by Jan C. (Wilt) Rasmussen and Stanley B. Keith

Glove Mine, Santa Rita Mts., Lyda Hill
Sources of photos and information

- Former Arizona Mining & Mineral Museum (467 wulfenite specimens)
- TGMS show 2012 Arizona Mineral Treasures
- www.mindat.org (approximately 275 localities, 1585 photos)
- Inventoried 150 localities from MRDS in 1980
- Flagg Mineral Foundation samples
- Stan Keith personal collection of ~566 worldwide, 343 Arizona wulfenite specimens
275 wulfenite localities in Arizona in www.mindat.org

Maps from www.mindat.org
Wulfenite is Arizona’s State Mineral

Mineralogy:
- Chemical & Physical Characteristics
- Mineralogical Associations

Geologic Setting: (age of primary deposit – wulfenite later)
- Alkali-calcic – lead-zinc-silver districts (Stage 3 and 4)
  - Jurassic – 170-160 Ma – Defiance, Silver Bill
  - Laramide – 85 - 65 Ma - Glove
  - Mid-Tertiary – 30-20 Ma – Red Cloud
- Calc-alkalic – in outer Pb-Zn-Ag zones (Stage 4)
  - Laramide porphyry copper - 75-60 Ma – 79 Mine
- Quartz alkalic – in Pb-Zn-Ag zones with stage 4 rhyolites
  - Jurassic - Bisbee
  - Laramide - Old Yuma
  - Mid Tertiary - Tiger, Rowley
- Peraluminous calcic
  - Laramide – Gold Basin
- Peraluminous calc-alkalic
  - Precambrian

Paragenesis - **Oxidized zones, water courses**
PbMoO₄

- Lead Molybdate (molybdenum and oxygen)

Colors

- Orange-yellow, yellow, honey-yellow, reddish-orange, rarely colorless, grey, brown, olive-green and black

Sub-adamantine to greasy luster

Defiance Mine, Gleeson (Turquoise) district, Cochise Co., AZ Mining & Mineral Museum, MM-M900, 18 cm, donor Les Presmyk

Common impurities: W, Ca, V, As, Cr (red), Ti
Wulfenite Crystallography

- Tetragonal
  - usually tabular (flat square), thin plates
  - rare dipyramidal
  - rare pseudo-cubic

Glove Mine, Tyndall district, Santa Cruz Co.  AZ Mining & Mineral Museum MM-T554  14 cm

H = 2 ½-3
Streak white, brittle, cleavage on {011}, density 6.5-7.5

Unusual crystal forms - dipyramid

Truncated dipyramid, San Diego mine, Tombstone district, Cochise Co., 3 mm FOV, Rolf Luetcke photo, specimen, www.mindat.org

Unusual crystal forms - dipyramid

Wulfenite, dipyramid, Melissa Mine, Silver District, La Paz Co., AZ, FOV 3 mm, Trevor Boyd photo, specimen, mindat.org
Unusual crystal forms –
elongated dipyramid - acicular

Needle-like dipyramid, Heavy Weight Mine, Helvetia-Rosemont district, Santa Rita Mts., Pima Co., FOV 4 mm, Rolf Luetcke photo, specimen, mindat.org
Unusual crystal forms – pseudo cube = very thick plates

Wulfenite, pseudo cube, Gleeson Mine, Turquoise district, Dragoon Mts., Cochise Co., FOV 1.46 mm, Matteo Chinellato photo & specimen, mindat.org
Wulfenite dipyramids on relict galena with pseudocubic wulfenite about 1 inch away from galena.

Gorilla Mine, Mineral Mountain, Pinal County, AZ

Collected by Ken Algier, Stan Keith specimen & photo
Whole rock geochemistry of associated plutonic rock (granite or quartz monzonite)

Keith & Wilt, 1986

Jan C. Rasmussen Ph.D., R.G.

TGMS Jan. 9, 2017

www.JanRasmussen.com
Alkali-calcic - Lead-Zinc-Silver -
Early Laramide 80-75 Ma

- Glove mine – Tyndall district - Santa Rita Mountains
- Emerald-Silver Plume, Toughnut mines – Tombstone district
- Total Wreck mine – Empire district - Empire Mts.

PbZnAg – Jurassic 160 Ma

- Silver Bill, Defiance, Mystery, Tom Scott mines –
- Gleeson district (formerly part of Turquoise district) (on Gleeson Ridge)
Wulfenite, Defiance Mine, ~2 in., owner Mark Hay
Silver Bill Mine, Gleeson Ridge (Turquoise district)

- Alkali-calcic, Jurassic
- Lead-Zinc-Silver
- Irregular small stringers, pockets, and replacement bodies of oxidized base metal sulfides in Pennsylvanian-Permian Naco Group limestones
- Adjacent to a quartz monzonite porphyry contact
- Shaft workings connected to the Mystery mine
- Large tonnage mined during late 1800s; 6570 tons produced during 1922-30, 1938-41

AZ Mining & Mineral Museum MM-T555, 8 cm

Alkali-calcic, Jurassic

Cerussite, anglesite, malachite, smithsonite, cerargyrite, and pyrolusite

Large amounts of magnificent wulfenite specimens lining solution cavities and in oxidized lead, manganese, and iron deposits

Ore bodies are in Pennsylvanian-Permian Naco Group limestones where fractures intersect or change dip or are parallel to bedding

Aplite dikes are related to Sugarloaf Quartz Latite Porphyry of Jurassic age

AZ Mining & Mineral Museum MM-M900, Donor Les Presmyk, 18 cm
Laramide (80-75 Ma) Alkali-Calcic - Lead-Zinc-Silver

- Tombstone
- Glove Mine
- Total Wreck (Empire Mts.)

From Keith & Wilt, 1986
Glove Mine, Tyndall district, Santa Rita Mts.

AZ Mining & Mineral Museum MM-8564, 9 cm, Arthur Bloyd donor
Glove Mine, Santa Rita Mts.

- Alkali-calcic, Lead-Zinc-Silver, Laramide
- Argentiferous galena, sphalerite, small amounts of pyrite, chalcopyrite & quartz
- Deposited in permeable zones at the intersection of a bedding plane fault and favorable beds in Permian Naco Limestone
- Extensive solution of the limestone and deep oxidation concentrated cerussite, anglesite, wulfenite, & smithsonite in the leached caverns as sand carbonate ore
- Worked various times 1911-1972
- Produced 29,260 tons of ore averaging about 22% Pb, 9% Zn, 7 oz Ag/T, 0.3% Cu, minor Au

Jan C. Rasmussen Ph.D., R.G.

AZ Mining & Mineral Museum
MM-T554 14 cm

Diagram = Olson, 1966, Glove mine, Economic Geology, v. 61, p. 731-743.
Toughnut & Empire Mines

- Tombstone district
- Alkali-calcic - Laramide
- Lead-Zinc-Silver
- Oxidized, base metal sulfides in replacement ore bodies in lower Cretaceous Bisbee Group
- Along anticlinal rolls and in pipes where rolls are cut by faults
- In NE fissures
- Shaft workings
- Several thousand tons
- Produced ore in late 1800s and early 1900s


Empire Mine, Peter Megaw, ~2 in.

Tombstone district, greenish yellow globular mimetite on wulfenite, Cochise County

Wulfenite under mimetite, Tombstone district, FOV 2 mm, Miguel Angel F. Periz collection, photo by Juan Miguel, www.mindat.org

Total Wreck Mine, Empire district, Empire Mts., Pima County

Wulfenite, Total Wreck Mine, Empire Mts., 2 in., Les Presmyk sample, Flagg show 2017

Wulfenite, mimetite, Total Wreck Mine, Empire Mts., Pima Co., FOV 7 mm, Michael Cline photo, specimen, www.mindat.org

www.JanRasmussen.com
Total Wreck Mine, Empire Mts.

- Alkali-calcic Laramide
- Lead-Zinc-Silver
- Cerussite, wulfenite, vanadinite, cerargyrite, malachite, azurite, chrysocolla & minor copper & lead sulfides
- In irregular replacement ore bodies in badly faulted Permian limestone beds intruded by Laramide diorite stringers & dikes
- Shafts & tunnels
- Worked from 1880s to 1940, producing some 14,000 tons of ore averaging 8% Pb, 6 oz Ag/T, & minor Au & Cu
- Shipped 8 tons of Mo concentrates in 1918.


Wulfenite, Total Wreck Mine, Empire Mts., Pima Co., 2.5 cm, Dennis Tryon collection, www.mindat.org
Alkali-calcic Lead-Zinc-Silver – mid-Tertiary 25-15 Ma

- Red Cloud Mine
- Aravaipa district
- Hilltop mine, Chiricahua Mts.
Red Cloud wulfenite, ~ 2 inches; collected by Rose from Edson-Rose pocket ~ 1972, photo and specimen in collection of Stan Keith

Red Cloud Mine

- Alkali-calcic, mid-Tertiary
- 25-15 Ma, Yuma Co.
- Irregular masses and vug linings of argentiferous lead and zinc carbonates with pyrolusite, vanadinite, wulfenite & minor malachite, nodules of partly altered argentiferous galena, & disseminated masses of silver chloride & bromide in a gangue of iron oxides, quartz, fluorite, calcite, gouge & brecciated wall rock
- Vein occurs in an irregular fault zone between Tertiary andesite breccia, dacite porphyry, rhyolite to dacitic tuffs & lapilli tuffs & Laramide granodiorite to quartz diorite intrusive
- Average grade 5-6% Pb, 10 oz Ag/T
- Shaft operations, 1880s
- total est. prod 21,000 tons ore ave. 18 oz Ag/T and 5.5% Pb and minor Au

AZ Mining & Mineral Museum, MM-T565, 7 cm
Red Cloud Mine, Silver district

AZ Mining & Mineral Museum MM-T274, 9.3 cm, Donors Les & Paula Presmyk

Red Cloud normal fault zone, vertical channels containing wulfenite

Photo by Dick Bideaux

Willemite on Red Cloud wulfenite, ~ 2 inches; collected by Gary Edson from Edson-Rose pocket ~ 1972. now in collection of Tony Potucek; photo by Stan Keith


Jan C. Rasmussen Ph.D., R.G.
Hilltop Mine, Chiricahua Mts.

- Alkali-calcic
- Pb-Zn
- mid-Tertiary
  - Galena, cerussite, sp shalerite, wulfenite, & spotty copper oxides and scheelite
  - In fissure veins and in irregular replacement lenses and bodies in banded and tilted, silicified Mississippian to Permian limestones and quartzites
- Extensive workings from several tunnels
- Total of 30,000 tons of base metal sulfide ore produced intermittently from early 1910s to 1954

Quartz Alkalic – Gold
Jurassic, Laramide, mid-Tertiary

Whole rock geochemistry of associated plutonic rock (granite or quartz monzonite)

MQA = Quartz Alkalic = pink
MAC=Alkali-calcic = orange
MCA= Calc-alkalic = yellow

%K₂O

%SiO₂

Keith & Wilt, 1986
TGMS Jan. 9, 2017

Jan C. Rasmussen Ph.D., R.G.
Quartz Alkalic - Jurassic

- Campbell shaft, Bisbee
- ~ 190 Ma
- Sacramento stock
- Warren district
- Mule Mts.

Campbell shaft, Warren district, Bisbee, FOV 4 mm, Rolf Luetcke photo, specimen www.mindat.org

Jan C. Rasmussen Ph.D., R.G.
Old Yuma Mine

~ 72 Ma

Amole pluton

Amole district

Tucson Mts.

Old Yuma Mine, Amole district, Jim & Gail Spann
• Quartz Alkaline
• Laramide
• Au, Pb, Zn

Wulfenite, owners John & Karen Cesar

Vanadinite, owner Dick Morris

Jan C. Rasmussen Ph.D., R.G.
Old Yuma Mine, Tucson Mts.

- Quartz Alkalic Laramide
- Au, Pb, Zn
- Partly oxidized base metal sulfides with spotty wulfenite & vanadinite, quartz & calcite gangue
- Steeply dipping, lensing & faulted orebody along a fracture zone cutting Cretaceous & associated with Laramide porphyry intrusive (Amole Granite)
- Shaft & underground workings
- Produced 1916-1947, total 5700 tons ore 4% Pb, 1% Cu, 0.6% Zn, .3% Mo, 1 oz/Ag/T, 0.1 oz Au/T

AZ Mining & Mineral Museum, MM-M120, 9 cm, donors Les & Paula Presmyk

Old Yuma Mine, Tucson Mts.

Wulfenite, Old Yuma Mine, Stan Keith photo, sample, 1.2 in. self collected 1968

Quartz Alkaline - Mid-Tertiary

- 20-12 Ma
  - Tiger (Mammoth-St. Anthony Mine, Mammoth district, Pinal County)
  - Rowley Mine, Painted Rock district, Maricopa County
  - Red Picacho district (Purple Passion mine) – (date, etc. uncertain)

- Mammoth St. Anthony Mine (Tiger)
- Rowley Mine
- Purple Passion Mine, Red Picacho district
Quartz alkalic –

Pb-Zn-Ag zones

mid-Tertiary

Collins Cut, Tiger, AZ
Mammoth-St. Anthony Mine (Tiger)

- Quartz Alkaline - mid-Tertiary

Flagg Mineral Foundation

Jan C. Rasmussen Ph.D., R.G.

TGMS Jan. 9, 2017
Wulfenite, vanadinite, gold in quartz, galena, sphalerite, anglesite, cerussite, and many oxidized minerals

In west-northwest shear zones intruded by mid-Tertiary (22 Ma) rhyolite, with widest fissure veins occurring in quartz monzonite (Precambrian) that was most intensely shattered and brecciated

Deposit was oxidized and faulted, then wulfenite and vanadinite were deposited with later oxidation


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Wulfenite & cerussite, Flagg Mineral Foundation

TGMS Jan. 9, 2017
Mammoth-St. Anthony Mine (Tiger)

AZ Mining & Mineral Museum, MM-T553, 7 cm, Schultz Cut circa 1880s
Rowley Mine, Painted Rock district, Maricopa County

- Quartz alkalic
- Pb-Zn-Ag zones
- mid-Tertiary 25-13 Ma

Red dot wulfenite, 2.58 mm crystal, Domenico Priete collection, www.mindat.org

Jan C. Rasmussen Ph.D., R.G.

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Barite, wulfenite, cerussite, base-metal sulfides, with secondary minerals of cerussite-anglesite suite, wulfenite suite, caledonite suite, and vanadinite suite.

In northwest fissure veins in mid-Tertiary andesite and rhyolite flows and dikes

Shipped 130 tons of wulfenite concentrate to California (18.26 % MoO₃),

Wulfenite on barite, AZ Mining & Mineral Museum, MM-9981, 4.5 cm, donors Floyd & Alice Getsinger
• Quartz alkalic? In Pb-Zn-Ag zones
- on fluorite near galena
• mid-Tertiary?

Wulfenite spicules, 2 mm long, Purple Passion mine, Red Picacho district; Steve Stuart, 2004, www.mindat.org
mid-Tertiary? Quartz Alkalic?

- Red Picacho district (Purple Passion mine)
  - Blades and unusual needle crystals. Some needles of wulfenite grow on the surfaces of wulfenite blades.
  - 3 and 4-colored fluorescent material
  - Wulfenite occurs on quartz (clear, smoky, milky and amethyst) and on fluorite, calcite or galena.
  - Other associations include anglesite, cerussite, sulfur, chlorargyrite, smithsonite and willemite.
  - Some specimens of calcite, fluorite, wulfenite and willemite strongly fluorescent.

Photos courtesy of William Gardner
Calc-alkalic – Later Pb-Zn zones

- Porphyry Copper deposits
  - Chilito, Christmas mine
  - 79 mine
  - Finch mine (S of 79 mine)
  - Grayhorse (Ray area)
  - Silver Bell
  - Twin Buttes
  - Mineral Park

From Keith, 2003, MagmaChem model book

Jan C. Rasmussen Ph.D., R.G.
Stage 4 Oxidized Pb-Zn zones of Porphyry Copper deposits

Chilito Mine, Christmas Mine, 79 Mine, Banner district

Owner Stan Keith, 1-2 in.

From Keith & Wilt, 1986, AGS digest

Banner district - Calc-alkalic - “outer”/ later (Stage 4) Pb-Zn zones

Owner Stan Keith,
1-2 in.

Jan C. Rasmussen Ph.D., R.G.

TGMS Jan. 9, 2017
Galena, sphalerite, pyrite, cerussite, with a large variety of secondary minerals

In permeable zones such as breccias, fractures, and shear zones

Especially as bedded and vein replacements, in favorable rock types, such as contact metamorphosed Pennsylvanian Naco limestone and silicified rhyolite porphyry dikes of probable Tertiary 62 Ma) age
Wulfenite, 79 mine, 4th level on main fault, large crystal 1.2 in. on edge, collected by Stan Espenshade, mid 1970s, photo and specimen by Stan Keith.
Wulfenite, 79 mine, 4th level on main fault, crystal 3/16 in. on edge, collected by Stan Keith, ~1972, photo and specimen by Stan Keith.
Finch Mine (Banner district)

- Galena, anglesite, cerussite, with vanadinite, descloizite, and copper carbonates

- In east-northeast striking fissure veins that juxtapose Williamson Canyon volcanics with Pennsylvanian Horquilla Formation

- 3 lots less than 1 ton of Molybdenum-vanadium concentrates produced in 1934

AZ Mining & Mineral Museum, MM-T305, 8.2 cm, Donors Robert & Catherine Sanders
Wulfenite covered by quartz, Finch Mine, Banner district, Dripping Spring Mts., Gila Co.
6 mm crystals, Paul Jaeger photo, specimen, www.mindat.org
Good cabinet-sized specimens from the porphyry copper districts are not spectacular specimens that are attractive to most collectors.

Wulfenite, Queen Creek/Belmont Mine, Pioneer/Superior district, Pinal Co., 3 in.
Wulfenite and Dioptase, Magma Mine, Superior/Pioneer district, Pinal Co.
FOV ~6 mm, specimen ex Roland Fogg Collection, photo by & specimen of Trevor Boyd, www.mindat.org

Silver Bell Mine, Pima County

Wulfenite under calcite, Silver Bell district, Silver Bell Mts., Pima Co., 7 mm, ex Ray Grant Collection, Chris Whitney-Smith collection & photo, www.mindat.org

Peraluminous Calcic Wulfenite

- Jurassic or Laramide
  - Mildren mine, Cababi district
  - Vulture Mine
  - Gold Basin district
    - Shelby Mine
    - Junction Mine
  - Herradura, Mexico
    - Wulfenite is guide to gold

Dipyramidal wulfenite, Shelby Mine, Gold Basin District, Mohave Co., FOV 3 mm, former Phil Partington collection, Rolf Luetcke specimen & photo, www.mindat.org
Peraluminous Calcic Wulfenite

Laramide 70 Ma – locally is a guide to gold at Herradura, Mexico

- Shelby Mine, Gold Basin district, White Hills, Cerbat Mts., Mohave Co., FOV 1.5 mm, Doug Merson photo, specimen, www.mindat.org
Oxidized zones – supergene zones of Lead-Zinc deposits

Largest, best specimens are formed in water courses

Wulfenite is deposited away from the primary ores
  - Examples with thick tabular plates
    - Glove mine,
    - 79 mine,
    - Red Cloud mine
    - Defiance etc. Gleeson Ridge

Wulfenite in open space watercourse near main fault, 79 mine, John Callahan photo
Water Courses

Fig. 5. Generalized view of the Glove ore body.

Olson, 1962, Glove mine

Main fault exposure in wulfenite room, 79 mine, Stan Keith photo
Wulfenite Colors

- **Colors**
  - Colorless (no impurities)
  - Red (Chromate)
  - Orange-yellow (Arsenate)
  - Yellow (Arsenate)
  - Brown (iron?)
  - Grey/black (Manganese?)
  - Greenish (arsenic-manganese?)

Jan C. Rasmussen Ph.D., R.G.
TGMS Jan. 9, 2017
www.JanRasmussen.com
Mineral Associations

- anglesite  PbSO₄
- cerussite  PbCO₃
- mimetite  Pb₅(AsO₄)₃Cl
- vanadinite  Pb₅(VO₄)₃Cl
- pyromorphite  Pb₅(PO₄)₃Cl
- descloizite  PbZnVO₄(OH)
- limonite  FeO·(OH)·nH₂O
- fornacite  Pb₂Cu(AsO₄)(CrO₄)(OH)
- hemimorphite  Zn₄Si₂O₇(OH)₂·H₂O
- smithsonite  ZnCO₃
- aurichalcite  (Zn,Cu)₅(CO₃)₂(OH)₆
- willemite  Zn₂SiO₄
- dioptase  Cu₆(Si₆O₁₈)·6 H₂O
- rosasite  (Cu,Zn)₂(CO₃)(OH)₂
- chrysocolla  (Cu,Al)₂H₂Si₂O₅(OH)₄·nH₂O
- fluorite  CaF₂

Cerussite, Mammoth-St. Anthony Mine (Tiger), Pinal County
On loan to AZ Mining & Mineral Museum in 2010 from AMMMF (Flagg Mineral Foundation)

- calcite  CaCO₃
- quartz  SiO₂
- never on molybdenite  MoS₂

Vanadinite
$\text{Pb}_5(\text{VO}_4)_3\text{Cl}$
- hexagonal prisms
- barrel shaped
- Soft, $H=2.75-3$
- Heavy, $\text{SG}=6.8-7.1$
- No cleavage

Old Yuma mine, northern Tucson Mts., Pima County, Evan Jones owner

Vanadinite, North Geronimo Mine, AZ Mining & Mineral Museum MM-T567, 9 cm

Vanadinite

$\text{Pb}_5(\text{VO}_4)_3\text{Cl}$

- barrel shaped
- Soft, $H=2.75-3$
- hexagonal prisms
- Heavy, $SG=6.8-7.1$
- No cleavage

| Table 1. Red Cloud mine wulfenite trace element semiquantitative analysis* |
|-----------------------------|----------------|
| Si                        | 0.028          |
| As                        | ND 0.05        |
| Mg                        | 0.0052         |
| Fe                        | 0.0028         |
| W                         | 0.20           |
| Ca                        | 0.0031         |
| Cr                        | 0.0030         |
| Sr                        | ND 0.001       |
| V                         | ND 0.002       |
| Other elements            | nil            |

### Table V: Oxidation of Transported Ions

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<th>Mineral</th>
<th>Oxide Deposition</th>
<th>Carbonate Deposition</th>
<th>Silicate Deposition</th>
<th>Molybdate, etc. Deposition</th>
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Paragenesis in the 79 Breccia System (3rd, 4th and 470 Levels)

Paragenesis in the Main Fault (4th Level)
Paragenesis: Galena $\text{PbS}$, then Anglesite $\text{PbSO}_4$

Galena with anglesite, vauquelinite, wulfenite, Farley's Collateral claim, Maricopa Co., AZ, Richard Bideaux sample, Sugar White photo
Paragenesis: Galena, then Anglesite

Pyramidal wulfenite near Galena → Anglesite → wulfenite → mimetite?

Galena with anglesite, Shelby mine, Gold Basin district, Mohave Co., AZ, FOV 3 mm, former Phil Partington collection, Rolf Luetcke specimen, photo, www.mindat.org

Anglesite $\text{PbSO}_4$ before Wulfenite

Wulfenite (dark spicules) on Anglesite (white), prospect in California district, Chiricahua Mts., FOV 3 mm, Rolf Luetcke photo, specimen, www.mindat.org
Cerussite $\text{PbCO}_3$ before Wulfenite

Cerussite and Wulfenite, Mammoth St. Anthony mine, Tiger, Pinal Co., FOV 26 mm, Ben Kirchner photo, specimen, www.mindat.org

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Mimetite $\text{Pb}_5(\text{AsO}_4)_3\text{Cl}$ later than Wulfenite

Mimetite on Wulfenite, Purple Passion mine, Red Picacho district, Wickenburg area, Maricopa Co., FOV 4 mm, Rolf Luetcke photo, specimen, www.mindat.org

Mimetite globules on Wulfenite, Rowley mine, Painted Rock district, Maricopa Co., FOV 2 cm, Chris Whitney-Smith photo, specimen, www.mindat.org

Hemimorphite $\text{Zn}_4\text{Si}_2\text{O}_7(\text{OH})_2\cdot\text{H}_2\text{O}$ later than Wulfenite

Hemimorphite and cerussite on Wulfenite, 79 mine, Banner district, Dripping Spring Mts., Gila Co., FOV 4.4 cm, Dan Weinrich photo, specimen, www.mindat.org

Vanadinite \( \text{Pb}_5(\text{VO}_4)_3\text{Cl} \) later than Wulfenite

Vanadinite on Wulfenite, Rowley Mine, Painted Rock Mts.. Maricopa Co., 2 cm, photo and specimens Rolf Luetcke, www.mindat.org

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Pyromorphite $\text{Pb}_5(\text{PO}_4)_3\text{Cl}$ later than Wulfenite

Pyromorphite and quartz on wulfenite, Rustler Park, California district, Chiricahua Mts., FOV 5 mm, Dave Owen photo, specimen, www.mindat.org

Dioptase $\text{Cu}_6(\text{Si}_6\text{O}_{18})\cdot 6\text{H}_2\text{O}$ later than Wulfenite

Dioptase on Wulfenite, Mammoth-St. Anthony Mine, Mammoth district, Tiger, 4 mm FOV, Rolf Luetcke photo, specimen, www.mindat.org

Quartz $\text{SiO}_2$ later than Wulfenite

Quartz on Wulfenite, Red Cloud Mine, Silver District, Trigo Mts., La Paz Co., crystal 4.2 mm, Cat Lemons photo, specimen, www.mindat.org
Chrysocolla $(\text{Cu,Al})_2\text{H}_2\text{Si}_2\text{O}_5(\text{OH})_4.n\text{H}_2\text{O}$ later than Wulfenite

Chrysocolla on Wulfenite, Rowley Mine, Painted Rock district & mountains, Maricopa Co., FOV 13 cm, Donald McCoy photo, specimen, www.mindat.org

Willemite \( \text{Zn}_2\text{SiO}_4 \) later than Wulfenite

Willemite (\( \text{Zn}_2\text{SiO}_4 \)) on Wulfenite, Mammoth-St. Anthony mine, Tiger, Pinal Co., 7.1 cm, Ian Whitlock specimen, photo, www.mindat.org

Aurichalcite ($\text{Zn,Cu}_5\text{(CO}_3\text{)}_2\text{(OH)}_2$) and Rosasite ($\text{Cu,ZnCO}_3\text{(OH)}_2$) on Wulfenite, 79 Mine, Banner district, Dripping Spring Mts., Gila Co., Paul Stephen Cyr photo, specimen, www.mindat.org
Wulfenite and Malachite on Cerussite

Malachite on Cerussite, Mammoth-St. Anthony Mine, Tiger, Pinal Co., 4.6 cm crystal, Ian Whitlock photo, specimen, www.mindat.org,
Rosasite and Hemimorphite on Wulfenite, 79 Mine, Banner district, Dripping Spring Mts., Gila Co.,

4 cm specimen, Cat Lemons photo, specimen, www.mindat.org
Calcite CaCO$_3$ on Wulfenite

Calcite on Wulfenite, Defiance Mine, Gleeson district, Dragoon Mts., Cochise Co., 6 x 4 cm., Cat Lemons sample, photo, www.mindat.org

275 wulfenite occurrences in Arizona in www.mindat.org – probably will be 300 (Ray Grant)

nearly all wulfenite occurrences were oxidation products of deposits with primary galena

No wulfenite found with primary deposits that contained primary molybdenite

Color is related to impurities installed during early colloidal element/ion diffusion under meteoric conditions

Wulfenite occurrence depends more on the proximity of the lead source (galena) than on the presence of moly source (molybdenite)

Best wulfenite specimens are in water courses/large open fillings in Alkali-Calcic and Quartz Alkalic districts away from immediate lead source

Enough Mo is present as a chemical component of meteoric waters to stabilize wulfenite after oxidation of the lead source (typically after cerussite formation).
Where to find more wulfenite?

http://repository.azgs.az.gov/sites/default/files/dlio/files/nid1010/azbmbulletin194map18verycleannjn.pdf

Arizona Geological Survey Bull. 194, map 18

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