 2 inches in diameter. The smaller crystals are brilliant, whereas the larger ones are dull and pitted and coated with crystals of carbonate. All the galena contains some silver, most of it as argentite. (S. F. Emmons, Irving, and Loughlin, 1927.)

In the Greenback ore body, 1 mile east of Leadville, Chapman and Stevens (1933) found galena, apparently homogeneous, that contains large proportions of silver and bismuth. (*See also* Chapman, 1941.)

La Plata County.—La Plata district. Galena with well-developed octahedral cleavage was found along the north side of Bedrock Creek by Hills (1917). His analyses show the presence of significant amounts of bismuth and antimony which he thinks is responsible for the anomalous cleavage.

Mineral County.—Creede district. Galena, probably the only primary lead mineral, is a valuable product of the district, although less so than silver. It ranges in size from very coarse grained to very fine grained and occurs as thin bands that alternate with sphalerite and quartz or as disseminations in thuringite. Locally veinlets of galena occur in the wallrocks. (W. H. Emmons and Larsen, 1923.)

Ouray, San Miguel, and San Juan Counties.—Galena occurs in important but variable amounts in nearly all the deposits of the San Juan Mountains. Most of it is argentiferous, particularly the finer grained varieties.

Pitkin County.—Aspen district. Argentiferous galena was the most important ore mineral in the district, at least after the rich bodies of polybasite, pearceite, and other silver minerals were exhausted. It occurs with sphalerite, pyrite, chalcopyrite, bornite, and the gray copper minerals in dolomite with some quartz and barite. (Spurr, 1898; Bastin, 1925.)

Park and Lake Counties.—Alma and nearby districts. In the Alma, Platte Gulch, Horseshoe, Sacramento, and Weston Pass districts, galena is an important mineral. In most places it is very largely confined to deposits in calcareous rocks, whereas gold deposits occur in siliceous rocks. Argentiferous tetrahedrite, argentite, and other minerals account for most of the silver in the primary galena-bearing ores. (Behre, 1932; 1953; R. D. Butler and Singewald, 1940; Q. D. Singewald and Butler, 1941.)

Park and Summit Counties.—Montezuma district. Most of the galena occurs as medium-grained granular masses, intergrown with other sulfides but some large nearly pure masses of galena have been mined. There are some crystals in vugs, often associated with crystals of sphalerite, chalcopyrite, or ankerite. Most crystals are less than 1 cm long, but there are a few cubes as much as 5 cm across. (Lovering, 1935.)

Saguache County.—Bonanza district. Galena is the only valuable lead-ore mineral in the district, as oxidized lead minerals are negligible. Much of the galena was deposited in the open parts of fissures, where it forms anhedral grains of cubo-octahedrons or octahedrons with small cubic faces. Very beautiful groups of octahedral crystals occur in parts of the Joe Wheeler vein on Alder Creek. Very little of the silver produced by the district came from galena, as most of the silver is in the copper ores. (Burbank, 1932.)

Summit County.—Breckenridge district. Galena is exceeded in abundance only by pyrite and sphalerite among the metallic minerals, and is the most valuable mineral in many ores; its presence is one of the best indications of good ore in many gold-silver mines. Most of the galena occurs in moderately coarse aggregates but some showing cleavage faces as much as 2 inches in diameter occur in the Wellington mine. Cubic crystals modified by octahedrons commonly line cavities in this mine. (Ransome, 1911.)

Tenmile district. Galena and sphalerite are the most important ore minerals in the district. Most of the silver in the ores is in the galena, but some is in sphalerite, silver sulfides, and sulfosalts. (S. F. Emmons, 1898.) Richly argentiferous galena ore was discovered in this district about 1864 or 1865. According to Whitney (1867) it was fabulously abundant and ranged from $50 to $7,700 per ton in value because of its silver content.

GALENA–CLAUSTHALITE

[*See* Clausthalite]

GALENOBISMUTITE

$PbBi_2S_4$

Galenobismutite has been identified by microscopic studies of two specimens from the Leadville district, Lake County. It is one of the minerals in the bismuth, or last, stage of mineralization. In a specimen from the Greenback mine it is associated with chalcopyrite and silver telluride-bearing galena. It was also found in a specimen from the Tucson mine. (Chapman and Stevens, 1933; Chapman, 1941.)

GARNET

The garnet species includes six important subspecies; these are alike in crystal habit but differ in composition. Five of the six subspecies are known in Colorado; these are listed below. The sixth—uvarovite, or chrome garnet—has not been reported here.

Subspecies	*Composition*
Grossularite	$Ca_3Al_2(SiO_4)_3$
Pyrope	$Mg_3Al_2(SiO_4)_3$
Almandite	$Fe_3Al_2(SiO_4)_3$
Spessartite	$Mn_3Al_2(SiO_4)_3$
Andradite	$Ca_3Fe_2(SiO_4)_3$, with Mg and Ti

Many Colorado occurrences are described simply as garnet, or else the descriptions show that they are intermediate between two subspecies. For these reasons the subspecies are not described separately here, although subspecies identifications are retained if given by the original authors.

Garnet is very widespread and abundant in the State, particularly in contact-metamorphic deposits and in calcium-silicate layers in schists and gneisses. Some excellent gems have been found and many fine Colorado garnet crystals are now in museums the world over. Little or no garnet has been produced for use as abrasives, although there are some deposits, almost inaccessible, that could be used for such purposes if there were sufficient demand. The occurrences given here are representative of dozens of others in many parts of the State. In addition to these, beautiful but tiny dark-red crystals of garnet, many of gem quality, are common in gold placers and other alluvial deposits in many localities.

Boulder County.—Allens Park. Pale-brown iron-rich grossularite is the most abundant mineral in all thin sections of the calcium-silicate rock at Allens Park. Most of the garnet is massive but some occurs as crystals. Wollastonite and other silicates are associated. (Dings, 1941—analysis.)

Chaffee County.—Calumet mine, Turret district (loc. 2). Finely developed clear crystals of grossularite with lustrous faces occur in metamorphosed limestone near the Calumet iron deposits. (W. B. Smith, 1887a; Behre, Osborn, and Rainwater, 1936.)

Mount Antero (loc. 3). Spessartite occurs in a pegmatite body in the canyon of Little Browns Creek, about 1,000 feet north of the trail to the aquamarine deposits and 1,000 feet above the trail in altitude. The reddish-brown translucent trapezohedral crystals are as much as 12 mm in size. (Pearl, 1941a.)

Monarch district. Garnet, most of it andradite but some almandite, is a very common mineral in the contact-metamorphic zone near the head of Taylor Gulch and at Cree Camp. It is massive to coarsely granular, in crystals as much as 1 inch in diameter. Finely granular garnet, gray green to black, occurs in a 35-foot thick body on the east shoulder of Taylor Mountain. All of the garnet crystals are dodecahedrons but some also have trapezohedral faces. The most common associates are epidote and calcite. (R. D. Crawford, 1913.)

Nathrop (loc. 4). One of the finest and best-known localities in the United States for gem-quality crystals of spessartite is that at Nathrop.

Some of the crystals, which occur in the lithophysae of rhyolite, are as much as 1 cm in diameter, but the average size is about 2.5 mm. The color ranges from bright clear deep red to cinnamon brown; the crystals are perfectly transparent and have brilliant dodecahedral and trapezohedral faces. Gem-quality topaz crystals, sanidine, and doubly terminated quartz crystals are all abundant. Rogers and Cahn (1937) describe quartz crystals with pinakoid faces. (J. A. Smith, 1883; Whitman Cross, 1886—analysis; Pearl, 1939b, 1941a, 1958; Ellermeier, 1947b.)

In the general study of the distribution of minor elements in garnet, Jaffe (1951) notes the presence of yttrium and other elements in the Nathrop spessartite and in the garnet from the Brown Derby mine, Quartz Creek district, Gunnison County (loc. 4).

Sedalia mine (loc. 5). Large perfectly formed dodecahedral crystals of almandite from the Sedalia mine are common sights in most mineral collections in the country. Generally called "Salida" garnets they are characteristically coated with green chloritic material; they weigh as much as 14 pounds and are 6 inches or more in diameter. The crystals occur in soft chloritic schist. Octahedral crystals of magnetite are also in the schist or attached to the deep-brown garnets. Small amounts of copper minerals, both primary and oxidized, are present and a little willemite has also been found. (Penfield and Sperry, 1886—analyses; Pearl, 1958; J. W. Adams, written communication.)

Clear Creek County.—McManus Gulch (loc. 4). Grossularite, calcite, and hornblende are among the minerals that are associated with well-developed vesuvianite crystals at this locality. (J. W. Adams, written communication.)

Costilla County.—Grayback district. The contact-metamorphic deposits in the vicinity of iron ore deposits on the west slope of Grayback Mountain contain much brown to reddish-brown garnet associated with epidote and recrystallized calcite. The garnet characteristically occurs as separate trapezohedral crystals with interstitial fine-grained quartz, epidote, and calcite. There is a tendency to form parallel aggregates of garnet crystals within large skeletal grains of calcite or quartz. (Patton, 1910.)

Custer County.—Rosita district. Minute crystals of garnet and topaz occur in quartz-lined lithophysae in rhyolite. The occurrence is similar in most respects to that at Nathrop, Chaffee County. (Whitman Cross, 1896.)

Fremont County.—Grape Creek (loc. 6). Biotite gneiss near Grape Creek 2 miles S. 75° W. of Canon City contains many almandite crystals that are embedded in biotite. They range in size from minute crystals to 3 inches across. Most are crushed and fractured but gem material can be obtained from the central parts of the crystals. Handsome red to pinkish-red gems weighing as much as 2 carats have been cut. (Sterrett, 1909.)

Eight Mile Park (loc. 4). Light-brown to clove-brown garnet, most of it spessartite, is locally abundant in the pegmatite bodies where it is commonly in or near the core. Well-formed crystals from ½ to 1 inch across are most common. Masses of spessartite as much as 6 feet in diameter are reported in the Mica lode; in the core there was a large pod of intergrown chalcocite and spessartite in a mass of blocky microcline. (Heinrich, 1948b.)

Gilpin County.—Evergreen mine (loc. 1). In the Evergreen mine, the copper ore minerals chalcopyrite, bornite, and chalcocite are intimately and contemporaneously intergrown with the silicate minerals of dikes and igneous breccia. These include the feldspars, augite, and abundant wollastonite. Garnet is one of the rare accessory minerals in most places but it becomes much more abundant in or near the small bunches of copper minerals and is intergrown with them. (Rogers, 1914; Bastin and Hill, 1917.)

Gunnison County.—Gold Brick district. The biotite-quartz-chlorite schists in several parts of the district contain many reddish-brown crystals of almandite from 1/8 to 1 inch in diameter. They have well-developed dodecahedral faces but many crystals are elongated—most of them parallel to the schistosity. A few hundred feet southeast of Boulder Creek and three-fourths of a mile due south of Boulder Lake there is a biotite-amphibole-quartz rock that contains dark bluish-gray garnets in great abundance. These are rounded in form, 3/8 to 5/8 inch in diameter, and resemble cordierite. They contain inclusions of quartz, magnetite, and colorless amphibole. Chemical and microscopic tests show them to be aluminous andradite. (R. D. Crawford and Worcester, 1916.) W. I. Wright (1938) records an analysis of garnet in limestone from the pass between Tincup and Pitkin.

Italian Mountain (loc. 3). Garnet, in a variety of forms and compositions, is the most abundant metamorphic mineral in the contact zone between red beds and intrusive bodies of quartz monzonite. The other chief minerals of interest are diopside, vesuvianite, epidote, and several zeolites. The most abundant variety is grossularite, which occurs as well-developed crystals 0.1 to 4 cm in size and ranges from pale buff through nearly colorless to green. Some of it is transparent. The crystals line open spaces in massive grossularite or grossularite-diopside rock. A second type, virtually a mixture of andradite and grossularite molecules, forms small but brilliant sulfur-yellow to greenish-yellow perfect dodecahedrons in coarse calcite. Perfect crystals of vesuvianite are also locally embedded in the calcite. Two specimens, composed of 1-cm dodecahedrons with narrow trapezohedrons, show uncommon color banding. The cores of the crystals are deep red; these are surrounded by outer borders of pale buff and thin outside shells of brown. There is also some black garnet (melanite) whose color is due to inclusions of graphite. (Whitman Cross and Shannon, 1927—analyses.)

Iron Hill (loc. 2). A black garnet that contains large amounts of titanium, hence approaches the rare species schorlomite in composition, is relatively abundant among the unusual assemblage of alkalic rocks at Iron Hill. It followed perovskite during the alteration of the uncompahgrite rock; most of it replaces melilite. The garnet occurs as veinlike masses, euhedral to subhedral crystals, and irregular borders around the earlier minerals. (E. S. Larsen, Jr., and Goranson, 1932—analyses; E. S. Larsen, Jr., and Jenks, 1942—analyses.) This may be the same locality that yielded a black garnet containing 8.11 percent TiO_2 described by Koenig (1886) as from southwest Colorado.

Snowmass Mountain area. Massive beds of brown to green garnet that range from 10 to 40 feet in thickness occur in several parts of the area. All are too remote and inaccessible to have much potential value. (Vanderwilt, 1937.)

Jefferson County.—Golden area. Several narrow bands of garnet-biotite schist crop out in Clear Creek Canyon about 1¼ miles northwest of Golden. The country rocks are largely gneiss with some pegmatite. Most of the garnet crystals are flattened parallel to the schistosity but some are fairly distinct trapezohedrons. The garnets are most abundant and best developed where quartz is also abundant. (E. W. Bailey, Rath, and Grider, 1905.)

Ralston Buttes (loc. 15). Individual garnets in the garnetiferous gneiss wallrocks of the Schwartzwalder mine range in composition from 15 to 90 percent spessartite, less than 40 to 75 percent almandite, less than 5 to 15 percent pyrope. and 0 to less than 5 percent grossularite. Garnets from eight other outcrops of the garnetiferous gneiss have similar composition and average 33 percent spessartite, 55 percent almandite, 11 percent pyrope, and 1 percent grossularite. Identification was by index-of-refraction, X-ray, and spectroscopic analyses. (D. M. Sheridan, written communication.)

Garnet from a pegmatite body in the S½ sec. 15, T. 3 S., R. 71 W. was determined by the index of refraction, specific gravity, X-ray, and spectroscopic analyses to be 50 percent spessartite, 40 percent almandite, and 10 percent pyrope. (D. M. Sheridan, written communication.)

Genessee Mountain (loc. 10). A calcium silicate unit in the Idaho Springs formation on the north side of U.S. Highway 40 and about 1 mile northeast of Genessee Mountain contains fine crystals of grossularite nearly 12 inches across. Well-formed crystals of titanite as well as allanite, epidote, scheelite, hornblende, and vesuvianite are also present. (J. W. Adams, written communication.)

La Plata County.—La Plata district. Yellow to brown garnet, most of which is andradite, is abundant in many contact-metamorphic deposits in limestone. It is a principal gangue mineral in the Bay City, Silver Falls, and several other mines. Most of the andradite is massive and intergrown with other silicates and iron-oxide minerals but well-formed crystals are widespread. (Galbraith, 1949.)

Larimer County.—Garnet is very widespread in the Precambrian rocks, especially east and north of North Poudre River and south of Log Cabin. A few of the more interesting localities are these: (a) brown crystals, 4½ inches in diameter, showing trapezohedron and dodecahedron, 2 miles above the mouth of Thompson River, North Fork; (b) brown trapezohedral crystals as much as 2 inches in diameter, in Poudre Canyon pegmatite, 8 miles above Ted's Place; (c) light-brown crystals with dodecahedral faces as much as 5 inches across, on Water Works Hill in Poudre Canyon; (d) green and brown masses and well-formed light-brown dodecahedrons at Pingree Park; and (e) red trapezohedrons in green muscovite, on the north slope of Crystal Mountain. (R. G. Coffin, written communication.)

Ouray County.—Mount Sneffels. Amygdules in the gabro-diorite Mount Sneffels stock, 5 miles southwest of Ouray, contain crystals of andradite with lesser amounts of actinolite, quartz, albite and prehnite. The andradite crystals, which Pearl (1951) says are the gem-quality variety, topazolite, are clear yellow brown to green and light yellow. They form trapezohedra, commonly striated with the rhombic dodecahedron, and reach a maximum diameter of 3 mm (Eckel, 1932.)

Park County.—Tarryall Creek. Very large bodies of garnet that are near andradite in composition are present in the metamorphosed sedimentary rocks. Most of the garnet is massive but contains some good crystals. Epidote, calcite, and magnetite are associated. (Muilenburg, 1925.)

Summit County.—Breckenridge district. Garnet is fairly abundant in many places where sedimentary rocks are in contact with porphyry bodies, especially on the south slope of Gibson Hill. Most of the garnet is hard, compact, and massive but some is granular and friable. It is commonly associated with calcite, epidote, quartz, and the common sulfides, but locally it occurs with hematite and amphibole. (Ransome, 1911.)

Kokomo district. Andradite occurs in the upper Denver and Rio Grande railroad tunnel on the southeast slope of Jaque Mountain in a molybdenite-bearing bed 2½ to 5 feet thick. It forms local aggregates with epidote and calcite, accompanied by magnetite, specular hematite, and pyrite. (Koschmann and Wells, 1946.)

GARNIERITE

$H_2(Ni,Mg)SiO_4$

Garnierite has been found in only 1 of the 2 known nickel deposits in the State; this is in the Copper King mine, Gold Hill district, Boulder County (loc. 1). It is found only in completely oxidized ore, hence is generally confined to the uppermost 15 to 20 feet beneath the surface. It is an oxidation product of polydymite. (Goddard and Lovering, 1942.)

GEARKSUTITE

$CaAl(OH)F_4 \cdot H_2O$

Gearksutite, the rare fluorine mineral, occurs in three localities in Colorado.

Boulder County.—Jamestown district. Thin seams of gearksutite cut some of the fluorspar ore in several mines. It is probably of supergene origin. (Goddard, 1946.)

El Paso County.—St. Peters Dome (loc. 5). At this famous cryolite locality, gearksutite is abundant as a white kaolinlike powder that fills cavities in fresh pachnolite; it is evidently deposited from solution in the cavities. Under the microscope it is seen to consist of very minute colorless needles, with an average length of 0.02 mm. (Whitman Cross, and Hillebrand, 1883, 1885—analyses.)

Mineral County.—Wagon Wheel Gap (loc. 1). The Wagon Wheel Gap fluorite-barite deposit known as the type locality for creedite is also a rich source of gearksutite. The lower level of the tunnel, about 100 feet east of one of the hot springs, passes through a large body of highly altered rhyolite or quartz latite. The altered material contains very abundant balls, up to several inches in diameter, of snow-white powdery gearksutite that resembles very fragile chalk or kaolin. The occurrence is of special note because here the gearksutite is a wallrock alteration product, whereas in other places it is an alteration product of cryolite or pachnolite. (E. S. Larsen, Jr., and Wells, 1916—analyses.)

GENTHELVITE†

$Zn_4Be_3Si_3O_{12}S$

[*See also* Helvite]

The extremely rare zinc-bearing member of the helvite group has been found at three closely spaced localities, all of them on or near Stove Mountain in El Paso County (loc. 6). The mineral was named by Glass, Jahns, and Stevens (1944) in honor of Genth, who gave the original description of a mineral under the new name danalite, from West Cheyenne Mountain, El Paso County (Genth, 1892b).

Although Genth's type material is now known to be genthelvite, the name danalite, $Fe_4Be_3Si_3O_{12}S$, is now applied to the closely related iron member of the helvite-danalite-genthelvite series. It seems fair, therefore, to list the name danalite among Colorado's type minerals.

Genth's material, of which he gives an analysis and a crystallographic description, consisted of a part of one crystal, 15 by 17 mm, and one larger fragment discolored by iron and manganese oxides. The color is pale rose red to brown; associated minerals are quartz and astrophyllite.

A single crystal of genthelvite is described by Glass and Adams (1953) from a small pegmatite dike in the Stove Mountain area (NW¼ sec. 4, T. 15 S., R. 67 W). The crystal, which is 5.5 by 4 cm, is a distorted combination of tetrahedra with narrow faces of the rhombic dodecahedron and is associated with microcline-perthite, smoky quartz, and a few crystals of brown zircon.

A third find of genthelvite is described by Scott (1957). This one, again only of a single fine crystal, is from a pegmatite on the northeast spur of Stove Mountain (NE¼NW¼NW¼ sec. 4, T. 15 S., R. 67 W). It is very close to the locality of Glass and Adams. The crystal, about 1 by 1 inch, is more vitreous than the one described by Glass and Adams, and is tetrahedral in shape with 5 other crystal forms. It was found in a miarolitic cavity, with smoky quartz, microcline-perthite, zircon, bastnaesite, and limonite after siderite.

GERSDORFFITE

NiAsS

Gersdorffite has been reported from only two localities. One of these is the Caribou mine in the Boulder County district of the same name. It occurs as small irregular veinlets in uraninite and apparently formed fairly early in the mineral sequence. Other minerals are the common sulfides, with proustite and native silver, in a gangue of quartz and carbonates (H. D. Wright, 1954).

The second locality is the very old Homestake mine near Tennessee Pass, Lake County. The galena-chalcopyrite-pyrite ore of this mine contained significant quantities of an arsenical nickel mineral which Raymond (1874) thought to be gersdorffite. See also S. F. Emmons (1885).

GIBBSITE

$Al(OH)_3$

Gibbsite has been reported in only one locality—the Silver Ledge mine, Silverton district, San Juan County. Here it was identified only as an assumption from the chemical analysis of a soft white mixture of claylike materials (Ransome, 1901b). It can scarcely be claimed as an authentic mineral occurrence although gibbsite is widespread enough to be present elsewhere in the State.

GILPINITE*

[*See* Johannite]

GLAUBER SALT

[*See* Mirabilite]

GLAUCONITE

Hydrous silicate of iron and potassium

Glauconite, a mica mineral which has recently been intensively studied, is reported from only one locality, but is probably present elsewhere. A glauconitic mica mineral, intermediate in composition between muscovite and glauconite and hence should be called ferriphengite, occurs in the Morrison formation near Uravan, Montrose County. It is an interstitial clay mineral in a bed of fine-grained sandstone and can only be identified by X-ray and microscopic means although it is responsible for the green color of the sandstone. Montmorillonite, which seems to alter to the glauconitic mica, and a little analcite are among the associated minerals. (W. D. Keller, 1956.)

GLAUCOPHANE

[*See* Amphibole group]

GLOCKERITE

$Fe_4(SO_4)(OH)_{10} \cdot 1\text{–}3H_2O$(?)

Glockerite, one of the ferric sulfate minerals, has been reported from only two districts; it is almost certainly present as part of the brown ferric sulfate mud or the encrustations that characterize many mines throughout Colorado.

Clear Creek and Gilpin Counties.—Central City, Idaho Springs, and Black Hawk districts. Glockerite is reported in mines from these districts by Endlich (1878). Reexamination of a U.S. National Museum specimen labelled as glockerite from the Esmeralda lode, Black Hawk district, proved it to be chalcedony with ferric sulfate and water as impurities. (Wherry and Glenn, 1917.)

Teller County.—Cripple Creek district. An analysis of altered ore from the Moose (Modoc) mine showed it to contain Fe_2O_3, SO_3 and H_2O in nearly the correct ratios required by the formula for glockerite, which is therefore supposed to be present. (Pearce, 1898a.)

In the Ophelia tunnel a brown sticky mixture of different hydrous sulfates probably contains glockerite among other minerals. It is probably also present in many other mines. (Lindgren and Ransome, 1906.)

GOETHITE

FeO(OH)

[*See also* Limonite]

Goethite is undoubtedly present in most or all of the material that is commonly classed as limonite throughout the State. It has been recognized as a specific mineral, however, in only a few places.

Boulder County.—Nederland tungsten district. Goethite is probably the chief constituent of the limonite in the oxidized zone throughout the tungsten belt. (Lovering and Tweto, 1953.)

El Paso and Teller Counties.—Florissant area (loc. 2). Goethite is an abundant associate of amazonstone and smoky quartz in miarolitic cavities. Some of it is pseudomorphic after siderite, but some forms bundles of long brilliant blades. The goethite is brownish black and contrasts well with the smoky quartz which it penetrates in some places. (Whitman Cross and Hillebrand, 1885.) Grim and Rowland (1942) record differential thermal analysis of goethite from El Paso County.

Fremont County.—Garden Park (loc. 5). Brown needlelike crystals of goethite penetrate calcite, barite, and quartz in some geodes. One geode also contained crystals of millerite(?). (G. R. Scott, written communication.)

Park County.—Alma district. In ore from the Ruby mine on Lincoln Gulch, a module of marcasite was found that was altered to goethite and turgite. (E. P. Chapman, Jr., written communication.)

Park and Summit Counties.—Montezuma district. The bog iron-ore deposits of Geneva Gulch, Handcart Gulch, Hall Valley, and the Snake River—some of them large—consist of limonite and goethite but some turgite is also present. (Lovering, 1935.)

Saguache County.—Orient mine. Analyses of the limonite ore from this formerly very productive iron mine indicate that the bulk of the ore is the mineral goethite. The deposit is further described under limonite. (J. B. Stone, 1934.)

GOLD

Au

The year 1858 is generally considered to mark the discovery of gold in what is now Colorado. There is no question that the first exciting rush of immigration and the first commercial production of gold took place in 1858. The presence of the magic metal was known, however, at least a decade earlier. The early history of gold discoveries is carefully summarized and as thoroughly documented as the records of the early days permit by C. W. Henderson (1926). According to him, there are reports that gold was first discovered about 1848 near the site of Lake City, Hinsdale County, by a member of Fremont's party. No confirmation of these reports exists.

The 1858 discoveries are credited to the leadership of the Russell brothers but they and several other members of their party seem to have found gold on Cherry and Ralston Creeks and the South Platte River during the "Fortyniner" gold rush to California in 1849–52.

Nevertheless the Russell party of 1858 found paying quantities of placer gold, first near the head of Cherry Creek near the present town of Parker, a little later at the junction of Cherry Creek and the South Platte River (now near the center of Denver), and then in Clear, Ralston, and other creeks along the mountain front. Montana City south of Overland Park, St. Charles on Cherry Creek, and Auraria City on the west bank of Cherry Creek at its mouth were founded in September and October. All of these were soon to become parts of Denver. The rush to the "Pikes Peak country" (really Cherry Creek and the South Platte) was on.

The gold rush continued through the winter of 1858–59 and resulted in many other discoveries of placer gold, some as far north as Boulder County and as far west as the headwaters of the Arkansas, in Lake and Chaffee Counties. May 7, 1859, is without question the most significant date in Colorado's mining history. It was then that John Hamilton Gregory found the first lode gold—on North Clear Creek near the present site of Black Hawk. The oxidized surface deposits of the veins in the Gregory diggings were rich and easily worked. The discovery set the stage for a great influx of miners and for new discoveries of both placer and lode deposits in many parts of the State; it laid the foundation of a mining industry that was, in the 100 years to come, to produce nearly $1 billion worth of gold and a total of $6 billion worth of new mineral wealth. One of the byproducts of the Gregory discovery, of course, was the beginning of Colorado mineralogy.

Half of the nearly $1 billion worth of gold produced in Colorado during the past 100 years came from Cripple Creek, Teller County. Most of this was in the form of tellurides rather than the mineral species gold. Much of the $20 million total gold production from Boulder, La Plata, and Montezuma Counties also came from tellurides. Virtually all the remainder, or about $500 million, was in the form of native gold. Six counties have each produced more than $20 million worth of native gold; these are Gilpin, San Miguel, Lake, Ouray, Clear Creek, and San Juan Counties. Ten other counties have each produced more than $1 million worth. Almost every other county in the State has produced some gold.

About 95 percent of the total gold production of Colorado has come from lode deposits; the rest has been taken from placers. Placer gold can still be found by the diligent prospector or collector in innumerable places in the State. The sites of the earliest discoveries will still yield a little gold, and many sand and gravel producers who supply building material for Denver and other cities recover some gold as a byproduct of their washing operations. The placer deposits are not further considered here but the main ones are shown on plate 1.

There are no really good records of the sizes of gold nuggets found in Colorado deposits, but it seems certain that there have been none of the enormous ones such as were taken in the early days of the California placers and in other parts of the world. There have, however, been several nuggets or masses of gold that weighed from 1 ounce to as much as 13 pounds. Only a few of these were nuggets in the sense that they were stream-worn pebbles of native gold in placer deposits. Instead, most of them were irregular pieces of massive, wire, or crystalline gold that were found in lode deposits.

Most of the gold produced in the earlier years of each mining district was in the oxidized, near-surface parts of the ore deposits. Many of these oxidized ores were very rich, owing partly to removal of less valuable minerals by solution and partly to some solution, transportation, and redeposition of the gold itself. Most of the spectacular specimens of crystalline, wire, and massive gold came from the oxidized zones, but much fine-grained rusty and mustard gold has also come from the oxidized ores, particularly where the primary minerals were gold tellurides that weathered easily.

In contrast to the rich and coarse gold of the oxidized ores, the gold in primary unweathered deposits is almost always lower in grade and is very fine grained. Much of it is present in pyrite and other sulfides in particles of microscopic or submicroscopic size. For this reason noteworthy specimens of native gold in primary ores are difficult to find.

Nearly all native gold is alloyed with some silver; if the proportion of silver is high the alloy is called electrum. Electrum is reported in Colorado from several deposits, but none seem worthy of special note.

Boulder County.—Most of the more than $15 million worth of gold produced by Boulder County mines was in the form of tellurides, but some native gold occurs in the primary ores and some of the oxidized ores were very rich in free gold; most of it was derived from the oxidation of tellurides. The following notes give an idea of the modes of occurrence in the county:

Gold Hill district. Native gold is locally abundant, particularly in the oxidized zones of the Logan, Red Cloud, Cold Spring, and Emancipation mines. Some of the gold was of the rusty variety but much occurred as delicate wires or leaves, with wire silver, throughout the near-surface ores. Petzite and sylvanite are the chief tellurides, but hessite is abundant in places, and a little altaite and coloradoite are widespread. (Endlich, 1874; Goddard, 1940.) Tetradymite, calaverite, and native tellurium have also been reported (Genth, 1874).

Jamestown district. In addition to veins that are characterized by gold-bearing tellurides there is a zone of pyritic gold veins. These are characterized by coarsely crystallized pyrite and chalcopyrite in glassy, milky, or sugary-grained quartz. The gold is free and is associated with the sulfides. In the Golden Age vein the gold is embedded in quartz in coarse grains to nugget-sized masses. (Farish, 1891; Goddard, 1935.)

Nederland tungsten district. Most of the gold in the tungsten belt is supergene rusty gold derived from alteration of gold-silver tellurides. There is, however, a little late primary gold in the ores. (Lovering and Tweto, 1953.)

Ward district. Most of the gold in the district is free, in quartz veins with pyrite or chalcopyrite and a little molybdenite and wolframite. There is much secondary enrichment of gold and coarse grains and flakes as much as one-fourth inch in diameter fill drusy cavities in "rotten" quartz. The enrichment is partly due to removal of sulfides from the vein matter and partly to solution and redeposition of the gold. Some silver is alloyed with all the gold. (Worcester, 1920.)

Clear Creek County.—Georgetown and nearby districts. Clear Creek County has produced more than $30 million worth of gold, nearly all of it native, from Georgetown, Idaho Springs, Empire, and other districts. The Hidden Treasure mine yielded the largest and finest specimens of native gold, both as leaves and as irregular masses, found in the Georgetown district. The gold is largely in pyrite in quartz gangue but some is associated with galena. In the primary ores the gold is very finely divided and only a small part of it can be seen with the unaided eye. The ratio of gold to silver in the pyritic ores averages about 1:20, but in some deposits, such as those at Empire, there is very little silver. (Spurr and Garrey, 1908.) Cubic crystals of gold, as much as several millimeters in size, occur in carbonate gangue at the Lamartine mine. (J. W. Adams, written communication.)

Custer County.—Silver Cliff and Rosita districts. Gold is second only to silver in value of metals produced in these districts. In the Bassick mine, where concentric shells of jamesonite and other sulfides coat fragments of breccia, some of the thin shells contain from 15 to as much as 200 ounces of free gold per ton. (Grabill, 1882; S. F. Emmons, 1896.)

Douglas and Elbert Counties.—Some of the earliest finds of placer gold were made in 1858 in the general vicinity of Castle Rock. The deposits are low grade and the gold is very fine grained. The localities include: Russelville Gulch, 5 miles southeast of Franktown; Ronk Gulch; Gold Run, southwest of Elizabeth; and Newlin Gulch, 7 miles northeast of Sedalia. Richardson (1915), who gives a good account of the first findings of placer gold on the plains, thinks the gold is concentrated by erosion of the Castle Rock conglomerate and possibly of the Dawson arkose. Both of these rocks are formed from the erosional debris of the Front Range.

Eagle County.—Gilman (Red Cliff) district. Free gold occurs in both sulfide and oxidized ores and in both quartzite and Precambrian rocks. Nuggets weighing as much as 2 ounces are reported as common in the Ground Hog and Champion mines; some of them are cemented by a ferric sulfate mineral, probably copiapite or coquimbite. The masses of gold are reportedly angular or horn shaped in pyrite but smooth and rounded in the oxidized ores. None, however, can be considered to be true nuggets in the sense that they are stream worn. (Guiterman, 1891; R. D. Crawford and Gibson, 1925.)

Gilpin County.—Central City district. Gilpin County is notable as the site of the first discovery of lode gold in Colorado, at the Gregory diggings near Black Hawk. Since that discovery in 1859 the Central City and nearby districts have produced nearly $90 million worth of gold, nearly all of it native, and have given Gilpin County the third largest gold production in the State.

In the pyritic ores gold is the most important metal but it is fine grained and is seldom visible. The ores are notably enriched in gold in the oxidized ores, largely by removal of the sulfide vein matter, although the gold is also coarser in the oxidized ores. In the galena-sphalerite ores, where gold is subordinate in value to other metals, it is commonly alloyed with silver. (Bastin and Hill, 1917.)

Lake County.—Leadville district. Lake County, dominated by the Leadville district, but also including several smaller districts and some of the oldest known placer deposits in the State, has produced more than $60 million worth of gold, placing it fourth among the gold-producing counties. Native gold occurs in variable quantity throughout the district. Most of it is microscopic or submicroscopic in size, but in the enriched parts of several lodes and associated blankets in the eastern part of the district the gold occurs as coarse flakes and wires. In the Ibex mine some of the sphalerite crystals in the rich zinc ore are coated with free gold. Much of the gold produced at Leadville came from the oxidized ores, where manganese oxides and alkaline chlorides seem to have led to downward concentration. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata and Montezuma Counties.—La Plata district. The greater part of the gold in the La Plata district is in the form of tellurides, but some native gold is present in many of the telluride ores and a little finely divided gold occurs in some contact-metamorphic deposits and in the Doyle pyritic blanket deposit near the head of the East Mancos River. The Red Arrow vein deposit on the East Mancos, whose discovery led to a flurry of wild excitement in the 1930's, contains spectacular crystals, wires, and irregular masses of native gold. One mass weighed more than 5 pounds. Some of the gold is intergrown with tetrahedrite. A few tens of thousands of dollars worth of gold were produced in a short time but the rich ore dwindled rapidly. The discovery was significant however, in giving new hope to 20th century prospectors of finding other rich deposits at "grassroots," even in districts that have been known and explored for many years. (Galbraith, 1949.)

Ouray County.—Ouray district. Most of the more than $40 million worth of gold produced by mines in Ouray County has come from gold-bearing pyrite and chalcopyrite veins. Some has also been taken from magnetite-pyrite replacement ores in limestone, but most of these are low grade. The well-known Camp Bird deposit is notable not only because it enabled the developers to pay annual dividends of more than 50 percent for many years but also because it was mined for silver and base metals for a long time before the identity of the rich gold ore alongside the base-metal vein was even discovered. (Irving, 1905; Whitman Cross, Howe, and Irving, 1907; Burbank, 1940.)

Park County.—Alma and adjacent districts. Gold is the main ore mineral in nearly all mines in the area. It is readily seen as ragged flakes and tiny veinlets in pockets of rich ore such as characterize the London mine deposit, but most of the gold is not megascopically visible. The gold is most abundant where it is in or near sphalerite, galena, and chalcopyrite; veins of quartz or quartz and pyrite are commonly low grade unless base-metal sulfides are also present. The gold ores are confined to siliceous rocks, whereas the silver-lead ores of the district are in calcareous ones. (Q. D. Singewald and Butler, 1941; Behre, 1953.)

Park and Summit Counties.—Montezuma district. Crystalline gold was widespread in the upper parts of stockworks in the southwestern part of the district and in the oxidized veins on Teller and Wise Mountains, but values diminished greatly within short distances below the outcrops. In the primary ores most of the gold is in small grains in chalcopyrite. (Lovering, 1935.)

Rio Grande County.—Summitville district. In the primary ores gold is disseminated in enargite, pyrite, and other minerals and is rarely visible. In the oxidized ores it was by far the most important metal. Most of it is disseminated in limonite, but some small crystals and some nuggetlike masses weighing as much as 1 ounce were found. Locally it is associated with abundant secondary barite and rusty quartz. Steven and Ratté (1960) give proof that much of the gold in the oxidized zone has been dissolved and redeposited.

San Juan County.—Silverton district. The Silverton and nearby districts have produced about $40 million worth of gold, all of it native. It occurs in association with spongy quartz as flakes or wires on quartz crystals or embedded in sphalerite, molybdenite, and other minerals. Quartz, rhodonite, and fluorite are the chief gangue minerals. (Ransome, 1901b.)

San Miguel County.—Telluride district. The Telluride and nearby districts have produced more than $65 million worth of native gold. It is more closely associated with chalcopyrite in quartz veins than with other minerals, but some is present in light-colored sphalerite, galena, and polybasite. Irregular particles and laminae fill small vugs in white quartz. (Purington, 1898; Hurst, 1922.) A specimen of yellow calcite that fills a cavity in white quartz from Marshall Basin contains grains of gold very evenly and abundantly disseminated through the calcite. (R. C. Hills, 1917.)

Summit County.—Breckenridge district. Summit County has yielded more than a third of all the placer gold produced in Colorado, principally from deposits on the Swan and Blue Rivers and their tributaries that drain parts of the Breckenridge, Montezuma, and Tenmile districts. The chief mineralogic interest in the county, however, lies in the spectacular specimens of leaf, wire, and crystalline gold that were produced in quantity and for some years from tiny veins on Farncomb Hill in the Breckenridge district. Specimens from here are in museums and private collections throughout the world, and as Ransome (1911) points out "it is probable that from no locality equally productive has so large a proportion of the gold mined been saved from the melting pot on account of the beauty and interest of its form." Within the State, two of the most attractive and showy displays of Breckenridge gold are those of the Denver Museum of Natural History and the Colorado School of Mines at Golden.

The occurrence and appearance of the gold is well described and illustrated by Ransome (1911) who says,

"The typical gold from the narrow veins of Farncomb Hill occurs as two general varieties locally known as wire gold and leaf or flake gold. It is stated by those familiar with the traditions of the hill that wire gold is characteristic of the veins west of American Gulch and leaf gold of those east of that ravine.

"The leaf gold is in exceedingly irregular masses, many of which consist of thin septa meeting at angles that strongly suggest deposition controlled in part by the cleavage planes of a rhombohedral carbonate of the calcite group. As a rule the sides of these septa and other less regular surfaces of the mass are covered with small crystal faces, generally the triangular face of the octahedron, up to about 3 mm in diameter. In some places these faces are irregularly crowded, distorted, and associated with planes not so clearly belonging to the octahedron. In other places the little triangular facets are in parallel orientation and suggest a regular imbrication of golden scales. Skeletal crystals are common, especially octahedrons, in which each face has a triangular depression or panel.

"The wire gold is fully as beautiful as the leaf gold, but being more fragile it is not often secured in as large specimens. It consists generally of a porous mass of curved and intricately felted or tangled crystalline wires, which may individually be 3 inches or more in length. There are all gradations between coherent spongy masses of felted wires and single filaments, but as a rule, where the gold occurs in commercial quantity, it is aggregated into masses of considerable size. The wires vary greatly in thickness and shape. Some are short, stout, and rodlike; others are of hairlike slenderness. Some are longitudinally striated and resemble curved capillary shavings such as might be made with a graving tool; others are transversely ridged and are evidently chains of crystals regularly grown together, or may be regarded as one tremendously elongated crystal exhibiting the phenomenon known as oscillatory growth and illustrated familiarly by the striated prisms of slender quartz crystals; still others are rough or frosted in appearance and as seen under the microscope are covered with tiny crystal facets much as are the surfaces of the leaf gold. In cross section the wires may be square, ribbonlike, or irregular, and they may vary in thickness from point to point. Some are simple; others branch and send off little curled tendrils. In fact no wire is straight, and most of them are bent and twisted in various directions. Specimens of the wire gold, while all possessing a character distinctive of Farncomb Hill, are never monotonous. Each has its individuality of texture, crystallization, aggregation, shape, and shade of color. Notwithstanding the extreme tenuity of many of the golden filaments, these are generally so interwoven as to give the mass a coherency greater than would at first appear to belong to so delicately beautiful a mineral aggregate.

"The thickness of the masses of leaf or wire gold is generally less than an inch, and, as a rule, nearly or quite equals the thickness of the vein in which they are found. The gold, however, does not occur in the clean, bright condition familiar in cabinet specimens, but is normally embedded in a reddish earthy matrix consisting largely of limonite with oxides and carbonates of copper and various earthy impurities." (See also Pearce, 1884a; Mining Science, 1911; Lovering, 1934.)

Teller County.—Cripple Creek district. The greatest part of the nearly $500 million worth of gold produced by this fabulous district has come from tellurides—principally calaverite and krennerite. Native gold, however, was abundant in the oxidized zones of most deposits and there is a little free gold in the primary ores, where it is associated with roscoelite, tetrahedrite, and other minerals. Most of the gold in the oxidized ores is derived from alteration of tellurides. It occurs as small particles or larger grains, spongy masses, thin sheets, and plates. Fine pseudomorphs of gold after crystals of calaverite and other tellurides have been found in several mines. (Lindgren and Ransome, 1906.)

GOLD AMALGAM

Au_2Hg_3(?)

Gold amalgam has been reported from only 1 locality; at least 1 of the silver-bearing amalgams is known to contain gold, however.

La Plata County.—La Plata district. Supergene amalgam, associated with native mercury, is present in telluride ores from several mines. The relative abundance of gold and silver in the district led Galbraith (1949) to suppose that the amalgams are gold bearing.

San Miguel County.—Telluride district. Pellets of gold amalgam, pea sized or larger, were found in quartz of the Gold and Silver Chief vein on Cornett Creek by R. C. Hills in 1879. (R. C. Hills, 1917.)

GOLDSCHMIDTITE*

[*See* Sylvanite]

GOSLARITE

$ZnSO_4 \cdot 7H_2O$

Goslarite is probably very widespread as a postmining efflorescence in mines that contain sphalerite or other zinc minerals. As is true of other similar minerals, it has been ignored in most descriptions of ore deposits or of mineralogy. The following few occurrences are all that I know to have been recorded.

Clear Creek County.—Idaho Springs district. Beautiful white efflorescences of goslarite, some in crystals 1 to 2 inches long, occur in an old mine on Santa Fe Mountain. The material contains 20 percent zinc and also copper and iron. (Randall.)

Eagle County.—Gilman (Red Cliff) district. Goslarite occurs in dry places in old stopes of the Eagle mine, near the top of sulfide ore bodies. In the Iron Mask, goslarite that contains a little iron hangs between the lagging as masses of soft white hairlike fibers as much as 1 foot long. (R. D. Crawford and Gibson, 1925.)

Gilpin County.—Central City district. Goslarite occurs in the Wood lode on Leavenworth Gulch. (Endlich, 1878.)

Lake County.—Leadville district. Fibrous masses of goslarite associated with epsomite and other hydrous sulfates occur in the mine workings. (S. F. Emmons, Irving, and Loughlin, 1927.)

Mineral County.—Creede district. Goslarite is present in many old workings as nests of heavy hairlike material on the walls and floors of mine workings. (W. H. Emmons and Larsen, 1923.)

GOYAZITE

$SrAl_3(PO_4)_2(OH)_5H_2O$

A mineral first described as hamlinite, but later found to be identical with goyazite, is abundantly disseminated in the early barren quartz and also associated with early ferberite throughout the Nederland tungsten belt of Boulder County. In the Eagle Rock mine, where it comprises 10 to 25 percent of the ore, it occurs as tiny crystals and fragments. Generally it is most abundant in green horn quartz where it accounts for the green color. Nearly all the tungsten ores contain some P_2O_5 on analysis; the phosphate is probably all in the form of goyazite. (Hess and Schaller, 1914; Lovering and Tweto, 1953.)

GRAPHITE

C

Boulder County.—Nederland tungsten belt. Graphite that is genetically related to the sulfides is abundant in a strongly developed shear zone east and southeast of the Conger mine. It is associated with molybdenite and other sulfides in schist. (Lovering and Tweto, 1953.)

Chaffee County.—Turret district (loc. 2). A deposit of graphite is known 2 miles northeast of Turret, on the west slope of Graphite Hill, about 1 mile from the Salida-Turret road. It was mined in 1909 but the operation closed the same year. It occurs in one principal bed and several subordinate ones, interbedded with limestone, quartzite, and schist. The main bed, more than half of which is low in graphite and high in clay, is 3 to 4 feet thick. The first-grade material is dull-black and very pure graphite. Both grades are very fine grained and earthy. The graphite represents coal and carbonaceous shale interbedded with sedimentary rocks that were metamorphosed by a nearby intrusion of granite. Shipping ore contained 75 to 90 percent carbon. (Bastin, 1911, 1914. See also Ihne, 1909.)

Garfield area. Graphite Basin, 1½ miles S. 70° E. of Cumberland Pass, contains a graphite deposit from which 78 narrow-gage carloads were shipped during World War I. The graphite, which is amorphous except for a few flaky streaks, occurs as seams 1½ to 15 feet wide in carbonaceous shale with dark limestone and some quartzite. The ore ranges from 45 to 90 percent carbon. (Dings and Robinson, 1957.)

Chaffee and Gunnison Counties.—Monarch and Tomichi districts. Black graphitic marble containing fine grains of graphite and magnetite occurs in several places in these districts. (R. D. Crawford, 1913.)

Gunnison County.—Italian Mountain (loc. 3). Black graphitic schist, in places comprised of massive graphite and containing black dodecahedral garnets as much as 5 mm in diameter, crops out on North Italian Mountain (Cross and Shannon, 1927). The locality is near the the head of Cement Creek and 10 miles from the nearest railroad. There are three parallel "veins," which probably represent metamorphosed anthracite coal, 50 feet apart and parallel to the other sedimentary rocks that are here nearly vertical. The middle and thickest "vein" is 4 to 6 feet thick. (Bastin, 1914.)

Pitkin area. Deposits of impure graphite in quartz veins 3½ miles north of Pitkin on branches of Quartz Creek have been known since 1883 or earlier; several carloads were shipped during World War I. (R. D. Crawford and Worcester, 1916.)

Larimer County.—Flaky and micaceous graphite occurs in gneiss in Long's Gulch. (R. G. Coffin, written communication.)

Las Animas County.—Trinidad. Some of the coal in the Trinidad and El Moro coal fields has been transformed to impure graphite by intrusions of igneous rocks. (Endlich, 1878; Schrader and others, 1916.)

Park and Summit Counties.—Montezuma district. Fine flakes of graphite are abundant microscopic constituents of contact-metamorphosed shale at the west end of the Montezuma quartz monzonite porphyry stock. (Lovering, 1935.)

San Juan County.—A large deposit of low-grade graphite is reported near the divide between Cascade Creek and the South Fork of Mineral Creek, that is, near the junction of Dolores, San Miguel, and San Juan Counties. (Aurand, 1920b.) This or another graphite deposit in San Juan County is listed by Endlich (1878).

GRAY COPPER

[*See* Tetrahedrite *and* Tennantite]

GREENOCKITE

CdS

Greenockite has been reported as coatings on sphalerite in only a few districts. Possibly it is more widespread than the record indicates, although in very small quantities, for it is one of the few minerals that would account for the cadmium byproduct that is recovered by zinc smelters from Colorado ores.

Gilpin County.—Greenockite is reported on sphalerite from the Dallas mine at Black Hawk, from the Running lode on Quartz Hill and the Jones mine near Central City. It has also been found in ore from a galena-bearing mine on South Boulder Creek. (Endlich, 1878.)

Gunnison and Chaffee Counties.—Tomichi district. Greenockite forms yellow coatings on sphalerite in the Bill Short mine and in a nearby prospect. A specimen of sphalerite practically free of visible greenockite contained 0.24 percent cadmium. (R. D. Crawford, 1913.) Dings and Robinson (1957) found greenockite as an accessory sulfide in small amounts in some of the pyrite-quartz veins of the Garfield quadrangle (which includes the Tomichi district).

Teller County.—Cripple Creek. The dark-brown sphalerite in the Last Dollar mine contains a large amount of cadmium, probably as greenockite. (Lindgren and Ransome, 1906.)

GROSSULARITE

[*See* Garnet]

GUITERMANITE†

$Pb_{10}As_6S_{19}$

Guitermanite was first discovered in ore of the Zuni mine, San Juan County, which is also the type locality of zunyite. It encloses minute sparkling tetrahedra of zunyite and is intimately associated with pyrite, enargite, kaolin, and barite. The guitermanite alters to anglesite and native sulfur. (Hillebrand, 1885b—analysis; Ransome, 1901b.) The status of guitermanite as a species is doubtful. In a polished section of the type material Ramdohr (1937) found it to be a mixture of jordanite ($Pb_{14}As_7S_{24}$?) and a similar unidentified mineral. Again, Ferrari and Curti (1934), who also give an analysis, found X-ray powder photographs of the original guitermanite to be identical with those of jordanite. Neither of these identifications seem to be definite enough to justify discrediting of the species. Harcourt (1942) reports X-ray powder diffraction data obtained on a sample of guitermanite from the type locality.

GRUNERITE

[*See* Amphibole group]

GUMMITE

$UO_3 \cdot nH_2O$ (?)

Gummite has been shown to be a mixture of several species by Frondel (1958), but since the few reports of Colorado occurrences have not been studied further it is necessary to give them here. Gummite has been found in minute quantities as an alteration product of uraninite in 3 localities, 2 in Larimer County and 1 in Saguache County. In the Hyatt mine and in another pegmatite in the Crystal Mountain district (loc. 1 and 2) it is associated with autunite and metatorbernite on small grains of uraninite. (Thurston, 1955.) In the Big Boulder prospect, SE¼, sec. 36, T. 7 N., R. 72 W., gummite and autunite are associated with uraninite, spodumene, apatite, beryl, and other minerals. (Hanley, Heinrich, and Page, 1950.)

In the Indian Creek area of Saguache County in T. 48 N., R. 6 E., gummite, uraninite and metazippeite II have been identified. (Gruner and Knox, 1957.)

GUNNISONITE*

[*See* Fluorite]

GYPSUM

$CaSO_4 \cdot 2H_2O$

Common gypsum is a white to gray granular rock that is used in large quantities in the manufacture of plaster and cement. Selenite is gypsum in colorless to clear crystals. Alabaster and satin spar are fine-grained dense varieties of gypsum, often nicely colored, that can be carved into ornaments or statuary; some examples are translucent. Gypsite is gypsiferous earth and has no value. All varieties of gypsum are widespread and very abundant in Colorado and there is a relatively small but steady industry based on the mineral. Common gypsum is mined only in Larimer and Fremont Counties, but far more could be produced there and elsewhere if there were demands for it. Alabaster for ornaments is produced from deposits near Livermore, Larimer County, and near La Junta, Otero County.

Only a few localities of interest to collectors, or those that have some significance in ore deposits are noted here. Those interested in gypsum as a resource rather than as a mineral should consult the following, among others: H. A. Aurand (1920b); R. W. Stone (1920); Larrabee and others (1945); J. W. Vanderwilt (1947, p. 242–244); G. O. Argall, Jr. (1949).

Dolores County.—Rico district. Some of the rich silver-lead ore bodies of Newman Hill replace massive gypsum in enormous blanket deposits. This is the only district in Colorado where gypsum is known as a gangue mineral, as well as the host rock, of important ore deposits. In places on Newman Hill, as well as in other parts of the district, some of the gypsum is recrystallized to selenite. Fine clear postmining crystals, with "ghosts" outlined by muddy inclusions are abundant in the mines of C. H. C. Hill. (Ransome, 1901a.)

Douglas County.—Perry Park (loc. 2). All varieties of gypsum—massive, alabaster, selenite, and satin spar—occur in the Lykins formation in Perry Park, 10 miles northwest of Palmer Lake. The satin spar is a rich pink with a distinctive satiny sheen; it is highly prized by collectors. (R. W. Stone, 1920; Pearl, 1948b, 1951a.)

El Paso County.—Massive, alabaster, and selenite varieties are abundant in the Lykins formation at the Garden of the Gods, on Fountain Creek, at Glen Eyrie, and elsewhere as far south as Trinidad. (R. W. Stone, 1920.) At a place 18 miles southwest of Colorado Springs near Table Mountain, veins of fibrous gypsum are abundant in the Lykins and Morrison formations; all are closely associated with massive beds of gypsum. (Thiesmeyer, 1938.)

Jefferson County.—Coon Gulch. Coon Gulch is 2.3 miles south of Golden and about 50 yards east of the intersection of State Route 93 and U.S. Highway 40. The Benton shale just south of the road contains fibrous gypsum and selenite crystals. The clear perfect crystals can be found in shale in the floor of the pit. (J. W. Adams, written communication.)

Teller County.—Cripple Creek district. As in nearly all mining districts in the State, small quantities of selenite are widespread in the oxidized ores. In the Deerhorn shaft large masses of gypsum are associated with fluorite and pyrite. (Lindgren and Ransome, 1906.)

HALITE

NaCl

Halite, or common salt, is widespread and very abundant in several parts of the State as a deeply buried sedimentary rock. In only one place—South Park—is any salt known to have been produced commercially. In addition to the South Park locality, salt is listed by Endlich (1878) as contained in springs along the Platte River in eastern Colorado, and present along Salt Creek, a tributary of the Dolores River near the west edge of the State. In the Salt Creek locality he says it is associated with gypsum and sulfur in sandstone of the red beds.

The South Park salt works in Park County (loc. 8) were established during the 1860's to recover salt from a group of springs; for some years they played an important part in the life and economy of the growing State. The abandoned salt works are just southwest of Antero Reservoir, in sec. 6, T. 13 S., R. 76 W. There is some doubt as to the date when salt was first produced. The earliest known published mention of the salt works in South Park is that of Whitney (1867), who gives a very brief description of the works and of the salt springs. Frazer (1873) says the salt business was begun in 1861, and that recovery was 1 part of salt, by bulk, from 9 parts of water. He also says that an artesian well was being sunk near the springs in 1869. Williams (1885) states, "In the South Park, Colorado, there are a number of salt springs. Before 1870 works were erected with a capacity of many barrels of salt daily, but for some reason they proved a failure and have not been running for years. It is not possible to ascertain how much salt has been produced and marketed."

Southwestern Colorado.—The Paradox member of the Hermosa formation, which underlies all of the southwestern corner of the State, contains much salt, gypsum, and anhydrite in many places. In parts of Paradox and Sinbad Valleys in Mesa, Montrose, and San Miguel Counties for example, there are 10,000 feet of salt-bearing beds. In places halite comprises as much as 80 percent of this thickness. (E. H. Baltz, written communication.)

Salt domes of western Colorado and eastern Utah, are described by T. S. Harrison (1927). The domes contain halite, anhydrite, and gypsum, originally interbedded in the lower part of the Hermosa formation but since intruded into younger beds. The Colorado salt domes described by Harrison are in or near the Paradox Valley, Montrose County.

Northeastern and southeastern Colorado.—Large but discontinuous bodies of salt, associated with gypsum and anhydrite, are present at great depth below the surface in rocks of Leonard and Guadalupe age. (Oriel and Mudge, 1956; M. R. Mudge, written communication.) Barb (1946) lists the locations and depths of wells in 10 counties in eastern and western Colorado in which salt beds were found.

Newspaper accounts of 1920 report the discovery of a 210-foot-thick bed of pure halite in Kiowa County, 18 miles southeast of Eads. It was found at 1,800 feet below the surface in an exploratory oil well.

HALLOYSITE

$Al_2Si_2O_5(OH)_4$

[*See also* Clay minerals]

Halloysite, one of the clay minerals, has been reported from only four localities. It is probably far more widespread than this.

Dolores County.—Rico district. Halloysite occurs in some earthy masses of oxidation products of the ore deposits. Both Ransome (1901a) and Clarke (1903) give an analysis of it from the Logan mine.

Jefferson County.—Table Mountain (loc. 18). Halloysite, here described as bole, occurs as light-to dark-brown clay in amygdaloidal lava at the center of the north face of South Table Mountain. Often associated with brown massive calcite, it fills the cavities completely. (Whitman Cross and Hillebrand, 1885—analyses.)

La Plata County.—La Plata district. Halloysite is present but not very abundant, in the altered wallrocks of several ore deposits. (Galbraith, 1949.)

Mineral County.—Wagon Wheel Gap (loc. 1). Halloysite is abundant in the upper parts of the fluorite-barite deposit. One type, which contains less water and is much more abundant than the other, forms the matrix for creedite. The second type is the matrix for nodules of gearksutite. (E. S. Larsen, Jr. and Wherry, 1917—analyses.)

HALOTRICHITE

$FeAl_2(SO_4)_4 \cdot 22H_2O$

As with other hydrous sulfates, halotrichite is far more widespread than the two available reports suggest.

Boulder County.—Halotrichite has been reported from several coal mines. It also occurs on outcrops of Laramie coal strata near Marshall, at White Rock, and elsewhere in the county. (George, 1913.)

Pitkin County.—Elk Mountains. The mineral was "found beside a ledge of black iron ore." Its capillary crystals, arranged in parallel bundles, are green at their ends, but otherwise soft and white with a beautiful silky luster, resembling that of satin spar. This was the first reported locality from the United States (E. H. S. Bailey, 1891—analysis.)

HAMLINITE

[*See* Goyazite]

HASTINGSITE

[*See* Amphibole group]

HAUSMANNITE

Mn_3O_4

[*See also* Wad]

Hausmannite has only been reported from one locality but is probably present among other mixtures of manganese oxides. The Iron King prospect on Cedar Creek, 15 miles east of Moffat, Saguache County, shipped 10 tons of 41-percent manganese ore in 1916. The manganese ore, apparently all as oxides, occurs as replacement deposits in shear zones in granite or as small veins in sedimentary rocks. In the veins the manganese oxides are crusted with fluorite several inches thick, which is in turn coated with small quartz crystals. One specimen was a complex intergrowth of psilomelane and a crystalline aggregate of hausmannite. (Jones, 1920.)

HAÜYNITE

$3NaAlSiO_4 \cdot CaSO_4$

Haüynite is a comparatively rare rock-forming mineral in some volcanic rocks, especially the more alkalic ones.

Boulder County.—Alum Hill. Small blue crystals are reported. (Andrews, 1895.)

Clear Creek County.—Analyses of specimens from a small stock on the south side of Clear Creek, east of the mouth of Soda Creek, show a little SO_3, indicating the presence of either haüynite or noselite; neither mineral was actually seen in thin sections, however. (Spurr and Garrey, 1908; Bastin and Hill. 1917.)

Teller County.—Cripple Creek district. Small quantities of haüynite occur in phonolite. (Whitman Cross and Penrose, 1895.)

HEDENBERGITE

[*See* Pyroxene group]

HELVITE

$Mn_4Be_3Si_3O_{12}S$

[*See also* Genthelvite]

Helvite occurs in only three of the many specimens of rare manganese minerals studied from the Sunnyside mine, Silverton district, San Juan County (loc. 1). It occurs as small grains of conspicuous bright honey-yellow color, commonly near pyrite or other sulfides. This is the only reported locality in Colorado and one of very few in the United States. (Burbank, 1933.)

HEMATITE

Fe_2O_3

Hematite is very widespread and occurs in some form in every part of Colorado. The brown earthy varieties are present with limonitic materials in the oxidized parts of many ore deposits and are responsible for the brown and red colors of many rocks and soils. The black varieties, including the glistening scaly specularite or specular hematite, are widespread in veins deposited at moderate or higher temperatures and are abundant constituents of many contact-metamorphic deposits. In a few places hematite has been mined as an ore of iron, but there are no truly large iron-ore deposits in Colorado. A few of the more significant or interesting localities are described below, followed by an annotated list of some other representative occurrences.

Chaffee County.—Calumet iron mine (loc. 2). Magnetite and hematite are the chief iron-ore minerals in this contact-metamorphic deposit in limestone near a contact with granodiorite. Diopside is the main silicate mineral, but epidote, garnet, biotite, tremolite, actinolite, and rare wernerite are also present. The deposit was discovered in 1881 (Putnam, 1886) and from 1882 through 1899 the mine produced 229,000 tons of iron ore that gradually dropped in grade during this period from 60 to 43 percent iron. (Behre, Osborn and Rainwater, 1936.)

Costilla County.—Grayback district. Magnetite is the chief ore mineral in the iron deposits that were once developed commercially by three mines. Specular hematite, however, occurs as coarse plates disseminated through the magnetite or as finer grained masses of nearly pure hematite. The iron minerals contain a little gold. (Patton, 1910.)

Gunnison County.—Cebolla district. Large bodies of highly titaniferous magnetite occur as segregations in mafic rocks and as contact-metamorphic deposits. Some of the ore contains much specular hematite, and siderite is locally abundant. (J. T. Singewald, Jr., 1912, 1913.)

Lake County.—Leadville district. The hematite on Breece Hill was once mined as flux for the Leadville smelter, but it was later replaced by second-grade silver ores for this purpose (Putnam, 1886). Most of the Breece Hill material was red compact or earthy hematite that resulted from the oxidation of magnetite but some was specular ore. Primary hematite is present in the high-temperature ores but is less abundant than magnetite. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata and Montezuma Counties.—La Plata district. Specular hematite is a prominent constituent of many contact-metamorphic deposits, associated with magnetite, garnet, augite, hornblende, and epidote. Magnetite pseudomorphs after hematite are associated with platinum-bearing chalcopyrite on Copper Hill. (Galbraith, 1949.)

Saguache County.—Bonanza district. Specular and other forms of hematite give the red color to jasper and also form veinlets in the jasper. Rarely pseudomorphs of pyrite after hematite are found. (Burbank, 1932.)

Other localities

Boulder County.—Nederland tungsten belt, the "breccia reefs" that traverse the county, and many other localities. (Lovering and Tweto, 1953.)

Chaffee County.—Monarch and Tomichi districts. (R. D. Crawford, 1913.)

Mount Antero (loc. 3), with phenakite and many other minerals.

Clear Creek County.—Colorado Central mine, in quartz at 1,050-foot depth. (Spurr and Garrey, 1908.)

Costilla County.—Plomo (Rito Seco) district. In base-metal veins and with fluorite in dikes. (Gunther, 1905.)

Custer County.—Oak Creek (Ilse) district. (Hunter, 1914.)

Dolores County.—Rico district. Abundant specularite in metamorphosed Devonian limestones. (Ransome, 1901a.)

Douglas County.—Devils Head Mountain (loc. 1). In tabular crystals with topaz crystals. (J. W. Adams, written communication.)

El Paso County.—Pikes Peak region. With amazonstone as pseudomorphs after siderite. (Randall.)

Gilpin County.—Central City district. (Endlich, 1878.)

Gunnison County.—Snowmass Mountain district. Locally abundant in veins; widespread in metamorphosed rocks. (Vanderwilt, 1937.)

Italian Mountain (loc. 3). Specularite with vesuvianite, stilbite and thomsonite. (Whitman Cross and Shannon, 1927.)

Hinsdale County.—Lake City district. Rare as a secondary mineral. (Irving and Bancroft, 1911.)

Larimer County.—Massive on south slope of Crystal Mountain.

Micaceous, with epidote in Longs Gulch.

As seams in Fountain and Ingleside formations 10 miles west of Loveland.

Specularite seams in granite, Stonewall Canyon and elsewhere.

Pseudomorphic after magnetite in many pegmatite bodies. (R. G. Coffin, written communication.)

Mesa County.—Unaweep district. Occasionally abundant in copper-bearing veins. (B. S. Butler, 1915.)

Mineral County.—Creede district. With limonitic material in oxidized zone; none in primary ore. (W. H. Emmons and Larsen, 1923.)

Ouray County.—Camp Bird mine. Specular hematite is abundant in the lower levels. (Burbank, 1930.)

Park County.—Platte Gulch area. Specularite and quartz replace pyrrhotite, pyrite and chalcopyrite in several mines. (J. W. Vanderwilt, written communication.)

Tarryall district. Abundant in contact-metamorphic deposits. (Muilenburg, 1925.)

North Elk Creek. With smoky quartz or pseudomorphs after siderite. (G. R. Scott, written communication.)

Park and Summit Counties.—Montezuma district. In contact-metamorphosed sediments. (Lovering, 1935.)

Pitkin County.—Large beds near Ashcroft and Carbondale. (Schrader, Stone and Sanford, 1916.)

San Juan County.—Silverton district. Widespread in quartz veins but nowhere abundant. (Ransome, 1901b.)

Summit County.—Kokomo district. With magnetite, audradite garnet, epidote, and calcite in high-temperature zone of mineralization. (Koschmann and Wells, 1946.)

Breckenridge district. Specular hematite is very widespread. (Ransome, 1911.)

HEMIMORPHITE

$H_2Zn_2SiO_5$

Hemimorphite is the modern name for the common zinc silicate formerly known as calamine. It is widespread in the oxidized ores of zinc and in a few districts was once a very important ore of zinc.

Clear Creek County.—White incrustations and stalactites of hemimorphite are reported in the Mendota mine (Randall). A crystallographic description of hemimorphite from the Maid of Erin mine, Clear Creek County, the first such study of a specimen from a locality in the United States, is given by Pratt (1894). The thin tabular long delicate needles are strongly striated on the prism faces. The county locality is possibly erroneous and the crystals may have come from the same Maid of Erin mine in the Leadville district as noted below.

Chaffee and Gunnison Counties.—Garfield area. In the Tincup, Monarch, and Tomichi districts hemimorphite is of local importance as an ore of zinc in some oxidized replacement deposits. It is commonly mixed with other oxidation products of galena and sphalerite. (Dings and Robinson, 1957.) In the Monarch district it forms small tabular crystals in veins in smithsonite; in the Tomichi district it is colorless to black and occurs partly as groups of radiating crystals. (R. D. Crawford, 1913.)

Custer County.—Rosita district. In the Bassick mine, hemimorphite, smithsonite, and free gold occur largely above the water table. None are very abundant, and none occur among the concentric layers of ore minerals, replacing breccia fragments, that characterize the primary ore. (Graybill, 1882; S. F. Emmons, 1896.)

Gunnison County.—Gold Brick district. Good specimens have been obtained from the Carbonate King mine, both as drusy colorless crystals and as gray-black masses. With cerussite, hemimorphite forms colorless crystals in quartzite on a mine dump three-quarters of a mile east of the Sacramento mine. (R. D. Crawford and Worcester, 1916.)

Lake County.—Leadville district. Hemimorphite is widespread and locally very abundant in the oxidized ores; in a few places it is as important a zinc ore as smithsonite. Many fine museum specimens have come from this district. It commonly occurs as fine to coarse druses of white to colorless bladed crystals or aggregates. Some replaces smithsonite, but some is deposited directly from solution. (S. F. Emmons, Irving, and Loughlin, 1927.)

The crystallography of small sharp water-clear crystals from an unspecified locality at Leadville is described by Paul (1912) and by P. B. Argall (1914b). A crystallographic description of a specimen of very well developed crystals from the Maid of Erin mine is given by Farrington and Tillotson (1908). The average crystal is 10 mm long, tabular, and striated in the prism zone. The crystals are charged with electricity by gentle heating. If a glass rod is rubbed with flannel the positively charged glass is attracted by the terminated ends of the heated crystals and is repelled by the broken basal ends.

Lake and Park Counties.—Weston Pass district. Hemimorphite and smithsonite together were very important as high-grade zinc ores in the early days of this district. The hemimorphite is very abundant, especially in the most thoroughly oxidized ores, where it forms rosette crystals and porous dense masses. (Behre, 1932.)

Mineral County.—Creede district. Although not reported in the earlier literature, calamine, green fluorite, manganite, and psilomelane are all present in the Amethyst and other veins. (Seaman, 1934.)

Park and Summit Counties.—Montezuma district. Hemimorphite is uncommon in the district but present in a few veins where it is associated with brown iron oxides in zinc ore that is partly altered to smithsonite. Some crystals are chisel shaped, but others are as thin as threads of glass. (Lovering, 1935.)

HENRYITE*

[*See* Altaite]

HESSITE

Ag_2Te

Hessite, one of the tellurides for which Colorado mines are well known, has been found in every district that contains telluride minerals and is an important source of silver in some of them.

Boulder County.—Hessite, like most of the tellurides, was first found in Colorado in Boulder County; its occurrence in the Slide, Red Cloud, Prussian, and other mines is described by Genth (1874). He says there are several varieties with small but varying amounts of gold and that pure hessite is rare. The gold shown by his analyses is probably present as intergrowths or inclusions of other minerals. Genth also says that the hessite contains cavities lined with minute crystals of pyrite and barite.

Gold-bearing hessite from Gold Hill, is described with analyses by Endlich (1874), and Silliman (1874a, b).

Among more modern workers, Wilkerson (1939) found hessite with sylvanite in the Magnolia district and Goddard (1940) found it to be locally abundant at Gold Hill but less important than petzite and sylvanite.

Clear Creek County.—Small quantities of hessite, associated with argentite and other minerals, were found in the Griffith mine near Georgetown (Spurr and Garrey, 1908). An analysis of ore from this mine by F. C. Knight is interpreted by Pearce (1896) and Kemp (1898) to represent a mixture of hessite and argentite with some chalcopyrite, galena, bismuthinite, gold-silver alloy, magnesite, and "insoluble."

The Independence mine in the Argentine district yielded small pockets of hessite ore at a depth of 100 feet that assayed 5,236 ounces of silver and 259 ounces of gold to the ton. (Randall.)

Custer County.—Silver Cliff district. Hessite has been reported from the Geyser mine, but S. F. Emmons (1896) thinks that either tetrahedrite or polybasite had been mistaken for hessite.

Eagle County.—Red Cliff district. Hessite has long been known in the Red Cliff ores, especially in the copper-and silver-bearing chimneys associated with replacement bodies in limestone. Some galena in pyrite-chalcopyrite ore contains small inclusions of hessite and petzite with blebs of free gold. Late silver minerals in vugs of this ore include freibergite, polybasite, stromeyerite, bournonite, and schapbachite. (Tweto and Lovering, 1947.)

Hinsdale County.—Hessite is reported from the Hodgkiss (or Hotchkiss) lode on the divide between the Uncompahgre and Animas Rivers. The occurrence is doubtful. (Endlich, 1878.)

Lake County.—Leadville district. Hessite is identified in ore of the bismuth, or last stage of mineralization from the Greenback, Tucson, and Louisville mines and from Breece Hill. It is associated with altaite or galena and is a favorite host for native gold; chalcopyrite is generally absent from hessite-bearing specimens. (Chapman, 1941.)

La Plata and Montezuma Counties.—La Plata district. Hessite was reported from near Parrott City early in the history of the district (Endlich, 1878). It is the most abundant telluride of the district and is intimately associated with other tellurides in contemporaneous hypogene intergrowth. Hessite and the other tellurides (including nearly omnipresent coloradoite) fill open spaces in the gangue or replace tetrahedrite as well as the common sulfides to a lesser extent. The tellurides are replaced by hypogene native gold in some ores and by supergene gold in one vein. (Galbraith, 1949.)

The Denver Museum of Natural History has many fine large specimens of hessite from the May Day mine.

Ouray County.—Although the tellurides are notably lacking in most of the ores from the San Juan region (including the misnamed Telluride district), a little hessite has been identified in ore from the famous Camp Bird mine. One specimen from the King stope, 160 feet above the third level, contains specks of hessite and native gold in galena. Other metallic minerals in the Camp Bird vein are pyrite, sphalerite, galena, chalcopyrite, gold, specular hematite, and magnetite. (Moehlman, 1936b.)

Saguache County.—Bonanza district. Hessite and empressite are irregularly intergrown in ore of the Empress Josephine mine. Altaite, sphalerite, galena, and chalcopyrite occur as microscopic specks in the silver telluride minerals. (Burbank, 1932.)

Teller County.—Cripple Creek district. Hessite was not found in Cripple Creek ores during the early boom days of the district. (Lindgren and Ransome, 1906.) It was first identified by M. N. Short in specimens of rich pyritic ore collected by Loughlin from the 2,900-foot level of the Portland mine. The pyrite is shattered and recemented by tellurides, quartz, and fluorite; hessite forms microscopic interstitial grains in calaverite and accounts for the moderately high silver values of the ore from the Portland mine. (Loughlin, 1927; Loughlin and Koschmann, 1935.)

HETAEROLITE

[*See* Hydrohetaerolite]

HEULANDITE

$CaAl_2Si_7O_{18} \cdot 6H_2O$

Heulandite, one of the zeolites, is present in volcanic rocks in several places in Colorado; it is probably more widespread than the record indicates.

Gunnison County.—Italian Mountain and vicinity (loc. 3). Red heulandite is abundant as an alteration product of andesite in upper Anthracite Creek (Eakins, 1892—analysis). It is also abundant in places in the metamorphosed rocks of Italian Mountain where it occurs in several ways. In the Bidwell Range, part of the Italian Mountain complex, it was noted in a crack in massive granular garnet as large crystaline masses, as much as 4 cm long, with perfect cleavage and pearly luster. Interspersed in the masses are small perfect glass-clear crystals. It also occurs as crystals in cavities of mizzonite, and in cracks in red sandstone. In some specimens composed of mizzonite, scolecite, and byssolite it forms 3- to 4-mm crystals embedded in byssolite; the crystals are colored green by included fibers of byssolite. (Whitman Cross and Shannon. 1927.)

Uncompahgre Peak. Small crystals are reported in basalt (Endlich, 1878.)

Jefferson County.—Green Mountain. Small glassy to white crystals of heulandite associated with ptilolite (now mordenite) occur in augite andesite near the north base of Green Mountain (Randall).

Park County.—South Park. Red heulandite is sparingly present in eruptive rocks near Como. (Randall.)

HEWETTITE

$CaO \cdot 3V_2O_5 \cdot nH_2O$

Although the minerals hewettite and metahewettite were first identified in specimens from Peru, their type description included specimens from southwestern Colorado. Hillebrand, Merwin, and Wright (1914) who first described both species, say that hewettite is very rare in southwestern Colorado as compared to metahewettite; they saw only one specimen—a single bundle of fibers on a layer of crystallized gypsum. Later, R. C. Coffin (1921) found that hewettite is widespread in Colorado Plateau deposits and that it makes up most of the miners' "red oxide of vanadium." It occurs as a red powder interstitial to sandstone grains or as aggregates of silky hairlike fibers in seams. It is associated with carnotite and commonly with gypsum.

Hewettite is one of the many oxidation products of montroseite (Weeks, Cisney and Sherwood, 1953). The mineral has been identified in ores from the following places, all in the Colorado Plateau:

Jo Dandy group and Opera Box mine, Bull Canyon district, Montrose County; Fox mine, Uravan district, Montrose County; Matchless mine, Gateway district, Mesa County; and Tiny mine, Gypsum Valley district, San Miguel County. (Weeks and Thompson, 1954.) These authors report no metahewettite from any Colorado localities, but Dwornik and Ross (1955) show an electron micrograph of hewettite from the Jo Dandy mine and another of metahewettite from the Matchless mine, Mesa County. A modern systematic X-ray study of specimens of hewettite from Colorado and elsewhere is reported by Barnes (1955).

HINSDALITE†

$(Pb, Sr)Al_3(PO_4)(SO_4)(OH)_6$

Hinsdale County.—Lake City district. Hinsdalite, whose first and only definitely known locality is the Golden Fleece mine, is very abundant there. The Golden Fleece vein, 3 miles south of Lake City, is in the Picayune group of the Silverton volcanic series. Ore from the mine dump contains the following minerals, listed in order of abundance: quartz, hinsdalite, barite, pyrite, galena, tetrahedrite, and rhodochrosite. The vein material contains bands 1 inch or more wide of nearly pure coarsely granular clear to greenish hinsdalite. These bands are bordered by finely crystalline aggregates of quartz and hinsdalite, in which are embedded well-formed crystals of hinsdalite as much as 1 cm in diameter. Galena and tetrahedrite and some of the pyrite are concentrated in the quartz-hinsdalite mixture. (E. S. Larsen, Jr., and Schaller, 1911—analyses; Schaller, 1912.)

Saguache County.—Bonanza district. Ore from the Liberty and Empress Josephine mines on Copper Gulch contain several mafic hydrous phosphates of the hinsdalite type. They occur in very small quantity, however, and could not be specifically identified by Burbank (1932).

HITCHCOCKITE

[*See* Plumbogummite]

HORNBLENDE

[*See* Amphibole group]

HUEBNERITE

$MnWO_4$

[*See also* Ferberite *and* Wolframite]

Huebnerite, the manganese member of the huebnerite-wolframite-ferberite series, is fairly widespread in the State, but the richest and best known occurrences are in the San Juan Mountains, particularly in Ouray and San Juan Counties.

Boulder County.—Magnolia district. Present in small quantities. (Dana, 1892.)

Nederland tungsten district. In this district that is noted for the abundance of ferberite and which also contains large amounts of scheelite, huebnerite has been found in only one vein. This is in the Forest Home mine, where it forms reddish-yellow blades, coated with crusts of manganese oxides. (Lovering and Tweto, 1953.)

Noted near Jamestown. (Randall.)

Chaffee County.—Huebnerite occurs in a copper vein near Salida. (W. P. Blake, 1899.)

Gunnison County.—Tincup district. The Gold Hill veins in this district contain huebnerite, molybdenite, and quartz with specks of a fluorescent mineral, possibly scheelite. They were worked for molybdenum during World War I, but the amount of huebnerite in them is small. (Goddard, 1936; G. O. Argall, Jr., 1943.)

In the old Quartz Creek district, now considered part of the Tincup district, north of North Quartz Creek and west of Cumberland Pass there are quartz veins with some pyrite and minor amounts of molybdenite, huebnerite, tetrahedrite, chalcopyrite, galena, and sphalerite; a little scheelite or powellite is also present. The huebnerite forms light-brown slender prisms from one-half to 2 inches long. The largest crystals are tabular rather than prismatic; one crystal was 5 inches long. (Dings and Robinson, 1957.)

Lake County.—Climax district. Huebnerite is widespread and relatively abundant in the Climax molybdenite deposit where it forms veins as much as one-half inch wide. They are easy to find on the surface in boulders of float ore and fairly easy to see underground. The mineral, which contains very little iron, is reddish brown to black with a high luster. Lathlike crystals in quartz are typical of its occurrence but small veins of huebnerite and sericite cut the silicified rock and molybdenite veins. A little of it also occurs in late pyrite-quartz veins. (B. S. Butler and Vanderwilt, 1931, 1933.)

Leadville district. The description of the "wolframite" from Breece Hill seems to fit that of huebnerite better than it does wolframite.

Ouray and San Juan Counties.—The first report of huebnerite in the United States was that of Hillebrand (1885a) who described it, with an analysis, from the Royal Albert vein in the Uncompahgre district, Ouray County. Here it forms long-bladed vertically striated crystals in quartz.

Not long after Hillebrand's description, it was found at many other places in the San Juan Mountains, including the Adams lode on Bonita Mountain near Silverton, which has furnished many fine collector's specimens of crystals.

One of the earlier and more complete descriptions is that of Genth (1892a), who describes the mode of occurrence, crystallography, and chemistry of huebnerite from the North Star mine on Sultan Mountain. The ore of this mine is quartz with disseminated galena, pyrite, and tetrahedrite; cavities in the ore are lined with drusy quartz and crystals of huebnerite, tetrahedrite, and rare beautiful rhombs of rhodochrosite. The huebnerite commonly forms groups of radiating long prismatic crystals. Many of the crystals are thinly coated with drusy quartz, which is easily removed from the prism faces but not from the terminal ones. In a single specimen long prismatic quartz-coated crystals were noted in one cavity, and in another one nearby the crystals were short, doubly terminated, and uncoated.

In the same paper, Genth (1892a) also describes huebnerite from Bonita Mountain and quotes an analysis by H. F. Keller (1889a,b). Here the huebnerite is "hair-brown" to reddish and yellowish brown and occurs in quartz and pyrite as radiating and divergent masses.

In the Silverton district, San Juan County, huebnerite is widely distributed as a vein mineral with quartz and fluorite. Some of it contains much iron and thus approaches wolframite in composition. Some huebnerite ore has been sold as concentrates, but the total production is very small. (Ransome, 1901b.) According to Prosser (1910), who notes several specific localities, the main occurrences of huebnerite fall in a belt 9 miles long that extends from Silverton to above Gladstone. Typically it forms very beautiful sheaflike clusters of crystals as much as 3 inches long, crusted with quartz and fluorite. See also C. A. Cooper (1899).

In the Dunmore mine 4 miles south of Ouray, there is a chimney of ore in which huebnerite comprises 30 to 40 percent of some masses. In blades as much as 1 inch long, it is associated with pyrite, sphalerite, coarsely crystalline quartz, and a little kaolin and sericite. (Kelley and Silver, 1946.)

Park County.—Alma district. In a vein near Montgomery in Platte Gulch huebnerite crystals from ½ to 1½ inches long occur in a vein of massive quartz and pyrite. The pyrite, which forms cubes as much as 4 inches in diameter, is much fractured whereas the huebnerite is not, suggesting that huebnerite is the younger mineral. In the Wheeler mine fine blades of huebnerite only 1 mm wide by 5 to 8 mm long form a poorly defined late vein that cuts galena and other sulfides. (J. W. Vanderwilt, written communication.)

Rio Grande County.—Summitville district. W. P. Blake (1899) notes that tungsten ores are being worked near Summitville. He does not mention the minerals produced, and no tungsten minerals have been reported from here by other workers.

Summit County.—In veins in and near the Navy mine in Monte Cristo Gulch in the upper Blue River area huebnerite is fairly abundant. It occurs as dark-brown needles and prisms as much as 1 inch long intergrown with quartz and pyrite. Scheelite and tungstite are also present. (G. O. Argall, Jr., 1943; Q. D. Singewald, 1951.)

Teller County.—Cripple Creek district. The only known occurrence of a tungsten mineral in the district is in the Puzzle vein at the Ophelia tunnel level. Here radial dark-brown to dark-green aggregates of huebnerite are intergrown with quartz in a small vein that contains galena and sphalerite. (Lindgren and Ransome, 1906.)

HUMMERITE†

$K_2Mg_2V_{10}O_{28} \cdot 16H_2O$

Hummerite is named for the mine where it was first found—the Hummer mine of the Jo Dandy group, Bull Canyon district, Montrose County. Later it was found at the North Star and Whitney mines, Uravan district, Montrose County. Translucent yellow in color and similar in appearance to pascoite, it forms vein fillings with columnar structure parallel to the walls. It also forms a granular crust and efflorescence that coats or cements sandstone in the oxidized uranium-vanadium ores. It is associated with hewettite and vanadiferous clay among the alteration products of montroseite and other earlier minerals. (Weeks, Cisney and Sherwood, 1950, 1953; Weeks and Thompson, 1954.)

HYALITE

[*See* Opal]

HYDROHETAEROLITE

$4HZnMn_{2-x}O_4$

Hydrohetaerolite is known only in the Leadville district, Lake County. There it is widespread, relatively abundant, and important as an ore of zinc. It has had a long history among mineralogists. It was first described as a new mineral by G. M. Butler (1913) and named wolftonite for its type locality, the Wolftone mine.

The mineral was quickly restudied and reanalysed by Ford and Bradley (1913), who found it to be hetaerolite, thus discrediting the species wolftonite. Frondel and Heinrich (1942) restudied the type material by modern X-ray, chemical, and other methods and decided that it is hydrohetaerolite, which differs from hetaerolite in its fibrous character, X-ray cell dimensions, and in apparently containing a small percentage of silica and water. McAndrew (1956) gives additional X-ray data on part of the type specimen studied by Ford and Bradley (1913). See also P. B. Argall (1914c).

The mineral is widespread in the district, even well below the main zone of oxidation. It occurs as fracture fillings, but mostly as thin drusy bands, alone or alternating with smithsonite in cavities. It is deep black and glossy and has a radiating mammillary structure, with smooth outer surfaces. It is always earlier than hemimorphite and may be coated by it or by chalcophanite. It is largely a segregation of zinc and manganese from the oxidation of manganosiderite bodies. (S. F. Emmons, Irving, and Loughlin, 1927; Ford and Bradley, 1913.)

HYDROPHANE

[*See* Opal]

HYDROZINCITE

$Zn_5(OH)_6(CO_3)_2$

Eagle County.—Gilman (Red Cliff) district. The smithsonite in the oxidized ores contains large amounts of H_2O, indicating the presence of hydrozincite. The mineral has not been specifically identified, however. (R. D. Crawford and Gibson, 1925.)

Lake County.—Leadville district. Hydrozincite is reported as a dull-lustered soft earthy alteration product of smithsonite (G. M. Butler, 1913). Loughlin found zinciferous clay in some abundance but was unable to confirm the presence of hydrozincite. (S. F. Emmons, Irving, and Loughlin, 1927.)

HYPERSTHENE

[*See* Pyroxene group]

IANTHINITE

Hydrated oxide of uranium of uncertain formula

Minute violet crystals of ianthinite occur in pitchblende from the Marshall Pass area, Saguache County. The mineral was identified by X-ray powder pattern. (Riley and Owens, 1957.)

ICE

H_2O

In addition to its occurrence in abundance in glaciers and perpetual snowfields, ice occurs both massive and as beautiful crystals in many mines in the higher altitudes. A few such occurrences have been mentioned in the literature but none seem to justify summarization here.

IDDINGSITE

Iddingsite, long known as an alteration product of olivine but formerly considered a variety of serpentine, was thought to be a valid mineral species by Ross and Shannon (1925a). Much of the work they did in establishing the species and in showing it to be widespread and abundant in basaltic rocks was performed on material from Colorado. They describe the occurrences given here with analyses of iddingsite from each.

More recently, it has been shown that iddingsite is probably a mixture of goethite and a chloritelike mineral. (See G. Brown and Stephen (1959) and Ming-shan Sun (1957) who worked partly on Colorado specimens.) As the material called iddingsite is remarkably uniform in properties for a mixture, and as the older Colorado occurrences have not been restudied, iddingsite is treated here like a mineral.

Conejos County.—Conejos quadrangle. At the base of a cliff in olivine basalt in La Jara Creek 19 miles northwest of Antonito, iddingsite occurs in masses as much as 4 mm in diameter. These have the outlines of olivine, which is incompletely altered.

At the head of South Elk Creek there is a black basalt with red spots of iddingsite as much as 2 mm across.

An andesite dike on Gato Creek, 2 miles above Tipton's Ranch, contains rounded grains of iddingsite no larger than 0.5 mm that are clearly derived from olivine.

Rio Grande County.—Creede quadrangle. Basaltic andesite crops out on Race Creek, 11 miles south of South Fork station on the D. & R. G. W. Railway. Iddingsite forms euhedral pseudomorphs after olivine as much as 3 mm long. The alteration process is not complete in all grains.

In addition to the occurrences described by Ross and Shannon (1925a), virtually all olivine found in basalt anywhere in the State will be partly altered to iddingsite. For example, throughout the lava flows of the San Juan Mountains the chief or only phenocrysts in the basalt are olivine. Without exception the olivine shows evidence of much magmatic resorption and almost without exception it is partly or completely altered to iddingsite. (E. S. Larsen, Irving, Gonyer, and E. S. Larsen 3d, 1936.)

IDOCRASE

[*See* Vesuvianite]

ILESITE†

$(Mn,Zn,Fe)SO_4 \cdot 4H_2O$ (?)

Ilesite, a hydrous sulfate of manganese, zinc, and iron, was first found in several mines near the head of Hall Valley in the Montezuma district, Park County. It has never been reported anywhere else. It was named and described by Wuensch (1881), whose description is based on that of its namesake M. W. Iles (1881) who also made the chemical analyses.

Ilesite occurs as incrustations and fillings in vein matter; it consists of loosely adhering friable thick prisms, many of them terminated by truncated pyramids. It is clear green where fresh, but turns white on partial dehydration. The type locality is on the McDonnell claim in Hall Valley 13 miles from Webster. In some places streaks of pure ilesite from 2 to 8 inches wide occur in vein matter that contains pyrite, sphalerite, galena, and traces of gold and silver.

ILLITE group

Hydrous aluminum silicates

[*See also* Clay minerals]

The name "illite" was proposed for application to a group "of clay mineral micas of dioctahedral and trisoctahedral types and of muscovite and biotite crystallizations." (Grim, 1953.) The term has not been accepted by all mineralogists, but it has been applied to a few clay minerals in Colorado. The most significant of these are:

Gilpin County.—Central City district. Some illite, together with a great deal of montmorillonite, comprise most of the altered wallrocks that contain metatorbernite. (Sims and Tooker, 1955.)

Jefferson County.—The Laramie formation that crops out south of Golden contains varying proportions of kaolinite, montmorillonite, and illite in different beds. Gude (1950) shows that X-ray diffraction methods can be used to identify the relative amounts of these minerals and that the variations can be applied to stratigraphic studies.

Similarly, W. D. Keller (1953) shows that in the type section of the Morrison formation at the town of Morrison illite is the dominant clay mineral in two of the argillaceous members, whereas kaolinite and montmorillonite are dominant in others.

Rio Grande County.—Summitville district. The quartz-alunite bodies are surrounded by envelopes of argillized rock. Illite and montmorillonite are the most common clay minerals but kaolinite is locally abundant. (Steven and Ratté, 1960.)

Front Range, general.—A study of shales in the Morrison, Benton, and Dakota formations as exposed from the latitude of Denver to that of Fort Collins is recorded by V. E. Larsen (1954). Using X-ray and differential thermal analysis techniques, he found that the dominant clay mineral in shales of the Morrison is illite, with less kaolinite and little or no montmorillonite. In the shales of the Dakota he found more kaolinite than illite in some beds and less in others. The lower part of the Benton is like the Dakota, but samples from higher in the section contain more illite, less kaolinite, and appreciable quantities of montmorillonite.

San Juan Basin, general.—X-ray diffractometer studies show that the clays of the lower Tertiary deposits are made up of montmorillonite, illite, and chlorite; kaolinite is absent. (Droste, 1955.)

ILMENITE

$FeTiO_3$

Ilmenite, and to some extent its magnesian variety called picrotitanite, is one of the most common accessory minerals in igneous and metamorphic rocks; hence small quantities are very widespread in such rocks and in the detrital material derived from them. None of these occurrences are given here, but a few deposits in which ilmenite is an important constituent are described.

Boulder County.—Caribou district. Bodies of titaniferous magnetite ore crop out on the northeast and southeast sides of Caribou Hill, which overlooks the camp of Caribou. Granite and gneiss are intruded by mafic igneous rocks, which contain many stringers and veinlets of nearly pure titaniferous magnetite. Locally these are sufficiently abundant and closely spaced to form small bodies of medium-grade titaniferous iron ore. The magnetite contains inclusions of green spinel; most of the ilmenite occurs as specks and small particles scattered through the magnetite. Early analyses showed as much as 36 percent TiO_2, but the correct average is probably from 3 to 5 percent. Pyroxene, ranging from diopside to augite and commonly altered to serpentine, is associated with the ore. (Jennings, 1912; J. T. Singewald, Jr., 1913; Bastin and Hill, 1917.)

Magnolia district. A chrysolite (olivine) dike that extends for 6 to 8 miles through part of the Magnolia district is described by Whitaker (1898). It contains many nodules of serpentine, picrotitanite (the magnesian variety of ilmenite), chlorite, and calcite. Mica, with inclusions of garnet crystals, a few crystals of chrysolite, and some zeolite minerals, is also present. The picrotitanite occurs as coarse nodules of undecomposed opaque material, not as fine particles in the groundmass.

Fremont County.—Iron Mountain (loc. 7). Iron Mountain is made up of gabbro which contains discontinuous zones or lenses, 10 to 50 feet wide, of titaniferous magnetite. The bodies are small and the total tonnage not great; its grade is 47.86 percent iron and 12.95 percent titanium. The ore is a compact aggregate of ilmenite and magnetite, which contains many inclusions of green spinel. The gangue minerals are those of gabbro—augite, olivine, and feldspar. (J. T. Singewald, Jr., 1913.)

Gunnison County.—Cebolla district. The Cebolla titaniferous magnetite deposit, not far from the alkalic rock complex of Iron Hill (loc. 2), is on the east side of Cebolla Creek, south of Powderhorn. The ore occurs as segregations in mafic igneous rocks and in a contact-metamorphic zone in limestone, an unusual type of occurrence for ilmenite. In the mafic rocks, where ilmenite is commonly more abundant than magnetite, the ore consists of intergrowths of ilmenite and magnetite with bunches of dark-brown mica. Pyroxene is not abundant in the richest ores, but these grade laterally into material in which pyroxene is the only mineral. In the contact-metamorphic ore the magnetite-ilmenite intergrowths occur in small pockets or nests in a light-green compact rock made up of calcite, augite, garnet, and less abundant zoisite and vesuvianite. (J. T. Singewald, Jr., 1912, 1913.)

Park County.—Ilmenite, largely altered to leucoxene, occurs with monazite in the Lone lode feldspar pegmatite, sec 23, T. 8 S., R. 72 W. (J. W. Adams, written communication.)

The Baumer pegmatite 3½ miles southeast of Guffey contains abundant radioactive ilmenite, with euxenite and some allanite and monazite. (Heinrich and Bever, 1957.)

ILMENORUTILE

[*See* Rutile]

ILSEMANNITE

$Mo_3O_8 \cdot nH_2O$?

Ilsemannite, also called molybdenum blue, is a hydrous molybdenum sulfate of somewhat uncertain composition and status as a mineral. As it has been authoritatively reported from several Colorado localities, and as there is no other confirmed species to which these occurrences can be ascribed, it is here included as a mineral species.

Boulder County.—The presence of molybdenite in some of the telluride-bearing veins is indicated by deep-blue stains, thought to be of ilsemannite, on the dumps. These are particularly noticeable at the Mogul tunnel near Eldora. (Lindgren, 1907.)

Clear Creek County.—Idaho Springs district. Mine water in the Lucania tunnel is deep blue and the rocks along the tunnel are stained blue. Presumably the blue material is ilsemannite in solution. (Horton, 1916—analysis.)

Costilla County.—Some of the handwoven wool materials made at the normal school at Monte Vista are dyed a beautiful soft blue. The mineral used for the blue dye, which is possibly ilsemannite, comes from the mountains on the east side of the San Luis Valley, in the southern part of the Trinchera estate. (Theodore Jones, oral communication.)

Jackson County.—The fluorspar mine operated by the Western Fluorspar Corp. at Northgate (loc. 1) contains ilsemannite on the mine walls, and the materials on the dumps become crusted with it after a few days of exposure. The ilsemannite forms a powdery azure to blackish-blue crust on fluorite or on altered granite. Associates are quartz, feldspar, fluorite, chlorite, pyrite, gypsum, and melanterite. (Goldring, 1942—partial analyses.)

Jefferson County.—The Mann uranium mine near Morrison contains some ilsemannite associated with pitchblende, pyrite, and asphaltic material in Dakota sandstone. (E. H. Goldstein, 1957.)

Saguache County.—Cochetopa district (loc. 2). In the Los Ochos mine minor amounts of ilsemannite are associated with marcasite and chalcedony in the primary pitchblende ore. (Derzay, 1956.)

San Miguel County.—Placerville district. Ilsemannite, at least partly an alteration product of jordisite, is present in the Black King No. 5 claim, associated with uraninite, metatorbernite, and many other minerals. (Gruner and Gardiner, 1952.)

Teller County.—Cripple Creek district. Ilsemannite is a direct alteration product of molybdenite in a vein in the Ophelia tunnel. The coarse-grained comb quartz of the vein is crusted on a fine-grained mixture of pyrite, molybdenite, and sphalerite. Where exposed to sun and air the quartz turns yellow or green and finally deep prussian blue. Close examination shows that the weathering products consist of minute yellow tufts, probably ferrimolybdite, and dark-blue mammillary coatings of a water-soluble molybdenum mineral that is probably ilsemannite. (Lindgren and Ransome, 1906.)

ILVAITE

$CaFe_2^{+3}Fe^{+2}(OH)(SiO_4)_2$

Ilvaite has been reported only once—from North Clear Creek, below Black Hawk in Gilpin County. No details are available. (J. A. Smith, 1883.)

IODIAN BROMYRITE

[*See* Bromyrite]

IODOBROMITE

[*See* Cerargyrite *and* Bromyrite]

IODYRITE

[*See also* Cerargyrite *and* Bromyrite]

AgI

Iodyrite was reported in the early days of mining from a few oxidized ore deposits.

Boulder County.—Gold Hill district. Small fragments occur in the surface ore of the Red Cloud mine. (J. A. Smith, 1883.)

Magnolia district. Present, with telluride minerals. (Dana, 1892.)

Lake County.—Leadville district. Very small quantities of minute yellow crystals occur in the Chrysotile mine. Much of the iodine in the Leadville oxidized ores is in either embolite or cerargyrite. (S. F. Emmons, 1886b; S. F. Emmons, Irving and Loughlin, 1927.)

IRIDIUM

[*See* Platinum *and* Iridosmine]

IRIDOSMINE

Ir, Os

Iridosmine, an alloy of iridium and osmium is reported only from a gold placer deposit in Ouray County, locality unspecified. According to Day and Richards (1906), the gold assay button made from black-sand concentrates contained 1.18 percent platinum and 4.51 percent iridosmium (now called iridosmine).

Minute amounts of both iridium and osmium in the platinum-bearing chalcopyrite of Copper Hill in the La Plata district possibly indicate that iridosmine is present there (see Platinum).

Iridium is reported by newspapers to have been found in the black sands of Cherry and Boulder Creeks along the Colorado Front Range, and also to occur in ore from a mine on Gibson Hill at Breckenridge (Randall). These reports have not been confirmed but if iridium is present it is probably in the form of iridosmine

JALPAITE

[*See* Argentite]

JAMESONITE

$Pb_4FeSb_6S_{14}$

Jamesonite has been reported from six localities but nearly all of the reports are old and probably unreliable.

Custer County.—Rosita Hills district, Bassick mine. The ore body of the Bassick mine, by far the most prolific producer of gold and silver in the district, is a breccia pipe that fills a volcanic neck. The ore minerals occur as concentric shells on fragments of breccia and as interstitial fillings. The first or inner shell on the rock fragments is made up of sphalerite and a black metallic crystalline sulfantimonide of lead resembling jamesonite. This shell, which ranges from a hairline to 5 mm in thickness is succeeded by a lighter colored layer containing more silver, gold, and lead. This is followed by a 0.5- to 5-cm shell of beautifully crystallized sphalerite containing considerable iron and some copper. It is very rich in gold and silver. In some places a fourth shell of chalcopyrite is present. The interstitial material in the breccia, as distinct from the concentric shells, contains tetrahedrite, tellurides of gold and silver, quartz, and kaolin. (Grabill, 1882; S. F. Emmons, 1896.)

Gunnison County.—Ruby district, Domingo mine. Some of the "warrenite" of the Domingo mine, discussed here under the name boulangerite, has been identified by L. J. Spencer (1907) and Robinson (1949) as jamesonite; other specimens of "warrenite" are owyheeite. This is the only jamesonite occurrence in Colorado to have been substantiated by modern methods.

Mineral County.—Creede district. On display in the Denver Museum of Natural History is a specimen, showing many very small crystals, that is labelled "jamesonite."

Park County.—Alma district, Sweet Home mine (loc. 1). Capillary fibers of jamesonite are reported. (Endlich, 1878.)

San Juan and Summit Counties.—Jamesonite is reported from both counties; no details or localities are given. (Endlich, 1878; J. A. Smith, 1883.)

JAROSITE

$KFe_3(SO_4)_2(OH)_6$

[*See also* Plumbojarosite]

Judging by the literature jarosite is fairly widespread among Colorado mining districts. It resembles limonitic material so closely that it is difficult to recognize or estimate its quantity; it is probably much more abundant than is indicated by its recorded occurrences. Plumbojarosite has been recorded only once—at Leadville; the other jarosite minerals—argentojarosite, ammoniojarosite, and natrojarosite—have never been reported but possibly they will be found with further work.

Chaffee County.—Iron Arrow mine. About 6 miles east of Salida and 2 miles north of the Arkansas River jarosite occurs in seams and cavity fillings with siliceous turgite and hematite. It forms brilliant but minute crystals; some are isolated but others occur as groups or crystalline crusts. The transparent crystals are light-amber yellow to dark brown, with adamantine luster on their faces but resinous luster on fracture surfaces. (Koenig, 1881b—analyses.)

Jarosite, together with ferrimolybdite, fills casts of pyrite crystals in the wallrock of the California vein west of Mount Antero (loc. 1) (Adams, 1953).

Dolores County.—Rico district. In the oxidized ore bodies of C. H. C. Hill, jarosite is mixed with limonite, earthy sulfates of lead, and other oxidation products. Ransome (1901a) gives an analysis of the mineral from the Pigeon mine. (See also Clarke, 1903.)

Eagle County.—Gilman (Red Cliff) district, Black Iron mine. Jarosite, associated with other ferric sulfates, occurs as an alteration product of melanterite, which is derived from pyrite. The jarosite crystals are minute but perfectly formed. In the alteration sequence galena is completely altered to anglesite before the pyrite is more than slightly pitted. (S. F. Emmons, 1886a; Clarke, 1903—both record the same analyses.)

Gilpin County.—Central City district. Jarosite is reported from the dump of the Wood mine, in Leavenworth Gulch. (J. A. Smith, 1883.)

Lake County.—Leadville district. Jarosite is abundant in a layer of oxidized materials beneath the rich lead carbonate ores of Carbonate Hill; plumbojarosite is also present. (S. F. Emmons, Irving and Loughlin, 1927.)

Climax district. Jarosite is common throughout the mineralized area of this rich molybdenum deposit. It forms ocher-yellow incrustations along fissures and in seams, but it resembles limonite so closely that its abundance is difficult to estimate. (B. S. Butler and Vanderwilt, 1933.)

Mineral County.—Creede district. Jarosite occurs in oxidized material near the outcrop of the Amethyst vein. (W. H. Emmons and Larsen, 1923.)

Park and Summit Counties.—Montezuma district. In the oxidized ores of the Tiger mine, jarosite is sparingly present with limonite and jaspery quartz. It can be distinguished from the limonite by its silky luster. (Lovering, 1935.)

Rio Grande County.—Summitville district. Jarosite is widespread in the oxidized zone where it is mixed with limonite and manganese oxides. (Steven and Ratté, 1960.)

Saguache County.—Bonanza district. Jarosite forms microscopic veinlets in silicified rock near the Chloride mine in the southern part of the district. It may be widespread in very small amounts but most yellow coatings on rocks and ore are phosphates and sulfates of iron and aluminum. (Burbank, 1932.)

Summit County.—Breckenridge district. Jarosite occurs in the supergene ores in both the secondary sulfide and the oxidized zone. (Lovering, 1934.)

JEFFERISITE

[*See* Vermiculite]

JOHANNITE

$Cu(UO_2)_2(SO_4)_3(OH)_2 \cdot 6H_2O$

Johannite has been found at three localities in Colorado. One of these is Gilpin County, with no clearer location given. It was first described as a new mineral and named gilpinite by E. S. Larsen, Jr., and Brown (1917), who give analytical and optical data. Larsen and Berman (1926) reexamined the original specimens and data and found the mineral to be johannite; they therefore withdrew the name gilpinite. Peacock (1935b) sudied the crystallography and chemistry of two of the crystals from Gilpin County and confirmed their identity with johannite.

In the original description, Larsen and Brown say that the johannite, associated with gypsum, occurs as pale-greenish-yellow to canary-yellow crystalline aggregates on green copper ore and black pitchblende.

Johannite is also reported as an efflorescence on mine walls in the Thornburg mine, Los Ochos or Cochetopa district, Saguache County (loc. 2). (Mahan and Ranspot, 1959.)

The Schwartzwalder mine, Jefferson County (loc. 15), contains thin coatings of johannite and a zippeitelike mineral on mine walls in the upper levels. (D. M. Sheridan, written communication.)

JORDANITE

[*See* Guitermanite]

JORDISITE

MoS_2

Jordisite is a black powdery colloidal form of molybdenum sulfide that is amorphous to X-rays. It is reported in Colorado only from the Black King No. 5 claim at Placerville, San Miguel County, where it is partly altered to ilsemannite. Among the associated minerals are uraninite in asphaltite and metatorbernite. (Gruner and Gardiner, 1952.)

JUANITE†

$10CaO \cdot 4MgO \cdot Al_2O_3 \cdot 11SiO_2 \cdot 4H_2O$

Juanite, named for the San Juan Mountains, was first found in the uncompahgrite rock of Iron Hill, Gunnison County (loc. 2). It is a fibrous, nearly white mineral, arranged in sheaflike aggregates about 1 mm long that partly follow cleavage or crystal boundaries. After the original melilite of the rock was partly replaced by vesuvianite and diopside, the remainder was attacked by four or more waves of hydrothermal alteration. The first of these produced abundant juanite Chemical analyses and optical properties are described by E. S. Larsen, Jr. and Goranson (1932); E. S. Larsen, Jr. and Jenks (1942).

KALINITE

[*See* Potash alum]

KALLILITE

[*See* Ullmannite]

KAOLINITE

$Al_2Si_2O_5(OH)_4$

[*See also* Clay minerals, Dickite, *and* Nacrite]

According to Grim (1953), the term "kaolin" is applied to a rock mass composed of clay material that is low in iron and commonly white or nearly white. The species kaolinite is the mineral that characterizes most kaolins, but much of the material formerly called kaolinite has been proved by modern studies (C. S. Ross and Kerr, 1931) to be either dickite or nacrite. As mentioned under the heading "clay minerals," several other species can be distinguished from kaolinite only by very exacting and modern techniques. Most of the older determinations, therefore, are suspect.

Some of the mining districts in which kaolinite or related minerals are prominent in the veins or in altered wallrocks are given below.

In addition to these, kaolinite has been definitely identified by modern methods in sedimentary rocks in Jefferson County, along the Front Range, in the San Juan Basin, and elsewhere. These occurrences are noted under illite.

In south-central Colorado—Las Animas, Huerfano, Custer, Fremont, and El Paso Counties—there are extensive deposits of refractory clays. These are made up chiefly of kaolinite with some quartz and muscovite and a little nontronite and organic matter. (Waagé, 1953.)

Custer County.—Silver Cliff and Rosita districts, Bassick mine. Kaolin is very abundant in this mine, where it is interstitial to the breccia that is marked by concentric shells of sulfides (including jamesonite) and other minerals. (Grabill, 1882.)

Eagle County.—Gilman (Red Cliff) district. Kaolin, not identified specifically, is associated with quartz in most of the veins or lies along vein walls in Precambrian rocks. Much kaolin is also in or near decomposed porphyry bodies that overlie the largest ore shoots in limestone. (R. D. Crawford and Gibson, 1925.)

Gunnison County.—Redwell Basin, Waterfall mine. Large masses of a mineral called kaolin fill a cavern in this mine. Aggregates of galena and pyrite crystals are enclosed by the clay. (Eakins, 1890b—analysis.)

Lake County.—Leadville district. A claylike mineral that is abundant in many deposits and locally called Chinese talc is a variable mixture of sericite, paragonite, potash, and soda alunite and kaolinite. (S. F. Emmons, Irving and Loughlin, 1927.)

Mineral County.—Creede district. Kaolinite or a related mineral is abundant in the oxidized ores where it is associated with cerussite and is an alteration product of both wallrock and gangue minerals (W. H. Emmons and Larsen, 1923.)

Montrose County.—Cashin mine (loc. 1). So-called kaolinite is an abundant gangue mineral in this copper-silver deposit; it encloses masses of native copper. (W. H. Emmons, 1906b.)

Rio Grande and Conejos Counties.—Platoro-Summitville district. Kaolinite (modern identification) is locally abundant in the envelopes of argillized rock that surround bodies of quartz and alunite; illite and montmorillonite, however, are more abundant. (Steven and Ratté, 1960.)

San Juan County.—Silverton and Red Mountain districts. Kaolin minerals are abundant in many mines commonly associated with pyrite and sericite. In the Zuni mine the associates are pyrite, barite, enargite, and zunyite. (Ransome, 1901b.) The material in the National Belle mine at Red Mountain was first described as kaolinite (R. C. Hills, 1884; Whitman Cross and Hillebrand, 1885; Milch, 1908) but was later shown to be exceptionally pure dickite.

KASOLITE

$Pb(UO_2)SiO_4 \cdot H_2O$

Kasolite, a rare silicate of uranium and lead, has been reported from the Two Sisters mine in Eureka Gulch, Central City district, Gilpin County, where it was found in small quantities on the mine dump. The yellowish-brown kasolite forms thin mats of fibers, rosettes, and tabular crystals that coat fractures and partly fill vugs in vein matter and in altered wallrocks. (Sims, Osterwald, and Tooker, 1955.)

Kasolite also occurs in fluorite veins in the St. Peters Dome area, El Paso County (loc. 5). (Wilmarth and others, 1952.)

KATAPHORITE

[*See* Amphibole group, subspecies Arfvedsonite]

KIMOLITE

[*See* Cimolite]

KOBELLITE

$Pb_2(Bi,Sb)_2S_5$

[*See also* Lillianite]

Kobellite, whose identity as a valid species is somewhat doubtful, has been reported from three districts. In at least one of these occurrences the supposed kobellite is a mixture.

Boulder County.—Kobellite is reported from the Moscow mine, Sugar Loaf district, by J. A. Smith (1883) and from the Magnolia district by Dana (1892).

Lake County.—Leadville district, Lillian mine. A high-silver antimony-free "variety" of kobellite later called lillianite and still later found to be a mixture of galena, bismuthinite, and argentite, was described, with analyses, from this mine on Printer Boy Hill. It formed nodules as much as several feet in diameter of fine-grained crystalline steel-gray material. (H. F. Keller and H. A. Keller, 1885; H. F. Keller, 1889a, b; S. F. Emmons, Irving and Loughlin, 1927.)

Ouray County.—Silver Bell mine. Kobellite, whose analysis approximates that of the correct formula, was found with barite and chalcopyrite in an occurrence similar to that of alaskaite. It was massive and finely granular and tended to be fibrous in texture. (H. F. Keller, 1889a, b.)

KRENNERITE

$AuTe_2$

Krennerite, although commonly less abundant than the other gold-bearing tellurides, is nevertheless fairly widespread and at Cripple Creek it is very abundant.

Clear Creek County.—Idaho Springs district, Jewelry Shop mine. Near Idaho Springs krennerite occurs with altaite, coloradoite, petzite, gold, galena, and sphalerite (Lovering and Goddard, 1950.)

Hinsdale County.—Golden Fleece mine. Krennerite is intergrown with aguilarite and contains blades of sylvanite. (W. H. Brown, 1926.)

La Plata and Montezuma Counties.—La Plata district. Small quantities of krennerite occur in contemporaneous intergrowth with other telluride minerals or with native tellurium. (Galbraith, 1949.)

Saguache County.—Bonanza district, Empress Josephine mine. Microscopic quantities of a gold-bearing telluride, possibly krennerite but more probably sylvanite, occur in ore from this mine. (Burbank, 1932.)

Teller County.—Cripple Creek district. The first krennerite to be identified in the United States came from the Independence mine at Cripple Creek. It forms brilliant yellowish-brown crystals, none more than 2 mm in diameter, that resemble arsenopyrite. The crystals are embedded in a thin layer of kaolinlike material on pyritic quartz gangue. Chester (1898) gives an analysis by W. S. Myers and a description of the crystallography by S. L. Penfield. Loughlin and Koschmann (1935) find krennerite with calaverite among the minerals of the second stage of mineralization. Short (1937) presents photographs of etch tests on polished sections of krennerite as well as of calaverite and sylvanite. The external crystallography of well-developed crystals from Cripple Creek is described by Tunnell and Ksanda (1937); results of X-ray study of euhedral crystals from the Moose and Vindicator mines are recorded by Tunnell and Murata (1950). According to A. H. Koschmann (oral communication) krennerite is nearly as abundant as calaverite in the Cripple Creek ores. It is thus one of the most valuable minerals in the State; about $150 million in gold can be credited to it.

KUTNAHORITE

[*See* Dolomite]

KYANITE

Al_2SiO_5

Fremont County.—Texas Creek region. Some of the mica-bearing pegmatites near Texas Creek are in contorted mica and kyanite schist. (Sterrett, 1909, 1923.)

Guffey region (loc. 8). On the north bank of Dicks Creek 2 miles west of Currant Creek, gneiss contains blades of kyanite as large as 2 by 5 cm; they are partly altered to sillimanite. Elsewhere in the area aggregates of small kyanite crystals appear to be pseudomorphs of single crystals of the same mineral. (Bever, 1953; Heinrich and Bever, 1957.)

Routt County.—A lead-zinc vein near Steamboat Springs cuts schist that contains garnet and kyanite. (E. P. Chapman, Jr., written communication.)

LABRADORITE

[*See* Feldspar group, plagioclase series]

LANARKITE

$Pb_2(SO_4)O$

Lanarkite has been reported from four localities in the State, but all of the reports are doubtful. According to J. A. Smith (1883) it was found in ores from South Park, from the Sacramento district in Park County, and from the Tincup district, Gunnison County. In addition bismuth-bearing lanarkite was reported by Guyard from the Florence mine in the Leadville district, Lake County. There it formed dull-black masses as an alteration product of schapbachite (S. F. Emmons, 1886b). S. F. Emmons, Irving and Loughlin (1927) regard this occurrence as doubtful.

LANTHANITE

$(La, Ce)_2(CO_3)_3 \cdot 8H_2O$

A white earthy mineral, probably an alteration product of the bastnaesite and fluocerite (tysonite) near Manitou, El Paso County, is referred by Hidden (1891) to the species lanthanite. The locality is probably either St. Peters Dome or Stove Mountain (locs. 5 and 6). Lanthanite has not been reported elsewhere.

LAPIS LAZULI

[*See* Lazurite]

LAUMONTITE

$(Ca, Na_2)Al_2Si_4O_{12} \cdot 4H_2O$

With other zeolites, laumontite is widespread in cavities of the lava flows that cap North and South Table Mountains at Golden, Jefferson County (loc. 18). It has not been recorded elsewhere in Colorado. The first formal record is that of Whitman Cross and Hillebrand (1882a, 1885) who give chemical analyses and describe it as forming reddish-yellow sandy material and as compact white crystalline masses with other zeolites on North Table Mountain. Additional description is given by Patton (1900). He finds fine-grained laumontite to be the first zeolite to be formed on the floors of cavities, where it is mixed with stilbite. Both minerals also occur as larger crystals that project freely from the upper surface of the cavity floors. Second generations of laumontite and stilbite are noted; in one occurrence, snow-white crystals of laumontite 5 to 10 mm long and 0.5 mm in diameter are perched on a layer of thomsonite.

An additional analysis and new determination of the optical properties are reported by E. P. Henderson and Glass (1933). They describe one specimen in which a sharply defined ¼-inch veinlet of brown thomsonite separates a ¼-inch band of light-brown compact laumontite from sandy golden-brown laumontite in the center of a cavity. Where the thomsonite veinlet is discontinuous the two kinds of laumontite grade into one another. A few spherulites of thomsonite are in the sandy laumontite.

LAVENITE

Complex zirconium silicate of Mn, Ca, and other cations, with F, Ti, Ta

Lavenite has been reported only as an accessory constituent of the phonolite bodies of Cripple Creek, Teller County. It forms minute colorless or pale-yellow needles, either isolated or grouped as pale bundles. (Whitman Cross and Penrose, 1895.)

LAZURITE

$3NaAlSiO_4 \cdot Na_2S$

What is probably the best North American deposit of the beautiful blue gem mineral lazurite, or lapis lazuli, is situated high on Italian Mountain, in Gunnison County (loc. 3). It has not been reported elsewhere. The exact locality has not been reported in the literature, but it is on the west side of North Italian Mountain, 10 miles northeast of Crested Butte. A metamorphosed limestone contains stringers of lapis lazuli as much as 8 inches wide in a vein that is 200 feet long and ranges from a few inches to 10 feet in width. The gem material, which is actually an intergrowth of lazurite with diopside, amphibole, mica, calcite, and pyrite, ranges in color from black to intense blue. The best blue gem material, which lacks the texture and hardness of the classic Siberian gems, comprises only 5 percent of the vein matter. The deposit was discovered in 1939 by Carl Anderson who produced 100 pounds of gem-quality material from the first 15-foot depth of development work. (Rosencrans, 1941; Dozier, 1944; Shaw, 1946.)

LEAD

Pb

Native lead has been reported from several localities, but none of the reports is confirmed. Endlich (1878) reports it from Hall Gulch and from Breckenridge, Summit County, and from near Gunnison, Gunnison County. Newspaper reports recorded the discovery of small nuggets of lead in ore from the Golden Fleece mine, Hinsdale County, and from an unknown locality at Leadville. At the latter place several specimens of galena, partly altered to cerussite and anglesite, contained small quantities of native lead both in the galena and in the oxidized minerals. (Randall.)

Small grains and wires of lead attached to partly decomposed galena were identified by J. A. Smith (1883) in a single specimen from ore shipped from an unnamed vein in the Breckenridge district, Summit County.

LEADHILLITE

$Pb_4(SO_4)(CO_3)_2(OH)_2$

Leadhillite has been reported only once. This was from Leadville, Lake County, where it was associated with lanarkite. (J. A. Smith, 1883; S. F. Emmons, 1886b.)

LEPIDOLITE

$K(Li,Al)_3(Al,Si)_4O_{10}(F,OH)_2$

Lepidolite, the lithium mica, is at least moderately abundant in two districts—the Quartz Creek, or Ohio City district, in Gunnison County, and in the Eight Mile Park area, Fremont County. In addition to these described below, it has been reported from Rito Alto Peak in the Sangre de Cristo Mountains, Saguache and Custer Counties (Endlich, 1878), and from one of the tributaries of the Gunnison River north of Cebolla. At the latter place it forms plates as much as 2 inches in diameter in a pegmatite dike (T. S. Lovering, written communication).

Fremont County.—Eight Mile Park (loc. 4). Lepidolite was described from near Canon City, almost certainly from the Eight Mile Park area, by Schaller (1912). He found it in a pegmatite dike as pink scaly masses, as larger plates, and as indefinite crystalline aggregates of pink to purple material. It was associated with pink tourmaline and fremontite (now called natromontebrasite). Heinrich (1948b), as a result of a more detailed study, found lepidolite only in the Meyers pegmatite quarry as a core-margin replacement mineral. It is associated with beryl, garnet, cleavelandite, muscovite, black, red, and green tourmaline, and a little natromontebrasite and columbite. He found three varieties: (a) abundant flaky, fine-grained, deep-purple material; (b) pale-lilac replacement rims on books of muscovite; and (c) large flat books of very pale lilac color. (See also Hanley, Heinrich, and Page, 1950.)

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). The occurrence of lepidolite in pegmatite bodies of the Brown Derby claims was first described by Eckel (1933a). These and other deposits in the Quartz Creek district have since been much more thoroughly studied and better described by many other workers, notably Hanley, Heinrich and Page (1950) and Staatz and Trites (1955). In addition to descriptions of the deposits, mineralogic studies and chemical analyses of the lepidolite have been given by R. E. Stevens (1938), A. N. Winchell (1942) and others.

Several hundred tons of lepidolite have been produced from the district and the reserves are large. Staatz and Trites found lepidolite in 17 of the pegmatite dikes in the district; it ranges in color from white through lilac to shades of purple and occurs as fine-grained aggregates, as large platy books from 2 to 10 inches in diameter, and as smaller curved concentric books. Only in the Brown Derby No. 1 are there rock units that contain more than 10 percent lepidolite, but here it is as much as 95 percent in places. Much of the finer grained lepidolite contains blebs of microlite, erroneously called samarskite by Eckel (1933a) but later correctly identified (Eckel and Lovering, 1935). Among the associated minerals are white, pink, blue, and green beryl, white topaz in huge crystals as much as 2 feet long, and many-colored tourmaline, some in crystals as much as 1 foot long.

LEUCITE

$KAl(SiO_3)_2$

The only reported occurrence of leucite that has come to my attention is that at Cripple Creek, Teller County. It was also reported at

Table Mountain, Jefferson County (loc. 18), by Endlich (1878) but this was probably a mistaken identification of one or more of the zeolite minerals, as it has not been reported since despite a large number of mineralogic studies of the Table Mountain zeolites and associated minerals.

At Cripple Creek there are small bodies of leucitophyre, thin sections of which show zeolites with octagonal, square, or hexagonal outlines as much as 0.5 mm in diameter. Lindgren and Ransome (1906) believe that the original mineral, since altered to zeolites, was leucite.

LEUCOXENE

[*See* sphene]

LEVERRIERITE

[*See* Beidellite]

LEVYNITE

$CaAl_2Si_2O_{10}\cdot 5H_2O$

Levynite, one of the rarer zeolites, has been reported from only one locality and there by only one of the many authors who have studied its minerals. On North Table Mountain, Jefferson County (loc. 18), levynite occurs with other zeolites as small white and colorless crystals. Associated with it is a dull-white fibrous unidentified mineral that is almost identical in composition with levynite. Whitman Cross and Hillebrand (1885) give analyses of both minerals.

LIEBIGITE

$Ca_2U(CO_3)_4\cdot 10H_2O$

Liebigite, with becquelerite-schoepite and uranophane, was identified in ore from the G–6 shaft in sec. 17, T. 6N., R. 94 W., Browns Park, Moffat County. (Gruner and Knox, 1957.)

LILLIANITE†

$Pb_3Bi_2S_6$

The new name lillianite was applied by H. F. Keller (1889a, b) to a mineral from the Lillian mine on Printer Boy Hill, Leadville district, Lake County, which he and H. A. Keller had earlier (1885) described as a high-silver antimony-free variety of kobellite. The type specimens of lillianite were later found to be mixtures of galena, bismuthinite, and argentite, but minerals that are very close, in chemical composition and other characteristics, to Keller's original description of lillianite have been found in many other places in Colorado and elsewhere. Lillianite, therefore, although based on erroneous identification, will probably continue to stand as a valid species.

In addition to the questionable "type" material from Leadville, lillianite has been reported from two other Colorado localities.

Hinsdale County.—White Cross-Hurricane Basin district. Lillianite has been observed in polished sections of ores from the Monticello and other mines near the mouth of Cleveland Gulch. The order of deposition as determined by microscopic study is pyrite, chalcopyrite, sphalerite, and galena. (W. H. Brown, 1926.)

San Juan County.—Silverton district. Lillianite was found by W. H. Brown (1927) in polished sections of ore from the Sultan mine, which adjoins the Alaska mine, the type locality for alaskaite. It was associated with alaskaite, sphalerite, tetrahedrite, covellite, and pyrite.

LIMONITE

[*See also* Goethite]

Although so-called limonite is actually a mixture of goethite, hematite, turgite(?), and other iron oxide minerals with varying amounts of water, few occurrences have been studied sufficiently to determine these species. It is therefore necessary to treat limonite as a species and record the occurrences that have been ascribed to it.

Limonite is exceedingly widespread and locally abundant. One of the principal products of oxidation of iron-bearing minerals, whether in ore deposits or in rocks, it is responsible for much of the red and brown coloration of surface rocks and soils throughout the State. In and near ore deposits some limonite is pseudomorphic after pyrite or other iron-bearing minerals. Only a few of its innumerable occurrences can be given here.

Boulder County.—Nederland tungsten area. Limonite occurs in the oxidized parts of many veins, where it is probably derived from specular hematite or iron-bearing carbonate minerals. Much of it coats or fills cracks in crystals of ferberite. (Hess and Schaller, 1914.) Lovering and Tweto (1953) found that most of the so-called limonite here is actually goethite, but they also found some hematite and some unspecified iron hyroxides of both hypogene and supergene origin.

Chaffee County.—Sedalia mine (loc. 5). Limonite is one of the most abundant minerals in the ore from this old copper mine, which is also noted for the presence of "Salida" garnets, corundum, and many other minerals. (Lindgren, 1908.)

Chaffee County.—Monarch district. Brown limonite, with less of the yellow ocherous variety, is present in nearly every ore body and much of it contains some silver. Pyrite commonly is altered to limonite. Very large bodies of limonite characterize the Madonna mine. (R. D. Crawford, 1913.)

Dolores County.—Rico district. Large bodies of limonite, some containing valuable amounts of gold or silver, are present on C. H. C. Hill, where they result from oxidation of massive pyrite. (Ransome, 1901a.)

Eagle County.—Gilman (Red Cliff) district. In the Black Iron mine, limonite is the final product of alteration of pyrite; melanterite, which itself alters to jarosite and other sulfates before oxidizing to limonite, is the chief intermediate product. (S. F. Emmons, 1886a.)

In other parts of the Red Cliff district limonite is present in nearly all the sulfide ores. It commonly contains some gold, silver, and copper and forms the best silver ore in the deep mines in limestone. Good pseudomorphic crystals, both cubes and pyritohedra, are common especially in bodies of massive pyrite. (R. D. Crawford and Gibson, 1925.)

Gunnison County.—Tomichi district. Limonitic gossan marks the outcrops of many ore bodies. On Galena Creek 1 mile southeast of the Iron King mine and in the sedimentary rocks three-fourths of a mile west-northwest of Granite Mountain it is intimately associated with magnetite. On the northeast slope of Lake Hill it forms fine cubes, ¼ to 2 inches in diameter that are pseudomorphic after pyrite. About 1½ miles above Whitepine, and near Tomichi Creek, there is a 3-foot-thick body of bog ore, principally limonite; some of the limonite replaces pine needles and other organic matter. (Harder, 1909; Crawford, 1913.)

Powderhorn district. Four miles northwest of Powderhorn Hill an opencut entirely in limonite was 15 feet long, 6 feet wide, and 3 feet deep. The ore contained 38.86 percent iron, 0.20 percent P_2O_5, and was high in silica. (Chauvenet, 1887.)

Lake County.—Climax district. Limonite occurs as yellow to reddish-brown stains on the surface rocks throughout the mineralized area. Where the rocks are massive it forms only thin surface films but along fractures it extends to some depth. The limonite is derived from oxidation of pyrite. (B. S. Butler and Vanderwilt, 1933.)

Leadville district. Mixtures of limonite, goethite, and turgite with manganese oxide minerals are abundant in the oxidized ores. Much of the limonitic material is derived from pyrite or ferruginous sphalerite, but nearly as much comes from siderite and some from magnetite and the rock-forming minerals. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata and Montzuma Counties.—La Plata district. Limonite and possibly goethite are present in the outcrops of many of the veins where they are derived from both pyrite and siderite. Small bog-iron deposits, in which the limonite is deposited from iron-bearing water, occur in Rush Basin, at the head of the East Mancos River, and near the town of La Plata. The latter deposit also contains native copper. (Whitman Cross, Spencer, and Purington, 1899; Galbraith, 1949.)

Larimer County.—Limonite that is pseudomorphic after marcasite is common along the contact between the Benton and Niobrara formations and in the marcasite horizon of the Niobrara. (R. G. Coffin, written communication, 1932.)

Mesa County.—Unaweep district. Malachite and limonite are the chief oxidation products in the copper-bearing ores. (B. S. Butler, 1915.)

Mineral County.—Creede district. Limonite is present in all vein outcrops, but is nowhere abundant. Because pyrite is scarce in the Creede deposits, most of the limonite is derived from the abundant thuringite. (W. H. Emmons and Larsen, 1923.)

Park County.—Weston Pass district. It is very common in massive or earthy form or as cubes pseudomorphic after pyrite. (Behre, 1932.)

Park and Summit Counties.—Montezuma district. Limonite and goethite, with some turgite, are abundant in the oxidized ores throughout the district. Large bog-iron-ore deposits composed largely of limonite and goethite, occur along Geneva and Handcart Gulches, Hall Valley, and the Snake River. In all these deposits, slope wash and ground moraines are cemented with the limonitic materials to depths of 20 feet or more. The material is too impure to be used as iron ore, but some was used as flux in the Hall Valley and Geneva Gulch smelters during the 1870's. (Chauvenet, 1886, 1890; Lovering, 1935.)

Rio Grande and Conejos Counties.—Summitville district. Limonite is very abundant, and is especially important because it contains most of the gold in the bonanza ores. The gold is believed to have been dissolved and reprecipitated from ferric sulfate-bearing water. (Patton, 1917.)

Saguache County.—Bonanza district. Limonite, mostly derived from pyrite, is common in all veins. In the southern part of the district thorough oxidation to limonite and manganese oxides extends to a depth of several hundred feet. (Burbank, 1932.)

Orient mine. The Orient mine on the west slope of the Sangre de Cristo Mountains and about 8 miles southeast of Villa Grove contains the only known commercial body of limonitic iron ore in Colorado. Discovered in 1880, it produced nearly 2 million tons of ore between 1880 and 1931. Limonite (possibly chiefly goethite) is the only ore mineral, and is derived from rich iron carbonate replacement bodies in limestone. The ore bodies are irregular lenses or pipes, most of them elongate parallel to the bedding. The highest grade ore, which had an average content of about 43 percent iron, is hard and cavernous or slaglike but there is some soft yellow-ocher and massive red ore and a little specular hematite. (Putnam, 1886; J. B. Stone, 1934.)

Summit County.—Breckenridge district. Limonite is present in the oxidized parts of all the ore deposits. It is of special interest as the principal matrix of much of the crystallized gold from Farncomb Hill. (Ransome, 1911.)

LIONITE*

[*See* Tellurium]

LITHARGE

[*See* Massicot]

LITHIOPHILITE

$Li(Mn,Fe)(PO_4)$

[*See also* Triphylite]

Lithiophilite, a lithium phosphate in which there is more manganese than iron, forms a complete isomorphous series with triphylite, in which iron exceeds manganese. Members of the series have been found in several pegmatite bodies in Colorado; in only one instance has the place of the mineral in the series been identified. This is a triphylite occurrence at the Burroughs mine, Jefferson County (loc. 4).

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). Three crystals of lithiophilite-triphylite with alteration products have been found in the Bucky pegmatite. (Staatz and Trites, 1955.)

Larimer County.—Lithiophilite-triphylite has been found in four pegmatites in the Crystal Mountain district (loc. 1). In the Hyatt beryl mine (loc. 2) it is associated with purpurite and uranium minerals in lenticular patches in the intermediate zone—commonly in albite-rich parts of the zone. (Hanley, Heinrich, and Page, 1950.) In the upper inner intermediate zone it is medium blue and forms blocky masses with quartz, pyrite, and lithia mica. In the lower inner intermediate zone it is cinnamon brown. (Thurston, 1955.)

LOELLINGITE

$FeAs_2$

Loellingite has been authentically described from 1 locality and noted in 3 others, all of them vaguely defined. These are San Juan County (Dana, 1892), Spanish Bar (Endlich, 1878) and the Whale mine (J. A. Smith 1883). The Whale was one of the mines in the old Spanish Bar district, now part of the Idaho Springs district, Clear Creek County; possibly these two localities are the same. In the Whale mine, fine specimens rich in silver were identified by J. A. Smith (1883) as loellingite.

The best known deposit is the Elk Mountains, Gunnison County. There the Luona, Horace Porter, and American Eagle mines on Teocalli and White Rock Mountains at the head of Brush Creek contain loellingite, some of it in specimens that weigh several pounds each. Associated minerals are smaltite, marcasite, galena, chalcopyrite, pyargyrite, argentite, proustite, and native silver in a gangue of calcite, siderite and barite. The loellingite, which contains appreciable quantities of nickel and cobalt, commonly forms dense radiating masses, but more rarely forms very minute simple trillings and single crystals. Much of it is altered to erythrite. Hillebrand (1884) and Whitman Cross and Hillebrand (1885) give analyses. The relationship of the loellingite to the reported smaltite and skutterudite from the same mines is not clear.

LORANDITE

[*See* Thallium minerals]

LUZONITE

[*See* Famatinite]

MAGNESIOHASTINGSITE

[*See* Amphibole group, hastingsite species]

MAGNESITE

$MgCO_3$

Magnesite has been reported only once. This is from the Griffith mine, Georgetown district, Clear Creek County, where a little of it is associated with a mixture of gold and silver minerals that probably include hessite and argentite. (Pearce, 1896.)

Although rare as a pure magnesium carbonate, the magnesite molecule is very widespread and extremely abundant as a constituent of dolomite and other carbonate rocks and vein fillings in many parts of the State.

MAGNETITE

Fe_3O_4

Magnetite is an accessory mineral in nearly all igneous and metamorphic rocks and is also very widespread in small quantities in most clastic sedimentary rocks. It is present in most pegmatite bodies and locally occurs as well-formed cubic and octahedral crystals or large masses. It is the principal constituent of the black sands recovered from placer deposits and is present in nearly all alluvial materials and soils. In addition to such occurrences, none of which are given here, magnetite is an important mineral in many veins and contact deposits and forms an ore of iron in a few of them. Only its most important or interesting occurrences are described below.

Boulder County.—Caribou district. Caribou Hill, 3 miles northwest of the Cardinal railroad station contains a large quantity of titaniferous magnetite as veinlike segregations in granite and gneiss that are intruded by mafic rocks. The ore lenses are small but where these are close together they form a good medium-grade iron ore which also may contain 3 to 5 percent TiO_2. In addition to magnetite and ilmenite the ore contains pyroxene, frequently altered to serpentine, and inclusions of spinel. The ilmenite forms small particles scattered through the magnetite and some specimens contain as much as 36 percent TiO_2. (Chauvenet, 1886, 1890; J. T. Singewald, Jr., 1913.)

Chaffee County.—Turret district, Calumet mine (loc. 2). Magnetite and intergrown specular hematite are the chief ore minerals in this commercial iron-ore deposit. Between 1882 and 1899 it produced 229,000 tons of ore, which dropped gradually in grade from 60 to 43 percent metallic iron. The deposit is in limestone near the contact with granodiorite. Diopside is the chief silicate, but epidote, garnet, biotite, wernerite, tremolite, and actinolite are also present. The ore contains a little pyrite and chalcopyrite. (Behre, Osborn, and Rainwater, 1936.)

Monarch district. In addition to its presence in several metalliferous veins, magnetite forms a vein 2 to 3 feet wide that crops out just east of Boss Lake. (Crawford, 1913.)

Clear Creek County.—Georgetown quadrangle. In places, magnetite comprises as much as one-third the volume of some pegmatite bodies, where it occurs as crystals as much as 4 inches in diameter. (Bastin and Hill, 1917.)

Costilla County.—Grayback district. Magnetite, which contains disseminated coarse plates of specular hematite, is the chief ore mineral in the large iron-ore deposits of the district. These deposits, developed by several mines, are on the west slope of Grayback Mountain in Carboniferous limestone at or near its contact with monzonite porphyry. The ore contains variable but small amounts of calcite, garnet, epidote, gold, and other minerals. (Patton, 1910.)

Dolores County.—Rico district. Magnetite occurs in some quantity in the Magnet prospect on the north side of Darling Ridge and in the Eagle prospect near the head of Sulfur Creek, where it has been mined for smelter flux. It occurs, with some chalcopyrite and a little gold and silver, as massive replacements of limestone. (Ransome, 1901a.)

Fremont County.—Iron Mountain (loc. 7). The first sizeable deposit of iron ore to be found in Colorado is that of Iron Mountain, 12 miles southwest of Canon City. The average ore contains about 48 percent Fe and 13 percent TiO_2; individually and collectively the ore bodies are small and comparatively little ore has ever been produced. Magnetite and ilmenite occur as segregations 10 to 50 feet wide in a large mass of gabbro. The gangue minerals are those of the host rock—augite, olivine, feldspar—as well as many inclusions of green spinel. (Putnam, 1886; J. T. Singewald, Jr., 1913.)

Gunnison County.—North Italian Mountain (loc. 3). Massive granular magnetite is abundant; it contains many small cavities that are filled with pearly talc or are lined with small sulfur-yellow garnets. (Whitman Cross and Shannon, 1927.)

Cebolla district (loc. 2). Highly titaniferous magnetite, which contains as much as 36 percent TiO_2 as intergrown ilmenite, occurs in fairly large bodies as segregations in mafic igneous rocks or in contact-metamorphic deposits in limestone. In the mafic rocks, dark-brown mica and pyroxene that varies in quantity inversely with the grade of the ore, are the chief gangue minerals. Calcite, augite, garnet, zoisite, and vesuvianite are the chief gangue minerals in the contact deposits, which are noteworthy because of the presence of ilmenite. Some of the ore contains much specular hematite and siderite. (Chauvenet, 1897; J. T. Singewald, Jr., 1912, 1913.)

Whitepine (Tomichi) district, Taylor Peak.—Magnetite is the chief ore mineral in contact-metamorphic deposits along the contacts between diorite or granite and beds of limestone; in the Iron King mine, 12 miles from Sargents, there is enough to be workable as iron ore. The magnetite, which locally contains enough pyrite to be detrimental, is associated with calcite, quartz, kaolin, siderite, and several silicate minerals, including chlorite, epidote, and garnet. The Iron King ore body is about 70 feet thick. Forty feet of this is minable; the remainder yields good ore by selective mining. It contains streaks of quartz, a few copper stains, and very little pyrite. Ilmenite, and hence TiO_2, is absent and phosphorus is very low. (Chauvenet, 1897; Harder, 1909; Crawford, 1913.)

Lake County.—Leadville district. Magnetite forms large irregular masses as much as 300 by 80 by 80 feet and has been mined extensively for smelter flux. Most of it is fine to medium grained and massive, but well-formed crystals are present where residual spots of manganosiderite, which is replaced by magnetite, are abundant. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata and Montezuma Counties.—La Plata district. The La Plata limestone, of local usage, on the northeast slope of Diorite Peak is entirely replaced by massive magnetite over a large area. Near the heads of Boren and Bedrock Gulches smaller replacement bodies of magnetite at the same stratigraphic horizon have strong lodestone qualities in place, but lose this property when magnetite is broken from the outcrop. (Galbraith, 1949.)

Park County.—Tarryall Creek. Magnetite is the predominant mineral in veins and contact-metamorphosed sediments with garnet, epidote, calcite, and pyrite. Most of it is massive but there are some well-formed octahedra. Most of the gold and silver in the ore is associated in the magnetite. (Q. D. Singewald, 1942.)

Park and Summit Counties.—Montezuma district. Magnetite is a major constituent of the contact-metamorphic deposits in the southwestern part of the district. Associates are garnet, epidote, quartz, hematite, and tremolite. (Lovering, 1935.)

MAGNOLITE*

Hg_2TeO_4(?)

A qualitative analysis of magnolite led to a supposed formula of Hg_2TeO_4; it was named for the Magnolia district, Boulder County, where it was found in the Keystone mine. It has since been discredited and is listed here only because it is in the literature.

A decomposition product of the mercury telluride coloradoite, the so-called magnolite forms silky radiating tufts of very minute acicular white crystals, associated with quartz, native mercury, limonite, and psilomelane. (Genth, 1877.) J. A. Smith (1883) notes the mineral from the American mine, also in Boulder County.

MALACHITE

$Cu_2(OH)_2(CO_3)$

Malachite, the beautiful green carbonate of copper, occurs as stains, films, veinlets, and botryoidal masses in the oxidized parts of virtually all ore deposits that contain primary copper minerals. Although malachite and the blue azurite with which it is often associated are striking because of their brilliant colors, they seldom occur in sufficient quantity to constitute an ore of copper. Small but showy specimens can be collected in many districts, but nowhere has anything been found that is comparable to the well-known specimens from Siberia and from Bisbee, Ariz., and other places. Not all of the known occurences are given here.

Boulder County.—Ward district. Malachite and azurite derived from chalcopyrite are present at Copper Rock. (Worcester, 1920.)

Clear Creek County.—Small but fine mammillary specimens have been obtained in the Kelly and Champion mines on Trail Run. (Hollister, 1867.)

Chaffee County.—Sedalia mine (loc. 5). Malachite is second in importance to chalcocite as an ore mineral in this relatively small copper producer that is notable not only for its supposed Precambrian age but for the occurrence of "Salida" garnets. Most of the ore is comprised of limonite, malachite, cuprite, and chalcocite, and scattered residual chalcopyrite. Many other minerals are in the ore itself or in the enclosing amphibolite. (Lindgren, 1908.)

Monarch district. Malachite is present in nearly all the copper-producing mines, especially the Lilly and the Madonna. With other oxidation minerals of copper, it is disseminated as replacements through limestone in sufficient quantity to constitute workable ore in many places. (R. D. Crawford, 1913.)

Costilla County.—Grayback district. Malachite stains mark the outcrops of the chalcocite-chalcopyrite deposits along the contact between Precambrian rocks and younger sedimentary rocks. (Patton, 1910.)

Fremont County.—Red Gulch. Chalcocite is the chief ore mineral in the Red Gulch deposits of Precambrian age, 9 miles north of Cotopaxi, but both malachite and azurite are also present. In the nearby deposits at Springfield, chalcocite, with the green and blue carbonates, occurs in compact bituminous shale, where it is intimately associated with coal. (Lindgren, 1908.)

Gunnison County.—Gold Brick district. Malachite ore of commercial grade occurs near the surface on the Bornite claim; 1 mile northeast of Henry Mountain a pegmatite dike exposed in a cliff face is coated with malachite. (R. D. Crawford and Worcester, 1916.)

Tomichi district. Malachite is widespread in the district and occurs in large amounts as veinlets and impregnations on Copper Hill, especially on its northwest slope. (Crawford, 1913.)

Jefferson County.—Cressman Gulch (loc. 6). Malachite occurs as thin coatings on the minerals of a pegmatite body, that is opened by a quarry. (G. R. Scott, written communication.)

Malachite mine (loc. 9). As would be suspected from the name, malachite is relatively abundant in the ore of this mine, where it is associated with cuprite, chalcopyrite, and several silicate minerals. No well-crystallized specimens can be found, however. (Hollister, 1867.)

Lake County.—Leadville district. Considering the amount of limestone and copper minerals in the district, malachite is surprisingly rare. It forms films and crusts in fractured porphyry and is mixed with manganese and iron oxides in the upper parts of many ore deposits, but only in small quantities. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata and Montezuma Counties.—La Plata district. Stains of malachite and azurite are present in the oxidized parts of most copper-bearing deposits. (Galbraith, 1949.) Near the head of Bedrock Creek and on the divide between that creek and the East Mancos River, native copper occurs as leaves in seams and cracks and many veinlets contain chalcocite, azurite, malachite, and chalcopyrite. (Toll, 1908.)

Mesa County.—Unaweep Canyon. Limonite and malachite are the chief oxidation products of the Unaweep copper deposits. (Endlich, 1878; B. S. Butler, 1915.)

Montrose County.—Cashin mine (loc. 1). Stains of malachite and azurite occur with some more massive material in and around this typical copper-silver deposit of the "red-bed" type. Chalcocite, native copper, and native silver are more abundant than the carbonates. (W. H. Emmons, 1906b; R. C. Coffin, 1921.)

Moffat County.—Blue Mountain. The carnotite deposits of Blue Mountain, 15 miles north of Rangely, contain malachite, azurite, a copper selenide, and several vanadium and uranium minerals. (Gale, 1908.)

Park and Summit Counties.—Montezuma district. Malachite is more conspicuous than abundant in the oxidized copper ores, where it forms thin crusts on outcrops and thin veinlets in the ores. (Lovering, 1935.)

Saguache County.—Bonanza district. Malachite forms superficial coatings and tufts near the outcrops of ore bodies. Azurite and chrysocolla are probably present with malachite under similar conditions, but none of these materials are of any importance except as indicators of copper ore. (Burbank, 1932.)

MALLARDITE

$MnSO_4 \cdot 7H_2O$

Mallardite has been reported only once. It occurs as an efflorescence in the Moon Anchor mine, Cripple Creek district, Teller County, and was shown by analysis to contain 2.55 percent MgO and traces of nickel. (Lindgren and Ransome, 1906.)

MANGANESE OXIDES

[*See* Wad]

MANGANIAN FLUORAPATITE

[*See* Fluorapatite]

MANGANITE

MnO(OH)

[*See also* Wad]

Manganite has been reported from very few localities in the State. It is possibly much more widespread than these reports indicate but has been included in general descriptions of mixtures of manganese oxides. Much reported manganite proves to be pyrolusite on careful examination.

Douglas County.—Devils Head Mountain (loc. 1). Loose radiating crystals of manganite were found in a pocket that also contained microcline, quartz, and fluorite. (J. A. Smith, 1883.)

Larimer County.—Caverns in the Ingleside formation at Pinon Pines contain some manganite. (R. G. Coffin, written communication.)

Saguache County.—Bonanza district. Manganite has not been identified anywhere in the district. Prismatic crystals of pyrolusite in the Pershing vein, however, seem to be pseudomorphic after manganite. (Burbank, 1932.)

San Miguel County.—Cedar area. Small replacement deposits of manganese oxides occur in brown sandstone at the south end of the basin at the head of a gulch that drains into Disappointment Creek. Manganite forms needlelike crystals, one-fourth of an inch long, or short prismatic crystals in granular aggregates. Some of the larger cavities are lined with needles of manganite, with crystals of barite in their centers. Pyrolusite is a minor constituent of the ore bodies. (Jones, 1920.)

MANGANOPHYLLITE

[*See* Biotite]

MANGANOSIDERITE

[*See* Rhodochrosite]

MARCASITE

FeS_2

Marcasite, a dimorph of pyrite, has been reported from comparatively few ore deposits, where it is commonly rarer than pyrite and denotes either primary or supergene deposition at relatively low temperatures. The mineral has been noted as secondary concretions or veins in very few sedimentary rocks; it is much more widespread and abundant in shale, coal, and other rocks than the record indicates.

Boulder County.—Nederland tungsten district. Marcasite and pyrite are widely distributed in the tungsten veins but commonly occur in minor quantity.

Marcasite is commonly the earliest sulfide mineral in the veins. (Lovering and Tweto, 1953.)

Clear Creek County.—Marcasite is reported as nodules in a lode on Clear Creek. (Randall.)

Delta County.—Gunnison Forks sulfur deposit (loc. 1). Marcasite and pyrite are the only metallic minerals seen in this low-grade deposit of native sulfur. Marcasite was found in a single fissure, 1 to 2 inches wide, in a quarry near the gas seep. It forms radiating fibrous layers and botryoidal nodules associated with plates of gypsum. Crystals of sulfur line cavities and coat the marcasite-gypsum mixture. (Dings, 1949.)

Gilpin County.—Marcasite is reported as a rare associate of pyrite in many gold mines in the county. (Randall.)

Hinsdale County.—Carson Camp. Marcasite is very common as the last mineral to form in the veins. It coats all the earlier minerals—enargite, barite, galena, sphalerite, and others. (E. S. Larsen, Jr., 1911.)

La Plata and Montezuma Counties.—La Plata district, Saxon mine. Gold-bearing marcasite is reported from a pyritic ore body in this mine by Whitman Cross, Spencer and Purington (1901). It was found, with chalcedony, in only one of the many polished sections of ore examined by Galbraith (1949) and is evidently rare in the district.

Larimer County.—Large crystalline concretions occur in the Niobrara formation west of Round Butte, north of the entrance to Campbell Springs Draw, and northwest of Rodger's ranch. Flat concretions, many of them with earthy surfaces, are common in the Niobrara in many places and have also been found in the Fox Hills formation north of Windsor Reservoir in sec. 27, T. 7 N., R. 67 W. (R. G. Coffin, written communication.) Similar concretions have been reported from the Niobrara and Fox Hills formations in other parts of the State and are probably very widespread.

Las Animas County.—Near the town of Thatcher, the base of the Timpas limestone contains many rough nodules of marcasite. (Diller, 1899.)

Mineral County.—Creede district. Marcasite is nowhere abundant but it forms crusts on fragments of rhyolite in breccia; it seems to represent a late stage of hypogene mineralization, but may be of secondary origin. (W. H. Emmons and Larsen, 1923.)

Park County.—The Ruby mine on Lincoln Gulch contains some maracasite nodules altered to turgite and goethite. The ore minerals are sulfides of lead, zinc, copper, and silver and their oxidation products. (E. P. Chapman, Jr., written communication.)

Routt County.—Hahns Peak district. Marcasite characterizes many of the gold-bearing veins. (George and Crawford, 1909.)

Saguache County.—Marcasite is associated with pitchblende in the uranium vein deposits in the Los Ochos or Cochetopa district (loc. 2). (Mahan and Ranspot, 1959.)

San Juan County.—Needle Mountains. Marcasite, with petzite, tetrahedrite, and other metallic minerals occurs in small quantities in a quartz-calcite-barite gangue. It has been mistaken for tellurides by miners. (Whitman Cross, Howe, Irving and Emmons, 1905.)

Summit County.—Tenmile district. In the Robinson mine, marcasite impregnates sandstone in the roof of a limestone-replacement ore body. Either pyrite or marcasite is also noted in mines of the Quail group. (S. F. Emmons, 1898.)

Teller County.—Cripple Creek district. Crystalline growths doubtfully identified as marcasite occur as crusts on dolomitic vein material in Stratton's Independence mine. (Lindgren and Ransome, 1906.)

MARIALITE

[*See* Scapolite group]

MARIPOSITE

Mariposite, a potassium-magnesium mica that differs from alurgite mainly in being green instead of red, has been reported from several places in western Colorado. At Placerville, San Miguel County, the roscoelite-bearing sandstone grades both laterally and vertically to green mariposite-bearing sandstone. Hess (1913b) believes that roscoelite and quartz were deposited first, followed by mariposite at lower temperatures, but that all three minerals are primary and of hydrothermal origin. In his studies of material from the same locality, Fischer (1937) found that the indices and possibly also the birefringence seemed lower than those of typical mariposite. See also Fischer, Haff, and Rominger (1947).

Kerr, Rasor, and Hamilton (1951) studied the Placerville material, and, finding that it contained chromium as an essential constituent, called it fuchsite (see muscovite, var. fuchsite). Later, however, Kerr and Hamilton (1958) restudied the same material and decided that it is more properly classified as a chrome mica-clay.

R. P. Fischer (oral communication) has noted similar layers of mariposite(?)-bearing sandstone in the Entrada sandstone at four other localities. These are along Lightner Creek, La Plata County; east of Rico, Dolores County; east of Delta, Gunnison County; and near Rifle, Garfield County. In all except the Delta occurrence, roscoelite-bearing beds are nearby.

MARMATITE

[*See* Sphalerite]

MASSICOT

PbO

Massicot has been reported from the Leadville district, Lake County, where it occurred sporadically in the more ocherous varieties of oxidized lead ores. (S. F. Emmons, Irving, and Loughlin, 1927.)

It is also reported as an oxidation product of galena in the Rico district, Dolores County. (Schrader, Stone, and Sanford, 1916.)

Although litharge has never been reported in the Leadville and Rico districts, it may occur in these localities because it is commonly a paramorph of massicot.

MATILDITE

$AgBiS_2$

[*See also* Alaskaite]

Matildite has been reported as such from only one locality—Lake City, Hinsdale County—but schapbachite, since found to be a mixture of matildite and galena, hence discredited as a species, has been reported from several other localities. All are reported here as matildite. As noted under the description of alaskaite, the type material of alaskaite, now discredited, is a mixture of matildite, aikinite, and other minerals. Possibly some of the other reported occurrences of supposed alaskaite are also more correctly referable to matildite.

Clear Creek County.—"Schapbachite" is reported from near Georgetown. No details or confirmation are available. (Endlich, 1878; J. A. Smith, 1883.)

Eagle County.—Gilman district. Late silver minerals in vugs of the copper-silver chimney deposits include freibergite, polybasite, stromeyerite, bournonite, and "schapbachite." (Tweto and Lovering, 1947.)

Hinsdale County.—Lake City district. Matildite occurs as needle-shaped deeply striated black crystals 1 mm thick and 10 to 25 mm long that penetrate granular quartz. Massive soft matildite is also noted, but the mine or mines from which the specimens came are not recorded. (Genth, 1886—analysis.)

Lake County.—Leadville district. There have been several reports of "schapbachite" from mines at Leadville. Some of the material was found by S. F. Emmons, Irving, and Loughlin (1927) to be a mixture of argentite, bismuthinite, and galena. Chapman (1941) examined specimens of supposed schapbachite which occurred as coatings on galena crystals from the 10th level of the Tucson mine. He found the material to be a microscopic mixture of hessite, with bismuth-bearing altaite and native gold. The existence of matildite, or "schapbachite," at Leadville is thus still to be established.

Ouray County.—Camp Bird mine. Matildite has been seen in polished sections of ore from this mine. (W. S. Burbank, written communication.)

Park and Summit Counties.—Montezuma district. Matildite or "schapbachite" may possibly be present in the bismuth ores of the Grand Trunk and nearby veins at the head of Geneva Gulch. An analysis of some of the ore shows it to be very close to this mineral in composition, but none was actually seen by Lovering (1935).

MEIONITE

[*See* Scapolite group]

MELACONITE

[*See* Tenorite]

MELANOVANADITE

$Ca_2V_4^{+4}V_6^{+5}O_{25}$

Melanovanadite with corvusite, hewettite, pascoite, and hummerite is among the oxidation products of montroseite. As such it has been identified in ore from the type locality of montroseite—the Bitter

Creek mine, Montrose County, and it possibly occurs in other deposits that contain that mineral. (Weeks, Cisney and Sherwood, 1953.)

MELANTERITE

$FeSO_4 \cdot 7H_2O$

[*See also* Pisanite]

Melanterite, some of which contains copper or zinc and can be classed as cuprian melanterite or zincian melanterite, has been reported from comparatively few mining districts, but is abundant in some of these. It is far more widespread as a postmining efflorescence than the record indicates and is likely to be found in any relatively dry mine whose ore contains pyrite.

Chaffee County.—Sedalia mine (loc. 5). Melanterite, chalcanthite, and other sulfates and carbonates are in the mine workings from which the well-known "Salida" garnets can be collected. (J. W. Adams, written communication.)

Eagle County.—Gilman (Red Cliff) district. Clear-green crystals and large masses of melanterite, which alters rapidly to basic ferric sulfates and jarosite on exposure, result from the oxidation of pyrite in the Black Iron mine. Oxidation of the ore begins with galena which alters completely to anglesite leaving a friable mass of pyrite, which only then begins to alter to melanterite. In the Ben Butler mine the melanterite occurs as hollow stalactites, many with well-formed crystals on their outer surfaces. (S. F. Emmons, 1886b.)

Melanterite(?) in aggregates of green to bluish-green poorly formed crystals occurs on the walls of a crosscut in the Eagle No. 2 ore body. Although ascribed to coquimbite or copiapite by R. D. Crawford and Gibson (1925), their description seems to better fit melanterite.

Gilpin County.—Central City district. Melanterite can be found on the dumps of many mines. (J. A. Smith, 1883.) A discussion of the mixed sulfates found in this and nearby districts is given by Bastin and Hill (1917).

Gunnison County.—Good Hope and Vulcan mines (loc. 5). These mines, noted as the type locality of the copper tellurides rickardite and weissite, contain a large body of pyrite, with chalcopyrite and sphalerite. Thin seams of quartz that contain gold and the telluride minerals occur in the walls of the pyritic body. The pyrite is extensively altered to melanterite which contains measurable quantities of both zinc and copper. (E. S. Larsen, Jr., and Glenn, 1920.)

Hinsdale County.—Lake City district. Melanterite is present but rare in the district because the mines are too wet to permit its retention. (Irving and Bancroft, 1911.)

Jackson County.—Northgate district (loc. 1). Melanterite is one of the minerals that is associated with the ilsemannite that forms on the mine walls and dump material of the Western Fluorspar Corp. mine. (Goldring, 1942.)

Lake County.—Leadville district. Melanterite is abundant as an efflorescence in mine workings within the sulfide zone. It is much less abundant in the oxidized zone, which is characterized by ferric oxides and sulfates. (S. F. Emmons, Irving, and Loughlin, 1927.)

In the Greenback mine, E. P. Chapman, Jr. (written communication) has noted separate deposition of iron and copper sulfates (melanterite and chalcanthite) from the same solutions. The melanterite was deposited on pyrite in the ore, whereas chalcanthite formed on mine timbers. See also Chapman and Stevens (1933).

La Plata and Montezuma Counties.—La Plata district. Melanterite, chalcanthite and other soluble sulfate minerals occur in many mines as postmining products but they are nowhere abundant. (Galbraith, 1949.)

Mineral County.—Creede district. Melanterite is common on most mine walls in the district. This is surprising, as pyrite is not abundant in any of the ores. (W. H. Emmons and Larsen, 1911.)

Ouray County.—American Nettie mine. Iron sulfate, probably melanterite, is among the oxidation products in ore of this mine. (Downer, 1901.)

Park and Summit Counties.—Montezuma district. Light-green crusts and stalactites of melanterite are not rare in old drifts of moderately dry mines. (Lovering, 1935.)

MELILITE

$Ca_2(Mg,Al)(Al,Si)_2O_7$

Melilite has been found only in the uncompahgrite of the Iron Hill stock of alkalic rocks in Gunnison County (loc. 2). The uncompahgrite occurs as several disconnected masses in the drainage basin of Beaver Creek, north of Iron Hill. The blue-gray fresh rock is two-thirds melilite, with the remainder made up of green diopside, magnetite, perovskite, and apatite. The melilite grains, or crystals, range from less than 0.1 to more than 50 cm in diameter; the largest ones enclose other minerals. Calcite, probably of primary origin, is interstitial to the melilite. Much of the uncompahgrite is partly or completely altered to such minerals as juanite, cebollite, and brugnatellite. (E. S. Larsen, Jr., and Hunter, 1914—analysis; E. S. Larsen, Jr., and Goranson, 1932; E. S. Larsen, Jr., and Jenks, 1942.) New facts on the crystal structure of melilite from Iron Hill, with an additional chemical analysis, are reported by J. V. Smith (1953).

MELONITE

$NiTe_2$

Melonite, the nickel telluride, has been found in only two of the telluride districts in the State—Boulder County and Cripple Creek.

Boulder County.—Melonite was first found in Colorado in the Forlorn Hope mine, Magnolia district, where it was crystalline but not in recognizable crystal form. (Hillebrand, 1885a.) Headden (1903) did not identify melonite as such in several specimens of mixed tellurides and native tellurium from the Valley Forge mine, but his chemical analyses show appreciable quantities of nickel, probably in the form of melonite. The Denver Museum of Natural History has several small specimens from the Wild Tiger mine.

Wahlstrom (1950), who gives a map showing the distribution of telluride ores and of melonite, found the mineral in ores from the Last Chance and John Jay mines at Jamestown, from the Slide at Gold Hill, from the Sunshine, Emancipation, and Little Johnny east of Gold Hill, from the Alpine Horn and Smoky Hill near Sugarloaf, and from the Empress, Lady Franklin, Cash, Keystone, and India mines at Magnolia. About one-fourth of the 200 telluride-bearing samples he tested showed the presence of nickel, but the distribution of melonite in individual deposits is very erratic. In a study of polished sections, Wahlstrom found it to be the earliest telluride mineral in a complex sequence of ore and gangue minerals. It forms thin colloform coatings on the walls of vugs and druses and in many specimens shows a constant association with coloradoite, calaverite or sylvanite, and native tellurium. Harcourt (1942) gives X-ray powder diffraction data on material from Boulder County.

Teller County.—A. H. Koschmann (oral communication) has found a little melonite in some of the Cripple Creek ores. In the Cresson mine it occurs as tiny crystals associated with gold; some is pseudomorphous after calaverite(?).

MENDOZITE

$NaAl(SO_4)_2 \cdot 11H_2O$

Mendozite, the naturally occurring variety of soda alum, has been reported from a lode 1½ miles southeast of Red Cliff, Eagle County. It is almost certainly a postmining efflorescence and is possibly present, but unreported, in many other mines. (Randall.)

MERCURIAN SILVER

[*See* Amalgam]

MERCURIAN TETRAHEDRITE

[*See* Tetrahedrite]

MERCURY

Hg

Native mercury, or quicksilver, is present in small quantities in at least three telluride-bearing districts in the State. An alteration product from coloradoite or cinnabar, or both, its only value is as a mineralogic curiosity.

Boulder County.—A little mercury was found in the near-surface telluride ores of the Sunshine and other districts in the county. (Endlich, 1878; J. A. Smith, 1883.) In the Nederland tungsten belt, Lovering and Tweto (1953) found it in oxidized ore of the Franklin mine, where it was derived from coloradoite. Specimens of horn quartz from a small vein near the shaft at the 65-foot level contain visible blades of sylvanite and become covered with minute globules of mercury when struck with a hammer. It is also reported by miners from other veins in this belt.

In 1933, Mr. Frank Culver of Sugarloaf told me that in the Sparkling Jewel and nearby mines at the head of Black Tiger Gulch it is not uncommon to see globules of native quicksilver on freshly broken vein quartz. He also reported the mineral from the Emancipation mine and from the vicinity of Salina.

La Plata and Montezuma Counties.—La Plata district. Small quantities of mercury, derived almost entirely from breakdown of the widespread coloradoite, are to be found in the ore from many mines in the district. (Galbraith, 1949.) In the Ruby mine it is associated with free gold and may be derived from cinnabar. (W. H. Emmons, 1905.)

Native mercury is present locally with native gold and sylvanite in the Hazel prospect, in the cliffs above Trimble Hot Springs, 10 miles north of Durango along the Animas River. (Lakes, 1906.)

Teller County.—Cripple Creek district. A little native mercury, associated with cinnabar, is reported from the Moon Anchor mine. (Lindgren and Ransome, 1906.)

MESITITE

[*See* Carbonate (mixed)]

MESOLITE

$Na_2Ca_2(Al_2Si_3O_{10})_3 \cdot 8H_2O$

Mesolite, one of the zeolites, has been reported in the literature only from the Table Mountains at Golden, Jefferson County (loc. 18), but the Denver Museum of Natural History also has a specimen labelled mesolite from Aspen, Pitkin County, that consists of a white feltlike sheet on red sandstone.

The Table Mountain locality was first mentioned by Endlich (1878), who notes the presence of antrimolite, a variety of mesolite, as a sparse constituent of amygdules in the lava.

The occurrence on North Table Mountain is described, with analyses, by Whitman Cross and Hillebrand (1882a, 1885) who found the mesolite in masses composed of exceedingly delicate needles loosely grouped together; some of it forms a continuous membrane, resembling a thick cobweb. Details of the North Table Mountain occurrence, together with several new chemical analyses, are given by Patton (1900). It forms extraordinarily delicate aggregates of long hairlike fibers, often exquisite and of infinite variety and appearance. One type consists of loosely felted masses like fine cotton wool. In another type, distinct and separate fibers form delicate brushes; this type is uncommon, but may grow on thomsonite. A third type consists of felted aggregates of fibers that lie in one plane to form a fragile gauze or membrane.

Superb specimens have been found recently at the main quarry on South Table Mountain, as well as one-half mile west of an old quarry on the south side of North Table Mountain. (J. W. Adams, written communication.)

META-AUTUNITE

$Ca(UO_2)_2(PO_4)_2 \cdot 6\frac{1}{2}\text{–}2\frac{1}{2}H_2O$

Meta-autunite, which is formed from autunite by drying or by slight heating, has been reported from several localities in the State, notably in the northwestern corner of Colorado, in Moffat County. In the Miller Hill area, T. 17 N., Rs. 87 and 88 W., uranophane and meta-autunite occur as films in vugs and on fracture surfaces in chalcedony in a bed of limestone in the Browns Park formation. In the

Browns Hill area, T. 15 N., Rs. 88, 89, and 90 W., the same minerals occur in fine-grained sandstone in the Browns Park formation. In the Maybell-Lay-Juniper Springs area, yellowish-green uranophane and meta-autunite, gypsum, and limonite are related to faults in sandstone. (Grutt and Whalen, 1955.)

The mineral was definitely identified in the Little Indian No. 36 mine in sec. 8, T. 48 N., R. 6 E., Gunnison County (Gruner and Knox, 1957.)

In the Aubrey Ludwig lease, Jefferson County, square plates of meta-autunite as much as 5 mm across occur on fracture surfaces of a pegmatite. The Washington vein in the Schwartzwalder mine (loc. 15) also contains some meta-autunite. (D. M. Sheridan, written communication.)

METAHEWETTITE†

$CaV_6O_{16} \cdot 9H_2O$

Paradox Valley, Montrose County, is the place where metahewettite was first identified, but Colorado must share the honors of the type locality with Utah because the chemical analyses on which the species was founded were made on specimens from Thompson, Utah. Its discoverers (Hillebrand, Merwin, and Wright, 1914) found that metahewettite is widespread on the Colorado Plateau in contrast to hewettite, which they found in only one specimen from Colorado. Metahewittite occurs as impregnations in sandstone, where it coats grains and fills cavities. It forms compact aggregates of separable shining deep-red blades; the powder ranges from claret brown to deep maroon.

It was found as a dark maroon powder at Morrison Camp in the McIntyre district by R. C. Coffin (1921), but was not identified elsewere. Dwornik and Ross (1955) show an electron micrograph of metahewettite from the Matchless mine, Mesa County. Weeks and Thompson (1954) describe its occurrence in Utah, but do not mention its presence in any of the Colorado uranium-vanadium ores. Barnes (1955) describes X-ray studies of the mineral and gives the chemical formula used here.

METAROSSITE†

$CaV_2O_6 \cdot 2H_2O$

Metarossite, a definite hydrate that results from the dehydration of rossite, was first found at the same type locality as rossite—Bull Pen Canyon, San Miguel County. It is a soft friable yellow mineral with pearly to dull luster, and forms small veinlets. (Foshag and Hess, 1927.)

Metarossite has also been identified in ore from the Buckhorn claim, Slick Rock district, San Miguel County, where it has the same mode of occurrence as rossite. (Weeks and Thompson, 1954.)

METATORBERNITE

$Cu(UO_2)_2(PO_4)_2 \cdot 8H_2O$

Metatorbernite, a partly dehydrated torbernite, has been found in many of the uranium deposits in Colorado, both on the Colorado Plateau and elsewhere.

Boulder County.—Gold Hill district, Goldsmith Maid vein. Torbernite, definitely identified, and minerals that are almost certainly metatorbenite and pitchblende, coat fractures in this vein and are disseminated in rocks of the hanging wall. (Campbell 1955.)

Gilpin County.—Central City district. In the Eureka Gulch area, metatorbernite occurs in several deposits in sufficient concentration to be of possible commercial value. It has been seen on the dumps of the Two Sisters, R.H.D., McKay, and Claire Marie shafts and also underground in the McKay workings. It is locally present in the upper workings of the Carroll mine, where it coats pitchblende; elsewhere it is disseminated as tiny apple-green crystals or fracture coatings in gneiss and amphibolite rocks that are largely altered to montmorillonite and illite. (Sims, Osterwald, and Tooker, 1955; Sims and Tooker, 1955.)

Jefferson County.—Golden Gate Canyon and Ralston Creek areas. Both torbernite and metatorbernite are rare in most of the uranium-bearing deposits of these areas, but together with autunite were common in the oxidized vein material at the Schwartzwalder mine, south of Ralston Creek (loc. 15). (Adams, Gude, and Beroni, 1953.)

Lake County.—Climax district. Light-green scaly crusts of metatorbernite coat seams and cracks in molybdenite-bearing rock of the Climax deposit. It has been found only on the Philipson level, which is 400 to 800 feet beneath the surface. (J. W. Vanderwilt, written communication.)

St. Kevin district. Metatorbernite is disseminated through granite in the Turquois Chief mine. It is also a minor constituent of the radioactive limonite that occurs in the oxidized ores of several mines. (Pierson and Singewald, 1954.)

Larimer County.—Crystal Mountain district, Hyatt pegmatite. Small green flakes of metatorbernite occur as an alteration product of uraninite in this pegmatite (loc. 2). (Thurston, 1955.)

Colorado Plateau, general.—Torbernite and metatorbernite, the latter probably more abundant, have been identified in ore from the Grey Dawn mine, Paradox district, San Juan County, Utah. They occur as crystalline aggregates on sandstones with pyrite, chalcopyrite, chalcanthite, and alunite. Metazeunerite is an associated mineral in ores from Utah but apparently none of the three have been identified in the Colorado part of the plateau. (Weeks and Thompson, 1954.) Metatorbernite is present in the Black King No. 5 claim at Placerville, San Miguel County. (Gruner and Gardiner, 1952.)

METATYUYAMUNITE†

$Ca(UO_2)_2(VO_4)_2 \cdot 3\text{–}5H_2O$

Metatyuyamunite, a dehydration product of tyuyamunite, was first found in ore from the Jo Dandy mine, Montrose County. Later it was identified in at least 35 other localities on the Colorado Plateau and elsewhere. Detailed studies on which the new species was based were made of specimens from the Jo Dandy and from the Small Spot and May Day mines on Calamity Mesa, Mesa County. The mineral occurs as yellow crystals that form radial aggregates on gypsum coatings of fractures. Tyuyamunite and carnotite are the chief associates among the uranium-bearing minerals. (Stern, Stieff, Girhard, and Meyrowitz, 1956.)

Metatyuyamunite, associated with dark-purple fluorite has been found in a vein in the Cripple Creek district, Teller County. Identification of the metatyuyamunite was by X-ray powder pattern. (J. W. Adams, written communication.)

METAZIPPEITE II

Metazippeite II, of unknown composition, is present with "gummite" and uraninite in the Indian Creek area, T. 48 N., R. 6 E., of Saguache County. (Gruner and Knox, 1957.)

MIARGYRITE

$AgSbS_2$

Unlike the ruby-silver minerals proustite and pyrargyrite, which are relatively widespread, miargyrite has been reported from very few districts.

Boulder County.—Nederland tungsten belt. Miargyrite is one of the chief ore minerals in the early silver ores, where it is intergrown with polybasite as a replacement of tetrahedrite. It is also abundant in the late silver ores that are associated with the tungsten deposits. (Lovering and Tweto, 1953.)

La Plata and Montezuma Counties.—La Plata district. Miargyrite, pyrargyrite, and proustite are the principal ore minerals in the ruby-silver belt that crosses the northern part of the district. In some places miargyrite is in contemporaneous intergrowth with pyrargyrite; both are probably of hypogene origin. (Galbraith, 1949.)

Park and Summit Counties.—Montezuma district. Miargyrite is one of the most abundant silver minerals in the district. It occurs in most of the ruby-silver ores and is always intergrown with pyrargyrite and is commonly associated with ankerite as a gangue mineral. Like the other ruby-silver minerals it is later than most of the pyrite, galena, and sphalerite but is contemporaneous with a late generation of galena and chalcopyrite. (Lovering, 1935.)

MICA GROUP

[*See* Biotite, Lepidolite, Mariposite, Muscovite, Paragonite, Phlogopite, Roscoelite, *and* Clay minerals]

MICROCLINE

[*See* Feldspar group]

MICROLITE

$(Na, Ca)_2Ta_2O_6(O,OH,F)$

[*See also* Pyrochlore]

Microlite, essentially a sodium-calcium tantalate, and pyrochlore, a sodium-calcium niobate, form a continuous isomorphous series. A mineral near the microlite end of the series is reported from 4 localities in Colorado but in only 1 of these has it been studied in any detail.

Fremont County.—Microlite is reported with lepidolite from near the Royal Gorge (G. R. Scott, written communication).

Gunnison County.—The best known microlite locality is in the lithium pegmatites of the Quartz Creek (Ohio City) district of Gunnison County (loc. 4). It was first described as samarskite (Eckel, 1933a), an error that was corrected by Eckel and Lovering (1935). A chemical analysis shows it to be close to calcium tantalate in composition and to contain a noteworthy amount of uranium. Its age, calculated by the logarithmic formula, is 760 million years. As seen by Eckel it occurred as small (2–10 mm) rounded dark-brown grains enclosed in fine-grained lepidolite with some albite and a little quartz. As is characteristic of many radioactive minerals, each grain is surrounded by a discolored halo. It was first seen in the Brown Derby mine, but was more abundant on the J.B.W. claim several hundred feet to the northeast. Some microlite has been produced commercially as a source of tantalum.

Staatz and Trites (1955), who studied the Quartz Creek pegmatite far more extensively than did Eckel, found microlite in 14 of the pegmatite dikes, most abundantly in the cores of zoned pegmatites. They find it to range in color from light yellow through greenish yellow, olive green and light brown to dark brown. It is anhedral where in massive lepidolite, but in quartz and cleavelandite it forms euhedral octahedra from 0.01 to 0.4 inches in diameter. Some of it is rich in uranium. Kulp, Volchok and Holland (1952) record a differential thermal analysis of microlite from Ohio City.

Jefferson County.—Microlite, topaz, and beryl are reported to occur in the Silver Glen Ranch mica-feldspar pegmatite in Swede Gulch (loc. 17). (Boos, 1954.)

The old Soda Creek School feldspar pegmatite is reported to contain minute grains of microlite. It is in NW¼, sec. 18, T. 4 S., R. 71 W. (Boos, 1954.)

MILLERITE

NiS

Millerite has been reported from only two localities. One of these is the nickel-bearing deposit of the Copper King mine, Gold Hill district, Boulder County (loc. 1). Millerite or a closely similar mineral occurs as feathery edges along veinlets of violarite; the same mineral also forms veinlets in most of the polydymite in the ore. (Goddard and Lovering, 1942.)

At Garden Park, Fremont County (loc. 5), a single geode of quartz, calcite, and barite contained a cluster of radiating needles of brassy yellow millerite(?). (G. R. Scott, written communication.)

MIMETITE

$Pb_5(AsO_4,PO_4)_3Cl$

[*See also* Pyromorphite]

Mimetite and pyromorphite form a complete isomorphous series; they are distinguished by the relative proportions of arsenic and phosphorus. Mimetite has been reported from only two localities, and in neither of these is there much evidence that the identifications were based on thorough chemical study.

Chaffee County.—Monarch and Garfield districts. Noted as present by R. D. Crawford (1913).

Lake County.—Leadville district. Mimetite occurs as small light-yellow and gray crystals in the Minnie mine. (Schrader, Stone, and Sanford, 1916; Randall.)

MINIUM

Pb_3O_4

Minium, the red oxide of lead, has been reported from several districts, but only at Leadville is it of commercial importance. It was rare in the Freeland mine on Trail Creek, Clear Creek County (Hollister, 1867). Endlich (1878) also reports it from mines in the Georgetown district, Clear Creek County, from the Central City district, Gilpin County, and from the Dutchman lode, San Juan County. It is present in the Telluride district (Purington, 1898).

Lake County.—Leadville district. Minium occurs in many of the oxidized lead ores, mixed with cerussite and iron oxides; it has value as specimens as well as being a source of lead. In the Rock mine, a body of cerussite with some galena occurs at the outcrop of an ore body that lies between porphyry and limestone. Minium is interspersed through the cerussite. Its cubic cleavage and the presence of small amounts of galena within the masses suggest that the minium is pseudomorphic after galena. An analysis of carefully picked red oxide is included in the description by J. D. Hawkins (1890).

Pitkin County.—Aspen district. Cerussite and anglesite were abundant in the near-surface ores, especially in those of Tourtelotte Park. Minium, limonite, cuprite, and a little melaconite were associated with them. (Spurr, 1898.)

MIRABILITE

$Na_2SO_4 \cdot 10H_2O$

Mirabilite, or glauber salt, has been reported from only three localities; it is far more abundant and widespread than the record indicates as a constituent of "alkali" deposits in dry lakes, as an efflorescence on soils, rock outcrops, mine walls, mines, and in other settings.

Delta County.—Doughty Hot Springs. Mirabilite forms incrustations around the springs. (Headden, 1905a.)

Jefferson County.—Bear Creek and vicinity. Mirabilite occurs along Bear Creek, at Soda Lake, and elsewhere southwest of Denver. (Endlich, 1878.)

Teller County.—Cripple Creek district. The mineral is very common as a post-mining efflorescence in the Anaconda-Raven tunnel, in the Last Dollar mine, and elsewhere. (Lindgren and Ransome, 1906.)

MIZZONITE

[*See* Scapolite group]

MOLYBDENITE

MoS_2

Molybdenite, the only commercial source of the alloy metal molybdenum, is the most valuable mineral product in the State. About $542 million worth of the mineral was produced from 1918 through 1958. Virtually all of this came from a single mine, the Climax, in Lake County, which still contains the world's largest known reserves of molybdenum ore.

In addition to the deposit at Climax, molybdenite is very widespread in the State, although few of the occurrences are of commercial size or grade. The distribution of the mineral, geologic and geographic, is described in detail by Horton (1916) and again by Worcester (1919). Both reports resulted from the intensive search for molybdenum that occurred during World War I. Both are based on personal observations plus other available information, but neither one is particularly well documented as to the literature. Many of the following notes are taken from these two authors without further reference and the reader is referred to the original reports for more detailed descriptions. Molybdenite has been known in Colorado since its early days; Endlich (1878), for example, notes it from the Alice Cary lode, San Juan County; Mount Silverheels and Fairplay, Park County; the Leavitt mine, Central City district, Gilpin County; the Douglas tunnel, Georgetown district, Clear Creek County; and from Boulder County. It was not until Climax (which had been long known and which began large-scale development toward the end of World War I) came into production, however, that molybdenite was much more than a mineralogic curiosity.

Boulder County.—Magnolia district. Massive molybdenite, some in flakes as much as 1 inch long, occurs with chalcopyrite on the lower levels of the Mountain Lion mine. A few hundred pounds have been produced.

Jamestown district. A large vein of low-grade ore is reported.

Caribou district. The Bighorn shaft, 2 miles northwest of Caribou contains finely disseminated molybdenite in a well-defined quartz-pyrite vein. Some rich specimens have been found but most of the ore is low grade.

General. Molybdenite is widespread in the telluride veins and in some of the ferberite veins as extremely fine grained intergrowths with barite. On dumps it is indicated by deep-blue stains of ilsemannite. (Lindgren, 1907.)

Chaffee County.—California mine (loc. 1). This mine, near the head of

Browns Canyon, exploits one of the two vein deposits of beryl that are known in Colorado; the vein is locally rich in molybdenite and large amounts have been produced. Both ferrimolybdite and molybdenite are present in quantity with quartz, muscovite, fluorite, a little pyrite, and crystals of nearly colorless beryl. In the richest streaks, masses of solid flaky molybdenite that are 1 to 2 inches wide and 6 to 24 inches long are common. In many places there are pockets between quartz and beryl crystals that yield 20 to 30 pounds of pure molybdenite or ferrimolybdite. (See also Landes, 1934, 1935; Adams, 1953.)

Monarch district. At Huffman Park, 4 miles northwest of Garfield, the Royal Purple and Nest Egg prospects contain quartz veins that are rich in molybdenite; the Royal Purple also contains much pyrite. (See also R. D. Crawford, 1913.)

Winfield district. In the vicinity of Winfield, near the headwaters of Clear Creek, several strongly developed veins of white quartz are rich enough in molybdenite to make the deposit an area of much future economic interest. Bismuthinite is intimately associated with molybdenite in the Banker mine, but silver ores are nowhere closely associated with molybdenite. (See also Chapman, 1935.)

Twin Lakes district. Several quartz veins in the district are rich in molybdenite, with much ferrimolybdite near the surface. (See also Howell, 1919.)

Clear Creek County.—In the Urad mine in the Daily mining district on the southeast slope of Red Mountain very finely granular molybdenite occurs as disseminations and veinlets in rhyolite porphyry. Ferrimolybdite is abundant in the upper workings. Several thousand tons of ore that contained about 2 percent MoS_2 were produced in 1915.

The ore of the Clifford mine, near Central City contains some molybdenite in a base-metal sulfide vein.

Conejos County.—Platoro district. A little molybdenite, in spheroidal forms, occurs in a small quartz vein on the Merrimac claim. It is also known elsewhere in the district but is nowhere abundant.

Custer County.—Rito Alto Peak. A narrow vein on the Knight-Stacy Claims, on the side of Rito Alto Peak contains honeycomb quartz, pyrite, and molybdenite, the latter in small crystals and amorphous aggregates. Several other insignificant occurrences are known in the county.

Eagle County.—In the Cross mining district on Mount Whitney, 18 miles from Gilman, there are quartz-pyrite veins that contain pockets and fracture coatings of molybdenite.

Fremont County.—The Copper Girl mine, 9 miles south of Parkdale, contains quartz and chalcopyrite with some molybdenite in quartz that has replaced certain bands of a schist. The richest molybdenite-bearing streak is 10 inches wide. There is also a little molybdenite on the Liberty Bond claim, 12 miles north of Westcliff and 12 miles east of Hillside.

Gilpin County.—Central City district. A cut on the Gray Eagle claim, three-quarters of a mile northeast of Apex exposes a mass of quartz veinlets, 1 to 8 inches wide, in gneiss and granite. They contain small amounts of molybdenite, molybdite, pyrite, and muscovite. Elsewhere in the district aggregates of small plates occur in a few of the gold-pyrite veins, commonly as narrow bands along the walls; molybdenite is rare in the galena-sphalerite ores. (See also Bastin and Hill, 1917.)

Grand County.—Molybdenite and molybdite are reported from along the Colorado River, 1½ miles above Radium, but the report has not been confirmed. (See also Aurand, 1920b.)

Gunnison County.—Gold Brick, Quartz Creek, and Tincup districts. Molybdenite is widespread and locally abundant in all of these districts. In the Quartz Creek district, where it is associated with huebnerite, it is disseminated as fine grains in sugary-textured quartz but forms coarser grained tufts and veinlets in milky quartz. Some ferrimolybdite is present near the surface. (Dings and Robinson, 1957.) In the Tincup district strongly developed veins occur in which molybdenite and huebnerite are the chief ore minerals; they were worked for both molybdenum and tungsten during 1917 and 1918. In most veins molybdenite is the only ore mineral, but in some huebnerite is closely associated. (Goddard, 1936.)

Snowmass Mountain area. Small amounts of molybdenite occur in quartz veins near the head of Yule Creek; it has not been found in the base-metal veins. (See also Vanderwilt, 1937.)

Wildcat Gulch. Deposits of molybdenite, with some tungsten and copper minerals, occur near the old town of Spencer, 12 miles south of Iola. Quartz and green hornblende are associated. (See also Hunter, 1925.)

Hinsdale County.—Small showings of molybdenite are reported from two places, one 3 or 4 miles north of Lake City and the other 12 miles south of that town, near the old camp of Sherman.

Huerfano County.—Mosca Pass. A 10-inch quartz "vein" with some molybdenite occurs in a northwestward-trending pegmatite body exposed 300 yards east of Mosca Pass.

Jefferson County.—South of Critchell. Molybdenite was observed disseminated in a foliated bed of quartz monzonite. (G. R. Scott, written communication.)

Lake County.—Climax district. The Climax deposit, part of which is in Summit County, is the world's largest producer and reserve of molybdenum ore. One of the earliest descriptions of the deposit, made when extensive development was just beginning, is given by Horton (1916). Later, after the mine had taken a leading role in world production, it was studied intensively by B. S. Butler and Vanderwilt (1933). Staples and Cook (1931) also give an excellent description of the mineralogy and of the country-rock alteration. Molybdenite is the chief ore mineral in the deposit although large amounts of tin, tungsten, and several other metals are recovered as byproducts of milling the vast tonnages of ore that are treated at Climax.

Characteristically the molybdenite occurs as fine specks along the margins of small ramifying veins that contain quartz or quartz and orthoclase. In most veins it is the only visible metallic mineral, but pyrite is very widespread through the country rock. The uniformly fine grained character of the molybdenite is almost as unique as the size of the deposit, for in most other places the mineral tends to be coarsely crystallized.

La Plata County.—Small amounts of molybdenite occur in narrow quartz veins on East Silver Mesa and in the Vallecito Basin, both in the general vicinity of Needleton. Some has also been found near the Animas River not far north of Durango.

Larimer County.—At the head of Big Thompson River, molybdenite and bismuthinite are associated in a vein of pink quartz. (Hillebrand, 1885a.) In the Iron King mine, in the old and little-known St. Cloud district on Prairie

Divide, small amounts of molybdenite, chalcopyrite, and sphalerite, with very abundant magetite, occur in a vein in granite.

Mesa County.—Several small deposits occur in Unaweep Canyon. In one of these the molybdenite forms isolated crystals in a dike of coarse granite.

Ouray County.—Red Mountain district. Small quantities are known in several veins near Ironton.

Park County.—Lake George area. Small quantities of molybdenite have been known in the Tarryall Range, near Lake George, since World War I and some ore was produced from the Redskin mine on Tarryall Creek, 8 miles north of Lake George. The molybdenite occurs in small pipelike deposits in granite, associated with base-metal sulfides and with quartz, muscovite, and fluorite. (See also R. D. Butler and Riley, 1940.)

Platte Gulch district. Both coarse and fine crystals of molybdenite occur with chalcopyrite and pyrite in a small irregular quartz vein on Van Epp's claim. The mineral also occurs in pockets in a pegmatite body between Buckskin and Platte Gulches.

Park and Summit Counties.—Montezuma district. A few small deposits are known on Glacier Mountain and elsewhere. None are promising. (See also Lovering, 1935.)

Pitkin County.—Lincoln Gulch district, Green Horn claim. Near the head of Lincoln Gulch, this claim contains three quartz-pyrite veins with small amounts of molybdenite.

Routt County.—Hahns Peak and Slavonia districts. Insignificant deposits of molybdenite occur in both these small districts.

Saguache County.—Alder area. A small and low-grade deposit exists 7 miles northeast of Alder, on the west slope of the Sangre de Cristo Mountains.

San Juan County.—Silverton district. Molybdenite has been long known in different deposits in the district. Worcester describes those near Chattanooga, near the head of South Mineral Creek on Bear Mountain, and in Cascade Basin. None seem to be of much importance.

San Miguel County.—Ophir (Iron Springs) district. Small quantities of molybdenite occur in pegmatitic quartz in quartz monzonite intrusive bodies; it also occurs as coatings along joints in the Silver Tip mine. (See also Varnes, 1947a.)

Summit County.—Kokomo district. Thin quartz veinlets that contain molybdenite cut the quartzites that are exposed on Tucker Mountain. In the upper D. & G. tunnel on Jaque Mountain, disseminated grains of molybdenite occur in garnetized rock and also in quartzite. Several other minor occurrences are known in the district. (See also Koschmann and Wells, 1946.)

Upper Blue River district. Molybdenite is a widespread but minor constituent of many veins in Monte Cristo Gulch. (See also Q. D. Singewald, 1951.)

Teller Country.—Cripple Creek district. Molybdenite is a very characteristic part of the vein matter in many mines and occurs at all depths below the oxidized zone. It forms soft lead-gray scales or smaller masses and is often overlooked. Outside the Cripple Creek district there are a few small quartz veins that contain a little molybdenite. (Lindgren and Ransome, 1906.)

MOLYBDITE

[*See* Ferrimolybdite]

MONAZITE

(Ce,La,Y,Th)(PO_4)

Monazite, which is commonly radioactive due to contained thorium, is present as an accessory mineral in many igneous and metamorphic rocks. In only one such source does it have commercial value. This is the Climax molybdenum mine, where monazite is one of the several commercial byproducts that result from the milling of enormous quantities of molybdenite-bearing ore. (Cooley, 1953.)

Monazite is also a comparatively minor constituent of the black sands, mostly magnetite, that are recovered from gold placers in many places. In addition to these kinds of occurrences, it has been found in scattered masses and crystals in many pegmatites; it is a vein mineral in at least two ore deposits. Only the pegmatite and vein occurrences are given here.

Boulder County.—Jamestown district (loc. 2). In the unique deposit of cerite, veinlets of reddish-brown monazite occur near the centers of tornebohmite veins. Monazite also occurs as lenses and grains scattered through other parts of the cerite deposit. (Goddard and Glass, 1940.)

Chaffee County.—Trout Creek Pass district, Yard and Luella pegmatities (loc. 6). Both these pegmatite bodies yield many fine museum specimens of euxenite and monazite, some of the latter in masses as much as 8 inches across. They occur as pods and clusters of crystals commonly between quartz and microcline, associated with tabular veins of muscovite that are as much as 5 feet long. (Heinrich, 1948a; Hanley, Heinrich, and Page, 1950.)

Clear Creek County.—Beaver Brook (loc. 2). Monazite is intergrown with gadolinite in a pegmatite dike. (G. R. Scott, written communication.)

Grover mine (loc. 3). Small euhedral crystals of monazite occur in the pegmatite. (Hanley, Heinrich, and Page, 1950.)

Fremont County.—Eight Mile Park (loc. 4). In an east-west trending pegmatite body 1 mile west-northwest of the Meyers pegmatite quarry, monazite occurs as small crystals and crystal fragments. Associates are beryl, black tourmaline, tantalite, and smoky quartz. (Bever, 1953.)

In the Colorado feldspar pegmatite, both monazite and euxenite are present. The monazite forms 4-inch hemispherical masses of radiating crystals. Individual blades are 1½ inches long and as much as ¾ inch thick, terminated with imperfect faces. (Heinrich, 1948b.)

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). Widely scattered crystals of monazite were found in 24, or 1.5 percent, of the pegmatite bodies in the district. It occurs as euhedral dark-red to clove-brown crystals as much as 2 inches long. Most of the larger crystals are in the Brown Derby No. 1 dike. (Staatz and Trites, 1955.)

Jefferson County.—Centennial Cone (loc. 5). In a pegmatite dike on the northeast flank of Centennial Cone, sharply defined clove-brown crystals of monazite as much as 1½ inches long are relatively abundant. They are in the complex part of the dike and most are embedded in beryl. Bertrandite and samarskite(?) are also present. (Waldschmidt and Adams, 1942; Hanley, Heinrich, and Page, 1950.)

Burroughs mine (loc. 4). Monazite in excellent clove-brown crystals as much as 1½ inches across is associated with euxenite, allanite, and several bismuth minerals. (G. R. Scott, written communication.)

Bigger mine (loc. 3). Monazite is present with columbite, zircon, and bismuthinite. Beryl occurs in huge crystals and there is some bertrandite. (J. W. Adams, written communication.)

Roscoe dike (loc. 14). A little monazite is associated with gadolinite and beryl in the main dike. On the hill above the outcrop of the Roscoe dike, monazite, beryl, and yttrotantalite or samarskite(?) are present. (J. W. Adams, written communication; Vance Haynes, written communication.)

Larimer County.—Very large crystals of monazite have been obtained from pegmatite in the Prairie Divide area in northern Larimer County. (J. W. Adams, written communication.) Results of age determinations on monazite from a pegmatite body about 5 miles east of the Copper King uranium mine (loc. 3) are discussed by Sims, Phair, and Moench (1958).

Park County.—Teller pegmatite (loc. 9). Small grains of reddish-brown monazite with brick-red earthy inclusions are widespread in the yttrian fluorite of this pegmatite but are not as abundant as xenotime and gadolinite. The monazite is probably an alteration product of gadolinite. (Glass, Rose, and Over, 1958. See also Heinrich, 1958, for mention of other occurrences in the same general area.)

Monazite occurs intergrown with ilmenite and leucoxene at the Lone Lode feldspar pegmatite (sec. 23, T. 8 S., R. 72 W.). (J. W. Adams, written communication.)

Saguache County.—Monazite crystals are found in pegmatite on the west flank of the Sangre de Cristo Mountains near Villa Grove. (J. W. Adams, written communication.)

MONHEIMITE

[*See* Smithsonite]

MONTANITE

$(BiO)_2(TeO_4)\cdot 2H_2O$?

Montanite is reported from three localities, but its identity in two of these is doubtful. Genth (1874) noted a yellow mineral on calaverite from the Red Cloud mine, Boulder County. He thought it to be montanite, but was not certain of the identification.

Excellent specimens of the mineral are reported from near Salida, Chaffee County, but the locality and mode of occurrence are not given. (Struthers, 1903.)

In his description of tellurobismuthite from Sierra Blanca, Huerfano, Alamosa, and Custer Counties, Frondel (1940) says, "stains of a green alteration product, presumably montanite, are present on most specimens."

MONTEBRASITE

$(Li,Na)Al(PO_4)(OH,F)$

[*See also* Amblygonite *and* Natromontebrasite]

Fremont County.—Eight-Mile Park (loc. 4). Montebrasite, the intermediate species in the amblygonite-natromontebrasite series has been found in Colorado only at the Meyers pegmatite quarry. It was in a zoned pegmatite about 200 feet south of the original natromontebrasite locality. The montebrasite, whose identity is supported by chemical analysis, occurs as chalky white rounded crystalline masses, averaging 1½ inches long but as much as 6 inches in places. Principal associated minerals are cleavelandite and red muscovite. (Heinrich and Corey, 1955.)

MONTICELLITE

$CaMgSiO_4$

Monticellite has been found only in the alkalic rocks of Iron Hill, Gunnison County (loc. 2). It forms poikilitic inclusions in the cancrinite-bearing rock and is associated with vesuvianite and melanite garnet in several places. It is pale yellow brown and leaches out of the rock on weathering. (Larsen and Foshag, 1926.)

MONTMORILLONITE

$(Al_{1.67}Mg_{0.33})Si_4O_{10}(OH)_2 \cdot 4H_2O \cdot Na_{0.33})$

[*See also* Clay minerals, Nontronite, *and* Sauconite]

The montmorillonite group includes all clay minerals except vermiculite that have an expanding lattice structure. The montmorillonite species, on the other hand, is restricted to the high-alumina end member of the montmorillonite group in which a little aluminum is replaced by magnesium and there is substantially no replacement of silica by aluminum (Grim, 1953). The name "bentonite" is applied to a rock that is comprised largely of montmorillonite and that retains the textures of the volcanic glass shards from which it was derived. (Ross and Hendricks, 1945.)

The montmorillonitic clays expand to greater or lesser degree as they absorb water in the crystal lattice. This makes some of them useful as filtering agents for oil and for other purposes, but it also causes them to be extremely troublesome in constructing buildings or road foundations.

The montmorillonitic clays are very widespread and abundant, particularly in beds of altered volcanic ash and in some of the Cretaceous formations, such as the Pierre and Mancos.

The specific mineral montmorillonite, has been identified at Central City, Gilpin County, at Summitville, Rio Grande County, and in other mining districts as a wallrock alteration product. It has also been found in sedimentary rocks in Jefferson County and elsewhere along the Front Range and in the San Juan basin. All of these occurrences are noted under the description of the illite group.

Some of the volcanic tuffs in the Creede district, Mineral County, are altered to bentonite. The altered rock consists of a few crystals of biotite and feldspar and abundant shards of volcanic glass in a matrix of montmorillonite. (E. S. Larsen, Jr., 1929.) The properties of a montmorillonite from the North Park formation near Granby are described in extreme detail by Mielenz, Schieltz, and King (1955). The mineral is derived from a dacite tuff.

MONTROSEITE†

VO(OH)

The type locality of montroseite was described in 1953 as the Bitter Creek mine, on the northeast side of Paradox Valley, Montrose County. The mineral was also found at about the same time, by its discoverers, in ore from the Jo Dandy and Whitney mines, Montrose County, where it is the chief ore mineral, from the Matchless mine, Mesa County, and from several mines in Utah. Montroseite also occurs in the Virgin mine, Montrose County.

It is probably a primary mineral and occurs as impregnations or solid masses in sandstone, associated with pitchblende, pyrite, galena, and other sulfides. In the oxidized zone it alters to paramontroseite, corvusite, melanovanadite, hewettite, pascoite, and hummerite. (Weeks, Cisney, and Sherwood, 1950, 1953—type description; Weeks and Thompson, 1954; Evans and Block, 1953—crystal structure.)

MORDENITE

$(Ca,K_2,Na_2)O \cdot Al_2O_3 \cdot 10SiO_2 \cdot 5H_2O$?

A supposedly new mineral named ptilolite, one of the zeolites, was found on Table and Green Mountains, Jefferson County. Later it was identified at Silver Cliff, Custer County. Material from the type locality was restudied by R. J. Davis (1958) by X-ray methods. He found that ptilolite is identical with mordenite, which name has priority. Thus, Colorado lost another of its type minerals 72 years after its discovery. Mordenite has not been reported elsewhere, but is possibly present in volcanic rocks that contain other zeolite minerals.

Custer County.—Silver Cliff district. About 3 miles southeast of Silver Cliff a low ridge of rhyolitic breccia extends outward from the volcanic center of the Rosita Hills. It consists of dull-green devitrified pitchstone with many nearly spherical vesicles, most of them less than 5 mm in diameter. Barite as colorless to pale-blue tablets is the most abundant vesicle filling but some cavities contain quartz. "Ptilolite" (now called mordenite) is present in nearly all the vesicles as transparent colorless needles that form feltlike masses, tufts, or balls. Six cubic feet of the rock yielded a one-half gram sample, indicating that the "ptilolite" is not abundant. The chemical composition of the material is similar to that from the type locality except that the Silver Cliff specimens contain more water. (Whitman Cross and Eakins, 1892—analysis.)

Jefferson County.—Table and Green Mountains (loc. 18). Ptilolite was identified as a new species in specimens from North and South Table Mountains and from Green Mountain; the best specimens were found on the north side of Green Mountain. In all three localities the "ptilolite" occurs as white downy tufts in the cavities of fragments of altered augite andesite in the conglomerates of these hills. Many of the vesicles also contain opal (some of it fire opal) chalcedony, and heulandite. The "ptilolite" is probably derived from the heulandite. (Whitman Cross and Eakins, 1886—analysis.)

MORENOSITE

$NiSO_4 \cdot 7H_2O$

A few small stalactitic growths of morenosite have been found on mine walls of the nickel deposit of the Copper King mine, Gold Hill district, Boulder County (loc. 1) (J. W. Adams, written communication).

MOSCHELLANDSBERGITE

[*See* Amalgam]

MUSCOVITE

$KAl_2(AlSi_3)O_{10}(OH)_2$

Muscovite, or common "white" mica, is very abundant as an essential constituent of many igneous and metamorphic rocks. Because it is tough and resistant to weathering it survives the disintegration of such rocks and reappears in many sedimentary rocks and soils. Much of the glitter to be seen in the sands of mountain streams, often mistaken for gold by the uninitiated, is due to fine flakes of muscovite.

Coarsely crystallized muscovite, in plates large enough to have possible commercial value for electrical insulation and other purposes, is almost entirely confined to pegmatite bodies. Only this mode of occurrence is listed here. The fine-grained variety sericite and the green chromiferous variety fuchsite are described separately.

Topical studies of the mico resources of Colorado have been made by several authors. One of the earlier authors is Holmes (1899); his facts, together with additional data, are summarized by Sterrett (1923). The most modern topical study is that of Hanley, Heinrich, and Page (1950); these authors summarize all of the pertinent earlier knowledge and add many new descriptions and maps. Except where otherwise credited, the following notes are largely abstracts of material presented in much greater detail by Hanley, Heinrich, and Page.

Boulder County.—Lefthand Creek district. Four small mica pegmatite bodies—the New Girl, Elkhorn, Highline, and Beryl lode—are in this district. Some scrap mica is produced, largely for home-insulation purposes. Two of the pegmatite bodies also contain beryl but reserves of beryl, potash feldspar, and mica are small.

Chaffee County.—Turret district (loc. 2). At least 3 of the pegmatites in the district—the Last Chance Spar-Mica Dyke, the Mica-Beryl, and the Rock King—contain scrap mica in commercial quantities. All 3 contain some beryl and the first 2 contain books of light-green to greenish-gray muscovite as much as 2 feet in diameter. Very little of this material is suitable for sale as sheet mica. (Heinrich, 1948a.)

Clear Creek County.—The Ajax mine, formerly called the Floyd Hill mine (loc. 2), is one of the few mica deposits in the State which has produced good sheet mica. It has also produced much scrap-grade material. The muscovite occurs as plates that range from ½ to 10 inches across. It is partly iron stained but mostly clear and transparent. Alternating stripes of clear and ruby material are characteristic and some is rippled and ruled. Inclusions of tourmaline, quartz, and albite occur in some books.

The Grover mine (loc. 3), which also contains columbite and beryl, contains large quantities of scrap-grade mica.

El Paso County.—Johnny Feldspar mine. Grayish-green muscovite occurs as clusters as much as 2 feet across in several pegmatite dikes. All of it is wedged, ruled, and fishtailed.

Fremont County.—Eight Mile Park district (loc. 4). All the pegmatite bodies in this district contain some mica, but only the Mica Lode mine has produced much commercially. This mine has produced more feldspar than any other pegmatite body in Colorado and also has been one of the largest scrap-mica and beryl producers. Muscovite occurs in all zones of the pegmatite except the wall zone. It has two habits—wedge-shaped flawed books, and small flakes that are mixed with albite and other minerals. The reserves of scrap mica are still very large. Frondel and Ashby (1937) describe and illustrate a sheet of muscovite from Fremont County that contains skeleton crystals of hematite. (See also Landes 1935, 1939; Heinrich, 1948b.)

Devils Hole mine (loc. 3). This mine, formerly known as the Wild Rose, has been worked intermittently since the early 1900's. It has produced commercially valuable amounts of beryl, feldspar, scrap mica, and columbite. The muscovite occurs as large round masses of wedge-shaped books. Single books as much as 3 feet long and 1 foot thick occur in many of the aggregates, which themselves may be as much as 30 by 20 by 5 feet.

Fremont and Park Counties.—Micanite district (loc. 8). The Micanite district straddles the line between Fremont and Park Counties. It contains 4 pegmatite bodies that yield sheet-quality mica and at least 9 others that have produced scrap mica, or could probably produce it in the future.

The Climax mine has produced many tons of mine-run mica and some microcline feldspar. Most of the muscovite is black stained and spotted, but clear flat hard sheets can be found in most books. Sheets of light- to dark-stained mica as large as 5 by 10 inches have been recovered.

The Rose Dawn has produced large quantities of crude mica from extensive workings. Gray-green muscovite, pink albite, and a little blue-green beryl comprise the productive zone that surrounds the core. Some excellent sheet-grade material is present and more may be found with further development.

The Whopper mine contains flat hard books 6 inches wide, that break free from the surrounding minerals. Nearly all the muscovite is strongly flawed, but some good sheet material can probably be found.

The Meyers Ranch mine is in Park County (loc. 5), some distance northwest of the main Micanite district. It has produced four minerals in commercial quantity—microcline feldspar, muscovite, beryl, and columbite-tantalite. The muscovite occurs in the intermediate zone in gray-green to rum-colored books as much as 8 inches wide. Many of the books are hard and clear and contain areas that would yield good-grade punch and sheet mica. Reserves are fairly large.

In addition to the deposits just described, the following mines all contain large quantities of scrap-grade muscovite: Rosemont, Tickon, Lower South, Upper South, Rowe's North, Rowe's No. 2, Rowe's South, Beryllium Lode, and Star Girl.

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). All of the pegmatite bodies in this district contain some muscovite, but the only ones in which it seems to be in commercial quality or quantity are the Buckhorn and the New Anniversary. In the Buckhorn most of it is in the intermediate zone which also contains beryl. The books are as large as 10 by 18 inches. The mica is all strongly flawed and is suitable only for scrap. The New Anniversary deposit is similar but smaller.

Last Chance mine. This mine, which has produced several thousand tons of feldspar and a few tons of scrap mica is 8 miles west of Sapinero. Muscovite occurs as aggregates of small felted plates; one such aggregate is 25 feet long and 10 feet wide. The mica is wedged, ruled, and crumpled and is commonly intergrown with garnet. Heinrich and Levinson (1953) describe rose muscovite associated with the topaz of this district. (See also Staatz and Trites, 1955.)

Jefferson County.—Bigger mine (loc. 3). The Bigger mine, which was discovered in 1884 and has been worked for feldspar and mica at intervals since that time, has produced mainly scrap mica, but some of the material seems to be of sheet grade. The muscovite books, which are as much as 18 inches across and 6 to 8 inches thick, occur with beryl near the outer edges of the core, and in the intermediate zone.

Larimer County.—Crystal Mountain district (loc. 1). Of all the pegmatite bodies in this district, the Buckhorn is the only one that has produced large amounts of mica; all of this has been scrap grade. The deposit was discovered in 1884. The muscovite is green and suitable for grinding but some books, which average 4 inches across, would yield small quantities of punch and sheet mica. (Thurston, 1955.)

Hyatt mine (loc. 2). The Hyatt deposit, which has produced large amounts of beryl, was not discovered until 1936. The greenish-white muscovite associated with small tourmaline crystals occurs chiefly in the intermediate zone of the pegmatite. The wedge-shaped books are as long as 1 foot; all of the material is flawed.

Mesa County.—Ladder Canyon. A very large pegmatite dike is exposed in the canyon 8 miles south of Grand Junction. Quartz and orthoclase make up the greater part of the body, but some translucent pale-rose quartz is present. Muscovite makes up a nearly continuous streak 1 to 3 feet wide between orthoclase and quartz. It occurs as masses of crystals 1 inch to 1 foot in diameter, commonly arranged in tufts and radiating groups. All of the mica is much ruled and broken and probably suitable only for scrap. (Sterrett, 1923.)

Park County.—Famous Lode prospect. Several small pegmatitic pods and lenses are exposed here. All are extremely rich in muscovite, which comprises as much as 60 percent of some of them. A small proportion of the total mica would yield sheet- and punch-grade material in pieces 1 by 1 inch or less.

Copper King prospect. Small amounts of scrap-quality mica are present.

Routt County.—Large sheets of clear muscovite with reticulated iron oxide(?) inclusions have been found in a pegmatite in Mica Basin near Slavonia. (J. W. Adams, written communication.)

Summit County.—Kokomo district. Volk (1939) gives a chemical analysis of muscovite.

Muscovite variety FUCHSITE

Fuchsite, although it requires more study, is probably a muscovite in which chromium is an essential constituent. It has only been reported twice from Colorado and one of these occurrences is in doubt.

A bright-green mica, shown by analysis to contain chromium, occurs in altered gneiss in the vicinity of veins on Democrat Hill near Georgetown, Clear Creek County. It is called fuchsite by Spurr and Garrey (1908).

The green micaceous mineral at Placerville, San Miguel County, identified as mariposite by most authors, is called fuchsite by Kerr, Rasor, and Hamilton (1951). Later, however, Kerr and Hamilton (1958) say that the material is more properly defined as a chrome mica-clay, a submicroscopic mixture of two mica polymorphs with montmorillonite; chromium is an essential constituent.

Muscovite variety SERICITE

The fine-grained silky variety of mica called sericite is very widespread and abundant as an alteration product of the wallrocks of many ore deposits. Most commonly it develops by alteration of feldspars and coarser grained micas, but the process of sericitization can proceed farther than this and attack many other minerals. In many mining districts sericite is also a true vein mineral. It is particularly abundant as a constituent of fault gouge but may also fill cavities between the other vein minerals. The finer grained sericites are closely related to clays in particle size and other properties and the relations between the two are not fully known.

Therefore many so-called sericites might prove to be other minerals as the science of clay mineralogy advances. No specific occurrences of sericite are given here.

NACRITE

$Al_2Si_2O_5(OH)_4$

[*See also* Clay minerals, Dickite, *and* Kaolinite]

Nacrite is one of three clay minerals—kaolinite, dickite, and nacrite—into which the mineral formerly known as kaolin or kaolinite is divided by modern mineralogists. Nacrite has only been described from one locality in the State, but is present in other places and has been called clay or kaolin.

Claylike material from the Eureka shaft, St. Peters Dome, El Paso County (loc. 5), was originally described and analysed by Cross and Hillebrand (1885), who called it kaolinite. Later, when Ross and Kerr (1931) subdivided the kaolin minerals, they worked on the same specimens and found the clay to be nacrite. They give chemical, optical, and X-ray data on the mineral, and point out that it is 1 of only 2 nacrite localities known at the time of their study.

NAGYAGITE

$Pb_5Au(Te,Sb)_4S_{5-8}$

Nagyagite is reported, with no details of its occurrence, from the Gold Hill and Sunshine districts, Boulder County (Endlich, 1878). It is also reported from the Coming Nation mine on Soda Creek near Idaho Springs, Clear Creek County. (Spurr and Garrey, 1908.) In this description, however, it is said to be a telluride of gold and silver; either the identification or the typography seem to be in error.

NAHCOLITE

$NaHCO_3$

Nahcolite, or naturally occurring sodium bicarbonate, is reported only from the Bureau of Mines oil-shale mine near Rifle, Garfield County. It is probably present, but unidentified to date, in oil shale of the Green River formation in other parts of northwestern Colorado. This suggestion is based on W. H. Bradley's report (1929) of the presence of saline phases of the shale in several places.

In the Rifle mine nahcolite occurs in unweathered shale as concretionary crystalline masses from pea size to 5 feet in diameter. In these concretions it ranges from colorless through white to brown and black. It also occurs as layers as much as 4 inches thick between the shale layers; here it is pure white and resembles satin-spar gypsum.

Ertl (1947) gives analyses; Glass (1947) describes the same occurrence and gives additional data on the optical properties.

NATRAMBLYGONITE*

[*See* Natromontebrasite]

NATROALUNITE

$NaAl_3(SO_4)_2(OH)_6$

[*See also* Alunite]

As described under alunite, several deposits in the State contain more sodium than potassium, hence belong technically to the species natroalunite.

NATROLITE

$Na_2Al_2Si_3O_{10}\cdot 2H_2O$

Natrolite is reported from five localities, all of them as cavity fillings in volcanic rocks and all associated with other zeolites. It is probably present in other similar environments.

Gunnison County.—Natrolite is the most abundant and widespread alteration product of the nepheline in the alkalic rocks of Iron Hill (loc. 2). Most of it is very finely fibrous and is mixed with other minerals. Locally, however, it is veinlike and is composed of coarser and purer natrolite than in the finely fibrous variety. (Larsen and Jenks, 1942—analysis.)

Hinsdale County.—Uncompahgre Peak. Natrolite is noted by Endlich (1878) as present in cavities in basalt.

Jefferson County.—Table Mountains (loc. 18). Natrolite was early noted as present among the zeolites of Table Mountains (Endlich, 1878). It is described from South Table Mountain by Cross and Hillebrand (1885), who give an analysis. There it forms delicate prisms and mealy crusts, mixed with other zeolites. In a few places it occurs on analcite in cavities or mixed with it in fissures; it can also be found as crystals or crusts perched on calcite, chabazite, and thomsonite. According to J. W. Adams (written communication), specimens can be obtained from the quarry on South Table Mountain and also from the old quarry on the south side of North Table Mountain. (See also Whitman Cross and Hillebrand, 1882a; Patton, 1900.)

Park County.—South Park (loc. 7). In the analcite-syenite bodies that form low ridges in South Park, 3 miles north of Hartsel, long prismatic crystals of natrolite with thomsonite and stilbite are present in analcite-lined cavities. (See also analcite.) (Jahns, 1938.)

NATROMONTEBRASITE

$(Na,Li)Al(PO_4)(OH,F)$

[*See also* Amblygonite *and* Montebrasite]

The rare lithium phosphate mineral natromontebrasite has been found at only one locality in the State, but there it has had a long history among mineralogists. It was first described as a sodium variety of amblygonite by Schaller (1911a, 1912), who called it natramblygonite. On further chemical and crystallographic study, Schaller (1916) withdrew the name natramblygonite and called the mineral fremontite. E. S. Larsen, Jr. (1921) gives the optical properties of fremontite. Still later Heinrich and Corey (1955) pointed out the identity of fremontite with the earlier-named natromontebrasite and the name fremontite was dropped. Thus Colorado lost two "type minerals" by discreditation for a single species.

Fremont County.—Eight Mile Park (loc. 4). Schaller (1911a, 1912, 1916) describes the locality as a large pegmatite mass 4 miles northwest of Canon City; this is the same body that was first described by Sterrett (1909) as a source of lepidolite and pink tourmaline. The natromontebrasite (then called natramblygonite) was massive or crystalline, grayish white to white with a vitreous luster, and it was cut by veinlets of both pink tourmaline and lepidolite. Heinrich and Corey (1955) describe the same locality and the Meyers quarry pegmatite, where montebrasite occurs instead of natromontebrasite.

NATRON

$Na_2CO_3 \cdot 10H_2O$

Natron has been specifically identified in only one place—the San Luis Valley, Costilla County. Many of the saline lakes in eastern Colorado, however, such as Soda Lake and others that lie between Bear and Turkey Creeks, just east of the foothills, contain sodium carbonate in solution. Although not yet identified as such, natron is almost certainly one of the minerals that form white deposits around the edges of such lakes during dry seasons.

Costilla County.—San Luis Valley. Many artesian wells in the vicinity of Soda Lake east of San Luis Lake and near the town of Mosca yield water that is colored brown by organic matter and that contains much sodium carbonate in solution. When springs and ponds dry up, the carbonate is deposited as the mineral natron in depressions locally as much as 4 feet thick and a third of an acre or more in extent. The masses of crystals are covered in places by yellowish-brown mother liquor. The upper parts of the crystalline mass, which is made up largely of natron, contain thin layers of bright thin prismatic needles that do not effloresce and are probably trona. Headden (1909) gives analyses of thoroughly dried natron and of the mother liquor.

NEPHELINE

$(Na,K)AlSiO_4$

Nepheline is an essential rock-forming mineral in nepheline syenite and other alkalic igneous rocks. Only two occurrences are given here, but it is probably present in other places.

Gunnison County.—Iron Hill (loc. 2). The Iron Hill ijolite, one of the alkalic rocks that is rare elsewhere but plentiful at this locality, is composed almost entirely of andradite garnet and nepheline. The nepheline makes up one-third and locally much more of the rock. Nepheline is also an essential mineral in the nepheline syenite and nepheline gabbro; it is also present locally in pyroxenite. In the ijolite outcrop on the hill between the forks of Beaver Creek, fragments of fresh nepheline several inches in diameter can be found on the surface; even larger pieces can be found with a little trenching. (E. S. Larsen, Jr., and Hunter, 1914; E. S. Larsen, Jr., and Goranson, 1943; E. S. Larsen, Jr., and Jenks, 1942.)

Teller County.—Cripple Creek district. Nepheline is the distinctive mineral of the phonolite rock that characterizes much of the district. It occurs as hexagonal prisms with basal planes; the crystals range from very small to about 2 mm in size. Many of the crystals, which are partly altered to stilbite and other zeolites, are rimmed by analcite. Pseudomorphs of sericite after nepheline are found near veins. (Lindgren and Ransome, 1906.)

NEPHELITE

[*See* Nepheline]

NICCOLITE

NiAs

Boulder County.—Gold Hill district, Copper King mine (loc. 1). Niccolite is a minor constituent of the nickel ore from this mine. It forms late veinlets in polydymite and other minerals. (Goddard and Lovering, 1942.)

Fremont County.—Pine Creek, Gem mine (loc. 9). Niccolite, partly altered to annabergite, was the chief ore mineral of the old Gem mine. An unknown, but apparently large amount of selected ore that contained 34 percent nickel and 3 to 4 percent copper was shipped to Swansea, Wales, for refining.

The deposit is in an irregular vein in gneiss or schist. The ore occurs as rounded or nodular masses disseminated through granular limestone. Niccolite forms globular and botryoidal aggregates; it is pale copper red with a grayish tint, but surfaces are coated with small indistinct black crystals. Chalcocite, with bornite and chalcopyrite are the copper minerals; wire silver occurs locally in large amounts. (Genth, analysis, 1886; Whitman Cross, 1885a; Charlton, 1893.)

NICHOLSONITE*

[*See* Aragonite]

NONTRONITE

Near $Fe_2^{+3}(Al_{0.33}Si_{3.67})O_{10}(OH)_2 \cdot 4H_2O \cdot Na_{0.33}$

[*See also* Clay minerals *and* Montmorillonite]

Nontronite is the iron-rich end member of the montmorillonite group of clay minerals. It was formerly considered a variety of chloropal but Ross and Hendricks (1945) showed that the two minerals are identical and the name chloropal has been dropped.

Nontronite has been reported from only a few places; it is probably much more widely distributed than indicated by the literature.

Boulder County.—Jamestown district. Nontronite, or a closely related mineral is, with sericite, the most abundant gangue mineral in the fluorspar deposits. (Goddard, 1946.)

Larimer County.—Specimen Mountain (loc. 5). Dendritic masses of "chloropal" mixed with allophane occur in chalcedony (see opal). (Wahlstrom, 1941.)

Sagauche County.—Bonanza district. Nontronite is described as a replacement of rhodochrosite in the oxidized ores of the Eagle mine. No optical data are given, and the commercial assay does not fit the composition of nontronite particularly well. The occurrence must be considered doubtful. (Wuensch, 1923.)

Teller County.—Cripple Creek district. Soft light-yellow "chloropal" analysed by Hillebrand is reported from the Ida May mine on Raven Hill. (Lindgren and Ransome, 1906.)

NOSELITE

$3Na_2Al_2Si_2O_8 \cdot Na_2SO_4$

Noselite, which is similar to haüynite but contains little or no calcium, is a rock-forming mineral in the phonolite rocks of the Cripple Creek district, Teller County. It may also be present in other alkalic volcanic rocks.

At Cripple Creek it forms well-developed dodecahedral crystals, 0.1 to 2 mm in diameter; many crystals are pale blue or green. Extremely small inclusions are arranged in two or more series of parallel lines, commonly more abundant near the peripheries of the crystals. Noselite was one of the first minerals to crystallize and is included in all other minerals of the phonolite but it is rare in nepheline. (Lindgren and Ransome, 1906.)

OCTAHEDRITE

[*See* Anatase]

OLIGOCLASE

[*See* Feldspar group, plagioclase series]

OLIGONITE

[*See* Rhodochrosite, var. ferroan rhodochrosite]

OLIVINE

$(Mg,Fe)_2SiO_4$

[*See also* Fayalite]

Chrysolite, or olivine, is a common constituent of many mafic igneous rocks and is an essential mineral in some of them. It is also present in a few metamorphic rocks. The few occurrences cited below give an idea of its distribution.

Custer County.—Rosita Hills. Present in some of the eruptive rocks. (Whitman Cross, 1888.)

Fremont County.—Iron Mountain (loc. 7). Olivine is present in the gabbro that encloses bodies of magnetite and ilmenite; it is also sparingly present as a gangue mineral in the titaniferous iron ore itself. (J. T. Singewald, Jr., 1913.)

Garfield County.—In basalt on the Colorado River below the mouth of the Eagle River. (Endlich, 1878.)

Gunnison County.—Chrysolite is the characteristic mineral in a small body of olivine gabbro on Willow Creek at the mouth of Sugar Creek. Olivine, augite, and labradorite are equally abundant, with less biotite, hypersthene, and magnetite. The olivine and augite enclose feldspar crystals poikilitically. (Hunter, 1925.)

Two small bodies of olivine-augite-orthoclase shonkinite crop out on Wildcat Gulch and Goose Creek. The gray olivine is partly altered to dusty magnetite and to serpentine. (Hunter, 1925.)

Monarch and Tomichi districts. The marble inclusion in quartz monzonite on Mount Stella contains many small rough crystals of olivine, partly serpentinized, together with magnetite and garnet. The mineral is also a minor constituent of other marble in both districts. (R. D. Crawford, 1913.)

Iron Hill area (loc. 2). Olivine is rare in the district as a whole but is present in large quantity in the nepheline gabbro. (E. S. Larsen, Jr., and Jenks, 1942.)

Pueblo, Huerfano, and Las Animas Counties.—Apishapa quadrangle. The most numerous dike rocks in this quadrangle are olivine-bearing augite vogesite. The olivine commonly forms phenocrysts as much as 1 cm in size. Some of it is very fresh but some is completely altered to chloritic aggregates. The mineral also occurs in olivine-plagioclase basalt where it is in better formed crystals than in the vogesite. (Whitman Cross, 1915; Stose, 1912.)

Rio Grande County.—The basaltic lava flows of the San Luis Valley contain transparent green chrysolite. It has also been noted in the rocks of a youthful volcanic crater near Cornwall. (Endlich, 1878.)

Teller County.—Cripple Creek district. It occurs in some of the basaltic dikes. (Lindgren and Ransome, 1906.)

San Juan Mountains.—Chrysolite is the chief or only phenocryst mineral in the basalts throughout the San Juan Mountains. It increases with decrease in silica and is not found in rocks containing more than 56 percent silica. In quartz basalt it is associated with quartz phenocrysts and is commonly present as phenocrysts in lava that contains either crystobalite or tridymite in gas cavities. Almost without exception the olivine in lava is partly or completely altered to iddingsite; in granular rocks it is commonly altered to serpentine. (E. S. Larsen, Jr., Irving, Gonyer, and E. S. Larsen 3d, 1936.)

ONYX

[*See* Quartz]

OPAL

$SiO_2 \cdot nH_2O$

Opal is very widespread, not only as a vein mineral in many ore deposits, but as an amygdule filling in volcanic rocks, as a hot-spring deposit, and as a major or minor constituent of petrified wood. Much beautifully banded opal has been found by collectors in many parts of the State; gem, or fire, opal however, has been reported very rarely and is probably nowhere abundant or of very fine quality.

To me, the most intriguing references to an occurrence of opal are those of Kunz (1887) and Church (1889). They describe a white opaque variety of hydrophane "from some Colorado locality." It occurs as rounded lumps 5 to 25 mm in diameter. It absorbs more than an equal volume of water, first becoming white and chalky, then perfectly transparent. Kunz says, "The finder has proposed the name 'magic stone' for it and has suggested its use in rings, lockets, and charms to conceal photographs, hair, or other objects which the wearer wishes to reveal only when his caprice dictates."

The descriptions abstracted here give some idea of the mode of occurrence and distribution of opal in Colorado. In addition to localities described, varieties have been noted by Endlich (1878), J. A. Smith (1883), Randall and other authors from the following places, among others:

Clear Creek County, Gilson Gulch, near Idaho Springs—blue and yellow, opalescent; Douglas County, Castle Rock—petrified wood; Eagle County, below junction of Eagle and Colorado Rivers—hyalite; Grand County, Hot Sulphur Springs—hyalite; Gunnison County, along Gunnison River—hyalite in basalt; Hinsdale County, along upper Rio Grande River—handsome varicolored opal in jasper boulders; hyalite on Godwin's Creek; Jefferson County, Table Mountains and Green Mountain—petrified wood and opal, some of it fire opal (Cross and Eakins, 1886); Larimer County, head of Cache la Poudre River—hyalite; Park County, south of salt works—brownish-yellow semiopal with jasper and chalcedony; Saguache County, near head of La Garita Creek—hyalite.

Boulder County.—Nederland tungsten district. Late opal is very common in the tungsten veins where it is commonly associated with beidellite and montmorillonite in vugs. The crusts of opal show that they were deposited under gravitational control. In the Clyde mine crusts of opal and beidellite form casts of coarse crystals of ferberite. (Lovering and Tweto, 1953.)

Chaffee County.—Buffalo Peaks. Milk-white common opal is abundant on Buffalo Peaks as irregular masses several feet in diameter. The central parts are opaque flinty chalcedony from which the opal is derived by hydration. Some hyalite is also reported. (Whitman Cross, 1883.)

Custer County.—Rosita Hills. A mixture of opaline silica and kaolin results from the alteration of spherulites and pitchstone in the rhyolites. Some masses are completely replaced by these minerals, with opal comprising about 65 percent of the mass. (Whitman Cross, 1896.)

Gunnison County.—Vulcan district (loc. 5). Much opal occurs as geyserite with patches of fire opal in the upper part of the Good Hope mine. Some of it is very rich in gold, especially where the opal is tinted purple, possibly by tellurium salts. (Rickard, 1903.)

Lake County.—Leadville district. Opal and chalcedony occur in large quantities as alteration products of porphyry rocks and ore deposits, but they are significantly rare or absent in the primary ores. In some places there are beautiful opalescent layers on the oxidized ore as much as one-fourth inch thick and 6 or 8 inches square. In the Ibex and Belgian mines opal is associated with aurichalcite and hemimorphite as fillings in cavities and fractures. (S. F. Emmons, Irving, and Loughlin, 1927.)

Larimer County.—Specimen Mountain (loc. 5). Specimen Mountain, a denuded explosive volcano in the northwest corner of Rocky Mountain National Park is one of the State's few really fine localities for collecting opal and related forms of silica.

Grayish- to reddish-brown chalcedony and jasper occur in faults and in pitchstone flows. More important, agate, onyx, opal, and calcite fill or partly fill abundant geodes. No gem opal has been found, but some of it is transparent and many beautiful specimens have been collected. Platy calcite is partly or completely replaced by opal and chalcedony in places. Among other references see especially Wahlstrom (1941, 1944). Onyx of the type desired for cameos is mentioned by Conn (1939).

Mesa County.—Opal Hill (loc. 1), 4 miles south of Fruita and the hills westward from there into Utah abundant opalized wood occurs, but there are very few large unfractured pieces. Most of the material is milk white but some is black, brown, and pea green. (Minor, 1939.)

Mineral County.—The gravel terraces along the Rio Grande River in Mineral County have long been known to contain opal-filled geodes from 3 inches in diameter upward. Some of the white opal north of Creede locally yields fine fire opal. (J. A. Smith, 1883; Shaw, 1946.)

Teller County.—Cripple Creek district. Opal is common in the ore deposits, where it generally represents the last phase of primary vein formation or is in the oxidized ores. It is especially abundant in the Zenobia mine, as yellow masses of tangled wires and rods. Locally it occurs in vugs to great depths. (Lindgren and Ransome, 1906.)

Yuma County.—On the South Fork Republican River, 20 miles north of Burlington, there is a deposit of good quality moss opal that takes an excellent polish. The mineral fluoresces a beautiful green. (Hoskin, 1947.)

OSMIUM

[*See* Platinum]

ORTHOCLASE

[*See* Feldspar group]

OWYHEEITE

$Pb_5Ag_2Sb_6S_{15}$

Owyheeite has been found in only one locality. Robinson (1949) restudied a group of specimens of "warrenite" (see boulangerite) from the Domingo and Garfield (King Cole) mines, Ruby district, Gunnison County. Using X-ray and chemical methods, he determined that most of the specimens were owyheeite, 3 were jamesonite, and 1 was boulangerite.

PACHNOLITE

$NaCaAlF_6 \cdot H_2O$

Pachnolite, known from only a few localities in the world, is known in Colorado only at St. Peters Dome, El Paso County (loc. 5), where it is associated with cryolite and other rare fluorine minerals. An alteration product of cryolite, most of it is massive, but cavities in the massive pachnolite contain small transparent twinned crystals of the same mineral. Whitman Cross and Hillebrand (1883b, 1885), who were the first to describe the occurrence, record four analyses.

Landes (1935) says that pachnolite is the most abundant fluorine mineral, and the third most abundant mineral of any kind, in the pegmatite. It is white, or rarely pale green, and opaque in hand specimens. Polysynthetic twinning can be seen in some grains. All stages of replacement between cryolite and pachnolite can be observed. When replacement is incomplete the pachnolite is translucent but where complete replacement has taken place it is chalky. The contacts between grains or masses of cryolite and of feldspar are very likely to be occupied by pachnolite.

PALLADIUM

Pd

Palladium has been reported only from the La Plata district, La Plata County, and even there its presence has been shown only by chemical assay, rather than by identification of the mineral.

The Copper Hill mine, one-half mile west of the town of La Plata and between Boren and Bedrock Creeks, exploits a deposit of disseminated chalcopyrite, with hematite, magnetite, and pyrite. Samples of the chalcopyrite ore contain small amounts of both platinum and palladium in about equal proportions which vary directly with the percentage of copper. Studies of polished sections of the ore failed to disclose the mode of occurrence of the platinum metals; they may be in solid solution in the chalcopyrite. (Eckel, 1938; Schwartz, Varnes, and Eckel, 1949.)

PARAGONITE

$NaAl_2(AlSi_3)O_{10}(OH)_2$

Paragonite, the sodium analogue of muscovite, has only been reported once to my knowledge. This claylike mixture, locally called Chinese talc, is in the Leadville district, Lake County. It is composed of sericite, paragonite, potash- and soda-alunite, and kaolinite. Most of this mixture is formed by replacement of carbonate minerals, but some replaces porphyry. (S. F. Emmons, Irving, and Loughlin, 1927.) The mineral is probably present elsewhere and has been either ignored or mistaken for muscovite, sericite, or kaolinite.

PARAMONTROSEITE†

VO_2

Paramontroseite is a metastable form of VO_2 that results from oxidation of crystals of montroseite. Its type locality is the Bitter Creek mine, Paradox Valley, Montrose County—the same mine where montroseite was first found. (Evans and Mrose, 1955.) It is commonly present as remnant slivers in doloresite in most of the places where that mineral has been found in Mesa and Montrose Counties. (Stern, Stieff, Evans, and Sherwood, 1957.)

PASCOITE

$Ca_2V_6O_{17} \cdot 11H_2O$

Pascoite is known in Colorado only from the uranium-vanadium ores of the Colorado Plateau but is fairly widespread there. The first mention of its occurrence is that of Hess (1924). In his description of vanoxite from the Henry Clay claim at Long Park, on the northeast side of Paradox Valley, Montrose County, he says that mined vanoxite-bearing rocks, if protected from the weather, develops beautiful orange crusts of pascoite.

Pascoite is one of several oxidation products of montroseite at the Bitter Creek mine, Montrose County, type locality of that mineral, and elsewhere (Weeks, Cisney, and Sherwood, 1953). In Colorado it has been positively identified in ore from the Bitter Creek and Mill No. 1 mines, Uravan district, Montrose County, and from the La Sal No. 2 mine, Gateway district, Mesa County. (Weeks and Thompson, 1954.)

PEARCEITE

$Ag_{16}As_2S_{11}$

[*See also* Polybasite]

Pearceite, named for a Coloradoan (Richard Pearce) but not a type Colorado mineral because the species was based on material from Montana, is present in many silver ores in Colorado and is extremely abundant in some of them. Pearceite is isomorphous with the antimony-bearing mineral polybasite. Both minerals occur in Colorado, and are found together in some ores. Because the identity of pearceite was not known at the time, the early descriptions of pearceite describe it as arsenic-bearing polybasite.

Boulder County.—Nederland tungsten district. Pearceite occurs in the supergene ore of a small prospect just north of Sherwood Gulch. Both polybasite and miargyrite are more widespread and abundant in the district than pearceite. (Lovering and Tweto, 1953.)

Dolores County.—Rico district. Primary pearceite is very abundant in polished sections of high-grade silver ores from several mines on Newman Hill. (Bastin, 1923.)

Gilpin County.—Central City district. Pearceite, some of it well crystallized, occurs with polybasite, proustite, native silver, chalcopyrite, and rare galena as oxidation products of galena-sphalerite ores. (Penfield and Pearce, 1892; Bastin and Hill, 1917.)

La Plata and Montezuma Counties.—La Plata district. Pearceite was found only in ore from the Cumberland mine in the ruby-silver belt near the north end of the district. Polished sections of the ore show an intergrowth of a pink isotropic mineral and a white anisotropic one. These give almost identical etch tests that are close to those of pearceite and both are probably pearceite or closely related to it. (Galbraith, 1949.)

Ouray County.—Ouray district. Arsenical polybasite, later called pearceite, is noted from the Yankee Boy mine by Penfield and Pearce (1892). They also note it in the ores from Red Mountain, Ouray and San Juan Counties.

In ores from the Bachelor and Wedge mines, pearceite is intergrown with tetrahedrite. In the Atlas mine, near Mount Sneffels, it occurs as small crystals in the vugs of tennantite. Most of the silver produced by the Yankee Boy mine was in the form of proustite, pearceite, and argentiferous tennantite. (Basin, 1923.)

Park and Summit Counties.—Montezuma district. Pearceite, here probably of primary origin, was noted only on the dump of the Star of the West No. 2 mine, on the west slope of Teller Mountain. It forms small blebs in galena. Quartz and tennantite, which replaces chalcopyrite, are associated. (Lovering, 1935.)

Pitkin County.—Aspen district. Pearceite, earlier called polybasite by Penfield and Pearce (1892) and by Spurr (1898), was the most abundant silver mineral in the famous Molly (Mollie) Gibson mine; large quantities of nearly pure pearceite that yielded from 10,000 to 16,000 ounces of silver to the ton were mined and shipped to the smelter. Pink barite with disseminated pearceite in sufficient quantity to yield 1,800 to 2,700 ounces of silver to the ton was very abundant, but pearceite also occurred as streaks and particles in shale and limestone along the borders of the deposit; some seams of coal above the shale were rich in silver. In some specimens brown fine-grained crystals of mixed carbonate coat tabular crystals of pearceite. (Pearce and Penfield, 1892; Penfield, 1898—analyses.)

Pearceite was found by Bastin (1925) to belong to the late hypogene stage of mineralization, associated with galena, sphalerite, chalcopyrite, and bornite; it is also present as a secondary mineral but as such is much less abundant than in the primary ore.

A specimen of pearceite from the Molly Gibson mine is one of those included in a modern chemical and X-ray study of the species by Peacock and Berry (1947). The specimen used is an intergrowth of rough dull-black hexagonal plates.

Saguache County.—Bonanza district. A mineral similar to pearceite, but in too-small quantity for positive identification is intergrown with galena in ores from the 600-foot level of the Eagle mine and from the 400-foot level of the Rawley mine. It is rare as compared to pyrargyrite and is undoubtedly of primary origin. (Burbank, 1932.)

San Miguel County.—Telluride district. Arsenical polybasite, later called pearceite, is reported in ores from Marshall Basin by Penfield and Pearce (1892). It was found in polished sections of ores from the Liberty Bell mine. There it is associated with tetrahedrite, the common sulfides and both primary and secondary argentite. The pearceite is probably primary. (Bastin, 1923.)

PENNINITE

[*See* Chlorite group]

PENTLANDITE

$(Fe,Ni)_9S_8$

Pentlandite, or a mineral that resembles it closely, is one of the primary nickel-bearing minerals in the Copper King mine, Gold Hill district, Boulder County (loc. 1). Polydymite is the most abundant of these, but bravoite, violarite, and pentlandite(?) are also present. All are disseminated through the host rock or form networks of veinlets that replace the silicate minerals. (Goddard and Lovering, 1942.)

PEROVSKITE

$CaTiO_3$

Perovskite is reported only from the Iron Hill area, Gunnison County (loc. 2). It may be present as a microscopic constituent of chlorite- or nepheline-bearing rocks in other places. At Iron Hill it occurs as a primary mineral in the uncompahgrite rock. In a few specimens a late generation forms narrow rims around magnetite and primary perovskite, adjacent to grains of melilite. Late perovskite is yellow brown and much lighter than the early kind. Small grains of the mineral are associated with bands of garnet that surround masses of magnetite. (E. S. Larsen, Jr., and Hunter, 1914; Larsen and Goranson, 1932; Larsen and Jenks, 1942.)

PETRIFIED WOOD

[*See* Opal *and* Quartz]

PETZITE

Ag_3AuTe_2

Petzite is one of the most widespread of the telluride minerals, yet it is less abundant in most districts than some other tellurides.

Boulder County.—Petzite was one of the first telluride minerals to be identified in Colorado. It is reported from the Red Cloud mine at Gold Hill by Eilers (1873), who gives assay values of the ore; by Genth (1874) with analyses; and by Endlich (1878) who also gives an analysis. Silliman (1874a, b) felt that the mineral was too low in gold content to be petzite, and considered it to be auriferous hessite. By 1883, J. A. Smith could report it as having been found in the American, Slide, Prussian, Cold Spring, and other mines.

At the Enterprise mine near Eldora, "the dark gray quartz carries finely disseminated tellurides, chiefly petzite, which render a width of 2 to 2½ feet sufficiently rich to yield an average of 2 ounces of gold to the ton." (Rickard, 1902.)

In a modern study of the Magnolia district, Wilkerson (1939) found sylvanite to be the chief ore mineral in the telluride veins; it is accompanied in all specimens examined by one or more other tellurides—calaverite, hessite, petzite, coloradoite, and altaite. The tellurides, which are locally abundant, occur in blades 1.5 to 2.5 mm long in veins that range from 1 inch to 4 feet in width.

At Gold Hill, Goddard (1940) found petzite and sylvanite to be the most abundant tellurides, with hessite abundant locally. He also found a little altaite and coloradoite, but did not find the tetradymite, calaverite, and native tellurium reported by Genth (1874) from ores that have long since been removed. In the Slide mine, roscoelite is closely associated with the tellurides. Free gold is locally abundant in the Logan, Red Cloud, Cold Spring, and Emancipation mines.

At least one specimen labelled as petzite from the Red Cloud mine is actually empressite (R. M. Thompson, Peacock, Rowland and Berry, 1951) but the presence of petzite in this and other Boulder County mines nevertheless seems to be well established.

Clear Creek County.—Petzite is reported from the Bear Creek district by Schrader, Stone and Sanford (1916), and from the Argentine district by Randall.

Custer County.—Silver Cliff district. A telluride mineral, probably petzite but apparently having a very low tellurium content, is mixed with tetrahedrite and quartz in interstitial material in breccia at the Bassick mine (see jamesonite). (Grabill, 1882; S. F. Emmons, 1896.)

Eagle County.—Gilman (Red Cliff) district. Small inclusions of hessite and petzite, with blebs of free gold occur with galena in the pyrite-chalcopyrite ore of chimneys in limestone. These are followed by a large number of silver minerals. (Tweto and Lovering, 1947.)

Gunnison County.—Petzite is probably the chief gold-bearing mineral in the Good Hope and Mammoth Chimney mines at Vulcan (loc. 5). This is the type locality o fthe copper tellurides, rickardite and weissite. (Rickard, 1903; Ford, 1903; W. P. Crawford and Johnson, 1922;[6] W. P. Crawford, 1927.)

Hinsdale County.—Lake City district. Petzite is present in ore from the Golden Fleece and probably in that of the Gallic-Vulcan and Hotchkiss mines. It forms irregular bunches, irregularly distributed through white dense granular quartz or disseminated through chalcedonic quartz. Tetrahedrite and other minerals are associated with it. (Irving and Bancroft, 1911.)

La Plata County.—Needle Mountains. Small quantities of petzite are associated with tetrahedrite in the northeastern part of the Needle Mountains quadrangle. They form small masses or pockets, with the common sulfides of iron, copper, lead, and zinc in a quartz-calcite-barite gangue. (Whitman Cross, Howe, Irving and Emmons, 1905; W. H. Emmons, 1906a.)

La Plata and Montezuma Counties.—La Plata district. Petzite is less abundant than hessite, krennerite, and coloradoite, but more abundant than sylvanite and calaverite. It is intimately intergrown with the other hypogene tel-

[6] Crawford, W. P., and Johnson, Frank, Geology and cyanidation of ore from the Good Hope mine, Vulcan, Colorado: Unpublished thesis, Colorado School of Mines, Golden, 1922.

luride minerals and in some ores forms a subgraphic pattern of tiny wormlike inclusions in hessite. (Galbraith, 1949.)

Rio Grande and Conejos Counties.—Platoro-Summitville district. The presence of tellurides in the district is well established, but the identity of the minerals is vague. In the Mammoth mine, for example, a telluride thought to be petzite occurs in some of the very rich gold ore, associated with quartz, arsenopyrite, and several silver minerals. Most of the gold in the Gilmore vein on Klondyke Mountain is contained in an unidentified telluride, possibly petzite. A quartz vein in the Eurydice mine near Stunner also contained tellurides of gold and silver, in addition to sulfide minerals. (Patton, 1917.)

Saguache County.—Bonanza district. Petzite is listed by Patton (1916) as present in the district, but it was not found in the specimens available to Burbank (1932).

Teller County.—Cripple Creek. Petzite is doubtfully reported from the Gold King mine, but if present in the district at all it is certainly in very small amounts. (Lindgren and Ransome, 1906.)

PHENACITE

[*See* Phenakite]

PHENAKITE

Be_2SiO_4

Crystals of phenakite, also spelled phenacite, occur in abundance in three localities in Colorado. All three have produced many gem specimens, and the crystallography has been studied by several mineralogists. The literature on these occurrences is imposing and not all the important reports are cited here. In addition to the three localities described below, phenakite is reported from the Gold King mine at Cripple Creek, Teller County.

Chaffee County.—Mount Antero (loc. 3). Mount Antero is almost as well known as a source of gem phenakite as it is of aquamarine beryl. Penfield (1887) describes the crystallography of phenakite from here and from Crystal Park and Florissant. They are associated with beryl, quartz, and feldspar. He notes two crystals that are three-fourths inch in diameter and points out that the Mount Antero crystals are prismatic rather than rhombohedral in habit; this corresponds with occurrences in Russia, where phenakite crystals on amazonstone are lenticular but those on emerald (beryl) crystals are prismatic. A more detailed description of the crystallography is given by Penfield and Sperry (1888) and by Penfield (1890). In the latter report Penfield describes a beautiful crystal which has partly enclosed crystals of bertrandite and beryl. He also notes and illustrates several twinned phenakite crystals. Production of $500 worth of phenakite crystals in 1888 is recorded by Kunz (1890a); none were suitable for cutting as gems. An interesting account of the occurrence of phenakite, aquamarine, bertrandite, and topaz is given by Sterrett (1909). Discovery of fine crystals, some perched on aquamarine and some on smoky quartz, is described by Over (1928, 1935). In addition to the finest twin crystal ever found on Mount Antero, he mentions pockets of clear smoky quartz crystals with a great many small single and twinned crystals of phenakite. Many details of the crystallography of mineral from this locality are given by Pough (1936) and Switzer (1939a, b).

El Paso County.—Crystal Park (loc. 2). The first find of phenakite in the United States was recorded from Crystal Park by Whitman Cross and Hillebrand (1882c). This discovery amounted to fragments of two crystals, one 2.5 cm long and the other 7 cm long. By 1884, about 50 crystals had been found in a single year (Kunz, 1885). At least a quarter of these were of gem quality. The largest crystal was 3 inches across. The crystal habit, here rhombohedral rather than prismatic, is described by Penfield (1887). Associated with topaz, zircon, amazonstone, and smoky quartz, the colorless transparent crystals are relatively large and most of them are broken. The history of the deposits, and good descriptions of the locality, are given by Pearl (1941e, 1951a).

Teller County.—Crystal Peak (loc. 2). The Crystal Peak locality, also known as "Florissant," Topaz Butte, and other names, is the most productive of phenakites in Colorado. The first mention of it in the literature is that of Whitman Cross and Hillebrand (1882c), who describe the very small and perfectly flat crystals as perched on amazonstone and associated with topaz, albite, limonite, and smoky quartz.

All crystals are small, and range from clear through pale yellow to gray; many are highly modified and of great interest to crystallographers. The crystallography is described by, among others, Kunz (1885), Hidden (1885 and 1886), Penfield (1887) and Pough (1936). An analysis of the mineral is given by Penfield and Sperry (1888).

Among the more complete and interesting descriptions of the locality are those of W. B. Smith (1886a), Sterrett (1909, 1914), Landes (1935) and Pearl 1941h, 1958).

PHLOGOPITE

$KMg_3(AlSi_3)O_{10}(OH)_2$

Phlogopite, a light-brown magnesium mica, has been noted at only one locality to my knowledge, but it is more widespread than this in rocks formed by metamorphism of calcareous sedimentary rocks. Phlogopite is the principal mica in the anthophyllite skarn of the Copper King uranium deposit, Larimer County (loc. 3). (Sims, Phair, and Moench, 1958.)

PHOSGENITE

$Pb_2(CO_3)Cl_2$

Phosgenite has been reported from only one locality, but it is abundant there, and occurs in large masses. This is at the Terrible mine at Ilse (Oak Creek), Custer County. The mineral is clear brown with adamantine luster and three perfect cleavages; it is always surrounded by cerussite which seems to be an alteration product of the phosgenite. Unlike the surrounding cerussite, it contains no strontium. (Warren, 1903; Brinsmade, 1907; Hunter, 1914; Waldschmidt, 1923.)

PHOSPHURANYLITE

Phosphuranylite is a hydrated phosphate of calcium and uranium of uncertain formula. An extremely fine grained alteration product of uraninite from the Aubrey Ladwig lease, SW¼ sec. 18, T. 3 S., R. 70 W., Jefferson County, was determined by X-ray analysis to be this mineral. (D. M. Sheridan, written communication.)

PICKERINGITE

$MgAl_2(SO_4)_4 \cdot 22H_2O$

Pickeringite, the magnesian alum, has been reported from only two localities but it is probably present in other places as an efflorescence.

Delta County.—Gunnison Forks sulfur deposit (loc. 1). Pickeringite is widely distributed in the middle unit of the Dakota sandstone as white powdery patches or fibrous incrustations. (Dings, 1949.)

El Paso County.—Colorado City. Efflorescences of pickeringite are described as from near Colorado City and Monument Park; it is clear that the locality is just west of Colorado Springs and near the Garden of the Gods. Goldsmith (1877) who gives an analysis, says this is the first recorded observation of the mineral in the United States. (Endlich, 1878; J. A. Smith, 1883.)

PICOTITE

[*See* Spinel]

PICROTITANITE

[*See* Ilmenite]

PIEDMONTITE

$HCa_2(Al,Mn)_3Si_3O_{13}$

Piedmontite, essentially a manganese epidote, is noted as a rare product of the resorption of biotite in some volcanic rocks of the San Juan Mountains. (E. S. Larsen, Jr., Irving, Gonyer and E. S. Larsen 3d, 1936.)

PIGEONITE

[*See* Pyroxene group]

PINTADOITE

$Ca_2V_2O_7 \cdot 9H_2O$

Pintadoite occurs as stains in cracks in sandstone or on rocks exposed on dumps. Although first identified in Utah, it is also reported from the Jo Dandy group on the southwest wall of Paradox Valley, Montrose County. There it is associated with vanoxite, tyuyamunite, and hewettite. (Hess, 1924a.) It has not been reported during the exhaustive studies of uranium deposits on the Colorado Plateau that have been done since World War II.

PISANITE

$(Fe,Cu)SO_4 \cdot 7H_2O$

[*See also* Melanterite]

Pisanite, called cuprian melanterite by some authors, has been reported only once in Colorado. It is almost certainly present elsewhere as postmining efflorescence or stalactitic growths but it either has been grouped with melanterite or dismissed as one of the unimportant sulfate minerals.

In the Wellington mine of the Rico district, Dolores County, pisanite is abundant as crusts on timbers and on the walls of a large body of pyrite that contains large amounts of galena and sphalerite and a little chalcopyrite. Other oxidation products are gypsum, chalcanthite, and unidentified ferric sulfates. The pisanite, which contains enough zinc to be classed as zincian pisanite, ranges from delicate green with a bluish tinge to blue green in color. Eckel (1933b) records an analysis and the results of dehydration experiments on the mineral.

PITCHBLENDE

[*See* Uraninite]

PLAGIOCLASE SERIES

[*See* Feldspar group]

PLATINUM

Pt

Platinum and the other metals of the platinum group have been reported from time to time in the black sands of some placers and in a few lode deposits. Some of these reports are unsubstantiated, and with the possible exception of the Copper Hill deposit, La Plata County, none seem to have commercial value. S. F. Emmons (1885) gives a list of reported occurrences.

Boulder County.—Caribou district. Newspaper report (Randall).

Chaffee County.—In black sands near Buena Vista (Schrader, Stone and Sanford, 1916). Black-sand concentrates from a placer near Buena Vista contained by assay $12.90 in platinum per ton. The gravel in the placer contains about 27 pounds of the black sand per cubic yard (Day and Richards, 1906).

Clear Creek County.—Georgetown district. One locality in the Centennial mine is reported to have yielded ore that assayed $3 per ton in platinum and iridium. (Spurr, and Garrey, 1908.)

Hinsdale County.—In a lode near the White Cross district. (Randall.)

Lake County.—Granite district. In ores of the B. and M., General Logan, and other mines. Newspaper report. (Randall.)

La Plata County.—La Plata district. Small but appreciable quantities of platinum and palladium are present in the chalcopyrite ore of the Copper

Hill mine, between Boren and Bedrock Gulches and about one-half mile west of the town of La Plata. Negligible quantities of other elements of the platinum group—osmium iridium, rhodium, and ruthenium—are also present. Thorough sampling of the deposits by the U.S. Bureau of Mines and geologic study by the U.S. Geological Survey indicate that the remaining ore is too low in grade to be of much commercial interest, but as the platinum metal content of the ore seems to vary directly with the percentage of copper, and as some of the chalcopyrite ore mined some years ago was rich, appreciable quantities of platinum and palladium probably once went to the smelter from this deposit. Although the presence of the platinum metals has been definitely established, their mode of occurrence is still unknown. Microscopic examination of polished sections of the chalcopyrite ore has failed to reveal platinum metals or minerals; they may be in solid solution in the chalcopyrite. (Eckel, 1938; G.M. Schwartz, Varnes, and Eckel, 1949.)

Ouray County.—Platinum made up 1.18 percent of the gold assay button from a sample of black sands from a placer deposit. The button also contained iridosmium. (Day and Richards, 1906.)

Park County.—In a lode in Mosquito Gulch. Newspaper report of 1878. (Randall.)

Pitkin County.—Aspen district (Schrader, Stone and Sanford, 1916.)

Saguache County.—Liberty mine (Schrader, Stone and Sanford, 1916.)

San Miguel County.—A discovery of platinum in a bed of sandstone known to be rich in gold is reported from Naturita Canyon, near Norwood. (Engineering and Mining Journal, 1911.) Platinum is also reported from the Telluride district. (Schrader, Stone and Sanford, 1916.)

PLEONASTE

[*See* Spinel]

PLUMBOGUMMITE

$PbAl_3(PO_4)_2(OH)_5H_2O$

Plumbogummite, formerly also called hitchcockite, has been reported only from the Dallas mine, Black Hawk district, Gilpin County, where it was crusted on minerals of lead and copper. (Endlich, 1878.)

PLUMBOJAROSITE

$PbFe_6(SO_4)_4(OH)_{12}$

[*See also* Jarosite]

Plumbojarosite, in which lead takes the place of the potassium in jarosite, is mixed with abundant jarosite and other oxidation products beneath the rich lead carbonate ores of Carbonate Hill, Leadville district, Lake County. As noted under jarosite it is possibly also present in other districts. (S. F. Emmons, Irving and Loughlin, 1927.)

POLYBASITE

$(AgCu)_{16}Sb_2S_{11}$

[*See also* Pearceite]

Polybasite, which is isomorphous with the arsenic-bearing mineral pearceite, seems to be more widely distributed than pearceite. However, some of the material originally described as polybasite may be pearceite, as at Aspen, Pitkin County, where Penfield and Pearce (1892) and Spurr (1898) ascribed to polybasite the rich and abundant silver mineral that Penfield (1898) later determined to belong to the new species pearceite. Whether any true polybasite occurs in the Aspen ores is uncertain, as Bastin (1925) found none in the specimens he examined.

Boulder County.—Nederland tungsten district. Polybasite, intergrown with miargyrite, contributes much to the richness of the early copper-silver ores. (Lovering and Tweto, 1953.)

Chaffe County.—Winfield district. A little polybasite occurs in the bismuthinite-bearing ore of the Banker mine. (E. P. Chapman, Jr., written communication.)

Clear Creek County.—Tabular crystals of polybasite were found in the Terrible mine at Georgetown (Endlich, 1878). It was also relatively abundant as masses, platy crystals, and aggregates in the Griffith, American Sisters, and other mines. (Genth, 1886—analysis from Terrible mine.) It was seen as free crystals on the walls of druses in several mines, where it followed galena and sphalerite but preceded deposition of the carbonate minerals. (Spurr and Garrey, 1908.)

Custer County.—Silver Cliff district. Polybasite is possibly present in the Geyser mine, associated with galena. (S. F. Emmons, 1896.)

Dolores County.—Rico district. Crystals of polybasite, argentite, stephanite (?), and proustite occur in vugs in the ores of Newman Hill. (Ransome, 1901a.)

Eagle County.—Gilman (Red Cliff) district. Polybasite and several other late silver minerals occur in vugs in the copper-silver chimney deposits in limestone. In addition to the silver minerals the ore contains pyrite and chalcopyrite with a little hessite, petzite, and free gold. (Tweto and Lovering, 1947.)

Gilpin County.—Central City district. Polybasite, containing pearceite, proustite, native silver, chalcopyrite, and a little galena occur in the oxidized ores derived from galena-sphalerite bodies. (Penfield and Pearce, 1892; Bastin and Hill, 1917.)

La Plata and Montezuma Counties.—La Plata district. Polybasite is reported by Whitman Cross, Spencer and Purington (1899) from the Daisy-Hibernia workings, associated with the usual base-metal sulfides and free gold in quartz. None was found in the specimens studied by Galbraith (1949).

Ouray County.—Tabular hexagonal crystals, associated with pyrargyrite in quartz, are described from the Yankee Boy mine, near Ouray. (Endlich, 1890.) In a modern study of the species, Peacock and Berry (1947) give new chemical and X-ray data on a specimen from this same mine. It consists of isolated dull hexagonal plates, with quartz and galena.

San Juan County.—Silverton and Red Mountain districts. Polybasite is present in several mines in these districts; it is invariably in near-surface ores. (Ransome, 1901b.)

San Miguel County.—Telluride district. Polybasite, with other silver minerals, is known in the Smuggler, Mendota, Sheridan, and other mines, where it is associated with the common sulfides, calcite, rhodochrosite, and a little quartz. (Purington, 1898.) In ore from the Smuggler Union mine, polybasite is intergrown contemporaneously with tetrahedrite; it has been seen in several specimens from the 1,800- and 1,900-foot levels. More commonly it fills tiny vugs in white vein quartz, where it is associated with tetrahedrite, silver, and gold. A single specimen from the 1,900-foot level contains well-formed crystals of pyrargyrite and polybasite on quartz in vugs. The pyrargyrite crystals are molded around the striated faces of the polybasite. (Hurst, 1922.)

POLYDYMITE

Ni_3S_4

Polydymite is reported from only 1 of the 2 known nickel deposits in Colorado—the Copper King mine, Gold Hill district, Boulder County (loc. 1). Here it is the most abundant primary ore mineral of nickel, associated with bravoite, violarite, and pentlandite. These minerals are disseminated through the coarser grained layers of the amphibolite host rock, or form networks of veinlets that replace the silicate minerals. The primary ore contains from 0.48 to 6.0 percent nickel; the oxidized ore, in which the sulfides are largely altered to garnierite, contains from 1.3 to 13.0 percent nickel. Goddard (1940) notes the presence of several other minerals that apparently were not substantiated by the more detailed work reported by Goddard and Lovering (1942).

POTASH ALUM

$KAl(SO_4)_2 \cdot 12H_2O$

Potash alum, also called kalinite, was reported from several localities during the 19th century; it seldom has been reported since that time. It is probably much more widespread than the record indicates. Possibly some of the "alkali" in soils and dry lakes throughout the States may be potash alum, although this is not substantiated by Headden (1918), who ascribes most of the "alkalis" of Colorado to salts of sodium and magnesium, rather than to salts of potash.

Alum is noted by Randall, and by George (1913), from the following localities: Fremont County, near Canon City; Jefferson County, Mount Vernon and Turkey Creeks; Larimer County, on Little Thompson River; Pueblo County, near Beulah. The Turkey Creek locality was first mentioned by Hollister (1867) and later by Williams (1885). George (1913) adds that alum occurs at other points in the Cretaceous shales east of the Front Range.

Delta County.—Gunnison Forks sulfur deposit (loc. 1). Lenticular seams, less than 0.3 inch thick, of colorless fibrous potash alum are present in a few places in the sulfur quarry. (Dings, 1949.)

POWELLITE

$Ca(Mo,W)O_4$

Powellite has been reported from only two localities. One of these is in a "vein-bed" in schist, 2 miles southeast of Black Hawk, Gilpin County. One small shipment of tungsten ore, which was made up of garnet, epidote, and powellite, has been recorded. (G. O. Argall, Jr., 1943.)

A quartz-feldspar "vein" near Wolf Creek, Gunnison County, contains much scheelite and some powellite. (G. O. Argall, Jr., 1943.)

PRASE

[*See* Quartz]

PREHNITE

$H_2Ca_2Al_2(SiO_4)_3$

Prehnite is listed by Endlich (1878) from the mines near Fairplay, Park County; it has not been reported by later workers.

The only other report of its occurrence in Colorado is that of Eckel (1932), who found very small quantities of prehnite in amygdules in lava on Mount Sneffels, Ouray County. Other minerals in the amygdules are andradite garnet, epidote, albite, and quartz.

PROCHLORITE

[*See* Chlorite group]

PROSOPITE

$CaAl_2(F,OH)_8$

St. Peters Dome, El Paso County (loc. 5), is the only reported Colorado locality for prosopite and one of the few in the world where unaltered specimens have been found. The prosopite is commonly massive, and only a few small crystals have been noted. It is associated with pachnolite, thomsenolite, and gearksutite, all alteration products of cryolite. (Whitman Cross and Hillebrand, 1883, 1885—analyses.)

According to Landes (1935), the prosopite occurs as scattered glassy blades or bundles of blades embedded in the earlier fluorides, or as veins that cut the fluorides or follow the contacts between feldspar and cryolite. Some of the prosopite occurs in very dense translucent white masses.

Pauly (1954) who made an exhaustive study of older specimens from St. Peters Dome, found that much of the material identified as cryolite is actually weberite. This mineral, then, must be listed as an associate of prosopite. A small aggregate of colorless transparent tabular crystals of prosopite which fill a druse in massive pachnolite, was described by Ferguson (1949) in a modern X-ray study of the prosopite species.

PROUSTITE

Ag_3AsS_3

[*See also* Pyrargyrite]

Proustite and pyrargyrite, the ruby-silver minerals, are widely distributed in the State and in some places have yielded important amounts of silver. The two minerals occur together in many deposits; in some reports no distinction has been made between them and they have been simply reported as "ruby silver."

Boulder County.—Caribou district. Proustite is closely associated with argentite as late primary minerals; they are followed by native silver. (H. D. Wright, 1954.)

Nederland tungsten district. The ruby-silver minerals occur in small quantity in vugs in the Quaker City and Hugo veins. (Lovering and Tweto, 1953.)

Clear Creek County.—Handsome specimens of both proustite and pyrargyrite were intergrown with galena in the Brown lode. (Endlich, 1878.) Proustite is one of the chief silver minerals in the silver-lead deposits of the Georgetown district but it is not as abundant as polybasite and tetrahedrite. It is later than galena and sphalerite but earlier than the carbonate minerals. (Spurr and Garrey, 1908.)

Dolores County.—Dunton district. Massive proustite, with argentite, pyrargyrite, and a little chalcopyrite is an important ore mineral in the zone of secondary sulfide enrichment; it is less abundant than pyrargyrite (Kranz and Freeman, 1923).[7] In some places, both the ruby-silver minerals are abundant in vugs and fractures. (Bastin, 1923.)

Rico district. Proustite, argentite, polybasite, and stephanite(?) occurred as very late crystals in vugs in the rich silver ores of Newman Hill. (Ransome, 1901a.)

Gilpin County.—Central City district. Proustite, pearceite, polybasite, and native silver are among the chief alteration products of the primary galena-sphalerite ores of the district. (Bastin and Hill, 1917.)

Gunnison County.—Elk Mountains. Both proustite and pyrargyrite, with argentite and native silver are among the many minerals associated with the loellingite-smaltite in the Luona and other mines on Teocalli and White Rock Mountains. (Hillebrand, 1884.)

Anthracite-Crested Butte area. Proustite, pyrargyrite, and tetrahedrite are the chief silver-bearing minerals in the Ruby, or Irwin, district and elsewhere. Sphalerite, pyrite, and a little galena are also present in the quartz

[7] Kranz, P. R., and Freeman, W. A., A study of the ores of Dunton, Dolores County, Colorado: Unpublished thesis, Colorado School of Mines, Golden, 1923.

gangue. In the Forest Queen mine the rich silver minerals are associated with arsenopyrite as cementing material in fault breccia. The Sylvanite mine on Whiterock Mountain, on the steep northern slope of Copper Creek, yielded a large quantity of remarkably rich silver ore. The vein, which is several feet wide, contained much quartz with some pyrite and calcite. Valuable silver minerals were native silver, proustite, and pyrargyrite and some argentite. (S. F. Emmons, Cross, and Eldridge, 1894.)

Hinsdale County.—Lake City district. A large part of the silver produced by this district was from the ruby-silver minerals, with pyrargyrite the more abundant. (Irving and Bancroft, 1911.)

Ouray County.—Yankee Boy mine. Specimens collected from the dump of the Yankee Boy mine near the head of Canyon Creek contained well-formed crystals of proustite between the quartz crystals of vugs. The ruby-silver ores of this mine, which were very rich, contained proustite, pearceite, and probably argentiferous tennantite; all are of primary origin. In the nearby Ruby Trust mine, the rich ruby-silver ores decreased with depth, suggesting that they are of secondary origin. A little proustite was found in tennantite ore in the Virginius vein. (Bastin, 1923.)

Park and Summit Counties.—Montezuma district. Proustite is present in most of the ruby-silver ores, but is less abundant than either pyrargyrite or miargyrite. Most of it is later than siderite, galena, and sphalerite, and contemporaneous with pyrargyrite, argentite, and late quartz. (Lovering, 1935.) A 21-inch vein exploited by the California mine on Glacier Mountain contained silver minerals for a length of 30 feet and a depth of 25 feet along the dip. The central seam, 2 to 14 inches wide, was of contemporaneous argentite, pyrargyrite, proustite, and quartz. This was flanked by symmetrical bands of manganiferous ankerite and siderite, followed by bands of mixed galena and sphalerite. (Van Horn, 1908—analysis.)

Routt County.—Hahns Peak district. Proustite is reported from the veins. (Gale, 1906; George and Crawford, 1909.)

Saguache County.—Bonanza district. Both proustite and pyrargyrite were reported by earlier workers, but Burbank (1932) found only pyrargyrite in the specimens he collected.

San Juan and Ouray Counties.—Red Mountain district. Both proustite and pyrargyrite are widespread in the rich ores of Red Mountain. In a specimen of rich ruby silver ore from the Robinson mine, Bastin (1923) found both proustite and pyrargyrite to be irregularly intergrown with each other and to clearly replace earlier galena.

San Miguel County.—Telluride district. Proustite is reported from the Smuggler mine by Purington (1898) where it is associated with pyrargyrite, polybasite, and the ordinary sulfides in calcite-quartz-rhodochrosite gangue. (Hurst, 1922.)

Bastin, (1923) found proustite in many other mines in the district. The rich silver ore of the Terrible No. 3 vein, for example, where cut by the Mountain Top tunnel in Marshall Basin, consists of white quartz with bunches of galena, sphalerite, pyrite, and tennantite. Thin discontinuous veins of proustite, apparently of secondary origin, cut through the ore. Primary proustite is very abundant in many parts of the Humboldt and Smuggler mines and forms small masses in contemporaneous intergrowth with galena and tennantite.

PSEUDOMALACHITE

$Cu_5(PO_4)_2(OH)_4 \cdot H_2O$?

Pseudomalachite is listed by Endlich (1878) from the Little Platte River, south of Fairplay, Park County. There are no other reports of its occurrence in the State.

PSILOMELANE

$BaMnMn_8O_{16}(OH)_4$

[*See also* Wad]

Formerly applied to most hard hydrous manganese oxides, the term "psilomelane" is now restricted to a basic oxide of barium with bivalent and quadrivalent manganese. Without X-ray data or chemical analyses, it is impossible to determine which of the many reports of psilomelane occurrences are actually referable to this species and which are mixtures of pyrolusite with other minerals. Probably few Colorado occurrences are true psilomelane. All descriptions of psilomelane, pyrolusite, and wad are grouped under wad, with specific minerals mentioned as these names appear in the original descriptions.

PTILOLITE*

[*See* Mordenite]

PURPURITE

$(Mn^{+3},Fe^{+3})PO_4$

Purpurite is reported from two pegmatite deposits in Larimer County, but from nowhere else. It is the most abundant phosphate mineral in the Double Opening prospect, SE¼SE¼ sec. 30, and NE¼NE¼ sec. 31, T. 7 N., R. 71 W. It occurs as nodules, associated with small patches of uranium minerals, and with several unidentified phosphate minerals. (Hanley, Heinrich, and Page, 1950.)

In the Hyatt beryl mine, also in Larimer County (loc. 2), purpurite and several uranium minerals form lenticular patches in lithiophilite-triphylite. (Hanley, Heinrich, and Page, 1950.)

PYRARGYRITE

Ag_3SbS_3

[*See also* Proustite]

Pyrargyrite, or "dark ruby silver," is apparently about as abundant and widespread as the "light ruby silver" mineral proustite. Together, they account for much of the silver produced by many mines. In many deposits the two minerals occur together; in some of these deposits, as well as elsewhere, no distinction has been made between them and they have been reported as "ruby silver."

Boulder County.—Pyrargyrite is noted from several mines. (J. A. Smith, 1883.)

Clear Creek County.—Georgetown district. Pyrargyrite and proustite are present, but not common, in several lead-silver mines in the Georgetown and nearby areas. Tetrahedrite and polybasite are more important sources of silver in most places. A few good crystals of pyrargyrite have come from the Jo Reynolds mine. (Endlich, 1878; Spurr and Garrey, 1908; Randall.)

Custer County.—Silver Cliff-Rosita district. Ruby silver is definitely present in the Geyser mine, the only deep mine in the district; it is possibly also present in other deposits. As the ore is reported to contain antimony, the ruby silver mineral is probably pyrargyrite rather than proustite. Other minerals in the narrow but very productive Geyser vein are galena, sphalerite, chalcopyrite, argentite, and tetrahedrite, with some stromeyerite or polybasite, hessite, and leaf gold. The gangue, which occurs in small amounts, is made up of barite, calcite and quartz, both crystalline and chalcedonic. (S. F. Emmons, 1896a.)

Dolores County.—Dunton district. Massive pyrargyrite predominates over proustite and argentite in the secondary sulfide zone. Some very rich ore has been recovered. (Kranz and Freeman, 1923.)[8] Crystals of pyrargyrite, polybasite, and chalcopyrite were found in vugs in ore from the Emma and Smuggler-Almont mines by Bastin (1923) who believes the silver minerals here are of secondary origin.

Rico district. The Enterprise mine yielded a large amount of a silver sulfide mineral, identified by Chester (1894) as acanthite. Associated with the acanthite and set in a matrix of bright-pink rhodochrosite were stephanite, polybasite, tetrahedrite, and pyrargyrite, with the common sulfides. Ransome (1901a) found some proustite in the Enterprise mine, but did not mention pyrargyrite, whereas Bastin (1923) found much pearceite but neither of the ruby-silver minerals in the specimens he studied from this mine.

Gilpin County.—Central City. Pyrargyrite is present, but rare in some of the mines. (Schrader, Stone, and Sanford, 1916.)

Gunnison County.—Gold Brick district. Large quantities of pyrargyrite were reported to have been produced by the Cortland mine. A specimen examined by R. D. Crawford and Worcester (1916) contained small patches and grains of the mineral, associated with stephanite, galena, and arsenopyrite.

Elk Mountains. In the loellingite-smaltite deposits of the Luona and neighboring mines on Teocalli and White Rock Mountains, both the ruby-silver minerals are present, together with argentite, native silver, and the common sulfides. (Hillebrand, 1883.)

Anthracite-Crested Butte area. Pyrargyrite, proustite, and tetrahedrite are the most abundant of the rich silver minerals in most of the deposits of the Ruby (Irwin) and neighboring districts. In the Forest Queen mine, arsenopyrite and the silver minerals cement fault breccias. In the Sylvanite vein, which once produced some very rich ore, most of the silver values were in native silver and the ruby silver minerals, with some argentite. (S. F. Emmons, Cross and Eldridge, 1894.)

Hinsdale County.—Lake City district. Pyrargyrite, with less proustite, are responsible for a large part of the silver produced by this district. They occur disseminated in cracks in sulfide ores, as beautiful crystals in vugs, or as irregular bonanza masses along fissures. Most abundant in the zone of secondary sulfide enrichment, they have been found along fissures to depths of 1,200 feet in the Golden Fleece and 1,300 feet in the Ilma mine. (Irving and Bancroft, 1911.)

[8] Kranz, P. R., and Freeman, W. A., op cit.

La Plata and Montezuma Counties.—La Plata district. Pyrargyrite, proustite and miargyrite are the principal ore minerals in the ruby-silver belt that crosses the northern part of the district. Miargyrite and pyrargyrite, probably of hypogene origin, were seen in contemporaneous intergrowth. (Galbraith, 1949.)

Ouray County.—Fine crystals of pyrargyrite are reported from the Wheel of Fortune vein near Mount Sneffels. (Endlich, 1878.) Very few of the specimens from mines in Ouray County collected by Bastin (1923) contained this mineral, although they were rich in other silver minerals.

Park and Summit Counties.—Montezuma district. Pyrargyrite is present in most of the rich silver ores. It is nearly everywhere intergrown with miargyrite, the two closely associated with late galena and chalcopyrite in dark fine-grained masses. (Lovering, 1935.)

Routt County.—Hahns Peak district. In the Hahns Peak Gold Mining and Milling Co. drift, pyrargyrite and galena occur with pyrite in rich gouge seams in the ore. In the Southern Cross tunnel, thin seams of pyrargyrite and galena along a fault zone formed the main ore body. (George and Crawford, 1909.)

Saguache County.—Bonanza district. Pyrargyrite occurs only in silver-bearing shoots in the manganese veins in the southern part of the district, where it seems to be the chief source of silver. It forms delicate deep-red crystals in cavities; the basal parts of the crystals are intergrown with rhodochrosite and galena. It is a late primary mineral and commonly replaces galena. (Burbank, 1932.)

San Juan and Ouray Counties.—Red Mountain district. Few of the rich silver ores contain pyrargyrite, but the near surface ores of the Robinson mine contain proustite and pyrargyrite, intergrown contemporaneously and replacing galena. (Bastin, 1923.)

San Miguel County.—Telluride district. Pyrargyrite occurs with other silver minerals in the San Bernardo and Smuggler mines, with the common sulfides and with calcite, quartz and rhodochrosite. (Purington, 1898.) In ore from the Smuggler mine pyrargyrite replaces tetrahedrite centrifugally, rather than centripetally, as native silver replaces polybasite. (Hurst, 1922.) The specimens from other mines near Telluride that were studied by Bastin (1923) contained almost no pyrargyrite, although they did contain much pearceite, proustite, and other silver minerals.

PYRITE

FeS_2

Pyrite is the most ubiquitous and abundant sulfide mineral in the State. It is present in greater or lesser amounts in virtually all ore deposits and their wallrocks; it is an accessory in many pegmatite and other igneous rocks and occurs as disseminations or concretions in many sedimentary rocks.

Highly pyritic ore is in demand by smelters for its value as a fluxing agent as well as for the more valuable metals it contains. The pyrite deposits of the Rico district supply a flourishing sulfuric acid industry. Probably the greatest economic value of pyrite, however, lies in the fact that much of it contains gold and some contains silver and copper. Whether or not these metals are present as discrete but microscopic particles of the elements or as mineral compounds in the pyrite, or are in solid solution, the practical fact is that their presence makes the pyrite an ore mineral instead of a worthless gangue. Many crystallographic studies of Colorado pyrite have been made; some of these are noted below. Among others, Palache (1932c) describes a cube "from Colorado" that is 12½ by 10 by 14 cm. Ayres (1899) also describes crystals "from Colorado." Schaller (1905) describes pyrite crystals from the Spanish Peaks, and Whitlock (1919) describes some from Bald Mountain, Boulder County.

Only a few of the more important or interesting occurrences are given here.

Clear Creek County.—Georgetown district. Pyrite is present in the silver-lead ores in varying amounts but is abundant in only a few. It is an important constituent of gold ores, much of the gold being contained within the pyrite. Much of this gold, some of which contains copper, occurs dispersed in the pyrite as microscopic particles. (Spurr and Garrey, 1908.)

Conejos and Rio Grande Counties.—Platoro-Summitville district. Pyrite is abundant and important, since in the primary ores it contains most of the gold and a little of the silver, and since its oxidation has produced the rich gold-limonite ore bodies. (Patton, 1917.)

Dolores County.—Rico district. Pyrite is the most abundant metallic mineral in the district, and together with quartz, chalcopyrite, galena and sphalerite forms the filling of most veins. It also occurs in huge blanketlike masses of solid sulfides on C. H. C. Hill, and as massive replacements of limestone. When sufficiently rich in galena and chalcopyrite the sulfide bodies grade into commercial ore, but the pyrite rarely contains enough gold or silver to be of value. (Ransome, 1901a.)

The massive deposits of pyrite in the Wellington and other mines on C. H. C. Hill north of Rico have recently become the raw materials for a sulfuric acid plant at Rico. Many of the masses of pyrite are so thoroughly fractured as to be virtually self stoping.

Eagle County.—Gilman (Red Cliff) district. The ore of the Eagle mine is essentially pyrite, with variable amounts of sphalerite, galena, siderite, calcite, dolomite, and chalcopyrite. It ranges from hard bright coarsely crystalline material to fine-grained massive pyrite. (Borcherdt, 1931.)

Gilpin County.—Central City district. Pyrite is the predominant sulfide in the gold-pyrite ores and is next in abundance to galena and sphalerite in the lead-zinc ores. Most of the pyrite is massive or in cubic crystals, but in the Rooks County mine, between Apex and Tolland, octahedral crystals crusted with small crystals of albite(?) occurred in a vug. (Bastin and Hill, 1917.) Fine complex crystals from the Saratoga and other mines are described by W. B. Smith (1886b). These are notable for their brilliant and numerous faces; many are as much as 3 inches in diameter.

A group of pyrite crystals, probably from Gilpin County, is described by Miers (1899). The crystals show brilliant combinations of cube and pentagonal dodecahedron. The cube corners are replaced by brilliant faces with projecting corners, which Miers believes is due to interpenetrant twinned crystals of tetartohedral habit.

Gunnison County.—Vulcan district (loc. 5). Pyrite is the most abundant mineral in the Good Hope mine, known as the type locality for rickardite and weissite. It has added interest as the source of comparatively large bodies of native sulfur and limonitic "sinter" near the surface of the deposit. (Lakes, 1898.)

Taylor Peak and Whitepine districts. Pyrite is sufficiently abundant in the contact-metamorphic magnetite deposits to raise the sulfur content of the ore above acceptable limits for many purposes. (Harder, 1909.)

Gunnison and Chaffee Counties.—Pyrite is one of the chief minerals in the replacement ore bodies of the Tincup, Monarch, and Tomichi districts. In places it forms large masses of nearly pure pyrite; elsewhere it is intergrown with argentiferous galena, sphalerite, and chalcopyrite and is gold bearing. It is abundant, but less so than quartz, in the quartz-pyrite veins that have yielded most of the precious and base metals produced from the above-mentioned districts and the Mary Murphy mine. Some of the vein pyrite contains copper and some contains free gold. (Dings and Robinson, 1957.)

Hinsdale County.—Lake City district. Pyrite occurs in all veins in variable amounts. It generally increases with depth and is more closely associated with high gold concentrations than any minerals except the tellurides. The lower levels of the Contention and Moro mines, whose chief ore mineral was argentiferous tetrahedrite, were also rich in gold-bearing pyrite. Pyrite, with quartz, is abundant in altered wallrocks of the district. (Irving and Bancroft, 1911.)

Lake County.—Leadville district. Pyrite is the most abundant primary metallic mineral in the district and is characteristically associated with quartz. It is locally conspicuous in contact-metamorphic deposits and also in veins and blanket deposits. In some of these it is the only sulfide, but it is more commonly associated with sphalerite, galena, and chalcopyrite. Pyrite also impregnates porphyry and other country rocks, where it is associated with sericite. In large masses the individual grains are anhedral, but isolated crystals are pentagonal dodecahedrons or cubes. (S. F. Emmons, Irving, and Loughlin, 1927.)

The presence of very large bodies of massive pyrite commonly surrounded by carbonates is pointed out by H. S. Lee (1918). If there were sufficient demand for pyrite for sulfuric acid manufacture, these pyrite bodies, which contain a minimum of 43 percent sulfur, could be mined separately from zones that are high in precious or base metals. In practice, if selective mining is too expensive, the pyritic bodies are removed as run-of-mine iron-gold-silver ore and sold for use in smelters.

Very precise X-ray measurements of a large crystal from Leadville are recorded by Peacock and Smith (1941). The lattice measurements of Leadville pyrite crystals are also discussed by Kerr, Holmes, and Knox (1945) and by Wasserstein (1949).

Park and Summit Counties.—Montezuma district. Pyrite is the most abundant sulfide in the district, as disseminations in altered porphyry and wallrocks, in contact metamorphic deposits, in sericitized stockworks, and as the most common mineral in most veins. Most of it is in crystalline grains, but some is massive. It is rarely gold bearing except where intimately associated with chalcopyrite. In the Josephine mine perfect crystals of complex form are embedded in white kaolin. (Lovering, 1935.)

Pitkin County.—Aspen district. Pyrite is present but not abundant in this district. In the Mary B tunnel on West Aspen Mountain, however, it occurs as large perfect crystals. These contain small amounts of As, Pb, Cu, Zn, Cd, Co, and Ni. (Spurr, 1898.)

Saguache County.—Bonanza district. Pyrite is the most abundant sulfide in many veins. It also occurs in silicified wallrocks, where it is better crystallized than in the veins, and in the massive sulfide ores. Most crystals are pentagonal docecahedrons but some are cubes. Its even distribution through the wallrocks is probably due to fumarolic or solfataric activity. (Burbank, 1932.)

San Juan County.—Silverton district. Red Mountain owes its magnificent coloration to the oxidation of pyrite, which is abundant here and in most other parts of the district. Pyrite contains enough gold to pay for the cost of mining but this is rarely so unless chalcopyrite or gold-bearing quartz is nearby. In general, abundant pyrite marks the lower limit of pay ore. (Ransome, 1901b.)

San Miguel County.—Telluride district. Pyrite is generally the most abundant metallic mineral and contains most of the gold in the district. The gold in the pyrite is free, in fine particles, and is not related in amount to the coarseness of the enclosing pyrite grains and crystals. (Purington, 1898.)

Summit County.—Tenmile district. Enormous bodies of pyrite, with some marcasite and pyrrhotite, replace thick limestone beds. Pyrite is also the dominant sulfide in both the veins and the lead-zinc replacement bodies, but many of the larger pyrite beds contain too low a content of base metals to be minable. (S. F. Emmons. 1898.)

PYROCHLORE

$NaCaCb_2O_2F$

[*See also* Microlite]

Microlite and pyrochlore form a virtually isomorphous series, the two being distinguished by the relative proportions of niobium (columbium) and tantalum. Only two occurrences of pyrochlore are reported. One of these is at St. Peters Dome, El Paso County (loc. 5), where some zoned octahedral crystals, yellow-brown in thin section, are thought by Lacroix (1889) to resemble this mineral. They are associated with zircon, astrophyllite, and violet fluorite in a riebeckite syenite.

The other reported occurrence is in the Powderhorn area, Gunnison County—presumably in the carbonatite deposits of Iron Hill (loc. 2). Wagner (1958), who reports the presence of a very large body of columbite-bearing material, notes that pyrochlore was found by Robert Grogan in 1956.

PYROLUSITE

MnO_2

[*See also* Psilomelane *and* Wad]

As pointed out under the headings "Psilomelane" and "Wad," much of the material ascribed to these minerals is probably a mixture of pyrolusite and other minerals. Without detailed loboratory study it is not possible to determine which minerals are present in a given specimen. All descriptions of psilomelane, pyrolusite, and wad are grouped under wad with specific minerals mentioned as described by the original authors.

PYROMORPHITE

$Pb_5(PO_4,AsO_4)_3Cl$

[*See also* Mimetite]

Pyromorphite and mimetite form an isomorphous series, the distinction between them based on the relative proportions of phosphorus and arsenic. Unlike mimetite, which is only doubtfully reported in Colorado, pyromorphite is fairly widespread in its occurrence.

Clear Creek County.—Georgetown and Idaho Springs districts. Pyromorphite is reported from the Freeland mine on Trail Creek and from several mines near Georgetown, where together with cerussite it forms white to brown fibrous crystals in vugs in the oxidized ore. Dana (1892) mentions its occurrence in the Astor and Mineral Chief mines as well as in the Freeland. (Endlich, 1878; J. A. Smith, 1883; Spurr and Garrey, 1908.)

Gunnison County.—Gold Brick district. Small quantities of greenish-yellow to green pyromorphite occur in the oxidized ores of the Gray Eagle, Chloride, Buckeye Chief, and Hilltop mines. In the Gray Eagle it is mosslike or forms small aggregates of minute radiating crystals that coat quartz or fill small cavities in limonite. (Crawford and Gibson, 1925.)

Lake County.—Leadville district. Pyromorphite occurs in nearly all the oxidized ores and forms well-developed crystals, especially in cavities of blanket and lode ores. (S. F. Emmons, Irving, and Loughlin, 1927.)

Mineral County.—Creede district. Yellow and brown crystals of pyromorphite were noted on the walls of cavities in oxidized ore in the upper levels of the Amethyst vein. (W. H. Emmons and Larsen, 1923.)

PYROPE

[*See* Garnet]

PYROPHYLLITE

$Al_2Si_4O_{10}(OH)_2$

Pyrophyllite, a talclike mineral, is a common constituent of some kinds of schist in many places. Only two occurrences in Colorado have come to my attention, but this may be because the literature on petrology of the metamorphic rocks has not been studied as thoroughly as it deserved. The two occurrences, both noted by E. P. Chapman, Jr., (written communication), are on the dump of the Lillian mine at Leadville, Lake County and on the pass between Pitkin and Tincup, Gunnison County.

PYROXENE GROUP

Pyroxenes are the most abundant ferromagnesian minerals in most igneous and metamorphic rocks, hence they are very widespread throughout most of Colorado. Members of the group are also present in several contact-metamorphic deposits and as such are considered as gangue minerals of certain ore deposits.

The members of the pyroxene group, like the amphiboles, are classified primarily as to crystal form and secondarily as to chemical composition. The principal species and subspecies that have been reported from Colorado are listed below.

Members of the pyroxene group that occur in Colorado

Species and subspecies	Chemical composition
ORTHORHOMBIC SECTION	
Enstatite	$MgSiO_3$
Bronzite	$(Mg,Fe)SiO_3$
Hypersthene	$(Fe,Mg)SiO_3$
MONOCLINIC SECTION	
Pyroxene	
Clinoenstatite	$MgSiO_3$
Pigeonite	$(Mg,Fe)SiO_3$ and $CaMgSi_2O_6$
Diopside	$CaMgSi_2O_6$
Sahlite	$Ca(Mg,Fe)Si_2O_6$
Hedenbergite	$CaFeSi_2O_6$
Augite	$Ca(Mg,Fe,Al)(Al,Si)_2O_6$
Acmite (aegirite)	$NaFe^{+3}Si_2O_6$
Spodumene	$LiAlSi_2O_6$
TRICLINIC SECTION	
Rhodonite	$MnSiO_3$

Spodumene and rhodonite, although technically members of the pyroxene group, are not commonly thought of as such; these minerals are described separately in their proper alphabetical places. Exemplary occurrences of all the other pyroxenes are described below in the order in which they appear in the classification just given. The section closes with a heading of "Pyroxene, undivided." This section includes descriptions of a few occurrences in which the specific mineral was not recorded by the original author or in which more than one species or subspecies is present.

Pyroxene species ENSTATITE

$MgSiO_3$

Enstatite, the magnesian end member of the enstatite-hypersthene series of orthorhombic pyroxenes, is a common rock-forming mineral in many of the more mafic igneous rocks and in some metamorphic ones. The iron-bearing variety bronzite is also present in many places. No special localities are given here.

Pyroxene species HYPERSTHENE

$(Mg, Fe) SiO_3$

Hypersthene, one of the end members of the enstatite-hypersthene series of orthorhombic pyroxenes, is an essential constituent of many igneous rocks, particularly those of intermediate composition. The following three descriptions give an idea of its mode of occurrence.

Chaffee County.—Buffalo Peaks. Hypersthene is an essential constituent of andesite and of andestic tuff. The rock is augite andesite, with predominant hypersthene and clear plagioclase; magnetite and apatite are accessory minerals. Whitman Cross (1883) gives analyses of the hypersthene by W. F. Hillebrand.

Summit County.—Breckenridge district. Hypersthene is a minor constituent in some diorite porphyry, but it alters easily and can be found only in very fresh rocks. (Ransome, 1911.)

Larimer County.—Hypersthene is associated with hornblende in Ingleside Wash and Soldier Canyon. (R. G. Coffin, written communication.)

San Juan Mountains.—Hypersthene is present in most of the silica-poor dark quartz latities, but clinoenstatite predominates in most of them. (E. S. Larsen, Jr., and Cross, 1956.)

Pyroxene subspecies CLINOENSTATITE

$MgSiO_2$

Clinoenstatite predominates in most of the dark silica-poor quartz latite of San Juan Mountains, but hypersthene is present in some of it. (E. S. Larsen, Jr., and Cross, 1956.)

Pyroxene subspecies PIGEONITE

$(Mg, Fe)SiO_3$ and $(Ca, Mg)Si_2O_6$

The subspecies pigeonite is confined to basalt in the San Juan Mountains, where it is nearly always interstitial to the feldspars. (E. S. Larsen, Jr., Irving, Gonyer, and E. S. Larsen 3d, 1936.)

Pyroxene subspecies DIOPSIDE

$(Ca, Mg)Si_2O_6$

Boulder County.—Allens Park. Diopside occurs as colorless anhedral to subhedral grains 0.5 to 2 mm long in the lime-silicate rock. (See wollastonite.) (Dings, 1941.)

Chaffee County.—Calumet mine (soc. 2). Diopside is the chief metamorphic mineral in the Calumet magnetite deposit. It occurs as bands that replace certain beds and also as spheroidal masses of radiating blades as much as 1 foot in diameter. (Behre, Osborn, and Rainwater, 1936.)

Monarch district. Pale-green diopside is associated with sphalerite in the New York mine. It is also present in many other parts of the district and is locally abundant as masses several feet thick and many yards long. Near the Victor mine a 6-foot bed of limestone is completely replaced by pale-greenish-gray diopside. Some of the marble on Missouri Hill contains white microgranular diopside that replaces chert nodules and seams of the original rocks. Near a dike in Cree Camp the diopside in marble is coarsely crystallized and is associated with asbestos. (Crawford, 1913.)

Gunnison County.—Italian Mountain (loc. 3). Diopside is common as almost perfectly twinned prisms, and as small perfectly twinned or simple crystals. It also occurs massive as solid-green diopside rock, or with garnet as hornfels forming the base for many fine specimens of vesuvianite and garnet. The twinned crystals, 8 mm. or more in length are gray green to olive green and line the walls of cavities in massive diopside. Nearly all are contact twins and the larger ones are highly modified. Whitman Cross and Shannon (1927) give crystallographic descriptions and analyses.

Jefferson County.—Bergen Park-Cresswell mine (loc. 2). Large light-green crystalline masses of diopside contain crystals ½ by 2 inches long in cavities. The diopside is associated with greenish-gray tremolite. Many other localities in calcium silicate beds of the metamorphic rocks are in the Front Range. (G. R. Scott, written communication.)

Pyroxene subspecies SAHLITE

$Ca(Mg, Fe)Si_2O_6$

Sahlite is a grayish-green to black variety of pyroxene that is intermediate in composition between diopside and hedenbergite. It has been noted only at Italian Mountain, Gunnison County (loc. 3). Most of the pyroxene is nearly pure diopside, but a few specimens are made up of sahlite. One specimen contains blackish-green massive and crystalline sahlite; the simple prismatic crystals, 4 by 10 mm, project into cavities or into calcite. A few apatite crystals rest on vesuvianite in vugs. Another specimen consists of euhedral crystals that project into a mass of stilbite and scolecite. The optical properties and crystallography are described by Whitman Cross and Shannon (1927).

Pyroxene subspecies HEDENBERGITE

$CaFeSi_2O_6$

Boulder County.—Allens Park. Very small amounts of hedenbergite are irregularly distributed through the lime-silicate rock. Diopside is much more abundant. (Dings, 1941.)

Gunnison County.—Snowmass Mountain area. Hedenbergite is widespread, with garnet, as a metamorphic mineral. It is also abundant as a gangue mineral in some veins and bedded deposits on Galena Mountain in North Pole Basin, and elsewhere. It forms bands in massive quartz, parallel to and near the walls of the veins. (Vanderwilt, 1937.)

Pyroxene subspecies **AUGITE**

$Ca(Mg, Fe, Al)(Al, Si)_2O_6$

Fremont County.—Iron Mountain. The iron-ore deposits of Iron Mountain (see ilmenite) are segregations of compact ilmenite and magnetite in a large mass of gabbro. The gangue minerals are those of gabbro—augite, chrysolite, and plagioclase feldspar, with many inclusions of spinel. (J. T. Singewald, Jr., 1913.)

Grand County.—Fine black crystals of augite occur in basalt and in the soil along the east face of the ridge between Trail Creek and Gold Run Creek, about a quarter of the distance below the crest. The crystals, which average one-half inch in length, are all stout, doubly terminated prisms. There are a few cruciform twins. (Ellermeier, 1946a.)

Gunnison County.—Cebolla iron deposit. Augite occurs with zoisite and other contact-metamorphic minerals in the titaniferous magnetite deposit. (J. T. Singewald, Jr., 1913.)

Gold Brick district. Augite is an abundant constituent in a 4-foot bed of quartzite that crops out three-quarters of a mile southeast of Boulder Lake. The quartzite, which grades into garnetiferous quartz-mica schist, contains bands and lenses of pale-green augite as much as 2 inches wide and several feet long. The augite, shown by optical properties and qualitative analysis to be close to a true augite, is coarsely crystallized, with grains as much as 2 inches in diameter, but crystal faces are rare. (Crawford and Worcester, 1916.)

Jefferson County.—Malachite mine (loc. 9). Augite and labradorite are coarsely intergrown with the chalcopyrite, sphalerite, and pyrrhotite that make up the ore deposits. (Lindgren, 1908.)

La Plata County.—La Plata district. Augite is a gangue mineral in the disseminated platinum-bearing chalcopyrite deposit of Copper Hill. It is also widespread in the contact-metamorphic bodies in the central part of the district. associated with garnet, epidote, magnetite, specular hematite, and other minerals. (Galbraith, 1949.)

Pyroxene species **ACMITE (AEGIRITE)**

$NaFe^{+3}Si_2O_6$

Two varieties of this mineral are known. The first, called acmite, commonly forms sharp-pointed crystals, often twinned. The second, called aegirite or aegirine, forms bluntly terminated crystals, seldom twinned. Both names have been used for Colorado occurrences, but the bulk of the evidence indicates that all reported occurrences are of aegirite.

Boulder County.—Camp Albion district, Snowy Range mine. Diopsidic aegirite is by far the most abundant gangue mineral in this small and relatively unproductive gold district. It is medium gray to dull-greenish gray, and has good cleavage but splintery fracture. It is associated with asbestos, a little quartz and feldspar, and the common sulfides. Wahlstrom (1934, 1940) gives chemical analyses and optical properties.

Clear Creek and Gilpin Counties.—Phenocrysts of greenish-black aegirite as much as 3 mm. long, most of which are fresh and show zonal growth, occur in a small stock of Tertiary age on the south side of Clear Creek, east of the mouth of Soda Creek. Associated phenocrysts are bluish-black garnet, probably melanite, anorthoclase, and some orthoclase. Analcite and fluorite are also present. Chemical analyses show the presence of a little SO_3 in the aegirite, suggesting the presence of haüynite or noselite. (Spurr and Garrey, 1908.)

Custer County.—Silver Cliff district. Aegirite is associated with riebeckite and barkevikite in a dike at the north base of the Rosita Hills, 5 miles east of Silver Cliff. It occurs as green grains and is an alteration product of pyroxene. Cross (1890) gives many data on the optical properties and includes an analysis by L. G. Eakins (see also Whitman Cross, 1891a, 1896).

Gunnison County.—Iron Hill district (loc. 2). Aegirite is everywhere associated with the soda tremolite-glaucophane group of amphiboles in the stock of alkalic rocks at Iron Hill. Aegirite is far less abundant or important than many other minerals, such as melilite and glaucophane. (E. S. Larsen, Jr. and Goranson, 1932; E. S. Larsen, Jr., and Jenks, 1942.)

Teller County.—Cripple Creek district. Aegirite, and less acmite are the only dark silicates of importance in the phonolite of this famous gold-producing district. They are best developed as inclusions in analcite where they form narrow prismatic laths. Many crystals are wrapped around crystals of nepheline, locally as sheaves of crystals. The ends of some aegirite crystals are acmite, which may also occur alone. (Lindgren and Ransome, 1906.)

PYROXENE UNDIVIDED

Boulder County.—Caribou Hill. The titaniferous magnetic ore of this deposit is made up of magnetite, ilmenite and pyroxene. The latter ranges from augite to diopside in composition and much of it is altered to serpentine. (J. T. Singewald, Jr., 1913; Bastin and Hill, 1917.)

Gunnison County.—Taylor Peak and Whitepine districts. Pyroxene is among the contact-metamorphic silicates of the iron deposits. It is especially abundant at the contact between sedimentary and intrusive rocks. (Harder, 1909.)

Larimer County.—Green cleavage masses of pyroxene can be found at Water Works Hill in Poudre Canyon, in Rist Canyon, and in Longs Gulch. Minute crystals can also be seen in a mafic dike and in extrusive rocks near Chambers Lake. (R. G. Coffin, written communication.)

San Juan Mountains, general.—Pyroxene is the most abundant of the mafic minerals of the San Juan lava flows. It is associated with olivine in the basalts and is the only mafic silicate in most low-silica andesite. It is present with biotite, with or without hornblende, in more than half of the quartz latite bodies and in small amounts in some rhyolite rocks. Hypersthene, which is most abundant in rocks with 57 to 59 percent silica, commonly forms better crystal than augite; the diopside subspecies of pyroxene grows around some hypersthene crystals. E. S. Larsen Jr., Irving, Gonyer, and Larsen (1936) give analyses of diopside and hypersthene. (*See also* E. S. Larsen, Jr., and Cross, 1956.)

PYRRHOTITE

$Fe_{1-x}S$

Pyrrhotite is widespread but nowhere very abundant as a vein mineral. The presence of nickel reported by some analysts is probably due to microscopic admixture of a nickel-bearing mineral.

Boulder County.—Gold Hill district (loc. 1). Pyrrhotite was reported by Goddard (1940) as a constituent of the nickel ore of the Copper King mine (see polydymite). Later work evidently showed the identification to be in error, as it is not included in the list of minerals described by Goddard and Lovering (1942).

Chaffee County.—Monarch district. In the Garfield mine, massive pyrrhotite is associated with galena, pyrite, and sphalerite. East of Bass Lake it is associated with fluorite and coarse calcite in baked shale. (Crawford, 1913; Dings and Robinson, 1957.)

Pyrrhotite that contains cobalt and nickel is reported by prospectors to occur with bismuthinite in several deposits near the head of Clear Creek and on Pine and Texas Creeks. The reports are not substantiated.

Clear Creek County.—Georgetown district. A solid vein of pyrrhotite, averaging 18 inches in width, is reported to have been cut by the Kansas City tunnel in Alpine Mountain, south of the Colorado Central mine. (Randall.)

Eagle County.—Gilman (Red Cliff) district. Minute residual grains of pyrrhotite is sphalerite and galena occur sporadically. (R. D. Crawford and Gibson, 1925.)

Gilpin County.—Nevada district. Pyrrhotite is reported. (Endlich, 1878.)

Gunnison County.—Snowmass Mountain area. Tiny grains of pyrrhotite occur in metamorphosed country rocks, but the mineral does not occur in the veins. (Vanderwilt, 1937.)

Jackson County.—Pearl district, Copper Queen claim. Pyrrhotite occurs in veins in hornblende schist on this claim, where it is associated with chalcopyrite, sphalerite, quartz, and calcite. (A. C. Spencer, 1903.)

Jefferson County.—Malachite mine (loc. 9). Coarse masses of chalcopyrite, sphalerite, and nickeliferous pyrrhotite, intergrown with rock-forming minerals, make up most of the ore. A little pyrite is embedded in the pyrrhotite. (Endlich, 1878; Lindgren, 1908.)

Schwartzwalder mine (loc. 15). The garnetiferous gneiss that forms the wallrocks of the uranium deposit contain grains of pyrrhotite and pyrite that range from microscopic to 1 inch in diameter. (D. M. Sheridan, written communication.)

La Plata County.—La Plata district. Small nodules of troilite(?), a member of the pyrrhotite series, are precipitated with native copper in a bog deposit near the town of La Plata. (Galbraith, 1949.)

Larimer County.—Lenticular masses of pyrrhotite, with chalcopyrite, pyrite, and other minerals occur in hornblende schist in the Copper King uranium mine (loc. 3). (Sims, Phair, and Moench, 1958.)

Park County.—Alma district. The dumps of the Pacific, Atlantic, and Lee Goss mines in the North Star Range contain massive and abundant pyrrhotite. It is associated with pyrite and chalcopyrite and is contemporaneous with, or older than, the pyrite. (J. W. Vanderwilt, written communication.)

Beaver-Tarryall area. Pyrrhotite occurs in microscopic blebs in some sphalerite. It is abundant in the Iron mine, in sec. 9, T. 8 S., R. 77 W., on the North Fork of Little French Gulch. Some iron ore, consisting of residual pyrrhotite, and limonite, with a little pyrite, magnetite, and chalcopyrite, has been shipped for use as smelter flux. The nearby limestone is replaced by garnet, epidote, magnetite, and coarse calcite. (Q. D. Singewald, 1942.)

San Juan County.—Needle Mountains district. Small quantities of pyrrhotite occur in some veins. (Whitman Cross, Howe, Irving, and Emmons, 1905.)

Summit County.—Kokomo district. The limestone replacement ores are aggregates of pyrite, pyrrhotite, marcasite, sphalerite, galena, and chalcopyrite. The pyrrhotitic ore is massive pyrrhotite intergrown with some fine-grained pyrite, and very little disseminated black sphalerite and galena. (Koschmann and Wells, 1946.)

QUARTZ

SiO_2

Quartz in all its varieties is by far the most common mineral in the State. It is an essential mineral in many igneous and metamorphic rocks and is present in smaller quantities in others. It is the most abundant gangue mineral in most ore deposits and is the chief constituent of all sandstones and quartzites and present in greater or less amount in most other sedimentary rocks. Finally it is the chief mineral in sand and gravel deposits and is also present in most soils. Only the occurrences that are of some interest to mineral collectors are listed here. The preoccupation displayed by most amateur collectors and lapidarists with the fine-grained varieties of quartz, especially agate, explains the preponderance of such occurrences in the list. The following table, with cross references to the section on localities where known, is condensed as to descriptions but contains most of the essentials needed by the collector.

Reported collecting localities for quartz and its varieties

BENT COUNTY

Locality	Description	Reference
Along Arkansas River	Agate	Randall.

CHAFFEE COUNTY

Locality	Description	Reference
Nathrop (loc. 4)	Tiny crystals, some with rare basal pinacoid.	J. W. Adams, written communication.
Turret district, Calumet iron mine (loc. 2).	Fine sagenitic quartz crystals with epidote fibers.	Ellermeier, 1947a; Randall.
Sedalia mine (loc. 5)	Apple-green chrysoprase on dump.	J. W. Adams, written communication.
Mount Antero and vicinity (loc. 3).	Rock crystal; smoky quartz.	Pearl, 1958.

Reported collecting localities for quartz and its varieties—Continued

CLEAR CREEK COUNTY

Locality	Description	Reference
Silver Creek, mine dumps	Light amethyst	Randall.
Red Elephant Mountain, mine dumps.	Light amethyst	Do.
Trail Creek, mine dumps	Fine deep amethyst	Do.
Near summit Floyd Hill	Massive rose quartz	Spurr and Garrey, 1908.
Lawson, Two Sisters mine	Amethyst	Do.
Lawson, Little Giant mine	Crystalline rose quartz	Do.
Chicago Creek, Kitty Clyde mine along Maximilian Gulch.	Amethyst	G. R. Scott, written communication.
Santa Fe Mountain pegmatite (loc. 5).	Rose quartz mass, 50 by 2 ft.	Hanley, Heinrich, and Page, 1950.

COSTILLA COUNTY

Along Rio Grande River	Prase	Randall; Pearl, 1942.

DEL NORTE COUNTY

West edge of San Luis Valley, 10 miles northwest of Del Norte, altitude 8,000 ft.	"Finest deposit of plume agate in Colorado;" as 8- to 14-in. "thunder eggs" in rhyolite.	Fahl, 1948.

DOUGLAS COUNTY

Castle Rock area	Agatized wood abundant	W. T. Lee, 1902.
Devils Head (loc. 1)	Very dark smoky quartz in large crystals; some amethyst.	G. R. Scott, written communication.
One mile south of Parker	Petrified log, 6 by 50 ft	Pearl, 1942.
Near head of Cherry Creek	Abundant petrified wood	Randall.
Larkspur	Ribbon agate, Egyptian jasper, petrified wood, carnelian.	Randall; Pearl, 1942.
Head of Plum Creek	Pebbles of false topaz	Randall.
Pine Creek (loc. 3)	Doubly terminated smoky quartz.	Reitsch, 1939; Pearl, 1958.

EAGLE COUNTY

Near Fulford	"A bed of very fine quartz crystals."	Randall.

ELBERT COUNTY

Near heads of Kiowa and Bijou Creeks.	Abundant petrified logs with much beautiful agate and carnelian.	Randall.
Between Cherry and Running Creeks.	Petrified wood	Do.

Reported collecting localities for quartz and its varieties—Continued

EL PASO COUNTY

Locality	Description	Reference
Austin Bluffs, near Colorado Springs (loc. 1).	Rich red, brown, and mottled agate, cutting quality.	Pearl, 1942, 1958.
Crystal Park (loc. 2)	Smoky quartz, rock crystal.	Pearl, 1958.

FREMONT COUNTY

Locality	Description	Reference
Curio Hill, near Canon City (loc. 2).	"St. Stephens stone;" choicest of Colorado banded agate.	Endlich, 1878; Sterrett, 1909; Pearl, 1942, 1958.
Garden Park, near Colorado Springs (loc. 5).	Varicolored agate replacing dinosaur bones; very fine agate, some St. Stephens stone, in geodes.	Do.
Ten miles south of Canon City.	Chalcedony in sandstone	Shaw, 1946.
Eight Mile Park, Wild Rose claim, 6 miles north of Texas Creek (loc. 4)	Rose quartz, some of flawless gem quality, in pegmatite.	Endlich, 1878; Sterrett, 1909, 1923.
Twelve miles northwest of Canon City, 1 mile south of Twelvemile Park	Gem amethyst and smoky quartz	Sterrett, 1909.
Grape Creek	Amethyst	Endlich, 1878.

FREMONT AND PARK COUNTIES

Locality	Description	Reference
Thirtyone Mile Mountain, 7 miles west of Guffey (loc. 8)	Light-blue banded chalcedony.	Sterrett, 1909.

GARFIELD COUNTY

Locality	Description	Reference
Not given	Gem-quality chrysoprase	Pearl, 1942.

GILPIN COUNTY

Locality	Description	Reference
Nevada district	Small beautiful amethyst crystals, in gravel	Randall.
Near Central City	Rose quartz	Do.

Reported collecting localities for quartz and its varieties—Continued

GRAND COUNTY

Locality	Description	Reference
Middle Park	"Best moss agate in Colorado;" chrysoprase.	Hollister, 1867; Pearl, 1942; Shaw, 1946.
Near junction of Willow Creek with Colorado River and ridges along Willow Creek.	Ribbon jasper, carnelian, sardonyx, chalcedony, heliotrope, basanite.	Endlich, 1878; Randall; Pearl, 1942.
Near Grand Lake	White onyx	Randall.
Near Hot Sulfur Springs	Cloudy agate, petrified wood.	Randall; Pearl, 1942.
Williams Fork, 2 miles above mouth.	Moss agate	Do.

GUNNISON COUNTY

Locality	Description	Reference
Gunnison River, above Black Canyon.	Blue chalcedony in rhyolite; jasper in Dakota sandstone.	Endlich, 1878; Pearl, 1942.
Elk Mountains	Large pale amethysts	Endlich, 1878.

HINSDALE COUNTY

Locality	Description	Reference
Head of Henson Creek	Fine large masses of amethyst.	Endlich, 1878.
Ute Creek, three-fourths of a mile above mouth.	Opal and chalcedony in spherulites in obsidian.	Patton, 1898.

JEFFERSON COUNTY

Locality	Description	Reference
Green Mountain and Table Mountain (loc. 18).	Petrified wood, including palms; mottled agate.	Randall.
Near Morrison	Agate, jasper, and carnelian in dinosaur bones.	Randall; Pearl, 1942.
Bear Creek	Rose quartz	Randall.
Elk Creek	Smoky quartz; doubly terminated flat crystals of quartz, 5 by 3 by ½ in. in size, loose in cavities.	J. A. Smith, 1883.
South Platte district, south of Spring Creek (loc. 16).	Clusters of 2-in. amethyst crystals coated with milky quartz.	G. R. Scott, written communication.

LARIMER COUNTY

Locality	Description	Reference
Twenty-five miles west of Fort Collins.	Large body gem-quality rose quartz.	Endlich, 1878.
Red Feather Lakes (loc. 4)	Fine deep amethyst in single crystals and masses.	R. G. Coffin, written communication; Longyear, 1939; Pearl, 1958.
Specimen Mountain (loc. 5)	Geodes with opal, agate, and onyx.	Seaman, 1936; Wahlstrom, 1941, 1944.

Reported collecting localities for quartz and its varieties—Continued

LAS ANIMAS COUNTY

Locality	Description	Reference
"Summit of Range of Animas River" (possibly La Plata County).	Fine fortification agate in geodes lined with amethyst.	Randall; Pearl, 1942; Shaw, 1946.

MESA COUNTY

Locality	Description	Reference
Pinon Mesa, south of Fruita (loc. 2).	Petrified wood	Pearl, 1942.
Colorado National Monument and vicinity.	Jasperized dinosaur bones	Do.
Gunnison River, near mouth.	Poor-quality moss agate	Endlich, 1878.
Opal Hill (loc. 1)	Opal, chalcedony	Pearl, 1958.

MINERAL COUNTY

Locality	Description	Reference
Embargo district, near Wagon Wheel Gap.	Beautiful, clear, variegated carnelian agate, very solid, egg-size to melon-size.	Eyles and Gisler, 1946.
Creede district	Fine amethyst; gem chrysoprase abundant in Mollie S. and Monte Carlo mines.	W. H. Emmons, and Larsen, 1923.

MOFFAT COUNTY

Locality	Description	Reference
Dinosaur National Monument.	Jasperized dinosaur bones.	Pearl, 1942.

MONTROSE COUNTY

Locality	Description	Reference
Not given	Clouded agate in lower trachyte.	Randall.

OTERO COUNTY

Locality	Description	Reference
La Junta	Gem agatized dinosaur bones.	Pearl, 1958.

Reported collecting localities for quartz and its varieties—Continued

PARK COUNTY

Locality	Description	Reference
Between Fairplay and old salt works (loc. 8).	Plasma, heliotrope, moss and clouded agate, petrified wood, beautiful lavender and blue chalcedony.	Hollister, 1867; Endlich, 1878; Randall; Pearl, 1942, 1958.
Between Hartsel and Guffey.	Fine blue agate and mammillary chalcedony in cavities of volcanic rocks.	G. R. Scott, written communication.

PROWERS COUNTY

Locality	Description	Reference
Eighteen miles south of Lamar on U.S. Highway 287.	Petrified wood	Pearl, 1942.

PUEBLO COUNTY

Locality	Description	Reference
Locality unknown	Fine-banded agate	Sterrett, 1914.

RIO GRANDE COUNTY

Locality	Description	Reference
On Rio Grande River, 15 miles north of Loma.	Amethyst-lined agate geodes.	Randall; Pearl, 1942; Shaw, 1946.

SAGUACHE COUNTY

Locality	Description	Reference
La Garita Creek	Fine chalcedony and onyx in lava.	Randall; Pearl, 1942.
Carnero Creek	Pale amethyst, with large prisms and small pyramids; many contain moving bubbles.	Randall.
Poncha Pass	Blue agate and jasper	W. A. Bowles, Jr., written communication.

TELLER COUNTY

Locality	Description	Reference
Florissant	Petrified wood	Pearl, 1942.
Crystal Peak (loc. 2)	Many fine smoky-quartz crystals, some 2 by 2 ft. to 4 by 6 ft.	Hurianek, 1938; Pearl, 1958.

WELD COUNTY

Locality	Description	Reference
Kalouse (loc. 1)	"Colorado's finest jasper" with agate and petrified wood.	Pearl, 1942, 1958.

QUICKSILVER

[*See* Mercury]

RALSTONITE

$NaMgAl_5F_{12}(OH)_6 \cdot 3H_2O$

Ralstonite, one of the rarer fluoride minerals, is reported only from the cryolite locality at St. Peters Dome, El Paso County (loc. 5). There it occurs as minute cubic crystals with octahedral faces. The crystals, which range from microscopic to 1 mm in diameter, coat crystals of pachnolite or line cavities in thomsenolite and pachnolite. (Whitman Cross and Hillebrand, 1883, 1885.)

RAUVITE

$CaU_2V_{12}O_{36} \cdot 20H_2O$

Rauvite, which was first discovered in Emery County, Utah, has been identified in ores from the Hummer mine, Bull Canyon district, Montrose County and from the Small Spot mine, Gateway district, Mesa County. It is associated with tyuyamunite in these and several deposits in Utah, and is probably an alteration product of pitchblende and low-valence vanadium oxide minerals. (Weeks and Thompson, 1954.)

REALGAR

AsS

Realgar has been reported only once. This occurrence is in the Greenhorn prospect near the head of the La Plata River in the La Plata district. It occurs as small crystals and is probably the result of the oxidation of tennantite or from some of the sulfarsenides of silver. (Whitman Cross, Spencer, and Purington, 1899; Galbraith, 1949.)

RHODIUM

[*See* Platinum]

RHODOCHROSITE

$MnCO_3$

Rhodochrosite is fairly common in many ore deposits and is abundant in a few. In some places beautiful pink to red crystals, of gem quality except for inferior hardness, have been found. These gem localities are described by Roots (1951), who lists the St. Elmo mine, Chaffee County; the Moose mine, Gilpin County; the John Reed mine, Lake County; the Sweet Home mine, Park County; and the Eagle and Rawley mines, Saguache County, as especially noteworthy. These and other significant localities are described further below.

By an increase in iron in isomorphous replacement of manganese, rhodochrosite becomes manganosiderite, now called ferroan rhodochrosite. This variety is described separately below.

Chaffee County.—Winfield district. In the Banker mine, rhodochrosite is abundant in barren northeastward-trending vertical veins that cut the ore-bearing veins. It forms pale-pink dogtooth crystals. (E. P. Chapman, Jr., written communication.)

Mary Murphy mine. The Mary Murphy mine, on Chalk Creek, contains small pink crystals of gem quality. In most places rhodochrosite and rhodonite are closely associated, but locally the Mary vein contains pods of clear rhodochrosite crystals with no rhodonite. (Roots, 1951; Dings and Robinson, 1957.)

Clear Creek County.—Georgetown district. In the Gomer and Hedensburg mine, galena and sphalerite crystals in vugs are crusted with crystals of quartz, ferruginous rhodochrosite and barite. (Spurr, Garrey and Ball, 1908.)

Idaho Springs district. Rhodochrosite occurs in many of the ore deposits; most of it is massive, but some is well crystallized. (Randall.)

Dolores County.—Rico district. Massive rhodochrosite, irregularly and beautifully banded with quartz and ore minerals, is abundant in the upper parts of the Newman Hill lodes and the Enterprise blanket. It is not very abundant in other parts of the district, but black outcrops of vein matter indicate that it or manganiferous mixed carbonates are widespread. (Ransome, 1901a.)

El Paso County.—Garden of the Gods (loc. 4). Small white radiate bunches of rhodochrosite are perched on blue celestite in lenticular geodes in parts of the red sandstones. (Finlay, 1916.)

Gilpin County.—Central City district. Rhodochrosite is virtually confined to the region near the head of Gilson Gulch. It is the most abundant gangue in parts of the Franklin mine, where it is mixed with galena, sphalerite, and other minerals. Locally it is very abundant in the Moose, Bellman, and Gem mines. (Bastin and Hill, 1916.)

Moose mine. The Moose mine is on the south side of Willis Gulch, one-fourth mile below the head of the gulch and 1½ miles south of Central City. It can be reached from the Idaho Springs via the Virginia Canyon road and either Gilson Gulch or Russell Gulch roads. Rhombohedral rhodochrosite crystals as much as 1 inch in diameter, pyrite, quartz, and purple fluorite, all in well-formed crystals, can be found on the mine dump. The rhodochrosite crystals are bright red and of gem quality. (Roots, 1951; J. W. Adams, written communication.)

Hinsdale County.—Lake City district. Rhodochrosite occurs in many of the veins, but in variable amounts. It is deep pink when fresh, but bleaches on exposure. Much of it is crystalline in quartz-lined vugs. Tetrahedrite is very commonly associated with rhodochrosite—so closely that the rhodochrosite is high in silver content even where grains of tetrahedrite cannot be noted. (Irving and Bancroft, 1911.) Flat rhombs of opaque flesh-colored crystals from the Ulay (Ulé) mine are described by Kunz (1887). The crystals, developed on argentiferous galena, have rough curved faces, and are as much as 23 mm in diameter.

Lake County.—Alicante district (loc. 1). The John Reed mine in this old district near Leadville has long been known as the source of beautiful rich-rose-pink gem-quality crystals of rhodochrosite. They are as much as one-half inch in diameter and some are clear enough to exhibit the well-known double refraction of Iceland spar. The crystals, 40 of which were found in a single cavity only 8 cm wide, are simple rhombohedra. There is also some opaque massive material that encloses bright cubes of pyrite. Kunz (1887) and Wherry and Larsen (1917) both give detailed descriptions and analyses. According to Roots (1951) the mine has long been closed and few if any specimens are available on the mine dumps.

Leadville district. Pure rhodochrosite is very rare in the district as a whole, although the ferroan variety and other mixed carbonates are very abundant. There are large quantities of rhodochrosite in the Ella Beeler lodes and in the Dinero vein in the Sugar Loaf district. (S. F. Emmons, Irving and Loughlin, 1927.)

La Plata County.—Needle Mountains district. Some of the veins are beautifully crusted with pink rhodochrosite crystals formed after the shattering of chalcedony-pyrite-chalcopyrite veins, and followed by several generations of quartz and fluorite. (Whitman Cross, Howe, Irving, and Emmons, 1905.)

Ouray County.—The Royal Albert and Mountain Monarch veins contain beautiful isolated rose-red crystals of translucent rhodochrosite. (Whitman Cross, Howe, and Irving, 1907.)

Park County.—Alma district (loc. 1). The Sweet Home mine in Buckskin Gulch near Alma has long been known as the source of the finest crystals of rhodochrosite ever found. They are bright red, clear, and as much as three-fourths inch in diameter. Pyrite, huebnerite, and green octahedral crystals of fluorite are among the associated minerals. Many of the finer specimens may be seen in museums. (Endlich, 1878; Roots, 1951.) Sundius (1925) records an analysis of rhodochrosite from Alma.

Saguache County.—Bonanza district. Rhodochrosite is distributed throughout the district, but it is only abundant in the southern part, where oxidation of rhodochrosite and rhodonite has produced abundant manganese oxides. In the Eagle vein and the "rhodochrosite vein" of the Express mine, rhodochrosite and fluorite are the chief gangue minerals. The rhodochrosite is nearly pure $MnCO_3$ and forms slightly warped deep-pink to rose-red clear rhombohedral crystals. (Burbank, 1932; Roots, 1951.)

San Juan County.—Silverton district. Rhodochrosite, massive or as crystals in vugs, is widely distributed and commonly associated with rhodonite. With quartz it forms the gangue of the rich gold ore of the Golden Fleece mine. The Grizzly Bear mine has yielded very beautiful crystals associated with native silver. (Ransome, 1901b; Whitman Cross, Howe, and Ransome, 1905.)

In the Sunnyside vein (loc. 1) rhodochrosite is widely distributed among the complex of rare manganese silicates. It is very abundant locally but is less common than rhodonite. Veinlets and irregular masses replace the silicates and, locally, the sulfides. (Burbank, 1932.)

San Miguel County.—Telluride district. Rhodochrosite seems to be more closely associated with sphalerite ores, whereas calcite is in the galena-rich ores. This is best exemplified in the Big Elephant sphalerite-rhodochrosite vein in Savage Basin. In the Smuggler mine rhodochrosite is fairly widespread. Most of it was deposited early with the first generation of quartz but there is a later generation found as platy aggregates or as crystals in vugs. (Purington, 1898; Hurst, 1922.)

Park and Summit Counties.—Montezuma district. Pure rhodochrosite is rare, although some of the ankerite approaches rhodochrosite in composition. Coarse-grained masses of moderately pure material are associated with pyrargyrite, miargyrite, and argentite in the Jerry tunnel, at the north end of Glacier Mountain. In the Queen of the West mine near Argentine Pass rhodochrosite lines vugs in alabandite. (Lovering, 1935.) Deep pink cleavage fragments as much as 4 inches in diameter occur in Hall Valley. (G. R. Scott, written communication.)

Teller County.—Cripple Creek district. Rhodochrosite is present but relatively rare. Crystals that are probably close to it in composition occur in the Fluorine mine. In the Pointer vein and in the Lead vein of the Moon Anchor mine there are many 3- to 4-inch veins of rhodochrosite with fluorite, pyrite, galena, and sphalerite. (Lindgren and Ransome, 1906.)

Rhodochrosite variety FERROAN RHODOCHROSITE (MANGANOSIDERITE)

Rhodochrosite grades, by substitution of ferrous iron for manganese, through a continuous isomorphous series to siderite, the iron carbonate. The intermediate minerals, formerly known as manganosiderite, are now grouped as ferroan rhodochrosite. It is very abundant and important in the Leadville district and is present as a gangue mineral in a few other districts. In addition to the few where it has been described as manganosiderite, many of the descriptions of mixed carbonates and other carbonate minerals may be more correctly ascribed to this one.

Boulder County.—Ward district. Ferroan rhodochrosite, reported as manganiferous siderite, is the most abundant and conspicuous mineral in the White Raven mine in California Gulch. It is commonly light greenish brown and occurs in vugs as well-developed flat rhombs with curved faces that range from microscopic size to three-fourths inch in diameter. A gold-bearing quartz-pyrite-chalcopyrite vein was first formed. This was later reopened and lead-silver ore was deposited in the following order—horn quartz, massive galena, ferroan rhodochrosite, crystallized galena, a second generation of ferroan rhodochrosite, and wire silver. Wahlstrom (1935) gives three analyses of the mineral.

Chaffee County.—Winfield district. Ferroan rhodochrosite, with quartz and calcite, forms the gangue of a bismuthinite-bearing deposit below Beaver. (E. P. Chapman, Jr., 1932.)

Lake County.—Leadville district. Ferroan rhodochrosite occurs as very large granular masses that border sulfide ore bodies; it also occurs within the sulfide bodies. It is a replacement of limestone and resembles the original limestone closely. It was deposited at high through mesothermal temperatures as the advance guard of the metallic sulfides, was replaced by them, and moved outward into the limestone. It contains small amounts of calcium and variable but large amounts of manganese and magnesium. Whether it should be classed as ferroan rhodochrosite or manganoan siderite is debatable. (P. B. Argall, 1914a; S. F. Emmons, Irving, and Loughlin, 1927.)

Mayo and O'Leary (1934) describe a specimen of oligonite, or manganosiderite, from the Tucson shaft of the Iron Silver Mining Co. and give many chemical and optical data. The specimen is a mass of chalcopyrite and sphalerite with hollows, supposedly dissolved by hot vapors, that are crusted with galena. The ferroan rhodochrosite, or oligonite, occurs as mushroomlike masses on the surface of the specimen, supposedly around the orifices of vapor vents. They are pale taffy colored and have one-sixteenth-inch outer shells that partly enclose bundles of tiny radiating needles.

Park and Summit Counties.—Montezuma district. Ferroan rhodochrosite, reported as manganosiderite, is locally abundant in the mines on Glacier Mountain. In the Wild Irishman vein it occurs only in the lower levels, giving way upward to quartz and barite. Galena is the dominant associated sulfide, but some pyrite and chalcopyrite are locally present. (Lovering, 1935.)

RHODONITE

$MnSiO_3$

[*See also* Pyroxene group]

Rhodonite, the beautiful pink manganese silicate, is rather widely distributed as a vein mineral. It is commonly associated with, and less abundant than, rhodochrosite and other manganese minerals. Surprisingly, in view of its color, toughness, and hardness, as well as its availability, it is little sought by gem collectors and lapidarists; it is barely mentioned by Pearl (1958) in his descriptions of gem localities. The more important localities are described below.

Chaffee County.—Chalk Creek district. In the ore deposits of the Mary Murphy and nearby mines, the chief gangue minerals are quartz, pyrite, and limonite; calcite, rhodochrosite, barite, and fluorite are minor constitutents. Rhodonite and rhodochrosite occur as tough, fine-grained intergrowths with quartz as stringers, lenses, and pods as much as 2 inches thick near the central parts of the veins. (Dings and Robinson, 1957.)

Fremont County.—Discovery of a deposit of gem-quality rhodonite about 10 miles southeast of Canon City is reported by Sterrett (1914). The mineral, which is fairly abundant, is of good pink color and fine texture.

Lake County.—Leadville district. Rhodonite has been found only in the lodes of the Ella Beeler group in Iowa Gulch. It forms narrow parallel bands that alternate with other minerals. (S. F. Emmons, Irving, and Loughlin, 1927.)

Saguache County.—Bonanza district. Rhodonite is present but not abundant in nearly all the veins in the district. It is an early mineral and was deposited before all the sulfides except possibly some pyrite and sphalerite; it is replaced by quartz and rhodochrosite. In most places it is very hard and fine grained and ranges from pink to rose red in color. (Burbank, 1932.)

San Juan County.—Silverton district (loc. 1). Rhodonite is a very abundant constituent of the Sunnyside vein at Eureka and is present in large quantities in many other veins, particularly those in the northeastern part of the district. (Endlich, 1878; Ransome, 1901b.) A large quantity of rhodonite from the Sunnyside mine, where it occurs in bodies tens of feet wide and hundreds of feet long, has been cut as gems (Aurand, 1920b). It is dense and fine grained and although seldom entirely free of rhodochrosite, is so tough that it has been used very successfully as abrasive material in ball mills in the district. Hudson (1947) mentions this and other minerals that can be found by the collector in this vicinity.

In his exhaustive study of the array of manganese minerals of the Sunnyside deposite, Burbank (1933) found rhodonite to be the most abundant of the manganese silicates. He gives the optical properties of the mineral, which occurs as tiny grains with other minerals and also as well-formed crystals as much as

1 mm. long in vugs in massive rhodonite. The color ranges from very pale pink to deep pink, depending on the texture.

Summit County.—Tenmile district. Both rhodochrosite and rhodonite are present in many of the sulfide ores of the Robinson and other mines. Apparently neither mineral is as widely distributed as quartz, calcite, and barite. (S. F. Emmons, 1898.)

RICKARDITE†

Cu_3Te_2

Rickardite and weissite, both copper telluride minerals, were first found in the Good Hope mine at Vulcan, Gunnison County (loc. 5). The fact that the two minerals are commonly intimately intergrown has led to confusion as to the identities and chemical formulas of both, but they are now well-established species.

Rickardite was named for T. A. Rickard who first found it. The type description of the species is that of W. E. Ford (1903). According to one writer (Ores and Metals, 1903) the mineral should have been named sanfordite for A. B. Sanford of Denver who is said to have worked out the identity of the new mineral in 1901 and to have given the samples and his data to Rickard, who turned them over to Ford for description.

The mineral, which is a beautiful purple, occurs as small lenticular masses, commonly associated with weissite and native tellurium. The Good Hope vein is made up largely of pyrite, with masses of tellurium as much as 6 inches in diameter; it also contains petzite, berthierite, roscoelite(?), and native sulfur. Studies of polished sections of rickardite-bearing ore are reported by Ramdohr (1937) and Short (1931). Forman and Peacock (1949) report on an X-ray study of the crystal structure and give the formula used here. (See also R. M. Thompson, 1949 and Harcourt, 1942.)

Small amounts of rickardite are also recorded from one other locality in Colorado. This is the Empress Josephine mine in the Bonanza district, Saguache County. (Patton, 1916; Burbank, 1932.)

RIEBECKITE

[*See* Amphibole group]

RILANDITE†

Rilandite, a hydrous aluminum chromium mineral of uncertain formula was described as a new mineral from the J. L. Riland claim, 13 miles east and a little north of Meeker, Rio Blanco County; it was also found in Routt County. It has not been found elsewhere and its status as a mineral species is in doubt.

At the type locality it occurred in small quantity on the outer surfaces of petrified logs in the sandstone of the lower beds of the Morrison formation. It is massive, compact, dark brown to black, and resembles dull pitch. (E. P. Henderson and Hess, 1933.)

ROBELLAZITE*

Robellazite was described as a new mineral from carnotite-bearing deposits in Montrose County. A partial chemical analysis showed the presence of a large amount of vanadium, with niobium, tantalum, tungsten, alumina, iron, and manganese. It has never been more closely defined, is presumably a mixture of minerals, and is discredited as a species. (Cumenge, 1900.)

ROSCOELITE

$(K,Na)(Al,V)_2(AlSi_3)O_{10}(OH,F)_2$

Roscoelite essentially a vanadiferous muscovite, is very widespread geographically and is locally abundant. Judging by its known distribution, however, it is limited to two mineralogic environments—as an associate of the telluride minerals, and of the vanadium-uranium minerals of the Colorado Plateau.

Boulder County.—Roscoelite has long been known as a close associate of the telluride minerals in several districts in the county. Here and elsewhere in the State this mineral probably causes the green color of dense vein quartz that is commonly considered an indication of good telluride ore. It was first described in Colorado from the Keystone and Mountain Lion mines in the Magnolia district. (Both Genth, 1877 and Endlich, 1878 give analyses.) The wide distribution of roscoelite in the Boulder County telluride ores is also noted by Rickard (1902). It is widespread in the veins near Eldora and is very abundant in the Mogul tunnel and the Enterprise mine. It forms dark-yellow-green masses intergrown with quartz or irregularly distributed in the ore. Microscopic crystals of pyrite and specks of gold tellurides are disseminated through the roscoelite. (Lindgren, 1907.) In the Gold Hill district, rosoelite is associated with free gold and telluride minerals in the Slide mine and a few other places. (Goddard, 1940.)

Garfield County.—The Denver Museum of Natural History has a large specimen of roscoelite labelled as coming from Rifle.

Gunnison County.—Vulcan district (loc. 5). A greenish-black micaceous substance in the ore of the Good Hope and Vulcan mines resembles roscoelite. It has not been definitely identified, but the associated tellurides (rickardite, weissite, and native tellurium) make the suggestion of identity with roscoelite seem reasonable. (Rickard, 1903.)

La Plata and Montezuma Counties.—La Plata district. Roscoelite is a widespread associate of the telluride minerals. Most of it is a microscopic intergrowth with fine-grained quartz and it is an almost certain indicator of high-grade ore. Locally, as in the Durango Girl mine, where abundant roscoelite probably contains from 4 to 8 percent vanadium, the mineral forms felted aggregates of small but microscopic platy crystals. (Galbraith, 1949.)

Rio Blanco County.—Roscoelite is reported along Coal Creek, near Meeker. (Schrader, Stone, and Sanford, 1916.)

San Miguel County.—Placerville. Roscoelite is one of the ore minerals of vanadium in sandstone deposits at Placerville. Some of it replaces the feldspar grains of arkosic sandstone in radial aggregates, but most of it is interstitial to the quartz grains. Pyrite is fairly abundant. The vanadium-bearing sandstone grades laterally into sandstone that contains a chromium-bearing mineral that is ascribed to mariposite, fuchsite, and chrome-mica clay. (Hess, 1913b.) The deposits are described further by Fischer (1937) and by Fischer, Haff, and Rominger (1947). The ore bed, which is 1½ to 5 feet thick, consists of sandstone impregnated with vanadium minerals, with roscoelite or a closely related mineral as the principal mineral. Optical properties and chemical analyses are reported.

Layers of roscoelite-bearing sandstone, similar to those at Placerville, have also been observed in the Entrada sandstone along Lightner Creek, La Plata County, east of Rico, Dolores County, and near Rifle, Garfield County. (R. P. Fischer, written communication.)

Teller County.—Cripple Creek district. Massive roscoelite, with quartz, fluorite, and calaverite occur in the Mary McKinney mines and probably elsewhere. (Lindgren and Ransome, 1906.) The mineral belongs to the second stage of mineralization. Some of it forms small soft drusy masses, but more often it forms the green coloring matter in rocks along the edges of veins or in inclusions in the veins. It is more conspicuous in basaltic than in other rocks. In the Cresson mine both roscoelite and celestite are very favorable indicators of rich ore. (Loughlin, 1927; Loughlin and Koschmann, 1935.)

Colorado Plateau, general.—In addition to the Placerville locality noted above, roscoelite has been positively identified recently in the following Colorado districts on the Colorado Plateau: Gateway district, Mesa County; Uravan and Paradox districts, Montrose County; Bull Canyon district, Montrose and San Miguel Counties; Gypsum Valley district, San Miguel County; and Slick Rock district, San Miguel and Dolores Counties. In all of these, roscoelite impregnates sandstone and replaces pellets and stringers of clay. It is associated with corvusite, hewettite, carnotite, tyuyamunite, and other vanadium minerals of the oxidized zones. (Weeks and Thompson, 1954.)

ROSSITE†

$CaV_2O_6 \cdot 4H_2O$

Rossite was first found in the Bull Pen Canyon area of San Miguel County. It has not been reported elsewhere in the Colorado Plateau despite the enormous number of mineralogical studies that have been done in the past decade. The type locality is in the McElmo formation of former usage near the Colorado-Utah boundry and 5 miles southeast of Summit Point post office, Utah. Rossite, which is fairly abundant here, occurs as small yellow glassy kernels embedded in flaky metarossite. Both minerals are later than a mixture of hewettite, vanoxite, and roscoelite. (Foshag and Hess, 1927; Weeks and Thompson, 1954.)

RUBY SILVER

[*See* Proustite *and* Pyrargyrite]

RUTHENIUM

[*See* Platinum]

RUTILE

TiO_2

Rutile is very widespread as an accessory mineral in many igneous and metamorphic rocks and is also commonly found among the "heavy minerals" that can be concentrated from sedimentary rocks. In addition to this kind of occurrence, which is not further described here, rutile is present as a minor vein or wallrock mineral in some mining districts and occurs in a few pegmatite bodies.

Chaffee County.—Mount Antero region (loc. 3). Complex twins of ilmenorutile occur with monazite in the quartz-rich massive pegmatite bodies that contain gem aquamarine. (Over, 1935.)

El Paso County.—St. Peters Dome (loc. 5). Near the fluoride mineral locality of the Eureka tunnel (see cryolite), very short prisms of rutile with pyramidal faces are associated with rough reddish-brown microcline, arfvedsonite, and a little zircon in quartz. (W. B. Smith, 1887b—analysis.)

West Cheyenne Canyon. Rutile, which contains a little tin, occurs as minute black crystals in quartz that fills cavities in altered pink orthoclase. Some crystals resemble pyramidal crystals of cassiterite; others are distorted or elongated prisms. (Genth, 1892a—analysis.)

Saguache County.—Bonanza district. Rutile occurs in many sericitic fault gouges and also in small amounts in some vein quartz and silica replacement deposits. In the veins it forms very small yellow or yellowish-brown crystals. In the jasper deposits, where it is common, it occurs as prismatic crystals, irregular grains, or fine aggregates. (Burbank, 1932.)

San Juan County.—Silverton district. In the Polar Star mine on Engineer Mountain, minute crystals of rutile occur in altered andesite near the veins. (Ransome, 1901b.)

Teller County.—Cripple Creek district. Microscopic crystals of rutile occur as alteration products of ilmenite in the wallrocks of veins. (Lindgren and Ransome, 1906.)

SAHLITE

[*See* Pyroxene group]

ST. STEPHENS STONE

[*See* Quartz]

SALT

[*See* Halite]

SAMARSKITE

(Y,Er,Ce,U,Ca,Fe,Pb,Th) $(Cb,Ta,Ti,Sn)_2O_6$

Samarskite, essentially an oxide of the rare earths and niobium has been found in several pegmatites in different parts of the State. It is nowhere very abundant.

Douglas County.—Devils Head (loc. 1). Samarskite occurs in weathered granite, presumably pegmatitic, associated with cyrtolite(?), allanite, and gadolinite. It was found only as small fragments with no crystal forms and is pitch black with a brilliant vitreous luster. (Hillebrand, 1889—analyses.)

Fremont County.—A mineral tentatively identified as samarskite is present with uraninite in the Cotopaxi feldspar prospect in sec. 8, T. 48 N., R. 12 E., 4 miles north of Cotopaxi (loc. 1). (Hanley, Heinrich, and Page, 1950.) Kulp, Volchok, and Holland (1952) record a differential thermal analysis of samarskite from "Canon City." This possibly refers to the Cotopaxi locality.

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). The mineral originally described as samarskite by Eckel (1933a) was found to be microlite on more careful study (Eckel and Lovering, 1935). Nevertheless samarskite or a very similar mineral is present in at least 7 of the pegmatites of this district, although there are not more than 1 or 2 crystals in each pegmatite. It is commonly associated with smoky quartz and is strongly radioactive. (Staatz and Trites, 1955.)

Jefferson County.—Centennial Cone (loc. 5). A brownish-black mineral, tentatively identified as samarskite, occurs sparingly in the complex part of the pegmatite dike, as small tabular irregular prismatic crystals. It is associated with beryl, monazite, bertrandite and other minerals. (Waldschmidt, 1942; J. W. Adams, written communication.)

Clear Creek Canyon. A mineral tentatively identified as either samarskite or yttrotantalite occurs in several of the pegmatite dikes that crop out on the hill above the well-known Roscoe dike (loc. 14). (Vance Haynes, written communication.)

SANFORDITE*

[*See* Rickardite]

SANIDINE

[*See* Feldspar group, orthoclase species]

SAPPHIRE

[*See* Corundum]

SARDONYX

[*See* Quartz]

SATIN SPAR

[*See* Gypsum]

SAUCONITE†

$(Zn, Al)_4Si_8O_{20}(OH)_4 \cdot nH_2O$

[*See also* Clay minerals *and* Montmorillonite]

Sauconite, a zinc-rich member of the montmorillonite groups has long been known as a zinciferous clay mineral from the Leadville district, Lake County. In establishing the sauconite species, Ross (1946) included specimens from the New Discovery and Yankee Doodle mines in his studies. In more detailed studies of the species Faust (1951) used material from the same mines. Both authors, and S. F. Emmons, Irving, and Loughlin (1927) give analyses and other data.

The sauconite from the New Discovery mine is laminated, with very perfect parallel arrangement of the individual micaceous plates. It is massive and brown in hand specimen. The material from the Yankee Doodle mine, which occurs in a 2-foot-thick layer below a thin bed of siliceous shale, is mottled brownish yellow and massive.

SCAPOLITE GROUP

The scapolites, which occur mainly in volcanic and metamorphic rocks, are analogous to the feldspars in that they form a gradational series in composition. The species in the group are as follows:

Species	*Composition*
Meionite (Me)	$CaCO_3 \cdot 3CaAl_2Si_2O_8$
Wernerite (common scapolite)	$Me_{80}Ma_{20}$ to $Me_{40}Ma_{60}$
Mizzonite (dipyre)	$Me_{40-60}Ma_{20-80}$
Marialite (Ma)	$NaCl \cdot 3NaAlSi_3O_8$

Wernerite and mizzonite are intermediate species, with proportions of the meionite and marialite end-member molecules about as shown.

Neither of the pure end-member species of the group have been reported from Colorado. Wernerite has been found in 3 localities and mizzonite in 1.

Scapolite species MIZZONITE

$Me_{40-60}Ma_{20-80}$, in which Me=meionite and Ma=marialite

Mizzonite, in which SiO_2 ranges from 54 to 57 percent, has only been reported from Italian Mountain, Gunnison County. There scapolite, all apparently of the species mizzonite, makes up the bulk of many specimens. The most striking of these specimens are large variously oriented prismatic masses or sheaves, as much as 4 by 10 cm in size, of ill-defined fibrous structure. Interstices in the pale-purple to cream-colored mizzonite are filled with white calcite. The mineral is partly altered to finely fibrous scolecite; there are a few clear grains of analcite(?) and a few cavities are lined with small perfect crystals of heulandite.

In diorite on the south slope of the Sawtooth Range veins of fresh grayish-white compact mizzonite occur as much as 6 cm wide, bordered by a mixture of mizzonite and a green mineral, probably diopside.

A specimen from Italian Mountain contains a loose-textured network of dirty-white prisms of mizzonite, 1 by 3 cm, whose interstices are filled with byssolitic hornblende and some heulandite and sphene. The masses are largely corroded and replaced by scolecite. (Whitman Cross and Shannon, 1927—analyses.)

Scapolite species WERNERITE

$Me_{80}Ma_{20}$ to $Me_{40}Ma_{60}$, in which Me=meionite and Ma=marialite

Wernerite, or common scapolite, has been reported from only three localities. It possibly occurs elsewhere in metamorphic rocks.

Chaffee County.—Turret district. Wernerite is a rare constituent of the contact-metamorphic magnetite deposit that forms the chief ore of the Calumet mine (Behre, Osborn and Rainwater, 1936). It has also been found in porphyry body 1 mile north of the mine and in a deposit one-half mile east of the mine where it is associated with epidote, topaz, and monazite (G. R. Scott, written communication).

Clear Creek County.—Georgetown district. The first reported occurrence of wernerite as a pegmatite mineral was from a locality 2.1 miles south of Mount Evans. There it forms greenish-gray columnar aggregates as much as 10 inches long in biotite pegmatite. The wernerite contains inclusions of apatite, allanite, and magnetite. (Spurr and Garrey, 1908.)

Jefferson County.—Genessee Mountain. Thin wernerite crystals occur in cavities in hornblende. (G. R. Scott, written communication.)

SCHAPBACHITE

[*See* Matildite]

SCHEELITE

$CaWO_4$

Scheelite, the chief ore of tungsten in most other parts of the world, is widespread in Colorado but it is much less important as an ore mineral than ferberite, wolframite, and huebnerite in most places.

Boulder County.—Nederland tungsten district. Scheelite was first noted in the Boulder County ferberite ores by Van Wagenen (1906), who found well-formed crystals in ore from the Iowa claim. Small quantities of scheelite are also reported by Hess and Schaller (1914), who found tiny octahedral crystals that range from clear colorless through white to reddish brown in color. These line vugs and fractures in ferberite and are also disseminated in the vein quartz.

Tweto (1947) calls attention to the facts that scheelite is very widespread in the district and is locally abundant enough to be of economic importance. He finds it as small veins, in vugs, and disseminated through sericitized rock and fault gouge; it is later than all minerals except calcite. Tweto suggests the use of a fluorescent lamp in the search for scheelite because the mineral is so inconspicuous in the ore.

Elsewhere in Boulder County, scheelite has been found in the Colorado and Union pyrite-gold-quartz veins at Ward, and in the Croesus gold telluride vein. (G. O. Argall, Jr., 1943. See also Loomis, 1937; Lovering and Tweto, 1953.)

Chaffee County.—Cleora district. The Grand View and Stockton mine, 2 miles southeast of Salida, contains relatively small quantities of scheelite and cuproscheelite(?) in a quartz vein. This is an old gold-copper mine with insignificant production. (G. O. Argall, Jr., 1943.)

Scheelite is also reported with copper minerals 3½ miles east of Salida. This is probably the same occurrence as that just noted. (Schrader, Stone, and Sanford, 1916.)

Fremont and Park Counties.—Guffey area (loc. 8). Disseminated grains and crystals of scheelite occur on a ridge one-fourth mile northeast of the West Ranch at the junction of State Route 9 with the Guffey road. The host rock is a coarse-grained aggregate of epidote, hornblende, quartz, calcite, and garnet. Some of the milk-white crystals of scheelite show zonal variation in their fluorescence. (Bever, 1953.)

Gilpin County.—Black Hawk district. Scheelite and powellite occur in a layered garnet-epidote rock in schist 2 miles southeast of Black Hawk. One small shipment of tungsten ore is reported. (G. O. Argall, Jr., 1943.)

Gunnison County.—Gold Hill(?) district. The huebnerite-molybdenite-quartz veins contain specks of a fluorescent mineral, possibly scheelite. This locality may refer to either the Gold Brick district or to the Tincup district noted below. (G. O. Argall, Jr., 1943.)

A quartz-feldspar "vein" near Wolf Creek contains large crystals and masses of scheelite and some powellite. (G. O. Argall, Jr., 1943.)

Tincup district. A little scheelite-powellite occurs in the huebnerite-molybdenite veins on the high ridge north of North Quartz Creek and west of Cumberland Pass. This is in the old Quartz Creek district, now considered an extension of the Tincup district. The scheelite-powellite forms small grains and coatings on comb quartz. In the Complex vein considerable scheelite-powellite occurs as borders on masses of huebnerite and tetrahedrite. (Dings and Robinson, 1957.)

Jefferson County.—Genessee Mountain (loc. 10). A calcium silicate unit in the Idaho Springs formation exposed along U.S. Highway 40 about 1 mile northeast of Genessee Mountain contains rough crystals of scheelite some of which are embedded in garnet crystals. (J. W. Adams, written communication.) Wernerite is among the associated minerals.

Lake County.—Leadville district. Large quantities of scheelite are in the siliceous pyritic gold ore of the South Ibex stockwork on Breece Hill. Huebnerite is associated. (S. F. Emmons, Irving and Loughlin, 1927.) In the Golden Queen mine some of the scheelite contains minute grains of free gold. (Schrader, Stone, and Sanford, 1916.)

The scheelite occurs as localized aggregates, some associated with wolframite, some with pyrite and quartz. Locally the scheelite is massive; elsewhere it occurs as imperfect doubly terminated crystals that line vugs. (Fitch and Loughlin, 1916.)

Larimer County.—Scheelite occurs in a quartz vein in granite at the Helmes No. 1 mine, in secs. 23 and 24, T. 8 N., R. 72 W. It also occurs in gold veins near Masonville. (G. O. Argall, Jr., 1943.)

San Juan County.—Silverton district. Scheelite was reported by Endlich (1878).

Summit County.—In the Navy or Royal George veins on North Star Mountain and Quandary Peak, scheelite occurs with huebnerite, pyrite, and quartz. A little tungstite is also present. (G. O. Argall, Jr., 1943.)

SCHIRMERITE†

$PbAg_4Bi_4S_9$

Schirmerite was first discovered in 1874 in ore from the Geneva district, Clear Creek County (now considered part of the Montezuma district, Park and Summit Counties). Earlier in the same year that the type discovery was made, a "new" mineral also called schirmerite was reported to be abundant in the Red Cloud and Cold Spring mines in the Gold Hill district, Boulder County, by Endlich (1874). Endlich's mineral, which he thought to be a telluride of gold, silver, and iron, was shown to be a mixture of tellurides and pyrite, thus discrediting his "schirmerite" and leaving the name free for application to the silver-lead-bismuth sulfide of the Geneva district. Schirmerite has since been reported from 2 other districts, but the identification in 1 of these is uncertain.

Hinsdale County.—Lake City district. X-ray powder diffraction data on a specimen of schirmerite from this district are given by Harcourt (1942). No details of the occurrence are given.

Park and Summit Counties.—Geneva (Montezuma) district. The Treasure Vault lode is considered the type locality of schirmerite, but the mineral is also present in other veins that parallel the Treasure Vault; it is not, however, present in cross veins. The schirmerite, which closely resembles cosalite, is massive, finely granular, and occurs disseminated in quartz. (Genth, 1874—analyses.)

San Miguel County.—Ophir district. A mineral suspected of being schirmerite occurs in the Santa Cruz mine. It is disseminated through granular quartz and is associated with native bismuth, bismuthinite(?), chalcopyrite, and galena. (Hillebrand, 1885a.)

The Denver Museum of Natural History has a specimen labelled as schirmerite from the Santa Cruz mine.

SCHOEPITE

$4UO_3 \cdot 9H_2O$ (?)

Becquelerite and schoepite are among the minerals identified in ore from the G–6 Shaft in Browns Park, Moffat County, in sec. 17, T. 6 N., R. 94 W. Associated minerals are liebigite and uranophane. (Gruner and Knox, 1957.)

SCHROECKINGERITE

$NaCa_3(UO_2)(CO_3)_3(SO_4)F \cdot 10H_2O$

Schroeckingerite was identified by X-ray methods as a postmining deposit on timbers in the Black Cloud mine, Gold Hill district, Boulder County. The Black Cloud vein contains quartz, pyrite, galena, sphalerite, gold, and sooty pitchblende. (Campbell, 1955.)

SCHWATZITE

[*See* Tetrahedrite, var. mercurian tetrahedrite]

SCOLECITE

$CaAl_2Si_3O_{10} \cdot 3H_2O$

Scolecite, a rare zeolite, is reported from two localities. In one of these it is the most abundant and widespread of the zeolite minerals.

Gunnison County.—Italian Mountain (loc. 3). Scolecite is the most abundant zeolite in the altered rocks of Italian Mountain but does not form attractive mineral specimens. It is present in cavities in the rock, associated with chabazite and stilbite. The more important occurrence, however, is in minute cavities in the dense garnet hornfels which contains the best-developed vesuvianite crystals in the deposit. In the hornfels, tiny vugs in massive garnet, are lined with minute crystals of grossularite; the remaining spaces are partly filled with white scolecite that ranges from compact translucent radial or divergent tough fibrous material to loosely grouped separable fibers. Scolecite is also common in specimens of vesuvianite, as crusts or fibrous aggregates that are clearly older than chabazite. It is even less well characterized where it is associated with mizzonite, but the microscope shows that much mizzonite is replaced by scolecite. (Eakins, 1893—analysis; Whitman Cross and Shannon, 1927—analysis.)

Jefferson County.—North Table Mountain (loc. 18). Scolecite is sparingly present in a zone just above that which is very rich in zeolites. It occurs only in small cavities as small spheres or segments of spheres, with radial structure, similar to the habit of thomsonite but easily distinguished from that mineral by the brilliant white color and satin luster of scolecite. Minute tablets of brown mica that are coated by a lavender material are the only close associates of scolecite, but some nearby amygdules contain chabazite and thomsonite. (Whitman Cross and Hillebrand, 1885.)

SCORODITE

$FeAsO_4 \cdot 2H_2O$

Scorodite has been described only from the Charter Oak mine at Red Mountain, Ouray County. There it forms green botryoidal incrustations on enargite and on the wallrocks. In addition to enargite, zunyite, pyrite, and native sulfur are associated with the scorodite. (Penfield, 1893.)

SEARLESITE

$NaBSi_2O_6 \cdot H_2O$

Searlesite has been identified in a single drill core from the Green River formation in northwestern Colorado. This is the only reported occurrence in the State, but the mineral is probably present elsewhere in the Green River formation. (Charles Milton, oral communication.)

SELENITE

[*See* Gypsum]

SELENIUM

Se

Native selenium is widespread but nowhere very abundant in the uranium-vanadium ores of the Colorado Plateau. Native selenium or other selenide minerals also seem to occur in base-metal ores in other parts of the State, but the form of occurrence is known in very few of these as the presence of selenium is known principally from its recovery as a smelter byproduct. Localities where selenium is noted in the literature, but not identified as to mineral, are included here.

Fremont County.—Whitehorn district. Tetradymite from near Whitehorn contains approximately 0.20 percent selenium. (Hillebrand, 1905.)

Gilpin County.—Black Hawk district. Selenium occurs with sphalerite in the Aetna tunnel; the selenium-bearing mineral has not been identified. (J. A. Smith, 1883.)

Gunnison County.—Vulcan district (loc. 5). Native selenium occurs as a smoky-purple powder in the Good Hope vein, better known as the type locality of rickardite and weissite, where it is associated with native sulfur. According to Whitman Cross and Larsen (1935) "* * * the sulfur is said to have been so rich in selenium as to make it unsuitable for some purposes." (See also George, 1927.)

Lake County.—Leadville district. The "sulfurets" of the Iron Silver mine contain small amounts of selenium and several other elements in material that assays 35 percent zinc and 6 percent lead. (Bartlett, 1889.)

Montrose County.—The first mention of selenium from the Colorado Plateau is that of Hillebrand, Merwin and Wright (1914) who believed it to be present in the new mineral, metahewettite, which they described. Gale (1908) says that selenium comprises as much as 1 percent of the vanadium ore from Thompsons, Utah, and is also present in the Henry Mountains, Utah, and in some small specimens from the Paradox Valley, Colo. It forms deep-red transparent prisms as much as 0.05 mm long embedded in metahewettite.

Abundant crystals of native selenium occur in the high-grade vanadium-uranium ore from the Peanut Mine, Bull Canyon district. The largest of the purple-gray acicular crystals are 2 mm long; most of them form feltlike aggregates associated with sherwoodite and other vanadium minerals (M. E. Thompson, Roach, and Braddock, 1956; M. E. Thompson, Roach, and Meyrowitz, 1958b.)

Selenium in the Colorado Plateau ores is also noted by R. C. Coffin (1921) but no details of occurrence are given.

Ouray County.—Selenium has been found in amounts from 0.99 to 1.5 percent in the mattes from zinc-box precipitates at the Camp Bird mine, but it has not been detected in the ores themselves. (Headden, 1907.) Native selenium is possibly also present in the fine-grained late sulfides of the Wheel of Fortune and other veins in the vicinity of the Camp Bird. (W. S. Burbank, written communication.)

Routt County.—An unnamed copper selenite or selenate mineral is reported in the carnotite-bearing sandstone at the southern foot of Blue Mountains, 18 miles east of the Utah boundary. Copper sulfates, vanadates, and carbonates are also present. (Gale, 1908.)

San Miguel County.—Telluride district. Both selenium and tellurium occurred in the matte obtained by smelting concentrates from the Liberty Bell mine near Telluride. The minerals that yielded these elements were not recognized. (Bastin, 1923.)

SERICITE

[*See* Muscovite]

SERPENTINE

$Mg_3Si_2O_5(OH)_4$

Serpentine is widespread, mostly as an alteration product of mafic igneous rocks, but locally as a gangue mineral in contact-metamorphic deposits. X-ray study has shown that material called serpentine actually includes several distinct species, the most common of which are chrysotile and antigorite. Few occurrences, however, have been sufficiently studied to classify the serpentines. Some of the material reported as asbestos and amianthite, described here under amphibole, is probably serpentine. The mineral antigorite, which is related to the chlorites, has been noted only once, but antigorite, like other kinds of serpentine, is probably much more widespread than is indicated by the occurrences given below.

Boulder County.—Caribou district. Serpentine is an alteration product of pyroxene in the titaniferous magnetite deposit of Caribou Hill. (J. T. Singewald, 1913.)

Magnolia district. Ropy knotted serpentine, with layers of calcite, is wrapped around nodules of chrysolite (olivine) and is clearly derived from that mineral. The serpentine contains small patches of a chloritic mineral. (Whitaker, 1898.)

Chaffee and Gunnison Counties.—In the Garfield quadrangle, serpentine is locally an abundant constituent of marble, especially in the area from Stella Mountain to the divide between Middle and South Quartz Creeks. Most of it is derived from the alteration of dolomite, but olivine is an intermediate product in some places. (Dings and Robinson, 1957.)

In the Tomichi district, massive gray to green serpentine is associated with magnetite in the Iron King mine. (R. D. Crawford, 1913.)

Lake County.—Leadville district. Serpentine is a gangue mineral in the contact-metamorphic magnetite-pyrite deposits, where it is probably a decomposition product of diopside or olivine. It either is smooth and massive or forms granular aggregates with many crystals of magnetite. Most of the serpentine is white to pale green, but in the Penn mine it is colored red by iron oxides. (S. F. Emmons, Irving, and Loughlin, 1927.)

St. Kevin district. The antigorite variety, with little or no fibrous structure, occurs in schist in and near this district. (E. P. Chapman, written communication.)

Larimer County.—Massive green serpentine is reported from the Greeley Poudre irrigation tunnel and from the water-main tunnel at Stearley's cabins. At the latter it is mixed with calcite and hornblende. (R. G. Coffin, written communication.)

SHERWOODITE†

$Ca_3V_8O_{22} \cdot 15H_2O$

Sherwoodite was first found in ore from the Matchless mine, Mesa County, but because the material used for description of the species came later from the Peanut mine, Montrose County, the latter is considered to be the type locality. Since its discovery, it has been found in the following localities: the vanadium ores of the J. J. and Mineral Jo mines of the Jo Dandy group, Montrose County; the Fall Creek mine, Placerville, San Miguel County; and several places in New Mexico and Utah.

The mineral is an oxidation product of other vanadium minerals and occurs as dark blue-black tetragonal crystals that coat fracture surfaces and partings in sandstone or along fractures in coalified wood. It is commonly associated with native selenium, metatyuyamunite, melanovanadite, and an undescribed vanadium mineral that resembles hewettite. M. E. Thompson, Roach, and Meyrowitz (1958b) give a complete description of the new mineral.

SIDERITE

$FeCO_3$

Pure siderite is comparatively rare in the ore deposits of the State. Carbonates that contain large amounts of iron in addition to manganese, magnesium, and calcium, should be classed respectively as ankerite, ferroan rhodochrosite, or simply "mixed carbonate."

Siderite, or minerals that approach it closely in composition, are abundant as concretions, lenses, and narrow veins in the shales and coal beds of Cretaceous and younger age. Described by most geologists as "clay ironstone" or "limonite," most such concretions consist of dense gray siderite surrounded with a shell of limonitic material. In the general vicinity of Pueblo these siderite concretions occur in such numbers on weathered surfaces of Pierre shale that large quantities have been collected and sold for iron ore to the Pueblo steel works. (Putnam, 1886; Gilbert, 1897; Fisher, 1906.)

Boulder County.—White Raven mine. The Denver Museum of Natural History has several specimens of siderite that comprise sticklike stalactitic growths, as much as ¾ by 3 inches, of small brown crystals. Some of these growths are crusted with galena crystals.

Eagle County.—Gilman (Red Cliff) district. Siderite, which according to two analyses contains some manganese and magnesium, is one of the most abundant gangue minerals in the district. It is light gray to brown, and cavities in massive siderite contain well-formed rhombohedral crystals. (R. D. Crawford and Gibson, 1925.)

Gilpin County.—Central City district. Siderite is a minor constituent in a few of the gold-pyrite deposits, but it is abundant in some of the galena-sphalerite veins. In the early days of the district it was reported especially from the Veto and the Rob Roy lodes. (Endlich, 1878; Bastin and Hill, 1917.)

Gunnison County.—Elk Mountains. In the Luona mine on Teocalli Mountain, crystals of loellingite are embedded in a matrix of barite and siderite. Elsewhere in this general part of Gunnison County, siderite is present but nearly everywhere subordinate to quartz and calcite. (S. F. Emmons, Cross, and Eldridge, 1894.)

Cebolla district. The titaniferous magnetite iron deposits contain some siderite. Locally it is altered to hematite. (J. T. Singewald, Jr., 1913.)

Taylor Peak-Whitepine district. Siderite is present, but not abundant, in the contact-metamorphic iron deposits. (Harder, 1909.)

Jefferson County.—Bear Creek. Zinciferous siderite is present in several small copper deposits. (Schrader, Stone, and Sanford, 1916.)

Lake County.—Leadville district. Manganosiderite, or ferroan rhodochrosite, is very abundant in the district, but pure siderite is relatively rare. Flat rhombs or disks, light to dark brown and not more than one-half inch across, line the walls of some cavities. Siderite is later than all other primary minerals except for some of the galena. (S. F. Emmons, Irving, and Loughlin, 1927.)

Park and Summit Counties.—Montezuma district. Pure siderite is rare, but iron-rich ankerite is common. Some true siderite is in the altered wallrocks; here and in the veins it is commonly later than the sulfides but is contemporaneous in part. (Lovering, 1935.)

Saguache County.—Bonanza district. In the Rawley and Clark veins and in some of the pyritic veins in the southern part of the district, siderite, some of which is manganiferous, occurs as small brown crystals and drusy coatings on calcite and manganocalcite. (Burbank, 1932.)

Orient mine. The Orient mine, 6 miles from Villa Grove in the foothills of the Sangre de Cristo range, has produced very large quantities of limonitic iron ore. The most abundant primary mineral, from which the limonite was derived by oxidation, was siderite. The Fremont limestone was almost completely replaced by this mineral except where chert was present. Massive bodies of siderite contain many small cavities that are lined with crystals of the same mineral. Oxidation is strongest near the surface, but some limonite extends to the lowest level worked by the mine, 600 feet below the highest outcrop. (B. S. Butler, written communication; J. B. Stone, 1934.)

San Miguel County.—Ophir district. Siderite occurs in many mines in this district, but it is much less common in the Telluride and other nearby districts. (Purington, 1898.)

SIDEROPHYLLITE†

[*See* Biotite]

SILLIMANITE

Al_2SiO_5

Sillimanite is very abundant and widespread as a constituent of many bodies of schist; it is also present in a few pegmatite bodies. Only a few occurrences are noted here, but there must be many others of equal or greater interest to collectors or as possible sources of relatively pure massive sillimanite. Heinrich and Bever (1957) list and describe several deposits.

Clear Creek County.—A biotite-sillimanite schist crops out on Sherman Mountain, near Silver Plume. The chief megascopic minerals are biotite, quartz, feldspar, and sillimanite, with muscovite, garnet, tourmaline, and corundum—each abundant locally. The sillimanite is white to green and occurs as microscopic single rods, meshes, and bunches of rods, commonly parallel to the schistosity. Sillimanite-rich layers are poor in feldspar. (Spurr and Garrey, 1908.)

Eagle County.—Gilman (Red Cliff) district. A sillimanite schist is exposed in a small area south of the Eagle River and west of the mouth of Homestake Creek. Sillimanite, in grains as much as three-quarters of an inch in diameter, makes up more than half the schist in places. Quartz, andesine, and biotite are associated (R. D. Crawford and Gibson, 1925.)

Fremont County.—Grape Creek (loc. 6). A pegmatite that contains corundum and dumortierite crops out on Grape Creek, 7 miles southwest of Canon City. Bundles of radiating needles of sillimanite are occasionally found in the rock. (Finlay, 1907.)

Fremont and Park Counties.—Guffey area (loc. 8). Sillimanite is very abundant near Guffey. Large quantities occur in the transitional zone of injection gneiss that lies between schist of the Idaho Springs formation and Pikes Peak granite. At the junction of Currant Creek and Lues Gulch, north of State Route 9, a lens of relatively pure white to greenish-white sillimanite occurs that is 175 feet long and as much as 30 feet wide. Biotite, feldspar, and sericite are accessory minerals.

An erosion surface that extends from ½ to 2 miles east of Micanite Ridge is cut on sillimanite schist that contains much magnetite.

Along some of the Micanite group of pegmatite dikes and elsewhere, pods of coarse-grained intergrowths of magnetite, quartz, and sillimanite occur along the margins of the dikes. (Bever, 1953; Heinrich and Bever, 1957.)

Jefferson County.—Much sillimanite is exposed on Guy Hill (loc. 11), near the Ramstetter Ranch. Layers of schist that contains 15 to 20 per cent sillimanite in small blades and irregular masses alternate with lime-silicate rocks. I have observed several of the pegmatite bodies that contain large masses (as much as 4 by 6 by 8 inches) of fibrous sillimanite.

Large masses of nearly pure sillimanite occur in schist near the Guy Hill chrysoberyl locality. (G. R. Scott, written communication.)

Lake and Chaffee Counties.—Twin Lakes district. Sillimanite is plentiful as radiating or fibrous bundles of prismatic crystals in a biotite-sillimanite schist. It alternates with quartz and biotite layers, or is mixed with biotite. (Howell, 1919.)

Larimer County.—Sillimanite is a common constituent of mica schists and gneisses in the Thompson Canyon district and northward to the Cache la Poudre. It is specially noted in Thompson, North Thompson, and Rist Canyons, and at a point in Poudre Canyon 18 miles from Fort Collins. (R. G. Coffin, written communication.)

A single specimen from one of the pegmatites in the Crystal Mountain district (loc. 1) contains a cluster of sillimanite needles (Thurston, 1955).

SILVER

Ag

Native silver is very widespread. It is largely in the secondary ores of silver-bearing deposits, but some seems to be of primary origin; a few occurrences in pegmatite bodies are known. Although it occurs in some places in large quantity, and in other places in spectacular masses, it is not as important a source of silver as many other primary and secondary minerals.

In addition to the occurrences that seem worthy of separate mention, small quantities of free silver are reported from the following districts, among others: Monarch district, Chaffee County; Rico district, Dolores County; Gold Brick, Tomichi and Tincup districts, Gunnison County; Lake City district, Hinsdale County; La Plata and Needle Mountains districts, La Plata County; Alma and Platte Gulch districts, Park County; Bonanza district, Saguache County; Silverton district, San Juan County; Breckenridge district, Summit County; and Cripple Creek district, Teller County.

Boulder County.—Gold Hill district. Native silver occurs as wires or leaves throughout the near-surface ores of the Red Cloud and Cold Spring mines. Silver and wire gold are decomposition products of tellurides and may occur as isolated wires or may comprise the greater parts of some specimens. Silver is also reported from the Caribou, Sunshine, and other districts. (Endlich, 1874, 1878; H. D. Wright, 1954.)

Ward district. Silver, probably alloyed with some gold, occurs in nearly all the gold mines; both metals are most abundant in chalcopyrite ore. In the White Raven mine, the best silver producer in the district, large amounts of native silver, mostly as wires, coat galena crystals in vugs and other openings; this silver is also alloyed with gold. (Worcester, 1920.) Native silver, a result of alteration of argentite, was the last primary mineral to form in the White Raven vein. Locally it forms heavy matlike coverings of fine interlacing wires on other minerals. Each wire is as thick as a hair and has a maximum length of one-half inch. (Wahlstrom, 1935, 1936.)

Clear Creek County.—Georgetown district. Wire and leaf silver is present in many mines and is locally abundant. It is rarer in the gold-pyrite veins than in the lead-zinc ores. (Spurr and Garrey, 1908.)

Fremont County.—Eight Mile Park (loc. 4). In the School Section pegmatite, rare minute blebs of silver occur in chalcocite associated with bismutite and beyerite. (Heinrich, 1947, 1948b.)

Gilpin County.—Central City district. In the Crystal lode in Virginia Canyon, very fine wires, branches, and "snarls" of native silver occur in cavities in the ore to a depth of 90 feet. Hollister (1867) says this is the first known native silver in the State. According to Bastin and Hill (1917) wires and small plates occur in the oxidized ores in several parts of the district. They do not occur below the water table and have never been seen in oxidized pyritic ores.

Gunnison County.—Anthracite-Crested Butte area. Native silver is a common oxidation product of the rich silver minerals—tetrahedrite, proustite, and pyrargyrite. The Sylvanite mine on Whiterock Mountain, for example, produced some remarkably rich ore, composed largely of native and ruby silver with argentite in quartz-pyrite-calcite gangue. (S. F. Emmons, Cross, and Eldridge, 1894.)

Snowmass area. Silver is of economic importance in the Black Queen mine. The mine yields striking specimens of wire silver that lines or fills small cavities in pink calcite; silver also occurs as small plates attached to the walls of seams in black shale. (Vanderwilt, 1937.)

Jefferson County.—Native silver, in small wirelike clusters, occurs at the Mena uranium mine on Ralston Creek. (J. W. Adams, written communication.)

Lake County.—Leadville district. Native silver is greatly subordinate to the silver halides, but it is widespread and is locally the chief ore mineral. There is more in the blanket deposits than in the veins. It occurs either as wires as much as one-half inch long, striated lengthwise, or as plates, scales, and flakes in gangue or country rock. It also fills some cavities in sulfides; bluish-gray jasperoid also contains small disseminated plates of silver. (S. F. Emmons, Irving, and Loughlin, 1927.)

St. Kevin and Sugar Loaf districts. Silver is widely distributed in some veins, including those veins that lack sphalerite and galena. In the Dinero vein silver persisted to depths of 1,000 feet and is probably of hypogene origin. Silver was the chief product of these districts but they also contained torbernite and other uranium minerals, and turquois. (Q. D. Singewald, 1956.)

Mineral County.—Creede district. Native silver was abundant in the Amethyst vein in the upper levels of the Solomon-Holy Moses, Corsair, and Alpha mines. It forms thin sheets in siliceous sulfide ores and on fracture walls. Nests of wire silver fill vugs in dark quartz; some of the silver ore is beautifully crusted with red jasper, milky chalcedony, and thin bands of comb quartz. At one place in the Amethyst vein free silver extends to a depth of 1,100 feet but most of it is closer to the surface and is clearly of secondary origin. (W. H. Emmons and Larsen, 1923.)

Southwest of the Commodore mine, fine-grained rhyolitic and latitic tuffs are fairly rich in silver, especially in or near carbonized wood which seems to have precipitated the silver. (V. G. Hills, 1924; E. S. Larsen, Jr., 1929.)

Montrose County.—Cashin mine (loc. 1). The native copper of the Cashin mine contains as much as 3 percent silver, presumably native (W. H. Emmons, 1906b). Recent development of the mine has exposed significant amounts of native silver that is not associated with copper. (Theodore Botinelly, written communication.)

Ouray County.—Ouray district. Silver, mostly derived from freibergite, is widespread but only near the surface. In the New Discovery vein on Red Canyon Creek, 4 miles northeast of Ouray, there is a narrow drusy quartz vein in porphyry. In the druses are nodules of black "coal," with clusters of native-silver crystals perched on the "coal." Some nodules of "coal," which seems unrelated to asphaltum, are also embedded in massive calcite. (Koenig, 1881a.)

Park and Summit Counties.—Montezuma district. Silver is moderately abundant in the rich silver ores near Montezuma. On Glacier Mountain wires occur in vugs and are scattered through open-textured galena-sphalerite ore that is cut by thin veins of pink ankerite. (Lovering, 1935.)

Pitkin County.—Aspen district. Native silver was very abundant and economically important in the rich ores mined in the early days of the district. Most of the silver was massive, but it also occurred as wires and delicate threads. In the Mollie Gibson there was a vug from 1 to 2 feet in diameter that was completely and closely festooned with threadlike silver. Spurr (1898) describes and illustrates fossil gastropods that are completely replaced by silver, as well as others that are replaced by sphalerite and galena. Much of the ore is essentially barite that is held together by silver. Some masses of pure silver were very large. Newspaper reports of 1894 record the discovery of a single "nugget" in the Smuggler mine that weighed 1,840 pounds.

A detailed description of the paragenesis of the minerals in the Aspen ores, and of their impressively great enrichment in silver in the secondary ores, is given by Bastin (1925). Oxidation of the ores is also discussed by Knopf (1926), but in terms of the geomorphic history rather than detailed studies of the minerals.

Routt County.—Hahns Peak district. In the Snowbird mine near Columbine, native silver and copper occur together in ore that is principally chalcopyrite, bornite, and chalcocite in quartz. (George and Crawford, 1909.)

San Miguel County.—Telluride district. Supergene native silver occurs in several mines. In the Smuggler it extends to depths of 1,800 feet. The silver nearly always contains some polybasite from which it seems to be almost entirely derived. Replacement of the polybasite began along cracks. (Hurst, 1922; Bastin, 1923.)

Summit County.—According to Whitney (1867), nuggets of pure silver were found along the Blue River and some of its tributaries as early as 1867. Masses or nuggets of silver that weighed from 1 ounce to as much as 1 pound, were commonplace in the Tenmile district.

SIMPLOTITE†

$CaV_4O_9 \cdot 5H_2O$

Simplotite, one of the many new vanadium minerals that have been discovered during the past decade, was first identified in ore from the Sundown claim, San Miguel County. Later it was found in the Peanut mine, in the Shattuck-Denn lease on Club Mesa, and in the J. J. mine in Paradox Valley, all in Montrose County.

Simplotite occurs as dark-green micaceous plates and hemispherical aggregates that coat fracture surfaces in sandstone containing unoxidized or partly oxidized vanadium and uranium minerals. It is associated with duttonite, melanovanadite, and abundant hexagonal crystals of native selenium. The discoverers, M. E. Thompson, Roach, and Meyrowitz, (1958) gave complete chemical, optical, and X-ray data.

SKUTTERUDITE

$(Co,Ni)As_3$

[*See also* Smaltite]

Both skutterudite and the closely analogous smaltite have been reported from the Elk Mountains, Gunnison County. Loellingite which contains some nickel and cobalt, and which may possibly represent a mixture of loellingite with some skutterudite or smaltite, has also been reported from there. The relations between the three minerals are not clear. The polished-section characteristics of iron-bearing skutterudite from the Horace Porter mine, on White Rock Mountain are recorded, with a chemical analysis, by Short (1931). No details of the occurrence are given. See also Hillebrand (1883) and Whitman Cross and Hillebrand (1885).

SMALTITE

$(Co,Ni)As_{3-x}$

[*See also* Skutterudite]

Smaltite, the closely related mineral skutterudite, and loellingite, have all been reported from the Elk Mountains, Gunnison County. As noted under these mineral names, the relations between the three reported occurrences are not clear.

Smaltite is reportedly abundant in the Horace Porter and American Eagle mines on White Rock Mountain, but rare at the Luona mine on Teocalli Mountain, whereas loellingite is abundant only in the Luona mine. Iles (1882a) describes smaltite from a vein near Gothic. It contains much crystallized calcite, with irregularly distributed smaltite and erythrite, a little pyrite, and very beautiful spongy leaflets of native silver. The vein contains no quartz and no other nickel minerals. Iles records the results of an analysis of the smaltite.

SMITHSONITE

$ZnCO_3$

Smithsonite, also known as calamine in some of the older literature, is widespread in the oxidized parts of many zinc-bearing ore deposits. In a few places it is very abundant and is an important ore of zinc. Most smithsonite contains other metals in addition to zinc, but complete analyses are available for only a few Colorado specimens.

Chaffee and Gunnison Counties.—Smithsonite is locally important with other oxidation products of galena and sphalerite in oxidized ores of the bed-replacement type in the Tincup, Monarch, and Tomichi districts. It is also widespread in the oxidized parts of quartz-pyrite veins in these districts and in the Chalk Creek district. In the Monarch district it is the most abundant zinc mineral, and forms hard massive dark-gray ore, containing small crystals in vugs and veinlets. (Crawford, 1913; Dings and Robinson, 1957.) Beautiful specimens of blue smithsonite have come from the Blistered Horn mine at Tincup. (E. P. Chapman, written communication.)

Custer County.—Silver Cliff district. In the Bassick mine, both smithsonite and hemimorphite (calamine) occur in the near-surface ores. (S. F. Emmons, 1896a.)

Eagle County.—Gilman (Red Cliff) district. Hard massive gray smithsonite, some containing a little calcium and magnesium, is present along the edges of a few old stopes, which suggests that it was an abundant ore mineral in the early days of the district. Much of it contains water, indicating the presence of hydrozincite. (Crawford and Gibson, 1925.)

Gilpin County.—Smithsonite is reported from the Jones mine at Central City and from the Running lode at Black Hawk. (Endlich, 1878.)

Jefferson County.—The ferroan variety of smithsonite, called monheimite, which here contains only 11.6 percent zinc and hence seems to be closer to siderite than to the zinc carbonate, occurs with secondary pyrite in a coarse mass of labradorite, quartz, and biotite in the F.M.D. mine. (Lindgren, 1908.)

Lake County.—Leadville district. Smithsonite is the most abundant of the oxidized zinc minerals and forms large blanket bodies that replace limestone and manganosiderite. Much zinc has been produced from these ores. It occurs as dense gray to brown massive smithsonite with some mixed carbonate minerals. Fine light-brown, colorless, white and green crystals line cavities in the massive rock. In some places, smithsonite is in alternating layers with hetaerolite, and elsewhere it forms cellular boxworks. (P. B. Argall, 1914b; S. F. Emmons, Irving, and Loughlin, 1927.)

Park and Lake Counties.—Weston Pass district. Smithsonite, associated with hemimorphite, made up a large part of the high-grade zinc ore mined in the early days of the district. It was abundant, however, in only a few places. (Behre, 1932.)

Park and Summit Counties.—Montezuma district. Smithsonite is rarely present as thin brown crusts in the vuggy oxidized ores. (Lovering, 1935.)

Saguache County.—Bonanza district. The mineral is reported to occur in very small amounts, with cerussite, in the oxidized part of the Bonanza vein. It is of no economic importance. (Burbank, 1932.)

Summit County.—Breckenridge district. Smithsonite that contains iron and a little manganese, is probably present in the upper parts of most sphalerite-bearing veins. At the Sallie Barber mine it forms minute crystals, rough spongy bunches, and incrustations. (Ransome, 1911.)

SODALITE

$3NaAlSiO_4 \cdot NaCl$

Sodalite is reported from the phonolite of Cripple Creek. It is probably present in highly sodic volcanic rocks elsewhere. At Cripple Creek it is more abundant than noselite and is a prominent constituent of the rocks in some places. It normally forms dodecahedra of variable size, ranging from 0.001 mm to as large as 2 mm. The crystals show clear outer borders and dull-brown interiors. (Lindgren and Ransome, 1906.)

SODA MICROCLINE

[*See* Feldspar group, microcline species]

SODA ORTHOCLASE

[*See* Feldspar group, orthoclase species]

SPECULARITE

[*See* Hematite]

SPESSARTITE

[*See* Garnet]

SPHALERITE

ZnS

Sphalerite is the source of most of the $334 million worth of zinc that has been produced in Colorado, hence is one of the 10 most valuable mineral species in the State. It is present in nearly every metallic-ore deposit and is also in some pegmatite bodies and other rocks; even the famous Yule marble, that is widely used as a decorative building stone, contains a little sphalerite. Only a few of the more important or interesting occurrences are described here, but these will give some idea of its distribution and mode of occurrence. Sphalerite is also an important constituent of the ores from the following districts, among others: Chalk Creek, Monarch, Tomichi, and Tincup districts, Chaffee and Gunnison Counties; Central City, Gilpin County; Snowmass district, Gunnison County; Lake City district, Hinsdale County; La Plata district, La Plata and Montezuma Counties; Creede district, Mineral County; Ouray district, Ouray County; Alma and nearby districts, Park County; Montezuma district, Park and Summit Counties; Silverton and Red Mountain districts; San Juan County; Telluride district, San Miguel County; and the Breckenridge, Kokomo, and Tenmile districts, Summit County.

Clear Creek County.—Transparent and translucent green crystals of sphalerite have been found in the Little Giant mine near Lawson and from several other mines in the Idaho Springs district. Jet-black crystals, some of them 2½ inches in diameter occurred in the Maine mine at Silver Plume. Massive sphalerite with resinous or waxy luster, is very abundant in many mines. (Spurr and Garrey, 1908.)

Custer County.—Silver Cliff and Rosita districts. Sphalerite is a very important mineral because in many places it is rich in gold. In the Bassick mine, where breccia fragments are covered with concentric shells of ore minerals, the third layer is made up of beautifully crystalline sphalerite, 0.5 to 5 cm thick, that contains 60 to 120 ounces of silver and 15 to 50 ounces of gold to the ton. This layer is missing in the outer part of the ore body. (Grabill, 1882; S. F. Emmons, 1896.) In the vein at the Geyser mine, sphalerite, associated with galena, forms distinct shoots that yield from 300 to 400 ounces of silver to the ton.

Dolores County.—Rico district. The rosin-jack variety is abundant in the ores of Newman Hill, where it is associated with galena, chalcopyrite, rhodochrosite, and quartz. In the Blackhawk mine it is massive and granular, and, with subordinate chalcopyrite, galena, and fluorite, makes up a large part of the limestone replacement body. In the Atlantic Cable contact-metamorphic deposit dark-brown coarsely crystalline sphalerite occurs as nodular masses with chlorite, specular hematite, chalcopyrite, and galena. (Ransome, 1901a.)

Eagle County.—Gilman (Red Cliff) district. Sphalerite is the chief ore mineral in this highly productive zinc district. It is in pyrite, with variable amounts of galena, carbonates, and chalcopyrite. It ranges from pure light-colored sphalerite to the more abundant black iron-bearing variety, marmatite. (R. D. Crawford and Gibson, 1925; Borcherdt, 1931.)

Lake County.—Leadville district. Next to pyrite, sphalerite is the most abundant metallic mineral in the district. It comprises a large percentage of the blanket and vein deposits but is sparse in the contact-metamorphic magnetite-pyrite bodies. Locally it is segregated as high-grade bodies of zinc ore, but more commonly it is mixed with pyrite and galena. Most is massive and granular, but twinned crystals as much as one-half inch in diameter occur in cavities. Such crystals are common in several of the mines of southern Iron Hill. Nearly all the sphalerite is marmatite, dark brown to black, and containing as much as 20 percent iron as FeS in combination with ZnS. (S. F. Emmons, Irving, and Loughlin, 1927.)

Saguache County.—Bonanza district. Sphalerite, which ranges from yellow to nearly black, commonly exceeds galena in quantity by a ratio of nearly 2 to 1. It occurs in veins and to a minor extent in replaced wallrocks, but the zinc-bearing solutions lacked the penetrating power of those that deposited pyrite. In the veins it forms large bodies and, like galena, formed largely in open spaces. Sphalerite is both earlier than, and contemporaneous with, other sulfides. In the oxidized zone some sphalerite is coated by covellite and chalcocite. (Burbank, 1932.)

Summit County.—The Big Four mine, above the north bank of Green Mountain Reservoir on the Blue River, near State Route 9, contains high-grade sphalerite ore in Dakota sandstone. The sphalerite, which is exceptionally pure, occurs in crystals as much as 4 inches in diameter. These are thinly covered with quartz. There is a little galena, chalcopyrite, and pyrite in the ore. (McCulloch and Huleatt, 1946.) A striking twin crystal of sphalerite from near Breckenridge is described and illustrated by Palache (1932b).

SPHENE

$CaTiSiO_5$

Sphene or titanite is an accessory mineral in virtually all igneous and metamorphic rocks in the State. It is also present among the heavy minerals of most clastic sedimentary rocks and most placer deposits. With the exception of these kinds of occurrences, none of which is detailed here, sphene is present in crystals of easily visible size in only a few places. Locally sphene is partly altered to a white coating called leucoxene, which is of indefinite composition, but is commonly considered closely akin to sphene.

Gunnison County.—Italian Mountain (Loc. 3). In addition to its normal occurrence as a microscopic accessory mineral, titanite is widespread as small but visible crystals. The best ones are closely associated with yellowish-green epidote, pyrite, and fine scaly chlorite in vugs in anorthite that has been partly replaced by orthoclase. The crystals, both simple and twinned, average 1 mm in diameter and reach a maximum size of 3 mm. They range from pale yellow to greenish yellow. Many honey-yellow crystals of titanite are impaled on needles of byssolite hornblende or are embedded in woollike byssolite in many specimens that consist of byssolite, mizzonite, and scolecite. (Whitman Cross and Shannon, 1927.)

Wildcat Gulch. A 2-foot pegmatite dike on the west border of a body of augite syenite consists of quartz with a little pink microcline and long slim needles of green hornblende. A few brown crystals of sphene as much as 1 inch long occur in one place in the dike. (Hunter, 1925.)

Jefferson County.—Genessee Mountain (loc. 10). Titanite occurs in fine tabular crystals as much as 1 inch across, associated with allanite, garnet, scheelite, and other minerals. (J. W. Adams, written communication.)

Critchell (loc. 7). A mine dump one-fourth mile northeast of Critchell contains hornblende, titanite, and very small blue crystals of fluorapatite. (J. W. Adams, written communication.)

Bergen Park (loc. 2). A mass of calcium silicate rock is exposed at the side of U.S. Highways 6 and 40, 1½ miles west of the Bergen Park road. In a pocket of loose weathered material, brown crystals of titanite as much as one-half inch in diameter occur, some with white coatings of leucoxene. Small bluish-green crystals of apatite and pearly radiating aggregates of wernerite are also present. (G. R. Scott, written communication.) In the Cresswell mine, rough distorted but unaltered crystals of titanite, some more than 1 inch in diameter, are present with small translucent blue crystals of apatite, as well as several silicates and sulfides. (J. W. Adams, written communication.)

SPINEL

$(Mg,Fe^{+2})(Al,Fe^{+3})_2O_4$

[*See also* Gahnite]

Spinel and its ferruginous and chromiferous varieties, ceylonite or pleonaste and picotite, have been seldom observed in Colorado. They are common accessory constituents of mafic igneous and metamorphic rocks, however, and are much more widespread than indicated by the literature. The zinc spinel, gahnite, is described separately.

Boulder County.—Caribou district. Green spinel occurs as inclusions in magnetite in the titaniferous magnetite deposit of Caribou Hill, 3 miles northwest of Caribou. (J. T. Singewald, Jr., 1913; Bastin and Hill, 1917.)

Custer County.—Rosita Hills. The variety pleonaste, or ceylonite, occurs in peridotite. (Whitman Cross, 1896.)

Fremont and Park Counties.—Guffey area (loc. 8). Green spinel is abundant as small grains in quartz-calcite-garnet-amphibole rock; some of it is in octahedra as much as 2 cm on an edge. (Bever, 1953.)

Iron Mountain (loc. 7). Many green spinel inclusions are present in the titaniferous magnetite of Iron Mountain, 12 miles southwest of Canon City, on a branch of Pine Creek. The ore is a compact aggregate of magnetite and ilmenite in a large body of gabbro. (J. T. Singewald, Jr., 1913.)

Gunnison County.—Iron Hill (loc. 2) Green spinel, variety pleonaste, occurs in a small limestone inclusion between the forks of Sammons Gulch. (E. S. Larsen, Jr., and Jenks, 1942.)

Jackson County.—Pearl district. Quartz veins associated with copper-bearing pegmatite contain fine crystals of ceylonite. There are large quantities of octahedra 5 to 25 mm in diameter; all crystals contain many inclusions of quartz. Cordierite is abundant in nodular schist nearby. (Read, 1903.)

San Miguel County.—Mount Wilson district. The variety picotite is noted from the Lakeside mine. (Purington, 1898.)

SPODUMENE

$LiAl(SiO_3)_2$

[*See also* Pyroxene group]

Spodumene has been reported from pegmatite in two widely separated localities.

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). White lathlike crystals of spodumene have been found on the dump of the Bazooka pegmatite; they came from the core of the dike. (Staatz and Trites, 1955.)

Larimer County.—Crystal Mountain district (loc. 1). No spodumene was found in the pegmatite bodies of this district by Thurston (1955), but he did find pseudomorphs of albite and sericite as much as 3 feet long by 2 to 4 inches thick; their characteristic lathlike shape and lamellar structure show clearly that spodumene was once present.

In the Buckhorn mica mine, in SW¼ sec. 29, T. 7 N., R. 71 W., tabular crystals of "rotten" powdery spodumene as much as 3 feet long and 3 inches thick, are distributed through quartz-cleavelandite pegmatite. They make up 5 to 10 percent of the rock. (Hanley, Heinrich, and Page, 1950.)

In the Big Boulder prospect in the SE¼ sec. 36, T. 7 N., R. 72 W., 2 miles southwest of Crystal Mountain, there are a few crystals of "rotten" spodumene, associated with uranium minerals. (Hanley, Heinrich, and Page, 1950.)

STAFFELITE

[*See* Fluorapatite]

STAUROLITE

$HFeAl_5Si_2O_{13}$

Staurolite is a widespread constituent of metamorphic rocks but it has been reported from only a few places. According to Goldstein (1950) it is common in the heavy minerals of the Dakota sandstone along the Front Range and it may be present in other sedimentary rocks.

Chaffee County.—Sedalia mine (loc. 5). Staurolite is one of the many minerals in this copper deposit in which chalcocite and other minerals are intergrown with garnet, corundum, spinel, feldspars, and other species. (Lindgren, 1908.)

Hinsdale, La Plata, and San Juan Counties.—Simple and twinned crystals occur in the Quartzite Mountains, near Mount Oso. (Endlich, 1878.)

Larimer County.—Fine crystals of staurolite have been found in muscovite schist on Milner Mountain, on Fish Creek at Buckhorn, in Thompson Canyon, and in Buckhorn Box Canyon. (R. G. Coffin, written communication.)

Moffat County.—The Red Creek quartzite of northeastern Utah contains abundant staurolite in its mica schist facies. Some of the crystals are as much as 40 mm long. The mineral is not specifically mentioned as having been found in Colorado, but may be present in the extension of the Red Creek quartzite in Moffat County. (Hansen, 1955.)

STEIGERITE†

$Al_2(VO_4)_2 \cdot 6\frac{1}{2}H_2O$

Steigerite was first identified as a new species from the Sullivan Brothers' claims on the north wall of Gypsum Valley. It was also found on the adjacent Ponto No. 3 claim.. It occurs as coatings on cracks in sandstone, and together with fervanite and gypsum, also fills minute cracks in corvusite, which is the most abundant of the vanadium minerals. Steigerite is a bright-yellow powdery mineral with a waxy luster. E. P. Henderson (1935), in the type description, describes the optical and chemical properties. In addition to other places along the north wall of Gypsum Valley, it has been identified as coatings on weathered sandstone at the Fox mine, Uravan district, Montrose County. (Weeks and Thompson, 1954.)

STEPHANITE

Ag_5SbS_4

Chaffee and Gunnison Counties.—Monarch and Tomichi districts. Stephanite is reported from the Little Charm mine and has been found as good-quality ore in the David H. mine. (Crawford, 1913.)

Clear Creek County.—Stephanite is reported from the Colorado Central, Terrible, and Brown lodes. (Endlich, 1878.)

Custer County.—Silver Cliff district. Stephanite is reported from the Humboldt and Pocahontas mines where it is associated with other silver-antimony minerals in ore made up largely of barite and tetrahedrite. (Charlton, 1890; S. F. Emmons, 1896.)

Dolores County.—Rico district. Stephanite is present with the argentite, proustite, and polybasite of the rich silver ores. (Chester, 1894; Ransome, 1901a.)

Gunnison County.—Gold Brick district. A single specimen from the Cortland mine shows a large quantity of stephanite as small grains associated with pyrargyrite, galena, arsenopyrite, and quartz. (Crawford and Worcester, 1916.)

Tincup district. The chief ore of the district is gold- and silver-bearing galena containing stephanite as replacements of dolomitic limestone. The gangue is quartz and calcite. (J. M. Hill, 1909.)

La Plata County.—La Plata district. Polished sections of ore from the Muldoon mine in the ruby-silver belt in the northern part of the district contain stephanite that fills open spaces in quartz. It is intergrown with ruby-silver minerals, all partly replaced by supergene anglesite. (Galbraith, 1949.)

Mineral County.—Creede district. Stephanite is sparingly present in the secondary ores. (W. H. Emmons and Larsen, 1923.)

Ouray County.—A little stephanite is present in mines of the Mount Sneffels and Uncompahgre regions. (Whitman Cross, Howe, and Irving, 1907.)

Park and Summit Counties.—Montezuma district. Although "brittle silver" is locally supposed to be widespread and abundant, Lovering (1935) found that it occurs only rarely in the ruby-silver ores near Montezuma.

San Miguel County.—Telluride district. Stephanite has been identified only in the Smuggler and Humboldt veins, where it is mixed with other silver minerals and with the base-metal sulfides. One specimen shows stephanite intimately associated with pyrite in a matrix of tabular calcite crystals. (Purington, 1898.)

STERNBERGITE

$AgFe_2S_3$

Sternbergite is reported only from the silver mines of the Georgetown district, Clear Creek County. (Endlich, 1878; J. A. Smith, 1883.)

STIBNITE

Sb_2S_3

Stibnite occurs in small quantities in several mining districts, but it is nowhere very abundant.

Boulder County.—Stibnite is reported from "several mines" by J. A. Smith (1883). The Denver Museum of Natural History has a fine large specimen of platy crystals from the Empire mine, Ward district. It also has a specimen of massive stibnite, coated yellow by an antimony oxide, from the Blue Coat mine in the same district.

Clear Creek County.—Endlich (1878) reports stibnite from the Terrible mine at Georgetown. Randall also reports nuggets of highly auriferous stibnite from the Alice mine at the head of Fall River.

Custer County.—Stibnite is noted from the Immortal mine by Charlton (1890).

Dolores County.—Dunton district. Clusters of radiating crystals of stibnite line vugs in the ore, but are not directly associated with the ruby silver or other ore minerals.[9] (Bastin, 1923.)

Grand County.—Masses of stibnite and quartz as much as 2 feet in diameter are reported to have been found as float on the divide between Troublesome Creek and Lost Lake. (Randall.)

Routt County.—Stibnite in sufficient quantity to form an ore deposit of antimony is reported from Hahns Peak by Randall.

San Juan County.—Silverton district. A single specimen of stibnite from the North Star mine on Sultan Mountain was found by Ransome (1901b) in his study of the district.

San Miguel County.—Mount Wilson district. Stibnite occurs in the Silver Pick and Magpie mines (Purington, 1898). Small amounts of stibnite occur in quartz veins of the district with large quantities of pyrite, chalcopyrite, and

[9] Krantz and Freeman, op. cit.

arsenopyrite and lesser amounts of galena, sphalerite, tetrahedrite, and calcite. (Varnes, 1947b)

Teller County.—Cripple Creek district. Stibnite is a common mineral in the rich gold ores. It forms groups or bunches of brilliant striated prismatic needles, and is often very rich in gold—almost certainly present as admixed calaverite. In the C. K. & N. mine it forms masses weighing as much as 50 pounds; it has also been found in the El Paso, Mary McKinney, Puzzle, Katrinka, Blue Bird, and Stratton's Independence mines and is probably present in nearly all veins. (Lindgren and Ransome, 1906.)

STILBITE

$CaAl_2Si_7O_{18} \cdot 7H_2O$

Stilbite is one of the most common and widespread of the zeolites. It is probably present in other lava flows than those noted here.

Gunnison County.—Very fine crystals are reported from Uncompahgre Peak. (Endlich, 1878.)

Italian Mountain (loc. 3). Stilbite is less abundant than either scolecite or chabazite, but it is widespread as inconspicuous crystals, drusy crusts, and rosettes. Much of it is mixed with garnet or with vesuvianite and chabazite in cavities in hornfels. The best specimens are from Taylor Peak, where it forms sheaves as much as 6 or 7 mm long, and from the Bidwell Range. (Whitman Cross and Shannon, 1927—analyses and optical data.)

Jefferson County.—Table Mountains (loc. 18). Stilbite was first reported from the Table Mountains by Whitman Cross and Hillebrand (1885), who record an analysis. It forms clear colorless crystals or rough sheaves of crystals as much as 1.5 cm long by 0.23 cm thick. It also occurs as reddish-yellow masses of mixed stilbite and laumontite. Patton (1900) found stilbite and laumontite on the floors of cavities, with larger crystals growing upward from the floors. He also notes second-generation crystals of both minerals. J. W. Adams (written communication) has found good specimens on the south side of North Table Mountain, one-half mile west of the old quarry.

Moffat County.—Stilbite comprises about 3 percent of the analcite-bearing basalt on Breeze Mountain (loc. 1), 4½ miles southeast of Craig. Both analcite and stilbite are interstitial to feldspar crystals. (Ross, 1926.)

Park County.—South Park (loc. 7). The analcite syenite that occurs with analcite diabase as a dike and several sills in South Park, 3 miles north of Hartsel, contains sheaflike masses of stilbite, with thomsonite and natrolite, in analcite-lined cavities. (Jahns, 1938.)

Teller County.—Cripple Creek. Stilbite occurs in phonolite as an alteration product of nepheline and other minerals. (Lindgren and Ransome, 1906.)

STROMEYERITE

CuAgS

Boulder County.—Gold Hill district. In the old Yellow Pine mine a small body of ore was found that was characterized by massive and apparently homogeneous stromeyerite that formed a layer covering sphalerite and galena. (Headden, 1925—analysis.) In the Vaucleuse vein of the same mine, Lovering and Tweto (1953) report stromeyerite intergrown with stephanite in early gray copper ore. The mineral is also reported from the Grant and Grand Lodge mines in Boulder County. (Randall.)

Clear Creek County.—Stromeyerite, both massive and as small crystals, occurs in the American Sisters mine; it is also reported from several mines on Saxon Mountain. In the Little Giant mine on Red Elephant Mountain the ore minerals in order or abundance are: galena, sphalerite, tetrahedrite, stromeyerite, polybasite, and argentite. Massive and crystallized barite and amethyst or colorless quartz are abundant. In the Plutus mine, near Idaho Springs, stromeyerite appears to be spottily distributed through bornite. (Pearce, 1888—analysis.)

Custer County.—Silver Cliff district. Stromeyerite is possibly one of the many minerals associated with galena in the Geyser mine. (S. F. Emmons, 1896.)

Eagle County.—Gilman (Red Cliff) district. Stromeyerite is among the late silver minerals in vugs in the copper-silver chimneys in limestone. Others are freibergite, polybasite, bournonite, and "schapbachite." (Tweto and Lovering, 1947.)

Park and Summit Counties.—Montezuma district. Stromeyerite is the chief ore mineral in the rich silver veins on Lenawee Mountain. In the Santiago mine it is present in sphalerite-chalcopyrite ore from the fifth level, and is intergrown with late galena and quartz in veinlets that cut early chalcopyrite. (Lovering, 1935.)

Pitkin County.—Mount Sopris. In the M. & J. claim on Bulldog Creek, 20 miles west of Aspen sulfide minerals, of which galena is the most abundant, occur in stringers and small masses in a matrix of recrystallized sandstone. Microscopic stuly of polished sections reveals pseudoeutectic intergrowths of stromeyerite and galena. Supergene covellite replaces the stromeyerite in these intergrowths. Argentite occurs in places, and also some graphic intergrowths of covellite and cerussite. (G. M. Schwartz and Park, 1930.) The Denver Museum of Natural History owns a beautiful specimen of crystallized stromeyerite from the Della S mine at Aspen.

Saguache County.—Bonanza district. Stromeyerite is probably an important source of silver in many veins. It has been definitely identified in ore from the Rawley, Cocomongo, and Joe Wheeler veins and is probably also present in the Rico, Liberty, and Express veins. In all occurrences it is primary and seems to be the result of a late stage of primary silver enrichment. It is associated and intergrown with bornite, tennantite, galena, and chalcopyrite. (Burbank, 1932.)

San Juan County.—Red Mountain district. Some very rich stromeyerite ore has been produced, but it is uncommon. In the Yankee Girl and Guston mines the stromeyerite occurs between depths of 200 and 500 feet between galena above and argentiferous bornite below. (T. E. Schwarz, 1889; Ransome, 1901b.)

One specimen of ore from the Yankee Girl mine shows definite replacement of sphalerite by stromeyerite and probable replacement of galena and tennantite by the same mineral. Another specimen shows contemporaneous intergrowth of chalcocite and stromeyerite, but there is evidence that the latter mineral is a pseudomorphic replacement of bournonite. (Bastin, 1923.)

STRONTIANITE

$SrCO_3$

Strontianite seems to be rare in the State; none of the few reported occurrences have entered the formal literature.

El Paso County.—Strontianite is reported from the Garden of the Gods (loc. 4), where it forms small spheres on celestite crystals. (Randall.)

Gunnison County.—Newspaper reports of 1912 and 1913 record the discovery of a 2-foot vein of the mineral between Pitkin and Bowerman. (Randall.)

Ouray County.—Several pieces of massive columnar strontianite were found by me in the talus of Hidden Treasure Basin. I presume these were derived from some small vein in the volcanic rocks.

San Juan County.—Columnar crystals of strontianite occur sparsely in solution cavities in quartz latite porphyry in the Koehler Tunnel on Red Mountain Pass. (J. W. Adams, written communication.)

Teller Country.—The Denver Museum of Natural History has geodes of clear-blue crystals of celestite labeled as coming from Florissant. Small spherical masses of greenish-white strontianite coat the celestite crystals.

SULFATIC CANCRINITE

[*See* Cancrinite]

SULFUR

S

Native sulfur is widely distributed, both as hot-spring deposits and as an oxidation product of sulfide ore bodies. In very few places is it abundant, however, and nowhere are there known to be deposits that are large and pure enough to have much commercial interest. Not all of the reported hot-spring occurrences are given here.

Archuleta County.—Pagosa Springs. The hot springs yield native sulfur. (Endlich, 1878.)

Chaffee County.—Mount Antero (loc. 3). Small amounts of sulfur, probably derived from pyrite, are present in a phenakite-bearing muscovite-quartz vein. (Switzer, 1939b.)

Clear Creek County.—Georgetown district. Sulfur is present in the Mineral Chief mine. (Randall.)

Custer County.—Near the road between Cotopaxi and Westcliffe the water from a hot spring is depositing barite and sulfur in calcareous sinter. (E. P. Chapman, written communication.)

Delta County.—Gunnison Forks sulfur deposit (loc. 1). Native sulfur is irregularly and widely distributed through most of the Dakota sandstone at this place, but generally in very minor amounts. Two fair-sized deposits that are described and mapped by Dings (1949) contain an estimated 5 percent sulfur. Some sulfur-bearing rock has been marketed sporadically for use as fertilizer.

Dolores County.—Rico district. Small amounts of sulfur are associated with the very abundant alunite of Calico Peak. It occurs as crystalline particles in porous areas in the rock that represent original phenocrysts of feldspar. (Ransome, 1901a.)

Eagle County.—Gilman (Red Cliff) district. Native sulfur is fairly abundant in the Spirit and Black Iron mines. In the Black Iron mine native sulfur is associated with jarosite and other sulfates as alteration products of massive melanterite that is derived from pyrite. (S. F. Emmons, 1886a.)

Gilpin County.—Central City district. Small crystals of sulfur occur on galena in the Clifton mine. (Endlich, 1878.)

Grand County.—Hot Sulphur Springs. Crystallized masses of sulfur are reported from the springs for which the town is named. (J. A. Smith, 1883.)

Gunnison County.—Vulcan district (loc. 5). The Good Hope and Vulcan mines, famous as the type locality for rickardite and weissite, as well as for abundant native tellurium, are also the locality for one of the largest bodies of native sulfur known in Colorado. During operation of the mines this sulfur caused much trouble by spontaneous combustion. Of the several large bodies of sulfur perhaps the largest is in the Good Hope. This deposit is 105 feet deep, 4 to 6 feet wide and of unknown length. The sulfur ore, which is a greenish-yellow loosely coherent powder was once shipped in carload lots to Denver, where it yielded 80 percent sulfur and 3 to 20 pennyweight of gold. The sulfur is derived from oxidation of pyrite, the iron formerly in the pyrite forming a limonitic cap at the surface of the ore bodies. (Rickard, 1903; Ford, 1903; W. P. Crawford and Johnson, 1922 [10].)

Lake County.—Leadville district. Sulfur is widespread in the oxidized ores with cerussite and other minerals. It is nowhere very abundant, but one mass 2 feet in diameter is reported from a mine on Iron Hill. (S. F. Emmons, Irving, and Loughlin, 1927.)

Mesa County.—Sulfur is reported near Grand Junction. (Aurand, 1920b.)

Mineral County.—Near the headwaters of Trout Creek and of the Middle Fork of the Piedra River, about 20 miles southwest of Creede in T. 39 N., R. 2 W., fairly large deposits of sulfur, interlayered with chalcedony and opal, occur as replacements of andesitic breccia. (E. S. Larsen, Jr. and J. F. Hunter, 1913.) The ore is reported to contain 54 to 56 percent sulfur; some brimstone of excellent purity has been produced from the ore for sale in Denver. (C. B. Carpenter, written communication.)

Montezuma County.—"A large deposit of low grade sulfur ore is reported about 20 miles east of Dolores. Very little work has been done on the deposit and no sulfur has been shipped to the present (1920). Data are lacking as to the nature of the occurrence and the size of the deposit." (Aurand, 1920b.)

Ouray County.—Ouray district. In the American Nettie mine, several pockets of ore near the top of the oxidized zone contain a mixture of native sulfur and porous black argentite. The sulfur is considered to be a sign of good ore and some of it assays as much as 10 ounces of gold to the ton. The primary ore here contains tetradymite in addition to the ordinary sulfides of iron, copper, zinc, and lead. (Downer, 1901.)

Red Mountain district. The Charter Oak mine near Red Mountain village contains small highly modified crystals of sulfur with scorodite, enargite, zunyite, and other minerals. (Penfield, 1893.)

Park and Summit Counties.—Montezuma district. Native sulfur is sometimes found in the oxidized parts of lead-zinc deposits, where it is mixed with earthy masses of anglesite and cerussite. (Lovering, 1935.)

Rio Grande and Conejos Counties.—Summitville-Platoro districts. Native sulfur is present on mine dumps and in outcrops of the ore deposits. It is sparse and fills cavities in vuggy quartz. Most of it is massive but there are some crystals. (Steven and Ratté, 1960.)

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[10] Crawford, W. P., and Johnson, F., op. cit.

SYLVANITE

$(Ag,Au)Te_2$

Except at Cripple Creek, where calaverite and krennerite are the chief sources of gold, sylvanite is probably the most widespread and valuable of the telluride minerals in nearly all the telluride-bearing districts in the State. It was once believed to be very abundant at Cripple Creek, but recent studies of available specimens by George Tunell, of the University of California at Los Angeles, has shown that most of the material thought to be sylvanite is actually krennerite. (A. H. Koschmann, oral communication.)

Goldschmidtite, a supposedly new telluride mineral intermediate in composition between sylvanite and calaverite, was analyzed and described from the Gold Dollar mine at Cripple Creek, Teller County, by Hobbs (1899). The type goldschmidtite was soon shown by Palache (1900) to be crystallographically identical with sylvanite and the name goldschmidtite was dropped.

Boulder County.—The first occurrence of sylvanite known in the United States was in the Red Cloud and Grand View mines; it was described almost simultaneously by Silliman (1874a, b) and Genth (1874), both of whom give analyses. Intimately associated with pyrite, most of it is massive, but with well-developed cleavage that gives it a platy appearance. A few crystals were found. (See also Endlich, 1878, and Clarke, 1877—analysis.)

Sylvanite from the Smuggler mine is described, with analysis, by Jennings (1877). Crystals and crystalline masses from the American and Grand View mines, Sunshine district, and from the Prussian and Cold Spring mines, Gold Hill district, are noted by J. A. Smith (1883).

Jamestown district. The telluride veins are in northeastward-trending faults, farther from the quartz monzonite stock than are the gold-pyrite veins. The telluride veins contain sylvanite, with smaller amounts of other gold-bearing tellurides, with finely divided pyrite in gray jaspery quartz. Locally sylvanite occurs in vugs in gold-pyrite veins or in lead-silver ore bodies, but in all occurrences it is the youngest primary mineral. (Goddard, 1935.)

Gold Hill. Goddard (1940) finds that sylvanite and petzite are the most abundant telluride minerals.

Magnolia district. Sylvanite is the chief ore mineral in the telluride veins, which range from less than 1 inch to 4 feet in width. Other tellurides found in the ore are calaverite, hessite, petzite, coloradoite or petzite (?), and altaite. All are associated with chalcedonic quartz, pyrite and a little native gold, sphalerite, marcasite, and fluorite. (Wilkerson, 1939a, b.)

In the eastern part of the Nederland tungsten district, the telluride mineralogy is similar to that of the Gold Hill and Jamestown districts. The telluride deposits are generally distinct from the tungsten deposits, but both tellurides and ferberite are present in the Herald, Red Signe, Grand Republic, and Logan mines. (Lovering and Tweto, 1953. See also Hess and Schaller, 1914.)

Eldora. Sylvanite in cherty quartz or in roscoelite is closely associated with abundant molybdenite and with barite. (Lindgren, 1907; Bastin and Hill, 1917.)

Specimens from the Buena mine at Jamestown and from Cripple Creek were included in a detailed study of the atomic structure of sylvanite made by Tunnell (1941).

Chaffee County.—Monarch district, Madonna mine. Sylvanite is possibly present as silver-white specks in some of the ore from this mine. The identification, however, rests only on the detection by assay of small amounts of tellurium. (Crawford, 1913.)

Clear Creek County.—Idaho Springs district, Treasure Vault mine. Sylvanite is the most important mineral in the telluride ore of this mine. It is in blue-gray cherty silica gangue with small amounts of fluorite, ferruginous calcite, and pyrite. All the telluride ores are within 125 feet of the surface. Some or all of the free gold in the ore is derived from oxidized sylvanite. (Bastin and Hill, 1917.)

Eagle County.—Gilman (Red Cliff) district. Sylvanite, hessite, gold, chalcocite, and pyrite are associated in ore from the Champion mine. (E. P. Chapman, written communication.)

Gilpin County.—Central City district. Sylvanite is the most important gold mineral in the telluride veins of the War Dance and East Notaway mines and is present in a few other deposits. In the War Dance mine a sulfide vein was mined for years before discovery of the nearby telluride vein. The sylvanite occurs as flakes or plates, with fluorite, quartz, and pyrite as networks of veinlets and as replacements of wallrocks.

In the East Notaway mine the sylvanite is most abundant as isolated blades and tabular crystals near the centers of 1- to 3-inch veins of chert, pyrite, and tetrahedrite. Some, however, is intergrown with the tetrahedrite. (Bastin and Hill, 1917.)

Gunnison County.—Vulcan district (loc. 5). A little sylvanite and petzite are present in ore of the Good Hope mine, but the locality is better known as a source of rickardite, weissite, and native tellurium. (Lakes, 1898; T. A. Rickard, 1903.)

Hinsdale County.—Lake City district. In the Governor Pitkin mine small particles of sylvanite are intimately intergrown with tetrahedrite. (Genth, 1882.) In the Golden Fleece mine, krennerite that contains blades of sylvanite is intergrown with aguilarite. (Brown, 1926.)

La Plata and Montezuma Counties.—La Plata district. Sylvanite, replaced in places by hypogene gold, is the most abundant and widespread telluride in the district and is responsible for much of the gold produced. (W. H. Emmons, 1905; Galbraith, 1949.) Sylvanite, native mercury, and free gold are reported from a small vein near Trimble Hot Springs. (Lakes, 1906.)

San Juan and La Plata Counties.—The Bear Creek district in the Needle Mountains yielded large amounts of sylvanite with some petzite and calaverite. The tellurides occurred as kidneys and seams along the walls of quartz-kaolin veins. (Whitman Cross, Howe, Irving, and Emmons, 1905; Prosser, 1911.)

San Miguel County.—Telluride district. An isolated occurrence of sylvanite on the Sheridan claim of the Smuggler Union mine is commonly supposed to have given the name to the mining camp. (Lakes, 1903.)

Saguache County.—Bonanza district. Very small amounts of a mineral that is probably sylvanite rather than krennerite, are present in ore from the Empress Josephine mine. Gold is greatly in excess of silver. (Burbank, 1932.)

Summit County.—Breckenridge district, Ontario mine. A specimen of crystallized gold from this mine shows octahedral and rhombic dodecahedral faces. The gold, probably pseudomorphous after sylvanite, is coated with oxides of manganese and iron that contain a little tellurium, bismuth, and phosphorus. (Pearce, 1884a.) Inasmuch as sylvanite is monoclinic and gold is isometric, it would seem that the only evidence for isomorphism lies in the traces of tellurium in the coatings.

Teller County.—Cripple Creek district. Calaverite, krennerite, and sylvanite are the chief gold-bearing minerals of this fabulous district. Sylvanite is reported from the Mabel and Little May mines by Palache (1900), from the Independence, Portland, Moon-Anchor and Anchoria-Leland by T. A. Rickard (1899), and from the Elkton and Blue Bird mines by Lindgren and Ransome (1906). Moses (1905b) describes a crystal from the district. As noted above, much of the material earlier thought to be sylvanite now seems to be krennerite. Loughlin and Koschmann (1935) find calaverite, krennerite, and sylvanite in the second stage of mineralization. Short (1937) describes etch tests on polished sections of sylvanite from Cripple Creek and Tunnell and Ksanda (1937) report on their investigation of crystals by means of the X-ray goniometer.

SYNCHISITE

$(Ce,La)Ca(Co_3)_2F$

Synchisite, or a rare-earth mineral tentatively identified as this species, is present with thorite in several samples studied by X-ray methods from the Powderhorn district, Gunnison County. It has not been reported elsewhere. (Olson and Wallace, 1956.)

TALC

$Mg_3Si_4O_{10}(OH)_2$

Talc has been reported from only one locality, but it is more widespread than this. In the complex of metamorphic minerals on North Italian Mountain, Gunnison County (loc. 3), small aggregates of greenish-gray pearly folia of talc fill cavities in granular magnetite. Other cavities in the magnetite contain small greenish-yellow garnets. (Whitman Cross and Shannon, 1927.)

TANTALITE

$(Fe,Mn)(Ta,Cb)_2O_6$

[*See also* Columbite]

The two minerals columbite and tantalite are the end members of a continuous series. As noted under columbite, most Colorado occurrences are higher in niobium than tantalum, hence they are classed as columbite. The only authentically reported occurrence of tantalite is in the pegmatites of the Guffey area, Fremont and Park Counties (loc. 8). There tantalite is abundant and is associated with euxenite. (Bever, 1953.)

Tantalite is also reported from near the Peerless Consolidated Copper Co. mine, 4½ miles from Hillcrest, on the east flank of the Sangre de Cristo Mountains. B. S. Butler, who examined the locality, says in his unpublished notes, "there is nothing about this rock to suggest tantalum or niobium."

TARNOWITZITE

[*See* Aragonite]

TELASPYRINE*

[*See* Tellurium]

TELLURIDE MINERALS, UNIDENTIFIED

Telluride minerals have been reported from several places in the State but have not been identified specifically. In some occurrences, the detection of tellurium with gold or silver suggests the presence of tellurides of those metals, in others, unidentifiable mixtures of tellurides and other minerals are reported. In at least two other occurrences, there are sufficient data to suggest the presence of new mineral species. Because tellurides play such an important part in the story of Colorado mineralogy, it seems worthwhile to summarize this kind of report here.

Boulder County.—Ward district. Tellurides occur in several mines in the district, especially those in its eastern part. In the Morning Star mine a rich body of tellurides, native gold, and sulfides was found. (Worcester, 1920.)

Conjeos County.—Stunner district. Tellurides in the Eurydice and other mines are reported by Patton (1917) and several private engineers.

Dolores County.—Rico district. Traces of tellurium and bismuth, with larger amounts of gold, have been shown by analysis of ore from the Johnny Bull mine. (Ransome, 1901a.)

Gilpin County.—Georgetown district. Tellurides are present in nearly all the pyritic ores of the district. (Pearce, 1890.)

Hinsdale County.—Lake City district. The ore of the Gallic-Vulcan mine contains several tellurides as fillings of vugs in white quartz. Calaverite, sylvanite, krennerite, petzite, and hessite are probably present, but no positive identifications are made. (Irving and Bancroft, 1911.)

Lake County.—Leadville district. Tellurides in the Leadville ores were first discovered when crystals of tellurium were formed during the kiln roasting of pyritic ores. Later, gray films on much of the pyrite were found to be composed of tellurium and silver; the specific mineral, possibly hessite, was not identified. (Pearce, 1890.)

San Juan County.—Silverton district. Very small amounts of tellurides, none definitely identified, have been found in four mines. In the Camp Bird vein tellurium has been recognized by chemical analysis. In the Barstow mine a telluride is associated with a silver-lead-bearing bismuthinite. One small pocket in the Silver Ledge mine contained calaverite(?) with free gold. The Magnet mine ore contained a little hessite(?) with argentiferous galena and gold in quartz. (Ransome, 1901b.)

San Miguel County.—Telluride district. There are no authentic occurrences of telluride minerals in the Telluride district. The camp is popularly said to have been named for the chance discovery of a small specimen of sylvanite in one of the mines. (Lakes, 1903.)

Teller County.—Cripple Creek district. A dense gray mineral that resembles tetrahedrite but that seems to be an unidentified telluride of silver and copper is reported in large quantities in the Findley vein, above level 16 of the Vindicator mine. (Loughlin and Koschmann, 1935.)

In his study of polished sections of ore from the Cresson mine Galbraith (1941) found a gold-silver telluride whose microscopic characteristics correspond with those of no known mineral. It is possibly a new species.

TELLURITE

TeO_2

Tellurite occurs in several places as an oxidation product of telluride minerals. It is probably more widespread than reports indicate, as it is white to yellow and could easily be mistaken for limonite or other oxidation products.

Boulder County.—Tufts of minute yellow crystals occur in cavities and as incrustations on native tellurium and the telluride minerals in the Keystone, Smuggler, and John Jay mines. (Endlich, 1878.)

Gunnison County—Vulcan district (loc. 5). In the Good Hope mine, noted especially for the copper tellurides rickardite and weissite, tellurite occurs as white translucent to dull coatings as much as one-eighth inch thick on native tellurium. It is very abundant in places where tellurium is interstitial to pyrite. Some well-formed crystals occur in cracks in the quartz gangue. (Headden, 1903—analysis.)

Teller County.—Cripple Creek district. In the oxidized ores of the W. P. H., Gold Sovereign, and Blue Bird mines, tellurite forms small soft white or yellowish white spherical masses that have an adamantine luster and excellent cleavage. In the W. P. H. mine, some of the tellurite occurs as thin tabular transparent yellow crystals as much as 2 mm in length; they have many vicinal faces. (Schaller, 1905; Lindgren and Ransome, 1906.)

TELLURIUM

Te

Native tellurium is present in most of the telluride-bearing deposits in the State, but is abundant in only a few places.

In addition to its own occurrences as a valid species, tellurium is responsible for two supposed new species or varieties, both now discredited. One of these, lionite, was named for the Mountain Lion mine in the Magnolia district, Boulder County. It is described by Genth (1877) as an apparently homogeneous mineral that forms flat platelike masses, 1/8 to 3/16 inch thick, dark gray, and almost lusterless. with a tendency toward columnar structure. Genth's analysis can only be interpreted as a mixture of native tellurium and quartz with small additional amounts of several other minerals. Lionite has long since been discredited as either species or variety.

Similarly, material from the Sunshine district, Boulder County, that contained tellurium, arsenic, sulfur, and iron was named telaspyrine by C. U. Shepard (1877). It is evidently a mixture of pyrite and tellurium with a little arsenopyrite or other arsenic mineral. The name telaspyrine has long since been dropped.

Boulder County.—The first Colorado discoveries of native tellurium were made in 1872 in Boulder County, but the original identification was doubtful. In 1874 it was positively and simultaneously identified by both Silliman and Endlich; see also Genth (1874). It has since been found in greater or less amounts in most of the telluride-bearing ores there.

Endlich (1874) describes 2 crystals of tellurium from the Gold Hill district, one from the Red Cloud mine and 1 from the Cold Spring mine. Both are very bright with foliated texture and both are hexagonal prisms with perfect lateral cleavage and poor basal cleavage. The crystals measure 1¼ by ⅜ inch and 1 by ¼ inch, respectively.

Silliman (1874a, b) says that tellurium from Gold Hill had been noted earlier by Genth, but with some doubt. Both Silliman and Endlich (1874) have now identified it without doubt. Most of it occurs as small hexagonal cleavage plates, but Silliman found one small perfect crystal. The tellurium contains no selenium and only a trace of gold. Silliman also notes the presence of tellurides in the Red Cloud, Seven-Thirty, Central, and Cold Spring mines.

Crystals and crystalline masses of native tellurium from the Keystone, Mountain Lion, and Dun Raven mines at Magnolia are described by Genth (1877). In the same paper he describes lionite, which is discussed above. The tellurium crystals are small, much distorted, and cavernous, with deeply striated prism faces; rhombohedral and basal faces are rarely present. Some of the tellurium occurs as sheets, from paper thin to one-eighth inch thick, between other minerals, including roscoelite(?), coloradoite, calaverite, and pyrite. Genth's analysis shows that the tellurium is very nearly pure.

In the same paper, Genth (1877) also describes tellurium from the Smuggler mine, Ballerat district, and the John Jay mine, Central district. He gives analyses of both. In the Smuggler mine the tellurium occurs as very minute brilliant crystals; deeper in the mine, it is granular and mixed with sylvanite, coloradoite and other minerals. The John Jay mine contains the largest quantities of tellurium observed by Genth. Masses of nearly pure tellurium, mixed with a little quartz and somewhat altered to tellurite, weigh as much as 25 pounds.

Jennings (1877) also describes the massive and crystalline tellurium from the John Jay mine and gives an additional analysis, but of material that is mixed with some sylvanite and altaite.

Three samples from the Valley Forge mine are described by Headden (1903). One contains flakes, seams, and bunches of native tellurium in quartz. Pyrite, chalcopyrite, and quartz are both intergrown with, and later than, the tellurium. A second sample, not described, seems from recalculation of its analysis, to contain much tellurium and melonite, with a little calaverite. The third specimen consists of very dark gray small irregular masses of tellurides that appear under the hand lens to be homogeneous. Headden's analysis indicates the presence of much native tellurium with some coloradoite, melonite, calaverite, and pyrite.

Ives (1935) notes slender crystals of native tellurium enclosed in clear fluorite in the Alice mine, Jamestown district.

Gunnison County.—Vulcan district (loc. 5). Native tellurium is abundant in the Good Hope mine. It is tin white with metallic luster and is commonly massive although a few specimens show rhombohedral prismatic crystals. It is associated with petzite, the copper tellurides rickardite and weissite, berthierite, opal, tellurite, and native sulfur. (Lakes, 1898; T. A. Rickard, 1903.)

Three specimens from the Good Hope mine are described, with chemical analyses, by Headden (1903). The first consists of streaks of tellurium as much as 1 inch wide but averaging about one-fourth inch, in chloritic schist. The mineral is crystalline with two well-developed cleavages. The analysis shows 0.40 percent selenium. The second sample analysed by Headden is steel gray with a dark-brownish-gray streak. It has no cleavage. The analysis suggests that the specimen is a mixture of tellurium with limonite and quartz or other source of silica.

The third specimen is a mass of radiating dark-gray crystals with metallic luster and uneven fracture apparently of arsenopyrite. Native tellurium, iridescent copper tellurides, and other minerals are interstitial to the arsenopyrite crystals. Recalculation of an analysis of the entire mass indicates that it is predominantly arsenopyrite with some tellurium and less rickardite and tetradymite.

La Plata and Montezuma Counties.—La Plata district. Tellurium occurs in small amounts in telluride ores from several mines. In the Gold King mine it is contemporaneously intergrown with krennerite, hessite, and coloradoite, all of hypogene origin. In the Mountain Lily mine, native tellurium is more abundant than the tellurides of gold and silver, so that the resultant mixture is low-grade ore. (Galbraith, 1949.)

Saguache County.—Bonanza district. Small tin-white masses of native tellurium occur in ore of the Empress Josephine mine. A little rickardite is associated with the tellurium in one specimen. (Burbank, 1932.)

In the Klondike mine, which is 10 miles west of Saguache and outside the Bonanza district, tellurium occurs with several telluride minerals, including one that is probably empressite. (E. P. Chapman, written communication.)

Teller County.—Cripple Creek district. Tellurium in crystal form is reported from the ores of Raven Hill but the report has not been authenticated. The apparent absence of the mineral in this rich telluride district is remarkable. (Lindgren and Ransome, 1906.)

TELLUROBISMUTHITE

Bi_2Te_3

[*See also* Tetradymite]

Tellurobismuthite has been definitely identified from four Colorado localities. As pointed out by Frondel (1940) some of the tetradymite reported from other localities may be this mineral.

Clear Creek County.—Tellurobismuthite occurs with beegerite(?) in the Treasure Vault mine. (Frondel, 1940.)

Fremont County.—Part or all of the tetradymite described by Hillebrand (1905) from a locality near Whitehorn has been shown by Frondel (1940) to be tellurobismuthite. X-ray-powder diffraction data on a specimen of tellurobismuthite from Whitehorn are also reported by Harcourt (1942). Frondel also notes the occurrence of this mineral on Mount Chipeta in Fremont County.

Huerfano, Costilla, and Alamosa Counties.—Sierra Blanca. A supposed new mineral, a telluride of silver and bismuth, was first described and analysed by Pearce (1898b) from the Hamilton and Little Gerald mines on the slopes of

Sierra Blanca, which marks the junction of these three counties (the locality is wrongly listed as San Luis County by Frondel, 1940). This mineral was later named Von Diestite, or vandiestite by Cumenge (1899) who also records an analysis. It was described by Pearce as threads associated with copper minerals and auriferous pyrite. Frondel (1940) studied specimens of the type material by X-ray and chemical means and finds it to be a mixture of tellurobismuthite intimately intergrown with hessite and occasional threadlike inclusions of native gold and specks of altaite(?). The species vandiestite is thus discredited.

TENGERITE

Yttrium carbonate

An yttrium carbonate, probably tengerite or a closely allied mineral, coats gadolinite crystals in the Roscoe dike in Clear Creek Canyon, Jefferson County (loc. 14). (Vance Haynes, written communication.)

TENNANTITE

$(Cu,Fe)_{12}As_4S_{13}$

[*See also* Tetrahedrite]

As noted under tetrahedrite, the gray copper minerals tennantite and tetrahedrite are the arsenic and antimony end members of a continuous series. The occurrences listed below are classed as tennantite by the authors who described them or they seem from the evidence at hand to belong close to this end of the series. Because nearly all specimens contain both arsenic and antimony, the occurrences listed under tetrahedrite must also be considered to acquire a clear idea of the distribution of the gray copper minerals.

Boulder County.—Gold Hill district. Argentiferous tennantite and galena are the chief ore minerals in the silver-lead deposits. They are associated with spalerite, chalcopyrite, and pyrite in sugary-textured to glassy quartz with some ankerite. Stromeyerite is also reported. (Goddard, 1940.)

Ward district. Tennantite is present only in th White Raven mine where it is very sparse. It is found only below the 700-foot level and seems to become more abundant with depth. (Worcester, 1920.)

Nederland tungsten district. Tennantite occurs in the Yellow Pine mine, but tetrahedrite and freibergite are more abundant elsewhere. (Lovering and Tweto, 1953.)

Chaffee and Gunnison Counties.—Tomichi district. Both tennantite and tetrahedrite occur with enargite in small quantities in a few bedded replacement deposits. Small amounts also occur in the quartz-pyrite veins of this district and in the Chalk Creek district. (Dings and Robinson, 1957.) Tetrahedrite, some of it silver bearing, is reported from several mines in the district but tennantite seems to be rare. One specimen from the Victor mine contained almost as much arsenic as antimony, hence is about midway between tennantite and tetrahedrite. (R. D. Crawford, 1913.)

Clear Creek County.—Fine specimens of tennantite with siderite and quartz have come from the Freeland and other mines. Well-crystallized material occurs in the Trail Creek and Idaho Springs district. (Endlich, 1878; Spurr, Garrey and Ball, 1908.)

Gilpin County.—Central City district. Tennantite is common, but much subordinate to chalcopyrite in the gold-pyrite ores; there are also a few occurrences in the galena-sphalerite ores. Some of the gray copper contains a little antimony, but all of it contains more arsenic than antimony, hence is classed as tennantite. Galena ore grades to tennantite ore in places, commonly with an increase in the silver content. (Bastin and Hill, 1917.)

Jefferson County.—Golden Gate Canyon. Tennantite is probably the most abundant copper mineral in the Union Pacific uranium prospect, where it forms tiny discontinuous veinlets. (Adams and Stugard, 1956.)

Lake County.—Leadville district. Tennantite is scarce throughout the district but a little is present in ore from the Greenback and Printer Boy mines and the Elva Elma tunnel. It belongs to the last, or bismuth, stage of mineralization. (Chapman, 1941.)

Park County.—Horseshoe and Sacramento districts. Tennantite is widespread and moderately abundant between Little Sacramento and Fourmile Creeks. Most of it is associated with galena, with which it is contemporaneous. (R. D. Butler and Singewald, 1940.)

Park and Summit Counties.—Montezuma district. Both tennantite and tetrahedrite are abundant; they are commonly later than the early pyrite, later or contemporaneous with sphalerite and galena, and are followed by late chalcopyrite, covellite, and chalocite. The two gray copper minerals, which commonly contain some silver, are most abundant as small irregular masses in quartz-barite ores. They have not been found together, but tetrahedrite seems to be slightly older than tennantite. (Lovering, 1935.)

Pitkin County.—Aspen district. The first known locality in the United States for tennanite was the Molly Gibson mine at Aspen. The tennanite occurred as patches of massive steel-gray material in specimens of polybasite. Penfield and Pearce's analysis (1892) shows a silver content of nearly 14 percent, so that the material would now be called argentian tennantite or the binnite variety. Both tennantite and tetrahedrite are abundant in the district, but tetrahedrite is less so; both are valuable ore minerals because of their high silver content. One of the chief ores on Smuggler Mountain is the so-called crisscross spar, which consists of barite with narrow seams of the gray copper minerals (Spurr, 1898. See also Bastin, 1925.)

Rio Grande County.—Summitville district. Massive pinkish-gray tennantite is intergrown with enargite in the Chandler mine. It seems to be abundant in the lower levels of many mines. The mineral is known locally as tetrahedrite, but it is arsenical and should be classed as tennantite. (Patton, 1917.)

Saguache County.—Bonanza district. Tennantite is very widely distributed and seems to be an important source of silver in all veins in the district. It forms solid masses or intimate mixtures with other sulfides. Tennantite also occurs as tetrahedral crystals, with chalcopyrite and galena crystals, in cavities in the ore. All of it seems to be of primary origin. An analysis shows that it contains appreciable amounts of zinc as well as both arsenic and antimony. (Burbank, 1932.)

San Juan County.—Red Mountain district. In ore from the Yankee Girl mine, enargite and tennantite are intimately intergrown and probably largely contemporaneous. Chalcopyrite and galena occur as small blebs in the tennantite. (Moehlman, 1936b.)

TENORITE

CuO

Tenorite, the massive to earthy forms of which are also called melaconite, is reported from a few widely scattered deposits that contain copper minerals. Nearly all the reports are old, reflecting the fact that the copper oxide minerals occurred only close to the surface and have long since been removed from most deposits.

Chaffee County.—Monarch district. Hard lustrous tenorite that contains much iron, occurs with copper carbonates in the Major and New York veins. The earthy variety melaconite also occurs in the Major and Lilly mines. (R. D. Crawford, 1913.)

Clear Creek County.—Tenorite is reportedly present in the Freeland lode. (Dana, 1892.)

Gilpin County.—Central City district. Tenorite is reported from the Pewabic, Gunnell, Sap, Briggs, and many other mines. (Endlich, 1878; Bastin and Hill, 1917.)

Jefferson County.—Tenorite is reported from the Malachite mine on Bear Creek. (Endlich, 1878.)

Park County.—Veins in the Mosquito Range contained tenorite. (Endlich, 1878.)

Pitkin County.—Aspen district. Thin coatings of tenorite are associated with cerussite, anglesite, cuprite and other minerals. (Spurr, 1898.)

San Juan County.—Silverton district. The variety melaconite, which may have contained some gold, made up some of the richest ore in the New York City lode in the Silver Lake area; it extended downward to the deepest workings, 700 feet beneath the surface. A friable stringer of melaconite occurred along the footwall of a quartz vein that contained chalcopyrite and pyrite, with less galena and sphalerite. (Ransome, 1901b.)

TEPHROITE

Mn_2SiO_4

Tephroite, the manganese olivine, is a rare constituent of the assemblage of manganese minerals in the Sunnyside mine, Silverton district, San Juan County (loc. 1). It has not been reported elsewhere.

Tephroite was seen in only four of the specimens studied by Burbank (1933). The small anhedral grains, which are associated with alleghanyite, are mottled gray, and darken on exposure at the surface faster than the other minerals. Burbank records the optical properties of the mineral.

TETRADYMITE

Bi_2Te_2S

[*See also* Tellurobismuthite]

Tetradymite, the bismuth telluride, is present in 6 districts, including 2 where no other tellurides have been reported. Frondel (1940) points out that some of the material recorded as tetradymite is actually tellurobismuthite.

Boulder County.—Gold Hill district. Tetradymite was one of the rarest minerals in ore of the Red Cloud mine during its early days; it has not been reported since. It occurred as a very few iron-gray scales, some with a bluish tarnish, associated with pyrite and auriferous hessite. (Genth, 1874.)

Camp Albion. Polished sections of galena that is characterized by octahedral cleavage show inclusions of tetradymite oriented in closely spaced laminae parallel to the octahedral directions. Wahlstrom (1937) believes the relations are due to exsolution.

Chaffee County.—Tetradymite is reported from the Chipeta mine, near Salida. No details are available. (Randall.)

Fremont County.—Whitehorn district. Tetradymite occurs in large masses. Although the masses possess the characteristic cleavage of this mineral, there is no evidence of external crystal form. (Hillebrand, 1905—analysis.) Some or all of this material is definitely tellurobismuthite. (Frondel, 1940.)

Gunnison County.—Vulcan district (loc. 5) Tetradymite has not been definitely recognized in the Good Hope mine, but recalculation of an analysis of a mass of native tellurium, rickardite, and arsenopyrite suggests the presence of a small amount of the mineral. (Headden, 1903.)

Ouray County.—Ouray district. A telluride of bismuth, which also contained gold and silver and was associated with bismuthinite, was found at one place in the American Nettie mine. It was not specifically identified as tetradymite and may be a microscopic mixture of several minerals. (Downer, 1901.)

Summit County.—Kokomo district. The Gold Crest vein, in sec. 29, T. 7 S., R. 78 W., contains large quantities of megascopic tetradymite in specimens from the upper parts of the vein. The mineral, which was identified by chemical and X-ray analyses, is associated with quartz, pyrite, gold, and a little chalcopyrite (Parker, 1954.)

TETRAHEDRITE

$(Cu, Fe)_{12}Sb_4S_{13}$

[*See also* Tennantite]

The gray copper minerals tetrahedrite and tennantite form a continuous series between the antimony end member, tetrahedrite, to the arsenic analogue, tennantite. Virtually all specimens contain both antimony and arsenic; chemical analysis is needed to determine the exact place of a specimen in the series. Moreover, zinc, silver, mercury, and possibly lead substitute for parts of the copper and iron in many specimens. Important varieties known in Colorado are argentian tetrahedrite, or freibergite, argentian tennantite, or binnite, and mercurian tetrahedrite, or schwatzite. In this report the more significant occurrences of tetrahedrite and tennantite, with their varieties, are separately described, the difference depending on the original descriptions or other evidence. In view of the wide variation in composition of these minerals, however, it is advisable to read the material on tennantite in parallel with that on tetrahedrite.

The gray copper minerals are very widely distributed in Colorado and are extremely important ore minerals in several districts. This importance stems not so much from their copper content, but from the significant amounts of silver that are contained in the tetrahedrite and tennantite produced by many mines. Some ores of these minerals are fabulously rich in silver.

Boulder County.—Jamestown district. Lead-silver deposits are associated with the fluorspar deposits on the west border of a quartz monzonite stock as pipes, veins, or borders of fluorspar breccia. The pipes are intergrown masses of argentiferous tetrahedrite and galena with auriferous pyrite and pyrite. (Goddard, 1935.)

Nederland tungsten district. Both tetrahedrite and the silver-bearing variety freibergite are present in the late silver phase of mineralization. They are largely replaced by miargyrite and chalcopyrite. Tennantite is known only in the Yellow Pine vein. (Lovering and Tweto, 1953.)

Chaffee and Gunnison Counties.—Tomichi district. Both tetrahedrite and tennantite are present with enargite in several ore deposits, but tetrahedrite seems to be more abundant. (Dings and Robinson, 1957; R. D. Crawford 1913.)

Clear Creek County.—Georgetown district. The only reported Colorado occurrence of mercurian tetrahedrite, or schwatzite, is in ore from the Colorado Central mine. The ore is galena and sphalerite, with pyrite and a large number of silver minerals. One specimen of massive rich ore was schwatzite. (Spurr and Garrey, 1908.)

Tetrahedrite is abundant in many other mines in the Georgetown and nearby districts and is noteworthy because of its high silver content in most places. In many occurrences it contains as much as 30 percent silver. Well-formed crystals have been found in the Champion, Freeland, and other lodes. (Spurr and Garrey, 1908.)

Custer County.—Silver Cliff-Rosita Hills district. In the Humboldt-Pocahontas mine, the ore is chiefly barite and tetrahedrite, with small amounts of galena, stephanite and other silver-antimony minerals. The ore body of the Bassick mine is in a breccia pipe that fills a volcanic neck. Many of the minerals, including jamesonite, occur as concentric shells on breccia fragments. Tetrahedrite, on the other hand, is always interstitial to the fragments; it is mixed with varicolored quartz and tellurides, probably largely petzite. (Grabill, 1882; S. F. Emmons, 1896.)

Dolores County.—Rico district. Tetrahedrite, most of it highly argentiferous, is abundant in the rich blanket ores of the Enterprise and Rico-Aspen mines. It is associated with sphalerite, polybasite, galena, rhodochrosite and quartz and locally replaces the predominant gypsum gangue. It is present in many other mines in the district but is abundant only in the blanket deposits. (Ransome, 1901a.)

Eagle County.—Gilman (Red Cliff) district. Both tetrahedrite and freibergite occur in small amounts in the high-silver ores; they are difficult to distinguish from each other. They are commonly associated with chalcopyrite and pyrite and in places are corroded and partly replaced by sphalerite and chalcopyrite. (Crawford and Gibson, 1925.) In the copper-silver chimney deposits in limestone, freibergite is one of many late silver minerals in vugs. (Tweto and Lovering, 1947.)

Gunnison County.—Anthracite-Crested Butte area. Tetrahedrite and the ruby-silver minerals are the main silver-bearing minerals of the rich silver ores. In the Augusta vein, which is 1 to 6 feet wide, the ore consists of the common sulfides with tetrahedrite and ruby silver cementing fault breccia and replacing the mafic constituents of diorite. On Augusta and Richmond Mountains, the Saint Elmo, Domingo, and Richmond mines once produced very rich ore similar to that of the Augusta mine, but also containing "warrenite," now known to be a mixture of boulangerite, jamesonite, and owyheeite. Tetrahedrite is also one of the principal ore minerals in the mines of Baxter and Queen Basins. (S. F. Emmons, Cross and Eldridge, 1894.)

Hinsdale County.—Lake City district. Argentian tetrahedrite (freibergite), containing as much as 2,500 ounces of silver to the ton, is one of the most prevalent and important minerals throughout the district and is present in greater or lesser amount in all ores. It is invariably massive and commonly intergrown with galena. No tennantite has been recognized in the district. (Irving and Bancroft, 1911.)

Genth (1886) gives two analyses of zincian tetrahedrite from the Governor Pitkin mine. It is nearly free of silver and is low in arsenic but contains 7.15 percent zinc. The mineral, which is coated with antimony oxides and is intimately associated with sylvanite, is massive and compact and is disseminated in quartz.

Fine crystals of both tetrahedrite and chalcopyrite are present in vugs in the ore from several mines. (Seaman, 1934, 1935b). In the Lake Fork, or White Cross district, particularly in the Ohio mine, tetrahedrite and chalcopyrite are important ore minerals of copper in the small vein deposits. (Woolsey, 1907.)

Jefferson County.—Tetrahedrite is present in the Malachite and Liberty lodes on Bear Creek. (Hollister, 1867.)

Lake County.—Leadville district. There is very little gray copper in the ores as compared with the San Juan and other districts. Where present, however, the tetrahedrite is generally rich in silver. One vein in the Ibex mine yielded small tetrahedral crystals as druses in pyrite and chalcopyrite. (S. F. Emmons, Irving, and Loughlin, 1927.)

La Plata and Montezuma Counties.—La Plata district. Tetrahedrite, all of which contains some arsenic, is one of the most widely distributed sulfides and is particularly abundant in the telluride ores. Crystals of tetrahedrite are perched on native-gold crystals in the Red Arrow vein. Locally the tetrahedrite is altered to covellite. (Galbraith, 1949.)

Needle Mountains district. Argentian tetrahedrite, (freibergite) occurs with petzite and other minerals in small pockets in quartz-calcite-barite gangue. (Whitman Cross, Howe, Irving and Emmons, 1905.)

Ouray County.—Ouray district. Argentian tetrahedrite (freibergite), associated with argentiferous galena, chalcopyrite, sphalerite, and pyrite, is the chief ore mineral in barite-quartz replacement bodies and is also common in veins. (Whitman Cross, Howe, and Irving, 1907.) The complex paragenesis and mineralogy of the Virginius, Terrible, and other deposits south of Stony Mountain are well described by Moehlman (1936b).

Park County.—Alma and nearby districts. Argentian tetrahedrite (freibergite) is responsible for most of the silver in the silver-lead deposits of Alma and adjoining districts. In the Russia mine on Mount Lincoln, where freibergite is the chief silver-bearing sulfide, the minerals are intimately intergrown in small clusters in a gangue of carbonate and barite. Listed in order of abundance, the sulfides are: sphalerite, galena, pyrite, chalcopyrite, freibergite, tetrahedrite, covellite, and chalcocite. (Q. D. Singewald, 1931; Q. D. Singewald and Butler, 1941; Behre, 1953.)

Park and Summit Counties.—Montezuma district. Both tetrahedrite and tennantite are abundant throughout the district. In a vein in the Toledo tunnel rich freibergite is present at one place about 1,200 feet below the surface, contemporaneous with a late generation of primary chalcopyrite. Some of the gray copper ore from Hall Valley contains as much as 100 ounces silver to the ton. (Lovering, 1935.)

Pitkin County.—Aspen district. Both tetrahedrite and tennantite are important ore minerals of silver, but tennantite is the more abundant. (Spurr, 1898.)

San Juan County.—Silverton district. Tetrahedrite, which nearly always contains some arsenic and is often rich in silver, rivals galena in importance and abundance. It occurs in quantity at Red Mountain. Associated minerals are galena, chalcopyrite, sphalerite, pyrite, quartz, and barite. (Ransome, 1901b.)

San Miguel County.—Telluride district. Gray copper, mostly tetrahedrite, is the main source of silver (Purington, 1898) in many mines. In the Alta mine, the gray copper alters to yellow arsenic and antimony oxides that are high in gold and silver. The presence of arsenic oxides suggests that some tennantite may be present. (W. E. Adams, 1900.)[11] In the Smuggler mine, tetrahedrite is fairly abundant, but not universally present. Most of it occurs in cavities or vugs in quartz; it contains polybasite in contemporaneous intergrowth and is cut by veinlets of native silver. Hurst (1922) thinks that the silver attributed to the gray copper comes from these minerals rather than from the tetrahedrite itself.

Teller County.—Cripple Creek district. Tetrahedrite, containing silver in varying amount, is virtually the only primary copper mineral at Cripple Creek. It is found in most veins and at all levels, commonly as steel-gray masses. In the Abe Lincoln and Doctor-Jackpot mines it occurs as good tetrahedral crystals. (Lindgren and Ransome, 1906.)

THALLIUM MINERALS

No thallium-bearing minerals have been specifically identified in Colorado, but George (1913) calls attention to the fact that a large quantity of thallium is recovered from the treatment of Colorado zinc and lead ores—probably the only production of the metal in the United States. He feels that prospectors would be justified in looking for thallium minerals in all parts of the Colorado mineral belt, especially in the La Plata and San Juan Mountains and in other places where the gray copper and ruby-silver minerals are to be found. The thallium minerals mentioned by George are crookesite, $(Cu, Tl, Ag)_2Se$, hutchinsonite, $PbS \cdot (Tl, Ag_2)S \cdot 2As_2S_3$, lorandite, $Tl_2S \cdot As_2S_3$, and vrbaite, $Tl_2S \cdot 3(As, Sb)_2S_3$. None of these is listed separately here.

[11] Adams, W. E., Report on the Alta Group of mines, San Miguel County, Colorado: unpublished thesis, Colorado School of Mines, Golden, Colo.

THENARDITE

Na_2SO_4

Thenardite is reported only at Burdsall's Lake, near Morrison, Jefferson County, where it occurs in quantity (Williams, 1885). It is probably present in other saline lakes.

THOMSENOLITE

$NaCaAlF_6 \cdot H_2O$

Thomsenolite is reported only from the rare fluoride mineral locality at St. Peters Dome, El Paso County (loc. 5). It is rare even there and occurs only as microscopic crystals mixed with pachnolite. Both of these minerals, and the more recently discovered weberite, are alteration products of cryolite. (Whitman Cross and Hillebrand, 1883; H. Pauley, 1954.)

THOMSONITE

$(Ca, Na_2) Al_2Si_2O_8 \cdot 2\frac{1}{2}H_2O$

Thomsonite is reported from 4 areas in the State and has been very extensively studied at 1 of them—Table Mountain. It is probably present as one of the zeolites in lava flows elsewhere.

Gunnison County.—Italian Mountain (loc. 3). Thomsonite was found in only one specimen from this locality. This was from a 3-cm vein in altered diorite. The vein walls are bordered by crusts of bluish-green sahlite, followed by large plates of specular hematite. The center of the vein is filled with radiating pearly blades of thomsonite. Whitman Cross and Shannon (1927) record the optical properties but no analysis.

Jefferson County.—North Table Mountain (loc. 18). Cavities in the lava of this famous zeolite locality contain minute rectangular blades of thomsonite, placed on each other like the leaves of a closed fan, as well as spherical concretions with velvety surface and radial structure. The thomsonite followed closely on deposition of chabazite and coats both the chabazite and the earlier yellow calcite. A late generation of thomsonite appears as crystals that are longer than those of the first generation and often occur as prolongations of the older ones. (Whitman Cross and Hillebrand, 1882a—analysis.)

A detailed description of material from a new quarry on the east side of North Table Mountain is given by Patton (1900). He finds four types of habit with differences in shape and arrangement of the crystals as well as differences in age. The paragenetic sequence of the cavity fillings is as follows: laumontite, stilbite, chabazite, thomsonite (type I), apophyllite, thomsonite (types II and IIa), laumontite, stilbite, analcite, thomsonite (type III), calcite, thomsonite (type IIIa), mesolite, analcite, and aragonite.

Additional analyses of thomsonite from Table Mountain, with some new optical data, are given by Clarke and Steiger (1902); Hey (1932); and E. P. Henderson and Glass (1933).

Moffat County.—Fortification Creek (loc. 2). Coarse-grained analcite syenite occurs as local masses near the center of Fortification dike on Fort Creek, 18 miles north of Craig. Radially fibrous thomsonite, which is not abundant, fills a few interstices between feldspar phenocrysts. The boundaries with feldspar are sharp, but fibers of thomsonite cut analcite in places. (Ross, 1926.)

Park County.—South Park (loc. 7). Cavities in the analcite syenite bodies that crop out on the floor of South Park contain megascopically visible radiating fibers of thomsonite, natrolite, and stilbite. The cavities are lined with analcite. (Jahns, 1938.)

THORITE

$ThSiO_4$

Thorite is reported from five localities; it may be present in other places. The variety uranothorite is known only in Boulder County.

Boulder County.—Jamestown district (loc. 2). Thorite is present in the cerite deposit. (Goddard, Lovering and Fairchild, 1935; Goddard and Glass, 1940.)

Custer and Fremont Counties.—Wet Mountains. Thorium-bearing minerals are widely distributed, but in small amounts, in northwestward-trending shear zones in Precambriam rocks in an area 20 miles long and 10 miles wide. The chief thorium mineral, tentatively identified as thorite, occurs as small veinlets and blebs that can be detected by their strong radioactivity. The mineral is dark-red-brown, with greasy luster and splintery conchoidal fracture.

The most abundant minerals associated with thorite are several unidentified rare-earth minerals, quartz, barite, limonite, and hematite. Less common are purple, yellow, and white fluorite, siderite, galena, chalcopyrite, bornite, and pyrite. (Christman and others, 1953.)

El Paso County.—Stove Mountain (loc. 6). Aggregates of brick-red thorite crystals occur in miarolitic pegmatite bodies along the Gold Camp road on the east flank of Stove Mountain. The crystals are metamict, but on heating give the X-ray pattern of thorite. Thorite was also observed as an alteration product of galena, associated with fibrous malachite. (J. W. Adams, written communication.)

Gunnison County.—Powderhorn district (loc. 2). Thorium minerals occur in small amounts in an area 6 miles wide and 20 miles long that extends from the well-known complex of alkalic rocks at Iron Hill to the Lake Fork of the Gunnison River. The deposits occur in shear zones in Precambrian rocks, in carbonate-rich veins near the Iron Hill complex, and as weakly radioactive zones in carbonate rock such as the marble of Iron Hill. In addition to thorite or thorogummite, the deposits contain carbonates, quartz, barite, the common sulfides, iron oxides, feldspar, apatite, and xenotime(?). Bastnaesite, cerite(?), and synchisite also occur in the carbonate veins near Iron Hill. (Olson and Wallace, 1956.)

Jefferson County.—The Oregon group of claims, 3 miles due west of the White Cloud mine (loc. 16), contains thorite in pegmatite. (Vance Haynes, written communication.)

Thorite variety URANOTHORITE

Uranothorite, a uranium-bearing variety of thorite, has been found only in ore from the Blue Jay mine, Jamestown district, Boulder County, where it occurs in fluorite breccia. It is in very small quantity and was found in the course of microscopic and heavy-mineral studies. Chemical, spectrographic, optical, and X-ray studies are recorded by Phair and Shimamoto (1952).

THOROGUMMITE

Silicate of U, Th, Ce, and other cations

[*See also* Thorite]

Custer and Fremont Counties.—Wet Mountains. Hundreds of thorium-bearing veins occur in a large area in the Wet Mountains. In most places the minerals are detectable only by their radioactivity, but in a few of the richest localities a reddish-brown mineral is visible as blebs and veinlets in microscopic intergrowth with barite and specular hematite. All available data suggest to Q. D. Singewald and Brock (1956) that the mineral is thorogummite or a closely related mineral. Christman and others (1953), however, are inclined to identify the mineral with thorite rather than with thorogummite.

Gunnison County.—Powderhorn district (loc. 2). Thorogummite has not been certainly distinguished from thorite in the extensive but very low grade thorium deposits but one or both minerals are certainly present. (Olson and Wallace, 1956; Wallace and Olson, 1956.)

THUCHOLITE

[*See* Uraninite]

THURINGITE

[*See* Chlorite group]

TITANITE

[*See* Sphene]

TOPAZ

$Al_2SiO_4(F,OH)_2$

Topaz, one of the favorites of mineral collectors, is widespread in the State. Large quantities have been sold for cutting as gems; the largest crystals of gem-quality topaz ever found in North America—some of them weighing as much as 5 pounds—have come from Colorado.

The modes of geologic occurrence of topaz are nearly as varied as are its geographic habitats. It occurs in pegmatites, in miarolitic cavities and schlieren of granitic rocks, and in lithophysae of rhyolitic rocks. It is relatively abundant, although in microscopic crystals, as a gangue mineral in the Climax molybdenum deposit. It occurs also as an accessory mineral in some igneous and metamorphic rocks and in sedimentary rocks derived from them.

The best known sources of gem-quality topaz are in the general vicinity of Pikes Peak. Several of the earlier descriptions are no more specific than "the Pikes Peak region" and it is necessary to give some of the occurrences thus. Although topaz has been found in many places within a semicircle of 30 miles radius that centers at or near Manitou Springs, most of the best finds have been made at 1 of 3 general localities—Devils Head Mountain, Douglas County; Crystal Park, El Paso County; and Crystal Peak (Florissant), Teller County. Of these, Devils Head Mountain seems to be the best known and the most productive locality.

Chaffee County.—Mount Antero (loc. 3). Some gem-topaz crystals occur on Mount Antero and in a few pegmatite lenses topaz may be the dominant mineral. The locality is, however, far more famous for its fine aquamarine, phenakite, and bertrandite than for topaz. (Sterrett, 1909: Switzer, 1939b.)

Nathrop (loc. 4). Brillant wine-yellow crystals of topaz are associated with the gem garnet in cavities in rhyolite. The yellow color fades on exposure. Most of the topaz and garnet crystals are too small for cutting, but some gem-quality prismatic doubly terminated topaz crystals have been found that are as much as 1 inch long. (J. A. Smith, 1883; Whitman Cross, 1886; Bixby, 1894; Penfield and Minor, 1894—analysis; Pearl, 1939b, 1958; J. W. Adams, written communication.)

Clear Creek County.—Beaver Brook (Brandt deposit) (loc. 1). The footwall zone of this pegmatite contains well-formed beryl crystals as much as 6 inches long associated with topaz crystals as much as by 1½ inches. The topaz crystals, which are rough and imperfect and coated with mica, are light green in their outer parts with pinkish white interiors. The core of the dike is chiefly pale-green amazonstone (microcline). (Hanley, Heinrich, and Page, 1950; J. W. Adams, written communication.)

Custer County.—Rosita Hills. Clear wine-colored and colorless topaz crystals and garnet crystals occur in the concentric cavities in the main lithophysae-rich rhyolite sheet of Silver Cliff. They are in a transition zone between huge spherulities and banded rhyolite. There are also some topaz, garnet, and quartz crystals in flat cavities in the banded rhyolite. (Whitman Cross, 1896.)

Douglas County.—Devils Head (loc. 1). Devils Head, formerly called Platte Mountain, has long been known as the source of the finest gem topaz in Colorado. The locality was first described by R. T. Cross (1883) who records the discovery of topaz in that year by W. B. Smith. Smith had found a pocket in decomposed albite that yielded more than 100 crystals or crystal fragments in 1 month's work. The largest fragment, which showed only two faces and was partly clear, weighed 11½ ounces. The largest and best-formed crystal, light-straw-colored and flawless, weighed 4 ounces. Further discoveries of even larger and finer specimens are recorded by Whitman Cross and Hillebrand (1885b) and by W. B. Smith (1885).

Kunz (1885) says that many fine crystals, some yielding cut stones from 10 to 193 carats have been found; they range from colorless to rich cinnamon brown and are free of flaws. He notes one cut stone of 125 carats that he says is as fine a gem of any kind as the United States has produced. An analysis of Devils Head topaz is recorded by Clarke (1903).

The results of intensive prospecting and modern study are reported by Peacock (1935a). Topaz as whole crystals and fragments is associated with smoky and clear quartz, microcline, albite, muscovite, a little fluorite, and very rare cassiterite in pockets in pegmatite bodies. The pockets, seldom more than 1 by 2 by 4 feet in size, are numerous. The best crystals, some of which are fist-sized, are in ferruginous mud and sand at the bottoms of pockets; mud that is richest in iron is poorest in topaz crystals. Peacock gives detailed descriptions of the crystallography.

Pearl (1941i) says that gems ranging from clear through yellow to blue have been found. The largest perfect crystal, found in 1935, weighed 1,160 grams. (See also Hanley, Heinrich, and Page, 1950; Pearl, 1958.)

Long Hollow. This locality 7½ miles south of Devils Head contains giant crystals of bluish-green sugary-textured topaz as much as 3 feet long and 8 inches in diameter. They are at the edge of the quartz core of pegmatite and are associated with microcline. (G. R. Scott, written communication.)

Eagle County.—Holy Cross Mountain. According to an old newspaper report, the mineral collection at the State House contains a very beautiful crystal of topaz, set in a cluster of smoky-quartz crystals, from Holy Cross Mountain. The bluish-green perfectly transparent flawless crystal is 1½ by ¾ by 1 inch in size. (Randall.)

El Paso County.—Crystal Park (loc. 2). Crystal Park, 2 miles south of Manitou Springs, is at the foot of Camerons Cone. Minerals, including fine topaz crystals, have been found over an area that extends from a point 1 to 2 miles northwest of Crystal Park southeastward for several miles. Bear Creek Canyon, south of the park, is a good collecting locality, as is Specimen Rock on the slope of Bear Creek Canyon. Phenakite, topaz, and other minerals have been found here. (Over, 1929; Pearl, 1941e, 1958.)

Gunnison County.—Quartz Creek (Ohio City) district (loc. 4). Topaz is a prominent constituent of the lepidolite-bearing pegmatites of the district and has been found in eight of them. It is milky white and crowded with fluid inclusions. Some masses are subhedral in form, but there are many long tapering euhedral crystals that range from several inches across to as much as 1 foot in diameter and 4 feet in length. The characteristic basal cleavage is distinct, but imperfect. (Eckel, 1933a; Staatz and Trites, 1955.)

Tomichi dome. Topaz is a significant accessory mineral in the fine-grained rock of Tertiary age which makes up the dome. Heavy minerals comprise 0.289 percent of the rock. Magnetite is the most abundant heavy mineral but topaz makes up about one quarter of the total heavy minerals. (Stark, 1934.)

Lake County.—Climax district. Topaz is widespread, and very abundant in the aggregate, in the Climax molybdenum deposit. Were there a use for finely divided topaz, very large quantities could be easily recovered from the mill tailings. It occurs as disseminations through the silicified rock, as irregular veinlets that cut molybdenite-quartz veins, and as a characteristic gangue mineral in late pyrite veins. Most of it is in equidimensional grains of microscopic size, but some is in lath-shaped grains with cleavage normal to the longer dimension. (Staples and Cook, 1931; B. S. Butler and Vanderwilt, 1931, 1933.)

Lake, Summit, and Eagle Counties.—Chalk Mountain (loc. 1). Well-formed clear crystals of gem-quality topaz occur but all are less than 4 mm long. They line druses in the coarsely crystalline variety of rhyolite porphyry are called nevadite. The rock contains phenocrysts of sanidine, oligoclase, quartz, and biotite in a white groundmass. Small crystals of sanidine are perched on many of the topaz crystals in the druses. (Whitman Cross, 1885b; S. F. Emmons, 1898; Pearl, 1939a.)

Larimer County.—Specimen Mountain (loc. 5). Clear colorless to light-pink topaz in well-formed crystals occurs, with tridymite and clear quartz of "rock crystal" quality, in the lithophysae of the rhyolite. Few of the crystals are large enough for cutting but they are otherwise perfect. (R. G. Coffin, written communication; Wahlstrom, 1941, 1944.)

Large crystals of topaz occur in the Red Head (Paradox) pegmatite (probably sec. 33, T. 11 N., R. 72 W.). The topaz, which is not of gem quality, is commonly rimmed by hemispherical aggregates of mica. (J. W. Adams, written communication.)

Park County.—Tarryall Mountains. Rediscovery of a good topaz collecting locality, first found in 1914, is reported by Wulff (1934). The deposit, almost certainly in T. 10 S., R. 72 W., is "3 miles by road past Tarryall, thence a 2-mile walk into the mountains." The topaz occurs in the weathered parts of two or more medium-coarse-grained pegmatite dikes in granite. Smoky and clear quartz, feldspar, muscovite, and a little biotite are also present. Many crystals ⅛ to 1 inch long, lie loose on the surface. They are prismatic and singly terminated and most are clear colorless. Some are stained red by iron oxides along cleavage planes. Large rough crystals of colorless to blue topaz were abundant in the Lone Lode feldspar pegmatite body. None are of gem quality. (J. W. Adams, written communication.)

Badger Flats area (loc. 2). Topaz, mostly as translucent white to gray grains and poorly formed crystals, is one of the most widely distributed minerals in the area. In the Boomer and Happy Thought beryl mines it forms masses of quartz-topaz greisen several feet across. At and near the Mary Lee prospect it occurs in quartz veins with wolframite. (W. R. Griffitts, written communication.)

Teller County.—Crystal Peak (Florissant) (loc. 2). The second discovery of topaz in Colorado was made in 1884 at Crystal Peak. Gems worth about $4,000 were produced within the next couple of years. The first specimen, a fragment of an enormous crystal, is noted below under the heading "Pikes Peak region, general." Most of the topaz is colorless, but many crystals are pale green and some have a yellowish or bluish tinge. Some crystals are doubly terminated. They are most commonly implanted on amazonstone and associated with phenakite. (Whitman Cross and Hillebrand, 1885; Pearl, 1941h, 1958.)

"Pikes Peak region," general.—Whitman Cross and Hillebrand (1882c) described three crystals "from Pikes Peak," all remarkable for their size and clarity. They were found about 1880 by a prospector. Later, R. T. Cross (1883) says that two of these crystals came from one of the steep slopes 4 miles from Manitou (possibly near Crystal Park?) and that the third was from near Florissant. The first crystal, which is colorless and has drusy terminal faces, is 2.5 by 3.3 by 2.8 cm in size. The second, which is less perfect than the first and has a slightly green tint, is 5 cm long. The third crystal—the one from Florissant—is only a corner of a large crystal, but the fragment is 9 cm long, indicating that the original crystal must have been about 1 foot in diameter. It is clear in parts, and it has a greenish tinge.

The crystallography of a single crystal of somewhat unusual habit is reported by Rogers (1901). Crystals from "Pikes Peak" and from Nathrop, Chaffee County, are also deescribed by Eakle (1899).

TOPAZOLITE

[*See* Garnet]

TORBERNITE

$Cu(UO_2)_2(PO_4)_2 \cdot 8\text{–}12H_2O$

Boulder County.—Gold Hill district. Torbernite and minerals tentatively identified as uraninite and metatorbernite coat fractures in the Goldsmith Maid vein and are disseminated in the hanging wall. (Campbell, 1955.)

Jamestown district. Torbernite occurs at the Nations Treasure mine. (V. R. Wilmarth, written communication.)

Clear Creek County.—Idaho Springs district. Torbernite is reported to occur in the Peabody lode in the Montana district. (Randall.) In the Freeland-Lamartine district torbernite, autunite, and dumontite(?) occur in vugs, fractures, or fault gouge in the oxidized parts of several veins. The torbernite is seldom visible to the unaided eye. (J. E. Harrison and Wells, 1956.)

On the Robineau claims, in sec. 35, T. 3 S., R. 74 W., on the ridge between Clear and Silver Creeks, bright green scales of torbernite together with an unidentified radioactive mineral, coat fracture walls. (R. U. King and Granger, 1952.)

Fremont County.—Translucent emerald-green torbernite, with gummite, are reported from an old shaft in Fremont County, very close to the Custer County line (Randall). In the Meyers pegmatite quarry, Eight Mile Park (loc. 4), minute flakes of a green uranium mineral, probably torbernite, are associated with pink tourmaline, lepidolite, and fremontite. (Heinrich, 1948b.)

Gilpin County.—Central City district. Some of the metatorbernite from deposits in Eureka Gulch may contain torbernite. Sims, Osterwald, and Tooker, 1955; Sims and Tooker, 1955, 1956.)

Jefferson County.—Torbernite occurs as an alteration product of pitchblende in several deposits in Golden Gate Canyon and Ralston Creek. It is rare except at the Schwartzwalder mine south of Ralston Creek (loc. 15), where torbernite, metatorbernite, and autunite were abundant in the oxidized zone. (Adams, Gude, and Beroni, 1953.)

Lake County.—St. Kevin district. Torbernite occurs as disseminations and fracture coatings in altered granite at the Josie May turquois mine. Associates, in addition to turquois, are malachite and chrysocolla. It is probably also present elsewhere in the district. (Pierson and Singewald, 1954.)

Larimer County.—Crystal Mountain district (loc. 1). Small quantities of torbernite are present with uraninite and other uranium minerals in the Hyatt mine (loc. 2) and the Big Boulder prospect. (Hanley, Heinrich, and Page, 1950.)

Montrose County.—Torbernite and metatorbernite, the latter probably more abundant, have been definitely identified in ore of the Grey Dawn mine, Paradox district, San Juan County, Utah. It has not been found in ores from the Colorado part of this district, but may be present. (Weeks and Thompson, 1954.)

Saguache County.—Cochetopa district (loc. 2.) Ore from the Los Ochos mine contains extremely sparse torbernite as an alteration product of pitchblende. (Derzay, 1956.)

TÖRNEBOHMITE

Silicate of cerium metals; chiefly $R_3(F,OH)(SiO_4)_2$

Törnebohmite, a hydrofluosilicate of the cerium metals, is reported from only one locality. This is the cerite deposit in the Jamestown district, Boulder County (loc. 2). Rectangular grains of törnebohmite, 0.16 by 0.48 mm, replace the cerite. (Goddard and Glass, 1940.)

TOURMALINE

$(Na,Ca)(Mg,Fe^{+2},Al,Li)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$

Tourmaline is very widespread in schists and some gneisses and is locally abundant. It is also a gangue mineral in a few ore deposits. Some pegmatite bodies contain fairly well formed crystals. Most Colorado tourmaline is black, but colored material occurs in a few pegmatites. Some translucent crystals are reported, but comparatively little gem quality tourmaline has been found. The descriptions that follow include the known localities of colored stones and of vein matter but are only representative of the occurrences in metamorphic rocks.

Fremont County.—Eight Mile Park (loc. 4). Common black tourmaline is only a minor constituent of the wallrocks but it is abundant in the margins of the pegmatites. In the School Section pegmatite, radiating black tourmaline crystals form "suns" as much as 4 feet in diameter, with individual crystals as much as 3 by 8 inches in size.

Colored tourmaline is know only in the Meyers pegmatite quarry. Red, light-green, and blue-black single-color crystals are present, but most of the crystals are zoned, with their cores very differently colored from the outer parts. The crystals are veined by quartz and albite and are associated with pink to purple lepidolite. (Heinrich, 1948b.)

The Royal Gorge No. 1 mine, 5 miles N. 70° W. of Canon City and in the east wall of a canyon that enters the Royal Gorge from the north, is about 200 yards from the gorge and 300 feet above the canyon floor. Fine pink, green, and colorless crystals of gem-quality tourmaline were found in a short and narrow vein along the wall of pegmatite dike.

The Royal Gorge No. 2 mine is 4 miles due northwest of Canon City, on the dissected plateau 2 miles north of the Royal Gorge. Colored tourmaline is associated with lepidolite and natromontebrasite (fremontite). Most of the tourmaline is "frozen" in the rock and is opaque to translucent, but some transparent gems are reported. (Sterrett, 1909; Schaller, 1912.) This deposit is possibly the same as that now called the Meyers Quarry pegmatite, described above.

Gunnison County.—Cochetopa district. The little-known Cochetopa mining district contains tourmaline as a minor gangue mineral in at least two deposits. In the Chance, or Lucky Strike mine, in sec. 10, T. 48 N., R. 1 E., and secs. 34 and 35, T. 49 N., R. 1 E., the vein, which has yielded a little gold, consists of iron-stained and white quartz with black tourmaline between hornblende diorite wallrocks. In the Denver City mine, 3 miles southeast of the Chance, in sec. 20, T. 48 N., R 1 E., low-grade gold-quartz veins with tourmaline cut actinolite schist. (James Boyd, written communication.)

Quartz Creek (Ohio City) district (loc.4). Tourmaline is rare in the district, having been found in only 48 of the 1,803 pegmatites examined by Staatz and Trites (1955). The colored varieties occur only in lepidolite-bearing pegmatites. All the crystals are somewhat fractured, bent, and warped. A few are as much as 2 inches thick and 1 foot long, but most are much smaller. (Eckel, 1933a.) In a detailed chemical and microscopic study of tourmalines from the Brown Derby No. 2 and 3 claims, Staatz, Murata, and Glass (1955) found a consistent variation in color, index of refraction, and composition according to position in the pegmatite. From wall to core they found the color to change from black through dark green, blue, and light green to pink. The concentration of minor elements in the tourmalines also increases toward the core.

Jefferson County.—Guy Hill (loc. 11). On the Ramstetter property on Guy Hill, alongside the Golden Gate Canyon road, several large pegmatite dikes cut a series of sillimanite schists, epidote-garnet rocks, and quartzites. Black tourmaline occurs in abundance in the dikes, some of it in well-formed but poorly terminated crystals nearly 1 foot long and 3 to 4 inches in diameter. Some of the crystals are spectacular partial replacements of quartz and feldspar; elsewhere large tourmaline crystals form the centers of rosettes of muscovite. I have observed some beryl in places. (See also Hollister, 1867.)

On the east side of the draw that exposes the above-described dikes, a tourmaline gneiss contains brilliant black crystals as much as 6 inches long and ½ inch in diameter; many are well terminated. (J. W. Adams, written communication.) The occurrence of abundant tourmaline in schists and pegmatite bodies in this vicinity is well described by Patton (1899).

La Plata County.—La Plata district. In the Neglected mine, where the wall-rocks are more intensely altered than those of most ore deposits in the district, tourmaline is microscopically intergrown with hornblende, sericite, and chlorite in altered porphyry near the vein. (Galbraith, 1949.)

Larimer County.—Black tourmaline is abundant and widespread in many of the metamorphic rocks near Estes Park and elsewhere. In the Crystal Mountain pegmatite district (loc. 1) it is very abundant locally in schist, granite, and pegmatite. The crystals range in size from microscopic to 4 inches in length. (R. G. Coffin, written communication; Thurston, 1955.)

Park County.—Near the Wilkinson Ranch, at the foot of Puma Pass on the edge of South Park, jetblack shining crystals of tourmaline as much as 6 inches long occur in milky quartz. This occurrence is ascribed to R. T. Cross in an 1877 newspaper report.

Pitkin County.—Aspen district. In the Midnight mine, in the southern part of the district, minute prisms of nearly colorless tourmaline occur in vein quartz. Associated minerals are galena, sphalerite, quartz, barite, and a little pyrite and sericite. (Knopf, 1926.)

TREMOLITE

[*See* Amphibole group]

TRIDYMITE

SiO_2

Tridymite is, like cristobalite, one of the high-temperature forms of silica. It is widespread, particularly in silicic volcanic rocks. A few of its more important localities are given here.

Custer County.—Rosita Hills. Tridymite occurs is a few places, particularly in the mica dacite dike that forms a low ridge north of Sugar Loaf near the Querida-Silver Cliff road. (Whitman Cross, 1888, 1896.)

Grand County.—Lithophysal rhyolite outcrops in sec. 10, T. 3 N., R. 76 W., about 3 miles west of Grand Lake. Tridymite crystals, with or without cristobalite, line the lithophysae and are also interstitial to the spherulites. A trachyandesite that caps the mountains that extend southward from Apiatan Mountain, 4 miles west of Grand Lake almost to Granby, also contains tridymite. A little of it fills gas cavities in devitrified glass, but it is also in amygdules. The vesicular cavities were first lined with calcite, followed by radiating fibrous chalcedony, and finally by tridymite. (Spock, 1928.)

Larimer County.—Near Home, on the north side of Cache la Poudre Valley and 500 feet north of State Route 14, large tabular phenocrysts of quartz, paramorphic after tridymite, occur in a quartz latite porphyry. They form flattened and rounded disks as much as 17 mm. across and 3 mm. thick. All lack good crystal faces because of rounding owing to resorption. (Ray, 1947.)

Specimen Mountain (loc. 5). Tridymite is locally abundant in the groundmass of sanidine-quartz trachyte that forms the country rock of the well-known opal and chalcedony deposits. (Wahlstrom, 1941, 1944.)

San Juan Mountains, general.—Although commonly considered a rare mineral, tridymite is somewhat more abundant than quartz in the volcanic rocks of the San Juan region. It is estimated that there are 350 cubic miles of tridymite in these mountains! It is in nearly all the volcanic rocks, but is most abundant in the porous parts of the groundmass or in spherulites of rhyolitic rocks. It is also common in the cavities of andesites and basalts, but somewhat less abundant than cristobalite in the basalts. In some rhyoltic tuffs it forms the binder of the tuff fragments. (E. S. Larsen, Jr., 1930; E. S. Larsen, Jr., Irving, Gonyer and Larsen 3d, 1936; E. S. Larsen, Jr., and Cross, 1956.)

Summit County.—Tenmile district. One mass of fine-grained rhyolite porphyry in McNulty Gulch contains small drusy cavities that are lined with tablets of tridymite and a few crystals of white feldspar and of smoky quartz. (S. F. Emmons, 1898.)

TRIPHYLITE

$Li(Fe,Mn)(PO_4)$

[*See also* Lithiophilite]

As noted under lithiophilite, several occurrences of members of the lithiophilite-triphylite isomorphous series are reported in Colorado. In only one occurrence has the mineral been tentatively identified as triphylite. This is in the Burroughs feldspar mine, in Jefferson County (loc. 4). There dark-brown triphylite occurs in quartz-microcline-biotite pegmatite. (Hanley, Heinrich, and Page, 1950.)

TRIPLITE

$(Mn,Fe,Mg,Ca)_2(PO_4)(F,OH)$

Triplite, a comparatively rare fluophosphate of manganese, iron, magnesium, and calcium, has been found in 2 pegmatite bodies in Fremont County, 1 in El Paso County, 1 in Jefferson County, and 3 in Larimer County. It may possibly be found in pegmatite in other parts of the State.

El Paso County.—The first reported find of massive triplite was from an abandoned quarry in a pegmatite dike near the south end of Deadmans Canyon (loc. 3). The triplite, which has resinous to adamantine luster and 2 well developed cleavages, is coarsely intergrown with brown apatite in a single mass 2 feet in diameter. Associated minerals are white orthoclase, milky quartz and muscovite. (Boucot, 1947; Wolfe and Heinrich, 1947.) In a general study of the species, Heinrich (1951) gives a new chemical analysis of the triplite from this locality.

Fremont County.—The first measurable crystals of triplite to be recorded from Colorado were taken from the Mica Lode and School Section quarry in Eight Mile Park (loc. 4). Crystallographic measurements and X-ray studies on 4 crystals from the Mica Lode, 2 of them 9 by 9 by 12 cm, are recorded by Wolfe and Heinrich (1947). In the School Section pegmatite, rounded anhedral masses as much as 6 inches long are abundant, associated with muscovite, plagioclase, tourmaline, and beryl. In the Mica Lode, where it is associated with beryl, about 10 tons of triplite from pods as much as 2 feet long have been recovered. Some of the triplite is veined and corroded by albite and muscovite and some is veined by tourmaline. The clove-brown triplite of the Mica Lode, some of which had been earlier described as allanite or thorite, was found by Hanley, Heinrich, and Page (1950) to be in the intermediate zone of the pegmatite. There, in addition to muscovite, quartz, and albite, it is associated with beryl, columbite, and bismuth carbonates. In the School Section mine these authors found triplite (or thorite?) to be associated with beryl and bismuth carbonates in masses of fine-grained mica. In his general study of triplite, Heinrich (1951) gives new analyses of triplite from each of these localities.

Jefferson County.—Dark-brown masses of triplite, identified by X-ray means, were found in float from a pegmatite body in the SW¼ sec. 3, T. 3 S., R. 71 W. (D. M. Sheridan, written communication.)

Larimer County.—Crystal Mountain district (loc. 1). Triplite has been found in the Big Boulder pegmatite and in two other pegmatite bodies one-half mile northeast of the Big Boulder. (Thurston, 1955.)

TROILITE

[*See* Pyrrhotite]

TRONA

$Na_3H(CO_3)_2 \cdot 2H_2O$

Trona, associated with natron, is reported in the literature only from the soda lakes of the San Luis Valley, in Costilla and other counties. It is almost certainly present elsewhere in saline lakes and as an efflorescence on soils and some rocks. At Soda Lake, near Mosca, Costilla County, there are thick layers of crystalline natron, surmounted by thin layers of bright prismatic needles that Headden (1909) believes to be trona.

Trona, associated with a large number of new and rare minerals, has been found in large quantity in shales of the Green River formation of southwestern Wyoming and also in northeastern Utah. None of these deposits has yet been reported from Colorado, but it would be surprising if they were not present in some part of the extensive bodies of the Green River in this State.

TSCHEFFKINITE

[*See* Chevkinite]

TUNGSTITE

$WO_3 \cdot H_2O$ (?)

Tungstite, or tungstic ocher, is reported from only two localities. It is probably present in small quantities elsewhere as an oxidation product of one or more of the primary tungsten minerals.

Boulder County.—Nederland tungsten district. Tungstite was seen only at the Roderick shaft in the Beaver Creek district. There, vugs in shiny black uncorroded ferberite are filled with soft bright-yellow tungstite; the larger vugs contain as much as 1 pound of the mineral. The relations are such that the tungstite must have been derived from weathering of ferberite higher in the vein. (Lovering and Tweto, 1953.)

Summit County.—The Navy or Royal George vein on North Star Mountain and Quandary Peak is comprised of huebnerite, pyrite, and quartz with some scheelite. A little tungstite is associated with the scheelite. (G. O. Argall, Jr., 1943.)

TURGITE

[*See* Limonite]

TURQUOIS

$CuAl_6(PO_4)_4(OH)_8{\cdot}4H_2O$

Turquois, the lovely blue gem stone, was probably one of the first Colorado minerals used by man, for it was apparently found and mined by Indians long before the coming of the white man.

It was early reported from southern Colorado by Endlich (1878) and included by J. A. Smith (1883) in his lists of minerals. Turquois is known to occur in several places and although the total production is small, it is the most valuable among the gem stones that have been produced in Colorado. For example, Pearl (1941f) says that Colorado is second only to Nevada in production of turquois and produced 15 percent of the total United States production of $30,000 worth in 1938.

Conejos County.—King mine (loc. 1). This deposit, like several of the other turquois deposits in the State, was originally worked by the Indians. Rediscovered by Pervine King in 1890 and worked intermittently since then, the deposit is developed by an open pit 333 feet long, 180 feet wide and 65 feet deep. (Pearl, 1941c, f, 1958.)

According to Sterrett (1909), the deposit is in extensively kaolinized trachyte which contains seams, veinlets, irregular masses, and a few nodules of pale-blue to strong-sky-blue turquois. The best quality material is hard. The matrix is stained with limonite which adds to the beauty of the cut stones.

Pearl (1947) describes a 1946 discovery of a nugget that weighs 8¾ pounds; it is blue green, with a fine spiderweb pattern. He also notes that the King mine produced 2,000 pounds of rough turquois worth $30,000, in 1946.

Lake County.—Holy Cross district. A small deposit of turquois of excellent gem quality was found in 1888 in the Holy Cross mining district, 30 miles west of Leadville. There was no evidence of prehistoric mining activity. The material was similar to that produced in Arizona and New Mexico but of better blue color (Kunz, 1890a). There are no later reports on the occurrence.

St. Kevin district. The Turquoise Chief mine, 7 miles northwest of Leadville, is just below the crest of a high ridge between Turquoise Lake and a drainage basin to the north. Originally worked by the early Indians, it was reopened in 1935 by two Navajos. They produced about 1,000 pounds of gem-quality turquois in two summers from an opencut 100 feet in diameter and 25 feet deep. The turquois occurs as veins and nodules in white altered medium-grained granite.

(Pearl, 1941c, f, 1958.) In the Josie May mine, the turquois is associated with malachite, chrysocolla, and torbernite, which occurs as disseminations and fracture coatings in the altered granite. (Pierson and Singewald, 1954.)

Mineral County.—Creede district. The Denver Museum of Natural History has a fine specimen of turquois of very good color collected by Richard Pearce from the Last Chance mine.

Small pieces of fairly good quality turquois have been found along the bed of Willow Creek, north of Creede and between the Amethyst and Commodore mines. (Pearl 1941c, f, 1958.)

Saguache County.—Villa Grove (loc. 1). The turquois deposits near Villa Grove were first reported in 1893 by J. S. Randall, who states in his notes that the Blue Gem and Manitou veins had been opened and had produced turquois that was of fair blue color but fissured and veined with dark streaks.

These deposits have since become the most valuable gem producer in Colorado. Known as the Hall turquois mine, which is 8 miles northwest of Villa Grove and 5 miles east of Bonanza, the mine is developed by a pit, opencuts, and underground drifts. The turquois, which has been sold uncut for $15 to $45 per pound, occurs as veins and nodules in weathered felsite porphyry. Some specular hematite, pyrite, and copper minerals are present. (Pearl, 1941c, f, 1958.)

Teller County.—Cripple Creek district. "Turquois has been found on the surface in various places in the district. One such place is on a hillside to the right of Colorado Highway 67 at a point 0.6 mile south of its junction with Colorado Highway 143." (Pearl, 1951a.)

TYSONITE*

[*See* Fluocerite]

TYUYAMUNITE

$Ca(UO_2)_2(VO_4)_2 \cdot 2H_2O$

Tyuyamunite, the calcium analogue of carnotite, has been found in all the carnotite localities on the Colorado Plateau. It is disseminated in sandstone and forms coatings on joints and fractures. In addition to carnotite, metatyuyamunite, rauvite, corvusite, and hewettite are the chief associates. (Weeks and Thompson, 1954. See also Hess, 1924a; Hillebrand, 1924.) Donnay and Donnay (1954) report X-ray measurements on tyuyamunite from Mesa County.

ULLMANNITE

NiSbS

A mineral identified as kallilite, which species has since been found to correspond to bismuthian ullmannite, occurs in the North Pole silver mine, Crystal district, Gunnison County, where with pyrite it fills cracks in barite. The mineral gives positive microchemical tests for nickel, bismuth, and antimony. (E. P. Chapman, Jr., written communication.)

UMANGITE

Cu_3Se_2

Umangite has not been reported as such, but zorgite, a supposed selenide of lead and copper, since shown to be a mixture of clausthalite and umangite, has been reported once. This is from the Pearl lode on Minnesota Gulch, San Juan County, where a large quantity was present. It formed fine granular masses of soft brittle lead-gray material with a metallic luster. (Randall.) The identification cannot be regarded as established.

URACONITE

[*See* Uranium sulfates]

URANINITE

UO_2

Uraninite, called pitchblende where it is massive, colloform, or sooty, has long been known in Colorado and is today one of the many source minerals of uranium from many deposits that yield the raw materials for the burgeoning atomic-energy industry.

Boulder County.—Caribou district. The occurrence of pitchblende in the Caribou mine is described by R. U. King (1952), F. B. Moore and Cavender (1952) and H. D. Wright (1954), among others. This mine is in secs. 8 and 9, T. 1 S., R. 73W., 5 miles northwest of Nederland. Most of the ore is galena and sphalerite with some argentite, proustite, and a little wire silver. In the Radium vein pitchblende, both as a sooty powder and in characteristic colloform masses, is irregularly distributed along the vein. In two ore shoots it forms a discontinuous seam as much as 6 inches wide along the wall of the sulfide vein.

Jamestown district. In the cerite deposit of this district (loc. 2), dull-black uraninite with a faintly metallic luster occurs as small rounded grains scattered through the veins. It is later than the rare-earth minerals. (Goddard and Glass, 1940.)

Sunshine district. According to Ores and Metals (1904). "* * * the section about Rowena above the town of Sunshine in the old Red Hoss Mountain mining district has produced an excellent grade of uraninite from time to time."

Clear Creek County.—Lawson-Dumont district. Pitchblende is reported from eight localities in the Jo Reynolds area, three-fourths of a mile south of Lawson. Eight tons of ore worth $80,000 and containing 72 percent U_3O_8 were reportedly shipped in 1919 from the lowest workings of the Jo Reynolds mine. (J. E. Harrison and Leonard, 1952.)

Fall River area. Pitchblende is the chief uranium mineral in both quartz-pyrite and galena-sphalerite veins in this area, which lies between Quartz Hill and Lawson. (L. E. Smith and Baker, 1951.) Pitchblende, both the hard lustrous primary material and soft sooty supergene material is known in five veins. Associated with the common sulfides, it occurs only at places where the veins intersect layers of garnet-quartz rock. (Hawley and Moore, 1955.)

Fremont County.—The Cotopaxi feldspar prospect (loc. 1) in sec. 8, T. 48 N., R. 12 E., 4 miles north of Cotopaxi, reportedly yielded 75 pounds of uraninite and some samarskite from one place in the deposit. (Hanley, Heinrich, and

Page, 1950.) This is possibly the same deposit as that reported by H. A. Lee (1903), although Lee does not mention the minerals as such.

Gilpin County.—Central City district. Uraninite (pitchblende) was first found in the Wood mine in 1871; shortly afterward it was discovered in the nearby Calhoun, Kirk, German, Belcher, and Alps mines. During this early period the Central City district was the most important locality in North America for uraninite and one of the very few known in the world. Comparatively large quantities were produced; the Wood vein alone yielded more than 45,000 pounds of U_3O_8 between 1871 and 1916. Much of the earlier production was used for coloring material in glass manufacture, but a little later the pitchblende was chiefly mined for its radium content. It is interesting to speculate on the amount of radioactive glassware that was produced, distributed and used in the days before the world had awakened to the hazards of radiation.

Pearce (1895) says that the uraninite in the Wood mine had been explored to a depth of 60 feet. The vein, which was 4 feet wide, contained lenticular bodies of solid uraninite as much as 2 feet thick. Associated minerals were pyrite, chalcopyrite, and a little pyrrhotite and galena in quartz gangue. Much of the uraninite was discarded through ignorance of its value. (See also N. P. Hill, 1873; W. F. Hillebrand, 1891—analysis; Tovote, 1906; Forbes Rickard, 1913; Bastin, 1915; Bastin and Hill, 1917.) An analysis of uraninite from Black Hawk is recorded by Clarke, 1903. Oscar Loew (1875) also gives an analysis of material from Leavenworth Gulch, but the material is a mixture of minerals.

Giletti and Kulp (1955) record measurements of radon leakage from uraninite from Rickard's mine, Gilpin County, and from the German and Belcher mines, Central City.

Among other modern workers who have studied the Gilpin County occurrences are Muench (1950); Armstrong (1952); Sims, Osterwald and Tooker (1955); and Drake (1957).

Muench records the results of analyses of uraninite from the Wood mine that show the lead-uranium ratios. He also refers to other age determinations of the material. Armstrong says that the recorded production from Quartz Hill, mostly from the Wood and Kirk mines, is 110,757 pounds of U_3O_8. He finds the uraninite, which has an estimated average grade of 0.2 percent U_3O_8, in a transition zone between the quartz-pyrite-gold veins to the east, and the quartz-pyrite-sphalerite-chalcopyrite-galena-gold-silver veins to the west.

Sims, Osterwald and Tooker (1955) describe occurrences in Eureka Gulch, where they found uraninite on the dumps of the J. P. Whitney, Bullion No. 2, and Carroll shafts and in an adit on the Rara Avis millsite.

Drake (1957) gives detailed and up-to-date descriptions of the mineralogy and mode of occurrence of uraninite in the Wood and East Calhoun mines, which he places at the head of Leavenworth Gulch, in unsurveyed sec. 14, T. 3 S., R. 73 E., 1½ miles southwest of Central City. His lead-uranium ratios lead to ages of 57.3 and 60 million years.

Gunnison County.—Uraninite, with "warrenite," is reported from the Domingo mine (Dana, 1892).

Jefferson County.—Golden Gate Canyon and Ralston Creek areas. Pitchblende occurs along the walls of fault zones that have vein fillings of ankerite and potash feldspar. Copper minerals are invariably present in the veins; pyrite is less abundant than chalcopyrite, and galena is rare. Secondary uranium minerals are rare except at the Schwartzwalder mine (loc. 15), where torbernite and metatorbernite are common. (Adams, Gude, and Beroni, 1953.) At the Aubrey Ladwig lease, 50- to 60-pound masses of pitchblende have been found. (D. M. Sheridan, written communication.)

Morrison area. Pitchblende is the ore mineral in the Mann mine, in sec. 12, T. 5 S., R. 70 W., near Morrison. Pyrite, asphalt, and ilsemannite are associated with the pitchblende in the deposit which is in the Dakota sandstone. (E. H. Goldstein, 1957.)

Critchell area (loc. 7). The Black Knight vein contains a little pitchblende in association with becquerelite and other uranium minerals. (Haynes, 1958.)

Larimer County.—Buckhorn district. In a mica prospect one-fourth of a mile southwest of the Buckhorn mica mine, Sterrett (1915) saw orange and red uranium stains around cores of a heavy black mineral that was possibly pitchblende.

Copper King mine (loc. 3). A study of the mineralogy and paragenesis is reported by Phair and Sims (1954) and in more detail by Sims, Phair, and Moench (1958). Pitchblende, intergrown with coffinite, was formed during the second stage of mineralization. It forms high-grade veinlets in boxwork pyrite and siderite ore and is also disseminated in breccia zones where it is intergrown with siderite.

Crystal Mountain and Hyatt districts (locs. 1 and 2). In the Hyatt pegmatite uraninite and its alteration products are widely scattered as small grains. Quartz close to such grains is smoky to black. (Thurston, 1955.) In the Big Boulder prospect, which also contains apatite, beryl, and other minerals, uraninite occurs with spodumene and small quantities of autunite and gummite. (Hanley, Heinrich, and Page, 1950.)

Park County.—Alma district. Uranium minerals are known in several types of ore deposits in the district, but nowhere in commercial quantity. Pitchblende is disseminated in both base-metal and precious-metal ores and also occurs as small veinlets in places. (Pierson and Singewald, 1953.)

Routt County.—Large cubic crystals of uraninite have been found in a pegmatite body in Mica Basin north of Slavonia. The uraninite commonly is partly altered to orange "gummite." (J. W. Adams, written communication.)

Saguache County.—Cochetopa district (loc. 2). Pitchblende, sooty to massive, is the chief ore mineral in the Los Ochos mine. The ore is in brecciated sandstone and granite. Pitchblende, with marcasite, chalcedony, copper minerals, barite, and ilsemannite, occurs as veinlets close to masses of clay and also as disseminations. The main secondary uranium minerals are uranophane, autunite, and a little torbernite. (Derzay, 1956.)

Marshall Pass. Uranium minerals were discovered in this area in 1955 and subsequently both pitchblende and secondary uranium minerals have been mined. One specimen of pitchblende found in overburden weighed 142½ pounds. (Dunn, 1957.)

A siliceous boulder from a streambed 4 miles east-northeast of Marshall Pass contains small pyrite crystals, some of them comprising alternating zones of pyrite and uraninite. The source of the boulder is not known. (A. G. King, 1957.)

San Miguel County.—Ophir district. Pitchblende occurs in the igneous rocks of the district. Huleatt and Keating (1921) think that occurrences such as these may be the source of the Colorado Plateau carnotite deposits.

Placerville district. The material that is sometimes called thucolite, which consists of uraniferous asphaltite, occurs in the White Spar and Black King prospects. It is associated with primary sulfides of copper, lead, zinc, antimony, and molybdenum. (Morehouse, 1951.)

Colorado Plateau, general.—Pitchblende is one of the chief primary uranium minerals in several vanadium-uranium deposits of the Colorado Plateau. It has been identified at Placerville, San Miguel County, in the Bitter Creek and Peanut mines, Montrose County, and elsewhere. It is found in unoxidized ores in mines that are at the heads of steep canyons or under protective cover. In the vanadiferous ores pitchblende is associated with vanadium oxides, montroseite, and coffinite; it alters to rauvite, carnotite, tyuyamunite, and other minerals. In the nonvanadiferous ores it is associated with the ordinary sulfides and commonly replaces the cellular structure of fossil wood. (Weeks, Cisney, and Sherwood, 1953; Weeks and Thompson, 1954; Thompson and Roach, 1955.)

URANIUM SULFATES

Among the ill-defined uranium sulfates that are now discredited as species are uraconite and uranochalcite. Both of these are reported from the Wood lode on Leavenworth Gulch, Central City district, Gilpin County (J. A. Smith, 1883) and uraconite is also reported by Randall from Montrose County and from Cripple Creek. The occurrences may possibly represent zippeite, but without more definite information no assignments to accepted mineral species can be made.

URANOCHALCITE

[*See* Uranium sulfates]

URANOPHANE

$Ca(UO_2)_2Si_2O_7 \cdot 6H_2O$

Uranophane, one of the few silicates of uranium, is known in several widely separated parts of the State. It is probably of secondary origin in all places and is nowhere abundant.

Jefferson County.—In the Black Knight vein, 2 miles south-southwest of Critchell (loc. 7), uranophane is associated with pitchblende, autunite, and becquerelite. (Haynes, 1958.)

The North Star mine contains uranophane with pitchblende and several unidentified uranium minerals. (Adams, Gude and Beroni, 1953.)

Moffat County.—In the Miller Hill area, T. 17 N., Rs. 87 and 88 W., uranophane and meta-autunite occur as films in vugs or on fractures in chalcedony in a limestone bed in the Browns Park formation. In the Browns Hill area, T. 15 N., Rs. 88, 89, and 90 W., the two minerals occur in fine-grained sandstone. In the Maybell-Lay-Juniper Springs area, yellowish-green uranophane, meta-autunite, gypsum, and limonite are related to faults in sandstone. (Grutt and Whalen, 1955.) In the G-6 shaft in Browns Park, in sec. 17, T. 6 N., R. 94 W., uranophane, bequerelerite-schoepite, and liebigite have been identified. (Gruner and Knox, 1957.)

Routt County.—In the Fish Creek district (loc. 1), uranophane and autunite occur along contracts between granitic rocks and biotite schist. (Beroni and Derzay, 1955.)

Saguache County.—Uranophane is one of the chief secondary minerals in the Los Ochos mine, Cochetopa district (loc. 2), but all the secondary minerals are sparsely distributed. Pitchblende is the chief primary mineral. (Derzay, 1956.)

URANOPILITE

$(UO_2)_6(SO_4)(OH)_{10}\cdot 12H_2O$

Uranopilite is present with uraninite in the Thornburg mine, sec. 4, T. 47 N., R. 2 E., Los Ochos (Cochetopa) district, Saguache County (loc. 2). Zippeite and johannite are also present. (Gruner and Knox, 1957; Mahan and Ranspot, 1959.)

URANOTHORITE

[*See* Thorite]

VANADINITE

$Pb_5(VO_4)_3Cl$

Vanadinite is noted as present in Montrose and San Miguel Counties, but no details are given. (Schrader, Stone, and Sanford, 1916.) It has been identified as a mineral of the oxidized ores at Breckenridge, Summit County (Lovering, 1934), and at Leadville, Lake County, where it is widely but sparsely distributed in the oxidized ores. Possibly some of the material reported as pyromorphite is actually vanadinite. (S. F. Emmons, Irving, and Loughlin, 1927.)

VANDIESTITE*

[*See* Tellurobismuthite]

VANOXITE†

$V_4V_2O_{13}\cdot 8H_2O$ (?)

The type locality of vanoxite, a black opaque mineral that occurs in microscopic crystals, is the Jo Dandy mine, on the southwest wall of Paradox Valley, Montrose County. It has also been found in ore from the Henry Clay claim at Long Park and from the Bill Bryan claim in Wild Steer Canyon, 6 miles south of Gateway.

In all three localities it replaces petrified wood and is cut or outlined by veinlets of gypsum. Red hewettite and a few stains of tyuyamunite and pintadoite are also present; the ore from the Henry Clay claim also contains some pascoite. (Hess, 1924—analyses.) Vanoxite has not been found in the Colorado Plateau, notwithstanding the intensive mineralogic studies related to the postwar search for uranium ores.

VERMICULITE

About $(Mg,Fe^{+2},Fe^{+3})_3(Al,Si)_4O_{10}(OH)_2 \cdot 4H_2O$

[*See also* Clay minerals]

Vermiculite, also called jefferisite, is a soft micaceous mineral that has the property of accordionlike expansion when heated. It is essentially an altered mica, commonly biotite, and is nearly always found in mafic igneous rocks. Finely divided vermiculite is also present among the claylike minerals in some soils. It was shown by Gruner (1934) and Hendricks and Jefferson (1938) that vermiculite is a valid mineral species. They point out, however, that many so-called vermiculites are really mixed-layer minerals composed principally of vermiculite and chlorite. Such mixtures have undoubtedly accounted for the many poorly defined species ascribed to the vermiculite group in the early literature. Inasmuch as detailed X-ray studies are required to distinguish true vermiculite from similar materials, and as few such studies have been made, many of the occurrences ascribed to this mineral in Colorado may be in error.

Expanded vermiculite has many commerical uses such as heat and sound insulation, as a lightweight aggregate for concrete and cinder-block construction, as a mulch and soil conditioner for gardeners. It follows, therefore, that the chief interest in it has been as a mineral resource rather than a mineral species.

Among the few mineralogic studies that have been made on Colorado material are those of Waldschmidt (1924), who describes a titaniferous vermiculite, or jefferisite, from near Westcliffe, Custer County, and records results of a chemical analysis. August Goldstein, Jr. (1946) gives a summary of the geologic occurrence of vermiculite with some mineralogic detail.

Another mineralogic study is that of W. F. Bradley and Weaver, 1956. In X-ray and other studies of the Brazer limestone of Late Mississippian age in Juniper Canyon, Moffat County, he found one of the clay minerals to be the mixed-layer mineral corrensite.

The most complete and modern description of the vermiculite resources of the State is that of Bush (1951). He summarizes the earlier literature, with an extensive bibliography, and adds many facts based on personal observation and those of others. The localities he describes are given below, and are shown on the accompanying map.

Chaffee County.—Tung Ash mine. Sec. 29, T. 15 S., R. 77 W. Four-foot veins, with books 2 to 3 inches in diameter.

Abe Lincoln No. 2 mine. Sec. 14, T. 14 S., R. 77 W. Reported to be 10 to 12 feet wide.

Custer County.—Shorty Robison mine. (Marjorie lode). Sec. 7, T. 22 S., R. 71 W. Large reserves indicated.

Young mine. Adjoins Marjorie lode; similar but better quality.

Sparling Ranch. Secs. 22 and 27, T. 21 S., R. 71 W.

Quist claim 72. Sec. 16, T. 21 S., R. 72 W. Fairly large reserves.

Voss Land mine (Vermiculite King). Secs. 16 and 17, T. 21 S., R. 72 W. Similar to and adjoining Quist deposit.

Phares and Allen mine. Sec. 26, T. 21 S., R. 73 W. Ten-foot-thick blanket of fairly good grade material.

Custer and Fremont Counties.—Gem Park mine. Secs. 3 and 4, T. 21 S., R. 73 W., and Secs. 33 and 34, T. 20 S., R. 73 W. Blanket deposit with large inferred reserves.

Fremont County.—Parkdale mine. T. 18 S., R. 72 W. Small deposit.

Gunnison County.—Powderhorn No. 1 mine. Sec. 14, T. 46 N., R. 2 W. Steeply dipping veins as much as 10 feet thick, with some books 2 to 3 inches in diameter.

Powderhorn No. 2 mine. Sec. 12, T. 46 N., R. 2 W. Large deposit of good grade material.

Jackson County.—Quaintance No. 1 mine. Sec. 34, T. 12 N., R. 80 W. Zones 2 to 18 feet wide with fine-grained vermiculite.

Fourney mine. Secs. 26 and 35, T. 12 N., R. 80 W.

Resort claim. Sec. 26, T. 12 N., R. 80 W.

Park County.—Spinney Mountain. Sec. 13, R. 12 S., R. 74 W. Fairly small and impure material.

Haymon mine. Sec. 11, T. 12 S., R. 72 W. Good area for additional prospecting.

Pueblo County.—San Isabel mine. Secs. 5 or 8, T. 24 S., R. 68 W. Very narrow zones.

VESUVIANITE

Nearly $Ca_{10}(Mg,Fe^{+2})_2Al_4(SiO_4)_5(Si_2O_7)_2(OH,F)_4$

Vesuvianite, or idocrase, some in splendid crystals, is known in a few calcium silicate bodies of metamorphic origin. Possibly it is present in similar rocks in other places.

Boulder County.—Allens Park. The wollastonite-bearing calcium silicate rock contains erratically distributed vesuvianite. It forms irregular patches of pale-brown anhedral grains ranging from a few millimeters to several centimeters in length. (Dings, 1941.)

Clear Creek County.—McManus Gulch (loc. 4). A body of calcium silicate rock in the Idaho Springs formation is comprised largely of grossularite garnet, calcite, and hornblende. Green vesuvianite in sharp crystals, some of which are terminated, can be found in place and in the talus. The richest material is on the steep west flank of the ridge. (J. W. Adams, written communication.)

Fremont and Park Counties.—Guffey area (loc. 8). Near the Lone Chimney (Betty) mine, 2½ miles west-southwest of Guffey I have seen a hornfels zone, 5 to 20 feet wide and 150 feet long, that contains garnet, dark-green hornblende, quartz, and rather abundant vesuvianite. (Lovering and Goddard, 1950, p. 69.) The presence of vesuvianite was not confirmed by Bever (1953), so the occurrence must remain in doubt.

Gunnison County.—Iron Hill (loc. 2.) Brown vesuvianite is very abundant in the alkalic rock complex of Iron Hill. Except in one vein, where it replaces cancrinite, all of the vesuvianite is a hydrothermal alteration product of the melilite in uncompahgrite rock. In some large bodies of uncompahgrite the melilite is completely replaced by intimate mixtures of garnet, diopside, and vesuvianite; elsewhere these minerals occur as thin veinlets in the melilite. (E. S. Larsen, Jr., and Foshag, 1926; E. S. Larsen, Jr., and Goranson, 1932; E. S. Larsen, Jr., and Jenks, 1942.)

Cebolla iron deposit. Vesuvianite occurs with zoisite and other "contact" minerals in the ilmenite-magnetite deposit. (J. T. Singewald, Jr., 1913.)

Italian Mountain (loc. 3). The vensuvianite crystals on Mount Italia, or Italian Mountain, were noted by Endlich (1878). This occurrence, said to be one of the finest for vesuvianite in the United States, has since been studied in detail by Whitman Cross and Shannon (1927).

In the most abundant type, fairly large transparent yellowish-olive-green crystals range in habit from bipyramidal to short prismatic. They occur singly or in groups on the walls of cavities in dense garnet-diopside hornfels. The crystals range from minute to 2.5 by 5 cm in size but the best and most numerous are about 1 cm long. Epidote, chabazite, and stilbite are contemporaneous with, or later than, the vesuvianite.

Another type is virtually a vesuvianite rock, comprised of greenish-yellow acicular prisms of vesuvianite with interstitial calcite. This grades into masses of calcite that contain small but very perfect crystals of vesuvianite, associated with small dodecahedrons of sulfur-yellow to greenish-yellow garnet.

A third and uncommon type consists of large imperfect and corroded crystals that contain white silky fibrous material. This resembles a zeolite, but is vesuvianite.

Whitman Cross and Shannon (1927) give an analysis of clear-green crystals.

Jefferson County.—Genessee Mountain (loc. 10). One prismatic greenish-blue crystal of vesuvianite, ½ by 2 inches, was found by G. R. Scott (written communication).

Bear Creek. At a point near the "castle," zoned vesuvianite, partly altered to talc, is associated with epidote, garnet, and calcite. (G. R. Scott, written communication.) This may be the same locality as is noted by Hollister (1867) who says that fine specimens could be found near Genessee Ranch.

Large brown crystalline masses of vesuvianite occur in calcium silicate gneiss in the NW¼ sec. 28, T. 3 S., R. 71 W. (D. M. Sheridan, written communication.)

VIOLARITE

Ni_2FeS_4

Violarite, one of the rare nickel sulfides, is authentically reported from one locality in Colorado and is possibly present in another.

Boulder County.—Gold Hill district (loc. 1). Ore from above the low level of the Copper King mine is complexly veined by violarite, which is in turn veined by pyrite, cobaltite, and pentlandite. The most abundant nickel mineral in the deposit is polydymite. (Goddard and Lovering, 1942.)

Larimer County.—The ore from a small gold mine on Buckhorn Creek, 1 mile north of Masonville and 12 miles northeast of Loveland, contains quartz, chalcopyrite, and either pentlandite or violarite as the principal minerals. The ore occurs as veinlets or bunches in granite and aplite. The nickel mineral appears as pink rounded areas in polished sections of the ore. (E. P. Chapman, written communication.)

VIVIANITE

$Fe_3(PO_4)_2 \cdot 8H_2O$

Vivianite is reported from the Freeland lode, Clear Creek County (Dana, 1892). The only noteworthy occurrence, however, is at Leadville, Lake County, where it occurs in small quantities in all the oxidized ores. It is most abundant in the oxidized parts of the magnetite-pyrite contact-metamorphic deposits where it forms solid aggregates, single crystals, druses, or masses embedded in clay. Elsewhere it forms indigo-blue to bluish-green prismatic crystals of variable sizes. (S. F. Emmons, Irving, and Loughlin, 1927.)

VOLBORTHITE

$Cu_3(VO_4)_2 \cdot 3H_2O$

Volborthite has been reported from four widely separated localities in the State. Three of the reports are somewhat old, however, and may be in error.

Custer and Huerfano Counties.—According to Hess (1913a), "black carbonaceous shales from Pass Creek, 9 miles south of Malachite, Huerfano County, contain golden yellow and yellowish green minerals which appear to belong to the volborthite and calcio-volborthite groups. Similar deposits are reported a few miles southeast of Silver Cliff, Custer County."

La Plata County.—La Plata district. Hess (1913a) says a vein that outcrops in Boren Gulch, "in a quartz vein discovered by C. C. Carnell is an unidentified vanadium mineral in yellowish-green globular masses 1 mm or less across, accompanied by golden yellow scales which are possibly volborthite, and by malachite." It was not found during later study of the district. (Galbraith, 1949.)

Park County.—A deposit in Jurassic or Triasssic sandstone one-half mile south of Garo (loc. 3), in South Park contains volborthite (and no other minerals) as green incrustations. Samples of the ore contained 5.5 to 8 percent Cu and 0.55 to 2 percent V_2O_5. (Fleck, 1909.)

San Miguel County.—Slick Rock district. Volborthite has been identified by modern methods in ores from the Radium No. 5, the San Juan No. 3, and the Cougar mines. In all three localities it is associated with gypsum as coatings on joints and fracture surfaces in sandstone. (Weeks and Thompson, 1954.)

VON DIESTITE*

[*See* Tellurobismuthite]

VRBAITE

[*See* Thallium minerals]

WAD

Hydrous manganese oxides

[*See also* **Hausmannite, Manganite, Psilomelane,** *and* **Pyrolusite**]

Wad is a field or generic term for hydrous manganese oxides that are difficult or impossible to identify as specific minerals. Detailed studies of material classed as wad commonly show it to be composed of mixtures of pyrolusite, psilomelane, and other minerals. Small but significant amounts of different metallic elements are commonly included in such mixtures.

Black manganese oxides are widespread as coatings, veins, and disseminations; some fairly large bodies are known. Very little manganese ore has been produced as such, because the bodies are too small, too impure, or too inaccessible, but large amounts of argentiferous manganese oxides have been produced at Leadville and elsewhere. These are doubly valuable because of their silver content and because the manganese is desirable as a smelter flux.

As noted under the headings "Psilomelane" and "Pyrolusite," most identifications of these minerals, as well as of wad, are so unsatisfactory that all reported occurrences of materials called psilomelane, pyrolusite, manganese oxides, manganese ore, or wad, are grouped here for convenience. Where mineral species are mentioned they follow the usage of the original descriptions. The occurrences of hausmannite and manganite seem to be better substantiated; these are described separately under their own names.

The distribution of manganese deposits in the State is described in some detail by Muilenburg (1919). His report also summarizes much of the earlier work of Penrose (1890), Leith (1906), Harder (1910), and Jones (1920). All these authors view the manganese deposits primarily as resources, rather than as assemblages of mineral species. In addition to abstracts of their findings, a few other occurrences are noted of manganese oxides that have some significance in metallic ore deposits.

Chaffee County.—Salida area. On the western slope of the Sangre de Cristo Mountains, from a point 10 miles north of Salida to near Wellsville, 8 miles south of Salida, manganese oxides occur as fissure fillings and replacements of limestone. Concretions with soft wad and pyrolusite in centers and thin hard shells of psilomelane are characteristic. (Muilenburg, 1919; Jones, 1920.)

Monarch district. Both pyrolusite and psilomelane are present in several mines. (Crawford, 1913.)

Custer County.—Silver Cliff district. In the Silver Cliff and other mines in rhyolite, chlorides of silver are confined to manganese-stained areas. S. F. Emmons (1896) gives a complete analysis of material he identifies as psilomelane. Muilenburg (1919) describes several large deposits of manganese ore near Westcliffe.

Dolores County.—Rico district. Wad is very abundant in the oxidized deposits, especially in those of Nigger Baby Hill. There it is mixed with hydrous alumina compounds, copper carbonates, and silver, lead, and zinc in unknown combinations. (Ransome, 1901a; Muilenburg, 1919.)

Eagle County.—Gilman (Red Cliff) district. Two enormous lenses of manganiferous iron ore are known in the Eagle No. 1 and No. 2 mines, formerly called the Iron Mask. Several hundred thousand tons of the material have been shipped as smelter flux and much more remains. The ore, a mixture of psilomelane and pyrolusite with much manganiferous limonite, contains some bunches of cerussite. It is derived from alteration of manganosiderite bodies and in places preserves pseudomorphs of that mineral. (Umpleby, 1917; Muilenburg, 1919; R. D. Crawford and Gibson, 1925.)

Gunnison County.—Cebolla. In the Cebolla valley, 2 miles above Powderhorn, manganese is associated with limonite and clay as the surface alteration of a body of magnetite, limonite and siderite. Most of the manganese ore is psilomelane, but there is a little pyrolusite. (Penrose, 1893; Harder, 1910; Muilenburg, 1919.)

Elk Mountains. Manganiferous iron ore is known in small quantities on Taylor Peak. (Penrose, 1893; Harder, 1910—analyses.)

Sapinero and Steuben Valley. About 4 miles south of Sapinero, and in Steuben Valley, 6 miles southwest of Gunnison, siliceous manganese oxides occur in a series of lava flows and in volcanic breccia. The wad fills cavities in the breccia and forms networks of narrow veins. Some of it is hard glossy and botryoidal, but some is soft and sooty; all of it contains a very high content of silica. (Penrose, 1893; Harder, 1910; Muilenburg, 1919.)

Lake County.—Leadville district. Wad, including both psilomelane and pyrolusite, and mixed in all proportions with iron oxides, is extremely abundant in much of the district. In places where the zinc content is high, the mineral chalcophanite is present. Very large quantities have been mined for each of the following purposes, depending on the composition: (a) as ores of lead and silver; (b) as raw material for spiegeleisen and ferromanganese; and (c) as smelter flux. (Harder, 1910; Muilenburg, 1919; S. F. Emmons, Irving, and Loughlin, 1927.)

Mineral County.—Creede district. Wad is fairly abundant in the oxidized ores. It seems to be derived from the decomposition of the abundant thuringite, since there is little rhodochrosite and no rhodonite in the primary ores. Rich silver ores of the Happy Thought and Amethyst mines are associated with wad. (W. H. Emmons and Larsen, 1923.)

Ouray County.—Manganese and iron oxides form the core of a mushroom-shaped tufa deposit near the radioactive hot springs at Box Canyon in the town of Ouray. The deposit, which has been largely mined out recently, also contains some tungsten (Burbank and Pierson, 1953; J. W. Adams, written communication.)

Park and Summit Counties.—Montezuma district. Manganese oxides mark the outcrops of many veins. Psilomelane and pyrolusite occur in fine-grained intergrowths as moderately hard mamillary crusts. There is also much typical wad. (Lovering, 1935.)

Saguache County.—Bonanza district. Manganese oxides, useful for smelter flux but too impure to be ores of manganese, are virtually confined to the oxidized zone of the rhodochrosite-rhodonite veins in the southern part of the district. The Headlight or Pershing vein contains pyrolusite as radial prismatic aggregates, granular crusts, and distinct prismatic striated crystals, probably pseudomorphic after manganite. Psilomelane is here much subordinate to pyrolusite. (Burbank, 1932; Muilenburg, 1919.)

San Miguel County.—Cedar. A bedded deposit of manganese oxides is near Cedar, in a basin at the head of a tributary to Disappointment Creek. The ore bed, which reaches a maximum thickness of 2 feet and an average thickness of 10 inches, consists of soft lumps of finely granular pyrolusite. Velvety crystals of manganite(?) line cavities. It contains much calcite and some barite and copper stains. The best ore in the comparatively small body contains about 80 percent MnO_2, but the average grade is much less. (Jones, 1920.)

Summit County.—Tenmile district. Wad is abundant in the oxidized zone of the Quail and other mines. It is mixed with iron oxides and commonly contains silver as cerussite or as cerargyrite. (S. F. Emmons, 1898.)

Teller County.—Cripple Creek district. Wad occurs in the oxidized ores as stains or veinlets and scattered as irregular masses and nodules. Most of it is soft and sooty, but some is hard and massive. (Lindgren and Ransome, 1906.)

WARRENITE*

[*See* Boulangerite, Jamesonite, *and* Owyheeite]

WAVELLITE

$Al_3(OH)_3(PO_4)_2 \cdot 5H_2O$

Wavellite is reported from only two localities. One of these, on South Table Mountain, Jefferson County (loc. 18) may be in error because wavellite has not been found by any of the later students of the zeolites and other minerals on the Table Mountains. (Endlich, 1878.)

In the Cripple Creek district, Teller County, a white mineral that occurs in small quantities in the Raven, Bertha B, and other mines is probably wavellite. It forms spherical masses of radiating crystals. (Whitman Cross and Ransome, 1895; Lindgren and Ransome, 1906.)

WEBERITE

Na_2MgAlF_7

Reexamination of old specimens of "cryolite" from the classic fluoride locality at St. Peters Dome, El Paso County (loc. 5), has shown that weberite comprises a large part of the material that was formerly thought to be cryolite. The weberite in the specimens, all probably from the old Eureka Tunnel, is associated with rutile, thomsenolite and (or) pachnolite, fluorite, and prosopite. Three other unidentified minerals with cubic habit are similar to minerals in the cryolite ore from Ivigtut, Iceland. (Hans Pauly, 1954—analyses.)

WEHRLITE

Bi_3Te_2(?)

A bismuth telluride mineral, probably wehrlite, is reported in a new mine in quartzite at Ouray, Ouray County (Pearce, 1890). It has not been found elsewhere.

WEISSITE†

Cu_5Te_3

The Good Hope and Mammoth Chimney mines at Vulcan, Gunnison County (loc. 5), are the type locality of two copper telluride minerals—rickardite and weissite. Weissite, which was discovered some years later than rickardite, is intimately intergrown with that mineral. There has been some question as to validity of weissite as a species but it now seems to be firmly established.

Weissite is massive, dark bluish black, tarnishing to deep black and has a shiny metallic luster. It occurs as small lenses as much as 2 inches across, associated with sylvanite, petzite and rickardite. The main vein material is pyrite, altered to abundant sulfur near the surface. Large masses of native tellurium characterize much of the ore. (W. P. Crawford, 1927—analyses. See also Forman and Peacock, 1949; R. M. Thompson, 1949.)

WERNERITE

[*See* Scapolite group]

WILLEMITE

Zn_2SiO_4

Willemite is definitely known from two localities, although it is not an ore of zinc in either. It is also reported from the Jones mine, Central City district, Gilpin County, and from the head of the La Plata River, where it occurs as pale-green semivitreous material that fills cavities in other ores. (Endlich, 1878; J. A. Smith, 1883.) Neither report has been confirmed by later workers.

Chaffee County.—Sedalia mine (loc. 5). The Sedalia copper mine was the third known locality for willemite in the United States. Transparent colorless tabular crystals as much as 3 mm in diameter were found on the mine dump. The crystals are warped and striated, showing low vicinal faces. (Penfield, 1894—crystallography.)

Jefferson County.—Augusta mine (loc. 1). Specimens collected by J. W. Adams and R. V. Gaines from the Augusta mine at Evergreen contain black crystals of willemite in cavities of green fluorite. The crystals are prismatic and 2 by 1 mm in size; they are clearly of secondary origin. Associated minerals are azurite, malachite, cerussite, barite, and limonite. (Pough, 1941.)

WINEBERGITE

[*See* Doughtyite]

WITHERITE

$BaCO_3$

Witherite is reported from only one district, and even here the report seems to be based on hearsay evidence. Behre (1932) says that witherite is reported from one small vein in the Weston Pass district, Park and Lake Counties.

WITTICHENITE

Cu_3BiS_3

Wittichenite is widespread in the rich silver mines of the Silverton district, San Juan County. (Comstock, 1883.) It has not been reported by later workers.

WOLFRAMITE

$(Fe,Mn)WO_4$

[*See also* Ferberite *and* Huebnerite]

Wolframite, the intermediate member of the ferberite-wolframite-huebnerite series, is fairly widespread, but seems from the record to be less abundant than the two end members of the series. More analyses of many specimens are needed to determine whether this relation is real or apparent.

Archuleta County.—According to newspaper reports of June 9, 1901, wolframite had been discovered along the San Juan River a few miles below Pagosa Springs. The report has not been confirmed but it may have been based on discovery of placer material derived from the eastern part of the San Juan Mountains.

Boulder County.—Nederland tungsten district. Ferberite is the chief ore mineral of this district, but a low-manganese variety of wolframite is present in veins in Gordon Gulch. North of the main tungsten belt wolframite occurs in a few scattered places, probably related to the deposits at Ward. (Lovering and Tweto, 1953.) Moses (1905a) describes the crystallography of specimens from Boulder County.

Ward district. Wolframite is present in nearly all the mines; it is especially abundant in the region west and south of Gold Lake and in the mines near Ward. This mineral is always intimately associated with quartz and pyrite and commonly with chalcopyrite. A little ore has been shipped from a few mines but most of it contains too much pyrite to be marketable. (George, 1909—analysis; Worcester, 1920.)

Fremont County.—Gold-bearing veins occur near Wilbur. In addition to gold, which is the most valuable ore mineral, several small deposits of uranium ore and good bodies of wolframite occur. (H. A. Lee, 1903.)

Lake County.—Climax district. Small amounts of wolframite occur in the upper parts of the Climax molybdenite deposit. It is apparently much less abundant than huebnerite. (Hess, 1924; Staples and Cook, 1931.)

Leadville district. A mineral described as wolframite, but which may be closer to huebnerite, occurs with scheelite in ore from the Nonie, Ontario, and Capitol claims and from the St. Paul group, all on Breece Hill. The wolframite (?) occurs as dull-brownish-black masses, intimately intergrown with pyrite locally, but in general terminating abruptly against pyrite, quartz, or scheelite. The wolframite has many small cavities that show some partial crystal faces. (Fitch and Loughlin, 1916.)

Park County.—Badger Flats area (loc. 2). Wolframite is abundant in the beryl-rich veins of the Mary Lee prospect, not far from the Boomer mine. It is dark brown, indicating a high iron content and occurs as poorly to moderately well formed crystals. Most of these are tiny, but a few are as much as 1 by 4 inches in size. Topaz and quartz are closely associated with the wolframite. (W. R. Griffitts, written communication.)

Park and Summit Counties.—Montezuma district. Wolframite was identified by Whitman Cross in the early days of the district. It formed small crystals intergrown with quartz and emplectite in the bismuth ores of the Missouri mine in Hall Valley. None was seen by Lovering (1935.)

San Miguel County.—Iron Springs (Ophir) district. Large quantities of manganiferous wolframite occur in the upper workings on the Ida vein in the Silver Bell mine. (Varnes, 1947a.)

San Juan County.—Silverton district. Some of the huebnerite that is widely distributed here contains much iron, and hence approaches the composition of wolframite.

WOLFTONITE*

[*See* Hydrohetaerolite]

WOLLASTONITE

$CaSiO_3$

Wollastonite is a constituent of many contact-metamorphic and similar deposits in the State. It is probably even more widespread than the record indicates.

Boulder County.—Allens Park. A roof pendant of calcium silicate rock in Silver Plume granite crops out in the E½NE¼ sec. 26, and W½NW¼ sec. 7, T. 3 N., R. 72 W. Most of the rock is crudely banded and comprised of grossularite, diopside, calcite, vesuvianite, and quartz. Locally there is a white rock largely comprised of wollastonite in beds from a few centimeters to 1 meter thick. (Dings, 1941.)

Chaffee and Gunnison Counties.—Bunches of wollastonite with radial structure occur in marble in the Garfield quarry. The mineral is also present, with tremolite, in the marble zones around the edge of the Mount Princeton batholith. (R. D. Crawford, 1913; Dings and Robinson, 1957.)

Dolores County.—Rico district. Wollastonite, chlorite, epidote, and garnet characterize several of the contact-metamorphic deposits. (Ransome, 1901a.)

Eagle County.—Gilman (Red Cliff) district. High on the slope west of Homestake Creek, 1½ miles south of Red Cliff, there is a mass of granular marble, 50 by 150 feet, that contains large masses of a mineral that has all the properties of wollastonite except that some shows inclined extinction under the microscope. Much monoclinic pyroxene is scattered through the rock. (R. D. Crawford and Gibson, 1925.)

Gilpin County.—Evergreen mine (loc. 1). Wollastonite, earlier thought by Ritter (1908) to be enstatite or diallage, is a very abundant and important constituent of the copper ores of the Evergreen mine. In places wollastonite is nearly equal to feldspar in amount; it occurs as prisms, most of them less than 0.1 cm long, but some as much as 1 cm long. Bornite is one of the chief ore minerals. (Bastin and Hill, 1917.)

Gunnison County.—Italian Mountain (loc. 3). Wollastonite has not been identified as such, but recalculation of the chemical analysis of diopside from here indicates the presence of the wollastonite molecule. (Whitman Cross and Shannon, 1927.)

Iron Hill (loc. 2). Small amounts of wollastonite occur in one locality where the ijolite rock has been contaminated with marble. (E. S. Larsen, Jr., and Jenks, 1942.)

Lake County.—Leadville district. Wollastonite forms small white irregular divergent or fibrous masses, 0.5 to 10 mm in diameter, in some of the contact-metamorphic magnetite deposits. It has been recognized definitely only from a drill hole at a depth of 350 feet in the My Day mine. (S. F. Emmons, Irving and Loughlin, 1927.)

Park County.—Small quantities of wollastonite are reported in altered limestone near Fairplay. (Endlich, 1878.)

San Juan County.—Silverton district. Several varieties of garnet, as well as calcite and wollastonite, are reported from an old limestone quarry about 1 mile southeast of Silverton. (Aurand, 1920b.)

Summit County.—Kokomo district. Wollastonite occurs in the zone of high-temperature ore deposition with garnet, epidote, biotite, sericite, and a little chlorite and hornblende. Magnetite, specular hematite, chalcopyrite, molybdenite, and pyrite are the chief metallic minerals. (Koschmann and Wells, 1946.)

WULFENITE

$PbMoO_4$

Wulfenite was reported from the Gold Hill district, Boulder County and from an unnamed locality in Park County by Endlich, 1878. Neither report has been further confirmed, but it has been definitely identified in several other districts. Nowhere is it important or abundant.

Chaffee and Gunnison Counties.—Monarch, Tincup, and Tomichi districts. The mineral is mixed with other oxidation products in bedded replacement deposits in all three districts. (Dings and Robinson, 1957.) Wulfenite was not seen in the mines of the Monarch district by R. D. Crawford (1913), but he found one specimen on the dump of the Hawkeye mine that contained many yellow tabular crystals that coated galena. Similarly, one specimen from the dump of the Gold Cup mine, Tincup district, contains minute yellow crystals of wulfenite in a cavity. (Goddard, 1936.)

Clear Creek County.—Freeland-Lamartine district. In the Diamond Mountain mine, formerly called the Lanagan, small tabular crystals and pseudotetragonal crystals occur in fracture fillings, associated with sooty pitchblende. (J. E. Harrison and Wells, 1956.)

Custer County.—Silver Cliff district. Wulfenite is present in the Review mine, but no details of its occurrence are known. (Charlton, 1890.)

Lake County.—Leadville district. Wulfenite is rare and unimportant in the oxidized ores. (S. F. Emmons, Irving and Loughlin, 1927.)

Summit County.—Breckenridge district. Wulfenite is present in the oxidized ores. (Lovering, 1934.)

XENOTIME

$Y(PO_4)$

Xenotime, an yttrium phosphate, commonly containing other rare earths, uranium, and thorium, is rather widely but sparsely distributed in pegmatite bodies. It will doubtless be found in other localities as the search for rare-earth minerals is intensified.

Chaffee County.—Trout Creek Pass area (loc. 6). Xenotime is present in the pegmatite dikes of Badger Creek but is uncommon there. It occurs in the quartz cores of the dikes, associated with euxenite and an yttrian garnet. Its identity has been confirmed by X-ray methods. (Vance Haynes, written communication.)

Douglas, Teller, and Park Counties.—South Platte-Lake George area. Xenotime is the chief rare-earth mineral in the pegmatite of this area; those in the Raleigh Peaks-Long Scraggy Peak section of Douglas County are especially rich. The xenotime occurs as minute inclusions in brown fluorite. Other minerals are yttrofluorite, fluocerite, gadolinite, allanite, samarskite(?), yttrotantalite, and thorite. (Heinrich, 1958.)

El Paso County.—Cheyenne Mountain. One of the earliest known localities in the United States for xenotime is Cheyenne Mountain, where it was reported by Endlich (1878).

A single tetragonal, chocolate-brown crystal, 1 cm in diameter, as well as some smaller crystals, are reported by Hidden (1885) as associated with bastnaesite and tysonite (now fluocerite) from this locality. A more complete crystallographic and chemical description based on better material is given by Penfield (1893). He describes a 1-cm crystal, consisting of a unit pyramid modified by a prism and a steeper pyramid, that is set on a quartz-feldspar intergrowth and associated with specular hematite, astrophyllite, bastnaesite, and tysonite (fluocerite). The crystal, which is very fresh and pure, is brown but pale pink in splinters.

Fremont County.—Currant Creek district. Crystals of xenotime, identified by X-ray means, occur in pegmatite in sec. 3, T. 17 S., R. 72 W. (Vance Haynes, written communication.)

Gunnison County.—Powderhorn district (loc. 2). A mineral similar to xenotime, but not positively identified, occurs in small quantities with thorite. (Olson and Wallace, 1956.)

Jefferson County.—Roscoe dike (loc. 14). Xenotime is present but rare in the gadolinite-bearing Roscoe dike in Clear Creek Canyon. (Vance Haynes, written communication.)

Burroughs mine (loc. 4). In the Burroughs mine on Kerr Gulch, small pieces of xenotime, whose identity was checked spectroscopically, are associated with euxenite, allanite, columbite and monazite. (G. R. Scott, written communication.)

South Platte area (loc. 16). Xenotime occurs with doverite and cyrtolite in the Big Bertha mine, west of Long Scraggy Peak and not far from Foxton. (Haynes, 1958.)

Park County.—Teller pegmatite (loc. 9). Xenotime is disseminated unevenly through fluorite and as aggregates in allanite. It is colorless to pale pink and occurs as grains as much as 1 mm long and ⅓ mm thick. Glass, Rose, and Over (1958) give results of a spectrographic analysis.

YTTRIAN FLUORITE

[*See* Fluorite]

YTTRIUM CALCIUM FLUORIDE

[*See* Fluorite variety yttrian fluorite]

YTTROCERITE

[*See* Fluorite variety cerian fluorite]

YTTROFLUORITE

[*See* Fluorite variety yttrian fluorite]

YTTROTANTALITE

$(Fe,Ca)(Y,Er,Ce,etc.)_2(Ta,Nb)_4O_{15}\cdot 4H_2O$

A mineral that is either yttrotantalite or samarskite is present with monazite, beryl, and other minerals in dikes on the hill above the Roscoe dike in Clear Creek Canyon, Jefferson County (loc. 14). (Vance Haynes, written communication.) Yttrotantalite and samarskite (?) are also present in the rare-earth pegmatite bodies of the South Platte-Lake George area, Douglas, Teller, and Park Counties. (Heinrich, 1958.)

ZINCIAN ARAGONITE

[*See* Aragonite]

ZINCIAN MELANTERITE

[*See* Melanterite]

ZINCIAN PISANITE

[*See* Pisanite]

ZINCITE

ZnO

Zincite is reported from two localities in the State: in the Jones mine, Central City district, Gilpin county (Endlich, 1878—no details of the occurrence were given); and from the Dick Weber mine, 6 miles east of Villa Grove, Saguache County, near the crest of the Sangre de Cristo Mountains. The primary ore consists of galena, quartz, tetrahedrite, sphalerite, and chalcopyrite. The "drybone" variety of hemimorphite and zincite are among the oxidation products. (E. P. Chapman, Jr., written communication.)

ZINKENITE

$Pb_6Sb_{14}S_{27}$

The first authenticated occurrence of zinkenite in the United States was described in Colorado in 1884; it had been reported much earlier from another Colorado locality, but this first report has not been confirmed.

Park County.—Alma district, Sweet Home mine (loc. 1). Small crystals of zinkenite are reported from this mine but no details are given. (Endlich, 1878; J. A. Smith, 1883.)

San Juan County.—Red Mountain district. Rare crystals of zinkenite, in a 4-foot vein of barite and feldspar, were found in the Brobdignag claim. Hillebrand (1885a) gives an analysis that shows a 5.64-percent arsenic content but otherwise the mineral is very close to the theoretical composition of zinkenite. (*See also* Whitman Cross and Hillebrand, 1885.)

ZIPPEITE

$(UO_2)_2(SO_4)O \cdot nH_2O$

Zippeite was first reported in Colorado by Endlich (1878) from the Wood lode on Leavenworth Gulch, Gilpin County. Since then, it has been definitely identified by modern methods in the pitchblende ores of several deposits in the Central City and adjoining districts of Gilpin and Clear Creek Counties. The chief secondary minerals of those ores are torbernite, metatorbernite, and autunite, but small amounts of zippeite, kasolite, and dumontite are also present. (Sims and Tooker, 1956.) As noted under uranium sulfates, materials reported as uraconite and uranochalcite may possibly represent zippeite, but there is no real evidence for this. Small amounts of zippeite, with uranopilite, occur as encrustations on uraninite ore of the Thornburg mine in the Los Ochos, or Cochetopa district, Saguache County (loc. 2). (Mahan and Ranspot, 1959.)

The Schwartzwalder mine, Jefferson County, contains thin coatings of johannite and a zippeitelike mineral on mine walls in the upper levels. (D. M. Sheridan, written communication.)

ZIRCON

$ZrSiO_4$

[*See also* Cyrtolite]

Zircon is a microscopic accessory mineral, in greater or lesser amounts, in nearly all igneous and metamorphic rocks. It is also present among the heavy minerals of clastic sedimentary rocks and is in the black sands of most placer deposits. It has geochemical significance as the source of most of the zirconium in the earth's crust. In addition, its geologic significance has been greatly increased by the recent development of the zircon method of age determination of rocks. (E. S. Larsen, Jr., Keevil, and Harrison, 1952.)

Aside from its occurrences as an accessory mineral, none of which are listed here, zircon is an important although minor constituent of a few pegmatitic bodies along the Colorado Front Range. One of these, at St. Peters Dome, El Paso County (loc. 5), is famous as a source not only of zircon, but of cryolite and many other rare species.

Clear Creek County.—Beaver Brook (loc. 1). Zircon, which is most closely associated with magnetite, forms perfect little prismatic crystals as much as three-sixteenths inch long. Gadolinite, monazite, garnet, and allanite are also present. (G. R. Scott, written communication.)

El Paso County.—St. Peters Dome (loc. 5). Zircon is extremely abundant in the vicinity of St. Peters Dome, particularly in the famous cryolite locality of the old Eureka Tunnel. The following description is condensed from those of Whitman Cross and Hillebrand (1882c, 1883, 1885), Kunz (1885). Lacroix (1889), Cahn (1895), Over (1929) Landes (1935), Pearl (1941g, 1958), and Mohr (1948). The crystals, which are as much as 3 or 4 cm in diameter, occur in drusy cavities in veins. Most of the crystals are brown to nearly black and are pyramids with small, if any, prism or basal faces. Some crystals, especially where enclosed in kaolin or quartz as in the Eureka Tunnel, are perfectly transparent and range from rich red brown to light wine or honey yellow. A few small crystals are deep emerald green; some pink crystals have spots of green. Most crystals are 0.1 to 1 cm in diameter, but they range up to 3 or 4 cm. Unfortunately, only the smaller ones are of gem quality, as the larger crystals are distorted and dull or partly altered. Microcline, riebeckite, astrophyllite, and many other minerals are associated with the zircon. Kulp, Volchok, and Holland (1952) record a differential thermal analysis of zircon from this locality.

Stove Mountain (loc. 6). A few crystals of zircon are associated with the genthelvite in 2 of the 3 known localities of that mineral. Cyrtolite is probably more abundant than zircon. (Glass and Adams, 1953; Scott, 1957.)

Jefferson County.—Guy Hill (loc. 11). Zircon occurs as tiny brown crystals with fine crystals of chrysoberyl and some garnet and tourmaline in pegmatite near Guy Hill. (G. R. Scott, written communication.)

Bigger mine (loc. 3). Zircon crystals are embedded in bismuthinite. Bertrandite, beryl, columbite, and monazite are also present. (J. W. Adams, written communication.)

ZOISITE

$HCa_2Al_3Si_3O_{13}$

Zoisite is reported from only three general localities in the State. It is almost certainly more widely distributed in metamorphic rocks than the record indicates.

Gunnison County.—Zoisite is present and locally abundant in several places along the Gunnison River. A zoisite-bearing amphibolite is especially well exposed on the north slope of Stumpy Creek and on part of the ridge south of Crystal Creek. The rock is largely hornblende, which contains many inclusions. Epidote, in grains or large crystals, is next in abundance, followed by zoisite, which forms small vaguely outlined crystals. Feldspar and quartz are rare.

In the Vernal Mesa granite, along the Black Canyon of the Gunnison, zoisite is a subordinate alteration product, with sericite, epidote and iron oxides.

Zoisite is present in the metagabbro of Cebolla and Beaver Creek basins. Hornblende is the most abundant mineral, with zoisite and epidote next. The zoisite is partly an alteration product of plagioclase feldspar. A few crystals show ghosts of former albite twins but in much of the rock the plagioclase crystals are dotted with zoisite and epidote. (Hunter, 1925. See also J. T. Singewald, Jr., 1912, 1913, regarding Cebolla titaniferous iron deposits.)

The Denver Museum of Natural History has a fine specimen of fibrous zoisite, collected by R. C. Hills from Yule Creek, Gunnison County.

Ouray County.—Zoisite is present in the Camp Bird vein, associated with adularia and hessite. (Moehlman, 1936b.)

San Miguel County.—Telluride district. Zoisite is a vein mineral in the Carribeau mine at Ophir, the Horatio mine in Bridal Veil basin, and the Yankee Boy mine on Canyon Creek. (Purington, 1898.)

ZORGITE

[*See* Clausthalite *and* Umangite]

ZUNYITE†

$Al_{13}(SiO_4)_5(OH,F,Cl)_{19}$

Zunyite, a rare basic orthosilicate of aluminum, is named for the Zuni mine near Silverton, where it was first discovered. It has since been found in the ores of Red Mountain and at Bonanza.

Ouray County.—Red Mountain district. The second discovery of zunyite was in the Charter Oak mine, just east of Red Mountain village and 5 miles north of the type locality, the Zuni mine. It forms fresh clear tetrahedral crystals 1 mm in diameter, scattered through an altered porphyry. It also occurs as a vein mineral, forming pulverulent pure-white crystals associated with enargite, pyrite, scorodite, and native sulfur. (Penfield, 1893—analyses.)

Saguache County.—Bonanza district. Zunyite is present with diaspore and sericite as alteration products of feldspars in a silicified dike rock in the southern part of the district. (Burbank, 1932.)

San Juan County.—Silverton district. Zunyite was first discovered in the Zuni mine; it was later found in several adjoining claims. The type material consists of glassy tetrahedral crystals, ranging from minute to 5 mm in diameter, enclosed in guitermanite. Associated minerals are pyrite, enargite, bournonite, diaspore, and barite. (Hillebrand, 1885b—analyses. See also Ransome, 1901b. Additional analyses are reported by Gossner and Mussgnug, 1926 and Palache, 1932a.)

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