University of Arizona Bulletin

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Services Offered by the Arizona Bureau of Mines

Among the many lines of activity in which the Bureau engages, the following have proved especially important and valuable:

1. The preparation and publication of bulletins and circulars containing authoritative information on a wide range of topics of interest to prospectors, miners, and others concerned with the development of Arizona's mineral resources and industries. The bulletins are distributed free of charge to residents and at cost to nonresidents of Arizona upon request.

2. The classification of mineral and rock specimens. Besides identifying rocks and identifying and giving the composition of minerals, the Bureau makes qualitative tests for important elements and answers inquiries concerning the probable market for and economic value of material similar to samples submitted. This service is furnished free on ores or minerals provided the specimens originate within the state of Arizona; a charge of $1 per specimen is made for samples submitted from outside the state. When assays, quantitative chemical analyses, spectrographic analyses, microscopic or thin sections are desired, they are furnished at rates established by law, a schedule of which will be submitted on request.

3. Geologic investigations of mining districts and counties and the making of topographic and geologic maps and reports. In co-operation with the United States Geological Survey a large-scale base map, a reconnaissance geologic map, and a topographic map (100-meter contours) of the entire state have been published. Geologic reports on various mineral resources of the state are prepared.

(Continued on inside back cover)

Statement of Mailing Privilege

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Vol. XVIII, No. 2 April, 1947

University of Arizona Bulletin

ARIZONA BUREAU OF MINES

MINERALS OF ARIZONA

By Frederic W. Galbraith

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(*Revised*)

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INTRODUCTION

Since the first edition of Bulletin 149 was published in 1941, Volume I of the revised Dana's *System of Mineralogy* has been published. A tremendous amount of new data on the elements, sulfides, sulfosalts and oxides has thus been made available, and based on this data the groupings and order of these minerals have been radically changed from that appearing in Dana's *Textbook of Mineralogy*, on which the first edition of this publication was based.

As the revision of the System will undoubtedly remain the standard mineralogical reference for many years, it was deemed advisable to arrange the minerals in Bulletin 149 to conform to that appearing in the new System, in spite of the fact that Volume I covers only about one third of the described species. This has been done, and all new mineralogical data on the elements, sulfides, sulfosalts, and oxides applicable to this publication, have been included.

For the remaining minerals, the arrangement which appears in Dana's *Textbook of Mineralogy* has been followed for the most part, but some alterations have been introduced in conformity with the recently published revision of Dana's *Manual of Mineralogy*. In addition, new data on many species, also obtained from the Manual, have been included.

It is obviously impossible in a publication of this nature to include all known occurrences of every mineral which has been found in the state. Of the more common species, an attempt has been made to list the more important economic and all unusual mineralogical occurrences; of the uncommon species, every locality known to the writer is included.

The future value of this publication depends largely upon the extent to which it can be kept up to date. Many new occurrences of an important or unusual nature come to light each year, but only a few of these find their way into scientific or popular publications. It is hoped, therefore, that information regarding the discovery of new minerals or localities which should be included in future editions of this bulletin will be forwarded to the Arizona Bureau of Mines, University of Arizona, Tucson.

ACKNOWLEDGMENTS

This description of the minerals of Arizona has been largely compiled from publications and manuscripts. Numerous persons were also consulted regarding undescribed mineral desposits and occurrences, and a great deal of valuable information was obtained from these sources. The writer is especially indebted to A. L. Flagg and other members of the Arizona Mineralogical Society for the many new localities which they have contributed; to the Arizona Bureau of Mines for use of its voluminous files on mineral occurrences in the state; to Dr. Eldred D. Wilson, without whose intimate knowledge of Arizona's mineral resources many obscure localities would have remained unlocated; and to the host of other individuals whose interest in the mineralogy of Arizona has made this publication possible.

A complete list of publications on Arizona mineralogy is to be found in the Arizona Bureau of Mines Bulletin No. 146, *Bibliography of the Geology and Mineral Resources of Arizona*, and it would be impracticable to reproduce here all the references consulted. Material has been drawn freely from many of them, much of it without change. References in the text other than those listed below are to Bulletin 146.

General

1:10 Guild, F. N.—The mineralogy of Arizona; Chemical Publishing Co., Easton, Pa., 1910.
1:17 Schrader, F. C.—Useful minerals of the United States: U.S. Geol. Survey Bull. 624, pp. 16-34, 1917.
1:27 Lausen, Carl, and Gardner, E. D.—Quicksilver resources of Arizona: Univ. Ariz., Ariz. Bur. Mines Bull. 122, 1927.
1:28 Wilson, E. D.—Asbestos deposits of Arizona; Univ. Ariz., Ariz. Bur. Mines Bull. 126, 1928.
1:30 Wilson, E. D., and Butler, G. M.—Manganese ore deposits in Arizona; Univ. Ariz., Ariz. Bur. Mines Bull. 127, 1930.
1:32 Ford, W. E.—Dana's textbook of mineralogy: John Wiley & Sons, New York, 1932.
1:34 Wilson, E. D., Cunningham, J. B., and Butler, G. M.—Arizona lode gold mines and mining: Univ. Ariz., Ariz. Bur. Mines Bull. 137, 1934.
1:37 Wilson, E. D., Fansett, G. R., and others—Arizona gold placers and placering: Univ. Ariz., Ariz. Bur. Mines Bull. 142, 1937.
1:38 Numerous authors—Some Arizona ore deposits: Univ. Ariz., Ariz. Bur. Mines Bull. 145, 1938.
1:39 Wilson, E. D.—Bibliography of the geology and mineral resources of Arizona: Univ. Ariz., Ariz. Bur. Mines Bull. 146, 1939.
1:41 Wilson, E. D.—Tungsten deposits of Arizona: Univ. Ariz., Ariz. Bur. Mines Bull. 148, 1941.

Apache County

2:17 Gregory, H. E.—Geology of the Navajo country. U.S. Geol. Survey Prof. Paper 93, 1917.

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3:04 Ransome, F. L.—The geology and ore deposits of the Bisbee quadrangle, Arizona: U.S. Geol. Survey Prof. Paper 21, 1904.
3:27 Wilson, E. D.—Geology and ore deposits of the Courtland-Gleeson region, Arizona: Univ. Ariz., Ariz. Bur. Mines Bull. 123, 1927.
3:38 Butler, B. S., Wilson, E. D., and Rasor, C. A.—Geology and ore deposits of the Tombstone district, Arizona: Univ. Ariz., Ariz. Bur. Mines Bull. 143, 1938.

Gila County

4:03 Ransome, F. L.—Geology of the Globe copper district, Arizona: U.S. Geol. Survey Prof. Paper 12, 1903.
4:19 Ransome, F. L.—The copper deposits of Ray and Miami, Arizona: U.S. Geol. Survey Prof. Paper 115, 1919.
4:25 Lausen, Carl, and Wilson, E. D.—Gold and copper deposits near Payson, Arizona: Univ. Ariz., Ariz. Bur. Mines Bull. 120, 1925.
4:25-2 Ross, C. P.—Ore deposits of the Saddle Mountain and Banner district, Arizona: U.S. Geol. Survey Bull. 771, 1925.

Graham County

5:25 Ross, C. P.—Geology and ore deposits of the Aravaipa and Stanley district, Graham County, Arizona: U.S. Geol. Survey Bull. 763, 1925.

Greenlee County

6:05 Lindgren, Waldemar—The copper deposits of the Clifton-Morenci district, Arizona; U.S. Geol. Survey Prof. Paper 43, 1905.

Maricopa County

7:18 Schrader, F. C.—Quicksilver deposits of the Phoenix Mountains, Arizona: U.S. Geol. Survey Bull. 690, pp. 95-109, 1918.

Mohave County

8:09 Schrader, F. C.—Mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Arizona: U.S. Geol. Survey Bull. 397, 1909.
8:31 Lausen, Carl—Geology and ore deposits of the Oatman and Katherine districts, Arizona; Univ. Ariz., Ariz. Bur. Mines Bull. 131, 1931.
8:36 Hewett, D. F., and others—Mineral resources of the region around Boulder Dam: U.S. Geol. Survey Bull. 871, 1936.

Navajo County

9:17 Gregory, H. E.—Geology of the Navajo country: U.S. Geol. Survey Prof. Paper 93, 1917.

Pima County

10:15 Schrader, F. C.—Mineral deposits of the Santa Rita and Patagonia mountains, Arizona: U.S. Geol. Survey Bull. 582, 1915.
10:22 Ransome, F. L.—Ore deposits of the Sierrita Mountains, Pima County, Arizona: U.S. Geol. Survey Bull. 725, pp. 407-28, 1922.
10:37 Gilluly, James—Geology and ore deposits of the Ajo quadrangle, Arizona: Univ. Ariz., Ariz. Bur. Mines Bull. 141, 1937.

Pinal County

11:19 Ransome, F. L.—The copper deposits of Ray and Miami, Arizona: U.S. Geol. Survey Prof. Paper 115, 1919.
11:25 Ross, C. P.—Ore deposits of the Saddle Mountain and Banner districts, Arizona: U.S. Geol. Survey Bull. 771, 1925.
11:26 Short, M. N., and Ettlinger, I. A.—Ore deposition and enrichment at the Magma mine, Superior, Arizona: Am. Inst. Min. Eng., Trans., vol. 74, pp. 174-222, 1926.
11:38 Peterson, N. P.—Geology and ore deposits of the Mammoth mining camp area, Pinal County, Arizona: Univ. Ariz., Ariz. Bur. Mines Bull. 144, 1938.

Santa Cruz County

12:15 Schrader, F. C.—Mineral deposits of the Santa Rita and Patagonia mountains, Arizona: U.S. Geol. Survey Bull. 582, 1915.

Yavapai County

13:26 Lindgren, Waldemar—Ore deposits of the Jerome and Bradshaw Mountains quadrangles, Arizona: U.S. Geol. Survey Bull. 782, 1926.

Yuma County

14:11 Bancraft, Howland—Reconnaissance of the ore deposits in northern Yuma County, Arizona: U.S. Geol. Survey Bull. 541, 1911.

14:33 Wilson, E. D.—Geology and mineral deposits of southern Yuma County, Arizona: Univ. Ariz., Ariz. Bur. Mines Bull. 134, 1933.

MINERALS OF ARIZONA

By Frederic W. Galbraith

ELEMENTS

Gold	Iron	Tellurium
Silver	Nickel-Iron	Sulfur
Copper	Arsenic	Diamond
Mercury	Bismuth	Graphite
Platinum	Selenium	

GOLD

Au. Golden-yellow to pale yellow. Luster metallic. Opaque. Streak yellow. H. = 2.5-3. Sectile, malleable, and ductile. Hackly fracture. G. = 19.3 when pure. Isometric, hexoctahedral. Distinct crystals rare. Skeletal crystals common with filiform, reticulated, or dendritic shapes. Also massive, and in thin plates, flattened grains, or scales.

Widely distributed in small quantities. Most abundant in quartz veins or in placer deposits from weathing of primary gold ores. Less commonly in the oxidized zone of sulfide deposits.

Most gold of the early days in Arizona was recovered from placers. These deposits, readily worked, soon declined in importance; but placer gold is still produced in many localities of the state. Much of the present gold production is from copper sulfide ores.

It is impracticable to list the numerous Arizona mines and prospects in which gold occurs. Descriptions and references are given in Arizona Bureau of Mines Bulletins 137 and 142, further references in Arizona Bureau of Mines Bulletin 146, and production figures in Bulletin 140.

Lode deposits

Cochise County.—Warren (Bisbee) and Turquoise districts, with ores of copper, silver, and lead. Tombstone district, with lead-silver ores. Pearce district, with silver ores. Dragoon Mountains, Manzoro district. Dos Cabezas Mountains, Dos Cabezas and Teviston districts. Huachuca Mountains. Swisshelm Mountains.

Gila County.—Globe-Miami district, with ores of copper and silver. Dripping Spring Mountains, Barnes district, with ores of copper, lead, and silver. Payson district.

Graham County.—Galiuro Mountains, Rattlesnake district. Pinaleno Mountains, Aravaipa and Stanley districts. Gila Mountains. Santa Teresa Mountains.

Greenlee County.—Clifton-Morenci district, with ores of copper and silver.

Maricopa County.—Vulture district, with lead and silver. Cave Creek district. Phoenix Mountains. Bighorn Mountains.

Mohave County.—Black Mountains, San Francisco and Katherine districts. Cerbat Range, Cerbat, Chloride, Stockton Hill, and Mineral Park districts. Hualpai Mountains, Maynard district, with ores of silver. Gold Basin district.

Pima County.—Ajo district, with ores of copper and silver. Baboquivari Mountains. Comobabi and Empire mountains with ores of copper, lead, and silver.

Pinal County.—Superior and Ray districts, with copper, silver, and lead ores. Mammoth district. Casa Grande district, with ores of copper and silver. Goldfield Mountains, Goldfield district.

Santa Cruz County.—Oro Blanco Mountains, with ores of lead, silver, and copper. Santa Rita Mountains. Patagonia Mountains.

Yavapai County.—Verde district, with copper and silver ores. Bradshaw Mountains at the Big Bug, Peck, Walker, and Tiger districts with ores of copper, silver, and lead; Hassayampa and Black Canyon districts with lead-silver ores; Pine Grove and Agua Fria districts, with copper-silver ores; Groom Creek, Turkey Creek, Bradshaw, and Tip Top districts, with silver. Santa Maria Mountains, Eureka district, with copper, silver, and lead ores. Date Creek Mountains, Martinez district. Wickenburg Mountains, Black Rock district.

Yuma County.—Kofa and Gila mountains, with silver. Harquahala Mountains, with ores of copper and lead. Williams Mountains, Cienega district, with copper ores. Castle Dome Mountains, Castle Dome district, with lead-silver ores. Also in the Plomosa, Sheep Tanks, Dome Rock, Laguna, Trigo, and Gila Bend mountains.

Placer deposits

Cochise County.—Small production from Dos Cabezas, Teviston, Huachuca, Gleeson, Pearce, and Gold Gulch (Bisbee) placers.

Gila County.—Small production from Dripping Spring, Barbarossa, Globe-Miami, and Payson placers.

Greenlee County.—Clifton-Morenci placers, along San Francisco and Chase creeks.

Maricopa County.—Vulture, San Domingo, and Hassayampa placers.

Mohave County.—Gold Basin, Chemehuevis, Lewis, Wright Creek, Lookout, and Silver Creek placers.

Pima County.—Greaterville, Quijotoa, Papago, and Horseshoe Basin districts. Less important are the Las Guijas, Old Baldy, Baboquivari, Armagosa and Alder Canyon placers. A $228 nugget was found at Greaterville in 1924.

Pinal County.—Canada del Oro placers.

Santa Cruz County.—Oro Blanco, Mowry, Harshaw, Tyndall, Nogales, and Palmetto placers.

Yavapai County.—Weaver Creek, Rich Hill, Lynx Creek, Big Bug, Minnehaha, Hassayampa, Groom Creek, Copper Basin, Placerita, and Black Canyon districts are the most important. Smaller production from several other deposits. A 271-gram nugget was found on Weaver Creek in 1930, and in 1932-33 several nuggets up to more than 3 ounces were recovered from the same general area.

Yuma County.—La Paz, Gila City (Dome), Plomosa, La Cholla, Oro Fino, Laguna, Castle Dome, and Kofa districts have yielded most of the production. Less important are the Muggins, Trigo, and Harquahala placers.

SILVER

Ag. Color and streak silver-white, commonly gray to black by tarnish. Luster metallic. Opaque. H. = 2.5-3. Sectile, ductile, and malleable. Hackly fracture. G. = 10.1-11.1. Isometric, hexoctahedral. Crystals malformed and acicular, recticulated, or arborescent. Commonly as grains, plates, or scales.

Most commonly secondary in the upper portions of silver-bearing deposits, or in the zone of sulfide enrichment with chalcocite. Less commonly of primary origin, disseminated in galena or tetrahedrite.

Cochise County.—Tombstone, as disseminated flakes at the Empire mine, and as small masses of wire silver, Flora Morrison mine. Bisbee district, in small amounts, with secondary chalcocite, more rarely with halloysite. Commonwealth mine, Pearce, with cerargyrite, embolite, and jarosite.

Gila County.—Globe district, as minute flakes in calcite at the Continental mine, as stout wires in the oxidized ore of the Old Dominion mine. Fine specimens from placers 4 miles north of Globe. At Richmond Basin, one of the chief ore minerals in fairly large masses. At Payson, as wire silver in the oxidized ore of the Silver Butte mine.

Graham County.—Aravaipa district, at the La Clede mine.

Mohave County.—Cerbat Range, Distaff mine, as chunks of several pounds' weight in the deeper workings; Lucky Boy and Samoa mines, Chloride district; Golden Bee and Queen Bee mines, Mineral Park district; Banner group, Stockton Hills district, in solid chunks and masses of wire silver; Tennessee-Schuylkill mine, Wallapai district.

Pima County.—Tortolita Mountains, Apache property, with chalcocite and cerargyrite. Cerro Colorado, Cerro Colorado mine with stromeyerite and tetrahedrite.

Pinal County.—Superior district, in the enriched ore of the Silver King mine, as magnificent crystallized and wire specimens; in the upper portions of the Magma mine. Galiuro Mountains, Little Treasure, and Adjust mines, Saddle Mountain district, as wire silver in small cavities.

Santa Cruz County.—Patagonia Mountains, Domino mines, Palmetto district, with crystallized cerussite and wulfenite; Worlds Fair mine, Harshaw district, with tetrahedrite. Santa Rita Mountains, as small crystals surrounded by magnetite in diorite on the southern slopes of the range.

Yavapai County.—United Verde mine, as a thin layer of high-grade ore immediately above the sulfide ore body. Bradshaw Mountains, at several properties, as the Dos Oris mine, Hassayampa district, with argentite and cerargyrite; Arizona-National mine, Big Bug district, as wire silver in cavities with argentite; Goodwin properties, Turkey Creek district, with cerargyrite; Thunderbolt mine, Black Canyon district, with proustite; Tip Top mine, Tip Top district, with ruby silver and cerargyrite. Monte Cristo mine, Wickenburg Mountains, with niccolite and chloanthite in rich ores of primary origin.

COPPER

Cu. Copper-red, commonly tarnished iridescent, green, or black. Luster metallic. Opaque. Streak copper-red. H. = 2.5-3. Sectile, ductile, and malleable. Hackly fracture. G. = 8.95. Isometric, hexoctahedral. Distinct crystals are rare, but commonly in distorted groups or twisted and wirelike forms. Sheets and irregular masses may reach large size.

Of secondary origin; widely distributed in the oxide zone of many copper deposits, accompanied by cuprite, malachite, tenorite, and "limonite." Also in beds of sedimentary rocks and in cavities of certain volcanic rocks. May pseudomorphously replace such minerals as cuprite, azurite, and chalcopyrite.

Cochise County.—Bisbee district, abundant in oxidized ore of the Copper Queen mine above the third level, as masses of several hundreds pounds' weight. Fine specimens of crystallized material, some coated with native silver, were taken from a single pocket. Calumet and Arizona mine, as small crystals, irregular networks throughout cuprite and in earthy mixtures of cuprite, limonite, and kaolin. Courtland-Gleeson district, as large arborescent masses.

Gila County.—Globe district, as small hackly particles in mineralized quartzite, Old Dominion mine. Dripping Spring Mountains, Christmas mine.

Greenlee County.—Clifton-Morenci district, common in upper parts of the veins, mostly with cuprite at the upper limit of the chalcocite zone. Arizona-Central mine, Williams vein, as solid copper up to 8 inches thick with fibrous structure and probably pseudomorphous after chalcocite.

Pima County.—Santa Rita Mountains, at various properties in the Helvetia district. Silver Bell Mountains, Silver Bell and El Tiro mines.

Pinal County.—Ray district, abundant in the upper workings. Galiuro Mountains, as twisted and wirelike masses in oxidized ore, Copper Prince mine.

Yavapai County.—United Verde Extension mine, locally abundant with cuprite. Also as fine specimens from near Walker.

MERCURY

Hg. Tin-white. Luster brilliant metallic. G. = 13.6. Small fluid globules in gangue.

Comparatively rare in the metallic state. Of secondary origin, formed from the alteration of cinnabar with which it is commonly associated.

Gila County.—Mazatzal Mountains, small amounts in Slate Creek deposits.

Maricopa County.—Mazatzal Mountains, Pine Mountain mine, Sunflower district.

Mohave County.—Maynard district, Hualpai Mountains, with cerussite.

Yavapai County.—In appreciable quantity from the Kirkland placers, lower Copper Basin Wash, probably from the low-grade cinnabar deposits in the vicinity.

PLATINUM

Pt. Alloyed with iron, iridium, or palladium. Color and streak whitish steel-gray. Luster metallic. Opaque. H. = 4-4.5. Sectile, malleable, and ductile. G. = 14-19. Isometric, hexoctahedral. Crystals rare. As grains or scales.

A rare mineral. Amost invariably in peridotite, serpentine, or in placers derived from them.

Maricopa County.—San Domingo placers and along the Gila River, opposite the old Riverside Stage station.

Yavapai County.—In black sands near Columbia and Prescott.

IRON—NICKEL-IRON

Fe. Color and streak steel-gray to iron-black. Luster metallic. Opaque. H. = 4-5. G. = 7.3-8.22. Malleable. Fracture hackly. Isometric, hexoctahedral. Crystals rare. Strongly magnetic. Meteoric iron, known as *kamacite*, is commonly alloyed with nickel, generally in amount from 2 to 7 per cent; meteoric nickel-iron, known as *taenite*, contains from 24 to 77 per cent Ni. Unusual compounds such as *schreibersite* $(Fe,Ni)_3P$, *moissanite*, CSi, *cohenite* $(Fe,Ni,Co)_3C$, and *lawrencite* ($FeCl_2$) occur in meteorites.

Terrestrial iron is of extremely rare occurrence and is not known from Arizona. but several important meteoric falls are known.

Coconino County.—The Canyon Diablo iron has been described by F. N. Guild (1:10) as follows:

> One of the most famous occurrences of meteoric iron in the world is that of the Cañon Diablo iron, found in the immediate vicinity of a slight elevation, variously known as Crater Mountain, Coon Butte, and Meteor Mountain. It is located in the plateau region of Arizona, about twelve miles from the Santa Fé station known as Cañon Diablo, and thirty-five miles from Flagstaff. The iron is found in fragments scattered on the surface of the ground in sizes varying from that of a bean to masses weighing over one hundred pounds. In all it is said that nearly twenty tons of the material have been gathered and distributed to various museums and private collections in all parts of the world.
>
> The locality is especially interesting—not only on account of the meteoric masses found there, but because of the interesting question as to the origin of the elevation apparently so intimately connected with them. The composition of the iron, as shown by the following analyses made by H. Moissan, of Paris, varies greatly in different parts of the same fragment.

Iron	91.12	95.06	91.09	92.08
Nickel	3.07	5.07	1.08	7.05

Small quantities of silica, magnesia, and phosphorus are also reported.

The only known occurrence of moissanite is in the Canyon Diablo meteorite, which also contains cohenite.

The San Francisco Mountains meteorite was discovered about 1920 on the lower northern slopes of the San Francisco Mountains. The Elden meteorite, a small mass of 3.5 kilograms, discovered in 1927 near Mt. Elden, is an intergrowth of nickel-iron and graphite in nearly equal proportions, and also contains lawrencite. As similar iron-graphite nodules are known from the Canyon Diablo iron, this occurrence is believed to be a part of that fall. The Winona meteorite, part iron, part stone, was discovered in 1928 in a prehistoric ruin near Winona.

Gila County.—Gun Creek meteorite, discovered in the Sierra Ancha Mountains in 1909.

Maricopa County.—The Rhoades meteorite, which fell during the shower of October 9, 1946, a short distance south of Chandler. The meteorite was discovered by plotting the azimuths of a particularly bright fall which registered on the plates of two cameras set up 19 miles apart.

Mohave County.—The Hualpai meteorite, consisting of two masses weighing 672 and 287 pounds respectively, were discovered on the Hualpai Reservation near the rim of the Grand Canyon in 1927. They consist of fine octahedrite with angular enclosures of schreibersite. Analysis by Shannon as follows:

Fe	Ni	Co	Cu	S	P	Insol.	Total
90.118	9.118	.147	.002	.006	.402	.032	99.825

Navajo County.—The Holbrook meteoric fall, a shower of some 3,000 stones containing iron, took place at Aztec, July 19, 1912. The largest complete stone weighed 14.5 pounds.

Analysis of Fragment of Holbrook Meteorite

(J. E. WHITFIELD, Analyst)

Schreibersite	0.11	Metal	4.85
Troilite	7.56	Silicates	87.48

The Navajo meteorite, found in 1921, consisted of a small shower, the main fall weighing about 3,000 pounds.

Pima County.—The Tucson meteorites are described by Guild (1:10) as follows:

> Two important masses of meteoric iron have been discovered in the vicinity of Tucson, but thoroughly reliable data as to the exact point where they fell seems to be lacking. . . .
>
> According to Mr. L. Fletcher, the attention of the scientific world was first called to these meteorites through the entomologist, Dr. J. L. LeConte, in 1851. He reported that "while passing through the village of Tucson in the preceding February, he had observed two large pieces of meteoric iron used by the blacksmiths of the town as anvils."
>
> In 1854, Professor Shephard gave a brief account of these meteorites, in which he states that according to information furnished him, they were found in a canyon of the Santa Rita Mountains, about 25 or 30 miles south of Tucson. Both were reported as being used as anvils, and one was described as being of a peculiar annular form.
>
> The dimensions of the annular meteorite, or Irwin Iron, now in the Smithsonian Museum in Washington, are given by Whitney as follows: Greatest exterior diameter, 49 inches; least exterior diameter, 38 inches; greatest width of central opening, 26½ inches; least width of central opening, 23 inches; greatest thickness at right angles to plane of ring, 10 inches; width of thickest part of ring, 17½ inches; width of narrowest part, 2¾ inches; weight, 1,400 lbs. This fragment is further known as the Tucson meteorite, the Signet, the Ring Meteorite, the Ainsa, the Muchacho, etc.
>
> The other fragment from Tucson is of the shape of an elongated flattened slab. Its length is 49 inches, average breadth 18 inches, and varies in thickness from 2 to 5 inches. Its weight was determined to be 632 lbs. It was taken possession of by Gen. Carleton and sent to San Francisco. Hence it is known in mineralogical literature as the Carleton Meteorite.
>
> As a result of the investigations on polished surfaces of these two meteoric masses, it is generally believed that they are portions of the same mass, or at least both were members of the same meteoric shower.

The chemical composition is illustrated by the following analysis:

	Smith	Genth	Brush
Fe	85.54	83.47	81.65
Ni	8.55	9.44	9.17
Co	0.61	0.42	0.44
Cu	0.03	0.008	0.08
P	0.12	0.10	0.49
Al_2O_3	Trace	Trace	Trace
CaO	.....	0.46	1.16
MgO	2.04	2.59	2.43
Cr_2O_3	0.21	.....	.....
SiO_2	3.02	2.89	2.63

The Silver Bell meteorite, weight 5,094 grams, was found in the Silver Bell mining district. Spectographic analysis shows Fe, Ni, and PO_4.

Yavapai County.—The Weaver meteorite, some 80 pounds in weight, found in the Weaver Mountains near Wickenburg in 1898, is of special interest because of its high percentage of nickel and cobalt.

Analyses of the Weaver meteorite

	W. B. Alexander, *Analyst*	F. Hawley, *Analyst*
Iron	79.60	81.81
Nickel	18.80	16.63
Cobalt	1.60	1.18

ARSENIC

As. Tin-white, commonly tarnished dark gray. Luster metallic. Opaque. Streak tin-white on fresh surface. H. = 3.5. G. = 5.63-5.78. Hexagonal scalenohedral. Perfect basal cleavage, not prominent. Generally fine granular, reniform, or stalactitic masses.

A primary mineral uncommon in large quantities. Mostly associated with silver, cobalt, or nickel ores, but also found in other sulfide deposits.

Santa Cruz County.—At the Double Standard mine, Patagonia district, 50 pounds or more was found in reniform masses attached to the walls of a small pocket in dolomitic limestone.

BISMUTH

Bi. Silver-white with reddish hue, commonly tarnished. Luster metallic. Opaque. Streak silver-white on fresh surface. H. = 2-2.5. Sectile. G. = 9.7-9.83. Hexagonal, scalenohedral. Perfect basal cleavage. Generally reticulated, arborescent, foliated, or granular.

An uncommon primary mineral in veins in granite, gneiss, or other crystalline rocks, accompanying ores of cobalt, nickel, silver, or tin; less commonly with galena.

Maricopa County.—Vulture district, Cleopatra mine. Also southeast of Granite Reef Dam and in the Salt River Valley.

Mohave County.—Aquarius Range, 30 miles south of Hackberry, with gadolinite.

Pima County.—Sierrita Mountains, Esmeralda mine.

Yavapai County.—Bradshaw Mountains, in the Humbug Creek placers and on Minnehaha Flats. A low-grade deposit is reported on Buckhorn Wash, east of Brooks Hill.

SELENIUM

Se. Gray. Luster metallic. Transparent (red) in thinnest splinters only. Streak red. H. = 2. G. = 4.8. Hexagonal, trigonal-trapezohedral. As acicular crystals; also in glassy droplets.

A relatively rare element. The following is the first authentic occurrence of native selenium as a mineral.

Yavapai County.—United Verde mine, as a coating of needlelike crystals on rock above the burning pyritic ore body. The crystals are up to 2 centimeters in length and consist of a first-order prism and positive rhombohedron.

Certain plants in the upper Verde Valley carry toxic amounts of selenium obtained from the soil, as do those on certain portions of Slate Creek in the Bradshaw Mountains.

TELLURIUM

Te. Tin-white. Luster metallic. Opaque. Streak gray. H. = 2-2.5. G. = 6.1-6.3. Hexagonal, trigonal-trapezohedral. Crystals prismatic. Perfect prismatic cleavage. Commonly columnar to fine granular massive.

A mineral of rare occurrence.

Cochise County.—At Tombstone microscopic blebs in galena are thought to be tellurium (3:38).

Yuma County.—Specimens submitted to the Arizona Bureau of Mines from Granite Wash Hills, 4 miles north of Vicksburg.

SULFUR

S. Various shades of yellow; greenish or reddish. Luster resinous. Transparent to translucent. H. = 1.5-2.5. G. = 2.07. Orthorhombic, dipyramidal. Crystals pyramidal or thick tabular. Commonly massive or as incrustations.

Formed directly from volcanic gases by reduction of sulfate minerals, particularly gypsum, and by decomposition of sulfide ores. Commonly in small quantities in the pyritic waste on old mine dumps.

Cochise County.—At Tombstone, resinous amber-yellow sulfur, somewhat resembling yellow sphalerite, occurs in small crystals and replaces anglesite and galena in the Skip shaft fissure on the fourth level of the Empire mine; also from the Mary Jo mine, Bisbee district, as small yellow crystals with sphalerite from the 1,500-foot level of the Junction mine.

Coconino County.—San Francisco Mountains, in small quantities at Sunset Crater and other near-by cinder cones.

Pinal County.—Two and one half miles east of Winkelman as tiny crystals, lining small vugs in a quartz vein; in small quantity from oxidized ore at the Mammoth mine.

Yavapai County.—United Verde mine, deposited under solfataric conditions caused by burning of a portion of the pyritic ore body. At the same locality a variety containing arsenic and selenium (jeromite), occurs as an amorphous black globular coating on rock fragments below iron hoods placed over vents in the burning ore body.

DIAMOND

C. Colorless, white, or black, also pale shades of other colors. Luster adamantine to greasy. Transparent to opaque. H. = 10. G. = 3.5-3.53. Isometric, hextetrahedral. Predominantly in octahedral crystals or fragments with perfect octahedral cleavage.

Meteoric diamond.—In 1891 a 40-pound meteoric mass from the Canyon Diablo area, Coconino County, was found to contain small cavities filled with tiny black diamonds. Subsequently, small diamonds imbedded in graphite have been found in other fragments from the same meteoric fall.

GRAPHITE

C. Iron-black to dark steel-gray. Luster metallic to dull and earthy. Transparent only in extremely thin flakes. Streak dark gray, shining. H. = 1-2. G. = 2.09-2.23. Hexagonal, dihexagonal-dipyramidal. Crystals six-sided and tabular. Perfect basal cleavage yielding thin, flexible plates. Commonly in masses which are scaly or slaty, granular, compact, or earthy. Also as disseminated grains or scales.

In gneiss, schist, quartzite, or crystalline limestone, probably as the result of metamorphism; in granite and basic eruptive rocks, perhaps as an original constituent.

Cochise County.—Dos Cabezas Mountains, as thin veins or streaks in gold-quartz veins. Also from near Bowie. Graphitic clay is reported in large quantities near Benson (1:10).

Coconino County.—As small nodules in the Canyon Diablo and Elden meteorites.

Mohave County.—Cerbat Range, disseminated in pre-Cambrian schist of Canyon Station Wash.

SULFIDES

Tetradymite	Alabandite	Orpiment
Domeykite	Sphalerite	Stibnite
Dyscrasite	Metacinnabar	Bismuthinite
Argentite	Chalcopyrite	Pyrite
Digenite	Pyrrhotite	Cobaltite
Hessite	Niccolite	Loellingite
Chalcocite	Pentlandite	Marcasite
Stromeyerite	Cubanite	Arsenopyrite
Bornite	Covellite	Molybdenite
Rickardite	Cinnabar	Smaltite
Galena	Realgar	Chloanthite

TETRADYMITE

Bi_2Te_2S. Color and streak pale steel-gray. Luster metallic, splendent. Opaque. H. = 1.5-2. Somewhat sectile. G. = 7.1-7.5. Hexagonal, rhombohedral. Perfect basal cleavage, yielding flexible, but not elastic laminae. Commonly in bladed forms or foliated to granular masses.

An uncommon mineral in gold-quartz veins, near-surface hydrothermal desposits, and contact-metamorphic zones.

Yavapai County.—Bradshaw Mountains, in small quantity, Montgomery mine; as bladed crystals, in quartz associated with pyrite near Bradshaw City, and from near Minnehaha.

Yuma County.—Reported from near Vicksburg, but the exact locality is not known.

DOMEYKITE

Cu_3As. Tin-white to steel-gray, readily tarnished. Luster metallic, but dull on exposure. Opaque. H. = 3-3.5. G. = 7.2-7.9. Isometric. Reniform and botryoidal; also massive or disseminated.

A rare mineral.

Cochise County.—Specimens of this mineral were received many years ago at the University of Arizona (1:10), but the exact locality from which they were obtained or other data regarding them is unknown.

DYSCRASITE

Ag_3Sb. Color and streak silver-white, usually tarnished to lead-gray, yellowish or blackish. Luster metallic. Opaque. H. = 3.5-4. Sectile. G. = 9.69-10.01. Orthorhombic, pyramidal. Crystals rare. Good basal cleavage. Commonly massive, foliated or granular. Pure mineral 72.9% Ag.

A primary mineral generally with other silver minerals, galena, and barite. Extremely rare in the United States. Reported in Arizona with ores of silver and lead, but no exact localities are given (1:17).

ARGENTITE

Ag_2S. Color and streak dark lead-gray, streak shining. Luster metallic. Opaque. H. = 2-2.5. Completely sectile and malleable with hackly fracture. G. = 7.2-7.4. Isometric, hexoctahedral.. Crystals octahedral or cubic in parallel or reticulated groups. More commonly as disseminated grains or small masses. Inverts at ordinary temperatures to *acanthite*. Pure mineral 87.1% Ag.

A primary mineral of lead-silver ores, commonly with other silver minerals, galena, tetrahedrite, and cobalt-nickel ores. Also a secondary mineral of the zone of sufide enrichment with chalcocite and native silver.

Cochise County.—Tombstone, in oxidized ores from alteration of argentiferous tetrahedrite. Pearce, with cerargyrite, bromyrite, embolite, and iodyrite, Commonwealth mines.

Gila County.—Richmond Basin, the chief primary mineral, in masses up to several pounds in weight.

Graham County.—Aravaipa district, in veins of the Grand Reef system.

Mohave County.—Cerbat Range, Keystone, Golden Star, and Queen Bee mines, Mineral Park district; Prince George mine and veins of the Banner group, Stockton Hill district; various properties in the Cerbat district.

Pima County.—Santa Rita Mountains, Blue Jay mine, Helvetia district. Sierrita Mountains, Sunshine mine, Papago district. Quijotoa Mountains, Morgan mine.

Pinal County.—Superior district, Silver King mine, in large quantity on the upper levels; Belmont property as small blebs in galena. Dripping Spring Mountains, Little Treasure mine, Saddle Mountain district.

Santa Cruz County.—Santa Rita Mountains, the Alto, Eureka, Ivanhoe, Montezuma, and Empress of India mines. Tyndall district; Augusta, Happy Jack, and Anaconda mines, Wrightson district. Patagonia Mountains, La Plata and Meadow Valley mines, Redrock district; January, Blue Eagle, Flux, and American mines, Harshaw district.

Yavapai County.—Bradshaw Mountains, Dos Oris mine, Hassayampa district, with native silver and cerargyrite; Arizona National, Big Bug district, in galena with freibergite and in cavities with wire silver. Wickenburg Mountains, Monte Cristo mine, in primary ore with native silver, niccolite, chloanthite, and proustite.

DIGENITE

$Cu_{2-x}S$. Blue to black. Luster metallic. Opaque. Streak dark gray. H. = 2.5-3. G. = 5.546. Isometric. Usually massive, rarely as octahedral crystals.

It has recently been determined that the so-called "blue chalcocite" or "isometric chalcocite," not uncommonly observed as microscooic intergrowths with chalcocite in copper ores, is this mineral.

Pinal County.—Superior district, forming a part of all chalcocite-bornite intergrowths on and below the 3,400-foot level, Magma mine.

Yavapai County.—United Verde mine, in the fire zone as distinct crystals.

HESSITE

Ag_2Te. Lead-gray to steel-gray. Luster metallic. Opaque. H. = 2-3. Somewhat sectile. G. = 8.24-8.45. Monoclinic at normal temperature, isometric above 149.5°. Cleavage indistinct. Massive, compact, or as small disseminated grains.

One of the commonest tellurides, but abundant in only a few districts in the United States.

Cochise County.—Tombstone, West Side mine, as bands and disseminations in quartz with cerargyrite and gold. Flora Morrison mine, altering to native silver.

CHALCOCITE—Copper Glance

Cu_2S. Color and streak blackish lead-gray, commonly tarnished black. Luster metallic. Opaque. H. = 2.5-3. Nearly sectile. G. = 5.5-5.8. Orthorhombic, dipyramidal. Crystals rare. Generally massive, with granular, compact, or sooty texture. Pure mineral 79.8% Cu.

A valuable copper mineral of wide distribution. Rare as a primary mineral, most abundant as a replacement of other sulfides in the zone of secondary enrichment. Many copper deposits of the state owe much of their value to secondary chalcocite.

Cochise County.—Bisbee district, most important in disseminated ore, locally abundant as a secondary mineral in limestone replacement deposits. Courtland-Gleeson district, an important constituent of the enriched ores.

Coconino County.—Grand Canyon, in small high-grade bodies at several places.

Gila County.—Globe district, Old Dominion mine, as compact massive bodies. Miami district, the essential mineral of the disseminated sulfide deposits.

Graham County.—Aravaipa district, Ten Strike group.

Greenlee County.—Clifton-Morenci district, the principal ore mineral of the disseminated and vein deposits, in places as solid seams 2 to 3 feet thick.

Maricopa County.—Cave Creek, Red Rover mine, with argentiferous tetrahedrite.

Mohave County.—Grand Wash Cliffs, Grand Gulch, Bronze L, and Copper King mines.

Pima County.—Ajo, disseminated in a narrow band bordering the New Cornelia ore body on the south. Sierrita Mountains, as large nearly pure masses, Glance and Queen mines, Twin Buttes. Silver Bell Mountains, as the sooty variety in veins and disseminated ores, Silver Bell district.

Pinal County.—Superior district, as large, nearly pure secondary bodies in the Magma mine, and an important constituent of the primary ores on the lower levels. At the Belmont as fine-grained sooty material. With native silver in the upper levels of the Silver King mine. At Ray and at San Manuel, the essential mineral of the disseminated ores. Galiuro Mountains, at several properties, and at the Childs-Aldwinkle primary chalcocite occurs on the lower levels.

Santa Cruz County.—Santa Rita Mountains, in rather large bodies, Ivanhoe mine, Tyndall district.

Yavapai County.—In oxidized ores of the United Verde mine, and in pure massive bodies of exceptionally large size, United Verde Extension mine. Eureka district, Bagdad mine. As disseminated mineralization in the Copper Creek district.

STROMEYERITE

AgCuS. Color and streak dark steel-gray. Luster metallic. Opaque. H. = 2.5-3. G. = 6.2-6.3. Orthorhombic, dipyramidal. Commonly massive. Pure mineral 53% Ag. 32.1% Cu.

An uncommon secondary mineral of the zone of sulfide enrichment. Formed in the same manner as secondary chalcocite, with which it is associated. In places with native silver.

Cochise County.—Tombstone, probably an important source of silver, Empire and Toughnut mines.

Gila County.—Globe district, Old Dominion mine; Richmond Basin, Mack Morris mine.

Pima County.—Cerro Colorado, Cerro Colorado mine, with tetrahedrite and native silver.

Pinal County.—Superior district, Silver King mine, the most important silver mineral of the ores; sparingly at Magma mine. Galiuro Mountains, with tennantite in the lower levels of the Blue Bird mine.

BORNITE

Cu_5FeS_4. Pinchbeck-brown on fresh frature. Tarnishes rapidly to iridescent peacock colors. Luster metallic. Opaque. Streak grayish black. H. = 3. G. = 5.06-5.08. Isometric, hexoctohedral. Commonly massive, with finely granular to compact structure. Pure mineral 63.3% Cu.

An important copper ore in many mines of the state. Almost invariably associated with either chalcopyrite or chalcocite, generally with both. Predominantly primary, but small amounts of secondary bornite are common in enriched ores. Also in contact-metamorphic deposits.

Cochise County.—Courtland-Gleeson district, Leadville, Great Western, Copper Belle, and Tejon mines. Little Dragoon Mountains, Johnson district. Bisbee district, important in the Campbell and other ore bodies.

Coconino County.—Grand Canyon, as high-grade bodies of bornite, chalcocite. and cuprite at several places.

Gila County.—Globe district, common in primary ore, Old Dominion mine; also secondary and forming a distinct blanket beneath the chalcocite zone.

Mohave County.—Grand Wash Cliffs, Bronze L mine. Atlanta and Pinkham mines, Chloride district.

Pima County.—Ajo, concentrated around pegmatitic bodies in the Cornelia quartz monzonite. Tucson Mountains, disseminated in prophyry, Arizona Tucson property. Silver Bell Mountains, in oxidized ore, Silver Bell district. Santa Catalina Mountains, in contact ores, Stratton-Daily camp.

Pinal County.—Superior district, as exceedingly rich ore found to the deepest levels of the Magma mine. Galiuro Mountains, Copper Creek district, Childs-Aldwinkle mine. Dripping Spring Mountains, Adjust mine, Saddle Mountain district.

Santa Cruz County.—In small quantities at several properties of the Patagonia and Santa Rita mountains.

Yavapai County.—Black Hills, Yeager mine, as an extensive shoot of high-grade ore.

Yuma County.—Buckskin Mountains, Planet mine.

RICKARDITE

Cu_4Te_3. Purple-red, dulling upon exposure. Luster metallic. Opaque. H. = 3.5. G. = 7.54. As disseminated grains accompanying copper sulfides.

A rare mineral found in only a few copper deposits.

Cochise County.—Bisbee district, as small purple fragments in a sample of sulfide pulp from the 1,400-foot level of the Junction mine (Crawford, 30).

GALENA

PbS. Color and streak pure lead-gray. Luster metallic. Opaque. H. = 2.5-2.75. G. = 7.58. Isometric, hexoctahedral. Commonly in cubes or cubo-octahedrons, less commonly in octahedral crystals. Perfect cubic cleavage. In cleavable and granular masses. Pure mineral 86.6% Pb.

A widely distributed primary mineral with copper, zinc, and silver sulfides, barite, and fluorite. The important ore of lead, but may contain appreciable quantities of silver.

Galena has been reported from several hundred properties in the state, only the more important of which are listed.

Cochise County.—Bisbee district, Campbell mine, from which considerable quantities are now being mined. Tombstone district, in ores of both the "roll deposits" and the fissure veins. Extensively replaced by cerussite, to a smaller extent by anglesite. Dragoon Mountains, Turquoise district, as scattered bunches in the copper sulfide ores.

Gila County.—Dripping Spring Mountains, "79" mine, Banner district.

Graham County.—Aravaipa district, Head Center, Iron Cap, and Grand Central mines.

Maricopa County.—A specimen from near Wickenburg, exact locality unknown, contains 4 per cent thallium.

Mohave County.—Cerbat Range and Grand Wash Cliffs, common in ores of many properties. McCracken Peak, McCracken mine.

Pima County.—Sierrita Mountains, San Xavier and Twin Buttes districts; the main ore mineral of the Sunshine mine, Papago district. Santa Rita Mountains, abundant at several properties. Quijotoa Mountains, Morgan mine, with argentite. Cerro Colorado, Cerro Colorado mine, with tetrahedrite, stromeyerite, and native silver. Empire Mountains, Chief, Prince, and other properties of the Hilton group.

Pinal County.—Superior district, Silver King mine; in fairly large bodies in the Belmont mine; and in the sphalerite ore of the Magma mine. Galiuro Mountains, the principal ore mineral of the Blue Bird mine. Mammoth mine, in the sulfide zone and altered to cerussite and anglesite in the oxide zone. Galiuro Mountains, Saddle Mountain district, Adjust mine, containing silver, and at the Saddle Mountain and Little Treasure properties.

Santa Cruz County.—Patagonia Mountains, abundant in nearly all districts. Mowry mine, yielded as high as 3,800 ounces of silver per ton. Flux mine, as excellent specimens of cubo-octahedral crystals. Santa Rita Mountains, at most of the properties. Oro Blanco Mountains, Montana mine, with sphalerite.

Yavapai County.—Bradshaw Mountains, at several properties in the Walker, Hassayampa, Big Bug, Turkey Creek, Peck, Pine Grove, Tiger, Tip Top, and Castle Creek districts, in many places with tetrahedrite. Golden Turkey mine, as cubo-octahedral crystals with highly splendent faces. Black Hills, Shea property, Verde district; Shylock mine, Black Hills district. Eureka district, Bagdad mine.

Yuma County.—Trigo Mountains, Black Rock, Chloride, Silver King, and Silver Glance properties. The highly argentiferous galena at the Red Cloud mine probably contains argentite. Castle Dome Mountains, Flora Temple, Senora, Little Dome, Hull, Lincoln, and Adams properties. Harquahala Mountains, Bonanza mine.

ALABANDITE

MnS. Iron-black, tarnishing brown on exposure. Luster submetallic. Opaque. Streak green. H. = 3.5-4. G. = 4. Isometric, hexoctahedral. Perfect cubic cleavage. As cleavable masses or as disseminated grains. Pure mineral 63.2% Mn.

An uncommon primary mineral, associated with sulfides of copper, zinc, lead, and silver, and with rhodochrosite.

Cochise County.—Tombstone, Lucky Cuss mine. Bisbee district, Higgins mine. Chiricahua Mountains, Trench mine.

Santa Cruz County.—Patagonia Mountains, Trench mine.

SPHALERITE—Zinc Blende

ZnS. Mostly yellow, brown, or black; also red, green, or white. Luster resinous to adamantine. Transparent to translucent. Streak lighter than the mineral. H. = 3.5-4. G. = 3.9-4.1. Isometric, hextetrahedral. Crystals tetrahedrons or distorted and rounded forms of the dodecahedron and tristetrahedron. Perfect dodecahedral cleavage. Most commonly cleavable or granular massive. Pure mineral 67% Zn.

The most common sulfide with the exception of pyrite, and a constituent of most sulfide ores. Closely associated with galena. Only the more important localities are listed.

Cochise County.—Bisbee district, Campbell mines, from which considerable quantities are now being mined at Tombstone, Silver Thread and Sulphuret mines, less abundant elsewhere. Little Dragoon Mountains, in copper ores, Johnson district. Courtland-Gleeson district, as scattered bunches in the pyritic ores, in places well crystallized.

Gila County.—Banner district, "79" mine.

Graham County.—Aravaipa and Stanley districts.

Greenlee County.—Clifton-Morenci district, in large quantities in the deeper parts of the mines.

Mohave County.—Cerbat Range, in most ores of the district.

Pima County.—In unoxidized ores of the Santa Rita and Empire mountains, Sierrita Mountains, San Xavier district, as bodies in limestone; Paymaster mine, Olive Camp.

Pinal County.—Superior district, the Belmont and Magma mines. At the Silver King mine it was the most abundant sulfide mineral in the ore, and cleavage masses of light sea-green color were held together by threads

of native silver. Galiuro Mountains, Adjust, Saddle Mountains, and Little Treasure properties Saddle Mountain district. Mammoth mine, on the lower levels, but extensively altered to smithsonite and hemimorphite in the oxidized zone.

Santa Cruz County.—Common in copper and silver ores of the Patagonia and Santa Rita mountains. As magnificent crystal groups at the Westinghouse property, Duquesne, where a single crystal measured nearly 1½ inches in diameter. Oro Blanco Mountains, with galena, Montana mine.

Yavapai County.—In pyritic ore, United Verde mine; and Copper Chief mine, Verde district. Bradshaw Mountains, most of the districts. Davis mine, Hassayampa district, as an unusual golden-yellow variety.

METACINNABAR

HgS. Grayish black. Luster metallic. Opaque. Black streak. H. = 3. G. = 7.65. Isometric-hextetrahedral. Rarely in small crystals, more commonly massive.

An uncommon mineral of secondary origin in the upper portions of cinnabar deposits.

Yuma County.—Dome Rock Mountains, as a thin coating on cinnabar, Colonial property.

Other occurrences of black material on cinnabar may be this mineral.

CHALCOPYRITE

$CuFeS_2$. Brass-yellow, commonly with a dull or iridescent tarnish. Luster metallic. Opaque. Streak greenish black. H. = 3.5-4. G. = 4.1-4.3. Tetragonal, scalenohedral. Crystals of tetrahedral habit. Compact massive, reniform or botryoidal. Pure mineral 34.5% Cu.

The most important ore mineral of copper. In appreciable quantity in neary all copper sulfide ore deposits. Predominantly of primary origin in veins and replacement bodies, as disseminated particles in granitic and schistose rocks, and in zones of contact metamorphism.

Chalcopyrite is so widely distributed through the ore deposits of Arizona that only the more important localities are listed.

Cochise County.—Bisbee district, important in primary ores, in places as large massive bodies. Tombstone, the most abundant copper mineral of the district. Courtland-Gleeson district, the main ore mineral of the pyritic bodies. Little Dragoon Mountains, Johnson district.

Gila County.—Globe district, Old Dominion mine, as large masses in Mescal limestone, and forming the bulk of the ore at the Summit mine. Miami district, in the protore of the Miami and Inspiration mines and as the principal primary ore mineral at the Castle Dome mines. Payson district, the chief mineral of the copper deposits. Dripping Spring Mountains, Christmas mine.

Graham County.—In the Aravaipa and Stanley districts.

Greenlee County.—Clifton-Morenci district, in the lower levels of the veins, and disseminated in limestone near prophyry contacts.

Mohave County.—Cerbat Range, common in nearly all copper mines and prospects. Grand Wash Cliffs, the main ore mineral at the Bronze L and Copper King mines.

Pima County.—The most important copper mineral of the Santa Rita, Silver Bell, and Sierrita mountains. Santa Catalina Mountains, with garnet and epidote in the contact deposits near Marble Peak. Ajo, as scattered grains in the Cornelia quartz monzonite.

Pinal County.—Superior district, Magma and Belmont mines. Galiuro Mountains, Copper Creek district, in all properties but especially the Childs-Aldwinkle. Ray district, in protore. San Manuel area, in protore.

Santa Cruz County.—Santa Rita Mountains, the most abundant ore mineral in most of the districts. Patagonia Mountains, Santo Niño mine, with large bodies of massive molybdenite.

Yavapai County.—The main ore mineral in the pyritic ore body of the United Verde mine, and abundant at the Copper Chief and Shea properties. Bradshaw Mountains, chiefly in the Big Bug, Agua Fria, Black Canyon, and Pine Grove districts. Eureka district, Bagdad mine.

Yuma County.—Buckskin Mountains, Planet mine. Harquahala Mountains, Golden Eagle mine.

WURTZITE

ZnS. Brownish black. Luster resinous. Transparent to translucent. Streak brown. H. = 3.5-4. G. = 3.98. Hexagonal, dihexagonal pyramidal. Crystals hemimorphic pyramidal, short prismatic or tabular. Also fibrous to columnar or as banded crusts.

A rare and unstable form of zinc sulfide, commonly intergrown with sphalerite, to which it reverts upon cooling.

Pinal County.—Mammoth mine, where it is reported to occur below the 900-foot level.

PYRRHOTITE

$Fe_{1-x}S$. Bronze-yellow to pinchbeck-brown, readily tarnished. Luster metallic. Opaque. Streak grayish black. H. = 3.5-4.5. G. = 4.58-4.65. Hexagonal, dihexagonal dipyramidal. May show distinct basal parting. Somewhat magnetic. Commonly in granular masses or disseminated grains.

Abundant in certain basic igneous rocks, sparingly in some copper sulfide ore bodies, particularly those of metamorphic origin, and in some gold ores. Generally associated with pyrite, chalcopyrite, or magnetite. May contain nickel, due to small enclosed grains of pentlandite.

Mohave County.—Near Littlefield, in basic dikes with chalcopyrite and pentlandite. At the Copper World mine, near Yucca, with sphalerite, chalcopyrite, and loellingite.

Navajo County.—As the iron rich variety (troilite) in the stones of the Holbrook meteorite.

Pima County.—Santa Rita Mountains, with pyrite, Helvetia district; as blebs in sphalerite, Busterville mine, Cuprite district. Sierrita Mountains, in chalcopyrite ores of Twin Buttes.

Yavapai County.—With gold ores of the Bradshaw Mountains.

NICCOLITE

NiAs. Pale copper-red. Luster metallic. Opaque. Streak pale brownish black. H. = 5-5.5. G. = 7.784. Hexagonal, dihexagonal dipyramidal. Generally massive; also reniform, columnar, reticulated, arborescent. Pure mineral 43.9% Ni.

An uncommon mineral of primary origin, found in large quantities only in a few localities. Generally associated with cobalt and silver-arsenic minerals and with primary native silver.

Yavapai County.—With chloanthite and native silver, Monte Cristo mine.

PENTLANDITE

$(Fe,Ni)_9S_8$. Light bronze-yellow. Luster metallic. Opaque. Streak light bronze-brown. Nonmagnetic. H. = 3.5-4. G. = 4.6-5. Isometric, hexoctahedral. Massive or granular. Pure mineral 22% Ni.

The most important ore mineral of nickel. Generally with pyrrhotite and chalcopyrite in basic igneous rocks.

Mohave County.—Near Littlefield, in basic dikes with pyrrhotite and chalcopyrite.

CUBANITE—Chalmersite

$CuFe_2S_3$. Brass-yellow to bronze-yellow, like chalcopyrite. Luster metallic. Opaque. Strongly magnetic. H. = 3.5. G. = 4.03-4.18. Orthorhombic, dipyramidal. In thin elongated prisms, vertically striated. Also massive.

Most commonly as an intergrowth with chalcopyrite, distinguishable only by microscopic methods.

Many, if not all, of the chalcopyrite occurrences in the state contain cubanite.

COVELLITE

CuS. Dark indigo-blue, often iridescent, turns purple when wet. Luster submetallic to resinous or dull. Opaque. Streak lead-gray to black, shining. H. = 1.5-2.5. G. = 4.6-4.76. Hexagonal, dihexagonal dipyramidal. Crystals generally thin plates. Perfect basal cleavage. Commonly cleavable, granular massive, or as crusts. Pure mineral 66.4% Cu.

A secondary mineral, in many places associated with chalcocite but less abundant. Also as a primary mineral with other sulfides. Probably present in small quantities in all oxidized copper deposits of Arizona.

Cochise County.—At Tombstone, lining boxwork structures formed by removal of primary minerals, and easily mistaken for sooty chalcocite.

Gila County.—Payson area, in small amounts replacing chalcopyrite and bornite. Dripping Spring Mountains, Christmas mine, Banner district, with secondary chalcocite.

Graham County.—As films and blebs in enriched ore, Aravaipa district.

Greenlee County.—Clifton-Morenci district, Ryerson and Montezuma mines.

Pinal County.—Superior district, sparingly distributed in the Magma mine. Mammoth mine, replacing chalcopyrite. Sierrita Mountains, La Coronado mine, Mineral Hill district.

Santa Cruz County.—Patagonia Mountains, as films on other sulfides at several properties.

CINNABAR

HgS. Scarlet, dark red, reddish brown. Luster adamantine to dull or earthy. Transparent to opaque. Streak scarlet. H. = 2-2.5. G. = 8.09. Hexagonal, trigonal-trapezohedral. Perfect prismatic cleavage. As finely granular or cleavable masses, crystalline incrustations, or earthy coatings. Pure mineral 86.2% Hg.

The ore mineral of mercury. Of near-surface origin as veins, replacement deposits, or impregnations.

Gila County.—Dripping Spring Mountains, Cowboy mine.

Maricopa and Gila Counties.—Mazatzal Mountains, mainly on Slate, Alder, and Sycamore creeks. Phoenix Mountains, the Rico, Mercury, and Eureka groups of claims.

Mohave County.—Northern Black Mountains (River Range), the Fry mine, Gold Basin district.

Pima County.—Roskruge Range, Roadside mine. Cerro Colorado, west of Cerro Colorado mine.

Pinal County.—Mickey Welch claims, south of Casa Grande.

Yavapai County.—Copper Basin district, Mercury, Cinnabar Queen, Zero Hour, and Shylock properties. White Picacho district, Westerdahl claims.

Yuma County.—Dome Rock Mountains, French, American, and Colonial properties, 8 miles southwest of Quartzsite.

REALGAR

AsS. Aurora-red to orange-yellow. Luster resinous to greasy. Transparent to translucent. Streak orange-red to aurora-red. H. = 1.5-2. Sectile. G. = 3.58. Monoclinic. Crystals short prismatic, striated vertically. Also coarse or fine granular, compact, or as an incrustation.

Most commonly a minor associate of other arsenic minerals and stibnite, also as a volcanic sublimate, or as a deposit from hot springs.

Pinal County.—In 1915 several pounds of realgar and orpiment were discovered at an undefined locality near the junction of the Gila River and Hackberry Wash.

Yavapai County.—Bradshaw Mountains, as specimen material from the vicinity of Castle Hot Springs.

ORPIMENT

As_2S_3. Lemon-yellow to brownish yellow. Luster pearly to resinous. Subtransparent to subtranslucent. Streak paler than the color. H. = 1.5-2. Sectile. G. = 3.49. Monoclinic. Highly perfect prismatic cleavage. In foliated or columnar masses, also granular.

Of secondary origin resulting from alteration of other arsenic minerals. Most commonly associated with realgar but is rarer in its occurrence.

Pinal County.—In 1915 several pounds of orpiment and realgar were discovered in an undefined locality near the junction of the Gila River and Hackberry Wash.

STIBNITE

Sb_2S_3. Color and streak lead-gray to steel-gray. Luster metallic, splendent. Opaque. H. = 2. G. = 4.61-4.65. Orthorhombic, dipyramidal. Perfect brachypinacoidal, imperfect basal, and prismatic cleavages. Crystals prismatic, striated or granular structure. Pure mineral 71.7% Sb.

Most important ore of antimony. A primary mineral, formed at shallow depth. Generally in quartz veins with silver and lead minerals, barite, calcite, realgar, or cinnabar. Readily alters to antimony oxide.

Gila County.—Near Payson, small amounts in some copper ores. Reported in Mazatzal Mountains on Slate Creek.

Graham County.—Stanley district, in contact-metamorphic ores, Cold Spring prospect.

Mohave County.—Cerbat Range, with galena, sphalerite, and pyrite, Golden Gem and Vanderbilt mines, Cerbat district.

Pima County.—Twin Buttes district, from the old Whitecomb property, near the Olivette mine.

Santa Cruz County.—Patagonia Mountains, Dura mine, Nogales district.

Yavapai County.—Bradshaw Mountains, Seventy-six and other veins of the Tip Top district; near the Tuscumbia mine, Bradshaw district, Malley Hill mine on Lynx Creek; Turkey Creek district; Robinson property, Walker district.

Yuma County.—Dome Rock Mountains, 8 miles southwest of Quartzsite, as radiating blades with cervantite and stibiconite.

BISMUTHINITE

Bi_2S_3. Lead-gray to tin-white with yellow or iridescent tarnish. Luster metallic. Opaque. Streak lead-gray. H. = 2. Somewhat sectile. G. = 6.75-6.81. Orthorhombic, dipyramidal. In acicular crystals. Massive, foliated, or fibrous. Pure mineral 82.1% Bi.

A rare mineral, mostly in primary deposits related to igneous rocks. Also found in the secondary sulfide zone.

Mohave County.—Aquarius Range, small quantities with gadolinite and native bismuth in pegmatite.

Yavapai County.—Bradshaw Mountains, Swallow mine, Castle Creek district, altering to bismite. Eureka district, 45 miles west of Prescott, in pegmatite.

PYRITE

FeS_2. Bright brass-yellow. Luster metallic. Opaque. Streak black. H. = 6-6.5.

G. = 5.018. Isometric, diploidal. Crystals cubic or pyritohedral. Also in granular to compact masses and disseminated grains.

The commonest sulfide mineral. May be accompanied by gold and copper and constitutes an important ore of these metals.

Abundant in most sulfide ores; only a few localities are listed.

Cochise County.—Bisbee district, in large massive bodies.

Greenlee County.—Clifton-Morenci district, as large crystals, Hudson and Fairplay veins.

Pima County.—Tucson Mountains, Arizona Tucson mine, as crystals from ⅛ to ¼ inch in diameter with remarkably abundant crystal faces.

Pinal County.—Superior district, as large crystals, Belmont mines; Magma mine, as large bodies too low in copper to be mined. Ray district, Iron Cap mine, as perfect pyritohedral crystals up to 1 inch in diameter in soft clay gangue. Galiuro Mountains, as excellent crystals, Childs-Aldwinkle mine.

Santa Cruz County.—Patagonia Mountains, as striated and twinned crystals and crystal aggregates up to 8 inches in diameter, 3 R mine, and as large crystal groups near the molybdenite bodies of the Santo Niño mine.

Yavapai County.—United Verde mine, one of the large pyritic ore bodies of the world.

Yuma County.—Dome Rock Mountains, Don Welsh prospect, as crystals an inch or more in diameter.

COBALTITE

CoAsS. Silver-white with pinkish cast. Luster metallic. Opaque. Streak grayish black. H. = 5.5. G. = 6.33. Isometric, tetartoidal. Crystals cubic or pyritohedral. Perfect cubic cleavage. Granular to compact massive. Pure mineral 34.5% Co.

An uncommon mineral generally found in small amounts in metamorphic rocks, less commonly in veins, and associated with other cobalt and nickel minerals.

Apache County.—White Mountains, as samples received by the Arizona Bureau of Mines. The exact locality is not known.

Maricopa County.—Mazatzal Mountains, along the Apache Trail between Fish Creek and Roosevelt Dam.

Pima County.—Comobabi Mountains, from a single unspecified locality in the Cobabi district.

Yavapai County.—Black Hills, near the old Prudential claim, along the contact between Bradshaw granite and greenstone of the Yavapai schist. Altered at surface to erythrite.

LOELLINGITE

$FeAs_2$. Silver-white to steel-gray. Luster metallic. Opaque. Streak grayish black. H. = 5-5.5. G. = 7.39-7.41. Orthorhombic, dipyramidal. In prismatic crystals. More commonly massive.

An uncommon mineral, generally accompanying iron and copper sulphides as a minor constituent.

Mohave County.—At the Copper World mine, near Yucca, with sphalerite, chalcopyrite, and pyrrhotite.

Analysis by Claude E. McLean as follows:

Fe	Co	Ni	As	S	Cu	Zn
25.76	0.10	1.55	65.57	2.73	0.40	0.15

Pb	Al_2O_3	SiO_2	MgO	CaO	Total
0.05	2.02	1.30	0.14	0.11	99.88

MARCASITE

FeS_2. Pale bronze-yellow, deepening upon exposure; tin-white on fresh fracture. Luster metallic. Opaque. Streak grayish or brownish black. H. = 6-6.5. G. = 4.887.

Orthorhombic, dipyramidal. Tabular or pyramidal, crystal groups common. Also massive, radiating fibrous, stalactitic or globular.

Less common than pyrite and formed under near-surface conditions. Generally in replacement deposits or as concretions in sedimentary rocks.

Mohave County.—Black Mountains, as thin plates in quartz, Moss mine, Oatman district.

Pima County.—Sierrita Mountains, as an alteration of pyrrhotite, Glance and Queen mines, Twin Buttes area; as thin coatings and veinlets, Mineral Hill and San Xavier districts.

Yavapai County.—Bradshaw Mountains, as small colloform masses in party oxidized ore, Iron Queen mine, Big Bug district.

ARSENOPYRITE

FeAsS. Silver-white to steel-gray. Luster metallic. Opaque. Streak grayish black. H. = 5.5-6. G. = 5.92-6.22. Monoclinic, with orthorhombic symmetry due to twinning. In diamond-shaped, prismatic or flattened crystals. Distinct prismatic cleavage. Also as columnar, granular, or compact masses.

The commonest arsenic mineral. Abundant in many gold-quartz veins and in some places the chief gold-bearing ore. Also with ores of tin and tungsten, sparingly in sulfide ores.

Mohave County.—Cerbat Range, in some mines of the Chloride and Mineral Park district, notably the Minnesota-Connor, Windy Point, and Queen Bee.

Yavapai County.—Sparingly at the United Verde and Shea properties, Verde district. Bradshaw Mountains, as crystals, Boggs mine, Big Bug district, and as massive material at several other properties. Eureka district, in a vein with bismuthinite, near the Hillside mine.

MOLYBDENITE

MoS_2. Lead-gray. Luster metallic. Opaque. Streak greenish. H. = 1-1.5. Somewhat sectile and greasy. G. = 4.62-4.73. Hexagonal, dihexagonal dipyramidal. Crystals hexagonal in form and commonly tabular. Perfect basal cleavage, yielding thin plates which are flexible but not elastic. In foliated or granular masses or in scales. Pure mineral 60% Mo.

The only common mineral of molybdenum, and widely distributed. A deep-seated, primary mineral in granitic rocks or quartz veins, with chalcopyrite, or with tin and tungsten ores. Also as a result of contact metamorphism.

Cochise County.—Little Dragoon Mountains, in copper ores, Johnson district.

Gila County.—Miami district, in small quantities through the copper ores, particularly at the Castle Dome mine.

Greenlee County.—Clifton-Morenci district, in veins with pyrite, chalcopyrite, and sphalerite.

Mohave County.—Cerbat Range, O.K. mine, Gold Basin district, with galena and wolframite; Samoa mine, Chloride district. Hualpai Mountains, Leviathan and American mines, Maynard district; Deluge Wash area, in small quantities at several properties.

Pima County.—Santa Rita Mountains, Helvetia district, Leader, Ridely, and Pauline mines, and in many prospects in Madera and Providencia canyons; Cuprite district, as small masses in chalcopyrite ore, Cuprite mine. Silver Bell district, at a small prospect north of the Kurtz shaft. Baboquivari Mountains, Gold Bullion mine, in quartz veins. Sierrita Mountains, Amargosa property, within quartz veins in granodiorite. Also in the Mineral Hill-Twin Buttes area. At Ajo in small amounts.

Pinal County.—Galiuro Mountains, Copper Creek district, the most important ore mineral at the Childs-Aldwinkle mine, and as fine crystallized specimens; in smaller quantities at the Copper Prince, Old Reliable, and other properties. (Rhenium, an element discovered in 1924 with properties similar to manganese, is known to occur in extractable quantities only in the mineral molybdenite. The rhenium content of the Childs-Aldwinkle molybdenite concentrates, 320 to 580 parts per million, is the highest so far known.)

Santa Cruz County.—Patagonia Mountains, Santo Niño mine, 2½ miles southwest of Duquesne, as large bodies of fine-grained massive material, as disseminated grains in quartz monzonite, and as good crystals in vein quartz with pyrite. Bonanza mine, Duquesne, where smaller quantities were mined; Benton and Line Boy properties; and in a prospect 4 miles southwest of Duquesne, with scheelite.

Yavapai County.—Sierra Prieta Range, as extensive deposits at the Copper Hill, Loma Prieta, and other properties, Copper Basin. Bradshaw Mountains, Black Hawk, Blue Bird, and Squaw Peak mines. Eureka district, in thin veins, Bagdad mine.

SMALTITE—CHLOANTHITE

$(Co,Ni)As_{3-x}$ to $(Ni,Co)As_{3-x}$. Tin-white to silver-gray, commonly tarnished. Luster metallic. Opaque. Streak grayish black. H. = 5.5-6. G. = 6.1-6.9. Isometric, diploidal. Usually massive. Percentages of cobalt and nickel vary widely.

Smaltite is the commonest cobalt mineral; the nickel member, chloanthite, is rarer. Generally in veins with other cobalt and nickel minerals or with ores of silver and copper.

Graham County.—Santa Teresa Mountains, Blue Bird mine, 15 miles west of Ft. Thomas, as smaltite.

Yavapai County.—Wickenburg Mountains, as chloanthite with native silver, Monte Cristo mine.

SULFOSALTS

Polybasite	Tetrahedrite	Aikinite
Pearceite	Tennantite	Diaphorite
Stephanite	Famatinite	Freislebenite
Pyrargyrite	Enargite	Dufrenoysite
Proustite	Bournonite	Jamesonite

POLYBASITE

$(Ag,Cu)_{16}Sb_2S_{11}$. Iron-black, dark red in thin splinters. Luster metallic. Opaque. Streak black. H. = 2-3. G. = 6-6.2. Monoclinic. Crystals short, six-sided, tabular prisms with beveled edges and triangular striations on the basal pinacoid. Also massive. Pure mineral 75.6% Ag. Isomorphous with pearceite.

A primary mineral of many silver veins, commonly in considerable amount. Resembles stephanite, with which it is generally associated.

Mohave County.—Cerbat Mountains, common in the silver ores of various districts.

Pinal County.—Superior district, as fine crystals from the upper levels of the Silver King mine.

Yavapai County.—Bradshaw Mountains, Davis Mine, Hassayampa district, with proustite.

PEARCEITE

$(Ag,Cu)_{16}As_2S_{11}$. Monoclinic. Other properties like polybasite, of which it is the arsenical variety.

Similar in occurrence to polybasite but is less common.

Mohave County.—Cerbat Range, reported in small amount from some of the high-grade silver ores.

STEPHANITE

Ag_5SbS_4. Color and streak iron-black. Luster metallic. Opaque. H. = 2-2.5. G = 6.22-6.28. Orthorhombic, pyramidal. Crystals short prismatic or tabular. Also compact, massive, and disseminated. Pure mineral 68.5% Ag.

A common primary mineral in the upper portions of silver deposits with other silver minerals, galena, and tetrahedrite.

Santa Cruz County.—Patagonia Mountains, Golden Rose mine, Patagonia district.

Yavapai County.—Bradshaw Mountains, Tuscumbia mine, Bradshaw district.

PYRARGYRITE—Ruby Silver

Ag_3SbS_3. Deep red. Luster adamantine to metallic. Somewhat translucent. Streak purplish red. H. = 2.5. G. = 5.85. Hegagonal, ditrigonal pyramidal. Crystals prismatic, hemimorphic. Distinct prismatic cleavage. Most commonly in small disseminated masses or grains. Pure mineral 59.9% Ag.

A primary mineral of the upper portions of silver sulfide deposits, formed by late hydrothermal solutions. Commonly associated with other silver minerals, galena, and tetrahedrite.

Pinal County.—Galiuro Mountains, Little Treasure mine, Saddle Mountain district.

Santa Cruz County.—Patagonia Mountains, Alta mine, Harshaw district, with embolite and fluorite; Sonoita mine, Palmetto district.

Yavapai County.—Bradshaw Mountains, Tillie Starbuck mine, Hassayampa district.

PROUSTITE—Ruby Silver

Ag_3AsS_3. Scarlet-vermillion. Luster adamantine. Translucent. Streak vermillion. H. = 2-2.5. G. = 5.57. Hexagonal, ditrigonal pyramidal. Crystals often rhombohedral, or scalenohedral. Distinct prismatic cleavage. As disseminated grains or compact masses. Pure mineral 65.4% Ag.

A primary mineral of the upper portions of silver sulfide deposits, formed by late hydrothermal solutions and generally associated with pyrargyrite.

Cochise County.—Pearce Hills, Commonwealth mine, with tetrahedrite.

Mohave County.—Cerbat Range, Minnesota-Connor and Merrimac mines, Chloride district; Gold Star mine, Mineral Park district; Paymaster mine, Cerbat district; in relatively large quantities at the Cupel mine, Stockton Hill district.

Pinal County.—Superior district, Belmont mine, as minute blebs in galena.

Yavapai County.—Bradshaw Mountains, Davis mine, Hassayampa district, with polybasite; with native silver and cerargyrite in a vein near the Thunderbolt mine, Black Canyon district; Morgan mine, Turkey Creek district; with native silver and cerargyrite, Tip Top mine, Tip Top district. Wickenburg Mountains, with argentite in primary silver ores, Monte Cristo mine.

TETRAHEDRITE—TENNANTITE

$(Cu,Fe)_{12}Sb_4S_{13}$ to $(Cu,Fe)_{12}As_4S_{13}$ and forming a continuous series. Flint-gray to iron-black. Luster metallic. Opaque. Streak from black in tetrahedrite to brown or cherry-red in tennantite. H. = 3-4.5. G. = 4.6-5.1. Isometric, hextetrahedral. Crystals tetrahedral in habit. Also granular or compact massive. Pure mineral from 46.7 to 52.7% Cu. Appreciable silver content not unusual.

Tetrahedrite and tennantite are seldom differentiated. They occur as primary constituents of copper, lead, and silver ores, are commonly argentiferous and then become important ores of silver. *Freibergite* is argentiferous tetrahedrite containing from 3 to 30 per cent of silver.

Cochise County.—Tombstone, particularly at the Toughnut, Lucky Cuss, and Ingersol mines, but common in most ores of the district, and containing silver. Pearce Hills, Commonwealth mine, with proustite.

Gila County.—Globe district, as crystals in cavities, Old Dominion mine. Richmond Basin, Helene vein, as silver-bearing tennantite. Payson district, the main ore mineral of the Silver Butte mine.

Graham County.—Aravaipa district, Grand Reef mine.

Mohave County.—Cerbat Range, a common constituent of the high-grade silver ores, commonly associated with proustite.

Pima County.—Santa Rita Mountains, Silver Spur mine, Helvetia district; Summit mine, Greaterville district; Busterville mine, Cuprite district. Sierrita Mountains, Helmet Peak mine, San Xavier district. Cerro Colorado, Cerro Colorado mine, with stromeyerite and native silver.

Pinal County.—Superior district, Silver King mine. Assays showed up to 3,000 ounces of silver per ton; much of the value was probably due to undetected stromeyerite. Abundant as in the Magma mine below the 900-foot level. Galiuro Mountains, Blue Bird and Childs-Aldwinkle mines, Copper Creek district, with stromeyerite.

Santa Cruz County.—Santa Rita and Patagonia mountains, at several localities. As fine crystals, American Boy mine, Wrightson district.

Yavapai County.—Wickenburg Mountains, with enargite, niccolite, and native silver, Monte Cristo mine. Black Hills, United Verde, Shea, Yaeger, and Shylock mines. Bradshaw Mountains, at several properties of the Walker, Hassayampa, Agua Fria, and other districts.

FAMATINITE

Cu_3SbS_4. Gray with tinge of copper-red. Opaque. H. = 3.5. G. = 4.47-4.57. As crusts of minute crystals, or as granular to dense masses.

Famatinite is of rarer occurrence than enargite, with which it generally occurs.

Cochise County.—Tombstone, in small amount, Ingersol and Toughnut mines.

ENARGITE

Cu_3AsS_4. Grayish black to iron-black. Luster metallic. Opaque. Streak grayish black. H. = 3. G. = 4.4-4.5. Orthorhombic, pyramidal. Crystal prismatic and vertically striated or tabular. Perfect prismatic, distinct pinacoidal cleavage. Commonly massive, granular or columnar. Pure mineral 48.3% Cu.

Of uncommon occurrence, but in a few localities found in large amount as an important ore of copper. Of primary origin, with other copper sulfides.

Pinal County.—Superior district, the most important ore of copper on the lowest levels of the Magma mine. Galiuro Mountains, sparingly with tennantite, Childs-Aldwinkle mine.

Yavapai County.—Wickenburg Mountains, with tennantite, niccolite, and native silver, Monte Cristo mine.

BOURNONITE

$PbCuSbS_3$. Color and streak steel-gray, lead-gray, or iron-black. Luster metallic, brilliant. Opaque. H. = 2.5-3. G. = 5.8-5.86. Orthorhombic, dipyramidal. Crystals commonly repeated twins, forming wheel-shaped forms. Imperfect brachypinacoidal cleavage. In granular to compact masses.

One of the commoner sulfosalts of primary origin, generally in lead-silver deposits with galena, tetrahedrite, or stibnite.

Cochise County.—Tombstone, sparingly with other copper-antimony minerals.

Pima County.—Santa Rita Mountains, Busterville mine, Cuprite district; Hosey and Augusta mines, Wrightson district, with tetrahedrite.

Yavapai County.—Bradshaw Mountains, as masses in quartz and as crystals with pyrite, chalcopyrite, siderite and fibrous actinolite, Boggs mine, Big Bug district. Analysis given by W. T. Schaller as follows:

Pb	Fe	Zn	Cu	Sb	As	S	Rem.	Total
40.21	0.35	0.35	15.12	18.99	2.81	20.04	1.67	99.54

AIKINITE

$PbCuBiS_3$. Blackish lead-gray. Luster metallic. Opaque. Streak grayish-black H. = 2-2.5. G. = 7.06-7.08. Orthorhombic. In acicular crystals. Also massive.

A rare mineral found at few localities in the world.

Pima County.—Roskruge Range, in small quantities, Roadside mine.

DIAPHORITE

$Pb_2Ag_3Sb_3S_8$. Steel-gray. Luster metallic. Opaque. H. = 2.5-3. G. = 6.04. Orthorhombic, dipyramidal. Crystals prismatic, often striated.

Reported under the name brongniardite, as occurring with other argentiferous ores (1:17). No specific localities were given.

FREIESLEBENITE

$PbAg_3Sb_5S_{12}$. Color and streak light steel-gray to dark lead-gray. Luster metallic. Opaque. H. = 2-2.5. G. = 6.04-6.23. Monoclinic. Crystals prismatic. In granular masses or disseminated grains.

A rare mineral occurring with other silver ores and reported from only a few American localities.

Yuma County.—Castle Dome Mountains, where a small amount was mined.

DUFRENOYSITE

$Pb_2As_2S_5$. Lead-gray to steel-gray. Luster metallic. Opaque. Streak reddish brown. H. = 3. G. = 5.5-5.56. Monoclinic. Crystals highly modified. Perfect clinopinacoidal cleavage. Also massive.

A rare species, known from only a few localities.

Mohave County.—Reported from the Mineral Park district (1:17), but the exact locality is not known.

JAMESONITE

$Pb_4FeSb_6S_{14}$. Color and streak gray-black; sometimes tarnished iridescent. Luster metallic. Opaque. H. = 2.5. G. = 5.63. Monoclinic. Crystals acicular to fibrous. Fibrous to compact massive.

An uncommon primary mineral in small quantities with other sulfosalts, galena, stibnite, and tetrahedrite. Probably many occurrences credited to jamesonite are of some other lead sulfosalt in fibrous form.

Yavapai County.—Reported from the Bradshaw Mountains with native gold (1:17).

OXIDES

SIMPLE OXIDES

Cuprite	Hematite	Cryptomelane
Tenorite	Ilmenite	Anatase
Paramelaconite	Clauditite	Cervantite
Massicot	Rutile	Stibiconite
Minium	Pyrolusite	Bismite
Corundum	Wad	Tungstite

HYDROXIDES

Lepidocrocite	Manganite	Psilomelane
	Gibbsite	

MULTIPLE OXIDES

Delafossite	Spinel	Chromite
Goethite	Magnetite	Hetaerolite
Limonite	Franklinite	Coronadite

MULTIPLE OXIDES—Containing Columbium, Tantalum, Titanium

Fergusonite	Tapiolite	Samarskite
Arizonite	Euxenite	

CUPRITE

Cu_2O. Generally dark red to ruby-red, less commonly other shades. Luster adamantine to submetallic to earthy. Transparent to opaque. Streak some shade of red or brownish red. H. = 3.5-4. G. = 6.14. Isometric, gyroidal. Crystals octahedrons, cubes, and dodecahedrons. Slender capillary crystals are known as *chalcotrichite*. Commonly massive or compact, earthy. Pure mineral 88.8% Cu.

In many oxidized copper deposits of the state. Commonly associated with malachite, tenorite, "limonite," and native copper.

Cochise County.—Bisbee district, an important constituent of the ores. In the Copper Queen mine, mostly as earthy material mixed with limonite, also as crystals and chalcotrichite. At the Calumet and Arizona, as large crystalline masses associated with native copper, and in beautiful druses of ruby-red crystals, mostly simple cubes. Tombstone district, as bright red cubic crystals with connellite, brochantite, and malachite lining small cavities in the Toughnut mines. Dragoon Mountains, Courtland-Gleeson district, as aggregates of octahedral crystals.

Gila County.—Globe district, as massive material and chalcotrichite at the Continental and Buffalo mines, and as large, dull octahedra at the Old Dominion mine. Mixed with limonite, it probably made up much of the high-grade "brown copper ore" of the Old Dominion and other mines of the district. Dripping Spring Mountains, "79" mine, Banner district.

Greenlee County.—Clifton-Morenci district, at the upper limit of the chalcocite zone, as cubic crystals and as chalcotrichite.

Pima County.—Santa Rita Mountains, at Rosemont, as crystal aggregates lining cavities. Silver Bell Mountains, as chalcotrichite and cubic crystals in small fractures. Tucson Mountains, disseminated in porphyry over a considerable area on the Saginaw and Arizona Tucson properties, Amole district.

Pinal County.—Ray district, as sparkling ruby-red aggregates of chalcotrichite in one of the stopes worked from the old Ray shaft.

Santa Cruz County.—Patagonia Mountains, Westinghouse property, Patagonia district. Oro Blanco Mountains, Montana mine, as fine bright crystals in vugs.

Yavapai County.—Black Hills, locally abundant and accompanied by native copper at the United Verde Extension mine, commonly as beautiful druses of crystallized material and as chacotrichite.

TENORITE

CuO. Steel-gray to black. Luster metallic to earthy. Opaque. Streak black. H. = 3.5. G. = 5.8-6.4. Monoclinic. In minute black scales or paper-thin twinned crystal aggregates. Most common as black earthy material known as melaconite. Black, pitchy material from the Calumet and Arizona mine described as melanochalcite has been shown to be a variable mixture of tenorite, chrysocolla, and malachite.

Common in most of the oxidized copper deposits of the state. Generally associated with malachite, chrysocolla, cuprite, and limonite.

Cochise County.—Bisbee district, as earthy material mixed with manganese oxide. In 1904 a botryoidal growth of tenorite and wad was being deposited on the walls of a large natural cavern in limestone in the Calumet and Arizona mine. Dragoon Mountains, Maid of Sunshine, and other mines of the Courtland-Gleeson district.

Gila County.—Globe district, sparingly in oxidized ore. Miami district, Van Dyke mine, with chrysocolla.

Greenlee County.—Clifton-Morenci district, generally referred to as "copper pitch ore."

Mohave County.—With chrysocolla at the Emerald Isle mine, Kingman.

Pima County.—Santa Rita Mountains, Rosemont.

Pinal County.—Mammoth mine, as coal-black nodules surrounded by thin shells of chrysocolla.

Santa Cruz County.—Patagonia Mountains, Meadow Valley, Sunnyside, and Blue Eagle mines.

PARAMELACONITE

Essentially CuO, with some cupric ions changed to cuprous. Black to purplish black. Luster adamantine. Opaque. Streak brownish black. H. = 4.5. G. = 6.04. Tetragonal, ditetragonal dipyramidal. As stout prismatic crystals.

An extremely rare mineral, ony two specimens being known, both from the locality given below.

Cochise County.—Bisbee district, Copper Queen mine, in a matrix of goethite, and associated with cuprite, native copper, tenorite, malachite, and connellite in crystals of unusually large size. Forms present are (001), (101), and (100).

MASSICOT

PbO. Sulfur-yellow to reddish. Luster greasy to dull. Transparent in very thin pieces. Streak lighter than color. H. = 2. G. = 9.56. Orthorhombic, dipyramidal. Massive, earthy, or scaly.

An uncommon mineral of secondary origin, formed from alteration of other lead minerals.

Gila County.—Payson district, Silver Butte mine, as an earthy yellow powder associated with anglesite and galena.

Maricopa County.—Bighorn Mountains, Tonopah-Belmont, with minium; also at the Potter and Cramer group.

Santa Cruz County.—Patagonia Mountains, Flux mine, with cerussite.

Yuma County.—Trigo Mountains, Silver district, as earthy powder associated with cerussite and smithsonite.

MINIUM

Pb_3O_4. Scarlet to brownish red, sometimes yellowish. Luster greasy or dull. Streak orange-yellow. H. = 2.5. G. = 8.9-9.2. Pulverulent, massive, earthy, or as microscopic crystalline scales.

Secondary, chiefly derived by alteration of galena or cerussite. Uncommon in large quantities.

Maricopa County.—Bighorn Mountains, Tonopah-Belmont with massicot; also at the Potter and Kramer group.

Mohave County.—Black Mountains, as pulverulent material in cavities in the Big Jim vein, Oatman district.

Santa Cruz County.—Patagonia Mountains, Flux mine, with cerussite.

Yuma County.—Castle Dome Mountains, Castle Dome district, with cerussite.

CORUNDUM

Al_2O_3. Blue, red, brown, gray to nearly white. Luster adamantine to vitreous. Transparent to translucent. Streak uncolored. H. = 9. G. = 4-4.1. Hexagonal, scalenohedral. Crystals generally rough and rounded. Perfect basal and rhombohedral parting. Commonly massive.

An accessory mineral in metamorphic rocks, such as granular limestone, gneiss, and schist; an original constituent of some igneous rocks; or in placers. Probably more widely distributed in the igneous rocks of the state than the occurrences listed below would indicate.

Mohave County.—Grand Wash Cliffs, Red Lake district, as blue, red, and white material in a pegmatite dike with andalusite.

Pinal County.—Reported from south of Casa Grande, but the exact locality was not disclosed.

HEMATITE

Fe_2O_3. Red, reddish brown, black. Luster metallic, to dull or earthy. Opaque. Streak bright red to reddish brown. H. = 5-6. G. = 5.26. Hexagonal, scalenohedral. Crystals tabular, in parallel groups or rosettes. Ganular, earthy or compact massive, with botryoidal, stalactitic or lamellar structure. *Red ocher* is soft and earthy, *specularite* is brillant crystalline material, *turgite* contains adsorbed water. Pure mineral 70% Fe.

One of the most abundant iron minerals, forming the chief ore of iron in beds and irregular masses resulting from weathering. In smaller amounts commonly mixed with other iron compounds in the earthy material known as "limonite," which forms the gossan or capping of many sulfide ores. Also in deep-seated veins; widey distributed as an accessory in igneous and sedimentary rocks; formed by contact metamorphism.

Several Arizona deposits of hematite are potential iron ore. Only a few characteristic occurrences can be listed.

Cochise County.—As fine grained, massive specularite near Willcox.

Maricopa County.—Pikes Peak area, northeast of Beardsley, replacements in schist.

Navajo County.—Sierra Ancha Mountains, Canyon Creek, as a large deposit of siliceous hematite, estimated at 10,000,000 tons, ranging from soft, pulverulent, bright red material to hard, dark blue oxide. Near Globe, as red ocher in a 2½-foot vein.

Yavapai County.—On the McBride claims, 17 miles south of Seligman, large deposits of earthy material from irregular lenses in limestone near the contact with diorite. Partial analysis as follows:

Fe	CaO	SiO_2
61.0	4.5	2.0

A high concentration of hematite and magnetite exists in schist near Townsend Butte and the Howard Copper property. Deposits are reported near Camp Wood.

Yuma County.—Buckskin Mountains, Planet mine, as extensive replacement deposits with carbonate and silicate copper ores in limestone. Plomosa Mountains, southwest of Bouse. Trigo Mountains, southeast of Eherenberg.

ILMENITE

$FeTiO_3$. Iron-black. Luster metallic. Opaque. Streak black. H. = 5-6. G. = 4.68-4.76. Hexagonal, rhombohedral. Crystals tabular. Usually massive, compact, or as imbedded grains.

A common accessory mineral in igneous rocks. especially gabbro and diorite. Less commonly as veins or large segregated masses near borders of the igneous rock.

Gila and Pinal counties.—A minor constituent of the Pinal schist. Also as tabular pieces in quartz, near Castle Dome.

Graham County.—Galiuro Mountains, where large quantities in disseminated form are reported from the northern end of the range.

Yavapai County.—Eureka district, with magnetite, as dikes and irregular bodies in gabbro. A low-grade deposit of large size is reported not far from the Bagdad mine. Bradshaw Mountains, in granite pegmatite near Cleator.

CLAUDETITE

As_2O_3. Colorless to white. H. = 2.5. G. = 4.15. Monoclinic. Luster vitreous. Transparent. In thin platy or elongated crystals.

A secondary mineral, formed from the oxidation of other arsenic compounds or as a sublimation product from mine fires.

Yavapai County.—United Verde mine, as silky crystals filling a small cavity above the burning ore body.

BRAUNITE

Possibly $(Mn,Si)_2O_3$. Color and streak brownish black to steel-gray. Luster submetallic. Opaque. H. = 6-6.5. Weakly magnetic. G. = 4.72-4.83. Tetragonal, ditetragonal dipyramidal. Perfect pyramidal cleavage. Crystals pyramidal and vertically striated. Also granulated massive.

Found as veins and lenses resulting from metamorphism of other manganese minerals, and from pyrolusite, wad, and psilomelane as a secondary mineral formed by weathering.

Cochise County.—Bisbee district, as radiating masses of compact needles.

RUTILE

TiO_2. Red, reddish brown, black; other colors rare. Luster metallic, adamantine. Transparent in small pieces. Streak pale brown to yellowish. H. = 6-6.5. G. = 4.21-4.25 for pure TiO_2. Tetragonal, ditetragonal dipyramidal. Crystals prismatic commonly in complexly twinned groups. Distinct pinacoidal and prismatic cleavage. Also massive. Pure mineral 60% Ti.

Widespread in igneous rocks, gneiss, and mica schist. Less commonly in granular limestone or dolomite. May occur as an alteration of mica. Probably more abundant in the state than the following brief list of localities would indicate.

Cochise County.—An accessory in granite northwest of Bisbee.

Gila and Pinal counties.—An accessory in Madera diorite and Pinal schist.

Santa Cruz County.—Patagonia Mountains, as slender crystals in outcrops of the Santo Niño and Washington areas.

Yavapai County.—Black Hills, as well-developed crystals at the United Verde mine. Bradshaw Mountains, with tourmaline in the gangue of the Howard Copper property, Black Canyon district.

PYROLUSITE

MnO_2. Steel-gray to black or bluish. Luster metallic to dull. Opaque. Streak black or bluish black. H. = 2-6.5. Soft material soils the fingers. G. = 4.4-5.06. Tetragonal, ditetragonal dipyramidal, but commonly pseudomorphous after manganite. Crystals are known as *polianite*. In granular, fibrous, or columnar masses, or as dendritic or reniform coatings. Pure mineral 63.2% Mn.

Secondary, formed by dehydration of manganite, or other manganese minerals, with which it is generally associated. Commonly in small quantities in many oxidized ore deposits and in places contains sufficient silver to be mined for that metal. Widely distributed in small amount throughout the state, and only the more important localities are listed.

Cochise County.—Tombstone district, in commercial quantities in the Oregon-Prompter, Lucky Cuss, Telephone, and Bunker Hills mines.

Greenlee County.—Clifton-Morenci district, in black, sooty masses, mixed with iron oxides in metamorphosed limestone.

Maricopa County.—Bighorn Mountains, Aguila district, with manganite or wad.

Mohave County.—Rawhide Mountains, Artillery Peak, as large deposits, with wad. Also reported 4 miles south of Boulder Dam, in veins. Little Chemehuevis Valley, in veins and shear zones, Arizona Manganese claims, with wad. Near Colorado River, 18 miles north of Parker Dam.

Pinal County.—Superior district, in the outcrop of the Magma vein and in silver deposits.

Santa Cruz County.—Patagonia Mountains, Mowry mine, with wad. Also in the Hardshell, North Mowry, Hermosa, and Black Eagle mines.

Yavapai County.—In the northern part of the Aguila district. On Castle Creek, 23 miles northeast of Morristown. At the Burmeister property, 14 miles southeast of Mayer on the Agua Fria River.

Yuma County.—Dobbins claims, 6 miles east of Bouse, and a locality 2½ miles west of Bouse. Deposits are reported from section 36, T. 10 N., R. 14 W.

WAD

A mixture, whose chief constituent is a hydrous manganese oxide. Black, bluish or brownish black. Luster dull. Opaque. Streak black, bluish, brownish black, reddish brown, liver-brown. Usually very soft, soiling the hands, less often to H. = 6.5. G. = 2.8-4.4. In earthy or compact masses; reniform, concretionary, incrusting.

The name is applied as a generic or field term, thus standing in much the same relation to the well-defined manganese oxides that "limonite" has to the iron oxides and "bauxite" to the aluminum oxides. It is thus highly probable that most, if not all, of the occurrences of psilomelane previously reported from Arizona belong under this classification, and here they have been placed. Re-examination of the material would undoubtedly show several distinct species of manganese oxides to be present.

Cochise County.—Bisbee district, as bodies of considerable size. Tombstone district, in veins and replacements, and containing silver.

Coconino County.—Long Valley region, as nodules and masses in Kaibab formation, Iron Mine Canyon.

Gila County.—Globe district, as earthy material along faults.

Graham County.—Reported at Aravaipa, replacing a fibrous mineral.

Greenlee County.—Ash Peak district, in shear zones with pyrolusite.

Maricopa County.—Bighorn Mountains, Aguila district, with manganite and pyrolusite.

Mohave County.—Rawhide Mountains, Artillery Peak, in extensive bedded deposits. Little Chemehuevis Valley. Topock district.

Pinal County.—Superior district, abundant in fractures and fault planes; as veins and irregular masses on the east 1,600-foot level, Magma mine. Globe district, in surface gash veins, Old Dominion mine, Black Hills. Camp Grant Wash, Tarr and Harper mine. Florence district, Chamberlain mine. Galiuro Mountains, Blue Bird mine, Copper Creek district. Mammoth mine, as botryoidal masses.

Santa Cruz County.—Santa Rita Mountains, Rosario group. Patagonia Mountains, Mowry, La Plata, Hermosa, Jarrilla, and Isabella mines.

Yavapai County.—Castle Creek district, 23 miles northeast of Morristown. Near Mayer.

Yuma County.—Granite Wash Hills, east of Bouse. Also 33 miles west of Congress Junction.

CRYPTOMELANE

Essentially a manganese oxide characterized by the presence of K_2O and little or no barium. Steel-gray, bluish gray to dull black. Opaque. Streak brownish black. H. = 6-6.5. Lower in massive or fibrous varieties. Usually as fine-grained, cleavable, or fibrous masses. Less commonly botryoidal.

The term *cryptomelane* has recently been proposed for what has been shown by X-ray powder patterns to be the commonest of the hard, compact manganese oxides, previously included under the term *psilomelane* and now included under the generic term "wad." Although the mineral is undoubtedly more widely distributed in the state than the single locality listed below would indicate, it is at present the only known authentic occurrence.

Cochise County.—Tombstone district, as fine-grained, cleavable, and fibrous material. Part of the analysis by M. Fleischer as follows:

MnO_2	MnO	ZnO	K_2O	H_2O
83.13	2.08	5.23	3.50	3.49

ANATASE—Octahedrite

TiO_2. Various shades of brown, indigo-blue, black. Greenish yellow by transmitted light. Luster adamantine to metallic. Transparent. Streak uncolored to pale yellow. H. = 5.5-6. G. = 3.90. Tetragonal, ditetragonal dipyramidal. Crystals either pyramidal or tabular. Perfect basal and pyramidal cleavage.

A rare mineral, generally derived from alteration of other titanium minerals. In granitic rocks or schist, associated with quartz, adularia, sphene rutile, or brookite.

Graham County.—Stanley district, Friend mine.

CERVANTITE

Perhaps Sb_2O_4. Yellow to white. Luster greasy or pearly. Transparent. Streak light yellow to white. H. = 4-5. G. = 6.64. Orthorhombic (?). In acicular crystals; pulverulent or massive. Pure mineral 64.8% Sb.

A secondary mineral, most commonly formed from alteration of stibnite. Generally associated with stibnite and stibiconite.

Yuma County.—Dome Rock Mountains, as radiating blades of stibnite partially altered to cervantite and stibiconite, in veins.

STIBICONITE

Perhaps Sb_3O_6OH. Pale yellow to yellowish white, grayish. Luster pearly to earthy. Transparent. H. = 4-5.5. G. = 5.58. Mostly as massive, compact material, or as crusts. Pure mineral 74.9% Sb.

Commonly accompanies cervantite as an alteration product of stibnite or other antimony minerals.

Pima County.—Specimens have been identified, but the locality is not known.

Yavapai County.—Bradshaw Mountains, as a 2- to 3-foot vein in the vicinity of Cañon.

Yuma County.—Dome Rock Mountains, as radiating blades of stibnite partially altered to cervantite and stibiconite, in veins.

BISMITE

Bi_2O_3. Grayish green, greenish yellow to bright yellow. Luster subadamantine to dull and earthy. Transparent in small fragments. Streak grayish to yellow. H. = 4.5,

but softer in earthy material. G. = 8.64. Monoclinic. Massive, compact granular to earthy and pulverulent.

Secondary from oxidation of bismuth minerals, with which it is commonly associated. Much so-called bismite is probably not identical with this species, and the validity of the occurrences listed below are open to question.

Yavapai County.—Bradshaw Mountains, alteration product of bismuthinite at the Swallow mine, Castle Creek district. Eureka district, Bagdad mine.

Yuma County.—A low-grade deposit in quartz is reported from north of Vicksburg.

TUNGSTITE

Probably $WO_3.H_2O$. Bright yellow, golden yellow, yellowish green. Luster resinous, pearly on cleavage. Transparent. H. = 2.5. Possibly orthorhombic. Perfect basal cleavage. Massive, pulverulent to earthy and as microscopic platy crystals.

Of secondary origin, formed by the alteration of primary tungsten minerals, such as wolframite and scheelite, with which it is generally associated. Has been reported in small amounts from most of the tungsten districts of Arizona.

BRUCITE

$Mg(OH)_2$. White to pale green, gray, bluish, honey-yellow to brownish. Luster vitreous to pearly on cleavages. Transparent streak white. H. = 2.5. G. = 2.39. Hexagonal, scalenohedral. Perfect basal cleavage. As crystals, plates, or foliated masses; also fibrous, rarely granular.

Typically a low-temperature hydrothermal vein mineral.

Mohave County.—Oatman district, in veins with magnesite and serpentine cutting volcanic rocks.

LEPIDOCROCITE

FeO(OH). Ruby-red to reddish brown. Luster submetallic. Transparent. Streak dull orange. H. = 5. G. = 4.05-4.13. Orthorhombic, dipyramidal. Perfect pinacoidal, less perfect basal cleavage. As flattened crystals or crystal groups. Also massive, bladed, fibrous, or micaceous.

Occurrence and association the same as for goethite, and the two often occur together, with crystals of lepidocrocite resting on massive goethite.

Pinal County.—Identified on a single specimen from the Mammoth mine, but is probably of far wider and more common occurrence than the one locality listed would indicate.

MANGANITE

MnO(OH). Dark steel-gray to iron-black. Luster submetallic. Transparent in thin splinters. Streak reddish brown to nearly black. H. = 4. G. = 4.32-4.34. Monoclinic. Crystals commonly prismatic and deeply striated vertically. Perfect pinacoidal and prismatic cleavage. Also columnar or stalactitic. Pure mineral 62.4% Mn.

Commonly with other manganese oxides in deposits of secondary origin. Also in veins.

Cochise County.—Tombstone district, as needlelike crystals in parallel groups and as soft fibers lining cavities.

Gila County.—Globe district, as needlelike crystals with earthy wad.

Maricopa County.—Bighorn Mountains, Aguila district, with pyrolusite and wad.

Santa Cruz County.—Patagonia Mountains, Mowry mine.

Yavapai County.—Castle Creek. With pyrolusite and wad in the northern part of the Aguila district.

Yuma County.—Planet district.

GIBBSITE

$Al(OH)_3$. White, grayish, greenish or reddish white; also reddish yellow when impure. Luster vitreous, pearly on cleavage. Transparent. Emits a strong clayey odor when breathed on. H. = 2.5-3.5. G. = 2.3-2.42. Monoclinic. Perfect basal cleavage. In tabular crystals; more commonly compact earthy, stalactitic, or as enamel-like coatings.

As a secondary product resulting from the alteration of aluminous minerals, and sometimes the chief constituent of bauxite deposits. Also as a low-temperature hydrothermal mineral in veins or cavities in igneous rocks.

Cochise County.—Bisbee district, as an impure variety with chalcoalumite and malachite.

PSILOMELANE

Probably $BaMnMn_8O_{16}(OH)_4$. Iron-black to dark steel-gray. Luster submetallic to dull. Opaque. Streak brownish black to black, shining. H. = 5-6, softer in the earthy varieties. G. = 4.70-4.72. Orthorhombic. Found only massive, as botryoidal, reniform or stalactitic crusts, or earthy and pulverulent.

A secondary mineral formed under surface conditions from the alteration of manganous carbonates or silicates, and associated with products of similar origin, such as pyrolusite, goethite, limonite, and "wad."

It is probable that most of the previously reported occurrences of this mineral are unidentified manganese oxides, or mixtures, and thus belong under the generic term "wad," where they have been placed in this edition.

Pima County.—From near Tucson, but the exact locality is unknown. Part of the analysis by Charles Milton as follows:

BaO	MnO	MnO_2	Fe_2O_3	H_2O
14.40	6.70	59.65	3.27	4.27

DELAFOSSITE

$CuFeO_2$. Color and streak black. Luster metallic. Opaque. Weakly magnetic. H. = 5.5. G. = 5.41. Hexagonal, scalenohedral. As tabular crystals and botryoidal crusts.

A rare mineral of secondary origin, occurring in a few oxidized copper deposits in the world.

Cochise County.—Bisbee district, Southwest mine, as small crystals, crystal aggregates and botryoidal crusts at the lower zone of oxidation. Analysis by G. S. Bohart as follows:

Cu	Fe	O	Insol.	Total
41.24	37.22	21.79	0.25	100.00

GOETHITE

$HFeO_2$. Blackish brown to ocher-yellow. Luster imperfect adamantine to dull; fibrous varieties silky. Transparent in thin splinters. Streak brownish yellow to ocher-yellow. H. = 5-5.5. G. = 3.3-4.28. Orthorhombic, dipyramidal. Crystals prismatic or flattened. Perfect pinacoidal, less perfect basal cleavages. Most characteristically with concentric or radiated fibrous structure or as earthy masses. Pure mineral 62.9% Fe.

Most commonly the dominant constituent of the impure mixture known as "limonite," the most abundant oxidation product of other iron minerals. Reported as pure material from only one locality in the state.

Cochise County.—Bisbee district, as thick botryoidal crusts with fibrous structure, Shattuck mine.

LIMONITE—Brown Iron Ore

A mixture of ferric iron minerals, principally goethite and hematite. Yellow, brown, black. Luster submetallic to dull. Streak yellowish brown. H. variable, mostly 4-5.5. G. = 2.7-4.3. In compact, botryoidal, or earthy masses. *Brown ocher* or *yellow ocher* is soft and earthy. Percentages of Fe vary widely.

Of secondary origin, the commonest alteration product of other iron minerals. Abundant in the gossan or capping of most sulfide ore deposits. Also deposited by ground waters in bogs or marshes, forming low-grade iron ores.

No commercial deposits of limonite are known in the state. It is so widely distributed in small quantities throughout the mining districts that occurrences need not be listed.

SPINEL

$MgAl_2O_4$. Various shades of red, blue, green, and brown to nearly colorless. Luster vitreous to dull. Transparent. Streak white. H. = 7.5-8. G. = 3.55 when pure. Isometric, hexoctahedral. Crystals octahedral. *Picotite*, or *chrome spinel*, contains a large proportion of Cr in substitution for Al.

An accessory mineral in many basic rocks, especially peridotites; as a metamorphic mineral in granular limestone and dolomite or their contact zones; in gneiss and schist; and in placer gravels, in places with corundum.

Gila County.—Large crystals of spinel, possibly picotite, in volcanic bombs of olivine near Peridot.

MAGNETITE

$FeFe_2O_4$. Iron-black. Luster metallic and splendent to submetallic and dull. Opaque. Streak black. H. = 5.5-6.5. G. = 5.175. Strongly magnetic. Isometric, hexoctahedral. Octahedral crystals common. Good octahedral parting. Also granular massive. *Lodestone* attracts particles of iron. Pure mineral 72.4% Fe.

An accessory mineral of many igneous rocks; in basic types may occur in large masses. Abundant in metamorphic rocks. The main constituent of black sands. No deposits of value as iron ore are known in the state, but some have been used as flux in smelting copper ores. Only a few characteristic occurrences can be listed.

Coconino County.—Grand Canyon, as octahedral crystals up to an inch in diameter in pegmatites.

Gila County.—Dripping Spring Mountains, Christmas mine, with a variety of contact silicates and sulfides. As large crystals in volcanic bombs of olivine from near Peridot.

Greenlee County.—Clifton-Morenci district, abundant in metamorphosed limestone, with garnet, amphibole, pyroxene, and sulfides. Mined as flux at the Manganese Blue and Arizona Central mines.

Pima County.—Santa Rita Mountains, abundant in contact-metamorphic copper ores at Rosemont camp. Sierrita Mountains, in contact ore bodies, Twin Buttes area.

Santa Cruz County.—Patagonia Mountains, as lodestone in considerable quantities at the Line Boy mine, near Duquesne.

Yavapai County.—Eureka district, as titaniferous magnetite in dikes and irregular bodies in gabbro. Partial analysis as follows:

Fe	Ti	Mn
60.35	8.40	Trace

McBride claims 17 miles south of Seligman, as segregations of titaniferous magnetite in gabbro. Bradshaw Mountains, with hematite in schist near Townsend Butte and the Howard Copper property; as large crystals with apatite and sphene in granodiorite at the Springfield group, Pine Grove district. As large pieces of lodestone near Stoddard.

Yuma County.—Harcuvar Mountains, Yuma Copper property, with actinolite, replacing limestone. Dome Rock Mountains, as crystals and masses of magnetite in wall rocks of the cinnabar veins.

CHROMITE

$FeCr_2O_4$. Iron-black to brownish black. Luster metallic to submetallic. Opaque. Streak brown. H. = 5.5. G. = 4.5-4.8. Isometric, hexoctahedral. Octahedral crystals. Commonly granular to compact massive. Pure mineral 68% Cr_2O_3.

As veins or masses in peridotite or in serpentine and formed by segregation. Generally associated with magnetite and ilmenite.

Yuma County.—Trigo Mountains, Eureka district, as disseminated grains and small masses with mariposite in mica schist.

HETAEROLITE

$ZnMn_2O_4$. Black. Luster submetallic. Transparent in very thin splinters. Streak dark brown. H. = 6. G. = 5.18. Tetragonal, ditetragonal dipyramidal. Crystals of octahedral habit. Perfect basal cleavage.

Rare, in small quantities with manganese oxides.

Cochise County.—Tombstone district, as tiny veinlets in manganite. As splendent botryoidal and stalactitic coatings and masses from the Campbell and Junction mines, Bisbee district.

CORONADITE

$MnPbMn_6O_{14}$. Galena-white. Luster dull to submetallic. Opaque. Streak brownish black. H. = 4.5-5. G. = 5.44. Pseudotetragonal. In dense fibrous masses, or fibrous botryoidal crusts.

A rare secondary mineral described from only two localities in the world.

Greenlee County.—First described from Clifton-Morenci (6:05), as fairly large amounts at the west end of the Coronado vein. Analysis by W. F. Hillebrand as follows:

MnO_2	MnO	PbO	FeO	ZnO	CuO	H_2O	Total
56.68	6.11	25.96	.91	.10	.05	1.03	100.84

As recalculated by Frondel and Heinrick:

MnO_2	MnO	PbO	Fe_2O_3	ZnO	Al_2O_3	H_2O	Rem.	Total
60.80	7.12	28.66	1.10	0.11	0.68	1.11	0.42	100.00

Pinal County.—Superior district, in small amounts near the lower limits of the oxidized zone, Magma mine, with sauconite, a waxy, zinc-bearing clay mineral.

FERGUSONITE

(Y, Er, Ce, Fe) (Cb, Ta, Ti)O_4 Brownish black to velvet-black. Luster dull to vitreous and submetallic. Transparent in thin splinters. Streak pale brown, yellow brown, greenish gray. H. = 5.5-6.5. G. = 5.5-5.8. Tetragonal, dipyramidal. In pyramidal or prismatic crystals. Also massive.

Of uncommon occurrence, generally in acid pegmatite with other rare-earth minerals.

Yavapai County.—Specimens have been received by the Arizona Bureau of Mines from the vicinity of Yarnell Hill.

ARIZONITE

$Fe_2Ti_3O_9$. Dark steel-gray. Luster submetallic to metallic. Transparent in very thin splinters. Streak brown. H. = 5.5. G. = 4.25. Monoclinic (?). In crystals with rough faces. Also massive.

Only known occurrence is in Mohave County, with gadolinite in pegmatite of the Aquarius Range, 25 miles south of Hackberry. Analysis by Chase Palmer as follows:

TiO_2	SiO_2	FeO	Fe_2O_3	H_2O	Total
58.82	1.02	0.70	38.38	1.10	100.12

TAPIOLITE

$FeTa_2O_6$. Black. Luster subadamantine to metallic. Transparent in extremely thin splinters. Streak cinnamon-brown to brownish black. H. = 6-6.5. G. = 7.85-7.95. Tetragonal, ditetragonal dipyramidal. In square pyramidal or short prismatic crystals.

An uncommon mineral generally found in pegmatite.

Yavapai County.—Bradshaw Mountains, in stream gravels on Castle Creek.

EUXENITE

$(Y, Ca, Ce, U, Th)(Cb, Ta, Ti)_2O_6$. Black, sometimes with brownish or greenish tint. Luster often brilliant, submetallic, or somewhat greasy or vitreous. Transparent in thin splinters. Streak yellowish, grayish or reddish brown. H. = 5.5-6.5. G. = 4.9-5.9. Pseudo-orthorhombic. Massive.

Found only in pegmatites. Rare in the United States.

Mohave County.—Cerbat Range, as scattered masses up to 50 pounds weight in pegmatite, Kingman Feldspar mine. Similarly east of the Big Sandy River, south of Burro Creek.

SAMARSKITE

$(Y, Er, Se, U, Ca, Fe, Pb, Th)\ (Cb, Ta, Ti, Sn)_2O_6$. Velvet-black. Luster vitreous to resinous. Streak dark reddish brown to black. H. = 5-6. G. = 5.69. Orthorhombic. Crystals rectangular prisms with rough faces. Commonly massive and in flattened disseminated grains.

Generally in small amounts in pegmatite with other rare-earth minerals.

Mohave County.—Aquarius Range, with allanite in pegmatite.

Yavapai County.—Black Hills, reported from near Jerome.

HALIDES

Halite	Iodobromite	Boleite
Sal Ammoniac	Iodyrite	Diaboleite
Cerargyrite	Cotunnite	Matlockite
Embolite	Fluorite	Paralaurionite
Bromyrite	Atacamite	

HALITE—Rock Salt

NaCl. Colorless or white when pure. Luster vitreous. Transparent to translucent. Streak white. Taste saline. H. = 2.5. G. = 2.16. Isometric, hexoctahedral. Perfect cubic cleavage. Crystals cubic. Cleavable to granular massive.

An important source of salt, found in irregular sedimentary beds and formed by evaporation of inland seas or salt lakes. Commonly associated with gypsum or anhydrite.

Gila and Maricopa counties.—Throughout the Salt River Valley as incrustations. Derived from evaporation of saline springs.

Mohave County.—With gypsum in badlands of the Virgin River Valley near the Nevada border.

Yavapai County.—Near Camp Verde, with thenardite, glauberite, mirabilite, and gypsum.

SAL AMMONIAC

NH_4Cl. White. As incrustations.

Most commonly a sublimation product about fumaroles.

Yuma County.—Reported from near Yuma.

CERARGYRITE—Horn Silver

AgCl. Pearl-gray, grayish green, whitish to colorless. Turns violet-brown on exposure to light. Luster waxy. Transparent to translucent. Streak whitish. H. = 2-3. Sectile and malleable. G. = 5.5±. Isometric, hexoctahedral. As small cubic crystals. Most commonly as waxy masses or crusts. Pure mineral 75.3% Ag.

An important silver mineral of oxidized silver deposits in arid regions, formed by reaction between descending waters containing chlorine and silver-bearing solutions. Horn silver ores have yielded much of the silver of the state.

Cochise County.—At Tombstone, probably abundant in oxidized ores of the district, but cannot be distinguished physically from other silver halides which are known to be present. Near Charleston, Bradshaw mine, as granular aggregates. Pearce Hills, with other silver halides and argentite at the Commonwealth mine. Dragoon Mountains, in oxidized lead-silver deposits of the Turquoise district.

Gila County.—Globe district, in many of the surficial ores; Old Dominion mine, with manganese oxides. Richmond Basin. In the Jumbo vein, massive cerargyrite forms plates ½ inch thick and several inches in diameter. Payson district, with native silver at the Silver Butte mine.

Graham County.—Aravaipa district, in the Bullis and Aravaipa groups.

Mohave County.—Cerbat Range, at several properties, principally in the Chloride, Mineral Park, Cerbat, Stockton Hills, White Hills, and Wallapai districts. Hualpai Mountains, at several properties in the Maynard district.

Pima County.—Santa Rita Mountains, Blue Jay mine, Helvetia district, and in the Greaterville district. Empire Mountains, Total Wreck mine. Quijotoa Mountains, Morgan mine. Tortolita Mountains, Apache property, Owl Head district. Cerro Colorado, Cerro Colorado and other mines.

Pinal County.—Superior district, as the chief near-surface ore mineral in the Belmont area.

Santa Cruz County.—Santa Rita Mountains, Ivanhoe mine, Tyndall district; Anaconda group, Wrightson district. Patagonia Mountains, La Plata and Meadow Valley mines, Redrock district; Hermosa and American mines, Harshaw district; Palmetto mine, Palmetto district.

Yavapai County.—Bradshaw Mountains, Dos Oris mine, Hassayampa district, with argentite and native silver; Thunderbolt mine, Black Canyon district, with proustite and native silver; Tuscumbia mine, Bradshaw district, with stephanite; with ruby silver at the Tip Top mine, Tip Top district. At the Silver Belt mine, Big Bug district, where the presence of stone hammers and gads in ancient working indicates that the deposit was mined in prehistoric time. Peck district, Swastika mine, as fine crystals.

Yuma County.—Trigo Mountains, Silver Clip and Red Cloud mines, as the principal silver mineral in the oxidized lead ores.

EMBOLITE—Horn Silver

Ag(Cl,Br). Grayish green and yellowish green to yellow. G. = 5.31-5.43. Other properties same as cerargyrite. Pure mineral 57.4 to 75.3% Ag.

So closely resembles cerargyrite that it is usually so identified, and the mineral is probably more common than is generally supposed. Origin similar to that of cerargyrite, with which it is commonly associated.

Cochise County.—At Tombstone, the principal silver mineral at the State of Maine mine. Pearce Hills, abundant at the Commonwealth and other properties of the district.

Pinal County.—Mammoth mine, as tiny yellowish cubo-octahedral crystals implanted on caledonite from the Collins vein.

Santa Cruz County.—Santa Rita Mountains, Ivanhoe mine, Tyndall district. Patagonia Mountains, Alta mine, Harshaw district, with pyrargyrite.

BROMYRITE—Horn Silver

AgBr. G. = 5.8-6. Other properties same as cerargyrite. Pure mineral 57.4% Ag.

Origin and associations similar to cerargyrite, from which it cannot be distinguished except by chemical analysis.

Cochise County.—At Tombstone, where in 1936 it was discovered in considerable quantity in ores of the Empire and Flora Morrison mines and is probably the most abundant silver handle in the ores of the district (3:38).

Analysis by R. Carrillo as follows:

Cl	Br	I	Ag	Total
0.6	38.9	2.6	56.7	98.8

Pearce Hills, with embolite, Commonwealth mine.

Gila County.—Reported from ores of Richmond Basin.

Graham County.—Aravaipa district, in oxidized ores of the Aravaipa group.

Mohave County.—Much "green horn silver" is reported from the Cerbat Range and from the Maynard district, Hualpai Mountains (8:09). At the Tennessee-Schuylkill mine, Wallapai district.

Santa Cruz County.—Santa Rita Mountains, Walker mine, Wrightson district. Patagonia Mountains, Meadow Valley mine, Redrock district.

Yavapai County.—Bradshaw Mountains, the main ore mineral at the Peck mine, Peck district.

IODOBROMITE—Horn Silver

Ag(Br,Cl,I). Sulfur-yellow to greenish. G. = 5.713. Other properties same as cerargyrite.

Similar to the silver halides already described, but much rarer.

Gila County.—Globe district, as thin seams and crusts in a vein of quartz and calcite of the Hechman mine.

IODYRITE—Horn Silver

AgI. Pale yellow or green. H. = 1-1.5. G. = 5.5-5.7. Hexagonal. Except for the crystal form it is identical in appearance with the silver halides already described.

A rare silver mineral, reported from only a few localities in the world.

Cochise County.—Pearce Hills, with cerargyrite, bromyrite, embolite, and argentite, Commonwealth mine.

Pima County.—Cerro Colorado, Cerro Colorado mine.

COTUNNITE

$PbCl_2$. White to yellowish. Soft. G. = 5.3-5.8. Orthorhombic. Perfect basal cleavage. In acicular crystals and semicrystalline masses.

A rare mineral, found in small quantity in only a few places in the world.

Mohave County.—Grand Wash Cliffs, as small veinlets replacing chalcocite at the Grand Gulch mine, Bentley district.

FLUORITE—Fluorspar

CaF_2. Most commonly colorless, white, green, purple, blue, yellow, and brown. Luster vitreous. Transparent to translucent. H. = 4. G. = 3.18. Isometric, hexoctahedral. Perfect octahedral cleavage. Cubic and octahedral crystals common. Also granular massive with prominent cleavage; rarely columnar. Some specimens are fluorescent.

Occurs most commonly as a primary mineral in veins of which it is the chief constituent, or in the gangue of lead, zinc, and silver ores. It is also found in sedimentary rocks, such as dolomite and limestone, and in plutonic igneous rocks, such as granite and monzonite. Used chiefly as a flux in the making of steel.

Cochise County.—At Tombstone, locally abundant in some silicified areas, particularly at the Empire mine. Near Government Draw, purple crystals with quartz. In the Chiricahua Mountains small quantities have been mined from quartz veins near Paradise. Dragoon Mountains, in granite pegmatites with huebnerite. Whetstone Mountains, vein west of San Juan siding.

Gila County.—Payson district, with epidote, Ox Bow mine. Eastern Tonto Basin, Packard claims, in veins.

Graham County.—Aravaipa district, Grand Reef mine and veins of the Landsman group. As crystals in barite veins of Stanley Butte.

Greenlee County.—In several properties near Duncan, some of which have produced.

Maricopa County.—Harquahala Mountains, Snowball property, in veins. Vulture Mountains, west of Morristown, in veins. Reported from the White Tank Mountains (1:17).

Mohave County.—Black Mountains, as white to pale green bands or as linings of cavities in the northern part of the Oatman district.

Pima County.—Santa Rita Mountains, New York mine, Helvetia district. Silver Bell Mountains, in considerable quantity in the old silver-lead pit near the Mammoth mine, and with barite and galena at several other properties in the Silver Bell district. Sierrita Mountains, as veins from a few inches to 2 feet in width, Neptune property.

Pinal County.—Mammoth mine, microscopically abundant but rarely visible. In cubic crystals from the lower levels.

Santa Cruz County.—Patagonia Mountains, as red material with embolite and pyrargyrite, Alta mine, Harshaw district.

Yavapai County.—Bradshaw Mountains, Springfield group, Pine Grove district; Swallow mine, Castle Creek district. McCloud Mountains, at a property near the Leviathan mine, from which material has been shipped. Eureka district, in a vein west of the Bagdad mine.

Yuma County.—Castle Dome Mountains, Castle Dome district, as greenish, purple, and rose-colored crystals and cleavage masses up to several inches in diameter, associated locally with galena, barite, and wulfenite. Material produced from the Big Dome claim showed the following analysis:

CaF_2	$CaCO_3$	SiO_2
98.7 to 99.0	1.15 to 1.65	0.05 to 0.20

Trigo Mountains, Silver district, as crystalline to dense varicolored bands coating quartz, and as vein material with quartz and barite. Kofa or S.H. Mountains, in a vein near the King of Arizona mines. Buckskin Mountains, Chicago and Mammoth properties, with barite.

ATACAMITE

$Cu_2Cl(OH)_3$. Bright green, dark emerald-green to blackish green. Luster adamantine to vitreous. Transparent to translucent. H. = 3-3.5. G. = 3.75-3.77. Orthorhombic, dipyramidal. Highly perfect pinacoidal cleavage. Commonly in slender prismatic crystals, vertically striated. Also in confused crystalline aggregates, massive, fibrous, granular to compact and as sand. Pure mineral 59.5% Cu.

Of secondary origin, derived from malachite and cuprite under arid or semiarid conditions. Reported from only a few localities in Arizona, but is probably more widely distributed.

Pinal County.—Galiuro Mountains, as small green crystals with olivenite on the main level of the Old Reliable mine, Copper Creek district. Mammoth mine, as coarse granular aggregates of deep green color in a single specimen from the 400-foot level, Collins vein.

Pima County.—Cerro Colorado, Cerro Colorado mine.

Yavapai County.—Black Hills, in small quantities, United Verde mine.

BOLEITE

$PbCuAgCl_2(OH)_2$. (?). Indigo-blue. H. = 3-3.25. G. = 5.08. Tetragonal. Perfect basal, distinct prismatic cleavage. In twinned pseudocubic crystals.

A rare mineral found in some oxidized sulfide ore bodies in arid or semiarid regions.

Pinal County.—Mammoth mine, as dark blue cubes with diaboleite and cerussite from the 400-foot level, Collins vein.

DIABOLEITE

$PbCuAgCl_2(OH)_2$ (?). Indigo-blue. H. = 3-3.25. G. = 5.08. Tetragonal. Perfect gonal, ditetragonal pyramidal. In thin platy to short, stubby crystals.

A rare secondary mineral previously known from only one locality in the world.

Pinal County.—Mammoth mine, in crystals of superb quality, with cerussite, wulfenite, and boleite, from the 400-foot level, Collins vein. Forms identified consist of (001), (010), (0.1.10), (110), (101), (012), (011), (021), (201), (112), (111). Analysis by F. A. Gonyer as follows:

PbO	CuO	Cl_2	H_2O	Total
72.32	12.73	11.47	6.06	100.00

MATLOCKITE

PbFCl. Yellowish, grayish, or greenish. Luster adamantine to pearly. H. = 2-3. G. = 7.21. Tetragonal. Perfect basal cleavage. Crystals tabular.

A rare secondary mineral previously recorded only from the original locality at Matlock, England.

Pinal County.—Mammoth mine, as minute crystals on boleite from the 400-foot level, Collins vein, and as a large nodule coated with cerussite from the 500-foot level.

PARALAURIONITE

$Pb(OH)_2.PbCl_2$. Colorless to white. G. = 6.05. Monoclinic. Excellent basal cleavage. As small crystals.

A rare secondary mineral, originally described from the ancient lead slags at Laurium, Greece.

Pinal County.—Mammoth mine, as small yellowish white crystals in the Collins vein. Characterized by an extremely good cleavage, and a certain degree of flexibility so that the crystals are often bent. Associated with diaboleite and leadhillite.

CARBONATES, NITRATES, BORATES

Calcite	Witherite	Loseyite
Dolomite	Cerussite	Hydrocerussite
Ankerite	Phosgenite	Bismutite
Magnesite	Malachite	Soda Niter
Siderite	Azurite	Niter
Rhodochrosite	Rosasite	Nitrocalcite
Smithsonite	Aurichalcite	Gerhardtite
Aragonite	Hydrozincite	Colemanite

CALCITE

$CaCO_3$. White to colorless or pale shades of gray, red, green, blue, yellow; brown or black when impure. Luster vitreous to earthy. Transparent to opaque. Streak white or grayish. H. = 3. G. = 2.72. Hexagonal, scalenohedral. Perfect rhombohedral cleavage. Commonly in crystals of rhombohedral or scalenohedral habit. Also cleavable massive, massive, granular, columnar, stalactitic, or chalky.

Most common as limestone and marble. Also a common vein mineral. Several varieties are based on color, structure, and impurities.

Ordinary calcite

Crystals and cleavable masses, so common that only a few typical occurrences are listed.

Cochise County.—Bisbee district, as masses of crystals in oxidized ore. Tombstone district, as coarsely crystalline aggregates along the flanks of the "roll deposits," and as snow-white linings of caverns in manganese ore bodies. Chiricahua Mountains, Crystal Cave, as crystal aggregates.

Gila County.—Globe district, Old Dominion mine, as fine groups of scalenohedral crystals in cavities in limestones.

Mohave County.—Grand Canyon, north side, as groups of white and amber scalenohedral crystals. Sand crystals, consisting of sand grains cemented by calcite crystals, occur in sediments of the Big Sandy Valley.

Pinal County.—Superior district, as delicate pink scalenohedral crystal groups, Magma mine.

Santa Cruz County.—Santa Rita Mountains, as magnificent groups of scalenohedral crystals at Onyx Cave.

Yavapai County.—Bradshaw Mountains, as beautiful specimens of crystallized calcite, quartz, adularia, and ore minerals, Cash mine, Hassayampa district. Material of optical quality reported from the Castle Hot Springs area.

Limestone

By far the commonest variety, occurring in rock masses with either compact or granular structure. Widely distributed throughout the sedimentary rocks of the state, particularly those of the Paleozoic era. The most extensive limestone deposits in northern Arizona are the Redwall and Kaibab formations, in southern Arizona the Escabrosa, Naco, and Snyder Hill formations.

Marble

Coarsely crystalline limestone, generally formed by metamorphism of originally fine-grained or compact limestone. Widely distributed in the state, but only occurrences suitable for industrial use are listed.

Cochise County.—Chiricahua Mountains, as extensive deposits near Ft. Bowie in Immigrant Canyon and at the head of Whitetail Creek. Dragoon Mountains, a few miles southeast of Dragoon station, quarried to some extent. Little Dragoon Mountains, northwest of Manzora.

Gila County.—Quarried 10 miles west of Globe, at the foot of Sleeping Beauty Mountain.

Pima County.—Santa Rita Mountains, quarried 6 miles north of Helvetia.

Yuma County.—Gila Mountains, very pure deposits south of Dome station.

Stalactite, stalagmite

Stalactites are cylinders or cones that hang from the roofs of limestone

caverns and are formed by the evaporation of water charged with calcium carbonate. Stalagmites are of the same material covering the floors of caverns, in places rising in cones to meet the stalactites. Most *oriental alabaster, onyx marble*, and *Mexican onyx* is stalagmite.

Cochise County.—Stalactites were abundant in the oxidized zone of the Copper Queen mine, Bisbee, locally colored with salts of copper. A cavern 340 feet in diameter and 80 feet high, lined with stalactitic calcite, was discovered on the 300-foot level of the Shattuck mine in 1914.

Pima County.—Both stalactites and stalagmites abound in Colossal Cave, on the southern slope of the Rincon Mountains.

Santa Cruz County.—In Onyx Cave, Santa Rita Mountains.

Travertine

Compact calcareous material deposited by springs or streams, generally distinctly banded and variously colored. Also called *onyx marble* or *Mexican onyx*.

Gila County.—Natural Bridge, south of Pine.

Coconino County.—Havasupai Falls, south of the Grand Canyon. In Havasu Canyon similar deposits at Mooney, Bridal Veil, and other falls.

Maricopa County.—On Camp Creek, west of Cave Creek, a deposit of soft travertine contains boulders prevailingly green and yellow with veins of brown and red.

Mohave County.—Abundant at the mouth of the Grand Canyon. Some miles to the west deposits up to 200 feet thick cap Greggs Breccia.

Santa Cruz County.—Santa Rita Mountains, at Cave Creek, Greaterville district, as brown material unusually free from cracks.

Yavapai County.—Bradshaw Mountains, Big Bug Creek, near Mayer, where deposits of banded material, colored by iron oxides, have yielded much decorative stone. A similar deposit is on Cave Creek. Another deposit is reported from the Eureka district. Also southwest of Ash Fork.

DOLOMITE

$CaMg(CO_3)_2$. White, reddish, greenish white, rose-red, green, brown, gray, and black. Luster vitreous to pearly. Transparent to subtranslucent to opaque. H. = 3.5-4. G. = 2.85. Hexagonal, rhombohedral. Crystals of rhombohedral habit with curved faces. Perfect rhombohedral cleavage. Commonly coarse or fine granular massive, resembling crystalline limestone or marble.

Most common as a rock, like limestone in occurrence. Also as a vein mineral with metalliferous ores. Dolomites and dolomitic limestones are widely distributed in the state, and only a few localities are listed here.

Cochise County.—Tombstone district, as massive beds interbedded with limestone and shale in the Naco formation.

Coconino County.—Analyses of the Kaibab limestone in the vicinity of Flagstaff show the formation there to be highly dolomitic. Analyses of Kaibab limestone from Grand Canyon:

	I	II
Silica	34.10	17.00
Iron and alumina	1.60	1.00
Calcium carbonate	33.81	48.20
Magnesium carbonate	26.43	34.40
	95.94	100.60

Greenlee County.—Clifton-Morenci district, as beds in the lowest part of the Modoc formation, and in the upper part of the Morenci shales. Sparingly in the Longfellow limestone.

Pima County.—Sierrita Mountains, San Xavier district, coarsely crystallized material in fissures.

Yavapai County.—Black Hills, a fairly abundant gangue mineral at the United Verde mine. Bradshaw Mountains, at the Tillie Starbuck mine, Hassayampa district, as small rhombohedrons coating walls of cavities.

Yuma County.—Harquahala Mountains, as a bed several feet thick near the Bonanza mine.

ANKERITE

$CaCO_3.(Mg,Fe,Mn)CO_3$. White, gray, reddish. H. = 3.5. G. = 2.95-3.1. Rhombohedral. Perfect rhombohedral cleavage. Most commonly cleavable massive, granular, or compact.

Probably rather widely distributed in metamorphosed limestones and metallic veins of the state, but reported only from those localities listed.

Gila County.—Payson district, with tetrahedrite, Silver Butte mine.

Yavapai County.—Black Hills, in pyritic ore of the United Verde mine. Bradshaw Mountains, Arizona-National mine, Big Bug district; Howard Copper and Kay Copper properties, Black Canyon district; M and M veins, Tiger district; Tillie Starbuck mine, Hassayampa district, as small rhombohedrons associated with dolomite in cavities.

MAGNESITE

$MgCO_3$. White, grayish white, yellowish, and brown. Luster vitreous. H. = 3.5-5. G. = 3.0-3.2. Hexagonal, scalenohedral. Perfect rhombohedral cleavage. Generally compact massive; also granular to cleavable.

May be formed from alteration of rocks rich in magnesium or through action of magnesium-bearing waters upon calcite. As a minor constituent of limestones or dolomites, probably extensively distributed in Arizona.

Greenlee County.—Sparingly in beds of the Longfellow limestone.

Mohave County.—Oatman district, in veins with brucite and serpentine.

SIDERITE

$FeCO_3$. Generally some shade of brown or gray. Luster vitreous to dull. Translucent to opaque. Streak white. H. = 3.5-4. G. = 3.85±. Hexagonal, scalenohedral. Crystals rhombohedral, with curved faces. Perfect rhombohedral cleavage. Commonly cleavable or granular massive. Also in botryoidal and globular forms, compact or earthy. Pure mineral 48.2% Fe.

May be formed by action of organic matter upon iron carbonate solutions, by surface alteration of iron silicates, or by replacement of limestone.

Cochise County.—Bisbee district, boxwork siderite has proved a guide to ore.

Gila County.—Dripping Spring Mountains, with wulfenite and vanadinite, McHur prospect, Banner district.

Mohave County.—Cerbat Range, a common gangue mineral in the Chloride and Gold Basin districts.

Pima County.—Santa Rita Mountains, Iron Mask mine, Old Baldy district, with magnetite and tourmaline. Empire Mountains, Hilton mines.

Yavapai County.—Bradshaw Mountains, Lynx Creek, in veins with chlorite and tourmaline; Gold Note group, Turkey Creek district; Peck and Swastika mines, Peck district, with native silver and bromyrite. Large crystalline nodules from the vicinity of Yarnell.

Yuma County.—Dome Rock Mountains, in cinnabar veins with tourmaline. Harcuvar Mountains, as nearly jet-black cleavable material with chalcopyrite, Cunningham Pass.

RHODOCHROSITE

$MnCO_3$. Rose-red, gray, dark red, or brown; commonly coated with a black oxidation product. Luster vitreous to pearly. Translucent to opaque. Streak white. H. = 3.5-4.5. G. = 3.45-3.6. Hexagonal, scalenohedral. Crystals like dolomite in habit. Perfect rhombohedral cleavage. Cleavable to granular or compact massive.

In sedimentary deposits, in origin similar to siderite. Also as gangue, particularly in veins of lead and silver, and generally associated with other manganese minerals.

Cochise County.—Tombstone, as small grains in oxidized albandite ore from the Lucky Cuss mine.

Gila County.—Banner district, in the London Range shaft.

Santa Cruz County.—Patagonia Mountains, Trench mine, with alabandite, sphalerite, and galena.

SMITHSONITE—Calamine

$ZnCO_3$. White or some shade of gray, green, blue, or brown. Luster vitreous to dull and earthy. Subtransparent to opaque. H. = 5.5. G. = 4.3-4.45. Rhombohedral. Perfect rhombohedral cleavage. In curved and cavernous crusts or bands, and botryoidal or reniform masses, with granular or fibrous structure. Also as friable or earthy masses known as *dry bone*. Pure mineral 52% Zn.

Secondary, formed by action of carbonate waters upon zinc sulfide or by reaction between sulfate waters and limestone. Generally in the oxidized zone and commonly accompanied by the zinc silicate, hemimorphite. In places an important zinc ore.

Cochise County.—Tombstone district, as tiny rhombohedral crystals, Toughnut mine. Turquoise district, as incrustations and crystalline masses, Mystery and Silver Bill mines.

Greenlee County.—Shannon Mountains, Clifton-Morenci district.

Pima County.—Empire Mountains, Hilton mines. Sierrita Mountains, as dry bone, San Xavier district. Silver Bell district, as earthy mixtures of smithsonite and cerussite. North of Sells, locality undisclosed, as small rhombs, and also as pale blue botryoidal masses similar to the material from Kelley, New Mexico.

Pinal County.—Mammoth mine, as crusts and porous masses.

Santa Cruz County.—Patagonia Mountains, Westinghouse property, Duquesne, with cerussite, anglesite, chrysocolla, and cuprite.

Yuma County.—Trigo Mountains, with cerussite and yellow lead oxide in cellular to crystalline masses.

ARAGONITE

$CaCO_3$. White, gray, yellow, green, and violet. Luster vitreous. Transparent to translucent. Streak white. H. = 3.5-4. G. = 2.95. Orthorhombic, dipyramidal. Crystals generally acicular. Distinct pinacoidal and prismatic cleavages. In columnar or fibrous masses, or as stalctitic, globular, or coralloidal forms. *Flos ferri* is a coralloidal variety, in groupings of delicate interlacing stems.

Less common than calcite, formed from springs and from saline solutions that contain sulfate, thus occurring in beds of gypsum. Also in cavities in lavas and in limestone caverns.

Cochise County.—At Bisbee, as magnificent coralloidal groups of flos ferri in limestone caverns. Dragoon Mountains, as stalactites and stalagmites lining solution cavities in silver-lead deposits, Turquoise district.

Pima County.—Empire Mountains, as large fibrous and stalactitic masses, Hiltano district. Santa Rita Mountains, as flos ferri in Onyx Cave. Sierrita Mountains, in fissures of the San Xavier district, commonly stained by copper.

WITHERITE

$BaCO_3$. White, yellowish, grayish. Luster vitreous to dull. Streak white. Subtransparent to translucent. H. = 3.5. G. = 4.3. Orthorhombic, dipyramidal. Distinct pinacoidal cleavage. Massive, columnar, or granular. Pure mineral 77.7% BaO.

Of infrequent occurrence, most commonly in veins with galena. May be formed by direct crystallization from solutions carrying barium carbonate or by action of carbonated waters upon other barium minerals.

Yuma County.—Castle Dome Mountains, as gangue in lead ores, De Luce mine, Castle Dome district. (Nevius, 12)

CERUSSITE

$PbCO_3$. White to gray. Luster adamantine, vitreous, resinous, silky, or pearly. Transparent to subtranslucent. Streak uncolored. H. = 3-3.5. G. = 6.55. Orthorhombic, dipyramidal. Commonly as tabular, less commonly as prismatic or pyramidal crystals. Distinct prismatic cleavage. Massive or granular, rarely fibrous. Pure mineral 77.5% Pb.

A common secondary mineral of oxidized lead deposits, formed by reaction between carbonated waters and lead minerals or solutions. Generally as a concentric layer about anglesite which surrounds a core of unaltered galena.

Cochise County.—At Tombstone, the most common lead mineral of the district. Bisbee district, in Hendricks Gulch, as impure "sand carbonate" bunches in limestone, near a fault fissure. Chiricahua Mountains, as large twinned crystals, Hilltop mine. The principal lead mineral of the Turquoise district.

Gila County.—The ore mineral at the London-Arizona mines, Banner district. "79" mine, as "sand carbonate" and as beautifully crystallized material with anglesite, wulfenite, and vanadinite.

Graham County.—Aravaipa and Stanley districts.

Greenlee County.—Clifton-Morenci district, Hormeyer mine, with gold ore.

Mohave County.—Cerbat Range, Chloride, Mineral Park, and Gold Basin districts, in some properties associated with free gold; Tennessee-Schuylkill mine, Wallapai district. McCracken Peak, McCracken mine.

Pima County.—Santa Rita Mountains, Golden Gate and Blue Jay mines, Helvetia district; Greaterville district. Empire Mountains, Total Wreck and Hilton mines. Sierrita Mountains, San Xavier district, as "sand carbonate"; Paymaster mine, Olive Camp, as massive and crystallized material. Silver Bell Mountains, in silky crystals and as earthy mixtures with smithsonite, El Tiro and other mines. Quijotoa Mountains, Morgan mine, with cerargyrite.

Pinal County.—Mammoth mine, as magnificent twinned and reticulated crystal aggregates, Collins vein. A single crystal in the collection of the U.S. National Museum at Washington exhibits the following forms: (001), (010), (100), (110), (130), (012), (023), (011), (032), (021), (031), (041), (051), (102), (302), (111), (112), (211). Galiuro Mountains, Blue Bird and other lead deposits, Copper Creek district; Saddle Mountain group, Saddle Mountain district.

Santa Cruz County.—Santa Rita Mountains, Victor, Ivanhoe, and Rosario properties, Tyndall district; American Boy mine, Wrightson district. Patagonia Mountains, Flux and Domino mines as splendid crystals and as massive material at several other properties.

Yavapai County.—Black Hills, Copper Chief mine, Verde district. Bradshaw Mountains, Silver Belt mine, with cerargyrite in ancient workings.

Yuma County.—Trigo Mountains, Red Cloud mine, as crystal specimens up to 1½ inches long. Many of the crystals were arrow-shaped twins.

PHOSGENITE

$(Pb,Cl)_2CO_3$. White, gray, yellow. Luster adamantine. Transparent to translucent. Streak white. H. = 2.75-3. G. = 6-6.3. Tetragonal. In prismatic crystals with basal cleavage.

A rare secondary mineral, generally with cerussite in oxidized lead deposits.

Pinal County.—Mammoth mine, as slender prismatic crystals with diaboleite, 400-foot level, Collins vein.

MALACHITE

$Cu_2CO_3(OH)_2$. Color and streak green. Luster adamantine to earthy. Translucent to opaque. H. = 3.5-4. G. = 3.9-4.03. Monoclinic. Distinct crystals rare. Most commonly massive or incrusting, with botryoidal surface and a banded, divergent, or fibrous structure. Pure mineral 57.5% Cu.

A common alteration product in oxidized copper deposits. Generally associated with other secondary copper minerals, particularly azurite, cuprite, and tenorite. Only the more important occurrences are listed.

Cochise County.—Bisbee district, as magnificent specimens from the Copper Queen mine, one of the outstanding American localities, commonly as geodes lined with velvety crystals. Courtland-Gleeson district, in large masses at the Maid of Sunshine mine, in some places as small but superb crystals.

Coconino County.—Kaibab Plateau, impregnated in chert beds of wide extent.

Gila County.—Globe district, a considerable part of the ore of the Buffalo, Big Johnny, Buckeye, and other mines, but nowhere in large masses. Miami district, Inspiration mine, as malachite, chrysocolla, chalcedony, and quartz aggregates of great beauty. Payson district, as stout primatic crystals in porous quartz, Silver Butte mine.

Greenlee County.—Clifton-Morenci district, one of the most common oxidized ores in the limestone deposits, intimately associated with kaolin, limonite, azurite, and brochantite. Fine radiating groups of crystals were obtained from the Standard mine, near Metcalf.

Navajo County.—White Mesa district, as irregular masses in beds of sandstone.

Pima County.—Santa Rita Mountains, as globular masses and veinlets, Rosemont. Sierrita Mountains, abundant in the San Xavier district, and the most important oxidized mineral at Mineral Hill.

Yavapai County.—Black Hills, as fine specimen material with crystallized azurite, Yaeger mine.

Yuma County.—Buckskin Mountains, Planet mine.

AZURITE

$Cu_3(CO_3)_2(OH)_2$. Azure-blue to Berlin-blue. Luster vitreous to silky. Transparent to subtranslucent. Streak blue. H. = 3.5-4. G. = 3.77. Monoclinic. Characteristically in aggregates of small crystals. Two perfect cleavages. Also massive or dull and earthy. Pure mineral 55.3% Cu.

Of secondary origin, formed by action of carbonated waters upon copper minerals or of copper solutions upon limestone. Commonly found in oxidized copper ores, associated with malachite, limonite, cuprite, and native copper.

Cochise County.—Bisbee district, as magnificent crystal specimens at the Copper Queen mine, one of the outstanding American localities. Courtland-Gleeson district, in small amount and as large crystallized masses.

Coconino County.—Kaibab Plateau, as an extensive impregnation in chert beds.

Gila County.—Payson district, as crystallized masses at the Silver Butte, Golden Wonder, and Bishops Knoll mines.

Greenlee County.—Clifton-Morenci district, as large bodies in the Longfellow, Detroit, Manganese Blue, and Shannon mines. Sheaflike and spherical masses, up to 40 pounds in weight, were found in cavities or in kaolinized shale.

Pima County.—Sierrita Mountains, common in the San Xavier district. Santa Rita Mountains, as fine crystallized specimens from the Copper Mountains prospect of the Anaconda group.

Pinal County.—Superior District, as small but beautifully crystallized groups in the open cut at the Silver King mine.

Yavapai County.—Black Hills, as fine specimen material from the Yaeger mine, Black Hills district.

ROSASITE

$(Cu,Zn)_2CO_3(OH)_2$. Bright green to sky-blue. In mammillary spherules which break up into rectangular plates.

A rare mineral, in composition near the commoner aurichalcite.

Cochise County.—Tombstone district, as bright green mammillary spherules in siliceous lining of vugs and between hemimorphite crystals, Toughnut and Empire mines.

Pima County.—North of Sells, exact locality not disclosed.

AURICHALCITE

$(Zn,Cu)_5(CO_3)_2(OH)_6$. Pale green to sky-blue. Luster pearly. Translucent. G. = 3.64. Monoclinic. One perfect cleavage. As drusy incrustations or as fibrous seams.

A secondary mineral of oxidized copper and zinc ores.

Cochise County.—Tombstone district, as plumose aggregates of pale blue crystals on the west side of the Quarry "roll." Bisbee district, in upper portions of the Copper Queen ore body. Turquoise district, as incrustations and drusy linings of cavities in oxidized lead-silver deposits.

Pima County.—Empire Mountains, as small radiating fibrous masses and seams with smithsonite and hemimorphite, Lone Mountain mine. Sierrita Mountains, in fissures in garnetized limestone, San Xavier district. Also at an undisclosed locality north of Sells.

Pinal County.—Vekol Mountains, Reward mine.

HYDROZINCITE

$(Zn_5CO_3)_2(OH)_6$. White, grayish, or yellowish. H. = 2-2.5. G. = 3.58-3.8. Monoclinic. Crystals minute, thin blades. Massive, fibrous, earthy, or compact, commonly as incrustations.

A secondary mineral formed from alteration of sphalerite. Generally associated with smithsonite but less common.

Cochise County.—Tombstone district, in a small seam with aurichalcite and hemimorphite on the west side of the Quarry "roll."

Coconino County.—Havasu Canyon, with other secondary minerals of lead and zinc.

Pinal County.—Superior district, as a white film on sphalerite from the 1,600-foot level, Magma mine. Also from the Hancock property, near Superior.

Yuma County.—Castle Dome Mountains, with gypsum in fissures, Señora claims.

LOSEYITE

$(Mn,Zn)CO_3.5(Mn,Zn)(OH)_2$. Bluish white. H. = 3. G. = 3.27. Monoclinic. As elongated crystals.

A rare mineral, previously reported only from Franklin, New Jersey.

Pima County.—At an undisclosed locality north of Sells, with rosasite and smithsonite.

HYDROCERUSSITE

$2PbCO_3.Pb(OH)_2$. Colorless to snow-white. H. = 3.5. G. = 6.8. Hexagonal. As thin platy or stout pyramidal crystals.

A rare mineral of secondary origin usually found with other alteration products of lead sulfide.

Pinal County.—Mammoth mine, Collins vein, as snow-white hexagonal pyramids accompanying diaboleite and leadhillite.

BISMUTITE

Perhaps $Bi_2O_3.CO_2H_2O$. White, green, yellow, and gray. Luster vitreous to dull. H. = 4. G. = 7. As incrustations and earthy or compact masses.

Of secondary origin, generally formed by alteration of bismuthinite or native bismuth, but probably may form from any bismuth mineral.

Maricopa County.—Identified from this county, but the locality is not known.

Mohave County.—Hualpai Mountains, east of Yucca.

Yavapai County.—Eureka district, in prospects at the Granites, near the Bagdad mine, with bismuthinite.

SODA NITER—Nitratine

$NaNO_3$. White, reddish brown, gray, and lemon-yellow. Luster vitreous. Transparent to translucent. H. = 1-2. G. = 2.29. Taste cooling. Hegagonal, scalenohedral. Perfect rhombohedral cleavage. Massive, as incrustations, or in beds.

The main source of commercial nitrates. Formed by evaporation of ground-waters in arid climate, deposits commonly in beds.

Mohave County.—Rawhide Mountains, reported 3 miles south of Artillery Peak.

NITER—Saltpeter

KNO_3. Colorless to white. Luster vitreous. Translucent. H. = 2. G. = 2.09-2.14. Orthorhombic, prismatic. Perfect domal cleavage. In thin crusts and silky tufts.

A product of evaporation or formed from guano or by action of bacteria upon other animal remains. In some caves or old mine workings, generally in such small amount as to escape observation.

Coconino County.—Walnut Canyon, as a thin white covering on limestone shelves in ancient cliff dwellings.

Pinal County.—Galiuro Mountains, Aravaipa Canyon, as thin crusts and in cracks below caves.

Graham County.—Peloncillo Mountains, associated with caves.

NITROCALCITE

$Ca(NO_3)_2nH_2O$. Colorless to white. One perfect cleavage. In efflorescent silky tufts and masses.

Generally in limestone caverns, probably formed from calcium carbonate and guano or other animal remains.

Gila and Pinal counties.—In fissures up to 6 or 8 inches wide in Mississippian limestone along the Gila River 2 miles above Winkelman.

GERHARDTITE

$Cu_2NO_3(OH)$. Emerald-green. H. = 2. G. = 3.43. Orthorhombic. Two perfect cleavages. As pyramidal orthorhombic crystals and in mammilary coatings.

A secondary mineral formed in small amount in oxidized copper deposits under arid or semiarid conditions. Accompanies such minerals as atacamite, bronchantite, and copper carbonates.

Greenlee County.—On cliffs of granite porphyry in Chase Creek Canyon, as a bright green coating of small, roughly mammillary forms.

Yavapai County.—United Verde mine, as small crystals along fractures in massive cuprite. Analyzed by R. C. Wells as follows:

H_2O	CuO	N_2O_5	Total
11.49	66.26	22.25	100.00

COLEMANITE

$Ca_2B_6O_{11}.5H_2O$. Colorless to milky white, yellowish white, gray. Luster vitreous. Transparent to translucent. H. = 4-4.5. G. = 2.42. Monoclinic. Crystals short prismatic. Perfect pinacoidal cleavage. Massive cleavable to granular and compact.

Most commonly formed by evaporation of inland bodies of salt water.

Maricopa County.—As crystallized, colorless material in a fossil egg from gravels of the Gila River.

PHOSPHATES, ARSENATES, VANADATES, ANTIMONATES

Monazite
Apatite
Pyromorphite
Mimetite
Vanadinite
Triplite
Olivenite
Higginsite
Libethenite
Descloizite
Cuprodescloizite
Mottramite
Brackebuschite
Calciovolborthite
Dihydrite
Lazulite
Turquoise
Erythrite
Hewettite
Conichalcite
Volborthite
Bermanite
Chalcophyllite
Chalcosiderite
Torbernite
Meta-Torbernite
Carnotite
Tyuyamunite
Bindheimite
Ecdemite
Beudantite

MONAZITE

$(Ce,La,Di)PO_4$, usually with some thorium silicate, $ThSiSO_4$. Reddish, brownish, yellowish. Luster resinous. Translucent. H. = 5-5.5. G. = 5.0-5.3. Monoclinic. Crystals small and flattened. Perfect basal cleavage. In masses yielding angular fragments and in rolled grains. The chief source of thorium oxide, usually from 8 to 9%. Ce_2O_5 from 25 to 35%.

An accessory mineral in granite, gneiss, aplite, and pegmatite. Commercial quantities only in placers.

Mohave County.—Mohave Mountains, Chemehuevis district, 20 miles southeast of Topock, sparingly in stream gravels.

APATITE

$Ca_5(F,Cl)(PO_4)_3$. White or a light shade of green or blue, less commonly yellow, gray, red, or brown. Luster vitreous to resinous. Transparent to translucent. H. = 5. G. = 3.15-3.20. Hexagonal, dipyramidal. Crystals prismatic. Imperfect basal cleavage. In granular masses.

An accessory mineral, generally as minute crystals. More abundant in metamorphic rocks, particularly granular limestone. In places as beds in sedimentary rocks. A source of mineral fertilizers.

Graham County.—Aravaipa district, in micropegmatite, Fisher prospect, Turnbull Mountain.

Pinal County.—Galiuro Mountains, as crystals up to several inches long, Childs-Aldwinkle and Old Reliable mines, Copper Creek district.

Yavapai County.—As large crystals in granodiorite, Springfield group, Pine Grove district. Eureka district, as an accessory in titaniferous magnetite ores near Bagdad.

PYROMORPHITE

$Pb_5Cl(PO_4)_3$. Most commonly green, yellow, or brown. Luster resinous to adamantine. Subtransparent to translucent. Streak white or yellowish. H. = 3.5-4. G. = 6.5-7.1. Hexagonal, dipyramidal. Crystals prismatic. In globular, reniform, or botryoidal masses or incrustations. Pure mineral 76.4% Pb. Grades into mimetite with the phosphorus being replaced by arsenic.

Common in oxidized lead deposits, generally in small quantity. Formed through action of phosphoric acid upon galena and cerussite.

Cochise County.—Tombstone district, as tiny crystals.

Pima County.—Cerro Colorado, Cerro Colorado mine.

Pinal County.—Mammoth mine, as olive-green prisms on mottramite.

Santa Cruz County.—Patagonia Mountains, as incrustations, Trench mine. Harshaw district; Javelina prospect, Patagonia district.

MIMETITE

$Pb_5Cl(AsO_4)_3$. White, yellow, orange, brown. Luster resinous to adamantine. Subtransparent to translucent. Streak white. H. = 3.5. G. = 7-7.2. Hexagonal, dipyramidal. Crystals like pyromorphite in habit. In mamillary crusts. *Endlichite* is intermediate between mimetite and vanadinite.

Of uncommon occurrence. Formed by alteration of lead ores.

Cochise County.—Gallagher Vanadium property, near Charleston. Also at Bisbee.

Pinal County.—Mammoth mine, as bright orange or canary-yellow crusts or as coatings of tiny prismatic crystals. Galiuro Mountains, as endlichite, with wulfenite and quartz, Table Mountain mine.

Yavapai County.—Vulture district, in considerable masses, Domingo mine, Castle Creek.

Yuma County.—Castle Dome Mountains, Castle Dome district.

VANADINITE

$Pb_5Cl(VO_4)_3$. Red, orange, or yellow. Luster resinous to adamantine. Transparent to translucent. Streak white or yellowish. H. = 3. G. = 6.7-7.1. Hexagonal, dipyramidal. Crystals prismatic, commonly with hollow basal pinacoid. Also as globular incrustations. Pure mineral 19.4% V_2O_5, 73.1% Pb.

A comparatively rare mineral of some oxidized lead deposits, with wulfenite. descloizite, and cerussite.

Cochise County.—Tombstone district, on calcite, Tribute and Tombstone Extension mine. Gallagher Vanadium property, near Charleston. Huachuca Mountains.

Gila County.—Globe district, as splendid crystal specimens, Apache Vanadium property, 8 miles north of Globe. Dripping Spring Mountains, "79," McHur, Premier, and C and B (International) properties, Banner district.

Greenlee County.—As single doubly-terminated crystals in gravels of the Haggin placers along the Coronado Trail north of Metcalf.

Maricopa County.—Vulture Mountains, Collateral, Phoenix, Montezuma, and Frenchman mines. Hieroglyphic Mountains, with wulfenite in veins, White Peak district.

Mohave County.—Cerbat Range, El Dorado and Climax mines, Gold Basin district. Also at the Western Union mine, as sheaflike bundles and single doubly-terminated crystals.

Pima County.—Tucson Mountains, Old Yuma mine, as magnificent crystal specimens. Empire Mountains, Total Wreck mine.

Pinal County.—Mammoth mine, as splendid groups of crystals with wulfenite and descloizite. Dripping Spring Mountains, 4 miles east of Kelvin. Superior district, Black Prince mine, as doubly-terminated crystals.

Yavapai County.—As fine specimens from the property of the American Kirkland Gold mines.

Yuma County.—Trigo Mountains, as fine crystal aggregates, Silver Clip and Princess mines, and as brilliant deep red crystals, Red Cloud mine. Also reported from the Chocolate Mountains.

TRIPLITE

$(Fe,Mn)_5F_2(PO_4)_2$ (?). Brown or blackish brown. Luster resinous. Subtranslucent to opaque. Streak yellowish, gray, or brown. H. = 4-5.5. G. = 3.44-3.8. Monoclinic. Cleavage in two directions. Massive.

An unusual mineral found in pegmatite.

Yavapai County.—Eureka district, as a spherical segregation about 2 feet in diameter, in a small pegmatite knot on the 7 U 7 ranch. Analysis by F. A. Gonyer as follows:

FeO	MnO	MgO	CaO	Na_2O	H_2O	P_2O_5	F	Total
11.68	34.55	11.87	2.48	0.52	0.75	33.32	8.02	99.81

Also at other localities in the same general area.

OLIVENITE

$Cu_2AsO_4(OH)$. Various shades of green to yellowish. Luster adamantine to vitreous. Subtransparent to opaque. Streak olive-green to brown. H. = 3. G. = 4.1-4.4. Orthorhombic. Generally in crystals. Also globular, reniform, fibrous, and granular.

A rare secondary mineral of copper deposits.

Pinal County.—Galiuro Mountains, Copper Creek district, as small olive-green crystals, Old Reliable mine. Superior district, Magma mine, as small crystals with dioptase, from the outcrop at the No. 1 Glory Hole.

HIGGINSITE

$CuCa(AsO_4)(OH)$. Deep green to yellowish green. Transparent. H. = 4.5. G. = 4.33. Orthorhombic. In small prismatic crystal incrustations.

A secondary mineral in seams and cavities of copper ore bodies.

Cochise County.—Bisbee district, originally described from the Higgins mine, as crystals and small masses in manganese oxides. Analysis by E. V. Shannon as follows:

CuO	CaO	V_2O_5	As_2O_5	H_2O	Fe_2O_3	MnO	Insol.	Total
28.27	20.83	1.97	41.23	3.49	0.48	2.84	0.86	100.37

It also occurs as acicular tufts in cavities in limonite.

Pima County.—As small, green, cubic crystals in vugs in shattuckite from the New Cornelia mine, Ajo.

LIBETHENITE

$Cu_2(PO_4)(OH)$. Dark olive-green. Luster resinous. Translucent to subtranslucent. Streak olive-green. H. = 4. G. = 3.6-3.8. Orthorhombic. Crystals short prismatic. In globular, reniform, or compact masses.

A rare mineral found in a few copper deposits of the world.

Greenlee County.—Morenci district, as small crystals in cavities, Coronado mine.

DESCLOIZITE—CUPRODESCLOIZITE—MOTTRAMITE

$PbZnVO_4(OH)$ to $PbCuVO_4(OH)$, forming a continuous series. Red, brownish red, brown, black. Translucent. Streak orange to brownish red or yellowish gray. H. = 3.5. G. = 5.9-6.2. Orthorhombic. Generally in drusy aggregates of small crystals. *Psittacinite* is synonymous with mottramite. Pure mineral about 40% V_2O_5.

Of secondary origin, in small amounts in some oxidized lead-zinc or copper deposits.

Cochise County.—Bisbee district, mottramite, as crystals from the Higgins mine, and as reniform masses from the Shattuck mine. Tombstone district, mottramite, as brilliant black crystals, Lucky Cuss and Toughnut mines. As descloizite, Tombstone Extension and Tougnut mines. Pat Hills, as mottramite.

Coconino County.—Havasu Canyon, as fine stalactitic crystal groups.

Gila County.—Payson district, as cuprodescloizite in small amounts, Ox Bow and Zulu mines. Globe district, 2 miles north of the Old Dominion mine, as descloizite, and on the 400-foot level, Comstock Extension mine.

Maricopa County.—Vulture Mountains, at the Black Hawk property, 1 mile south of the Vulture mine, as a velvety coating of fine crystals.

Mohave County.—Grand Wash Cliffs, as descloizite, Grand Gulch mine, Bentley district.

Pima County.—Tucson Mountains, as cuprodescloizite, Old Yuma mine.

Analysis by F. N. Guild as follows:

V_2O_5	PbO	CuO	ZnO	MnO	H_2O	Total
23.02	52.26	11.64	6.71	2.16	2.52	98.31

Pinal County.—Mammoth mine, as descloizite and mottramite, forming

crusts of small pointed crystals. Dripping Spring Mountains, 4 miles east of Kelvin.

Santa Cruz County.—Near Nogales, locality unknown, as reddish fibrous layers of cuprodescloizite up to an inch thick.

BRACKEBUSCHITE

$(Pb,Mn,Fe)_3(VO_4)_2$ (?). Black. Monoclinic (?). In prismatic crystals.

A secondary mineral, in small quantities with other vanadium minerals.

Cochise County.—Reported in minute amounts from the Gallagher Vanadium property, near Tombstone.

CALCIOVOLBORTHITE

$(Cu,Ca)_2VO_4(OH)$ (?). Yellow, green. H. = 3.5. G. = 3.5. Monoclinic (?). In pseudohexagonal scales, rosettes, and as fine granular masses.

A secondary mineral, in small quantities accompanying other vanadium minerals.

Cochise County.—Reported from the Gallagher Vanadium property, near Tombstone.

DIHYDRITE

$Cu_3P_2O_8.2Cu(OH)_2$. Dark emerald-green. H. = 4.5-5. G. = 4-4.4. Triclinic. As distinct crystals or as fibrous aggregates.

A secondary rare mineral previously reported from only a few localities in the world.

Gila County.—Miami district, Castle Dome mine, as small, dark emerald-green crystals.

LAZULITE

$MgAl_2(OH)_2(PO_4)_2$. Azure-blue. Luster vitreous. Translucent. H. = 5-5.5. G. = 3-3.1. Monoclinic. Usually massive, granular to compact.

A rare mineral, usually found in pegmatites or metamorphic rocks.

Maricopa County.—Reported from a locality on the Phoenix-Cave Creek road, 1.2 miles north of Hyatt's Camp.

TURQUOISE

$Al_2(OH)_3PO_4H_2O+xCu$. Sky-blue, bluish green to apple-green. Luster waxy. Streak white or greenish. H. = 6. G. = 2.6-2.8. Triclinic. Massive, with amorphous or cryptocrystalline structure. In thin seams, disseminated grains, or incrustations.

An uncommon mineral of secondary origin, found in altered rocks.

Cochise County.—Turquoise district, as stringers up to a few inches wide and small nuggetlike masses in granite and quartzite. Bisbee, as minute stringers in massive pyrite, 1,200-foot level, Cole shaft. Also reported from Pearce vicinity.

Gila County.—Globe district, in small amount with copper ores; also Sleeping Beauty area. Miami district, Castle Dome mine, in large quantities; also on Canyon Creek.

Maricopa County.—Reported 12 miles east of Morristown.

Mohave County.—Cerbat Range, Ithaca Peak, Mineral Park district, as gem material in prophyry cutting schist and gneiss.

Pinal County.—Reported 2 miles south of Kelvin.

ERYTHRITE—Cobalt Bloom

$Co_3(AsO_4)_2.8H_2O$. Crimson to peach-red. Luster adamantine, vitreous, or pearly to dull and earthy. Transparent to subtranslucent. Streak paler than the color. H. = 1.5-2.5. G. = 2.95. Monoclinic. Crystals prismatic and vertically striated. Perfect pinacoidal cleavage. Globular, reniform, or earthy.

Of secondary origin, characteristic of outcrops of cobalt ores.

Apache County.—White Mountains, exact locality unknown, with cobaltite.

Gila County.—Reported from ½ mile northeast of the Mule Shoe Bend of the Salt River.

Yavapai County.—Black Hills, as powdery incrustations from alteration of cobaltite near claims of the old Prudential Copper Mining Co.

HEWETTITE

$CaO.3V_2O_5.9H_2O$. Deep red. G. = 2.5-2.6. Orthorhombic. In needles or fibrous incrustations.

A rare secondary product found with other vanadium minerals.

Apache County.—Carrizo Mountains, as hairlike crystals and fibrous incrustations in sandstone with carnotite.

CONICHALCITE

Perhaps $(Cu,Ca)_2AsO_4(OH).½H_2O$. Pistachio-green to emerald-green. H. = 4.5. G. = 4.1. Orthorhombic. Fibrous. Resembles malachite.

An uncommon secondary mineral of oxidized copper deposits.

Gila County.—Globe Hills, Copper Hill mine.

VOLBORTHITE

A hydrous vanadate of copper, barium, and calcium. Olive-green to citron-yellow. Pearly to vitreous luster. Streak yellowish green. H. = 3. G. = 3.5. Monoclinic (?). In small six-sided tablets or globular forms.

A rare mineral of uncertain origin. Reported from copper and lead ores of the state (1:17) but no specific localities were given.

BERMANITE

$(Mn^{II},Mg)_5Mn_2(PO_4)_8(OH_{(01}.15H_2O$. Reddish Brown. H. = 3.5. G. = 2.84. Orthorhombic. Perfect basal, imperfect prismatic cleavage. Crystals of pronounced tabular habit. Also cleavable massive.

A new species discovered in 1936 in a pegmatite knot on the 7 U 7 ranch near the Bagdad mine, Yavapai County, as narrow veinlets and small crystals in triplite. Accompanied by torbernite and other phosphates. Analysis by F. A. Gonyer as follows:

Fe_2O_3	Mn_2O_3	MnO	MgO	CaO	Na_2O	H_2O	P_2O_5	Total
3.03	26.76	13.79	2.39	0.72	0.32	19.33	31.39	99.73

CHALCOPHYLLITE

$Cu_{20}Al_2(AsO_4)_4(SO_4)_3(OH)_{14}11H_2O$ (?). Emerald-green to grass-green. Luster vitreous. Transparent to translucent. Streak paler than the color. H. = 2. G. = 2.4-2.66. Rhombohedral. Crystals tabular. Perfect basal cleavage. As foliated masses or in druses.

A comparatively rare secondary mineral of oxidized copper deposits.

Cochise County.—Bisbee district, in irregular crystal plates imbedded in connellite, Calumet and Arizona mine.

CHALCOSIDERITE

$CuFe_5(OH)_8(PO_4)_4.10H_2O$ (?). Light siskin-green. H. = 4.5. G. = 3.1. Triclinic. As incrustations of sheaflike crystal groups.

A rare secondary mineral, found in oxidized copper deposits.
Cochise County.—Bisbee district, in small quantity.

TORBERNITE

$Cu(UO_2)_2(PO_4)_2(.12H_2O)$. Emerald-green to pale green. Luster subadamantine to pearly. Transparent to subtranslucent. Streak paler than color. H. = 2-2.5. G. = 3.2. Orthorhombic, pseudo-tetragonal. Crystals square tabular. Also foliated or micaceous. *Meta-torbernite* is a dehydration product, with $8H_2O$. G. = 3.68. Dehydration takes place at ordinary temperatures, and the same specimen can be one or the other at different times. It is probably commoner than torbernite.

A rare species, usually associated with other uranium minerals.
Gila County.—Miami district, as meta-torbernite in a rosettes and spherical aggregates of apple-green scales at the Castle Dome mine.
Yavapai County.—Eureka district, as torbernite in small amounts with bermanite and triplite in a pegmatite knot on the 7 U 7 Ranch.

CARNOTITE

$K_2(UO_2)_2.(VO_4)_28H_2O$. As yellow crystalline powder, or in loosely cohering masses intimately mixed with sandy rock. Pure mineral 64.5% U_3O_8, 21.2% V_2O_5.

Apache County.—West of Carrizo Mountains, in Morrison (McElmo) sandstone.
Navajo County.—Monument Valley, with fossil wood in Shinarump sandstone.
Maricopa County.—Vulture Mountains, southeast of Aguila, in tuff.

TYUYAMUNITE—Calciocarnotite

$Ca(UO_2)_2(VO_4)_2.H_2O$) (?) G. = 3.7-4.3. Orthorhombic. One perfect and two distinct pinacoidal cleavages. As scales, or cryptocrystalline and earthy.

A rare mineral in places accompanying carnotite.
Cochise County.—Bisbee district, in small amount from an unknown locality.

BINDHEIMITE

A hydrous antimonate of lead. Color and streak gray, brownish, or yellowish. Resinous luster. Amorphous. As reniform or earthy masses or incrustations.

A secondary mineral, generally in small quanties in oxidized antimonial lead ores.
Cochise County.—Tombstone district, as yellowish gray spots in siliceous ores.
Santa Cruz County.—Patagonia Mountains, in small amounts, Mowry mine.

ECDEMITE

$Pb_3Cl_2AsO_4$ (?). Bright yellow to green. H. = 2.5. G. = 6.9-7.1. Tetragonal. As incrustations of tiny prismatic crystals. Also massive.

A rare secondary mineral found in some oxidized lead ores.
Pinal County.—Mammoth mine, as bright orange incrustations on wulfenite crystals.

BEUDANTITE

$PbFe_3(SO)_4(AsO_4)_6.6H_2O$ (?). Green to brown and black. H. = 4. G. = 4.1. Rhombohedral crystals with basal cleavage.

A rare mineral generally found in limonitic ores.
Pinal County.—Mammoth mine, as bright orange incrustations on wul- tufts of yellowish green fibers.

SULFATES, CHROMATES, TELLURITES

Thenardite	Spangolite	Pickeringite	Beaverite
Glauberite	Brochantite	Halotrichite	Copiapite
Barite	Antlerite	Kornelite	Rhomboclase
Celestite	Linarite	Coquimbite	Lausenite
Anglesite	Mirabilite	Alunogen	Butlerite
Anhydrite	Gypsum	Ransomite	Alunite
Crocoite	Epsomite	Guildite	Jarosite
Phoenicochroite	Goslarite	Louderbackite	Natrojarosite
Vauquelinite	Melanterite	Voltaite	Plumbojarosite
Leadhillite	Pisanite	Roemerite	Chalcoalumite
Caledonite	Chalcanthite	Cyanotrichite	Emmonsite
Connellite			

THENARDITE

Na_2SO_4. White, grayish, or brownish. Luster vitreous. Translucent to opaque. Streak white. Water soluble. H. = 2.7. G. = 2.68. Orthorhombic. Crystals pyramidal, short prismatic, or tabular. Good basal cleavage. In cleavable masses.

Formed by evaporation of salt lakes, commonly along the shores.

Pinal County.—Near Maricopa.

Yavapai County.—Verde Valley, as extensive beds in the salt deposits 3 miles southwest of Camp Verde.

GLAUBERITE

$Na_2Ca(SO_4)_2$. Pale yellow to gray; also brick-red. Luster vitreous. Transparent to translucent. Streak white. Taste slightly saline. H. = 2.5-3. G. = 2.7-2.85. Monoclinic. Crystals thin tabular. Perfect basal cleavage.

Found in small quantities in salt beds.

Yavapai County.—In salt deposits of the Verde Valley, 3 miles southwest of Camp Verde.

BARITE

$BaSO_4$. White, yellow, gray, blue, red, or brown. Luster vitreous. Transparent to translucent. Streak white. H. = 3-3.5. G. = 4.5. Orthorhombic, dipyramidal. Crystals tabular or prismatic. Perfect basal and prismatic cleavage. Granular massive, lamellar, or concretionary. Pure mineral 65.7% BaO.

As a gangue mineral with sulfide ores. Also in veins or massive beds. Only the more important occurrences are listed.

Cochise County.—Tombstone district, Ground Hog mine, as a vein, and near the Lucky Cuss mine as white crystals. Dragoon Mountains, as veins, Middle Pass.

Coconino County.—Grand Canyon, as crystal masses in caves, Kaibab Trail.

Gila County.—Richmond Basin, abundant in veins.

Graham County.—Stanley district, abundant in several veins near Stanley Butte. Reported south of Klondyke.

Maricopa County.—Goldfield Mountains, as veins, Arizona Barite mine.

Mohave County.—Reported 20 miles from Boulder Dam. Aquarius Range, as veins. Near Alamo crossing, as veins.

Pima County.—Comobabi Mountains, Cobabi district, with galena in veins.

Pinal County.—Galiuro Mountains, as tabular crystals and crystal groups, Old Reliable mine, Copper Creek district. Mammoth mine, as groups of large tabular crystals.

Yavapai County.—Bradshaw Mountains, gangue in several mines. Eureka district, Bagdad mine.

Yuma County.—Trigo Mountains, Mendevil claims, in veins. Castle Dome Mountains, in many veins, and as large, clear crystals with wulfenite and fluorite, Castle Dome mines. Mohawk Mountains, Barite mine, as white to pink radiating crystals in calcite veins.

CELESTITE

$SrSO_4$. White or bluish; reddish. Luster vitreous to pearly. Transparent to translucent. H. = 3-3.5. G. = 3.95-3.97. Orthorhombic, dipyramidal. Crystals like barite. Perfect basal, nearly perfect prismatic cleavage. Fibrous, columnar, and granular massive. Pure mineral 56.4% SrO.

In veins, beds, or lenticular masses in limestone or sandstone. Also with gypsum and halite, and in gangue of lead-zinc ores.

Maricopa County.—With gypsum in sandstone and conglomerate 15 miles south of Gila Bend. In fanglomerate, northeast slope of the Vulture Mountains, 15 miles southeast of Aguila.

Yuma County.—Plomosa district, with lead and silver ores.

ANGLESITE

$PbSO_4$. White; also yellow, brown, or gray. Luster adamantine to dull. Transparent to translucent. Streak uncolored. H. = 3. G. = 6.2-6.4. Orthorhombic, dipyramidal. Crystals prismatic or tabular. Distinct basal and prismatic cleavage. Granular to compact massive. Pure mineral 68.3% Pb.

Abundant in oxidized lead deposits, most commonly as masses surrounding galena and cerussite.

Cochise County.—Tombstone district, with galena, Tombstone Extension mine. Dragoon Mountains, as crystals in cavities, Silver Bill mine.

Gila County.—Dripping Spring Mountains, in large quantity with cerussite, wulfenite, and vanadinite, "79" mine, Banner district. Globe district, Lost Gulch mine.

Graham County.—Aravaipa and Stanley districts.

Mohave County.—Cerbat Range, at the Tennessee-Schuylkill mine, Wallapai district; in several mines of the Mineral Park district.

Pima County.—Empire Mountains, in the mines of the Hilton group. Sierrita Mountains, abundant at the Paymaster mine, Olive Camp. Quijotoa Mountains, at the Morgan mine.

Pinal County.—Galiuro Mountains, at the Saddle Mountain group. At the Mammoth mine.

Santa Cruz County.—Patagonia Mountains, at the Westinghouse and Mowry mines.

Yavapai County.—Bradshaw mountains, in the Copperopolis mine, Castle Creek district.

Yuma County.—Castle Dome Mountains, Castle Dome district.

ANHYDRITE

$CaSO_4$. White; but may be grayish, bluish, or reddish. Luster vitreous to pearly on cleavage. Transparent to translucent. Streak uncolored. H. = 3-3.5. G. = 2.89-2.98. Orthorhombic, dipyramidal. Crystals rare, usually in crystalline masses with rectangular cleavage; also fibrous, granular, massive.

Anhydrite is usually found in beds associated with salt deposits, limestone, or gypsum, but is not nearly so common as the latter.

Gila County.—Dripping Spring Mountains, Christmas Copper Company, as a fairly abundant constituent of diamond drill cores between the 1,000- and 1,200-foot levels.

CROCOITE

$PbCrO_4$. Bright hyacinth red. Luster adamantine. Translucent. Streak orange-yellow. H. = 2.5-3. G. = 5.9-6.1. Monoclinic. Crystals prismatic, slender and vertically striated. Distinct prismatic cleavage. Columnar and granular massive.

An unusual secondary mineral of oxidized lead deposits, formed by action of chromic acid.

Greenlee County.—Clifton-Morenci district, as a single specimen from an undisclosed locality.

Maricopa County.—Vulture Mountains, Collateral, Chromate, Blue Jay, and Phoenix mines. Also reported from near the Hassayampa River upstream from Amazon Wash.

Pinal County.—Mammoth mine, in small amounts with vanadium and wulfenite.

Yuma County.—Reported from the Castle Dome Mountains (1:17).

PHOENICOCHROITE

$Pb_3Cr_2O_6$. Cochineal- to hyacinth-red. H. = 3. G. = 5.75. Orthorhombic. One perfect cleavage. As crystals and massive material.

A rare secondary mineral accompanying crocoite in oxidized lead deposits.

Maricopa County.—Vulture Mountains, Collateral, Chromate, Blue Jay, and Phoenix mines.

VAUQUELINITE

$(Pb,Cu)_5(PO_4)_2(CrO_4)_2$ (?). Green to brown. H. = 2.5-3. G. = 6. Monoclinic. In crystals, mammillary, and reniform masses.

A rare secondary mineral of oxidized lead deposits.

Maricopa County.—Vulture Mountains, Collateral, Chromate, Blue Jay, and Phoenix mines.

LEADHILLITE

$Pb_4(CO_3)_2SO_4(OH)_2$. White, yellow, green, blue, or gray. Luster adamantine, resinous and pearly. Transparent to translucent. Streak uncolored. H. = 2.5. G. = 6.26-6.44. Monoclinic. Perfect basal cleavage. In tabular crystals or cleavable masses.

A rare secondary mineral of oxidized lead deposits. Closely resembles cerussite.

Cochise County.—Bisbee district, locality and mode of occurrence unknown.

Pinal County.—Mammoth mine, with other rare minerals, 400-foot level of the Collins vein as crystals with brilliant basal cleavage. Some of the crystals are prismatic, composed of sectors of monoclinic symmetry; others are pseudorhombohedral or tabular, composed of 2, 3, or 6 individuals, twined according to the Artini law.

CALEDONITE

A basic sulfate-carbonate of lead and copper. Deep bluish green to pale blue. Luster vitreous to adamantine. H. = 2.5-3. G. = 5.64-6.4. Orthorhombic. Perfect basal, distinct pinacoidal, cleavage. In prismatic crystals striated vertically, or in confused crystal masses.

A secondary mineral of rare occurrence.

Pinal County.—Mammoth mine, as excellent crystals, 400-foot level, Collins vein. Forms: (100), (120), (010), (101), (111), (131), (011).

CONNELLITE

$Cu_{22}Cl_4(OH)_{32}SO_4H_2O$ (?). Deep blue. Tanslucent. H. = 3. G. = 3.4. Hexagonal. As slender, prismatic crystal aggregates. *Footeite* is identical with connellite.

A secondary mineral of considerable rarity from oxidized copper deposits, generally in small cavities in cuprite.

Cochise County.—Bisbee district, Copper Queen, Calumet and Arizona, and Czar mines, as small radiating aggregates of slender crystals. Analysis by W. M. Bradley as follows:

CuO	Cl	SO_3	N_2O_5	H_2O	Total
73.38	6.82	3.15	0.72	17.13	101.20

Tombstone district, as small clusters of crystals in cuprite, Toughnut mine.

Pima County.—At Ajo, in a vug lined with cuprite crystals.

SPANGOLITE

$Cu_6AlClSO_{10}9H_2O$. Dark green. H. = 2.5. G. = 3.1. Hexagonal. In small tabular or short hemimorphic crystals with basal cleavage.

A rare mineral, originally described from an unknown locality thought to be in Pinal County, near Globe. As crystals on a rounded mass of impure cuprite.

Cochise County.—Reported from the Bisbee district, but the locality is not known.

Greenlee County.—Clifton-Morenci district, as a scaly coating on chrysocolla from Metcalf.

BROCHANTITE

$Cu_4(OH)_6SO_4$. Emerald-green to dark green. Luster vitreous. Transparent to translucent. Streak green. H. = 3.5-4. G. = 3.9. Orthorhombic. Crystals prismatic or flattened. Perfect brachypinacoidal cleavage. Massive, with reniform structure. Pure mineral 56.2% Cu.

A common secondary mineral in oxidized copper deposits. Generally confused with malachite, with which it is commonly associated.

Cochise County.—Bisbee district, widely distributed as an intergrowth with malachite; in magnificent coarse crystalline masses at the Shattuck mine. Tombstone district, as needlelike crystals lining vugs in cuprite.

Greenlee County.—Clifton-Morenci district, abundant as an intergrowth with malachite, less commonly as crystals.

Mohave County.—Grand Wash Cliffs, Grand Gulch mine, Bentley district.

Pima County.—Silver Bell district.

Pinal County.—Galiuro Mountains, Copper Creek district.

Yavapai County.—Black Hills, United Verde mine.

Yuma County.—Buckskin Mountains, Mineral Hill property.

ANTLERITE

$Cu_3(OH)_4SO_4$. Emerald to blackish green. Luster vitreous. Transparent to translucent. H. = 3.5-4. G. = 3.9. Orthorhombic, dipyramidal. Crystals slender prismatic, vertically striated; often acicular. Also in parallel aggregates, reniform or massive.

A rare secondary mineral, generally mistaken for brochantite, which it resembles.

Cochise County.—Bisbee district, with brochantite.

Mohave County.—Hualpai Mountains, at the Antler mine, from which it was first described, as soft green lumps.

LINARITE

$(Pb,Cu)_2(OH)_2SO_4$. Deep azure-blue. Luster vitreous. Subtranslucent. Streak pale blue. H. = 2.5. G. = 5.4. Monoclinic. Perfect orthopinacoidal cleavage. Most commonly as columnar or platy masses.

An uncommon secondary mineral generally mistaken for azurite.

Graham County.—Aravaipa district, in the Tenstrike group.

Pinal County.—Mammoth mine, with cerussite and wulfenite. In places as perfect crystals with the forms (110), (101), ($\bar{1}$01), (001), (111), (201), ($\bar{2}$12).

MIRABILITE

$Na_2SO_4.10H_2O$. White. Luster vitreous. Transparent to opaque. Streak white. Taste cool, then saline and bitter. Water soluble. H. = 1.5-2. G. = 1.481. Monoclinic. Crystals like pyroxene in habit and angle. Generally in efflorescent crusts.

Formed most commonly by evaporation of salt lakes, but also found in old mine workings.

Yavapai County.—In salt deposits of the Verde Valley, with halite, thenardite, and glauberite.

GYPSUM

$CaSO_4.2H_2O$. White; also gray, reddish, yellowish, brown, or black. Luster vitreous to satiny. Transparent to translucent. H. = 2. G. = 2.32. Monoclinic. Crystals tabular or prismatic. Perfect clinopinacoidal cleavage, yielding thin plates. Massive to earthy. *Alabaster* is fine-grained, *selenite* clear and lustrous, *satin spar* is fibrous.

The commonest sulfate mineral. Most abundant in beds in sedimentary rocks, formed by evaporation of salt waters or by alteration of anhydrite. Also found in oxidized sulfide ores.

Cochise County.—Near Douglas, mined for plaster and other gypsum products. Analysis by Arizona Gypsum Plaster Co., as follows:

CaO	SO_3	CaSO	$Fe_2O_3+Mn_2O_3$	SiO_2	H_2O
31.00	44.17	79.05	1.00	1.60	21.86

Sulphur Spring Valley, as beds in recent lake sediments. San Pedro Valley, deposits reported both north and south of Benson.

Greenlee County.—Clifton-Morenci district, common in oxidized deposits in limestone.

Maricopa County.—Fifteen miles south of Gila Bend, as beds in sandstone and conglomerate, with celestite. Reported from the Superstition Mountains (1:17).

Mohave County.—Abundant in the Virgin Valley badlands, as thick beds in South Mountain and Quail Canyon. Williams River, in beds northeast of the Planet mine. As satin spar, Mammoth claim, 60 miles southeast of Kingman.

Navajo County.—Near Winslow, mined for several years. As large plates of selenite, Fort Apache Indian Reservation.

Pima County.—Empire, Santa Rita, and Sierrita mountains, as beds up to 50 feet thick below the Snyder Hill limestone. Santa Catalina Mountains, foothills north of Tucson. In recent sediments near Vail.

Pinal County.—As thick beds in lake deposits near Feldman and Reddington. Galiuro Mountains, Copper Creek district, as layers in Gila conglomerate.

Yavapai County.—In salt deposits of the Verde Valley.

Yuma County.—Plomosa Mountains, at Mudersbach camp, as a bed several feet thick. Eastern foot of Harquahala Mountains, as beds.

EPSOMITE—Epsom Salt

$MgSO_4.7H_2O$. White or colorless. Luster vitreous to earthy. Transparent to translucent. Streak white. H. = 2-2.5. G. = 1.75. Taste bitter. Orthorhombic, disphenoidal. Cleavage perfect brachypinacoidal. As long slender fibers, fibrous crusts, or botryoidal masses.

Generally as efflorescence in old mine workings or natural caves.

Greenlee County.—Clifton-Morenci district, as delicate efflorescence on the walls of tunnels.

Pima County.—Silver Bell Mountains, as capillary hairs, El Tiro mine.

GOSLARITE

$ZnSO_4.7H_2O$. White, reddish, yellowish. H. = 2. G. = 2. Orthorhombic-sphenoidal. Crystals acicular or hairlike. Perfect brachypinacoidal cleavage. Massive or as incrustations. *Cuprogoslarite* is a blue variety containing copper.

Formed by decomposition of sphalerite, or by action of sulfate waters upon smithsonite. Most common on walls of old mine workings.

Gila County.—Globe district, as efflorescence, Continental and Old Dominion mines.

Greenlee County.—Clifton-Morenci district, as efflorescence, Arizona Central mine.

Mohave County.—Chloride district, at the De la Fontaine property.

Pima County.—As cuprogoslarite in old workings, Silver Bell district.

MELANTERITE

$FeSO_4.7H_2O$. Green to white; becomes yellowish on exposure. Luster vitreous. Subtransparent to translucent. Streak uncolored. H. = 2. G. = 1.89-1.90. Monoclinic. Perfect basal, less perfect primatic cleavage. Fibrous, massive, or earthy.

Formed from oxidation of iron sulfides.

Greenlee County.—Clifton-Morenci district, sparingly in the upper mine levels.

Pima County.—Sierrita Mountains, as efflorescence on walls of old workings, Mineral Hill district.

PISANITE

$(Fe,Cu)SO_4.7H_2O$. Blue. Luster vitreous. H. = 1-2. Monoclinic. Basal cleavage. In long slender prisms and concretionary or stalactitic forms.

A secondary mineral formed from oxidation of iron and copper sulfides. Generally of recent formation.

Gila County.—Globe district, 15th level, Old Dominion mine.

Pima County.—Silver Bell Mountains, in small amounts, El Tiro mine.

CHALCANTHITE

$CuSO_4.5H_2O$. Deep azure-blue. Luster vitreous. Transparent to translucent. Streak uncolored. H. = 2.5. G. = 2.12-2.3. Triclinic. With stalactitic, reniform, fibrous or compact structure.

Generally deposited from mine waters in cavities in the oxidized zones.

Cochise County.—Bisbee district, as stalactites and fibrous crusts in old mine workings.

Gila County.—Globe district, as stalactites or as a coating on floors of old openings, Old Dominion mine.

Greenlee County.—Clifton-Morenci district, as small bodies in the oxidized ores of Copper Mountain and as stalactites nearly filling one of the upper drifts, Jay shaft.

Pima County.—Silver Bell Mountains, as thick coatings in old workings, Silver Bell district. Santa Rita Mountains, Rosemont, as fibrous veins.

Pinal County.—Galiuro Mountains, as coatings on walls of drifts and in fractures, Old Reliable and Copper Giant mines.

Yavapai County.—United Verde mine, as stalactites up to 2 feet long.

PICKERINGITE

$MgSO_4.Al_2(SO_4)_3.22H_2O$. Colorless, yellowish to red. H. = 1. G. = 1.85. Monoclinic. In long fibers, fibrous masses, or as efflorescences.

A weathering product of pyritic schists, usually associated with other members of the alum group of minerals.

Cochise County.—Reported to occur in large quantities some 30 miles east of Douglas.

HALOTRICHITE

$FeAl_2(SO_4)_4.22H_2O$. Yellowish. H. = 2. G. = 1.9. Monoclinic. In silky fibrous forms.

Commonly formed from weathering of rocks containing disseminated pyrite, but also by action of sulfate waters upon rocks containing potassium and aluminum silicates.

Cochise County.—Tombstone district, as material previously identified as ettringite.

KORNELITE

$Fe_2(SO_4)_3.7H_2O$. Pale rose or violet. Silky luster. G. = 2.306. Orthorhombic. Prismatic and pinacoidal cleavage. As primatic or fibrous tufts.

A rare mineral formed by evaporation in old mine workings.
Cochise County.—Bisbee district, in irregular porous crusts, Copper Queen mine.

COQUIMBITE

$Fe_2(SO_4)_3.9H_2O$. White, yellowish, brownish. H. = 2-3. G. = 2.1. Rhombohedral or trigonal. Perfect prismatic cleavage. As granular masses or crusts.

An uncommon mineral formed in oxidized sulfide ores, in old mine workings, or under fumarolic conditions.
Cochise County.—Bisbee district, as porous crusts in the Copper Queen mine.
Yavapai County.—At the United Verde mine, as a result of burning of pyritic ore.

ALUNOGEN

$Al_2(SO_4)_3.16H_2O$. White, yellow, or red. H. = 1.5-2. G. = 1.65. Monoclinic or triclinic. As rosettes of thin crystals; also as fibrous masses or crusts.

Formed under fumarolic conditions or by decomposition of pyrite.
Yavapai County.—United Verde mine, as small crystal aggregates formed from burning of pyritic ore.

RANSOMITE

$Cu(Fe,Al)_2(SO_4)_4.7H_2O$ (?). Sky-blue. H. = 2.5. G. = 2.632. Orthorhombic. Perfect cleavage. In slender prisms.

Yavapai County.—United Verde mine, as crusts and small tufts of crystals formed as a result of burning of pyritic ore.

GUILDITE

$(Cu,Fe'')\ (Fe''',Al)_2(SO_4)_2.9H_2O$ (?). Deep chestnut-brown. H. = 2.5. G. = 2.725. Monoclinic. Perfect basal and orthopinacoidal cleavage. In crystals with a cubic habit.

Yavapai County.—Black Hills, United Verde mine, under fumarolic conditions as a result of burning of pyritic ore. Relatively rare. Crystals up to ½ centimeter in width.

LOUDERBACKITE

$Fe''(Fe''',Al)_3(SO_4)_5.17H_2O$ (?). Pale chestnut-brown. H. = 2.5-3. G. = 2.185. Orthorhombic. Two good cleavages. As thin crystalline crusts coating pyrite.

Yavapai County.—Black Hills, United Verde mine, formed under fumarolic conditions as a result of burning of pyritic ore. Relatively rare. As thin crusts on pyrite.

VOLTAITE

$(K_2,Fe'')\ (Al,Fe''')_3(SO_4)_3.9H_2O$ (?). Dull oil-green to brown or black. H. = 3-4. G. = 2.8. Isometric (?). Generally in octahedral crystals.

An uncommon mineral formed in oxidized sulfide ore bodies, on walls of old mine workings, and under fumarolic conditions.
Cochise County.—Bisbee district, in irregular porous crusts several inches thick in the Copper Queen mine, with coquimbite, roemerite, copiapite, kornelite, and rhomboclase.
Yavapai County.—Black Hills, United Verde mine, as black resinous cubo-octahedral crystals up to 5 millimeters in length, formed as a result of burning of pyritic ore.

ROEMERITE

$Fe''Fe_2'''(SO_4)_4.14H_2O$. Chestnut-brown. Taste saline, astringent. H. = 3-3.5. G. = 2.15. Triclinic. Crystals tabular. Granular, massive, or as crusts.

An uncommon mineral found on walls of old mine workings.
Cochise County.—Bisbee district, in porous crusts, Copper Queen mine.

CYANOTRICHITE—Lettsomite

$Cu_4Al_2SO_4.8H_2O$. Bright blue. G. = 2.74. Orthorhombic. In velvetlike druses or spherical forms.

A rare secondary mineral of some oxidized copper ores.
Coconino County.—Grand Canyon, Grandview mine, in methyl-blue capillary crystals; also from the Last Chance mine.
Greenlee County.—Clifton-Morenci district.

BEAVERITE

$CuPbFe_2(SO_4)_3.4H_2O$. Canary-yellow. Hexagonal. In microscopic plates.

Rare. Formed in oxidized lead-copper deposits.
Cochise County.—Tombstone district, in small quantities with cerussite, Empire and Toughnut mines.

COPIAPITE

$Fe_4(OH)_2(SO_4)_5.18H_2O$ (?). Sulfur-yellow to citron-yellow. Luster pearly. Translucent. H. = 2.5. G. = 2.1. Orthorhombic. Basal cleavage. In loose aggregates of crystalline scales, granular masses, or incrustations.

The most common ferric sulfate, formed under a variety of conditions. Probably more widely distributed in the state than the localities listed indicate.
Cochise County.—Bisbee district, in porous crusts. Copper Queen mine.
Pima County.—Sierrita Mountains, as silky fibers and foliated masses, Mineral Hill district.
Yavapai County.—United Verde mine, as incrustations, crystals, or crystalline masses formed by burning of pyritic ore.

RHOMBOCLASE

$Fe_2(SO_4)_4.9H_2O$. Clear and colorless to gray and opaque. H. = 2. Orthorhombic (?). Basal cleavage. Most commonly in rhombic plates.

A rare secondary mineral formed from highly acid sulfate solutions.
Cochise County.—Bisbee district, in porous crusts, Copper Queen mine.

LAUSENITE

$Fe_2(SO_4)_3.6H_2O$ (?). White. Monoclinic. In aggregates of minute, silky fibers.

Yavapai County.—United Verde mine, formed as a result of burning of pyritic ore.

BUTLERITE

$(Fe,Al)_2(SO_4)_2.5H_2O$. Deep orange. Orthorhombic. Brachypinacoidal cleavage. In minute pyramidal crystals.

Yavapai County.—United Verde mine, as a thin crystalline coating formed as a result of burning of pyritic ore.

ALUNITE

$KAl_3(OH)_6(SO_4)_2$. White, grayish, or reddish. Luster vitreous to earthy. Transparent to translucent. Streak white. H. = 4. G. = 2.6-2.8. Hexagonal, scalenohedral. Crystals high-angle rhombs. Distinct basal cleavage. Massive, with granular or impalpable texture.

Most abundant in wall rocks of sulfide ore bodies, formed by solutions under high pressure and temperature.

Gila County.—Globe district, as veins in diabase, Old Dominion mine. Dripping Spring Mountains, Apex mine, Banner district.

Greenlee County.—Clifton-Morenci district, Ryerson mine as grains, irregular masses, and fibrous aggregates in altered porphyry.

Santa Cruz County.—Patagonia Mountains, as alunitization of wall rock, 3R mine.

Yuma County.—Sugarloaf Butte, near Quartzsite, as irregular veins in dacite. Partial analysis by F. S. Wartman as follows:

Al_2O_3	SO_3	K_2O	Na_2O	SiO_2
36.5	38.1	4.85	4.3	1.2

JAROSITE

$KFe_3(OH)_6(SO_4)_2$. Yellow to brown. Luster vitreous, silky, dull. Streak yellow. H. = 2.5-3.5. G. = 3.15-3.26. Rhombohedral. Distinct basal cleavage, yielding micaceous flakes. Most commonly in scaly masses or crusts.

A secondary mineral of common occurrence in oxidized sulfide bodies.

Cochise County.—Tombstone district, abundant in the Toughnut and Empire mines. Turquoise district, as small flaky bunches. Commonwealth mine, Pearce, with cerargyrite and native silver.

Maricopa County.—Vulture Mountains, as minute transparent crystals, Vulture mine. Analysis by S. F. Penfield as follows:

SO_3	Fe_2O_3	K_2O	Na_2O	H_2O	Total
30.42	48.27	8.53	0.28	12.91	100.41

Also from the Black Rock mine, Vulture district.

Pima County.—Empire Mountains, Total Wreck mine, with wulfenite, vanadinite, and cerargyrite; in the Hilton mines with cerussite and smithsonite.

Yuma County.—Ajo district, as yellow coatings.

NATROJAROSITE

$Na_2Fe_6(OH)_{12}(SO_4)_4$. Yellowish brown. H. = 3. G. = 3.2. Hexagonal, rhombohedral. Usually as a glistening yellow-brown powder made up of minute crystals.

A secondary mineral similar in occurrence to jarosite.

Gila County.—From the vicinity of Globe, exact locality unknown.

Mohave County.—From near Kingman.

PLUMBOJAROSITE

$PbFe_6(OH)_{12}(SO_4)_4$. Dark brown. G. = 3.7. Rhombohedral. Crystals small and tabular. Rhomobohedral cleavage. Compact to earthy. Pure mineral 18.3% Pb.

Similar to jarosite in origin and occurrence, but less abundant.

Cochise County.—Tombstone district, abundant in brown oxide ore of the Holderness "roll." Material from the Empire mine assayed 58.92 ounces of silver, from the Toughnut mine up to 200 ounces.

Pima County.—Empire Mountains, as earthy masses, Hilton mines. Sierrita Mountains, San Xavier district.

Mohave County.—Cerbat Range, Tennessee-Schuylkill mine.

CHALCOALUMITE

$CuAl_2SO_4.9H_2O$. Turquoise-green. H. = 2.5. G. = 2.29. Probably triclinic. Several perfect cleavages. In matted fibrous crusts.

A rare secondary mineral found in a few oxidized copper deposits.

Cochise County.—Bisbee district, from which it was described in 1925, as delicate crusts on brown limonitic material.

EMMONSITE

Probably a hydrated ferric tellurite. Yellow green. H. = 5. Monoclinic. In thin scales.

A rare alteration roduct of other telluride minerals.

Cochise County.—Tombstone district (Hillebrand, 86).

TUNGSTATES AND MOLYBDATES

Ferberite	Scheelite	Stolzite
Wolframite	Cuprotungstite	Wulfenite
Huebnerite	Powellite	Ferrimolybdite

FERBERITE—WOLFRAMITE—HUEBNERITE

$FeWO_4$ to $MnWO_4$, forming a continuous series. Dark gray or brownish black. Luster submetallic. Opaque. Streak dark brown to nearly black. H. = 5-5.5. G. = 7-7.5. Monoclinic. Crystals commonly tabular. Perfect clinopinacoidal cleavage. In bladed, lamellar, or granular masses or as disseminated grains. Pure mineral 76.5% WO_3.

Most abundant in quartz veins in granite and schist that have been invaded by pegmatite. Commonly the only metallic minerals present, but in places accompanied by scheelite or sulfides. Detailed descriptions of occurrences in the state are given in Arizona Bureau of Mines Bulletin No. 148.

Cochise County.—Whetstone Mountains, in veins and replacements with scheelite, eastern slope of the range. Little Dragoon Mountains, in quartz veins and placer gravels.

Gila County.—Pinal Mountains, at several places south of Globe. West of Miami, on Pinto Creek. Spring Creek, southwest of Young. Mazatzal Mountains, northwest of Four Peaks.

Maricopa County.—Cave Creek district, as ferberite. Mazatzal Mountains, northwest of Four Peaks.

Mohave County.—Hualpai Mountains, in quartz veins of the Boriana, Telluride Chief, Laxton, and Moon properties. Aquarius Range, in quartz veins in the Williams and other mines in the vicinity of Boner Canyon. Also west of Cottonwood Cliffs and west of Greenwood Peak. White Hills, O. K. Mine, Gold Basin district.

Pima County.—Las Guijas Mountains. Baboquivari and Comobabi mountains.

Pinal County.—Tarr property, northwest of Mammoth, with scheelite.

Santa Cruz County.—Southeast of Calabasas. Patagonia Mountains, Red Mountain property.

Yavapai County.—Bradshaw Mountains, Tip Top and Tule Creek areas. Eureka district, in quartz veins, Black Pearl and Joy properties, south of Camp Wood. Silver Mountain district.

SCHEELITE

$CaWO_4$. White, yellow, brown, or green. Luster vitreous to adamantine. Transparent to translucent. Streak white. H. = 4.5-5. G. = 5.9-6.1. Tetragonal, dipyramidal. Distinct pyramidal cleavage. As pyramidal crystals, granular masses, or as disseminated grains. Pure mineral 80.5% WO_3.

Generally in quartz veins associated with pegmatite or granitic instrusives; in contact zones; and as replacements. Commonly associated with wolframite.

Cochise County.—Little Dragoon Mountains, in quartz veins, contact zones, and placers. Near the Republic mine, Johnston, crystals of scheelite are imbedded in quartz crystals. At the Cohen tungsten mine, 10 miles southwest of Willcox, as light brown crystals up to several pounds in weight, and as smaller crystals imbedded in gray, doubly-terminated quartz crystals. Whetstone Mountains, in quartz veins and replacements in granite, eastern slope of the range. Huachuca Mountains, Tungsten Reef, James, Harper, and other properties.

Maricopa County.—Mazatzal Mountains, northwest of Four Peaks. Near Morristown, on upper Santo Domingo Wash, with powellite.

Mohave County.—Hualpai Mountains, with wolframite in quartz veins, Boriana, Telluride Chief, and Laxton properties. Aquarius Range, sparingly at the Williams mine, Boner Canyon. In small amounts with Wolframite, Cottonwood and Greenwood areas. Mohave Mountains, Dutch Flat.

Pima County.—Las Guijas Mountains, sparingly present. Santa Rita Mountains, in contact-metamorphic zone, Helvetia district. Sierrita Mountains, in contact zones, Twin Buttes. Gunsight Hills.

Pinal County.—Campo Bonito area, Maudina and other properties. Northwest of Mammoth, Tarr and Antelope Peak areas.

Santa Cruz County.—Near Calabasas, with wolframite. Patagonia Mountains, with molybdenite 4 miles south of Duquesne.

Yavapai County.—Bradshaw Mountains, Tip Top district. Wickenburg Mountains, disseminated in garnet-epidote schist on upper San Domingo and Little San Domingo washes. Silver Mountain area.

Yuma County.—Trigo Mountains, in a sheared quartz vein, Gold Reef claims, Silver district.

CUPROTUNGSTITE

$CuWO_4$. Green. Luster vitreous to waxy. H. = 4.5. Cryptocrystalline or fibrous. *Cuproscheelite* is a variety with both copper and calcium.

Formed by replacement of the calcium in scheelite by copper; generally in concentric layers about scheelite.

Maricopa County.—Cave Creek district. Recalculated analyses by W. T. Schaller as follows:

WO_3	CuO	CaO	MgO	H_2O	Total
55.36	32.66	4.12	0.67	7.19	100.00
59.04	32.68	2.98	0.45	4.94	100.00

POWELLITE

$Ca(Mo,W)O_4$. Grayish to greenish yellow. Resinous luster. H. = 3.5. G. = 4.35. Tetragonal. In minute pyramidal crystals or as fine massive material.

An uncommon secondary mineral generally found in small quantities in tungsten ores.

Maricopa County.—Near Morristown, on Upper Santo Domingo Wash, with scheelite.

Mohave County.—Reported from Cerbat Range.

Pima County.—Helvetia district, disseminated with scheelite in contact zone near the Black Horse shaft.

STOLZITE

$PbWO_4$. Green to gray or brown. H. = 3. G. = 7.87-8.13. Tetragonal. In pyramidal crystals.

A rare secondary mineral found in some oxidized lead deposits.

Cochise County.—Dragoon Mountains, Primos mine, as small, highly complex, pale yellow crystals, in cavities in a quartz vein containing chalcopyrite, sphalerite, huebnerite, scheelite, fluorite and galena. A single crystal exhibited the following forms: (001), (130), (110), (011), (113), (111), (441), (137), and (133). Huachuca Mountains, Reef Mine, as pale yellow crystals, 1-2 mm. in length, on the walls of cavities in a quartz vein containing scheelite, galena, chalcopyrite, pyrite and limonite. Forms exhibited are (001), (320), (110), (111), and (121).

WULFENITE

$PbMoO_4$. Orange to bright red; also grayish or yellowish. Luster vitreous to adamantine. Transparent to subtranslucent. Streak white. H. = 3. G. = 6.8±. Tetragonal, dipyramidal. Generally as thin, square, tabular crystals. Pure mineral 26.2% Mo, 56.4% Pb.

An uncommon mineral generally considered to be secondary (11:38).

Cochise County.—Tombstone district, as clusters and rosettes of crystals. Turquoise district, in cavities, Mystery, Silver Bill, and Tom Scott workings. Chiricahua Mountains, Hilltop mine, as groups of deep yellow crystals.

Gila County.—Dripping Spring Mountains, Banner district, "79," McHur, Premier, C and B, and London Range properties.

Graham County.—Aravaipa district, Silver Coin and Dogwater mines.

Maricopa County.—White Peak district, 12 miles north of Beardsley.

Mohave County.—Rawhide Mountains, near Artillery Peak. Gold Basin district, Climax mine.

Pima County.—Tucson Mountains, Old Yuma mine, as deep orange-red crystal groups. Empire Mountains, Total Wreck and Hilton mines.

Pinal County.—Mammoth mine, in light yellow to bright red crystals containing tungsten. Black Prince mine, Superior district. Dripping Spring Mountain, 4 miles east of Kelvin.

Santa Cruz County.—Santa Rita Mountains, Gringo mine, Wrightson district, with native gold. Patagonia Mountains, Domino mine, Palmetto district, as beautifully crystallized specimens with galena, cerussite, and native silver.

Yuma County.—Trigo Mountains, as crystals, Red Cloud, Hamburg, and other properties. Specimens exhibiting unusual crystal forms have been obtained from the Melissa mine.

FERRIMOLYBDITE—Molybdite

$Fe_2Mo_3O_{12}.8H_2O$. Sulfur- to canary-yellow. H. = 1.5. G. = 4.5. Orthorhombic. In aggregates of crystal fibers.

Formed in small quantity by oxidation of molybdenite.

Pima County.—Santa Rita Mountains, as hairlike crystals and tufts near Madera Canyon. Average analysis by F. N. Guild as follows:

MoO_3	Fe_2O_3	H_2O	Total
60.805	21.835	17.355	99.995

Pinal County.—Galiuro Mountains, as yellow powder and radiating crystal aggregates, Childs-Aldwinkle mine, Copper Creek district.

Santa Cruz County.—Patagonia Mountains, Red Mountain mine.

SILICATES

Quartz	Andalusite	Zinnwaldite
Tridymite	Sillimanite	Biotite
Cristobalite	Kyanite	Chlorite
Opal	Gadolinite	Cronstedtite
Orthoclase	Zoisite	Vermiculite
Microcline	Clinozoisite	Serpentine
Albite-Anorthite	Epidote	Talc
Enstatite	Piedmontite	Sepiolite
Pyroxene	Allanite	Iddingsite
Wollastonite	Hemimorphite	Glauconite
Anthophyllite	Tourmaline	Kaolinite
Amphibole	Dumortierite	Halloysite
Beryl	Sphene	Endellite
Zunyite	Chevkinite	Montmorillonite
Garnet	Staurolite	Beidellite
Olivine	Hillebrandite	Nontronite
Fayalite	Ptilolite	Sauconite
Monticellite	Analcime	Anauxite
Willemite	Scolecite	Pyrophyllite
Dioptase	Thomsonite	Chrysocolla
Scapolite	Muscovite	Shattuckite
Idocrase	Mariposite	Bisbeeite
Zircon	Lepidolite	Thaumasite

QUARTZ

SiO_2. Colorless to various shades of yellow, red, brown, green, blue, and black. Luster vitreous and splendent to greasy or nearly dull. Transparent to translucent. H. = 7. G. = 2.65. Hexagonal, trigonal trapezohedral. No cleavage. Good conchoidal fracture. Commonly in prismatic crystals with the prism faces horizontally striated. Massive forms are common and in great variety, from granular to flintlike.

The most common of minerals, comprising about three fifths of the earth's crust. An essential component of many igneous and metamorphic rocks, sandstone, quartzite, gravel, and sand. It forms a large part of mineral veins and is deposited from waters of hot springs.

Quartz is so widespread and abundant that only a few typical occurrences are listed.

PHENOCRYSTALLINE QUARTZ

Rock crystal

Clear, colorless quartz, whether in distinct crystals or not. A common constituent of mineral veins but rare in large flawless masses which are of considerable value. Many localities other than those listed exist in the state.

Cochise County.—Little Dragoon Mountains, Johnson district, as well-formed crystals, some of which reach large size.

Gila County.—Globe district, Old Dominion mine, where crystals colored blue by chrysocolla line cavities in oxidized ores, and some of the massive quartz is brilliant red due to finely divided hematite. Payson district, as clear crystals up to 1 inch long at the Ox Bow mine.

Graham County.—As good crystals in druses of veins of the Tenstrike group, Aravaipa district.

Mohave County.—Oatman and Katherine districts, as colorless crystals in abundance in the gold veins.

Pima County.—Tucson Mountains, as geodes in basalt flows near "A" Mountain.

Pinal County.—Galiuro Mountains, Copper Creek district, as good crystals up to several inches long.

Yavapai County.—Bradshaw Mountains, Cash mine, Hassayamapa district, where clear crystals lining open veins are accompanied by crystals of adularia, calcite, and ore minerals.

Yuma County.—As large crystals in pegmatites of pre-Cambrian granites over considerable areas.

Amethyst

Clear purple or bluish violet. Generally in crystals, less commonly massive. A valuable gem stone.

Gila County.—Mazatzal Mountains, as crystals lining vugs in Mazatzal quartzite of Four Peaks.

Mohave County.—Cerbat Range, as crystals in pre-Cambrian granite of the McConnico district, northeast of Boulder Spring. Black Mountains, as bands in colorless quartz of gold veins of the Oatman and Katherine districts.

Santa Cruz County.—Sierra de Tordillo mine, Parker Canyon district. Patagonia Mountains, as large crystals in pegmatite near Duquesne.

Rose quartz

Rose red or pink; becomes paler upon exposure. Generally massive. Luster somewhat greasy. Color is perhaps due to titanium.

Mohave County.—Black Mountains, locally abundant in gangue of Moss mine, Oatman district. Specimens of good quality have been received from a locality 40 miles northeast of Kingman.

Sandstone and quartzite

Compacted or cemented quartz sand. Widely distributed in large quantities throughout the state. In some localities it has been quarried for building purposes.

Cryptocrystalline Quartz

Chalcedony

Includes cryptocrystalline quartz with a waxy or greasy luster, either transparent or translucent, ranging from white through gray, blue, pale brown, dark brown, and black. Occurs as mammillary, botryoidal, or stalactitic masses, lining or filling cavities in rocks.

Apache and Navajo counties.—The main constituent of petrified wood at various localities, most abundant at the Petrified Forest, near Holbrook.

Gila County.—Globe district, Old Dominion mine, in place colored blue or green from intergrown chrysocolla or malachite.

Mohave County.—Black Mountains, Gold Road and Gold Ore veins, Oatman district. On the western slopes of the River Range.

Pima County.—Santa Rita Mountains, reported from the Greaterville district. Silver Bell district, El Tiro mine, as clear, nearly transparent material of a beautiful emerald-green color. Tucson Mountains, in cavities in basalt.

Pinal County.—Abundant in spherulites and irregular cavities in dacite-rhyolite flows.

Santa Cruz County.—Grosvenor Hills, near the old village of Santa Cruz.

Yavapai County.—In the vicinity of Morgan City and Slow Springs washes as spherulitic nodules in lava. Much of the chalcedony is fluorescent.

Yuma County.—Chocolate Mountains, excellent specimens. East of Parker, near milepost 87, Santa Fe Railway.

Chrysoprase

Strictly an apple-green chalcedony. Greenish and bluish chalcedony is commonly included in the term.

Mohave County.—River Range, Weaver district, and elsewhere on the western slopes.

Gila County.—"Blue chrysoprase," a blue or bluish-green copper-stained chalcedony, abundant at the Live Oak and Keystone mines, Miami district.

Agate

A variegated chalcedony, with colors either banded, irregularly clouded, or due to visible impurities, as of manganese oxide in "moss agate."

Coconino and Mohave counties.—As nodules in Kaibab limestone.

Pima County.—Tucson Mountains, geodes of blue and white agate abundant in basalts near "A" Mountain.

Yavapai County.—In the vicinity of Morgan City and Slow Springs washes, as spherulitic nodules in lava.

Onyx

Like agate, a banded chalcedony, but the layers are even and the banding parallel.

Yavapai County.—Near Morgan City and Slow Springs washes, as spherulitic nodules in lava.

Flint

Similar to chalcedony, but more opaque, of dull colors, generally gray, smoky brown, and brownish black.

Coconino, Mohave, and Yuma counties.—As irregular nodules in limestones, especially of the Kaibab formation, and as stream pebbles.

Chert

An impure, flinty rock, including hornstone and certain jaspers.

Abundant in many limestones of the state, as irregular sheets, lenses, and nodules.

Jasper

Impure, opaque cryptocrystalline quartz, commonly red but also yellow, dark green, brown, and grayish blue.

Jasper, like chert, is widely distributed throughout the state, but in much smaller amount. It is most abundant as petrified wood of the Petrified Forest and elsewhere in Apache, Navajo, Mohave, and Yuma counties.

Silicified (petrified) wood

Cryptocrystalline quartz pseudomorphous after wood. Largely chalcedony and jasper, commonly beautifully colored.

Apache and Navajo counties.—Principally in and around the Petrified Forest, where many square miles are in part covered by silicified logs, branches, and fragments. Also in the vicinity of Nazlini Canyon, north of Ganado, and at numerous other localities.

Coconino, Mohave, and Yuma counties.—Abundant along the Colorado River.

Lechatelierite

Naturally occurring fused quartz.

Coconino County.—At Meteor Crater, west of Winslow, where it was apparently formed by fusion of fine-grained sandstone.

TRIDYMITE

SiO_2. Colorless to white. Luster vitreous. Transparent to translucent. Streak uncolored. H. = 7. G. = 2.26. Orthorhombic but pseudohexagonal, after high-temperature tridymite. In minute, thin tabular crystals.

Quartz, tridymite, and cristobalite may be considered as polymers. Quartz forms below 870° C., tridymite above 870°, and when heated to 1,470° tridymite passes to cristobalite.

Chiefly in cavities in rhyolite, trachyte, and andesite, generally with sanidine, hornblende, or augite.

Pima County.—Roskruge Mountains, with cristobalite and anauxite in cavities in andesite.

CRISTOBALITE

SiO_2. Colorless. Luster vitreous. Translucent. H. = 7. G. = 2.30. Tetragonal(?), pseudo-isometric. In small octahedral crystals.

The temperature polymer of quartz and tridymite forming above 1,470° C.

Pima County.—Roskruge Mountains, associated with tridymite and anauxite in cavities in andesite.

OPAL

$SiO_2.nH_2O$. Commonly white, yellow, red, brown, green, gray, blue. Vitreous to resinous, pearly or waxy. Transparent to translucent. Conchoidal fracture. H. = 5-6. G. = 1.9-2.2. Amorphous. Massive, botryoidal, or stalactitic.

A colloid deposited at low temperature. Occurs in veins; deposited by hot springs; also formed by weathering of rocks. Makes up the siliceous skeletons of many sea organisms. Some precious opal is formed by replacement of wood. Varieties are based on differences of color, structure, or origin.

Precious opal

Exhibits a play of delicate colors.

Maricopa County.—Reported from the vicinity of Morristown.

Common opal

In part translucent, most commonly milk white, brown, green, or red.

Cochise County.—At Tombstone, as seams in ore, Lucky Cuss mine.

Yavapai County.—Bradshaw Mountains, with chalcedony, 14 miles from Mayer on the Agua Fria River. Eureka district, Bagdad mine, in quartz veins.

Hyalite

Colorless and clear or whitish and translucent. As concretions or crusts with a globular or botryoidal surface. Commonly in cavities in basalts of other lava flows.

Mohave County.—Eastern slopes of the Black Mountains, northwest of Kingman.

Pinal County.—Pinal Mountains, in cavities in dacite, Superior district.

Santa Cruz County.—Grosvenor Hills, near Santa Cruz.

Yavapai County.—Reported from several localities (1:17).

Diatomaceous earth, diatomite, tripolite

Earthy material resembling chalk, made up of siliceous shells of diatoms, in places as extensive deposits.

Cochise County.—Near Curtis, deposit 4 to 8 feet in thickness of considerable extent.

Graham County.—Near Solomonville, a partly eroded deposit originally 16 to 18 feet thick.

Pinal County.—Along the San Pedro River, south of Mammoth, pure, snow white in beds 40 to 70 feet thick covering an area of 10 to 12 square miles. Partial analysis by H. A. Mann:

SiO_2	FeO-Fe_2O_3	Al_2O_3	NaCl	CaO	Ign. loss	Total
82.81	1.10	4.84	0.45	2.10	5.07	96.37

On the Gila River 20 miles east of Florence.

ORTHOCLASE—Potash Feldspar

$KAlSi_3O_8$. White or flesh-red, also colorless and gray. Luster vitreous to stony, pearly on cleavage faces. Transparent to translucent. Streak uncolored. H. = 6. G. = 2.57. Monoclinic. Crystals commonly Carlsbad twins. Perfect basal, less perfect clinopinacoidal cleavage, making an angle of 90° with each other. Coarsely cleavable to granular massive.

An abundant constituent of acid igneous rocks and pegmatites, and in sandstones and conglomerates derived from them. Most commonly as disseminated grains of various sizes and as large masses in the pegmatites. Also formed extensively by action of mineralizing solutions on wall rocks of ore deposits. Widely distributed in all the acid igneous rocks of the state. Forms large phenocrysts up to 2 or 3 inches long in some granites of pre-Cambrian and later ages.

Maricopa County.—Bradshaw Mountains, as pipes in granite up to 175 feet in diameter, Cave Creek district.

Mohave County.—Mined from pegmatites of the Cerbat and Hualpai mountains. Thick veins are reported from the vicinity of Hackberry.

Yavapai County.—Bradshaw Mountains, reported as relatively pure material near the old townsite of Middleton on the Crown King road.

Adularia

The pure or nearly pure potassium orthoclase, in transparent crystals commonly twinned according to the Baveno law.

Moonstone is adularia with an opalescent play of colors.

Gila County.—Richmond Basin, an important gangue mineral of the veins.

Mohave County.—Oatman and Katherine districts, a common constituent of the veins as white bands up to 2 inches in width between layers of quartz, as plates, as grains, and locally as crystals with well-developed terminations. Gold is commonly associated with the adularia. Analysis by R. J. Leonard as follows:

SiO_2	Al_2O_3	CaO	Na_2O	K_2O	Total
65.81	17.64	0.32	1.76	15.08	100.61

Yavapai County.—Bradshaw Mountains, as crystals in open portions of the Cash vein, Hassayampa district.

Yuma County.—Kofa Mountains, with banded chalcedony at the North Star mine. Little Horn Mountains, in the gold-quartz veins of the Sheep Tanks mine.

Sanidine

A transparent, glassy variety of orthoclase occurring as crystals in rhyolite, trachyte, or other lava flows.

Gila and Pinal counties.—Abundant as phenocrysts in dacite flows.

MICROCLINE—Potash Feldspar

$KAlSi_3O_8$. White or creamy yellow, red, and green. Luster vitreous to stony, pearly on the cleavage. Transparent to opaque. Streak white. H. = 6-6.5. G. = 2.54-2.57. Triclinic. Crystals near orthoclase in angles and habit. Perfect basal, less perfect brachypinacoidal, cleavage. Cleavable to granular massive.

Widespread and occurs under the same conditions as orthoclase. Much of the potash feldspar commonly classed as orthoclase is microcline.

ALBITE—ANORTHITE—Plagioclase

$NaAlSi_3O_8$-$CaAl_2So_2O_8$, forming a continuous series. White to dark gray; also blue, red, or green. Luster vitreous to stony; pearly on cleavage surfaces. Transparent to translucent. Streak uncolored. H. = 6. G. = 2.62-2.76. Triclinic. Perfect basal, less perfect brachypinacoidal, cleavage. Characteristically twinned according to the Albite law, visible as numerous minute striations on the basal cleavage. As disseminated grains or imbedded crystals; also lamellar or granular massive. Intermediate members of the group are *oligoclase, andesine, labradorite,* and *bytownite.*

Essential constituents of igneous rocks of intermediate and basic composition. Also in gneisses, crystalline schists, pegmatite, and coarse arkosic sediments. Abundant and widespread in the rocks of state.

PYROXENE GROUP

ENSTATITE

$MgSiO_3$. Commonly contains iron. Gray, green, greenish black. Luster pearly to metalloidal. Streak uncolored to grayish or brownish. Translucent to nearly opaque. H. = 5.5. G. = 3.2-3.5. Orthorhombic, dipyramidal. Distinct prismatic cleavage at angle near 90°. Commonly foliated massive. *Hypersthene* contains more than 15% FeO. *Bronzite* exhibits a submetallic bronzelike luster.

Common in basic igneous rocks such as gabbro, norite, and peridotite, and in their extrusive equivalents. Commonly associated with calcic plagioclase feldspars. Makes up the bulk of some rocks, such as pyroxenites.

Gila County.—Dripping Spring Mountains, Banner district, Reagan claims, near the "79" mine.

Navajo County.—Twenty miles west of Dilkon, as dikes of hypersthenite in shale.

Pima County.—At Ajo, in the basal facies of the Batamote andesite series.

Santa Cruz County.—Sparingly in the younger andesite of the Patagonia and Santa Rita mountains.

PYROXENE

In general $(Ca,Mg)SiO_3$, but commonly containing iron, aluminum, or manganese. Generally some shade of green; also nearly colorless, white, gray, brown, or black. Luster vitreous to dull; in some varieties pearly or metalloidal. Transparent to opaque. Streak white to gray and grayish green. H. = 5-6. G. = 3.2-3.6. Monoclinic. Crystals prismatic. Rather perfect prismatic cleavage at angle near 90°. Also granular massive, rarely columnar or fibrous.

A common mineral in igneous rocks, some of which consist almost entirely of pyroxene. Most abundant in dark-colored volcanic rocks; also in crystalline limestone, dolomite, and schist.

The pyroxene group includes several subspecies based on composition.

Pigeonite

A mixture of $MgSiO_3$ and $CaMgSi_2O_6$. General physical properties like those of diopside. Occurs in diabase, basalt, gabbro, and other basic rocks, and also as a product of contact metamorphism.

Cochise County.—At Tombstone, as dark-green grains with idocrase in the contact silicate zone of the Lucky Cuss mine.

Diopside

$CaMgSi_2O_6$. Iron generally present in small amounts, increasing as the mineral grades toward hedenbergite. White, yellowish, grayish to pale green, dark green, and black. G. = 3.2-3.3. In prismatic crystals, columnar aggregates, and granular masses. Generally of metamorphic origin, most abundant in crystalline limestones.

Cochise County.—Bisbee district, as grains in unoxidized pyritic ores. Tombstone, as small pale-green crystals in the contact zone of Comstock Hill. Little Dragoon Mountains, Johnson district, as small grains in metamorphosed limestone.

Greenlee County.—Clifton-Morenci district, common in metamorphosed limestones of the Longfellow formation.

Pima County.—Santa Rita Mountains, in wall rocks of ore bodies and in metamorphosed limestone, Helvetia district. Sierrita Mountains, in contact rocks, Twin Buttes area.

Santa Cruz County.—Patagonia Mountains, Westinghouse property, Duquesne.

Yavapai County.—Bradshaw Mountains, Henrietta mine, Big Bug district, with magnetite.

Hedenbergite

$CaFeSi_2O_6$. Black to greenish black. G. = 3.4-3.58. In prismatic crystals, but generally massive with columnar or lamellar structure. Characteristically of metamorphic origin.

Pima County.—Sierrita Mountains, common as gangue, San Xavier district.

Santa Cruz County.—Patagonia Mountains, Westinghouse property, with diopside and other contact silicates.

Augite

Chiefly $Ca(Mg,Fe,Al)(Al,Si)_2O_6$. Greenish, brownish, or black. G. = 3.2-3.4. As short, stout, prismatic crystals or as scattered grains. Most commonly in basic igneous rocks, as gabbro, diabase, and basalt. Widely distributed, and only a few typical occurrences are listed.

Cochise County.—Tombstone district, in diorite porphyry dikes and basaltic rocks.

Gila and Pinal counties.—Abundant in diabase sills which intrude rocks of the Apache group over large areas in central Arizona. In the Dripping Spring Mountains with olivine and iddingsite in Tertiary basalts.

Yuma County.—Abundant in metamorphosed limestones of the northern part of the county.

WOLLASTONITE

$CaSiO_3$. White to grayish, yellow, red, or brown. Luster vitreous, pearly on cleavage surfaces. Subtransparent to translucent. Streak white. H. = 5-5.5. G. = 2.8-2.9. Monoclinic. Crystals tabular or short prismatic. Perfect basal and orthopinacoidal cleavage. Cleavable massive, bladed, fibrous, or compact.

A contact mineral in crystalline limestones, common as gangue in contact-metamorphic ore deposits.

Cochise County.—Tombstone district, as radiating fibrous masses in the Silver Thread and West Side mines.

Gila County.—Dripping Spring Mountains, Christmas mine, Banner district.

Pima County.—Santa Rita Mountains, Rosemont, where large masses of limestone are completely altered to wollastonite. Sierrita Mountains, throughout metamorphosed rocks of the Mineral Hill area. Silver Bell district, locally abundant.

Yuma County.—Harcuvar Mountains, Cabrolla prospect, replacing entire beds of limestone.

AMPHIBOLE GROUP

ANTHOPHYLLITE

$(Mg,Fe)_7Si_8O_{22}(OH)_2$. Brownish gray, brownish green, emerald-green. Luster vitreous. Translucent. Streak uncolored or grayish. H. = 5.5-6. G. = 2.85-3.2. Orthorhombic. Perfect prismatic cleavage at angles near 54° and 126°. Lamellar or fibrous massive. *Gedrite* is a variety with considerable aluminum.

A metamorphic mineral common in schists and gneisses, less common in contact rocks.

Mohave County.—Hualpai Mountains, 10 miles east of Yucca, in schist.

Santa Cruz County.—Patagonia Mountains, as gedrite in gangue of the Westinghouse ores.

Yavapai County.—Eureka mining district, precise locality not known.

AMPHIBOLE

In general $(Ca,Mg)SiO_3$, but commonly containing iron, manganese, aluminum, sodium or potassium, and hydroxyl. Black, various shades of green, dark brown,

yellowish, or white. Luster vitreous to pearly. Translucent to opaque. Streak paler than color. H. = 5-6. G. = 2.9-3.4. Monoclinic. Crystals commonly prismatic. Perfect prismatic cleavage at angles near 56° and 124°.Granular massive, columnar, or fibrous.

Amphibole includes several subspecies based upon composition. They are common, widely distributed rock-forming minerals, abundant in certain igneous and metamorphic rocks.

Grunerite

$(Fe,Mg)SiO_3$ with manganese generally present. Brown. Silky luster. G. = 3.4-3.6.

Graham County.—Santa Teresa Mountains, in limestone contact rocks, Stanley Butte district.

Tremolite

$Ca_2Mg_5Si_8O_{22}(OH)_2$. White to dark gray, generally with silky luster. G. = 3.0-3.3. Crystals commonly long bladed. In columnar or fibrous aggregates or granular masses. A common product of contact metamorphism, abundant in some schists, and in some contact ores.

Cochise County.—Bisbee district, the most abundant metamorphic gangue of the unoxidized pyritic ores. Tombstone district, as long fibrous masses, Toughnut mine. Little Dragoon Mountains, in metamorphic limestones.

Greenlee County.—Clifton-Morenci district, in metamorphosed limestones and in wall rocks of veins.

Santa Cruz County.—Patagonia Mountains, as gangue, Westinghouse property.

Yuma County.—Dome Rock Mountains, as asbestos in marbleized limestones of the northern part of the range.

Actinolite

$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$. Bright grass-green, dark green to grayish green. Commonly in long prismatic crystals or in fibrous or bladed masses. Generally of metamorphic origin. *Mountain leather* is a fibrous variety in thin flexible sheets.

Cochise County.—Little Dragoon Mountains, in metamorphosed limestones, Johnson district.

Graham County.—Aravaipa and Stanley districts, as gangue of contact-metamorphic ores. Galiuro Mountains, as mountain leather, Ash Peak.

Greenlee County.—Black Mountains, Oatman district, as thin sheets of mountain leather between layers of quartz, Big Jim vein.

Pima County.—Sierrita Mountains, abundant in contact rocks, Twin Buttes district.

Pinal County.—Globe district, Old Dominion mine, as mountain leather along bedding planes of Mescal limestone.

Santa Cruz County.—Patagonia Mountains, Westinghouse property.

Yavapai County.—Bradshaw Mountains, in country rock, Iron Queen mine; as the fibrous variety with bournonite at the Boggs mine, Big Bug district.

Yuma County.—Harcuvar Mountains, Yuma Copper and Cabrolla properties, as a replacement of limestone beds.

Hornblende

An amphibole containing aluminum with ferric or ferrous iron, magnesium, calcium, and alkalies. Light green to dark green to black. G. = 3.2. A common constituent of igneous rocks, generally most abundant in those of the diorite and syenite groups. Also in gneisses and schists and the chief mineral of the amphibolites.

Cochise County.—Tombstone district, as long prismatic crystals in the Schieffelin granodiorite.

Gila and Pinal counties.—The principal constituent of the greenstone facies of the Pinal schist. In intrusive bodies in the vicinity of Picket Post Mountain, near Superior.

Greenlee County.—Abundant in diorite porphyry, Clifton-Morenci district.

Pima County.—At Ajo, as bodies of hornblendite, the largest 2,000 by 1,000 feet, in the Cardigan gneiss. Empire Mountains, as phenocrysts in a diorite porphyry dike at the Prince mine.

Yavapai County.—Lenticular beds composed largely of hornblende are found at many places in Yavapai schist.

Yuma County.—Harcuvar Mountains, as crystals more than an inch long near dikes in pre-Cambrian granite.

BERYL

$Be_3Al_2Si_6O_{18}$. Emerald-green, pale green, light blue, yellow, white. Luster vitreous. Transparent to translucent. Streak white. H. = 7.5-8. G. = 2.75-2.8. Hexagonal, dihexagonal-dipyramidal. Crystals generally long prismatic. Imperfect basal cleavage. Coarse columnar, granular, or compact. Pure mineral 14% BeO.

Most common in cavities in granite or pegmatite, also in tin ores and mica schists.

Cochise County.—Dragoon Mountains, as small colorless crystals with fluorite at the Boericke tungsten property.

Mohave County.—Aquarius Range, as crystals in pegmatite. Wright Creek, 15 miles south of Peach Springs, in pegmatite.

Yavapai County.—Eureka district, Bagdad vicinity. Also in the Weaver Mountains, Hillside mine. Bradshaw Mountains, 4 miles southeast of Wagoner, in pegmatite veins.

Yuma County.—Gila Mountains, 1½ miles east of the Fortuna mine, as small lavender- and rose-colored crystals in a matrix of yellowish quartz. Associated with the beryl are small masses of a black, unidentified mineral containing columbium.

ZUNYITE

Approximately $(Al(OH,F,Cl)_2)_6.(Al_2Si_3O_{12})$. H. = 7. G. = 2.875. In minute transparent tetrahedrons.

A rare mineral, probably formed as the result of metamorphism.

Yuma County.—Dome Rock Mountains, as small, transparent, buff-colored crystals from the Big Bertha Extension mine, 5 miles southwest of Quartzsite.

GARNET

Essentially a silicate of calcium, magnesium, iron, or manganese, the composition varying with different varieties. Red, brown, yellow, white, green, or black. Luster vitreous to resinous. Transparent to opaque. Streak white. H. = 6.5-7.5. G. = 3.5-4.3. Isometric, hexoctahedral. Characteristically in dodecahedral or trapezohedral crystals. Also in tough compact masses or granular aggregates.

Generally of metamorphic origin. Most abundant in rocks derived from contact metamorphism of limestone; also in schists and gneisses. Several subspecies are based upon composition.

Grossularite

$Ca_3Al_2(SiO_4)_3$. G. = 3.53. White to colorless, pale green, yellowish, brownish yellow, cinnamon brown, and red.

Cochise County.—Bisbee district, as rounded crystals in unoxidized pyritic ores. Tombstone district, of cinnamon-brown color in contact-metamorphic zones; forms massive beds on Comstock Hill. Little Dragoon Mountains, a gangue of copper ores, Johnson district.

Pyrope

$Mg_3Al_2(SiO_4)_3$. G. = 3.51. Deep red to nearly black. Transparent varieties are prized as gems.

Apache County.—Navajo reservation, just south of the Utah line, as pebbles of gem quality on Garnet Ridge. Also at Buell Park, near Fort Defiance, in alluvium, agglomerate, and as inclusions in igneous rock.

Almandite

$Fe_3Al_2(SiO_4)_3$. G. = 4.25. Deep red to brownish red. Transparent varieties used as gems.

Coconino County.—Grand Canyon, in Archean rocks of the Inner Gorge. As crystals over an inch in diameter on Phantom Creek.

Mohave County.—Aquarius Range, as crystals in light-colored volcanic rocks at the south end of the range.

Andradite

$Ca_3Fe_2(SiO_4)_2$. G. = 3.75. Various shades of yellow, green, brown, or black. The most common variety of garnet, particularly abundant in contact-metamorphic zones.

Cochise County.—Dragoon Mountains, common in wall rocks of pyritic ores in Abrigo limestone, Turquoise district.

Gila County.—Dripping Spring Mountains, Banner district, Christmas mine, in large massive beds.

Graham County.—Aravaipa and Stanley districts, as gangue in contact-metamorphic ores. At Stanley Butte as aggregates of well-formed green crystals.

Greenlee County.—Clifton-Morenci district, in altered limestones, forming masses from 50 to 100 feet thick.

Pima County.—Empire Mountains, as zones of massive material at the contact of Paleozoic limestone and quartz monzonite. Sierrita Mountains, as zones up to 200 feet wide at Twin Buttes, and containing chalcopyrite ore. Santa Rita Mountains, the commonest metamorphic product of limestones, Rosemont.

Santa Cruz County.—Patagonia Mountains, as crystals up to 2 inches in diameter in metamorphosed limestone, Westinghouse property.

OLIVINE

$(Mg,Fe)_2SiO_4$. Luster vitreous. Transparent to translucent. Streak uncolored. H. = 6.5-7. G. = 3.27-3.37. Orthorhombic, dipyramidal. Granular massive or as disseminated grains.

Most abundant in basic igneous rocks such as gabbro, basalt, peridotite, and diabase, formed by crystallization of magmas rich in magnesia and low in silica. The clear green gem variety of olivine is known as *peridot.*

Apache County.—As clear green to brown stones of gem quality at Buell Park, 10 miles north of Fort Defiance, and at Garnet Ridge, just south of the state line.

Cochise County.—Tombstone district, in contact zone of Comstock Hill and in the Lucky Cuss mine.

Coconino County.—In basalts of the San Francisco Mountains.

Gila County.—In basalt rocks and stream gravels of the San Carlos Indian Reservation near Peridot and Tolkai. A cut stone from this locality weighed 25.75 carats.

Pinal County.—An accessory mineral in diabase sills which intrude the Apache group in this and adjoining counties. Dripping Springs Mountains, with augie and iddingsite in Tertiary basalts. Galiuro Mountains, in the contact zone between granodiorite and Cretaceous sediments.

Santa Cruz County.—Sparingly in gabbro, diabase, and younger andesite of the Patagonia and Santa Rita mountains.

FAYALITE

Fe_2SiO_4. Light greenish yellow, but brown to black after exposure. Luster vitreous to somewhat greasy. Transparent to translucent. Streak uncolored. H. = 6.5. G. = 4.1. Orthorhombic. Crystals like those of olivine. Commonly massive.

An end member of the olivine series. Same origin and occurrence as olivine, but comparatively rare.

Gila County.—A minor constituent of volcanic bombs and stream gravel in the vicinity of Peridot and Tolkai.

MONTICELLITE

$CaMgSiO_4$. Colorless to gray. H. = 5. G. = 3.2. In small prismatic crystals or grains.

A rare member of the olivine group.

Cochise County.—Tombstone district, as narrow bands in contact silicates on the fourth level of the Lucky Cuss mine.

WILLEMITE

Zn_2SiO_4. Green, yellow, brown, reddish brown, flesh-pink, or white. Luster somewhat resinous and weak. Transparent to translucent. Streak uncolored. H. = 5.5. G. = 3.9-4.2. Hexagonal, rhombohedral. Crystals generally hexagonal prisms. Basal cleavage. Cleavable to granular massive or in disseminated grains.

A relatively rare mineral, most commonly found in crystalline limestones as a result of metamorphism; also as a secondary mineral in the oxidized zone of zinc deposits.

Cochise County.—Chiricahuha Mountains, at Hilltop, as small white to rose-colored prisms in cavernous rock.

Gila County.—Abundant at the Apache Mine, north of Globe, with vanadinite.

Greenlee County.—Clifton-Morenci district, as small grayish crystals on garnet rock on the north side of Modoc Mountain.

Pima County.—Tucson Mountains, as crystals on dump of prospect 1 mile south of Old Yuma mine. North of Sells, locality undisclosed, as small blue barrel-shaped crystals.

Pinal County.—Mammoth mine, as small colorless rhombs and bluish barrel-shaped crystals on wulfenite and vanadinite. In veinlets with calcite from the McCarthy-Henshaw property south of Casa Grande, highly fluorescent. Partial analysis as follows:

Zn	Pb	Fe	Mn	SiO_2	Insol.
38.60	11.17	7.00	0.89	30.00	23.76

DIOPTASE

H_2CuSiO_4. Emerald-green. Luster vitreous. Transparent. Streak uncolored. H. = 5. G. = 3.28-3.35. Hexagonal, rhombohedral. Perfect pyramidal cleavage. In prismatic crystals or crystal aggregates.

A rare mineral of secondary origin found with oxidized copper minerals.

Greenlee County.—Clifton-Morenci district, Bon Ton mine, as crystals in cavities in chrysocolla (6:05).

Gila County.—Payson district, as small prismatic crystals, Ox Bow and Summit mines.

Pinal County.—Mammoth mine, as deep emerald-green aggregates of small crystals. Superior district, Magma mine, as deep green crystal incrustations from the upper levels, particularly from the outcrop at the #1 Glory Hole. Dioptase of identical character was found on a mine dump near Riverside, on the Gila River.

Yuma County.—Buckskin Mountains, in small quantities, Chicago property.

Yavapai County.—From Amazon Wash, near the Gold Bar mine, Black Rock district, 15 miles northeast of Wickenburg.

SCAPOLITE—Wernerite

$(Na,Ca)_4\,Al_3\,(Al,Si)_3\,Si_6O_{24}\,(Cl,CO_3,SO_4)$ to $(Ca,Na)_4\,Al_3\,(Al,Si)_3\,Si_6O_{24}\,(Cl,Co_3,SO_4)$, forming an isomorphous series of which *marialite* and *meionite* are the respective end

members. White, gray, pale green, bluish, or reddish. Luster vitreous to strong. Transparent to translucent. H. = 5-6. G. = 2.65-2.74. Tetragonal, dipyramidal. Imperfect prismatic cleavage. Crystals usually coarse prismatic, or with fibrous appearance. Also massive, granular, or columnar.

Formed by regional or contact metamorphism and therefore found in schists, gneisses or crystalline limestones.

Yavapai County.—Bradshaw Mountains, Black Canyon district, 6 miles south of Cleator, in the Yavapai schist.

IDOCRASE—Vesuvianite

$Ca_{10}Al_4(Mg,Fe)_2Si_9O_{34}(OH)_4$. Yellow green to brown, rarely pale blue. Luster vitreous. Subtransparent to translucent. Streak white. H. = 6.5. G. = 3.35-3.45. Tetragonal, ditetragonal-dipyramidal. Crystals prismatic or pyramidal. Commonly massive.

Formed by contact metamorphism of impure limestones. Generally associated with grossularite, diopside, and wollastonite.

Cochise County.—Tombstone district, in the contact zone of Comstock Hill; Lucky Cuss mine, with monticellite, hillebrandite, and thaumasite. Little Dragoon Mountains, as small pale green crystals in metamorphosed limestone, Johnson district.

Gila County.—Dripping Spring Mountains, Christmas mine.

Yuma County.—Abundant in metamorphosed limestones.

ZIRCON

$ZrSiO_4$. Colorless, pale yellowish, grayish, yellowish green, brownish yellow, reddish brown. Luster adamantine. Transparent to translucent and opaque. H. = 7.5. G. = 4.68. Tetragonal, ditetragonal-dipyramidal. Commonly in square prismatic crystals. Also in irregular forms and grains. Pure mineral 67.2% ZrO_2.

A common accessory mineral of igneous rocks, generally present as minute crystals, but commonly of large size in pegmatites. Also in crystalline limestones and schists, and in sands.

Cochise County.—Bisbee district, as small crystals in Pinal schist with tourmaline, and in granite northwest of Bisbee. Tombstone, as microscopic grains in light-colored intrusive rocks.

Gila County.—In Pinal schist, Madera diorite, and Ruin granite.

Greenlee County.—Clifton-Morenci district, in granite.

Pima County.—Santa Rita Mountains, in granite porphyry.

Pinal County.—Sparingly in Pinal schist.

Santa Cruz County.—Patagonia Mountains, in granite.

Yavapai County.—Bradshaw Mountains, sparingly in Bradshaw granite. Reported in possible commercial quantities from the black sands of the Kirkland-Copper Basin placers.

ANDALUSITE

Al_2SiO_5. Whitish, rose-red, flesh-red, violet, pearl-gray, reddish brown, olive-green. Luster vitreous. Transparent to opaque. Streak uncolored. H. = 7.5. G. = 3.16-3.2. Orthorhombic, dipyramidal. Crystals nearly square prismatic. Good prismatic cleavage near 90°. Commonly massive, with granular or columnar structure.

Of either regional or contact-metamorphic origin, most commonly in slates, but also in gneiss, mica schists, and other altered rocks. Generally associated with sillimanite or kyanite, the mixture commonly known as "spark plug ore."

Gila and Pinal counties.—Locally abundant in Pinal schist near post-Cambrian granitic rocks.

Mohave County.—Cedar mining district, 11 miles east of Yucca, in quartz veins in schist. Grand Wash Cliffs, Red Lake district, in pegmatite.

Yavapai County.—Bradshaw Mountains, as scattered lenses and disseminations in schist. Reported to occur in considerable quantities near Cleator. Large crystals of pinkish material have been found near Middleton, on the Crown King road. Near Granite Mountains in extensive veins. Santa Maria Mountains, near Camp Wood, as flakes and nodules in schist.

Yuma County.—Near Quartzsite, with kyanite and dumortierite in schist.

SILLIMANITE

Al_2SiO_5. Brown, grayish brown, grayish white, grayish green, olive-green. Luster vitreous. Transparent to translucent. Streak uncolored. H. = 6-7. G. = 3.23. Orthorhombic, dipyramidal. Crystals long, slender, and not distinctly terminated. Perfect brachypinacoidal cleavage. In closely parallel groups, passing into fibrous and columnar forms

Of metamorphic origin, like andalusite with which it is commonly associated. Generally in gneisses and schists, less commonly in contact-metamorphic deposits.

Coconino County.—Grand Canyon, abundant in the Inner Gorge ½ mile downstream from Monument Creek.

Gila and Pinal counties.—In Pinal schist near post-Cambrian granite contacts.

Mohave County.—Hualpai Mountains, Maynard district, in quartz veins cutting schist.

Yavapai County.—Santa Maria Mountains, near Camp Wood, as veins, flakes, and nodules in schist. Eureka district, Bagdad vicinity.

KYANITE—Cyanite

Al_2SiO_5. Blue, white, gray, green, black; commonly blue along the center of the blades or crystals and white along the margins. Luster vitreous to pearly. Transparent to translucent. Streak uncolored. H. = 5-7, 5 on the cleavage parallel to the c axis, 6-7 on the cleavage normal to the c axis. G. = 3.56-3.66. Triclinic. Crystals long bladed and rarely terminated. Perfect macropinacoidal cleavage. In columnar or coarse granular masses.

Of metamorphic origin, like andalusite and sillimanite with which it is commonly associated in schists and gneisses.

Yuma County.—Near Quartzsite, with dumortierite and andalusite in schist. Gila Mountains, 8 miles west of Wellton, on the east side of the range.

Maricopa County.—Phoenix Mountains.

Mohave County.—Specimens have been received from this area by the Arizona Bureau of Mines, but the localities are not known.

GADOLINITE

$YFe''Be_2(SiO_4)_2O_2$. May contain cerium oxide. Black, greenish black, brown. Luster vitreous to greasy. Transparent to translucent. H. = 6.5-7. G. = 4-4.5. Crystals prismatic with rough faces. More commonly massive.

A rare mineral, principally from pegmatites.

Mohave County.—In pegmatite veins of the Aquarius Range, 30 miles south of Hackberry, from which several tons of the mineral have been mined. Near Kingman, and in the northern part of the county, in sand dunes. Partial analysis by Chase Palmer as follows:

SiO_2	Yttria earths	Ceria earths	BeO	FeO	Total
24.21	38.86	11.50	11.50	11.56	95.83

ZOISITE

$Ca_2Al_3(SiO_4)_3(OH)$. Grayish white, gray, greenish gray, yellowish brown, apple-green; rarely peach-red to rose-red. Luster vitreous. Transparent to translucent.

Streak uncolored. H. =.6-6.5. G. = 3.25-3.37. Orthorhombic. Crystals prismatic, deeply striated vertically. Perfect brachypinacoidal cleavage. In columnar to compact masses.

Most commonly in crystalline schists from metamorphism by basic igneous rocks. Also from alteration of plagioclase feldspar.

Cochise County.—Tombstone district, microscopically in igneous rocks.

Yavapai County.—Bradshaw Mountains, in scattered lenses in schist, Eureka district, as an accessory mineral in bodies of titaniferous magnetite and in gangue of copper deposits at Bagdad.

Yuma County.—Dome Rock Mountains, in wall rocks of cinnabar veins.

CLINOZOISITE

$Ca_2Al_3(SiO_4)_3(OH)$. Colorless, light yellow, green, pink. Luster vitreous. Transparent to translucent. H. = 6-6.5. G. = 3.25-3.37. Monoclinic. Crystals prismatic. Perfect basal cleavage. Also columnar and granular.

Dimorphous with zoisite, for which it is commonly mistaken.

Cochise County.—Tombstone district, as small vitreous green grains with idocrase, monticellite, and thaumasite, Lucky Cuss mine.

Gila County.—Miami district, as stringers and scattered grains in sericitized plagioclase of the quartz monzonite, Castle Dome mine.

EPIDOTE

$Ca_2(Al,Fe)_3(SiO_4)_3(OH)$. Pistachio-green to dark green, also colorless to yellow. Luster vitreous to dull. Transparent to translucent. Streak uncolored or grayish. H. = 6-7. G. = 3.35-3.45. Monoclinic. Crystals prismatic, commonly deeply striated. Perfect basal cleavage. In granular, fibrous, or columnar masses, or as disseminated grains.

A common contact-metamorphic mineral in limestone, with garnet and iodcrase, and as gangue in contact-metamorphic copper deposits. Also in crystalline schist and gneiss, and an alteration product of such minerals as garnet, augite, hornblende, biotite, and scapolite.

Cochise County.—Tombstone district, in shale and quartzite. Chiricahua Mountains, common; in the California mining district, a copper-bearing epidote vein up to 5 feet wide extends for over a mile. Turquoise district, in wall rocks of pyritic deposits in Abrigo limestone.

Gila County.—Payson district, with chalcopyrite, Harrington claims. Dripping Spring Mountains, Christmas mine, Banner district.

Graham County.—Mount Turnbull, with chalcopyrite, sphene, apatite, and chlorite in micropegmatite, Fisher prospect. Widely distributed in contact copper deposits, Aravaipa and Stanley districts.

Greenlee County.—Clifton-Morenci district, principally in metamorphic rocks, rarely as well-defined crystals.

Pima County.—Santa Rita Mountains, widespread in metamorphosed limestones and wall rocks of copper deposits. Sierrita Mountains, common as a metamorphic product and as an alteration product of dikes. Santa Catalina Mountains, in contact copper deposits near Marble Peak, in places as splendid crystals.

Santa Cruz County.—Abundant in metamorphosed limestones, Santa Rita and Patagonia mountains.

Yavapai County.—Bradshaw Mountains, in lenses in the schist; Weaver district, in dikes, Rich Hill.

Yuma County.—Abundant in metamorphosed limestones. Dome Rock Mountains, in the wall rock of cinnabar veins.

PIEDMONTITE

$Ca_2(Al,Mn)_3(SiO_4)_3(OH)$. Pink, rose-red, reddish brown, and reddish black. H. = 6.5. G. = 3.404. Monoclinic. Crystals like those of epidote in habit. Commonly in rock masses.

The rare manganese member of the epidote group. In some crystalline schists, rhyolites, and closely related volcanics.

Cochise County.—In andesitic rock of Pat Hills, northeast of Pearce.

Pima County.—In rhyolite and adjacent sandstone, Tucson Mountains. Also in the Santa Rita Mountains, near Madera Canyon. Analysis by Paul H. M. P. Brinton as follows:

SiO_2	Al_2O_3	Fe_2O_3	CaO	Mn_2O_3	TiO_2	H_2O	Total
37.43	21.27	3.80	24.75	11.80	0.10	0.96	100.11

ALLANITE—Orthite

A silicate of variable composition, $R_2'', R_3'''(SiO_4)_3(OH)$, where R'' = Ca, Fe'',Mg Na and R''' = Al, Fe,Fe''',Mn,Be,Ce,Ia,Y. Brown to black. Luster submetallic, pitchy, or resinous. Subtranslucent to opaque. H. = 5.5-6. G. = 3.5-4.2, Monoclinic. In tabular or acicular prismatic crystals. More commonly massive or as disseminated grains. Often coated with a yellow-brown alteration product.

An accessory mineral in granite, syenite, diorite, or pegmatite, or in metamorphic rocks derived from these. Commonly associated with bodies of magnetite.

Cochise County.—Tombstone district, microscopic in granodiorite.

Mohave County.—Aquarius Range, in pegmatite with gadolinite. Cerbat Range, as small masses in pegmatite at the Kingman Feldspar mine.

Yavapai County.—Eureka district, in pegmatite knots on the 7 U 7 ranch, near Bagdad, with triplite and bermanite.

HEMIMORPHITE—Calamine

$Zn_4Si_2O_7(OH)_2.H_2O$. Colorless, white, yellowish, brownish; also blue or green. Luster vitreous. Transparent or translucent. H. = 4.5-5. G. = 3.4-3.5. Orthorhombic, pyramidal. Commonly in tabular or prismatic crystals arranged in bunches, or grouped in sheaflike aggregates. Also in cavernous masses or layers. Pure mineral 54.4% Zn.

A mineral of oxidized zinc ores, generally with zinc carbonate, which the massive varieties closely resemble.

Cochise County.—Tombstone district, sparingly as radiating aggregates in oxidized ore, Empire and Toughnut mines. Turquoise district, as incrustations and druses, Mystery and Silver Bill mines.

Greenlee County.—Clifton-Morenci district, as small transparent crystals on decomposed garnet rock, Shannon mine.

Pima County.—Empire Mountains, as small colorless crystals in smithsonite, Hilton mines. Sierrita Mountains, in small quantity in the San Xavier district.

Pinal County.—Mammoth mine, as porous to compact granular masses and as slender needles bristling from quartz crystals on the walls of open cavities.

TOURMALINE

A complex silicate of boron and aluminum. Most commonly black or brown, also blue, green, red, rarely white or colorless. Luster vitreous. Transparent to translucent. Streak uncolored. H. = 7-7.5. G. = 3.0-3.25. Hexagonal, ditrigonal-pyramidal. Crystals prismatic, rarely flattened. Also in columnar, coarsely fibrous, or compact masses.

Common in granitic crystalline rocks, particularly pegmatites, generally with quartz, albite, microcline, and muscovite. Transparent colored varieties are prized as gems.

Cochise County.—As miscroscopic prismatic crystals with zircon in Pinal schist. As nests of small prismatic crystals in muscovite in granite northwest of Bisbee.

Coconino County.—Grand Canyon, as black crystals in pegmatites, Hermit Creek.

Maricopa County.—Mazatzal Mountains, in cinnabar veins.

Pima County.—Santa Rita Mountains, with magnetite and siderite, Iron Mask mine, Old Baldy district. Sierrita Mountains, as veinlike masses with quartz in soda-granite, Papago district.

Pinal County.—In vein quartz in Pinal schist near post-Cambrian granite contacts. Santa Catalina Mountains, in pegmatites of the Oracle granite. Galiuro Mountains, Copper Creek district, as radiating groups of slender prismatic crystals.

Yavapai County.—Bradshaw Mountains, in pegmatites of the Bradshaw granite, in lenses in schist and scattered through the schist near granite contacts. In veins of the Prescott district, and as blue gray prisms in quartz and dolomite, Iron King mine, Big Bug district. Eureka district, in pegmatites of the Bagdad area.

Yuma County.—Dome Rock Mountains, with magnetite and siderite in gangue of cinnabar veins.

DUMORTIERITE

$Al_6BSi_3O_{19}(OH)$. Lilac, blue, bluish green, rose, pink. Luster vitreous. Transparent to translucent. Streak uncolored. H. = 7. G. = 3.26-3.36. Orthorhombic, prismatic. Poor pinacoidal cleavage. Generally in fibrous to columnar aggregates, frequently radiating.

Most common as a metamorphic mineral in schist and gneiss, and generally associated with sillimanite or kyanite. Used in manufacture of refractory porcelain.

Yuma County.—As fine fibrous material in boulders along the Colorado River between Ehrenburg and Yuma, and in schist near Quartzsite. Associated with kyanite and altered to pyrophylite. Average analysis by W. E. Ford as follows:

SiO_2	Al_2O_3	Fe_2O_3	B_2O_3	H_2O
29.86	63.56	0.23	5.26	1.41

SPHENE—Titanite

$CaTiSiO_5$. Brown, gray, yellow, green, and black. Luster adamantine to resinous. Transparent to translucent. Streak white. H. = 5-5.5. G. = 3.4-3.55. Monoclinic. Crystals wedge-shaped and flattened. Distinct prismatic cleavage. Cleavable to compact massive.

An accessory mineral in intrusive rocks of intermediate composition, in gneiss and schist, and in granular limestone. Commonly associated with pyroxene, amphibole, chlorite, and scapolite.

Cochise County.—Tombstone district, microscopic in granodiorite and porphyries.

Graham County.—Aravaipa district, Mount Turnbull, in micropegmatite, Fisher prospect.

Yavapai County.—Bradshaw Mountains, in schist, Butternut mine, Big Bug district; as large crystals in granodiorite, Springfield group, Pine Grove district.

CHEVKINITE—Tscheffkinite

A titano-silicate containing iron, thorium and members of the cerium group of rare-earth metals. Black. Luster dull, velvety. Opaque. Streak white. H. = 5-6. G. = 4.5-4.67. Monoclinic or amorphous. Usually massive.

A rare mineral in granitic pegmatites.

Mohave County.—Aquarius Range, in a vein traversing a "granite dike," and intimately associated with sphene, monazite, cronstedtite, and quartz. Analysis by Albert J. Kauffman, Jr. and Howard W. Jaffe as follows:

SiO_2	TiO_2	ThO_2	Ce_2O_3	$(La,Di)_2O_3$
12.04	17.08	0.82	25.29	18.35
Y_2O_3	Al_2O_3	Fe_2O_3	FeO	MnO
1.50	0.93	9.56	7.76	0.50
CaO	MgO	P_2O_5	H_2O	Total
3.35	0.74	0.38	1.50	99.80

STAUROLITE

$Fe''Al_6Si_2O_{12}(OH)$. Dark reddish brown or brownish black. Luster subvitreous to resinous, to dull or earthy. Streak uncolored to grayish. Translucent. H. = 7-7.5. G. = 3.65-3.75. Orthorhombic. Generally in twinned prismatic crystals having the form of a cross.

In crystalline schist as a result of regional or contact metamorphism, generally with garnet, sillimanite, andalusite, kyanite, or tourmaline.

Coconino County.—Grand Canyon, as brownish red stout prismatic crystals with garnet in metamorphic rocks of Lone Tree Canyon.

Yavapai County.—Bradshaw Mountains, in schist near contacts with granite bodies.

HILLEBRANDITE

$Ca_2SiO_4.H_2O$. White. H. = 5.5. G. = 2.7. Orthorhombic. In radiating fibrous masses.

Exceedingly rare, formed by contact metamorphism of limestone.

Cochise County.—Tombstone district, Lucky Cuss mine, with monticellite and idocrase.

PTILOLITE

Essentially a hydrous aluminum silicate. Colorless to white. H. = 5. G. = 2.1. Orthorhombic. In short capillary needles aggregated in delicate tufts.

A rare zeolite formed in cavities in basic lavas.

Pinal County.—Galiuro Mountains, as delicate cottonlike aggregates of white to colorless capillary needles in basalt flows, Copper Creek district.

ANALCIME—Analcite

$NaAlSi_2O_6.H_2O$. Colorless to white, also grayish, greenish, yellowish, or reddish. Luster vitreous. Transparent to translucent. H. = 5-5.5. G. = 2.27. Isometric, hexoctahedral. Generally in trapezohedral crystals. Also granular to compact massive.

One of the more common zeolites, formed in cavities in basic lavas. Also a component of some basic igneous rocks.

Pima County.—Santa Rita Mountains, in miscroscopic cavities of amygdaloidal basalts, Rosemont camp.

Yavapai County.—As small crystal grains making up the bulk of granular beds in the Big Sandy Valley a few miles east of Wikieup, formed from the alteration of glassy volcanic ash in the presence of strong solution of sodium salts.

SCOLECITE

$CaAl_2Si_3O_{10}.3H_2O$. White to flesh-pink. Luster vitreous to silky when fibrous. Transparent to translucent. H. = 5-5.5. G. = 2.16-2.4. Monoclinic. Crystals slender prismatic. Most commonly fibrous and radiating. Also massive.

One of the less common members of the zeolite family, but having the same origin and associations as the other members of that group.

Graham County.—At Black Point, some 4 miles below Geronimo on the Gila River, as amygdaloidal fillings up to ½ inch in diameter in basalt. The mineral is nicely fluorescent.

THOMSONITE

$Ca,Na_2)Al_2SiO_2½H_2O$. Snow-white to reddish green; impure varieties known. Luster vitreous to pearly. Transparent to translucent. H. = 5-5.5. G. = 2.4. Orthorhombic. Commonly in radiating fibrous spherical concretions; also compact.

Most common in cavities in amygdaloidal lavas, locally with nepheline as an alteration product.

Pinal County.—As radiating fibrous amygdules in basalts just east of the highway about midway between Tucson and Florence.

MUSCOVITE—White Mica

$KAl_3Si_3O_{10}(OH)_2$. Colorless, gray, brown, pale green, yellow. Luster vitreous to pearly or silky. Transparent to translucent. Streak uncolored. H. = 2-2.25. G. = 2.76-3. Monoclinic. Crystals tabular with rhombic or hexagonal outline. Perfect basal cleavage, yielding thin plates which are flexible and elastic. In scales or scaly masses, cryptocrystalline and compact forms. *Sericite* is a finely divided, soft variety.

Most abundant in granitic pegmatite, gneiss, and schist, in places making up a large proportion of the rocks. As sericite, an abundant alteration product in the wall rocks of many ore deposits and widely distributed in sediments and sedimentary rocks. In granite pegmatite muscovite may occur in large plates. An abundant and widely distributed mineral in Arizona. Only two relatively unusual occurrences are noted.

Yavapai County.—Weaver Mountains, near Peeples Valley, as segregations in Yavapai schist. Bradshaw Mountains, as segregations in a pegmatite dike, extending from Middleton to Horse Thief, a distance of some 5 miles.

Mariposite

A green chromium mica. Exact composition and properties in doubt. Is placed here as a variety of muscovite only for convenience.

Yuma County.—Trigo Mountains, Eureka district, disseminated in schist and accompanied by chromite.

LEPIDOLITE—Lithia Mica

$K_2Li_3Al_1Si_7O_{21}(OH,F)_3$. Rose-red, violet-gray, lilac, yellowish, grayish, white. Luster pearly. Translucent. H. = 2.5-4. G. = 2.8-3. Generally in cleavable plates, also coarse to fine granular.

A mineral of lithia-bearing granite pegmatite, generally associated with lithia tourmaline, amblygonite, and spodumene.

Yavapai County.—Eureka district, from pegmatites of the Bagdad area.

ZINNWALDITE

An iron-lithia mica in form near biotite. Pale violet, yellow, brown, and dark gray.

Most commonly in tin- and topaz-bearing pegmatite or in granite.

Santa Cruz County.—Patagonia Mountains, from the Line Boy mine, Duquesne.

BIOTITE—Black Mica

$K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$. Deep black or brown to green. Luster splendent, pearly on cleavage surfaces. Transparent to translucent. Streak uncolored. H. = 2.5-3. G. = 2.8-3.2. Monoclinic. Crystals tabular or short prismatic. Perfect basal cleavage. In disseminated scales or massive scaly aggregates.

The commonest of the micas. An important constituent of many igneous rocks, gneisses, schists, and contact-metamorphic zones. Widespread in the rocks of the state.

CHLORITE

Essentially $(Mg,Fe)_5(Al,Fe''')_2Si_3O_{10}(OH)_8$. Includes several minerals with similar chemical, crystallographic, and physical properties. Generally some shade of green. Luster vitreous to pearly. Transparent to translucent. H. = 2-2.5. G. = 2.6-2.9. Monoclinic. Crystals tabular and pseudohexagonal. Perfect basal cleavage, yielding flexible but nonelastic plates. Commonly foliated massive, as scaly aggregates or disseminated particles.

Most common in crystalline schist, in places making up a considerable proportion of the rock. Also resulting from alteration of ferromagnesian silicates such as biotite, pyroxene, or amphibole. Widely distributed in the state.

CRONSTEDTITE—Cronstedite

$4FeO.2Fe_2O_3.3SiO_2.4H_2O$. Black to brownish-black. Luster pearly to dull. Translucent to opaque. Streak dark olive-green. H. = 3.5. G. = 3.34-3.35. Monoclinic. Perfect basal cleavage. In tapering pyramidal crystals, divergent groups, or amorphous.

A compartively rare mineral of the chlorite group.

Mohave County.—Aquarius Range, in a vein traversing a "granite dike," with sphene, monazite, apatite, chevkinite, and quartz.

VERMICULITE

Includes several hydrated silicates, in part related to the chlorites. Composition varies widely. White to yellow and brown, with pearly or bronzelike luster. Generally soft with micaceous cleavage, occurring in flaky or scaly masses. Exfoliates when heated, swelling to several times the original thickness or opening into long wormlike threads.

An alteration product, chiefly of the micas, found in highly altered rocks.

Maricopa County.—Reported from near Aguila and between Wickenburg and the Vulture Mountains.

Mohave County.—In northeastern part of Hualpai Mountains.

SERPENTINE

$(Mg_3Si_2O_5(OH)_4$. Green, brownish, and yellowish to white. Luster resinous, greasy, silky to earthy. Translucent. H. = 2-5, usually 4, may be harder. G. = 2.2-2.65. Monoclinic. *Antigorite* is platy, granular or massive; *chrysotile* is a fibrous variety.

Of secondary origin, from alteration of nonaluminous magnesian silicates, particularly olivine, amphibole, or pyroxene, in places in large rock masses derived from peridotite or other basic igneous rocks. Also a common product of contact metamorphism of magnesian limestones. Chrysotile is the chief source of asbestos.

Cochise County.—Tombstone district, in altered limestone, Lucky Cuss mine. Chiricahua Mountains, as chrysotile with contact-metamorphic ores. Dos Cabezas Mountains, in metamorphosed limestone.

Coconino County.—Grand Canyon, as chrysotile, Bass and Hance properties, where the pre-Cambrian Bass limestone has been altered by diabase sills.

Gila County.—The most extensive deposits of chrysotile in the state are north and northeast of Globe along the Salt River in the vicinity of Chrysotile and along Cherry Creek. The deposits originated through metamorphic action of diabrase intrusives upon pre-Cambrian Mescal limestone. Analyses by R. E. Zimmerman as follows:

	MgO	SiO_2	Al_2O_3	FeO	CaO	H_2O	Total
(1)	42.05	41.56	1.27	0.64	0.00	14.31	99.83
(2)	41.85	41.35	0.91	0.69	0.07	13.34	98.21

Other deposits occur in the Pinal and Mescal mountains and in the Pinto Creek region.

Greenlee County.—Clifton-Morenci district, as yellow transparent material on the ridge just west of Morenci, and at the Thompson mine as green, banded material with magnetite.

Pinal County.—Globe district, Old Dominion mine, as massive yellow to green material in diabase and Mescal limestone.

TALC

$Mg_3Si_4O_{10}(OH)_2$. Green to white; brownish or reddish if impure. Luster pearly to dull. Subtransparent to translucent. Streak white. H. = 1. Feels greasy. G. = 2.7-2.8. Monoclinic. Perfect basal cleavage yielding thin flexible plates. Generally foliated, also granular to compact massive. Rocklike material is also known as *soapstone* or *steatite*.

Formed by alteration of nonaluminous magnesian silicates. Commonly associated with serpentine.

Abundant in the mining regions of the state where metamorphism has occurred, but usually highly impure.

Yavapai County.—Relatively pure material in appreciable quantity is reported from the Eureka district.

SEPIOLITE—Meerschaum

$Mg_2Si_3O_8.2H_2O$. White, grayish white, or faintly yellowish. Luster dull and earthy. Streak white. H. = 2-2.5. G. = 2. In compact masses with smooth feel and earthy texture, a mixture of fine fibrous material and an amorphous substance apparently of the same composition.

An alteration product of magnesian rocks and generally associated with serpentine or magnesite.

Maricopa County.—Reported from a locality 42 miles north of Phoenix and 2 miles east of Highway 69.

Yavapai County.—In the basin of the Santa Maria River west of the McCloud Mountains, as completely crystalline, fibrous material, without any indication of an "amorphous" constituent. Analysis by Albert J. Kauffman, Jr., as follows:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
54.83	0.28	0.45	0.55	24.51
Na_2O	K_2O	$H_2O(-)$	$H_2O(+)$	Total
0.35	0.03	8.18	10.74	99.92

IDDINGSITE

$H_8MgFe_2Si_3O_{14}$ (?) Brown; reddish by transmitted light. Bronzelike luster. H. = 3. G. = 2.5-3.8. Orthorhombic. Pinacoidal cleavage. As small disseminated flakes or foliated masses.

A relatively uncommon mineral formed by alteration of olivine in basic rocks.

Cochise County.—Tombstone district, as microscopic particles in basaltic rocks.

Gila and Pinal counties.—Pinal Mountains, as small reddish plates in the basalt flow above the Mescal limestone. Dripping Spring Mountains, as pseudomorphs after olivine in Tertiary basalt.

GLAUCONITE

$K_2(Mg,Fe)_2Al_6(Si_4O_{10})_3(OH)_{12}$. Dull green. Soft. Generally amorphous and resembles earthy chlorite.

Abundantly only in rocks known as "greensands," and in ocean sediments near continental shores. Believed to have been formed by alteration of such minerals as augite, hornblende, and biotite. Surface oxidation of glauconitic sediments has in some places formed iron ores.

Mohave County.—Big Sandy Valley, east of Wickieup, as extensive glauconitic sand beds.

Greenlee County.—In Clifton-Morenci district, glauconite (?) occurs in shale of the Morenci formation and in green shales above the Coronado quartzite.

KAOLINITE GROUP

White, grayish, yellowish, also brownish, bluish, or reddish. Luster pearly to dull and earthy. H. = 2-2.5. G. = 2.6-2.63. Monoclinic. Perfect basal cleavage. In thin scales or plates constituting claylike masses.

The Kaolinite group includes five minerals; of these *kaolinite, dickite, halloysite*, and *nacrite* have the same chemical composition, $Al_2Si_2O_3(OH)_4$, and *endellite* has the composition $Al_2Si_2O_5(OH)_8$. Kaolinite is the most important member of the group being a widespread component of soils, where it is the result of weathering processes. It is rarely the result of low-temperature hydrothermal processes.

Dickite is of widespread occurrence in certain types of mineral veins. Halloysite is abundant in soils as in endellite from which it is derived. These five minerals are properly termed *kaolin*. Although the term is commonly extended to include other clay minerals of similar composition and origin, properly only the above-mentioned minerals are included.

In the following occurrences. unless specifically indicated, the mineral members of the group have not been differentiated. Only occurrences of relatively pure material are listed.

Cochise County.—Bisbee district, as nearly pure kaolinite in snow-white waxy masses, from the second level of the Copper Queen mine; also as halloysite in small quantities, South West mine. Tombstone district, Toughnut mine. Silver Bell mine, Turquoise district.

Gila County.—Globe district in chalcocite and oxidized zones, Old Dominion mine. Miami district, Castle Dome mine, where halloysite and endellite occur as small masses filling open fractures in quartz monzonite.

Greenlee County.—Clifton-Morenci district, in large masses at the Longfellow mine, and in snow-white mammillary masses with azurite and malachite at the Copper Mountain and Mammoth mines.

Pima County.—Silver Bell Mountains, as large masses in wall rock on the upper levels of the El Tiro mine.

MONTMORILLONITE

$5Al_2O_3.2MgO.24SiO_26H_2O(Na_2O,CaO)$. White or grayish to rose-red, brownish, bluish, or greenish. Luster feeble. H. = 1-1.5. G. = 2. Massive and claylike.

Most important member of the montmorillonite-beidellite-nontronite-saponite-sauconite group. An intermediate product of a progressive alteration of aluminous minerals or volcanic glass of which the kaolinite group is the end product.

Bentonite, both swelling and nonswelling varieties, an alteration product of volcanic glass, ash or tuff, is largely composed of montmorillonite. Only reported occurrences of montmorillonite are in bentonite.

Apache, Navajo, and Coconino counties.—Lenticular beds of bentonite occur in the lower part of the Chinle formation.

Cochise County.—East of Elgin. Reported 2 miles south of Benson.

Maricopa County.—Bentonite occurs 2 miles northeast of Wickenburg and has been reported from the vicinity of Phoenix. Poor quality bentonite near Carl Pleasant dam.

Mohave County.—Reported as bentonite from the southern part of the county and east of the Big Sandy River.

Pinal County.—Near Ray and Superior, as bentonite.

Yavapai County.—In Thompson Valley, between Kirkland and Yava, in bentonite.

Yuma County.—Bentonite occurs near Wellton and Bouse.

BEIDELLITE

$13Al_2O_3.5Al_2O_3.38SiO_2.12H_2O(CaO,Na_2O)$. White, reddish or brownish gray. Waxy to vitreous luster. In thin crystal plates.

Gila County.—Miami district, Castle Dome mine, where it occurs as veinlets, fine aggregates and scattered flakes in the altered quartz monzonite.

NONTRONITE—Chloropal

Nearly $6Fe_2O_3.Al_2O_3.22SiO_2.6H_2O$ (Na_2O,CaO). Canary yellow, slightly greenish. Luster dull to waxy. Opaque to subtranslucent. H. = 2.5-4.5. G. = 1.727-2.105. Forms onion-shaped masses, also compact massive to earthy.

An iron-rich clay forming an isomorphous series with montmorillonite and beidellite; analagous with kaolin but not in kaolin group. Commonly contains impurities of quartz, opal, manganese oxides. A secondary mineral of uncertain origin. *Morencite* is identical with nontronite.

Greenlee County.—Clifton-Morenci district, as silky seams in limy shale, Arizona Central mine.

Pima County.—Santa Rita Mountains, in metamorphosed wall rock, Pauline mine, Helvetia district.

Yavapai County.—Black Hills, in limonite of the gossan, United Verde mine.

SAUCONITE

Approximately $(Zn,Mg,Al,Fe)_3(Al,Si)_4O_{10}(OH)_2$. Other properties presumably the same as for montmorillonite.

A proposed name for the recently characterized zinc member of the montmorillonite-nontronite-saponite group of clay minerals. This substance was previousy referred to as "tallow clay."

Pinal County.—Superior district, Magma mine, as soft, waxy, gougelike material from near the lower limit of oxidation, associated with coronadite. Partial analysis as follows:

SiO_2	Al_2O_3	H_2O	Zn
33.6	22.0	14.9	14.6

Gila County.—Miami district, Castle Dome area, as purplish, waxy lumps in highly manganiferous material.

ANAUXITE

$Al_2Si_3O_8.2H_2O$. White. Luster pearly. H. = 2.5. G. = 2.524. Monoclinic. Perfect basal cleavage. In crystal plates with hexagonal outline.

A kaolinlike mineral believed to be of wide occurrence in clays.

Pima County.—Roskruge Range, as minute pale brown tabular crystals with tridymite and cristobalite in cavities in andesite.

PYROPHYLLITE

$Al_2Si_4O_{10}(OH)_2$. White, apple-green, gray, brown. Luster pearly to dull. Translucent. Streak white. H. = 1-2. Feels greasy. G. = 2.8-2.9. Monoclinic. Perfect basal cleavage. In radiating, lamellar, or fibrous rosettes, or in foliated, granular compact, or cryptocrystalline masses.

In schistose rocks, largely of metamorphic origin, but may also form as an alteration product. Commonly associated with kyanite. Massive varieties closely resemble talc.

Mohave County.—Williams River, near Alamo, Cactus Queen mine. Also reported in large quantities from southeast of Yucca.

Yuma County.—Near Quartzsite, with dumortierite and kyanite. Near Alamo Springs, 27 miles southeast of Quartzsite, as a deposit reported to be 8 feet in width and extending for some 3,000 feet. Also reported from Bouse vicinity.

CHRYSOCOLLA

$CuSiO_3.2H_2O$. Green to bluish green, sky-blue, and turquoise-blue. Luster vitreous to earthy. Translucent to opaque. Streak white. H. = 2.4. G. = 2-2.4. Cryptocrystalline. Generally enamellike in texture, also earthy. Pure mineral 35.8% Cu.

Of secondary origin, formed in practically all oxidized copper deposits. Generally mixed with tenorite and malachite. Only the more important or interesting localities are listed.

Cochise County.—Bisbee district, a minor constituent of oxidized ores.

Gila County.—Globe district, an important ore mineral, particularly at the Old Dominion mine. Miami district, in the Bulldog tunnel of the Inspiration mine, with malachite, chalcedony, and quartz in aggregates of great beauty; Van Dyke property, with tenorite and azurite.

Greenlee County.—Clifton-Morenci district, in places as fine glassy-green specimens.

Mohave County.—Near Kingman, as specimen material of fine color, Emerald Isle mine.

Navajo County.—White Mesa district, as cementing material in beds of sandstone.

Pima County.—Silver Bell Mountains, Silver Bell district. As clear emerald-green material, El Tiro mine. Sierrita Mountains, San Xavier and Mineral Hill districts.

Pinal County.—Mammoth mine, in places of gem quality.

Yavapai County.—Black Hills, as a mamillary filling in Tertiary conglomerate, Arizona-Dundee property. Bradshaw Mountains, bright blue material, Copperopolis and Whipsaw properties, Castle Creek district.

Yuma County.—Buckskin Mountains, Planet mine.

SHATTUCKITE

$2CuSiO_3.H_2O$. Color blue. G. = 3.8. Monoclinic. In compact, granular, or fibrous masses.

An alteration product of other secondary copper minerals.

Cochise County.—Bisbee district, Shattuck mine.

Pima County.—Ajo, in veins, New Cornelia mine.

BISBEEITE

$CuSiO_3.H_2O$. Color pale blue to nearly white. Orthorhombic. In massive aggregates of fibers or thin laths.

Formed by hydration of shattuckite, with which it is associated.

Cochise County.—Bisbee district, Shattuck mine.

Pima County.—Ajo, in veins, New Cornelia mine.

THAUMASITE

$Ca_3SiO_3(CO_3)(SO_4).15H_2O$. White. Luster somewhat greasy to silky. H. = 3.5. Fibrous structure.

Cochise County.—Tombstone district, Lucky Cuss mine.

BULLETINS AVAILABLE

The Arizona Bureau of Mines still has the following bulletins available for *free distribution to residents of Arizona.* Bulletins not listed herein are out of stock and cannot be procured from the Bureau.

Because of the very heavy demand for bulletins from nonresidents of Arizona, which quickly exhausted stocks, it has become necessary to discontinue sending free bulletins out of the state. *Nonresidents may purchase bulletins* at the prices quoted, which include mailing charges.

123. Geology and Ore Deposits of the Courtland-Gleeson Region, Arizona, by Eldred D. Wilson. 1927 ..... .15
125. The Mineral Industries of Arizona, by J. B. Tenney. 1928 ..... .25
131. Geology and Ore Deposits of the Oatman and Katherine Districts, Arizona, by Carl Lausen. 1931 ..... .25
134. Geology and Mineral Deposits of Southern Yuma County, by Eldred D. Wilson. 1933 ..... .50
137. Arizona Lode Gold Mines and Mining, by Eldred D. Wilson, J. B. Cunningham, and G. M. Butler. 1934 ..... .50
138. Treating Gold Ores (Second Edition), by T. G. Chapman. 1935 ..... .15
139. Some Facts About Ore Deposits, by G. M. Butler. 1935 ..... .15
140. Arizona Metal Production, by Morris J. Elsing and Robert E. S. Heineman. 1936 ..... .25
141. Geology and Ore Deposits of the Ajo Quadrangle, Arizona, by James Gilluly. 1937 ..... .25
142. Arizona Gold Placers and Placering (Fourth Edition), by Eldred D. Wilson, G. R. Fansett, and others. Reprinted in 1937 ..... .35
143. Geology and Ore Deposits of the Tombstone District, Arizona, by B. S. Butler, Eldred D. Wilson, and C. A. Rasor. 1938 ..... .50
144. Geology and Ore Deposits of the Mammoth Mining Camp Area, Pinal County, Arizona, by Nels Paul Peterson. 1938 ..... .25
145. Some Arizona Ore Deposits, by numerous authors. 1938 ..... .35
146. Bibliography of the Geology and Mineral Resources of Arizona, by Eldred D. Wilson. 1939 ..... .35
148. Tungsten Deposits of Arizona, by Eldred D. Wilson. 1941 ..... .25
150. Field Tests for the Common Metals (Eighth Edition), by G. R. Fansett. 1942 ..... .20
152. Arizona Nonmetallics, by Eldred D. Wilson, 1944 ..... .30

SERVICES OFFERED BY THE ARIZONA BUREAU OF MINES

(Continued from inside front cover)

4. The Bureau provides an ore-testing service for ores originating within the state of Arizona. Full details will be furnished on request.
5. Semitechnical meetings with miners and prospectors are held throughout the state.
6. The collection and dissemination of statistics relating to the mineral industries of the state.
7. The collecting and filing of all items relating to Arizona mines and minerals that appear in Arizona newspapers and in many technical periodicals.

MAPS OF ARIZONA

The Arizona Bureau of Mines now has available for distribution the following maps of the state:

A. *Base Map of Arizona* on a scale of about 17 miles to the inch. This map is strictly geographic, indicating the positions of towns, railroads, rivers, surveyed lands, national forests, national parks and monuments, etc., revised to 1939. It is printed in black on one sheet 22x26 inches and sells for 20 cents unmounted.

B. *Topographic Map of Arizona* in one sheet 42x54 inches, on a scale of about 8 miles to the inch. It conveys all of the information given by the Base Map and, in addition, shows topography and highways. The topography is indicated by contour lines of 100-meter intervals. A table for converting meters to feet is printed on the map. This map was issued in 1933 and revised as to highways in 1946. It is sold, unmounted, for $1.00.

C. *Geologic Map of Arizona* in one sheet of many colors on the same scale as the Topographic Map. It was issued in 1924 and is sold, unmounted, for $2.50.

D. *Metallic Mineral Map of Arizona,* 25x27 inches. This map consists of a red overprint made on map A, and shows the principal known localities of metallic minerals by means of representative symbols. It also gives the value of metal production for the major districts and for the state. Roads are indicated. This map was revised in May, 1946, and sells for 25 cents.

E. *Nonmetallic Mineral Map of Arizona,* 25x27 inches, similar to map D but devoted to nonmetallic minerals. This map was revised in May, 1946, and sells for 25 cents.

F. *Map of Arizona Mining Districts,* 25x27 inches. This map consists of a red overprint made on map A and shows the principal known mining districts or mining localities by means of numerals. Roads are also indicated. An index to the districts or localities is printed on the margin. This map was revised in May, 1946, and is sold for 25 cents.

The Arizona Bureau of Mines is also an agent for the sale of available U.S. Geol. Survey Arizona quadrangular sheets. Most of these sell for 20 cents.

Postage prepaid on all maps.

All communications should be addressed and remittances made payable to the Arizona Bureau of Mines, University Station, Tucson, Arizona.