FOREWORD

As a service about mineral matters in Arizona, the Arizona Bureau of Mines, University of Arizona, is pleased to reprint the long-standing booklet on MINERALS OF ARIZONA. This basic journal was issued originally in 1941, under the authorship of Dr. Frederic W. Galbraith, as a bulletin of the Arizona Bureau of Mines. It has moved through several editions and, in some later printings, it was authored jointly by Dr. Galbraith and Dr. Daniel J. Brennan. It now is being released in its Fourth Edition as Bulletin 181, Arizona Bureau of Mines.

The comprehensive coverage of mineral information contained in the bulletin should serve to give notable and continuing benefits to laymen as well as to professional scientists of Arizona.

J. D. Forrester, Director
Arizona Bureau of Mines
February 2, 1970

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Widely distributed in small quantities. Most abundant in quartz veins or in placer deposits from weathering 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 impractical 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 161, 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—Galileo Mountains, Rattlesnake district. Piñaleno 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.


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 Big Bug, Gila Placers, with copper ores; Pine Grove and Agu 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, Clenega 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, Tevis ton, Huachua, Glesson, Pearce, and Gold Gulch (Biabe) placers. **Gila County**—Small production from Dripping Spring, Barbarossa, Global-Globe, 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, Chemeheuviis, Lewis, Wright Creek, Lookout, and Silver Creek placers.

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

**Pinal County**—Cañada 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, Minneahah, 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**


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

**COPPER**


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 pseudomorphically replace such minerals as cuprite, azurite, and chalcocyprite.
Cochise County—Bisbee district, abundant in oxidized ore of the Copper Queen mine above the third level, as masses of several hundred 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 Moun-
tains, Christmas mine. Rarely, as a secondary mineral in the Castle Dome 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.

Mohave County—In small amounts as a secondary mineral in the Wallapaal Mining district.

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. Galicuro 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.

LEAD


Occurs as native metal in oxidized zone of vein deposits. Usually oxidized when found near the surface.

Maricopa County—Reported from the benches of Oxbow Creek, Old Woman Gulch, Little San Domingo Creek, in red sand with magnetite.

Yavapai County—Reported as sized masses in Gold Crater (15 miles west of Congress) and at La Paz in red quartz.

MERCURY


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 cressuerte.

Yavapai County—In appreciable quantity from the Kirkland placers, lower Copper Basin Wash, probably from the low-grade cinnabar deposits in the vicinity.
Mohave County—The Hualapai meteorite, consisting of two masses weighing 672 and 287 pounds respectively, were discovered on the Hualapai Reservation near the rim of the Grand Canyon in 1927. They consist of fine octahedrites with angular enclosures of schreibersite. Analysis by Shannan as follows:

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<tr>
<th>Element</th>
<th>Fe</th>
<th>Co</th>
<th>Cu</th>
<th>Ni</th>
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The Navajo meteorite, found in 1921, consisted of a small shower, the main falling weighing 3000 pounds.

Pima County—The Tucson meteorites are described by Guild as follows:

Two important masses of meteoric iron have been discovered in the vicinity of Tucson, but thoroughly reliable data as to their nature have not been forthcoming. In 1879, the American Museum of Natural History received a fragment of a meteoric iron, weighing about 3000 pounds. It was first called the "Tucson meteorite," but later the attention of the scientific world was fixed on the "Tucson meteorite," a shower of some 3000 stones containing iron, taken place at Tucson, July 19, 1879. The largest complete stone weighed 145 pounds.

Analysis of Fragment of Tucson Meteorite

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<th>Element</th>
<th>Fe</th>
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The Tucson meteorite, found in 1921, consisted of a small shower, the main falling weighing 3000 pounds.

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 galadinite.

Yavapai County—Bradshaw Mountains, in the Humbug Creek placer and in Minehahna Flats. A low-grade deposit is reported on Buckhorn Wash, east of Brooks Hill. Midnight Owl mine, as irregular masses and thin flakes, and one mass weighing 2½ pounds.

Selenium


Tellurium


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

S. Various shades of yellow; greenish or reddish. Luster resinous. Transparent to translucent. H. = 1.5-3.5. G. = 2.87. Orthorhombic, dipyrmdal. Crystals pyramidal or hackly tabular. Commonly massive or as intergrowths. 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 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.

Maricopa County—As crystals in cavities in quartz, on the result of the decomposition of pyrite, on the Surprise gold claim northwest of Morristown.

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

Yavapai County—United Verde mine, deposited under sol-fatary 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 absorptions 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. = 3.3.5. Isometric, hextetrahedral. Predominantly in octahedral crystals or fragments with perfect octahedral cleavage.

Meteoritic 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


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.

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.

MINERALS OF ARIZONA

SULFIDES

Tetradymite
Domeyrite
Dyscrasite
Argentite
Digenite
Hessite
Chalcolite
Chromeyrite
Borrnite
<table>
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<th>TETRADYMITE</th>
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An uncommon mineral in gold-quartz veins, near-surface hydrothermal deposits, 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

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A rare mineral.

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

DYSCRASITE

Ag5Sb, Color and streak silver-white, usually tarnished to lead-gray, yellowish or blackish. Luster metallic. Opae, H. = 3-3.4. G. = 9.08-10.51. Orthorhombic, pyramidal. Crystals rare. Good basal cleavage. Commonly massive, foliated or granular.

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.

ARGENTITE


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 sulfide enrichment with chalcocite and native silver.
Cochise County—Tombstone, in oxidized ores from alteration of argentiferous tetrahedrite. Pearce, with cerargyrite, bromyrite, embolite, and iodotype, Commonwealth mines.

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

 Graham County—Aramoa 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, Sierra Mountains, Sunrise mine, Papago district. Quijotoe 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 Park district, in galena with freibergite and in cavities with wire silver. Wickenburg Mountains, Monte Cristo mine, in primary ore with native silver, niccolite, chalcosthite, and proustite.

DIGENITE


It has recently been determined that the so-called "blue chalcocite" or "isometric chalcocite," not uncommonly observed as microscopic 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


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


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. Reported to occur in the 79 Mine.

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. Sierra 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


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

BORNITE

An important copper ore in many mines of the state. Almost invariably associated with either chalcopyrite or chalocite, 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, chalocite, 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 chalocite zone.

Mohave County—Grand Wash Cliffs, Bronze L mine. Atlanta and Pinkham mines, Chloride district.
Pima County—Ajo, concentrate around pegmatitic bodies in the Cornelia quartz monzonite. Tucson Mountains, disseminated in propyry, 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, Adjut mine, Saddle Mountain district. Sparingly scattered in the San Manuel copper deposit.

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

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.
**UNIVERSITY OF ARIZONA**


**ALABANDITE**


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


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 = 3-4. G = 3-4-1. Isometric, hexoctahedral. Crystals tetrahedrons or distorted and tritetrahedron. Perfect dodecahedral cleavage. Most commonly cleavable or granular massive.

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.

Coconino County—Bisbee district, Campbell mines, from which considerable quantities are now being mined at Tombstone, Silver Thread and Sulphuret mines, less abundant elsewhere. Little Dragon 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 unwashed 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, Adjut, 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 14 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.

**MINERALS OF ARIZONA**

**METACINNABAR**


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

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

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

**CHALCOPYRITE**


The most important ore mineral of copper. In appreciable quantity in nearly 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.

Coconino 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 body. Little Dragon 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 prolores 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 prophecy contacts.

Mohave County—Cerbat Range, common in nearly all copper mines and prospects. Grand Wash Cliffs, th 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 prolores. San Manuel area, in prolores.

Santa Cruz County—Santa Rita Mountains, the most abundant ore mineral in most of the districts. Patagonia Mountains, Santo Nino 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

**Wurtzite**

ZnS. Brownish black. Luster resinous. Transparent to translucent. Streak brown, H. = 3.5-4. G. = 3.96. 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.

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

**Greenockite**


**Cochise County**—Reported as an earthy yellow coating on sphalerite in Bisbee area.

**Pyrrhotite**


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.

**Maricopa County**—White Picacho district, scattered in pegmatites, especially in the coarse-grained interiors.

**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 (trolley) in the stones of the Holbrook meteorite.

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

**Yavapai County**—With gold ores of the Bradshaw Mountains. In pegmatites of the White Picacho district.

**Niccolite**


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 chalcocite and native silver, Monte Cristo mine.

**MINERALS OF ARIZONA**

**Pentlandite**


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


A secondary mineral, in many places associated with chalcopyrite 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 chalocite.

**Gila County**—Payson area, in small amounts replacing chalcopyrite and bornite. Dripping Springs Mountain, Christmas mine, Banner district, with secondary chalocite. "79" Mine, minor amounts associated with oxidation products of galena.

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

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

**Mohave County**—Common as an accessory mineral in the Wallapai district.

**Final County**—Superior district, sparingly distributed in the Magna mine. Mammoth mine, replacing chalcopyrite. Sierrita Mountains, La Coronado mine, Mineral Hill district. Reported from the San Manuel mine.

**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. = 3-3.5. G. = 6.0. Hexagonal, trigonal-dipyramidial. Perfect prismatic cleavage. As finely granular or ecleavable masses or earthy coatings.

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—Mazatal 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


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 regular 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


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


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 Mazatlan Mountains on Slate Creek.
Graham County—Stanley district. in contact-metamorphic ores, Cold Spring prospect.
COBALTITE


An uncommon mineral generally found in small amounts in metamorphic rocks, less common 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—Cobobabi 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 eurhythrite.

LOELLINGITE


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

Maricopa County—Disseminated in pegmatites throughout the White Picacho district.

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

Analysis by Claude E. McLean as follows:

<table>
<thead>
<tr>
<th></th>
<th>Fe</th>
<th>Co</th>
<th>Ni</th>
<th>As</th>
<th>S</th>
<th>Cu</th>
<th>Zn</th>
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<td>3.73</td>
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</table>

MARCASITE

FeS2. Pale bronze-yellow, deepening upon exposure; tin-white on fresh fracture. Luster metallic. Opaque. Streak grayish or brownish black. H. = 3-3.5. G. = 4.87. 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.

Coconino County—Near Cameron, as cyclic twinned inclusions in amethystine quartz crystals in petrified wood.

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 partly oxidized ore, Iron Queen mine, Big Bug district. In pegmatites of the White Picacho district.

ARSENOPYRITE


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

Maricopa County—Sparingly in pegmatites of the White Picacho district.

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 Sheba 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 bismuthinitene, near Hillside mine. Sparingly in pegmatites of the White Picacho district.

MOLYBDENITE


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 Drogon 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.

Maricopa County—Sparingly scattered through pegmatites of the White Picacho district, locally abundant.

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

Pima County—Santa Rita Mountains, Helvetia district, Leader, Ridley, 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. Bacoquivari 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—Caliuro 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 and 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, 21 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. In pegmatites of the White Picacho district.

SMALTLITE—CHLOANTHITE


Smaltilte 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 smaltilite.

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

SULFOSALTS

Polybasite
Peacsite
Stephanite
Pyrargyrite
Proustite

Tetrahedrite
Bournonite
Aikinite
Diaphorite
Enargite
Freieslebenite

Dufrenoisite
Cosalite
Miargyrite
Jamesonite

POLYBASITE


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)4 Sb,S11. 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

silver. Freibergite is argentiferous tetrahedrite containing from 3 to 30 per cent of silver.

Cochine County—Tombstone, particularly at the Tougnot, 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. Santa Rita Mountains, Silver Spur mine, Helvetia district; Summit mine, Greaterville district; Busterville mine, Cuprite district. Sierra 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. Galuro 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


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

Cocheize County—Tombstone, in small amount, Ingersol and Tougnot mines.

ENARGITE


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. Galuro Mountains, sparingly with tennantite, Childs-Aldwinkle mine.

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

**MINERALS OF ARIZONA**

BOURNONITE


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

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

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<th>Pb</th>
<th>Fe</th>
<th>Zn</th>
<th>Cu</th>
<th>Sb</th>
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<th>S</th>
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<td>0.35</td>
<td>15.12</td>
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<td>2.81</td>
<td>20.04</td>
<td>1.67</td>
<td>99.54</td>
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</table>

Aikenite


Reported under the name brongniardite, as occurring with other argentiferous ores. No specific localities were given.

FREIESLEBENITE


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.

MIARGYRITE

Ag$_3$Sb$_3$S$_8$. Iron black to steel gray. Luster metallic, adamantine. Streak cherry-red. Nearly opaque in thin splinters, translucent and deep red in color. H. = 2.5. G. = 5.25 ± 0.05. Cleavage (010) imperfect. Occurs as thick tabular crystals, also massive.

Mohave County—Wallapai district, as a primary mineral.

DUFRENOYSITE


A rare species, known from only a few localities.

Mohave County—Reported from the Mineral Park district, but the exact locality is not known.
**COSALITE**


**Graham County**—Aravaipa district, on the Lundsman claim, with calcite and diopside.

**JAMESONITE**


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 sulfosalts in fibrous form.

**Yavapai County**—Reported from the Bradshaw Mountains with native gold.

**SIMPLE OXIDES**

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<th>Mineral</th>
<th>Formula</th>
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<th>Streak</th>
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<td>Black</td>
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<td>Cu₂O</td>
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<td>Black</td>
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<td>Imitate</td>
<td>Cu₂O</td>
<td>Black</td>
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<tr>
<td>Parameleacite</td>
<td>Cu₂O</td>
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<td>Pyrolusite</td>
<td>CuO</td>
<td>Black</td>
<td>Black</td>
<td>3.5-4</td>
<td>6.04</td>
</tr>
</tbody>
</table>

**CUPRITe**

CuO. 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. = 6.04. Isometric. Crystals octahedrons, cubes, and dodecahedrons. Slender capillary crystals are known as chalcocite. Generally massive or compact, earthy.

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 chalcocite. 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 malachite, brochantite, and malachite lining small cavities in the Troughmet mines. Dragoon Mountain, Courtland-Gleeson district, as aggregates of octahedral crystals.

**Gila County**—Globe district, sparingly in oxidized ore. Miami district Van Dyke mine, with chrysocolla. Also from the "79" mine.

**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. At the Continental and Buffalo mines, and as large, dull octahedras 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 chalcocite.

**Maricopa County**—White Picacho district, as a supergene mineral in some of the pegmatites.

**MINERALS OF ARIZONA**

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

**Pinal County**—Ray district, as sparkling ruby-red aggregates of chalcocite 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 chalcocite. White Picacho district, as a supergene mineral in some of the pegmatites.

**TENORITE**

Cu₂O. Steel-gray to black. Luster metallic to earthy. Opaque. Streak black. H. = 3.5. G. = 6.06. Monoclinic. In minute black scales or paper-thin twinned crystal aggregates. Most common as black earthy material known as melanochlite. Black, pitchy material from the Calumet and Arizona mine described as melanochlite 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 1906 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. Also from the "79" mine.

**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**


An extremely rare mineral, only 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).
MINERALS OF ARIZONA

HEMATITE


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 covering of many sulfide ores. Also in deep-seated veins; widely 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—Pike’s 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.

Pinal County—Near Winkelman as iridescent material.

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:

\[
\begin{align*}
\text{Fe} & : 61.0 \\
\text{CaO} & : 4.5 \\
\text{SiO}_2 & : 2.0
\end{align*}
\]

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

ILMENITE

\[
\begin{align*}
\end{align*}
\]

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


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


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


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 gange of the Howard Copper property, Black Canyon district.

PYROLUSITE

MnO. Steel-gray to black or bluish black. Luster metallic to dull. Opaque. Streak black or bluish black. H. = 4-4.5. Soft material soaks the fingers. G. = 4.4-5.06. Tetragonal, ditetragonal dipyramidal, but commonly pseudomorphous after manganese. Crystals are known as polylute. In granular, fibrous, or columnar masses, or as dendritic or reniform coatings.

Secondary, formed by dehydration of manganese, 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, Agua district, with manganese 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 Agua district. On Castle Creek, 25 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.

MINERALS OF ARIZONA

WAD

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

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, Agua district, with manganese and pyrolusite.

Mohave County—Rawhide Mountains, Artillery Peak, in extensive brecciated 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, Galilio 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 K₂O 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 includes 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:

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<th>MnO</th>
<th>MnO₂</th>
<th>ZnO</th>
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</table>

CASSITERITE


Usually as short prismatic crystals in pegmatites. Most important ore of tin.

Graham County—In spherulitic rhyolite and in placers derived from it some 25 miles east of Safford on highway 70.

Maricopa County—In the Outpost pegmatite, associated with bismuth and copper minerals, as tabular crystals with well-defined faces, honey-yellow to very dark brown, some zoned, up to 1.5 inches in diameter.

PLATNERITE


Santa Cruz County—Glove mine, as crystal incrustations on wulfenite.

ANATASE—Octahedrite


MINERALS OF ARIZONA

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.

BROOKITE

TiO₂. Various shades of brown to black. Transparent in small fragments. Luster metallic adamantine to submetallic. Streak uncolored to gray or yellow. H. = 5-5.6. G. = 4.14 ± 0.06. Found only as crystals, usually tabular and elongated.

Gila County—Reported as occurring in concentrates derived from the Globe area with biotite, quartz and ilmenite.

CERVANTITE

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

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, 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


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.

VANOXITE

Probably V₂O₅·8H₂O. Color black.Opaque; extremely thin fragments transmit a brownish color. Occurs as microscopie crystals, sometimes with a rhombohedral section; massive, as a cement in sandstone.
Apache County—Lukachukai Mountains and several mesas to the north, in the Saltwash sandstone.

CORVUSITE

\[ \text{V}_2\text{O}_3\text{H}_2\text{O}(?) \]. Color and streak blue-black to brown. Opaque. Fracture conchoidal. \( H = 2.5-3.0 \). \( G = 2.85 (?) \). Found only as massive material.

Apache County—Monument Valley, in the Monument No. 2 mine.

TUNGSTITE

Probably \( \text{WO}_3\text{H}_2\text{O} \). 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 in Arizona.

NAVAJOITE

\[ \text{V}_2\text{O}_3\text{H}_2\text{O} \]. Dark brown, silky luster. Streak brown. Hardness less than 2. \( G = 2.56 \). Monoclinic. Occurs as fibrous aggregates, also as a coating around pebbles and sand grains and as thin seams in sandstone.

Apache County—Monument Valley, in a conglomeratic sandstone in the Monument No. 2 Mine.

DOLORESITE

\[ 3\text{V}_2\text{O}_3\text{H}_2\text{O} \]. Nearly black. Luster submetallic. Streak greenish black. \( G = 3.27-3.41 \).

Apache County—Monument Valley, from the Monument No. 2 Mine, as chocolate-brown, bladed masses with satin-like cleavage surfaces, associated with a variety of other vanadium oxides.

OXIDES CONTAINING URANIUM, THORIUM AND ZIRCONIUM

Uraninite
Gummite
Becquelerite
Fourmarierite
Davidite

URANINITE

\( \text{UO}_2 \). Steely to velvety black, and brownish black. Luster submetallic to pithchy to greyish and dull. Transparent in very thin splinters. Fracture uneven to conchoidal. Brittle. Streak brownish black. \( H = 5-6 \). \( G = 10.80 \). Isometric hexagonal, octahedral habit. Massive variety is pitchblende. Usually more or less oxidized from \( \text{U}^3+ \) to \( \text{U}^6+ \) resulting in lower specific gravity.

There are many reported occurrences of this mineral in Arizona. Following are some of the authenticated localities.

Apache County—Lukachukai Mountains in several claims and mines, including Luki, Mesa 1½, Mesa 2, Cove School, Mesa 4½. Monument Valley, Monument No. 2 mine. Garnet Ridge, near Dinnehotso.

Cochise County—As minute cubes along slip planes in the Copper Queen mine at Bisbee.

Coconino County—In the workings of the A & B Mining Co., Flagstaff. On several claims in the Cameron area. Hosteen Nez claims near Tuba City.

Gila County—At a number of places in the Dripping Spring quartzite.

Navajo County—At many localities including Monument No. 1 mine, and a property six miles north of Holbrook.

Pima County—Rincon Mountains, Blue Rock claims.

Santa Cruz County—Annie Laurie prospect near Ruby; also at Alamot SPRING.

Yavapai County—Hillside Mine.

GUMMITE

\( \text{UO}_2\text{H}_2\text{O}(?) \). Composition not definite, as this is a generic term for oxides of uranium, usually containing Pb and Th, with relatively large amounts of H₂O, whose true identity is unknown. Color yellow, orange, reddish yellow, orange-red, reddish brown, brownish black and black. Luster greasy or waxy to vitreous, brilliant to dull; often somewhat resembling gum. Fracture conchoidal to uneven. Brittle. Streak yellow or brownish olive-green. \( H = 2-3 \). \( G = 3.9-6.4 \).

Apache County—In the Monument Valley No. 2 Mine, with many other uranium minerals.

BECQUELERITE

\( 2\text{UO}_2\text{H}_2\text{O}(?) \). A hydrated oxide of uranium. Formula uncertain. Amber to brownish yellow. Transparent. Luster adamantine, inclining to greasy. Streak yellow. \( H = 3-4 \). \( G = 5-5.5 \).

Apache County—Monument No. 2 Mine.

Navajo County—Cato Sells mine, as a secondary mineral. Also reported six miles north of Holbrook.

FOURMARIERITE

\( \text{PbO.4UO}_3\text{H}_2\text{O}(?) \). A hydrated oxide of uranium and lead. Formula uncertain. Red to golden-red; also brown. Luster adamantine. Transparent. \( H = 3-4 \). \( G = 6.046 \). A secondary mineral.

Apache County—Monument No. 2 Mine, with several other uranium minerals.

DAVIDITE

An oxide of titanium, iron, uranium, chromium and the rare earths. Dark brown to brownish black. Luster submetallic to glassy. Streak brownish black.

Pima County—Quijotoe Mountains, as dark brown pitchy lustered masses in a matrix of sphenite and feldspar, near Covered Wells.

HYDROXIDES

Brucite
Lepidocrocite
Montroseite
Paramontroseite
Manganite
Gibbsite
Psilomelane
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 magnesiite and serpentine cutting volcanic rocks.

LEPIDOCROCITE


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.

MONTROSEITE—PARAMONTROSEITE

(VFe)₂O₂(OH) (Montroseite); VO₂ (Paramontroseite). Both orthorhombic. Montroseite: Grayish black. Luster submetallic. G. = 4.0. Perfect side pinacoidal cleavage. Occurs as bladed crystalline masses. Paramontroseite is an alteration product of the oxidation and dehydration of montroseite, and is pseudomorph after montroseite.

Apache County—As montroseite at the Martin Mine, Carrizo Mountains; the Mesa 4½ and Cove School Mines, Lukachukai Mountains. As paramontroseite at the Monument No. 2 Mine, Monument Valley. Probably both minerals are present in all locations.

MANGANITE


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. As irregular masses with oxidized copper ore in the "79" mine.

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. As shiny black crystals in the property of the Mohave Mining and Milling Co., east of Wickenburg.

Yuma County—Planet district.

MINERALS OF ARIZONA

MAGNETITE

Fe₃O₄. White, grayish, greenish, or reddish white; also red; yellow when impure. Luster vitreous, pearly on cleavages. Transparent. Emits a strong clayey odor when breathed on. H. = 5.5. G. = 5.2-5.4. 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 chalcolanumite and malachite.

PSILOMELANE

Probably BaMnMnO₆. (OH). Iron-black to dark steel-gray. Luster submetallic to dull. Opaque. Streak brownish black to black. 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:

<table>
<thead>
<tr>
<th></th>
<th>BaO</th>
<th>MnO</th>
<th>MnO₃</th>
<th>Fe₂O₃</th>
<th>Mn₂O₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insol.</td>
<td>14.40</td>
<td>6.70</td>
<td>59.65</td>
<td>3.27</td>
<td>4.27</td>
</tr>
</tbody>
</table>

A rarely 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:

<table>
<thead>
<tr>
<th>Cu</th>
<th>Fe</th>
<th>Mg</th>
<th>Mn</th>
<th>Insol.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>41.54</td>
<td>37.22</td>
<td>21.79</td>
<td>0.25</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

GOETHITE


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.

**GROUTITE**


**Cochise County—At Bisbee,** in the Campbell Shaft, as tiny dark brownish black crystals coating sooty manganese oxide matrix.

**LIMONITE—Brown Iron Ore**

A mixture of ferro iron minerals, principally goethite and hematite. Yellow, brown, or 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 ochre or yellow ochre 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**

MgAl₂O₄. Various shades of red, blue, green, and brown to nearly colorless. Luster vitreous to dull. Transparent. Streak white. H. = 7.5-8. G. = 3.85 when pure. Isometric, hexoctahedral. Crystals octahedral. Picotite, or chrome spinel, contains a large proportion of Cr in substitution for Al. Gahnite is essentially Zn, Al spinel; Pleonaste is Mg, Fe spinel.

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.**

**Maricopa and Yavapai Counties—Gahnite is found as small blue-gray to deep green crystals in pegmatites of the White Pine district, as pleonaste, in greenish black crystals.**

**MAGNETITE**


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.

**Cochise County—Grand Canyon,** as octahedral crystals up to an inch in diameter in pegmatites. As segregations of titaniferous magnetite in gabbro south of Seligman.

**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. In large amounts on the surface, five miles from Tule Wells.

**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:

<table>
<thead>
<tr>
<th>Fe</th>
<th>Ti</th>
<th>Mn</th>
</tr>
</thead>
<tbody>
<tr>
<td>60.35</td>
<td>8.40</td>
<td>Trace</td>
</tr>
</tbody>
</table>

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**


As veins or masses in peridotite or in serpentinite 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**


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**


A rare secondary mineral described from only two localities in the world.
Greenlee County—First described from Clifton-Morenci, as fairly large amounts at the west end of the Coronado vein. Analysis by W. F. Hillebrand as follows:

<table>
<thead>
<tr>
<th>Oxide</th>
<th>MnO</th>
<th>MnO₂</th>
<th>PbO</th>
<th>FeO</th>
<th>ZnO</th>
<th>CuO</th>
<th>H₂O</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>56.6</td>
<td>6.11</td>
<td>26.96</td>
<td>0.10</td>
<td>1.02</td>
<td>1.35</td>
<td>100.84</td>
<td></td>
</tr>
</tbody>
</table>

As recalculated by Frondel and Heinrick:

<table>
<thead>
<tr>
<th>Oxide</th>
<th>MnO</th>
<th>MnO₂</th>
<th>PbO</th>
<th>FeO</th>
<th>ZnO</th>
<th>CuO</th>
<th>H₂O</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60.90</td>
<td>7.12</td>
<td>38.69</td>
<td>1.11</td>
<td>1.11</td>
<td>0.42</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

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

MULTIPLE OXIDES

Containing Columbium, Tantalum, Titanium

Pyrochlore

Tapiolite

Euxenite

Microlite

Columbite

Polycrase

Fergusonite

Tantalite

SamarSkyte

PYROCHLOR-MICROLITE

\( \text{Na}_2\text{Ce}_{1+x}\text{Fe}_{4-x} \) \( \text{Ta}_x\text{Fe}_{4-x} \) \( \text{O}_{5+x} \). A complex oxide series. Pyrochlore brown to black, microlite yellow to brown, streak of pyrochlore light brown, yellowish brown, streak of microlite pale yellowish or brownish. Brittle, \( H = 5-5.5 \). \( G = 4.2-6.4 \), increasing with Ta content. Isometric hexoctahedral. Octahedral habit.

Yavapai County—White Picacho district, in the Outpost, Midnight Owl and Picacho View pegmatites as tiny, olive-green to dark brown and black crystals of microlite with sharply defined octahedral and dodecahedral faces, associated with pyrochlore.

FERGUSONITE

\( \text{Y}(\text{Er,Ca,Ce,U,Fe}) \) \( \text{Ta}_x\text{Fe}_{4-x} \) \( \text{O}_{5+x} \). Brownish black to velvet-black. Luster dull to vitreous. Transparent in thin splinters. Streak yellowish, grayish or reddish brown. \( H = 5.5-6.5 \). \( G = 5.5-5.8 \). Tetragonal, dipyramidal. In pyramidal or prismatid crystals. Also massive.

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

Mohave County—Reported to occur near the Aquarius mountains.

Yavapai County—Mica-Feldspar quarry northwest of highway maintenance camp on White Spar road just beyond Yarnell.

TAPIOLITE

\( \text{FeTa}_2\text{O}_6 \). Black, luster subadamantine to metallic. Transparent in extremely thin splinters. Streak cinnamon-brown to brownish black. \( H = 6-6.5 \). \( G = 3.8-3.9 \). 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.

COLUMBITE-TANTALITE

A series from \( \text{Fe}(\text{Mn}) \) \( \text{Ta} \) \( \text{Os} \) to \( \text{Fe}(\text{Mn}) \) \( \text{Ta} \) \( \text{Os} \) \( \text{Os} \). Iron-black to brownish black, with reddish brown internal reflections. Transparent in thin splinters. Cleavage (010) distinct. Brittle, streak dark red to black. \( H = 6 \). (Columbite) to 6.5 (Tantalite). \( G = 5.35 \) (Columbite) to 7.5 (Tantalite). Orthorhombic, dipyramidal.

The most abundant and widespread of the natural columbates and tantalates, especially in granite pegmatites containing lithium minerals.

Maricopa County—White Picacho district, as crystals up to 5 inches in diameter in the quartz-rich zone of the Midnight Owl pegmatite. Ferberite deposits of the Cave Creek district carry 2.19 per cent combined columbium-tantalum probably as columbite-tantalite.

Yavapai County—In small quantities in several pegmatites of the White Picacho district.

EUXENITE-POLYCRASE

A series from \( (\text{Y},\text{Ca},\text{Ce},\text{U},\text{Th}) \) \( \text{Ta},\text{Fe}_{4-	ext{Ta}} \) \( \text{O}_{5+	ext{Ta}} \) to \( (\text{Y},\text{Ca},\text{Ce},\text{U},\text{Th}) \) \( \text{Fe},\text{Ta}_{4-	ext{Fe}} \) \( \text{O}_{5+	ext{Fe}} \). \( \text{Cb} \) plus \( \text{Ta} \) end is pyrochlore. \( \text{Ta} \) end is pyrochlore, sometimes with a greenish or brownish tint. Luster often brilliant, submetallic, or somewhat greasy or vitreous. Transparent, in thin splinters. Streak yellowish, grayish or reddish brown. \( H = 5.5-6.5 \). \( G = 5.00 \). Orthorhombic, dipyramidal.

Maricopa County—As pyrochlore south of Buckeye in pegmatite, associated with kasolite. Assayed 8% \( \text{U}_3\text{O}_8 \).

Mohave County—As euxenite in the Cerbat Range, as scattered masses weighing up to 50 pounds, in pegmatite, Kingman Feldspar Mine. Similarly east of the Big Sandy River, south of Burro Creek and near the Aquarius Mountains.

Pima County—On Hugh Barton’s claim in the Holbrook district.

Pima County—As euxenite in the New Year’s Eve Mine, Sierrita Mountains, associated with molybdenite and chalcopyrite.

SamarSKITE

\( (\text{Y},\text{Er},\text{Ce},\text{U},\text{Fe}) \) \( \text{Ta},\text{Fe}_{4-	ext{Ta}} \) \( \text{O}_{5+	ext{Ta}} \). Violet-black. Luster vitreous to resinous. Stransk dark reddish brown to black. \( H = 5-8 \). \( G = 5.6 \). Orthorhombic. Crystals rectangular prism 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. Also northeast of Kingman.

Pima County—Sierrita Mountains, as black, shiny crystals, probably samarskite, in the New Year’s Eve Mine.

Yavapai County—Black Hills, reported from near Jerome.

HALIDES

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halite</td>
<td>Colorless or white when pure. Luster vitreous. Transparent to translucent.</td>
</tr>
<tr>
<td>Cerargyrite</td>
<td>Fluorite</td>
</tr>
<tr>
<td>Bromyrite</td>
<td>Cotunnite</td>
</tr>
<tr>
<td>Salammoniac</td>
<td>Matlockite</td>
</tr>
<tr>
<td>Salammoniaca</td>
<td>Diaboleite</td>
</tr>
</tbody>
</table>

HALITE—Rock Salt

\( \text{NaCl} \). Colorless or white when pure. Luster vitreous. Transparent to translucent. Streak white. Tactile 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.

Pima County—Reported from the Papago reservation.

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

**CERARGYRITE-BROMYRITE**

A series from AgCl (Cerargyrite) to AgBr (Bromyrite). Bromian cerargyrite is known as embolite. Iodobromine is an iodine-bearing bromyrite. Colorless when pure and fresh, but usually gray, also yellowish and greenish brown. Luster resin­ous to adamantine, horn-like. Transparent to translucent. H. = 2.5. G. = 5.55. (AgCl) to 6.47 (AgBr). Sceptile and ductile. Plastic. Isometric; hexoctahedral. Perfect octahedral cleavage. Cubic and octahedral crystals common. Also granular massive with prominent cleavage; rarely columnar. Some specimens are fluorescent.

Cochise County—At Tombstone, in the oxidized ores of the district; also near Charleston, at the Bradshaw mine as granular aggregates. Pearce hills, at the Commonwealth mine. Dragoon Mountains, in oxidized lead-silver ores 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 ¼ inch thick and several inches in diameter. Payson district, with native silver at the Silver Butte mine. Globe district, as iodobromine, as thin seams and crusts in a vein of quartz and calcite of the Hechman mine.

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. Mammoth mine, as tiny yellowish cubo-octahedral crystals implanted on calcedony from the Collins vein.

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.

**IODYRITE—Horn Silver**

AgI. Pale yellow or green. H. = 1.15. G. = 5.3-5.8. 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.

**FLUORITE—Fluorspar**


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 Para­dis. 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. In small amounts in open fractures in the Castle Dome mine, associated with barite.

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. In the white quartz quarry on Pinnacle Peak, east of Paradise Valley.

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. Sierra­rita 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. As dodecahedral crystals 3-4 feet in diameter northeast of Congress Junction, in pegmatite dikes.

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:

\[\begin{array}{ccc}
\text{CaF}_2 & 98.7 & \text{to} & 99.0 \\
\text{CaCO}_3 & 1.18 & \text{to} & 1.65 \\
\text{SiO}_2 & 0.05 & \text{to} & 0.29
\end{array}\]

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.

COTUNNITE


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.

MATLOCKITE


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.

PARALUORIONITE


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.

MINERALS OF ARIZONA

ATACAMITE

\(\text{Cu}_2(\text{OH})_2\text{Cl}\) 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.

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

Pinal County—Galuro 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

\(\text{PbCuAg}_2\text{Cl}_6(\text{OH})_2\cdot\text{H}_2\text{O}\) Deep prussian blue, inclining to blackish blue on crystal faces. Luster weakly vitreous, inclining to pearly on cleavage faces. Streak blue with greenish tint. H. = 2.5. G. = 5.08. Tetragonal. A rare mineral found in some oxidized sulfide ore bodies in arid or semi-arid regions.

Gila County—Reported from the Apache Mine north of Globe. Questionable.

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

DIABOLEITE

\(\text{PbCuCl}_2(\text{OH})_3\) Deep blue. Transparent. Streak pale blue. H. = 2.5. G. = 5.42. Tetragonal. 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), (012), (101), (011), (021), (012), (111). Analysis by F. A. Gonyer as follows:

\[\begin{array}{cccc}
\text{PbO} & 72.32 & \text{CuO} & 12.73 \\
\text{Cl}_2 & 11.47 & \text{H}_2\text{O} & 6.56 \\
\text{Total} & 100.00
\end{array}\]

CHLOROXIPHITE


Yavapai County—Walker district.

CARBONATES, NITRATES, BORATES

Calcite Dolomite Losegyte Hydrocerussite
Magnesite Ankerite Aurichalcite Beyerite
Siderite Schroepkegerite Rosasite Leadhillite
Rhodochrosite Voglite Malachite Soda Niter
Smithsonite Bayleyite Phosgene Niter
Aragonite Swartzite Nitrocalcite
Witherite Andersonite Bismutite Gerhardtite
Cerussite Liebigite Azurite Colemanite
C L A C T E

CaCO₃. 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. = 2.71. 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 manganiferous 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, Dragon 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 Cottontail 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 prevalingly 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.

**MAGNESITE**


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


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

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

Mohave County—Dripping Spring Mountains, with wulfenite and vanadinite, McHir 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 bismuthite. 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


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.

Coconino County—Tombstone, as small grains in oxidized alabandite 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

ZnCO₃. White or some shade of gray, green, blue, or brown. Luster vitreous to dull and earthy. Subtranslucent to opaque. H. = 3.5. G. = 3.4-3.45. 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.

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.

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

Gila County—At the Curtin or Humphrey mine with cerussite and anglesite; also in the "79" mine.

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. Waterman Mountains, Silver Hill mine, as small rhombs, and also as pale blue botryoidal masses similar to the material from Kelly, 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. Castle Dome district, in channels and vugs with hydrozincite, wulfenite, vanadinite and mimetite.

ARAGONITE

CaCO₃. White, gray, yellow, green, and violet. Luster vitreous. Transparent to translucent. Streak white. H. = 3.5-4. G. = 2.96. Orthorhombic, dipyrudinal. Crystals generally acicular. Distinct pinacoidal and prismatic cleavage. In columnar or fibrous masses, or as stalactitic, globular, or coralloid forms. Flos ferris is a coralloid 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 limestones and in limestone caverns.

Coconino County—At Bisbee, as magnificient coralloid groups of flos ferris in limestone cavens. 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, Hilltonia district. Santa Rita Mountains, as flos ferris in Onyx Cave. Sierrita Mountains, in fissures of the San Xavier district, commonly stained by copper.

YUMA COUNTY—Castle Dome district, in channels and vugs with smithsonite, hydrozincite, wulfenite, vanadinite and mimetite.

WITHERITE


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.

CERUSSE

PbCO₃. White to gray. Luster adamantine, vitreous, resinous, silky, or pearly. Transparent to subtranslucent. Streak uncolored. H. = 3-3.5. G. = 6.05. Orthorhombic, dipyrudinal. Commonly as tabular, less commonly as prismatic or pyramidal crystals. Distinct prismatic cleavage. Massive or granular, rarely fibrous.

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.

Greenlee County—At the Rainbow or Theba mine, near Theba. Mohave County—Cerbat Range, Chloride, Mineral Park, and Gold Basin districts, in some properties associated with free gold; Tennessee-Schuykill mine, Wallapai district. McCracken Peak, McCracken mine.

Pima County—Santa Rita Mountains, Golden Gate and Blue Jay mines, Helvetia district; Greetingsville 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 material, 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), (030), (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, Verde district; M and M veins, Tiger district; Tillie Starbuck mine. Hassayampa district, as small rhombohedrons coating walls of cavities.

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

ANKERITE

CaCO₃. (Mg,Fe,Mn)CO₃. 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, at the Tillie Starbuck mine. Hassayampa district, as small rhombohedrons associated with dolomite in cavities.

SCHROECKINGERITE


Yavapai County—Hillside mine, occurring as a ¼ inch coating on gypsum, with andersenite, bayleyite, and schwartzite. Johannite and pitchblende reported from the same mine.

VOGLITE

Ca₂Cu₂(UO₂)₂(PO₄)₂·7H₂O (?). Emerald green to bright grass-green. Luster pearly. Streak pale green. Trichistic. As coatings of scales. The scales are rhombohedral with an interior acute angle of 75°-80°.

Navajo County—Red Mesa district, near the Red Mesa Trading Post. This is the only known occurrence outside of the original locality, near Joachimsthal, Bohemia.

DOLomite

CaMg(CO₃)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. = 2.95. Hexagonal. Crystals of rhombohedral habit with curved faces. Perfect rhombohedral cleavage. Commonly coarse or fine granular masses, 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.

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

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<th>MgO</th>
<th>Fe₂O₃</th>
<th>FeO</th>
<th>K₂O</th>
<th>Na₂O</th>
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Greenlee County—Clifton-Morenci district, as beds in the lowest part of the Modoc formation, and in the upper part of the Modoc Shales. Sparsingly in the Longfellow limestones.

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.

MINERALS OF ARIZONA
BAYLEYITE

Mg₆(UO₂)(CO₃)₄·6H₂O. Sulfur-yellow. As minute, short, prismatic crystals; also in acicular, divergent groups (artificial). \( G = 2.65. \) Monoclinic. Fluoresces feebly in ultraviolet light.

Yavapai County—As an efflorescence on the walls of the Hillside mine, associated with schroeckingerite, andersonite, swartzite, gypsum, johannite, and uraninite.

SWARTZITE

CaMg(UO₂)(CO₃)₂·3H₂O. Green. \( G = 2.3. \) Monoclinic. As clusters of tiny prismatic crystals. Fluoresces bright green in ultraviolet light.

Yavapai County—With gypsum, schroeckingerite, bayleyite, andersonite, johannite, and uraninite, as an efflorescence on the walls of the Hillside mine.

ANDERSONITE

Na₂Ca(UO₂)(CO₃)₂·6H₂O. Bright yellow-green. \( G = 2.8. \) Hexagonal-rhombohedral. As clusters of minute pseudocubic crystals. Fluoresces a bright whitish-green in ultraviolet light. Stable on exposure.

Yavapai County—Hillside mine, with gypsum, schroeckingerite, bayleyite, andersonite, johannite, and uraninite, as an efflorescence on the walls.

LIEBIGITE

Ca₆U(OH)₁₂·4H₂O. Siskin-green to yellowish green. Luster vitreous, slightly pearly on the cleavage. Transparent to translucent. \( H = 2.5-3. \) \( G = 2.41. \) Fluoresces green in ultraviolet light. Commonly as granular or scaly crusts.

A secondary mineral sometimes associated with schroeckingerite. Reported from one of the diatremes of the Hopi-Navajo country, but exact locality unknown.

LOSEYTE

\((Zn,Zn')₂(CO₃)(OH)₆\). Bluish white. \( H = 3. \) \( G = 3.27. \) Monoclinic. As elongated crystals.

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

Pima County—Waterman Mountains, at the Silver Hill mine, with rosasite and smithsonite.

HYDROZINCITE

\((Zn,Cu)₂(CO₃)(OH)₂\). White, grayish, or yellowish. \( H = 2-2.5. \) \( G = 3.58-3.6. \) Monoclinic. Crystals minute, thin blades. Massive, fibrous, earthy, or compact, commonly as incrustations. Luster dull to earthy. Fluoresces pale blue or lilac in ultraviolet light.

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."

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

Maricopa County—As a supergene mineral in the pegmatites of the White Picacho district, from the alteration of sphalerite, and associated with hemimorphite.
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, Yeager mine.

Yuma County—Buckskin Mountains, Planet mine.

PHOSGENITE

\((\text{Pb,Cl})_2\text{CO}_3\) White, gray, yellow. Luster adamantine. Transparent to translucent. Streak white. \(\text{H.} = 2.75-3.6\). \(\text{G.} = 6.1-6.3\). Tetragonal. In prismatic crystals with basal cleavage.

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

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

BISMUTITE

\((\text{BiO})_2\text{CO}_3\). White, green, yellow and gray. Luster vitreous to dull. \(\text{H.} = 2.5-3.5\). \(\text{G.} = 6.1-6.3\). Tetragonal. 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—In the Outpost pegmatite, White Picacho district.

Mohave County—Hualpai Mountains, east of Yavanna.

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

AZURITE

\((\text{CuCO}_3)(\text{OH})_2\). Azure-blue to Berlinda-blue. Luster vitreous to silky. Transparent to subtranslucent. Streak blue. \(\text{H.} = 3.5-4\). \(\text{G.} = 3.77\). Monoclinic. Characteristically in aggregates of small crystals. Two perfect cleavages. Also massive or dull and earthy.

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.

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 Bishop 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 slate.

Pima County—Sierra 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.

HYDROCERUSSITE

\((\text{Pb}_3\text{CO}_3\text{(OH)}_2)_n\). Colorless to snow-white. Transparent to translucent. \(\text{H.} = 3.5\). \(\text{G.} = 6.8\). 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.

BEYERITE

\((\text{Ca,Co})_2\text{CO}_3\). Crystals bright yellow to lemon-yellow; massive material yellowish white, grayish green or gray. Luster vitreous in crystals. \(\text{H.} = 2-3\). \(\text{G.} = 6.06-6.44\). Tetragonal.

Maricopa County and Yavapai Counties—White Picacho district, as grayish green films on bismuthite and bismuth (?), also as dense masses and pearly white flakes in small cavities.

LEADHILLITE

\((\text{Pb}_4\text{CO}_3\text{SO}_4\text{(OH)}_2)_n\). White, yellow, green, blue, or gray. Luster adamantine, resinous and pearly. Transparent to translucent. Streak uncolored. \(\text{H.} = 2.5\). \(\text{G.} = 6.38-6.44\). 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. One fine specimen was found in 1942 on the dump of the old Manila mine on the Tombstone-Charleston road, adjoining the Gallagher mines, about one mile from the Charleston railroad crossing.

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 pseudohexagonal or tabular, composed of 2, 3, or 6 individuals, twinned according to the Artini law.

SODA NITRE—Nitratine

\(\text{NaNO}_3\). White, reddish brown, gray, and lemon-yellow. Luster vitreous. Transparent to translucent. \(\text{H.} = 1-2\). \(\text{G.} = 2.29\). Taste cooling. Hexagonal, scalenohedral. Perfect rhombohedral cleavage. Massive, as incrustations, or in beds.
The main source of commercial nitrates. Formed by evaporation of groundwaters in arid climate, deposits commonly in beds. **Mohave County**—Rawhide Mountains, reported 3 miles south of Artillery Peak.

**NITRATE**—Saltpeter


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 thick white covering on limestone shelves in ancient cliff dwellings.

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

**Graham County**—Peloncillo Mountains, associated with caves.

**NITROCALCITE**


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**


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

<table>
<thead>
<tr>
<th></th>
<th>CuO</th>
<th>Na₂O</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂O</td>
<td>11.49</td>
<td>66.35</td>
<td>22.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100.00</td>
</tr>
</tbody>
</table>

**COLEMANITE**


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.

**SULFATES, CHROMATES, TELLURITES**

**THENARDITE**


Formed by evaporation of salt lakes, commonly along the shores.

**Coconino County**—As tufts in ice caves at Sunset Crater.

**Pinal County**—Near Maricopa.

**Yavapai County**—Verde Valley, as extensive beds in the salt deposits 3 miles southwest of Camp Verde.

**BARITE**


As a gangue mineral with sulfide ores. Also in veins or massive beds. Only the more important occurrences are listed.

**Gila County**—Rico district, Ground Hog mine, as a vein, and near the Lucky Cuss mine as white crystals. Dragoon Mountains, as veins, Middle Pass.

**Yavapai County**—Grand Canyon, as crystal masses in caves, Kaibab Trail.

**Gila County**—Richmond Basin, abundant in veins. In small amounts with fluorite at the Castle Dome mine. Reported in a vein about 500 feet long near the Coolidge Dam, associated with galena.

**Graham County**—Stanley district, abundant in several veins near Stanley Butte. Reported south of Klondyke.

**Maricopa County**—Goldfield Mountains, as veins, Arizona Barite mine. At the Rainbow or Theba mine near theha.

**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. Picacho de Calera Hills, Rincon Mountains at the Heavy Boy mine. Silver Bell Mountains in House Canyon.

**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. At Cottonwood Pass, near Salome.

CELESTITE


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 Agulla.

Yuma County—Plomosa district, with lead and silver ores.

ANGLESITE


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, Defiance mine.

Graham County—Aravaipa and Stanley districts.

Maricopa County—As nodules one to three inches in diameter in the dumps of the Montezuma and Prodigal mines, west of Montezuma. At the Rainbow or Theba mine, near Theba.

Mohave County—Cerbat Range, at the Tennessee-Schuykill mine, Wallapai district; in several mines of the Mineral Park district.

Pima County—Empire Mountains, in the mines of the Hilton group. Sierra Vista Mountains, abundant at the Paymaster mine, Olive Camp. Quijotoa Mountains, at the Morgan mine.

Pinal County—Galturo 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.

ANCHYDRITE

CaSO4. White; but may be grayish, bluish, or reddish. Luster vitreous to pearly on cleavage. Transparent to translucent. Streak uncolored. H. = 3-3.2. G. = 2.89-2.98. Orthorhombic, dipyramidal. Crystals rare, usually in crystalline masses with rectangular cleavage; also fibrous, granular, massive.
Cochise County—Near Douglas, mined for plaster and other gypsum products. Analysis by Arizona Gypsum Plaster Co., as follows:

\[
\begin{align*}
\text{CaO} & \quad 94.3 \quad \text{SiO}_2 & \quad 3.3 \\
\text{SO}_3 & \quad 0.3 \quad \text{FeO} & \quad 0.0 \quad \text{Fe}_2\text{O}_3 & \quad 1.40 \\
\text{MnO} & \quad 0.0 \quad \text{SiO}_2 & \quad 21.56 \\
\text{H}_2\text{O} & \quad 79.65
\end{align*}
\]

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 standstone and conglomerate, with celestite. Reported from the Superstition Mountains.

Mohave County—Adventitious 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 Sierra 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 Redington. Galiuro Mountains, Copper Creek district, as layers in Gila conglomerate.

Yavapai County—In salt deposits of the Verde Valley.

Yuma County—Flomosa Mountains, at Madera camp, as a bed several feet thick. Eastern foot of Harquahala Mountains, as beds.

CHALCANTHITE

\[
\text{CuSO}_4 \cdot 5\text{H}_2\text{O}.
\]


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 workings, 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.

Mohave County—As a common secondary mineral in the Wallace district.

Pima County—Silver Bell Mountains, as thick coatings in old workings, Silver Bell district. Santa Rita Mountains, Rosemont, as fibrous veins.

Pinal County—Galluro Mountains, as coatings on walls of drifts and in fractures, Old Reliable and Copper Giant mines.

Yaupati County—United Verde mine, as stalactites up to 2 feet long. Crown King district, on timbers in the dump of the Springfield mine, as fire crystals. Also in the Copper Creek area.

MINERALS OF ARIZONA

MELANTERITE

\[
\text{FeSO}_4 \cdot 7\text{H}_2\text{O}.
\]


Formed from oxidation of iron sulfides.

Gila County—In the "79" mine as spotty massive incrustations associated with pyrite on the 6th level.

Greenlee County—Clifton-Morenci district, sparingly in the upper mine levels.

Pima County—Sierra-Rita Mountains, as efflorescence on walls of old workings, Mineral Hill district.

PISANITE

\[
(\text{Fe,Cu})\text{SO}_4 \cdot 7\text{H}_2\text{O}.
\]


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.

EPSONITE—Epsom Salt

\[
\text{MgSO}_4 \cdot 7\text{H}_2\text{O}.
\]


Generally as efflorescence in old 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. Also in the Pima district.

GOSLARITE

\[
\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}.
\]


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.

MORENOSITE

\[
\text{NiSO}_4 \cdot 7\text{H}_2\text{O}.
\]


A secondary mineral formed by oxidation of nickel-bearing sulfides.

Maricopa County—Reported from near Wickenburg.
RANSOMITE  
\( \text{Cu(Fe,Al)\textsubscript{2}(SO\textsubscript{4})\textsubscript{2}7H\textsubscript{2}O} \). 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.  

ROEMERITE—Louderbackite  
\( \text{Fe}^{2+}\text{Fe}^{3+}\text{Cu}(\text{SO\textsubscript{4}}\textsubscript{2})\cdot14\text{H}2\text{O} \). Chestnut-brown. Taste saline, astringent. \( H = 3-3.5 \), \( G = 2.15 \). Triclinic. Crystals tabular. Granular, massive, or as crusts.  
A common mineral found on walls of old mine workings.  
**Cochise County**—Bisbee district, in porous crusts, Copper Queen mine.  
**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.  

PICKERINGITE  
\( \text{MgSO\textsubscript{4}}\cdot\text{Al(SO\textsubscript{4})\cdot22H\textsubscript{2}O} \). 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  
\( \text{FeAl(SO\textsubscript{4})\cdot2H\textsubscript{2}O} \). 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.  

LAUSENITE  
\( \text{Fe(SO\textsubscript{4})\cdot6H\textsubscript{2}O} \). White. Monoclinic. In aggregates of minute, silky fibers.  
**Yavapai County**—United Verde mine, formed as a result of burning of pyritic ore.  

KORNELITE  
\( \text{Fe(SO\textsubscript{4})\cdot7H\textsubscript{2}O} \). Pale rose or violet, Silky luster. \( H = 2.306 \). Orthorhombic. Prismatic and pinacoidal cleavage. As prismatic 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  
\( \text{Fe(SO\textsubscript{4})\cdot5H\textsubscript{2}O} \). White, yellowish, brownish. \( H = 2-3 \), \( G = 3.1 \). 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.  

MINERALS OF ARIZONA  

**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. Also near Prescott.  

ALUNOGEN  
\( \text{Al(SO\textsubscript{4})\cdot16H\textsubscript{2}O} \). 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.  

BROCHANTITE  
\( \text{Cu(OH)\textsubscript{2}SO\textsubscript{4}} \). Emerald-green to dark green, Luster vitreous. Transparent to translucent. Streak green. \( H = 2.5-4 \), \( G = 3.9 \). Orthorhombic. Crystals prismatic or flattened. Perfect brachypinacoidal cleavage. Massive, with reniform structure.  
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**—Galindo Mountains, Copper Creek district.  
**Yavapai County**—Black Hills, United Verde mine.  
**Yuma County**—Buckskin Mountains, Mineral Hill property.  

ANTLERITE  
\( \text{Cu(OH)\textsubscript{2}SO\textsubscript{4}} \). Emerald to blackish green, Luster vitreous. Transparent to translucent. Streak green. \( H = 2.5-4 \), \( G = 3.9 \). Orthorhombic, dipyrudial. 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.  
**Greenlee County**—Reported from the Morenci district.  
**Mohave County**—Hualapai Mountains, at the Antler mine, from which it was first described, as soft green lumps.  

LINARITE  
\( \text{FeAl(\text{SO\textsubscript{4}}\textsubscript{2})\cdot6H\textsubscript{2}O} \). Deep azure-blue. Luster vitreous. Subtranslucent, Streak pale blue. \( H = 2.9 \), \( G = 5.4 \). Monoclinic. Perfect orthorhombic cleavage. Most commonly as columnar or platy masses.  
An uncommon secondary mineral generally mistaken for azurite.  
**Graham County**—Aravaipa district, in the Tenstrike group.  
**Maricopa County**—At the Rainbow or Theba mine near Theba; also in the Old Rowley mine 18 miles northwest of Theba.
Pinal County—Mammoth mine, with cerussite and wulfenite. In places as perfect crystals with the forms (110), (101), (010), (001), (111), (201), (212).

**ALUNITE**

\[\text{KA}_2\text{O} \cdot \text{(OH)} \cdot (\text{SO}_4) \cdot \text{H}_2\text{O}\]


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.

**Pima County**—Associated with jarosite in veins of the Oxide district, Silver Bell Mountains.

**Santa Cruz County**—Patagonia Mountains, as alunization of wall rock, 3R mine.

**Yuma County**—Sugarloaf Butte, near Quartzsite, as irregular veins in dacite. Partial analysis by F. S. Wartman as follows:

\[
\begin{align*}
\text{Al}_2\text{O}_3 & = 36.5 \\
\text{SO}_3 & = 36.1 \\
\text{K}_2\text{O} & = 4.65 \\
\text{Na}_2\text{O} & = 4.2 \\
\text{SiO}_2 & = 1.2 \\
\end{align*}
\]

**JAROSITE**

\[\text{KFe}_3\text{O} \cdot (\text{OH}) \cdot (\text{SO}_4) \cdot \text{H}_2\text{O}\]


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. Gila County—As a supergene mineral in the Castle Dome mine.

**Maricopa County**—Vulture Mountains, as minute transparent crystals, Vulture mine. Analysis by S. F. Penfield as follows:

\[
\begin{align*}
\text{SO}_3 & = 30.42 \\
\text{Fe}_2\text{O}_3 & = 40.17 \\
\text{K}_2\text{O} & = 3.93 \\
\text{Na}_2\text{O} & = 0.26 \\
\text{H}_2\text{O} & = 12.91 \\
\text{Total} & = 100.41 \\
\end{align*}
\]

Also from the Black Rock mine, Vulture district.

**Mohave County**—As a secondary mineral in the Wallapai district.

**Pima County**—Empire Mountains, Total Wreck mine, with wulfenite, vanadinite, and cerargyrite; in the Hilton mines with cerussite and smithsonite. With alunite in the Oxide district, Silver Bell Mountains.

**Yuma County**—Ajo district, as yellow coatings.

**NATROJAROSITE**

\[\text{Na}_2\text{Fe}_2\text{O}_3 \cdot (\text{OH}) \cdot (\text{SO}_4) \cdot \text{H}_2\text{O}\]


A secondary mineral similar in occurrence to jarosite.

**Gila County**—From the vicinity of Globe, exact locality unknown.

**Mohave County**—From near Kingman.
CHALCOALUMITE

CuAl₂(PO₄)₂·H₂O. 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.

ETTRINGITE

Ca₆Al₂(SO₄)₃(OH)₁₂·26H₂O. Colorless and transparent, becoming white and opaque on partial dehydration. H. = 2-2.5. G. = 1.77.

Cochise County—As an alteration of calcium and aluminum silicates in the Lucky Cuss mine, Tombstone.

ZEPITE

(UO₂)₂(SO₄)·OH·H₂O. Orange-yellow. Probably orthorhombic. Fluoresces green. As fragile crusts and reniform or spheroidal aggregates composed of microscopic crystals. Luster dull to silky.

An alteration product of uraninite.

Cocconino County—Cameron district, on the Huskon No. 7 and No. 8 claims.

Navajo County—Holbrooks district, on the Ruth Group claims.

JOHANNITE


A secondary mineral formed by the alteration of uraninite and associated with gypsum.

Yavapai County—Reported to occur with several other uranium minerals in the Hillside mine.

BUTLERITE

(Fe,Al)₂(SO₄)·5H₂O. 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.

GUILDITE


Yavapai County—Black Hills, United Verde mine, under fumarolic conditions as a result of burning of pyritic ore. Relatively rare. Crystals up to 1/2 centimeter in width.

COPIAPITE


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.

CALEDONITE


A secondary mineral of rare occurrence.

Marcopoa County—At the Rainbow or Theba mine near Theba; also in the Old Rowley mine, 18 miles northwest of Theba, with larnite.

Pinal County—Mammoth mine, as excellent crystals, 400-foot level, Collins vein. Forms: (100), (120), (010), (101), (111), (131), (011).

WHERRYITE

Pb₂(Fe⁺⁺Cu⁺⁺)(SO₄)·(OH)·Cl·O (?). Light green. G. = 6.45. Massive, fine granular.

Pinal County—Mammoth mine, in a vug on the 760-foot level with leadhillite, paralaurionite, diaboleite, chrysocolla and cerussite.

EMMONSITE


A rare alteration product of other telluride minerals.

Cochise County—Tombstone district.

CROCOITE


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.

Marcopoa County—Collateral, Chromate, Blue Jay and Pheonix claims east of the present location of the Trilby Wash. Southwest of the Vulture mine, in the Black Rock claim. Also reported from near the Hassayampa River upstream from Amazon Wash.

Pinal County—Mammoth mine, in small amounts with vanadinite and wulfenite.

Yuma County—Reported from the Castle Dome Mountains.

PHOENICOCHROITE


A rare secondary mineral accompanying crocoite in oxidized lead deposits.

Marcopoa County—Collateral, Chromate, Blue Jay and Pheonix claims east of the present location of Trilby Wash.

VAUQUELINITE

(Pb,Cu)₂(PO₄)₃(CrO₄)·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.

Marcopoa County—Collateral, Chromate, Blue Jay and Pheonix claims east of the present location of Trilby Wash.

MINERALS OF ARIZONA
PHOSPHATES, ARSENATES, VANDATES, ANTIMONATES

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Color</th>
<th>Luster</th>
<th>Cleavage</th>
<th>Hardness</th>
<th>Specific Gravity</th>
<th>Crystal System</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erythrite</td>
<td>Peach-blossom-red to carmine, violet, also nearly colorless.</td>
<td>Transparent to translucent.</td>
<td>Pearly to dull and earthy.</td>
<td>3.5-4.5</td>
<td>3.06</td>
<td>Orthorhombic</td>
<td>Generally as small flattened grains, sometimes as small felted aggregates.</td>
</tr>
<tr>
<td>Monazite</td>
<td>Peach-blossom-red to carmine, violet, also nearly colorless.</td>
<td>Transparent to translucent.</td>
<td>Pearly to dull and earthy.</td>
<td>3.5-4.5</td>
<td>3.06</td>
<td>Orthorhombic</td>
<td>Crystals prismatic and vertically striated.</td>
</tr>
<tr>
<td>Hureaulite</td>
<td>Peach-blossom-red to carmine, violet, also nearly colorless.</td>
<td>Transparent to translucent.</td>
<td>Pearly to dull and earthy.</td>
<td>3.5-4.5</td>
<td>3.06</td>
<td>Orthorhombic</td>
<td>Perfect cline-pinacoidal cleavage.</td>
</tr>
<tr>
<td>Lithiophilite</td>
<td>Peach-blossom-red to carmine, violet, also nearly colorless.</td>
<td>Transparent to translucent.</td>
<td>Pearly to dull and earthy.</td>
<td>3.5-4.5</td>
<td>3.06</td>
<td>Orthorhombic</td>
<td>Crystals prismatic and vertically striated.</td>
</tr>
</tbody>
</table>

TRIPHYLITE-LITHIOPHILITE

Li(Mg, Mn)2(PO4)2. Up to three per cent Si may replace P. Reddish, brownish, yellowish. Luster resinous. Translucent. H = 3-4. Brittle. G = 3.15-3.28. Orthorhombic. Crystals rare; commonly cleavable, massive or compact.

Yavapai County—White Picacho district, as thin discontinuous rims on lithiophilite and triphyllite.

SICKLERITE


Yavapai County—White Picacho district, as tiny needles and plates forming crusts and cavity fillings associated with sicklerite.

PURPURITE


Yavapai County—White Picacho district, as tiny needles and plates forming crusts and cavity fillings associated with sicklerite.

MONAZITE

(La, Y, Th)2(PO4). Up to three per cent Si may replace P. Reddish, brownish, yellowish. Luster resinous. Translucent. H = 5-6.5. G = 3.0-3.3. Monoclinic crystals small and flattened. Perfect cleavage parallel to orthopinacoid. In masses yielding angular fragments and in rolled grains. The chief source of thorium oxide, usually from 8 to 10 per cent. CeO2 from 25 to 35 per cent.

An accessory mineral in granite, gneiss, aplites and pegmatites. Commercial quantities only in placers.

Graham County—Santa Teresa Mountains, as small crystals in pegmatite.

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

HUREAULITE

Mn2+P2O7·4H2O. Orange, shades of red to brown and amber, also gray to colorless. Luster vitreous, somewhat greasy, bright. Cleavage on front pinacoidal good. Transparent to translucent. Streak nearly white. H = 3.5. G = 3.15. Monoclinic.

Yavapai County—White Picacho district, as tiny needles and plates forming crusts and cavity fillings which usually appear as small felted aggregates with distinctive pinkish, lavender or deep red color, associated with purpurite.

STEWARTITE


Maricopa and Yavapai Counties—White Picacho district, as numerous pale yellow films, as finely crystallized aggregates cementing microbreccias of hureaulite and lithiophilite, and as thin subparallel fibers along fractures in other minerals, mainly strengite and purpurite.

VIVIANITE

Fe3(PO4)2·H2O. Colorless and transparent when fresh and unaltered, rapidly becoming pale blue or greenish blue due to oxidation and deepening on further exposure to dark blue to dark greenish blue, indigo-blue or bluish black. Streak colorless to white, soon changing to dark blue or brown. H = 1.5-2. G = 2.05. Monoclinic.

Maricopa and Yavapai Counties—White Picacho district, as finely crystalline bluish gray films on triplite.

ERYTHRITE—Cobalt Bloom


Apache County—White Mountains, exact locality unknown, with cobaltite.

Gila County—Reported from 1/2 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.

STRENGITE

Fe3(PO4)2·2H2O. Peach-blossom-red, carmine, violet, also nearly colorless. Transparent to translucent. Luster vitreous on crystals, faintly waxy in dense varieties. Streak white. H = 3.5-4. G = 2.87. Orthorhombic.

Maricopa and Yavapai Counties—White Picacho district, as crusts and cavity fillings which usually appear as small felted aggregates with distinctive pinkish, lavender or deep red color, associated with purpurite.

SCORODITE

Fe(AsO4)2·2H2O. Pale leak-green or grayish green to liver-brown, sometimes nearly colorless or bluish. Luster strongly vitreous to subadamantine and subresinous. Transparent in crystals. H = 3.5-4. G = 2.88. Orthorhombic.

Mohave County—A common secondary mineral in the Wallapai district.
PSEUDOMALACHITE—Dihydrite
\(\text{Cu}_2(\text{PO}_4)(\text{OH})_2\cdot\text{H}_2\text{O}\). Dark emerald green. Luster vitreous. H. = 4.5-5. G. = 4.4. Monoclinic. Distinct clinopinacoidal cleavage. 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.

CONICHALCITE—Higginsite

Coconino County—Bisbee district, originally from the Higgins mine, as crystals and small masses in manganese oxides. Analysis by E. V. Shannon as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Wt. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CuO</td>
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<tr>
<td>CaO</td>
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<tr>
<td>V(_2)O(_5)</td>
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<td>As(_2)O(_3)</td>
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<td>H(_2)O</td>
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<tr>
<td>Fe(_2)O(_3)</td>
<td>0.46</td>
</tr>
<tr>
<td>Mn(_2)O(_3)</td>
<td>2.84</td>
</tr>
</tbody>
</table>

It also occurs as acicular tufts in cavities in limonite.

Gila County—Globe Hills, Copper Hill mine.

Pima County—As small, green, cubic crystals in vugs in shattuckite from the New Cornelia mine, Ajo.

Yavapai County—In a shallow pit 13 miles west of Congress, just off State road 93. Also in the Bagdad open pit, lining vugs.

DESCLOIZITE—MOTTRAMITE
\(\text{Pb}_2\text{Zn}_2(\text{VO}_4)(\text{OH})_2\) to \(\text{Pb}_2\text{Cu}_2\text{Zn}_2(\text{VO}_4)(\text{OH})_2\). Red, brownish red, brown, black. Transparent to nearly opaque. Streak orange to brownish red or yellowish gray. H. = 4.5. G. = 3.5-3.6. Orthorhombic. Generally in drusy aggregates of small crystals. Pseudomorphs of cuprodescloizite are synonymous with mottramite.

Of secondary origin, in small amounts in some oxidized lead-zine or copper deposits.

Coconino 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, from the Higgins mine, and as reniform masses from the Shattuck mine. As descloizite, Tombstone Extension and Toughnut mines. As mottramite, as a velvety coating of fine crystals. Also in the White Picacho district.

Gila County—Payson district, as descloizite in small amounts, Oxbow and Zulu mines. Globe district, 2 miles north of the Old Dominion mine, as descloizite; on the 400-foot level, Cornstock Extension mine, and disseminated in the Defiance mine.

Maricopa County—Vulture Mountains, at the Black Hawk property, 1 mile south of the Vulture mine, as a velvety coating of fine crystals. Also in the White Picacho district.

Mocave County—Grand Wash Cliffs, as descloizite, Grand Gulch mine, Bentley district.

Pima County—Tucson Mountains, as mottramite, Old Yuma mine. Analysis by F. N. Guild as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Wt. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>V(_2)O(_5)</td>
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<tr>
<td>Pb(_2)O(_4)</td>
<td>28.22</td>
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<tr>
<td>CuO</td>
<td>11.54</td>
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<tr>
<td>ZnO</td>
<td>6.71</td>
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<tr>
<td>MnO</td>
<td>2.16</td>
</tr>
<tr>
<td>H(_2)O</td>
<td>2.53</td>
</tr>
</tbody>
</table>

Empire Mountains, Total Wreck mine, as mottramite. Santa Rita Mountains, Globe (Sunrise) mine, replacing and forming incrustations on wulfenite.

MINERALS OF ARIZONA

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.

CALCIVOLBORTHITE
\(\text{CuCa}(\text{VO}_3)(\text{OH})\). Yellow, green. Luster vitreous to pearly. H. = 3.5. G. = uncertain. Monoclinic (?). In pseudoheXagonal scales, rosettes, and as fine granular masses.

A secondary mineral, in small quantities accompanying other vanadium minerals.

Coconino County—Reported from the Gallagher Vanadium property, near Tombstone.

Navajo County—Monument Valley, at Monument No. 1 mine.

VOLBORTHITE
\(\text{Cu}_2(\text{VO}_3)\text{H}_2\text{O}\) (?). may have small amounts of Ba, Ca, substituting for Cu. Olive green to citrine yellow. Pearly to vitreous luster. Streak yellowish green. H. = 3.5. G. = uncertain. Monoclinic (?) in small six-sided tablets or globular forms. Subtranslucent.

A rare mineral of uncertain origin. Reported from copper and lead ores of the state but no specific localities are given. Also reported from some of the diatremes of the Navajo Reservation, but exact locality unknown.

AMBYLGYONITE
\((\text{Li},\text{Na})\text{Al}(\text{PO}_4)(\text{F},\text{OH})\). White to milky or creamy white, also yellowish, beige, salmon-pink, greenish, bluish gray, rarely colorless. Transparent to translucent. Luster vitreous to greasy, pearly on well-developed cleavages. H. = 5-5.5. Brittle. G. = about 2.9. Monoclinic. Occurs in quartz to short prismatic, rough crystals, and in cleavable masses.

Maricopa and Yavapai Counties—In the pegmatites of the White Picacho district, associated with spodumene and zinnwaldite.

TRIPHITE

An unusual mineral found in pegmatite.

Maricopa and Yavapai Counties—In the pegmatites of the White Picacho district, especially well crystallized in the Midnight Owl pegmatite, as roughly-faced tabular crystals up to seven inches in length.

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

<table>
<thead>
<tr>
<th>Element</th>
<th>Wt. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>FeO</td>
<td>11.68</td>
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<tr>
<td>MnO</td>
<td>34.95</td>
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<tr>
<td>MgO</td>
<td>11.37</td>
</tr>
<tr>
<td>CaO</td>
<td>2.48</td>
</tr>
<tr>
<td>Na_2O</td>
<td>0.52</td>
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<tr>
<td>H_2O</td>
<td>0.75</td>
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<tr>
<td>P_2O_5</td>
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<tr>
<td>F</td>
<td>8.62</td>
</tr>
<tr>
<td>Total</td>
<td>99.81</td>
</tr>
</tbody>
</table>

Also at other localities in the same general area.

OLIVENITE
\(\text{Cu}_3\text{As}_2(\text{OH})_6\). Various shades of green to yellowish. Luster adamantine to vitreous. Translucent to opaque. Streak olive green to brown. H. = 3. G. = 3.9-4.4. 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 diopside, from the outcrop at the No. 1 Glory Hole. Also in the Mammoth mine at Tiger.

LIBETHENITE


A rare mineral found in a few copper deposits of the world.

Gila County—At the Castle Dome mine along open fractures forming crusts composed of small emerald-green prisms or a drusy mat of acicular crystals.

Greenlee County—Morenci district, as small crystals in cavities, Coronado mine.

APATITE

Ca₅(FCl)(PO₄). White or a light shade of green or blue; less commonly yellow, gray, red or brown. Luster vitreous to resinous. Transparent to opaque. H. = 5. G. = 3.1-3.2. Hexagonal, dipyrsmal. 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.

Mohave County—Hualpai Mountains, as white crystals of fluorapatite with golden yellow fluorescence, associated with muscovite.

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-MIMETITE

Pb₅[PO₄]₂Cl to Pb₅[AsO₄]Cl. Pyromorphite green, yellow and brown of various shades, also wax-yellow, orange-yellow, orange-red, brownish-red. Mimetite pale yellow to yellowish brown, orange-yellow, white or colorless. Luster resinous to sub-adamantine. Subtranslucent to translucent. H. = 3.5-4. G. = 7.04±0.04. Brittle. Hexagonal.

Found in oxidized lead deposits, with pyromorphite being more common.

Cochise County—Pyromorphite: Tombstone district as small crystals. Mimetite: Gallagher vanadium property, near Charleston. Also at Bisbee.

Maricopa County—Pyromorphite: In the pegmatites of the White Picacho district. Mimetite: Near Gila Bend and also east of the Alaska mine, southwest of Aguila.

Mohave County—Mimetite: As a common secondary mineral in the Wailapai district.

Pima County—Cerro Colorado Mountains, at the Cerro Colorado mine, as pyromorphite.
DUMONTITE

\( \text{Fe}_2(\text{UO}_2)_2(\text{PO}_4)\cdot 3\text{H}_2\text{O} \). Color and streak ocher-yellow. Orthorhombic. Fluoresces greenish.

Pima County—Reported from the Tucson district.

TURQUOISE-CHALCOSIDERITE

A probably complete series from \( \text{CaAl}_2(\text{PO}_4)_2(\text{OH})_2\cdot 4\text{H}_2\text{O} \) to \( \text{CuFe}_2(\text{PO}_4)_2(\text{OH})_2\cdot 4\text{H}_2\text{O} \), although most analyses are close to Al end. \( H = 3-4 \) (Turquoise); 4.5 (Chalcosiderite). \( G = 2.5-2.8 \) (Turquoise); 3.25 (Chalcosiderite). Turquoise sky-blue, bluish green to apple green, greenish gray. Chalcosiderite silic-in-green and transparent. Luster of crystals vitreous, massive, somewhat waxy, feeble. Subtranslucent to opaque. Streak white or greenish to pale green. Triclinic.

Secondary minerals, formed essentially at surface conditions. Chalcosiderite is quite rare.

Cochise County—Turquoise: Turquoise district, as stringers up to a few inches wide and small nuggetlike masses in granite and quartzite. Bisbee, in the Lavender Pit and as minute stringers in massive pyrite, 1200-foot level Cole shaft. Also reported from Pearce vicinity. Chalcosiderite: Bisbee district, in small quantities.

Gila County—Turquoise: 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—Turquoise: Reported 12 miles east of Morristown.

Mohave County—Turquoise: Cerbat Range, Ithaca Peak, Mineral Park district, as gem material in prophory cutting schist and gneiss.

Pinal County—Turquoise: Reported 2 miles south of Kelvin.

Yavapai County—Turquoise: Found in Yavapai County, but the exact locality is unknown.

WAVELLITE

\( \text{Al}_2(\text{OH})_3(\text{PO}_4)_2\cdot 5\text{H}_2\text{O} \). Greenish white and green to yellow. Luster vitreous, inclining toward pearly and resinous. Translucent. Fracture uneven to subconchoidal. Streak white. \( H = 3.5-4 \). \( G = 2.36 \). Brittle. Orthorhombic. Crystals rare.

Gila County—Castle Dome mine, localized along fractures crossing the trend of ore veins.

BERMANITANE

\( (\text{Mn,Fe})_2(\text{Mn,Fe})_2(\text{PO}_4)_2(\text{OH})_2\cdot 15\text{H}_2\text{O} \) (?). Reddish brown, Luster vitreous to subrubbulous. \( H = 3.5 \). \( G = 2.94 \). Orthorhombic. Imperfect pinacoidal cleavage. Crystals of pronounced tubular habit with perfect basal. Also as cleavable masses.

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. Analyses by P. A. Gonvay as follows:

<table>
<thead>
<tr>
<th></th>
<th>FeO</th>
<th>MnO</th>
<th>NaO</th>
<th>MgO</th>
<th>CoO</th>
<th>CaO</th>
<th>H_2O</th>
<th>PO_4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.03</td>
<td>28.76</td>
<td>13.79</td>
<td>2.39</td>
<td>9.72</td>
<td>0.32</td>
<td>19.33</td>
<td>31.39</td>
<td>59.73</td>
<td></td>
</tr>
</tbody>
</table>

TORBERNITE

\( \text{Cu}_2(\text{UO}_2)_2(\text{PO}_4)_2\cdot 12\text{H}_2\text{O} \). Tetragonal. Emerald green to grass green. Luster vitreous to subadamantine, pearly on (001). Transparent to translucent. Streak paler than the color. \( H = 2-2.5 \). \( G = 3.32 \). Not fluorescent in ultraviolet light.

A secondary mineral found associated with autunite and other secondary uranium minerals.
Gila County—Sierra Ancha Mountains, Red Bluff mine, in the Dripping Spring quartzite.

**BEUDANTITE**

\( \text{PbFe}_5(\text{AsO}_4)(\text{SO}_4)(\text{OH})_2 \). Green to brown and black. Luster vitreous to resinous. Transparent to translucent. \( H = 3.5-4.0, G = 4.43. \) Hexagonal. Rhombohedral crystals with basal cleavage.

A rare mineral generally found in limonite ores.

**CARNOTITE**

\( \text{K}_2(\text{UO}_2)_2(\text{VO}_4)_3(\text{OH})_2 \). Bright yellow to lemon yellow, also greenish yellow. Luster dull to earthy, also pearly or silty when coarse crystalline. Occurs as a powder or loosely coherent microcrystalline aggregates, sometimes compact; disseminated, rarely as crusts or imperfect platy crystals.

**Apache County**—At numerous places in the Salt Wash member of the Morrison formation throughout the Carizzo and Lukachukai mountains.
PINTADOITE

\[
\text{Ca}_3\text{V}_2\text{O}_8\cdot 9\text{H}_2\text{O}.
\]
Light to dark green. Occurs as a thin efflorescence.

*Apache County*—In the Salt Wash sandstone on Mesa No. 5 and Mesa No. 6; and in the Lukachukai Mountains, southwest of Cove.

ROSSITE

\[
\text{Ca}_3\text{V}_2\text{O}_8\cdot 4\text{H}_2\text{O}.
\]
Yellow. Luster vitreous to somewhat pearly. Transparent. \(H = 2-3\). Brittle. \(G = 3.4\). Triclinic. Occurs as glassy lumps surrounded by flaky alteration rims of metarossite.

*Apache County*—Lukachukai Mountains, at Mesa No. 1 mine.

METAROSSITE

\[
\text{Ca}_3\text{V}_2\text{O}_8\cdot 2\text{H}_2\text{O}.
\]
Light yellow. Luster dull, pearly. As soft and friable, platy to flaky masses and veinlets.

*Apache County*—As an alteration product of rossite in the Lukachukai Mountains, and in the Monument No. 2 mine, Monument Valley.

PASCOITE

\[
\text{Ca}_3\text{V}_2\text{O}_8\cdot 1\text{H}_2\text{O}.
\]
Dark red-brown to yellow-orange. Translucent. Streak cadmium yellow. \(H = \text{about 2.5}\). Brittle. \(G = 1.87\). Triclinic.

*Apache County*—Lukachukai Mountains, Mesas No. 1, 5, and 6. Carizzo Mountains, Zona No. 1 claim.

UVANITE

\[
\text{U}_2\text{O}_3\cdot 1.5\text{H}_2\text{O}.
\]
Brownish yellow. Probably orthorhombic. As minutely crystalline masses and coatings.

*Apache County*—Monument Valley, at Monument No. 2 mine.

RAUVITE

\[
\text{Ca}_3\text{U}_2\text{O}_6\cdot 2\text{H}_2\text{O}.
\]
Purplish to bluish black. Streak yellowish brown to olive. Minutely crystalline. Occurs as dense slickened masses, botryoidal crusts and flaky coatings.

*Apache County*—Monument Valley, at Monument No. 2 mine.

*Navajo County*—Monument No. 1 mine, and in the adjoining Mittern mine.

MELANOVANADINITE

\[
\text{Ca}_3\text{V}_2\text{V}_3\text{O}_8\cdot \text{O}_6.
\]
Black. Luster almost submetallic.opaque. Streak dark reddish brown. \(H = 2.5\). Brittle. \(G = 3.4\). Monoclinic.

*Apache County*—Lukachukai Mountains, in the Mesa No. 1 and 5 mines; also in the Ker-McGee 4-1 mine.

HEWETTITE—METAHEWETTITE

\[
\text{Ca}_3\text{V}_2\text{O}_8\cdot 3\text{H}_2\text{O}.
\]
Deep red. Luster somewhat silky. \(G = 2.5\) plus, depending on the stage of dehydration. Probably orthorhombic. These are separate, but dimorphous, mineral species.

A rare secondary product found with other vanadium minerals.

*Apache County*—Carrizo Mountains, as hairlike crystals and fibrous incrustations in sandstone with carnottite. Also in the Monument No. 2 mine.
Yavapai County—Brindisi Mountains, Tip Top and Tule Creek areas. Eureka district, in quartz veins, Black Pearl and Joy properties, south of Camp Wood. Silver Mountain district.

WULFENITE

PbMoO₄. Orange to bright red; also grayish or yellowish. Luster vitreous to adamantine. Transparent to sub translucent. Streak white. H. = 3. G. = 5.82. Tetragonal, dipyrismal. Generally as thin, square, tabular crystals.

An uncommon mineral generally considered to be secondary.

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," McMur, Premier, C and B, and London Range properties.

Graham County—Aravaipa district, Silver Coin and Dogwater mines.

Maricopa County—Bright orange-red crystals with mimetite on matrix and quartz occur near Theba.

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; Tyrall district, Glove (Sunrise) mine, as remarkable crystal aggregates of various color and habit, with some tabular crystals measuring as much as 4 inches along the edge. Patagonia Mountains, Domino mine; Palmetto district, as beautifully crystallized specimens with galena, cerasite, 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.

SCHEELITE


Generally in quartz veins associated with pegmatite or granitic intrusives; 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 Wilcox, 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, sparlingly at the Williams mine, Boner Canyon. In small amounts with wolframite, Cottonwood and Greenwood areas. Mohave Mountains, Dutch Flat.

Pima County—Las Guías Mountains, sparingly present. Santa Rita Mountains, in contact-metamorphic zone, Helvetia district. Sierra Rita Mountains, in contact zones, Twin Buttes. Gunsite Hills.

Pinal County—Campo Bonito area, Maudina and other properties. Northeast 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—Brindisi 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.

POWELLITE

Ca₃(Mo,W)O₆. Grayish to greenish yellow. Resinous luster. H. = 2.5. G. = 4.35. Tetragonal. In minute pyramidal crystals or as fine massive material.

An uncommon secondary mineral 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


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).
Gila County—As a molybdenian variety from near Miami.

Maricopa County—Near mouth of Amazon Wash, east of Wickenburg.

Yuma County—Livingston claims, south of Quartzite.

CUPROTUNGSTITE

CuWO₄. Green. Luster vitreous to waxy. H. = 4.5. Cryptoocrystalline or fibrous. Cupro-tungstate 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 analysis by W. T. Schaller as follows:

<table>
<thead>
<tr>
<th>MoO₂</th>
<th>Cu₂O</th>
<th>CaO</th>
<th>MgO</th>
<th>H₂O</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.36</td>
<td>32.66</td>
<td>4.12</td>
<td>0.67</td>
<td>7.19</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Pima County—On the 200-foot level of the Helvetia mine, Santa Rita Mountains.

Yuma County—Reported from the Livingston claims south of Quartzite.

FERRIMOLYBDITE—Molybdate

Fe₅Mo₂O₈·8H₂O. 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:

<table>
<thead>
<tr>
<th>MoO₂</th>
<th>Fe₂O₃</th>
<th>H₂O</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>60.80</td>
<td>21.83</td>
<td>17.35</td>
<td>99.95</td>
</tr>
</tbody>
</table>

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.

LINDGRENITE


Gila County—Inspiration mine.

Maricopa County—Cave Creek district, with cuprotungstite.

QUARTZ

SiO₂. Colorless to various shades of yellow, red, brown, green, blue, and black. Luster vitreous and pendent 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 seven inches long.

Yavapai County—Bradshaw Mountains, Cash mine, Hassayampa 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 titantium.

Maricopa County—North of Scottsdale, in a quarry about 7 miles northeast of Curry’s Corner.

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.

Tiger-eye

Gila County—San Carlos Indian Reservation, mottled mahogany-brown, soft yellow and shades of pink, metamorphosed from chrysotile.

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.

CRYPTOCRYSSTALLINE QUARTZ

Chaledony

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 mamillary, 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 chaledony 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 basaltic 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
$\text{SiO}_2$. Colorless to white. Luster vitreous. Transparent to translucent. Streak uncolored. H. = 7. G. = 2.9. 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°C, and when heated to 1,470°C 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

OPAL
$\text{SiO}_2 \cdot n\text{H}_2\text{O}$. Commonly white, yellow, red, brown, green, gray, blue. Vitreous to resinous, pearly or waxy. Transparent to translucent. Conchoidal fracture. H. = 5-6. G. = 1.9-2.3. 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 replacment of wood. Varities 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. Mohave County—Fire opal in tiny specks in Union Pass west of Kingman under a power line.

Common opal
In part translucent, most commonly milk white, brown, green or red. Cochise County—At Tombstone, as seams in ore. Lucky Cuss mine. Maricopa County—On the north slope of Saddle Mountain west of Hassayampa. Pima County—Silver Bell Mountains, as veinlets in the oxide zone of the Silver Bell mine. Yavapai County—Bradshaw Mountains, with chalcedony, 14 miles from Mayer on the Agua Fria River. Eureka district, Bagdad mine, in quartz veins. Also east of Black Canyon Road near Moore wash.

Hyalite
Colorless and clear or whitish and translucent. As concretions or crusts with a globular or botryoidal surface. Commonly in cavities in basalt 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.

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:

<table>
<thead>
<tr>
<th>Component</th>
<th>SiO₂</th>
<th>FeO-Fe₂O₃</th>
<th>Al₂O₃</th>
<th>NaCl</th>
<th>CoO</th>
<th>Ig. loss</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>62.81</td>
<td>1.10</td>
<td>4.84</td>
<td>0.45</td>
<td>2.10</td>
<td>5.97</td>
<td>93.37</td>
</tr>
</tbody>
</table>

On the Gila River 20 miles east of Florence.
ORTHOCLASE—Potash Feldspar


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 faceted crystals 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 Hualapai 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:

<table>
<thead>
<tr>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>CaO</th>
<th>Na₂O</th>
<th>K₂O</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>65.51</td>
<td>17.64</td>
<td>0.32</td>
<td>1.76</td>
<td>15.08</td>
<td>100.61</td>
</tr>
</tbody>
</table>

Pinal County—In the Mammoth-St. Anthony mine at Tiger.

Yavapai County—Bradshaw Mountains, as crystals in open portions of the Cash vein, Hassayampa district.

Yuma County—Kofa Mountains, with banded chaledony 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.

Celsian

“Barium orthoclase” BaAl₂SiO₄.

Yavapai County—At an undisclosed locality near Yarnell.

MICROCLINE—Potash Feldspar


Widespread and occurs under the same conditions as orthoclase. Much of the potash feldspar commonly classed as orthoclase is microcline.

ALBITE—ANORTHITE—Plagioclase

NaAlSiO₃—CaAl₂Si₂O₈, 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. = 2.5-3. Monocline. Perfect basal, less perfect cleavage, making an angle of 90° with each other. Cleavable to granular massive.

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.

Yavapai County—White Picacho district, at the Independence Mine, as a reported but unconfirmed occurrence.

SPODUMENE


In general (Ca,Mg)SiO₃, 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 metallic. 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.

PYROXENE

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, 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 Batomote adesite series.

Santa Cruz County—Sparingly in the younger adesite of the Patagonia and Santa Rita mountains.

PYROXENE

In general (Ca,Mg)SiO₃, 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 metallic. 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 MgSiO₃ and CaMgSi₂O₆. General physical properties like those of diopside.

Occurred in diabase, basalt, gabbro, and other basic rocks, and also as a product of contact metamorphism.

**Pigeonite** — At Tombstone, as dark-green grains with idocrase in the contact silicate zone of the Lucky Cuss mine.

**Diopside**

CaMgSi₂O₆. Iron generally present in small amounts, increasing as the mineral grades toward hedenbergite. White, yellowish, grayish, pale yellow, 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.

**Diopside** — Bisbee district, as grains in oxidized pyritic ores. Tombstone, as small pale-green crystals in the contact zone of Comstock Hill. Little Dragon Mountains, Johnson district, as small grains in metamorphosed limestone.

**Diopside** — Clifton-Morenci district, common in metamorphosed limestones of the Longfellow formation.

**Diopside** — Santa Rita Mountains, in wall rocks of ore bodies and in metamorphosed limestone, Helvetia district. Sierra Mountains, in contact rocks, Twin Buttes area.

**Diopside** — Patagonia Mountains, Westinghouse property, Duquesne.

**Diopside** — Bradley Mountains, Henrietta mine, Big Bug district, with magnetite.

**Hedenbergite**

CaFeSiO₄. Black to greenish black. G. = 3.4-3.58. In prismatic crystals, but generally massive with columnar or lamellar structure.

Characteristically of metamorphic origin.

**Hedenbergite** — Bisbee district, as grains in metamorphosed rocks.

**Hedenbergite** — Clifton-Morenci district, common in metamorphosed limestones of the Longfellow formation.

**Hedenbergite** — Santa Rita Mountains, in wall rocks of ore bodies and in metamorphosed limestone, Helvetia district. Sierra Mountains, in contact rocks, Twin Buttes area.

**Hedenbergite** — Patagonia Mountains, Westinghouse property, Duquesne.

**Hedenbergite** — Bradley Mountains, Henrietta mine, Big Bug district, with magnetite.

**Augite**

Chiefly Ca(Mg,Fe)Si₂O₆. 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.

**Augite** — Bisbee district, as grains in oxidized pyritic ores. Tombstone, as small pale-green crystals in the contact zone of Comstock Hill. Little Dragon Mountains, Johnson district, as small grains in metamorphosed limestone.

**Augite** — Clifton-Morenci district, common in metamorphosed limestones of the Longfellow formation.

**Augite** — Santa Rita Mountains, in wall rocks of ore bodies and in metamorphosed limestone, Helvetia district. Sierra Mountains, in contact rocks, Twin Buttes area.

**Augite** — Patagonia Mountains, Westinghouse property, Duquesne.

**Augite** — Bradley Mountains, Henrietta mine, Big Bug district, with magnetite.
Cochise County—Bisbee district, the most abundant metamorphic gangue of the unoxidized pyritic ores. Tombstone district, as long fibrous masses, Toughnail 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(Mg,Fe)₃Si₆O₁₉(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. Galluro 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 Cabrillo properties, as a replacement of limestone beds.

Hornblende

An amphibole containing aluminum with ferric or ferrous iron, magnesium, calcium, and alkalis. Light green to dark green to black. G. = 3.2. A common constituent of igneous rocks, generally the 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 hornblende, 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.

Kaersutite

A titaniferous amphibole closely related to arfvedsonite and barkevikite.

Mohave County—As large phenocrysts in a campionite dike about 8 miles south of Hoover Dam, on U.S. highway 93.

Beryl


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. Also reported from the Swissheim Mountains.

Mohave County—Aquarius Range, as crystals in pegmatite. Wright Creek, 15 miles south of Peach Springs, in pegmatite. Beryl Wash, near Kingman, as greenish-blue crystals up to 12 inches long and 4 inches in diameter. G and M pegmatite, 15 miles southwest of Wickieup, as bluish green crystals up to 9 feet long and 18 inches in diameter.

Pima County—Sierrita Mountains, as massive material and as beautiful blue-green crystals in quartz on the Bella Donna Claim. Also from an undisclosed locality in the Baboquivari Mountains.

Yavapai County—Eureka district, Bagdad vicinity. Also in the Weaver Mountains, Hillside mine. Bradshaw Mountains, 4 miles southeast of Wagoner, in pegmatite veins. Peck Mining district, in a pegmatite dike, 3 miles east of the Crown King post office. White Picacho district, as crystals 2 to 11 inches long in pegmatites, and associated with lithium minerals.

Yuma County—Gila Mountains, 1/2 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 columbite.

ZUNYITE


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. = 5 ≤ 0.5. G. = 3.5-4.3. Isometric, hexahedral. 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.
MINERALS OF ARIZONA

GROSSULARITE

CaAl₂(SiO₄)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

Mg₂Al₃(SiO₄)₅. 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

Fe₃Al₃(SiO₄)₅. G. = 4.25. Deep red to brownish red.

Transparent varieties used as gems.

Cochise 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.

SPESSARTITE

Mn₃Al₃(SiO₄)₅. Dark hyacinth red, sometimes with a tinge of violet, to brownish red. G. = 4.16.

Yavapai County—In nearly all the pegmatites of the White Picacho district, as crystals up to ½ inch in diameter.

ANDRADITE

Ca₃Fe₂(SiO₄)₃. 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.

GREENLEAF 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. Sierra Vista 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


Most abundant in basic igneous rocks such as gabbro, basalt, peridotite, and diabase, formed by crystallization of magmas rich in magnesium 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.

CONOCINO COUNTY—In basalt and basaltic lavas and pillow lavas 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 augite and iddingsite in Tertiary basalts. Galuro 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


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.

MONTICELLIITE

CaMgSiO₄. 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


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—Chiricahua 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. Also at the Defiance mine with vanadinite and desclozite.
Greenlee County—Clifton-Morenci district, as small grayish crystals on garnet rock on the northern side of Modoc Mountain.

Pima County—Tucson Mountains, as crystals on dumps of prospect 1 mile south of Old Yuma mine. Waterman Mountains, as small, barrel-shaped crystals at the Silver Hill mine, near the head of inclined surface tram.

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:

<table>
<thead>
<tr>
<th>Element</th>
<th>Zn</th>
<th>Pb</th>
<th>Fe</th>
<th>Mn</th>
<th>SiO₂</th>
<th>Insol.</th>
</tr>
</thead>
<tbody>
<tr>
<td>28.60</td>
<td>11.37</td>
<td>7.90</td>
<td>0.69</td>
<td>30.00</td>
<td>29.75</td>
<td></td>
</tr>
</tbody>
</table>

Yuma County—Reported from a property near Wenden.

DIOPTASE—Huebnerite


A rare mineral of secondary origin found with oxidized copper minerals.

Greenlee County—Clifton-Morenci district, Bon Ton mine, as crystals in cavities in chrysoocolla.

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 No. 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

(NaCa)₂Al₅(AlSiO₄)(ClCO₃) to (CaNa)₂Al₅(AlSiO₄)(ClCO₃). Forming an isomorphous series of which muranoite and mendite 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


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 thumarsite. Little Dragoon Mountains, as small pale green crystals in metamorphosed limestone, Johnson district.

Gila County—Dripping Spring Mountains, Christmas mine. Pinal County—From an undisclosed locality in the Baboquivari Mountains.

Yuma County—Abundant in metamorphosed limestones.

ZIRCON


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.

Mohave County—The variety cyrtolite, which contains uranium, has been found near Kingman.

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.

COFFINITE

U(SiO₃)ₓ(OH)ₓ. A uranous silicate with substitution of (OH) for (SiO₃) ions. Physical properties not fully determined. Black. H. = 5-6 (?). G. = about 3.4-3.6. Tetragonal. Does not fluoresce. Occurs as extremely finely divided material, difficult to separate from other minerals and carbonaceous material.

Seems to occur with other uranium and with vanadium minerals deposited under reducing conditions.

Gila County—At the Workman No. 1 mine, in Dripping Spring quartzite.

Navajo County—Near Holbrook, at the Ruth group claims. Also on Stinking Spring Mountain.

TOPAZ


Cochise County—Dos Cabezas Mountains, as masses weighing several hundred pounds, associated with quartz and muscovite in coarse grained granite, 6 miles ESE of Dos Cabezas and ¾ mile SE of the Cottonwood mine on the William DeBorde property.
ANDALUSITE


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 Gorge, in sericitized plagioclase of the quartz monzonite, Castle Dome mining district, 11 miles east of Yucca, 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:

<table>
<thead>
<tr>
<th>SiO₂</th>
<th>Yttria earths</th>
<th>Ceria earths</th>
<th>BeO</th>
<th>FeO</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.21</td>
<td>38.85</td>
<td>11.50</td>
<td>11.50</td>
<td>11.56</td>
<td>95.83</td>
</tr>
</tbody>
</table>

SILLIMANITE


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

Al₂SiO₅. 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. = 3.36-3.66. Triclinic. Crystals long biaxial and rarely terminated. Perfect macropinacoidal cleavage. In columnar or 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 Welton, on the east side of the range.
Mohave County—Specimens have been received from this area by the Arizona Bureau of Mines, but the localities are not known.

MICRATIONAL


Dimorphous with zoisite, for which it is commonly mistaken.

Cochise County—Tombstone district, as small vitreous green grains with idocrase, monticellite, and thumastite, Lucky Cuss mine.
Gila County—Miami district, as stringers and scattered grains in sericitized plagioclase of the quartz monzonite, Castle Dome mine.

CLINOZOISITE


A common contact-metamorphic mineral in limestone, with garnet and idocrase, and as gangue in contact-metamorphic copper veins.

THALENITE


Mohave County—Reported from the Guy Hazen claims, near Boulder Springs.

ZOISITE


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.

EPIDOTE


A common contact-metamorphic mineral in limestone, with garnet and idocrase, and as gangue in contact-metamorphic copper veins.
deposits. Also in crystalline schist and gneiss, and an alteration product of such minerals as garnet, augite, hornblende, biotite, and scapolite.

Coehise 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 A-birgo 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 metamorphosed limestones and wall rocks of copper deposits. Sierrita Mountains, 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. Crystals with an indicated prism diameter of 5 inches have been found on Pylan (?); 100 miles southeast of Wagoner. White Picacho district, as small crystals widely dispersed.

Yuma County—Abundant in metamorphosed limestones. Dome Rock Mountains, in the wall rock of cinnabar veins.

Piedmontite


The rare manganese member of the epidote group. In some crystalline schists, rhyolite, and closely related volcanics.

Coehise 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 of Paul H. M. P. Brinton as follows:

\[
\begin{array}{cccccccc}
\text{SiO}_2 & 37.43 & \text{Al}_2\text{O}_3 & 21.27 & \text{Fe}_2\text{O}_3 & 3.90 & \text{CaO} & 24.75 & \text{MnO} & 11.80 & \text{TiO}_2 & 0.10 & \text{H}_2\text{O} & 0.60 & \text{Total} & 100.11
\end{array}
\]

Allanite—Orthite

A silicate of variable composition, $\text{R}^{-}_2\text{R}^{+}_2(\text{SiO}_3)(\text{OH})$, where $\text{R}^{+}$ = Ca, Fe$^{3+}$, Mg, Na and $\text{R}^{-}$ = Al, Fe$^{2+}$, Al$^{3+}$, Be, Ce, La, Y. Brown to black. Luster submetallic, pearly, or resinous. Subtranslucent to opaque. H. 5-6. G. = 3.5-4. Monoclinic. In tabular or 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.

Coehise County—Tombstone district, microscopic in granodiorite.

Maricopa County—in a very coarse granite of the Estrellas Mountains southwest of Phoenix, as phenocrysts, up to 1 x 1/4 inch.

Moehave 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. White Picacho district, as a rare accessory mineral. Also from near Yarnell.

MELANOTEKITE


A rare lead silicate.

Pinal County—Mammoth mine.

BERTRANDITE


Occurs in pegmatites, associated with beryl.

Maricopa County—Independence claim, White Picacho district.

HEMMORPHITE—Calamine

$\text{ZnSiO}_4(\text{OH})_2$. Colorless, white, yellowish, brownish; also blue or green. Luster vitreous. Transparent to translucent. H. = 4-5. 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.

A mineral of oxidized zinc ores, generally with zinc carbonate, which the massive varieties closely resemble.

Coehise 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.

Maricopa County—White Picacho district, as a supergene mineral after sphalerite, associated with hydrozincite.

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. 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 microscopic 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. Mummy Mountain, northeast of Phoenix. In the pegmatites of the White Picacho district, both as schorl and elbaite.

Pima County—Santa Rita Mountains, with magnetite and siderite, Iron Mask mine, Old Baldy district. Sierrita Mountains, as vein-like 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. Galluro 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


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 pyrophyllite. Average analysis by W. E. Ford as follows:

<table>
<thead>
<tr>
<th></th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>Fe₂O₃</th>
<th>B₂O₃</th>
<th>H₂O</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>29.86</td>
<td>0.23</td>
<td>0.23</td>
<td>5.28</td>
<td>1.41</td>
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</tbody>
</table>

STAUROLITE

Fe₃Al₂Si₃O₁₀(OH)₂. Dark reddish brown or brownish black. Luster subvitreous to resinous, to dull or earthy. Streak uncolored to grayish. Translucent. H = 7.5. G = 3.58-3.78. 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.

**MINERALS OF ARIZONA**

**HILLEBRANDITE**


Cochise County—Tombstone district, Lucky Cuss mine, with monticellite and idocrase.

**PTILOLITE**


A rare zeolite formed in cavities in basic lavas.

Pinal County—Galluro Mountains, as delicate cottonlike aggregates of white to colorless capillary needles in basalt flows, Copper Creek district.

**LAUMONTITE**

(Ca₂Na₂)Al₂Si₅O₁₀.4H₂O. White, passing into yellow or gray; sometimes red. Luster vitreous, inclining to pearly on cleavage faces. Transparent to translucent. H = 3.5-4. G = 2.45-2.56. Monoclinic.

Cochise County—Variety leonhardite, from Huachuca Mountains, 1½ miles east of Sunnyside.

**ANALCIME**—Analcite

Na₂AlSi₅O₁₀.H₂O. Colorless to white, also grayish, greenish, yellowish, or reddish. Luster vitreous. Transparent to translucent. H = 5.5-6. G = 2.27-2.56. Monoclinic. 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 microscopic cavities of amygdaloidal basalts, Rosemont camp.

Yavapai County—As small yellowish crystals 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**

CaAl₂Si₅O₁₀.3H₂O. White to flesh-pink. Luster vitreous to silky when fibrous. Transparent to translucent. H = 5-5.5. G = 2.19-2.24. 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.

Gila County—At Black Point, near railroad station of Calva.

Graham County—At Black Point, some 14 miles below Geronimo on the Gila River, as amygdaloidal fillings up to ½ inch in diameter in basalt. The mineral is nicely fluorescent.

**THOMSONITE**

Ca₃(Na₂Al₂)Si₅O₁₀.3H₂O. Snow-white to reddish green; impure varieties known. Luster vitreous to pearly. Transparent to translucent. H = 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

KAlSi3O8(OH)2. Colorless, gray, brown, pale green, yellow. Luster vitreous to pearly or silky. Transparent to translucent. Streak uncolored. H. = 2-2.5. G. = 2.5-2.93. 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.

ROSCOEILITE

Essentially a muscovite in which vanadium has partly replaced aluminum. Cleft brown to greenish brown. H. = 2.5. G. = 2.97. In minute scales, with micaceous structure and cleavage.

A rare vanadium mica.

Apache County—Monument Valley, Monument No. 2 mine, with many other vanadium and uranium minerals.

LEPIDOLITE—Lithia Mica

KLi3AlSi3O10(OH)2. 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, amphibole, and spodumene.

Maricopa County—White Picacho district, as light pinkish-gray to deep lilac or lavender compact aggregates and small books in lithium-bearing pegmatites. Southwest of Wickenburg on Boyd-Porter claims. Also west of Morristown near the Garcia mine. Vulture Mountains, at eastern end, and in Harquahala Mountains, in masses almost identical in appearance to muscovite.

Yavapai County—Eureka district, from pegmatites of the Bagdad area.
VERMICULITE

Includes several hydrated silicates, in part related to the chlorites. Composition varies widely. White to yellowish-brown with pearly or brassy-like 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

(MgSiO₃(OH)). Green, brownish, and yellowish to white. Luster resinous, greasy, silky to earthy. Translucent. H = 5-6. G. = 2-2.5. 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 diabase intrusives upon pre-Cambrian Mescal limestone. Analysis by R. E. Zimmerman as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>MgO</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>FeO</th>
<th>CaO</th>
<th>H₂O</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>42.83</td>
<td>41.56</td>
<td>1.27</td>
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<td>0.05</td>
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<tr>
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<td>42.85</td>
<td>41.53</td>
<td>0.91</td>
<td>0.09</td>
<td>0.07</td>
<td>14.34</td>
<td>99.82</td>
</tr>
</tbody>
</table>

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 Thomson 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

Mg₃SiO₅(OH)₂. Green to white; brownish or reddish if impure. Luster pearly to dull. Subtranslucent to translucent. Streak white. H = 2-2.5. G. = 2.2-2.5. Monoclinic. Perfect basal cleavage yielding thin flexile 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.

MARICOPA COUNTY—As massive green waxy material in pegmatite 10 miles south of Wickenburg.

YAVAPAI COUNTY—Relatively pure material in appreciable quantity is reported from the Eureka district.

SEPIOLITE—Meerschaum

Mg₂Si₂O₅·2H₂O. 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.

Analysis by Albert J. Kauffman, Jr., as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>MgO</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>FeO</th>
<th>CaO</th>
<th>H₂O</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>54.83</td>
<td>54.83</td>
<td>0.38</td>
<td>0.45</td>
<td>0.55</td>
<td>10.74</td>
<td>99.92</td>
</tr>
</tbody>
</table>

IDDSINGSITE

K₃(Mg₂Fe₂Al₃(Si₆O₁₅)(OH)₈). Dull green. Soft. Generally amorphous and resembles earthy chlortie.

Abundant 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 glauconite sediments has in some places formed iron ores.

MOHAVE COUNTY—Big Sandy Valley, east of Wickieup, as extensive glauconite 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. = 2.2-2.6. 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, $\text{Al}_2\text{Si}_4\text{O}_{10}(\text{OH})_8$, and endellite has the composition $\text{Al}_2\text{Si}_3\text{O}_{10}(\text{OH})_6$. 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 Bill mine, Turquoise district.

**Gila County**—Globe district in chalcolite 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.

**ANAXITE**


A kaolinlike mineral believed to be of wide occurrence in clays.

**PYROPHYLLITE**


In schistose rocks, largely of metamorphic origin, but may also form as an alteration product. Commonly associated with kyanite. Massive varieties closely resemble talc.

**MOONMORILLONITE**

$6\text{Al}_2\text{Si}_2\text{O}_{10}(\text{OH})_8$ (Na$_2$O, CaO). White or grayish to rose-red, brownish, bluish, or greenish. Luster pearly. H. = 1-2. G. = 2.5. Massive and claylike.

Most important member of the montmorillonite-beidellite-nonntronite-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.

**Coconino 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. Also from near Wagoner.

**Yuma County**—Bentonite occurs near Wellton and Bouse.

**SAUCONITE**

Approximately ($\text{Zn}, \text{Mg}, \text{Al}, \text{Fe})_3(\text{Al}, \text{Si})_4\text{(OH)}_8$. Other properties presumably the same as montmorillonite.

A proposed name for the recently characterized zinc member of the montmorillonite-nonntronite-saponite group of clay minerals. This substance was previously referred to as "tallow clay."

**Pinal County**—Superior district, Magma mine, as soft, waxy gogolike material from near the lower limit of oxidation, associated with coronadite. Partial analysis as follows:

<table>
<thead>
<tr>
<th>SiO$_2$</th>
<th>Al$_2$O$_3$</th>
<th>H$_2$O</th>
<th>Zn</th>
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<td>14.3</td>
<td>13.5</td>
<td>22.1</td>
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**Gila County**—Miami district, Castle Dome area, as purplish, waxy lumps in highly manganiferous material.

**PYROPHYLLITE**


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 Quartzite, with dumortierite and kyanite. Also near Alamo Springs, 27 miles southwest of Quartzite, as a deposit reported to be 8 feet in width and extending for some 3,000 feet. Also reported from Bouse vicinity.

**CATLINITE**

A clay-like mineral or mineral substance.

**Yavapai County**—Reported from near Del Rio.

**NONTRONITE—Chloroponal**

Nearly $6\text{Fe}_2\text{O}_3\cdot\text{Al}_2\text{O}_3\cdot\text{Si}_2\text{O}_5$ (Na$_2$O, CaO). Canary yellow, slightly greenish. Luster dull to waxy. Opaque to subtranslucent. H. = 2.5-3. G. = 2.72-2.16. Forms onion-shaped masses, also compact massive to earthy.
An iron-rich clay forming an isomorphous series with montmorillonite and beidellite; analogous 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.**

**CHRYSOCOLLA**


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 the 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 limonite of the gossan, United Verde mine.**

**BISBEITE**

Cu₄O·3H₂O. Color pale blue to nearly white. Orthorhombic. In massive aggregates to fibers or thin laths.

Formed by hydration of shattuckite, with which is it associated.

**Cochise County—Bisbee district, Shattuck mine.**

**Pima County—Ajo, in veins, New Cornelia mine.**

**MINERALS OF ARIZONA**

**SHATTUCKITE**


An alteration product of other secondary copper minerals.

**Cochise County—Bisbee district, Shattuck mine.**

**Pima County—Ajo, in veins, New Cornelia mine. Tortolita Mountains, exact locality undisclosed.**

**PLANCEITE**

3Cu₂SiO₄·H₂O. Blue. H. = 5.5. G. = 3. Fibrous or mammillary. In appearance is identical with shattuckite.

**Pinal County—Galiuro Mountains, Table Mountain mine, near Klondyke, as blue crystalline grains and masses disseminated in compact green conichalcite.**

**AJOITE**

Hydrous copper aluminum silicate. Bluish green. Mineralogical data not yet published.

**Pima County—New Cornelia open pit, Ajo, as pale aquamarine tufts and crystals filling the interstices of radiating spherulitic dark blue crystalline shattuckite.**

**THAUMASITE**

Ca₃SiO₄·(CO₃)·15H₂O. White. Luster somewhat greasy to silky. H. = 2.5. Fibrous structure.

**Cochise County—Tombstone district, Lucky Cuss mine.**

**SPURRITE**


A contact metamorphic in limestones.

**Yavapai County—Reported from Bagdad.**

**URANOPHANE**


**Navajo County—Monument No. 2 mine; Cato Sells mine.**

**Pima County—From the Papago Reservation, exact location unknown, as coatings along shear slickensides in altered andesite porphyry (?).**

**Santa Cruz County—In a vein near Alamo Springs, associated with autunite and uraninite.**

**Coconino County—Beta-uranophane reported from the Cameron area.**

**KASOLITE**

K₂O·3CuO·2SiO₂·9H₂O. Yellow to brown. Luster resinous to greasy. H. = 4-5. G. = 5.96. Monoclinic. Minute prismatic crystals.
Maricopa County—South of Buckeye, in pegmatite dike associated with polymeric.

SPHENE—Titanite

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 rare mineral in granitic pegmatites.

Mohave County—Aquarius Range, in a vein traversing a "granite dike," and intimately associated with sphene, monazite, crossettite, and quartz. Analysis by Albert J. Kauffman, Jr., and Howard W. Jaffe as follows:

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ARIZONA BUREAU OF MINES
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G. R. FANSETT, Mining Engineer Emeritus
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S. B. KEITH, Geologist
H. W. PERCE, Associate Geologist
R. T. MOORE, Principal Geologist
G. H. ROSEFAVE, Metallurgist
F. L. STUDDS, Associate Mining Engineer

SERVICES AVAILABLE FROM ARIZONA BUREAU OF MINES
THE UNIVERSITY OF ARIZONA, TUCSON, ARIZONA

The ARIZONA BUREAU OF MINES was created and placed under the authority of the Arizona Board of Regents in 1915 by an act of the State legislature. The Bureau is directly charged with developing, maintaining, and disseminating to the people of Arizona information relating to geology, mining, metallurgy, and earth sciences generally. The Bureau's primary functions, therefore, are scientific investigation and public service activities comparable to those conducted by geological survey agencies and mineral experiment stations in other states. These primary functions are achieved through the following continuing programs:

1. Prepare and publish 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. Classify mineral and rock specimens. Besides identifying rocks and giving the composition of minerals, the Bureau makes qualitative tests for important elements and answers inquiries concerning the probable market for and the economic value of material similar to samples submitted. This service is furnished free of charge providing the specimen originates within the State of Arizona; a charge of $2 per specimen is made for samples submitted from outside the State. Spectrographic analyses and detailed microscopic determinations are furnished at established rates, a schedule of which will be submitted on request.

3. Conduct laboratory and pilot-plant metallurgical testing of mining substances in cooperation with industries and individual mine operators in the State. Such tests are conducted on the basis of nominal charges to compensate for wear and depreciation of equipment needed in the experimentation.

4. Make geologic investigations and compile geologic maps and reports. Geologic maps of each county, on a scale of 1:75,000, have been issued and geologic reports on numerous mining districts have been made available as bulletins. In addition to maps and reports on counties and mining districts, comprehensive studies of basic problems in the geology of Arizona are being carried out in order that the maximum benefits may be derived by the people of the State by having a more complete knowledge of its geologic setting.


6. Develop well-log storage facilities and a library of data pertaining to oil and water wells drilled in Arizona.

7. Conduct state-wide commodity studies as to modes of occurrence and potential industrial value of various mineral materials.

8. Collect and file items relating to Arizona mines and minerals that appear in Arizona newspapers and in many technical periodicals.

The basic philosophy which obtains in the operation of the Arizona Bureau of Mines is that of providing for the people of Arizona educational services in the earth sciences which cannot be readily secured elsewhere, and furnishing advice and service about mineral occurrences which cannot be obtained conveniently from commercial sources.

An inquiry addressed to: Director, Arizona Bureau of Mines, University of Arizona, Tucson, AZ 85721, will bring a prompt response if further information is desired about the services which are available.