Wulfenite in Arizona

Glove Mine, Santa Rita Mts,, Lyda Hill

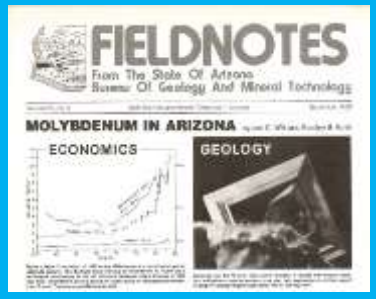
by Jan C. (Wilt) Rasmussen and Stanley B. Keith

Wulfenite in Arizona

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

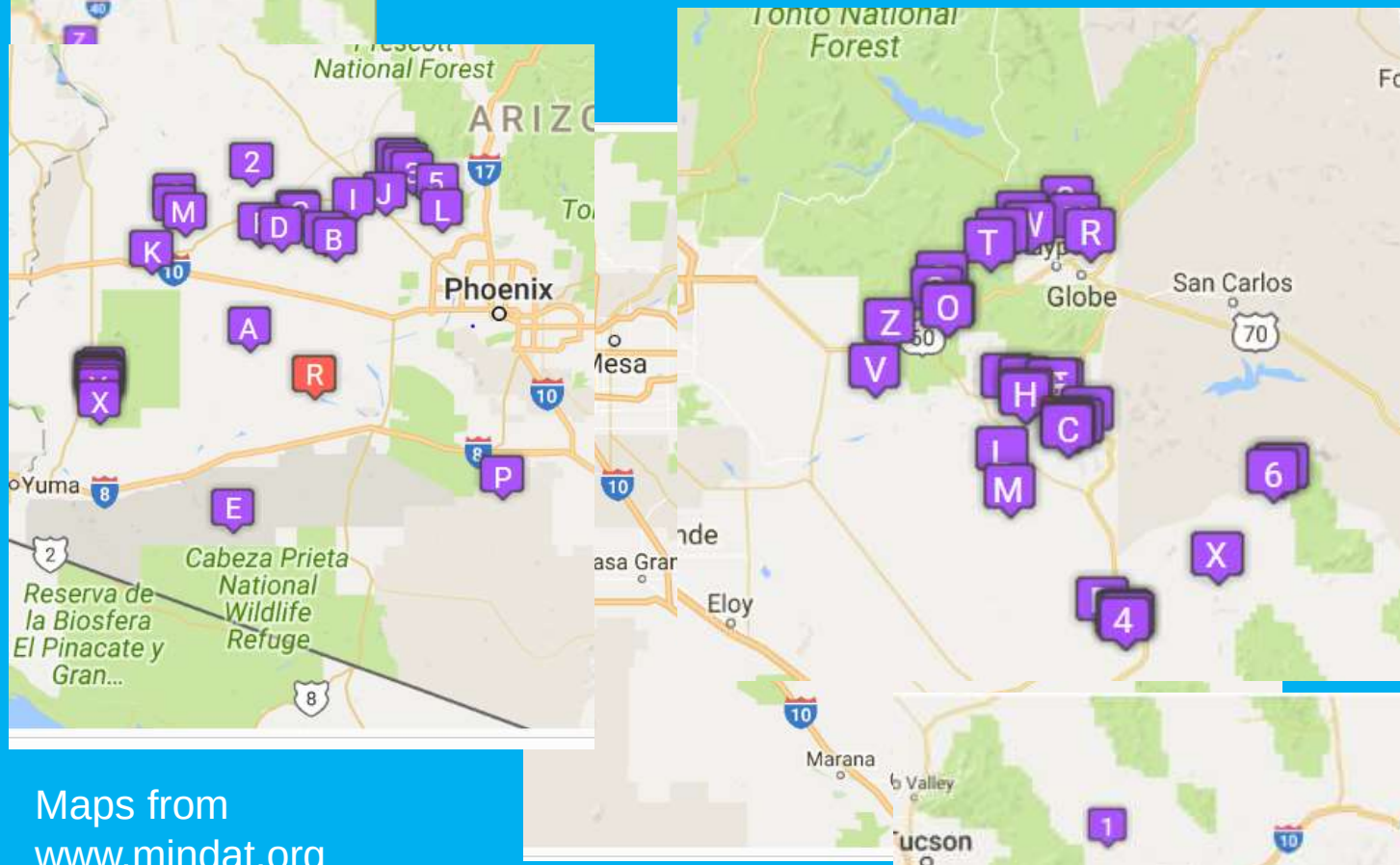
16 YEARS mindat.org



FLAGG MINERAL FOUNDATION

Map of Arizona Wulfenite Localities

275 wulfenite localities in Arizona in www.mindat.org



Maps from www.mindat.org

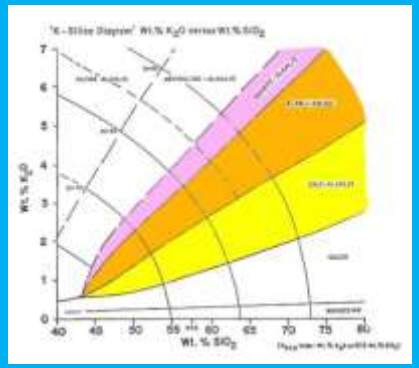
Wulfenite is Arizona's State Mineral

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

Wulfenite Mineralogy

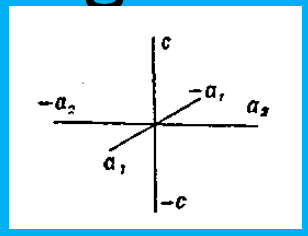
- $PbMoO_4$
  - Lead Molybdate (molybdenum and oxygen)
- Colors
  - Orange-yellow, yellow, honey-yellow, reddish-orange, rarely colorless, grey, brown, olive-green and black
- Sub-adamantine to greasy luster

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

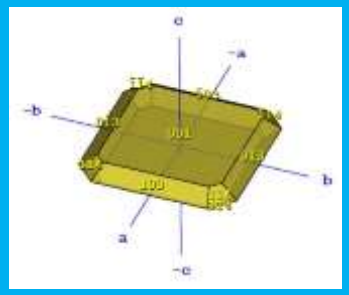
Common impurities: W, Ca, V, As, Cr (red), Ti

Wulfenite Crystallography

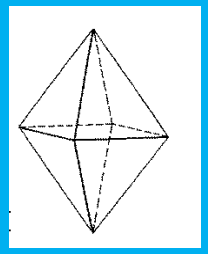
- Tetragonal



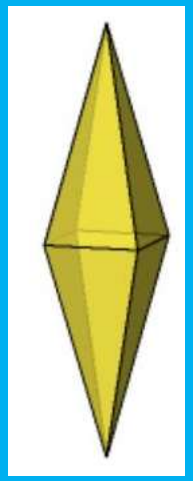
  - usually tabular (flat square), thin plates



  - rare dipyramidal



  - rare pseudo-cubic

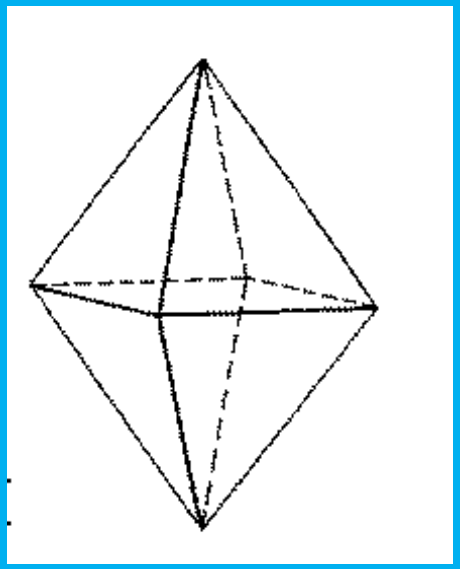


Glove Mine, Tyndall district, Santa Cruz Co.
AZ Mining & Mineral Museum MM-T554 14 cm

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

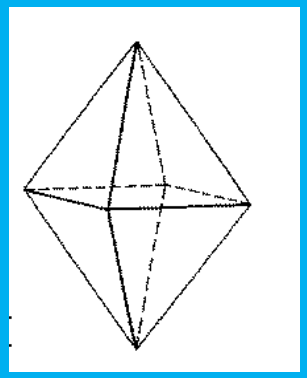
Unusual crystal forms - dipyramid

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

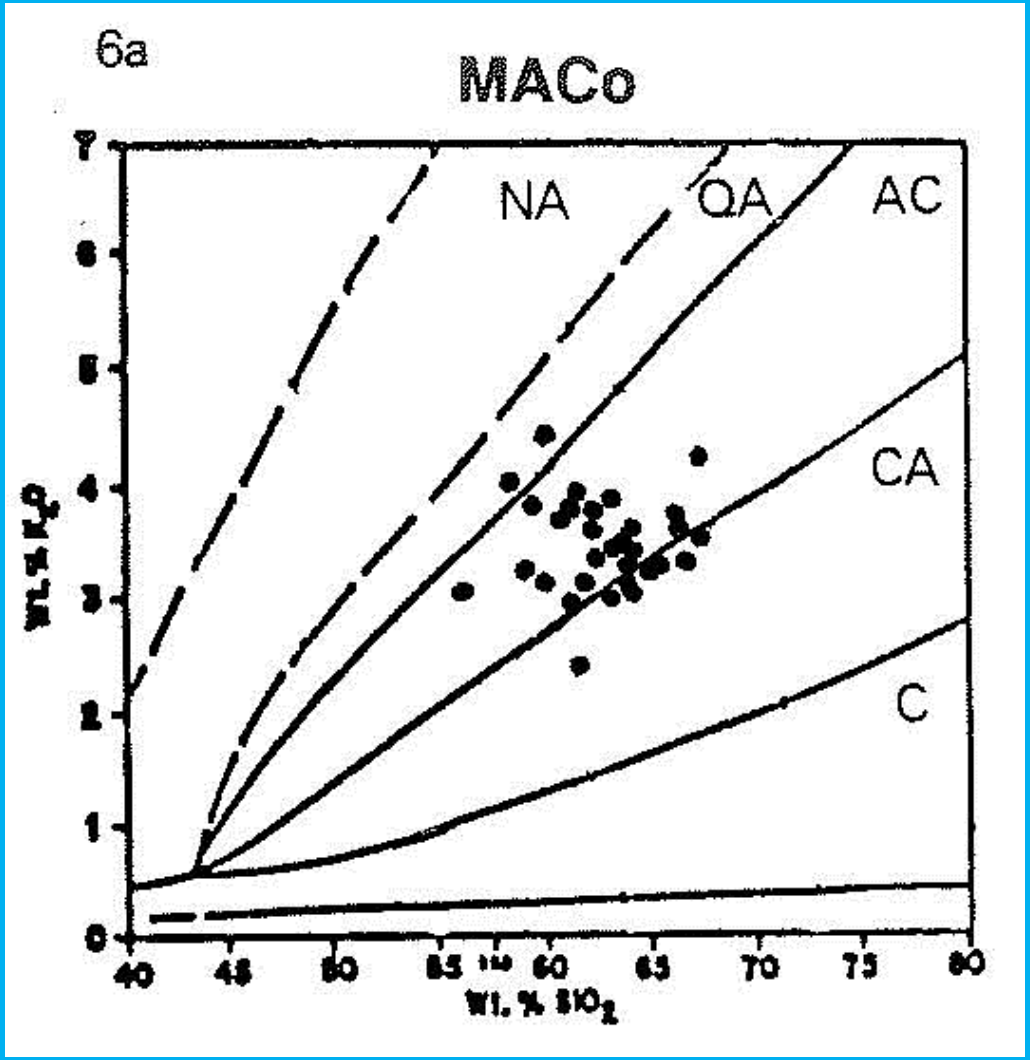
Wulfenite dipyramids on anglesite/galena

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

Alkali-Calcic - Lead-Zinc-Silver



%K_2O

%SiO_2

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

Keith & Wilt, 1986

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.

Glove Mine, Flagg Mineral Foundation

Empire Mine, Tombstone, Peter Megaw

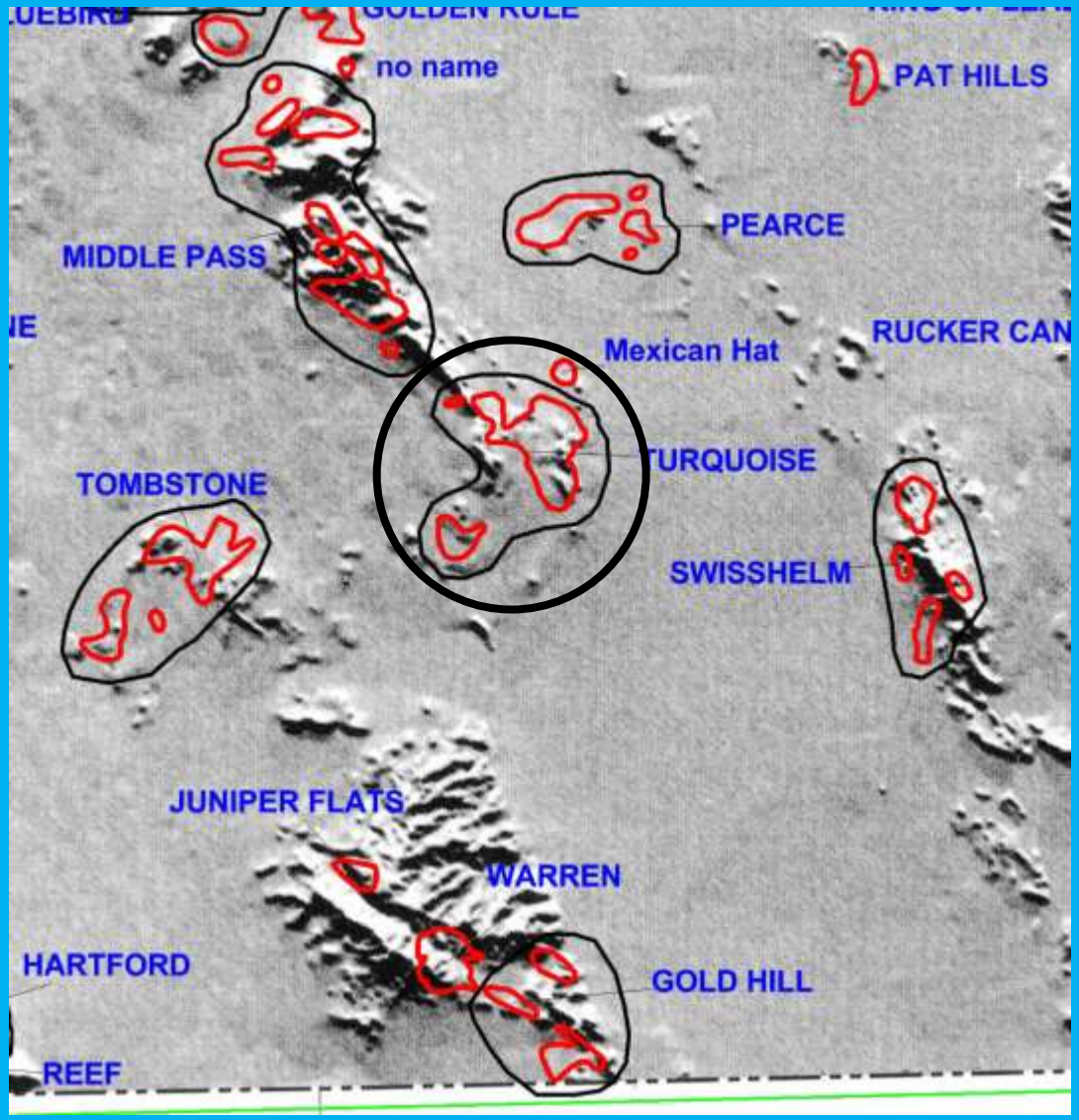
Total Wreck Mine, Empire dist.

PbZnAg – Jurassic 160 Ma

- Silver Bill, Defiance, Mystery, Tom Scott mines –
- Gleeson district (formerly part of Turquoise district) (on Gleeson Ridge)

Silver Bill Mine, Turquoise dist, MM-T555

Defiance & Silver Bill Mines, Turquoise district, Dragoon Mts., Cochise County - Jurassic



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

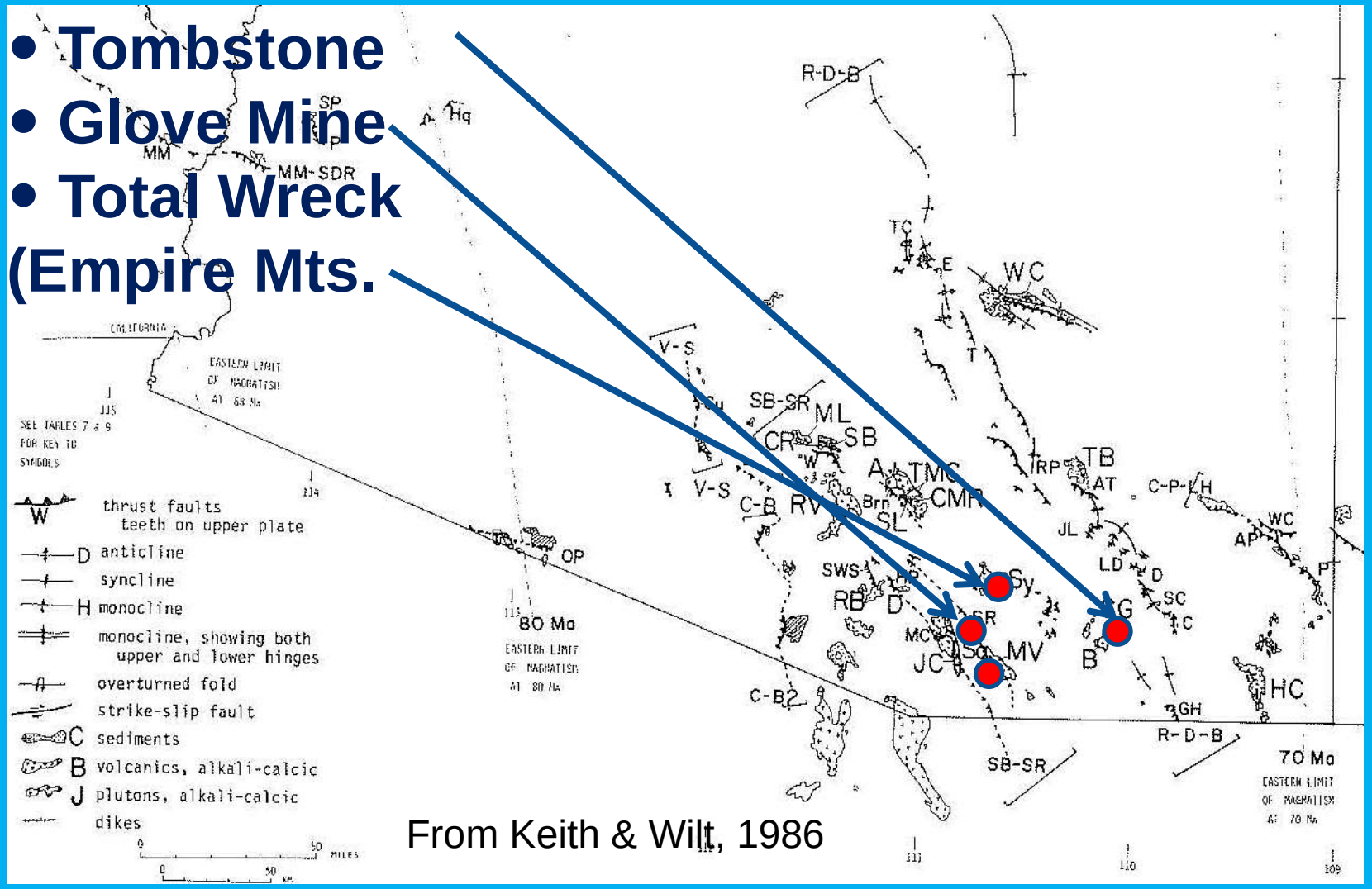
Defiance Mine, Gleeson dist.

- 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

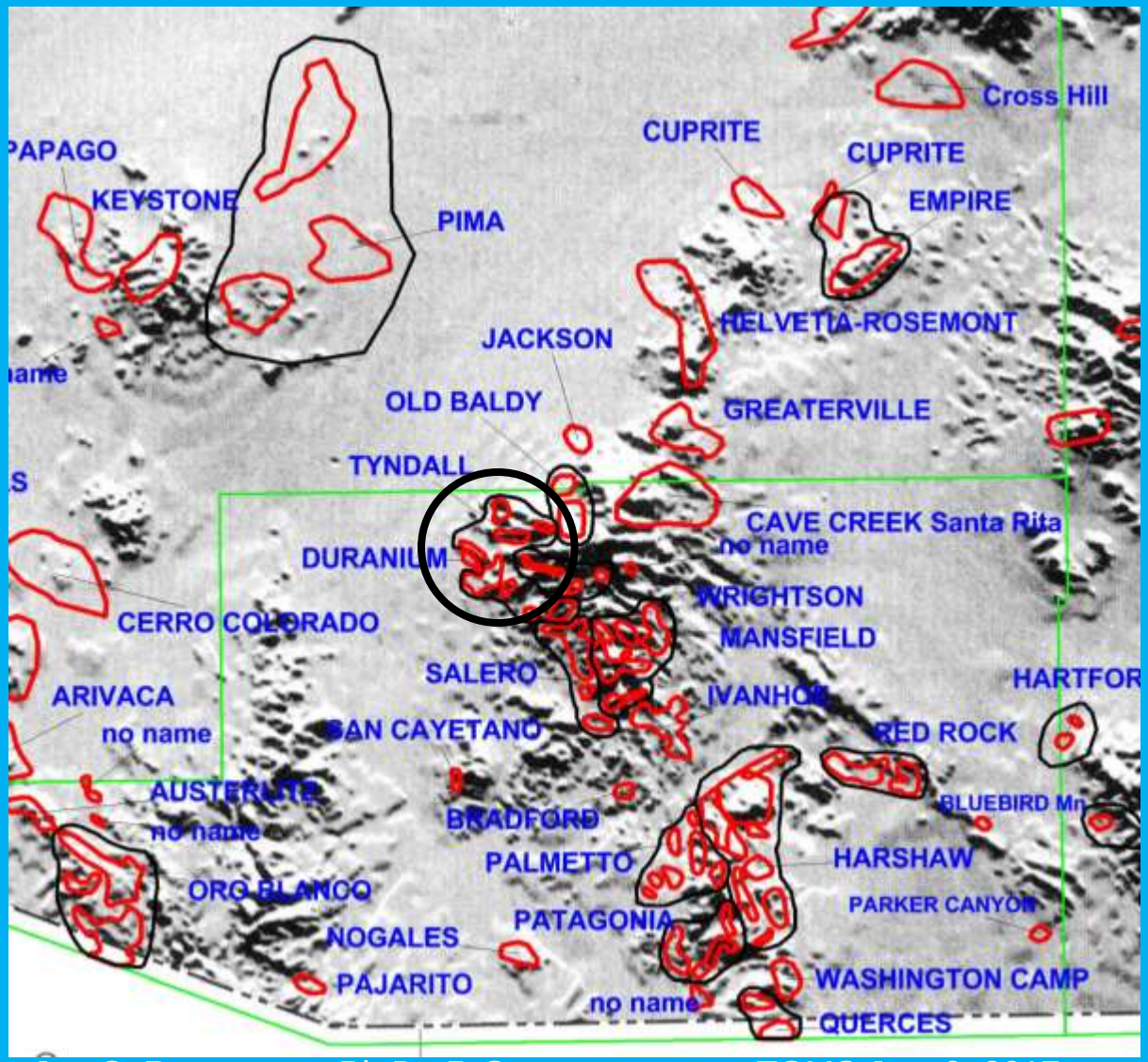
Laramide (80-75 Ma) Alkali-Calcic - Lead-Zinc-Silver

- 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

AZ Mining & Mineral Museum MM-T554 14 cm

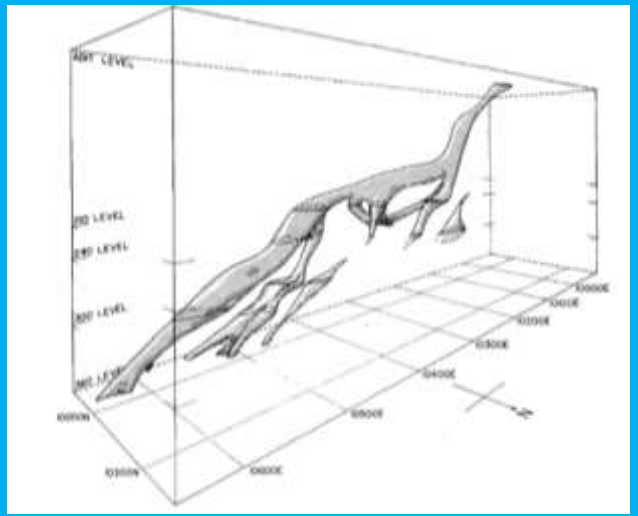
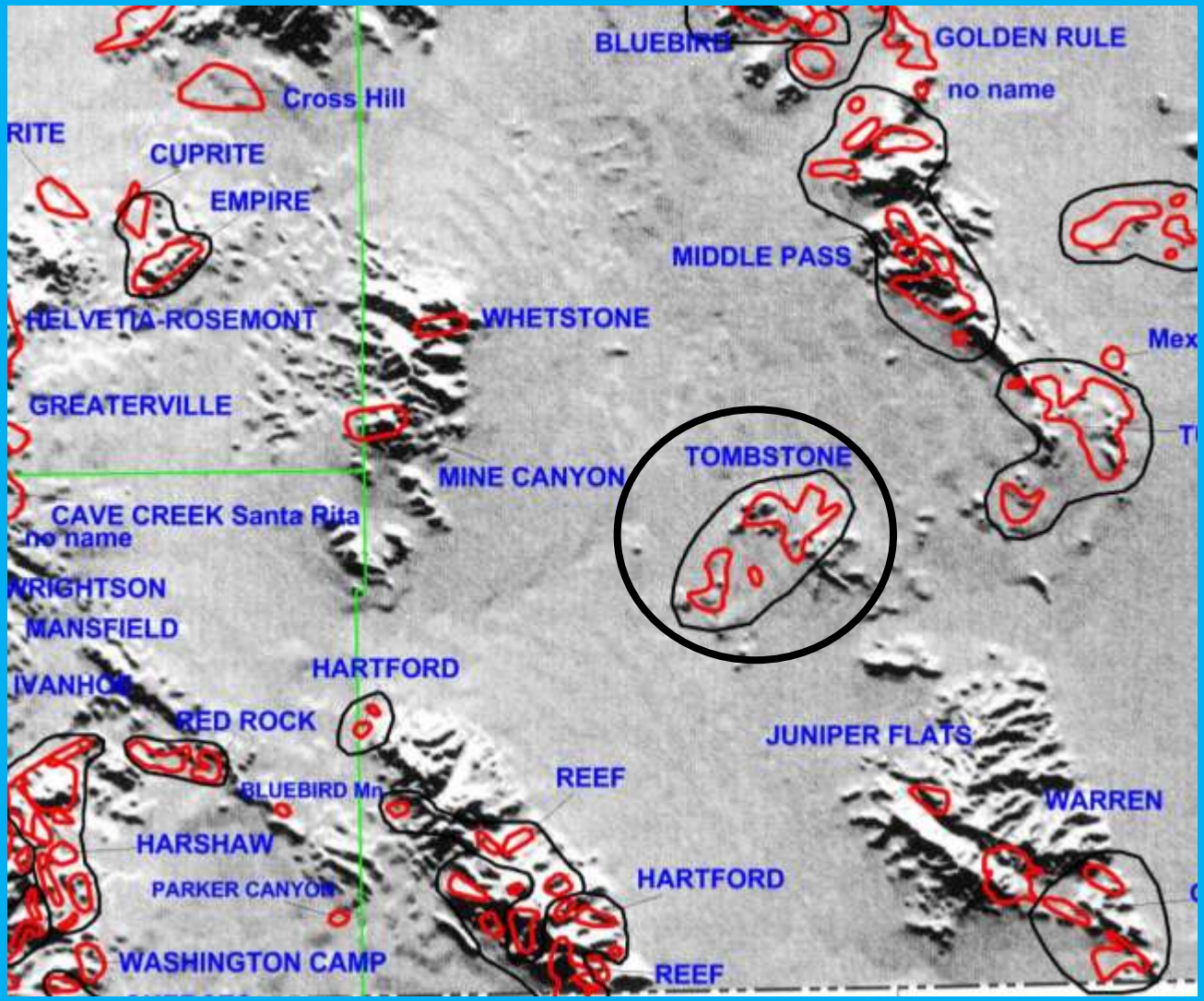


diagram = Olson, 1966, Glove mine, Economic Geology, v. 61, p. 731-743.

Tombstone district, Tombstone Hills, Cochise County



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

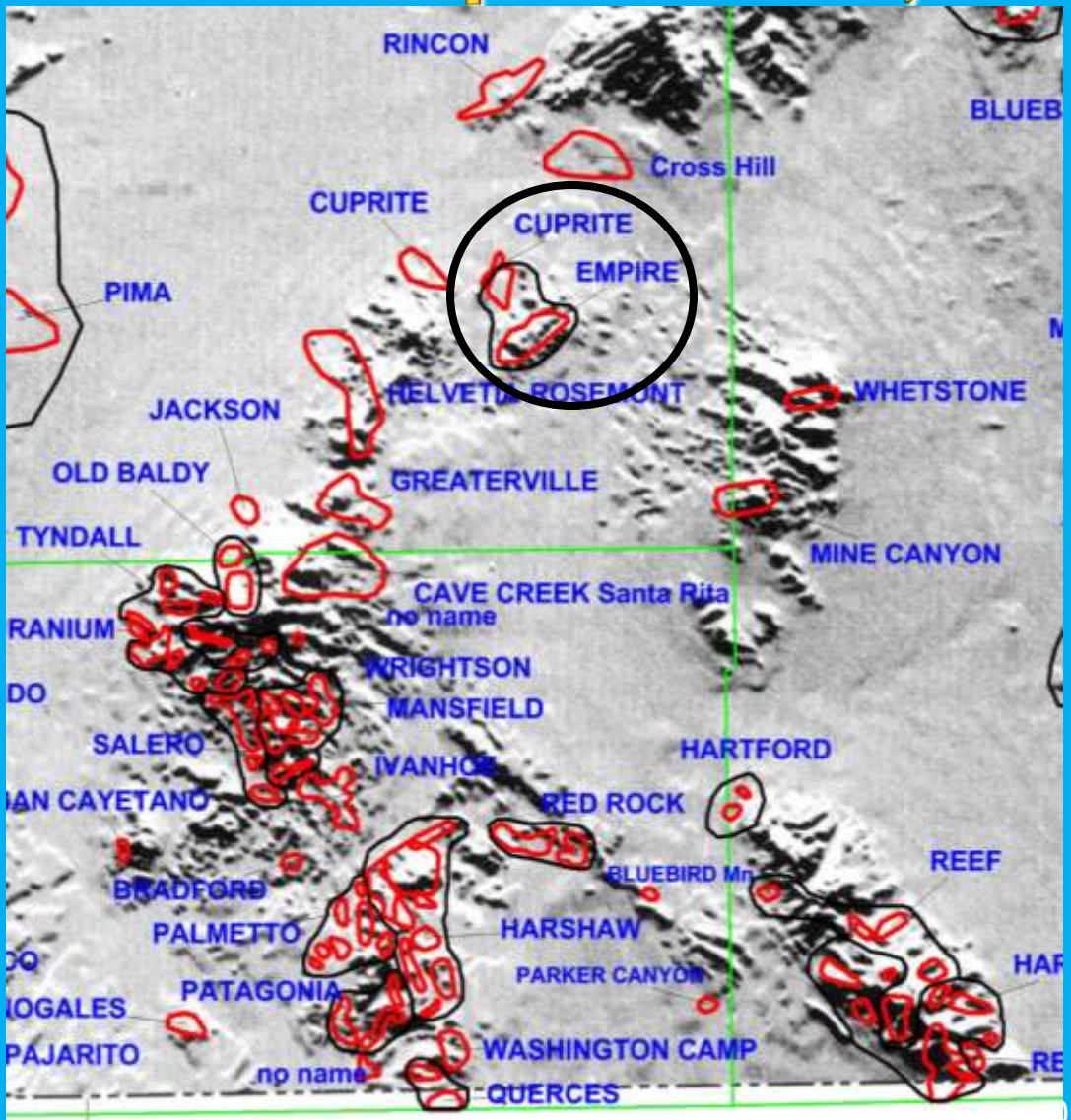
Wulfenite, Tombstone district, Cochise Co., 2-4 in., Arthur Montgomery collection, Rock Currier photo, www.mindat.org

Empire Mine, Peter Megaw, ~2 in.

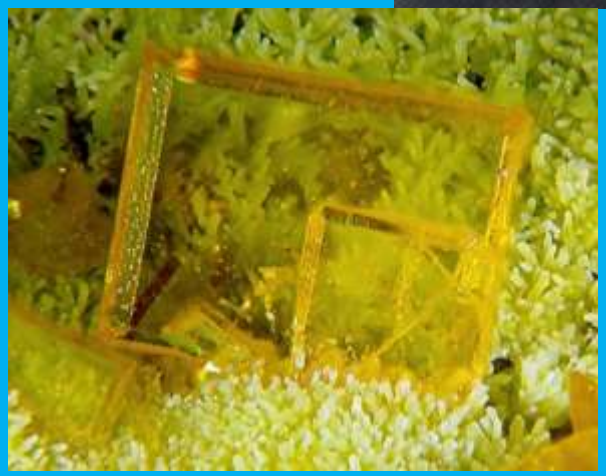
Tombstone district, greenish yellow globular mimetite on wulfenite, Cochise County

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



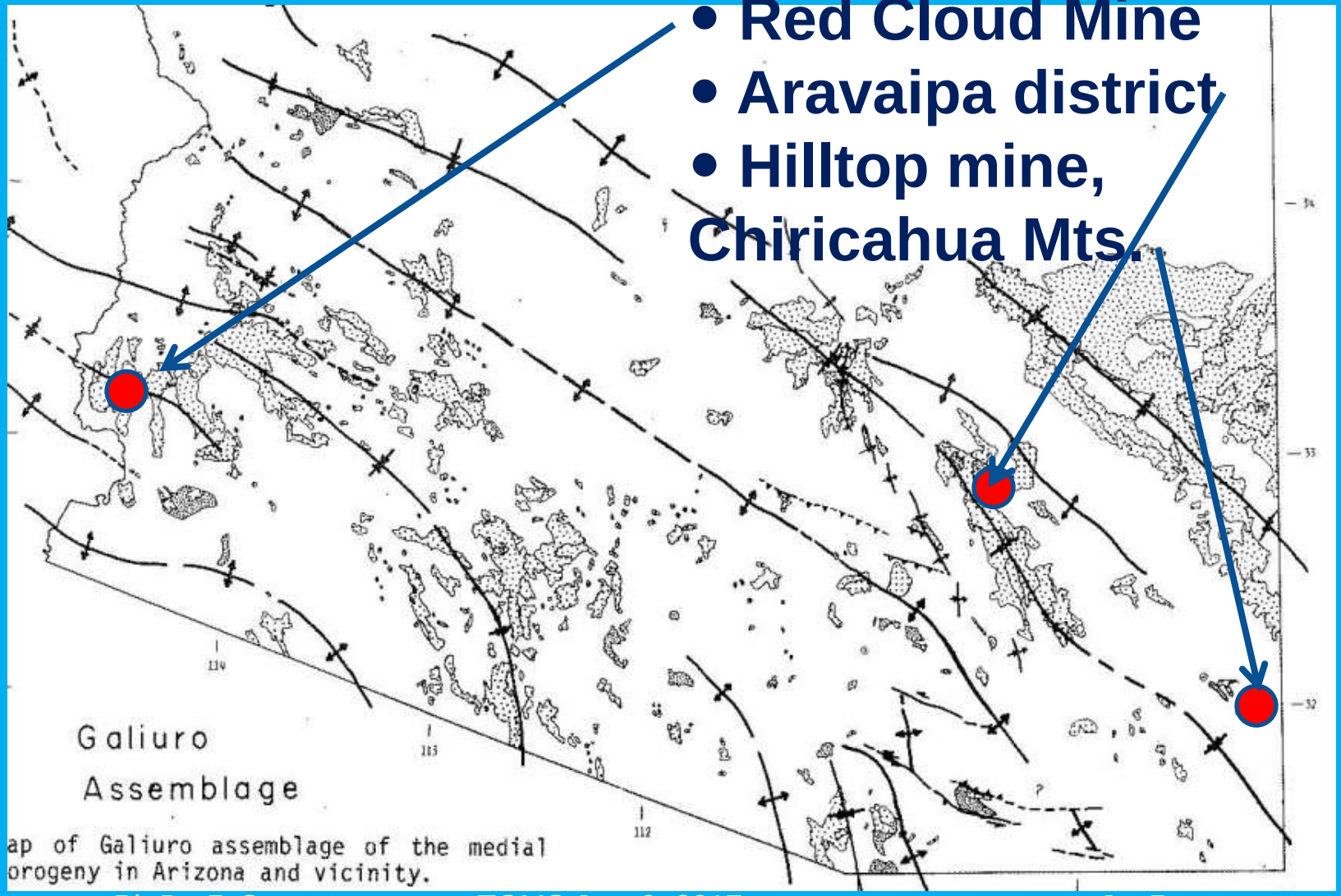
Wulfenite, mimetite, Total Wreck Mine, Empire Mts., Pima Co., FOV 7 mm, Michael Cline photo, specimen, www.mindat.org

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 Mine wulfenite

Red Cloud wulfenite, ~ 2 inches; collected by Rose from Edson-Rose pocket ~ 1972, photo and specimen in collection of Stan Keith

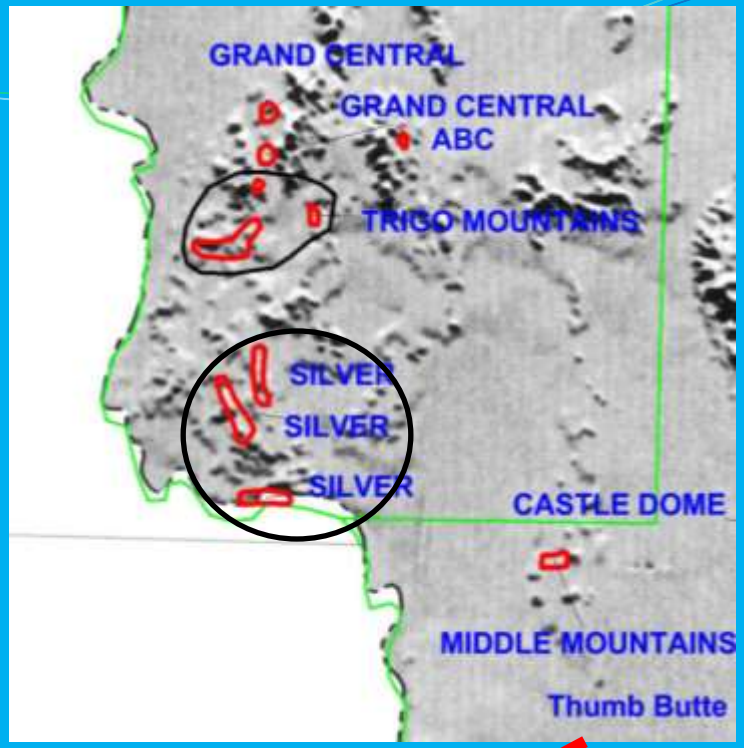
Red Cloud Mine

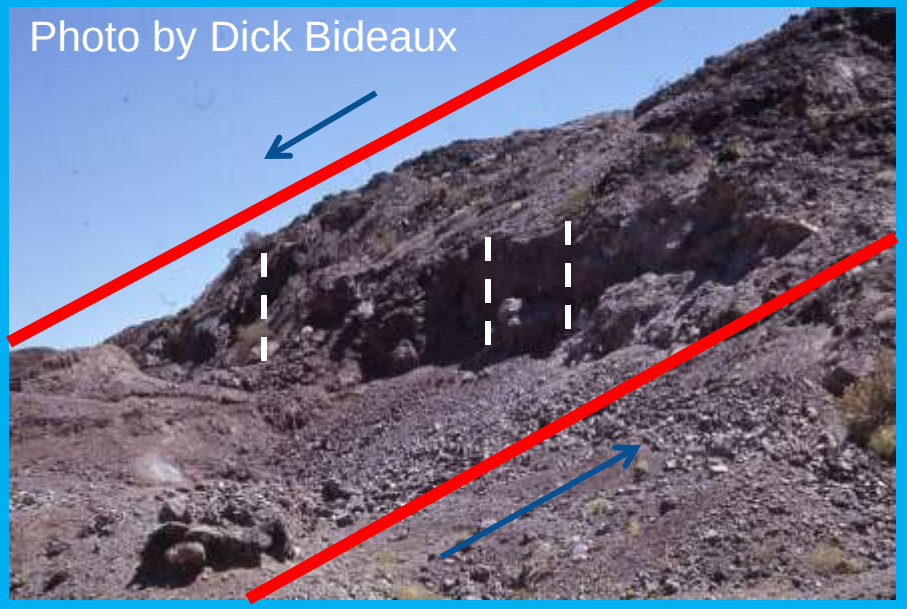
- Alkali-calcic, mid-Tertiary
- 25-15 Ma, Yuma Co.
- Irregular masses and vug linings of argentiferous lead and zinc carbonates with pyrolusite, vanadinite, wulfenite & minor malachite, nodules of partly altered argentiferous galena, & disseminated masses of silver chloride & bromide in a gangue of iron 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





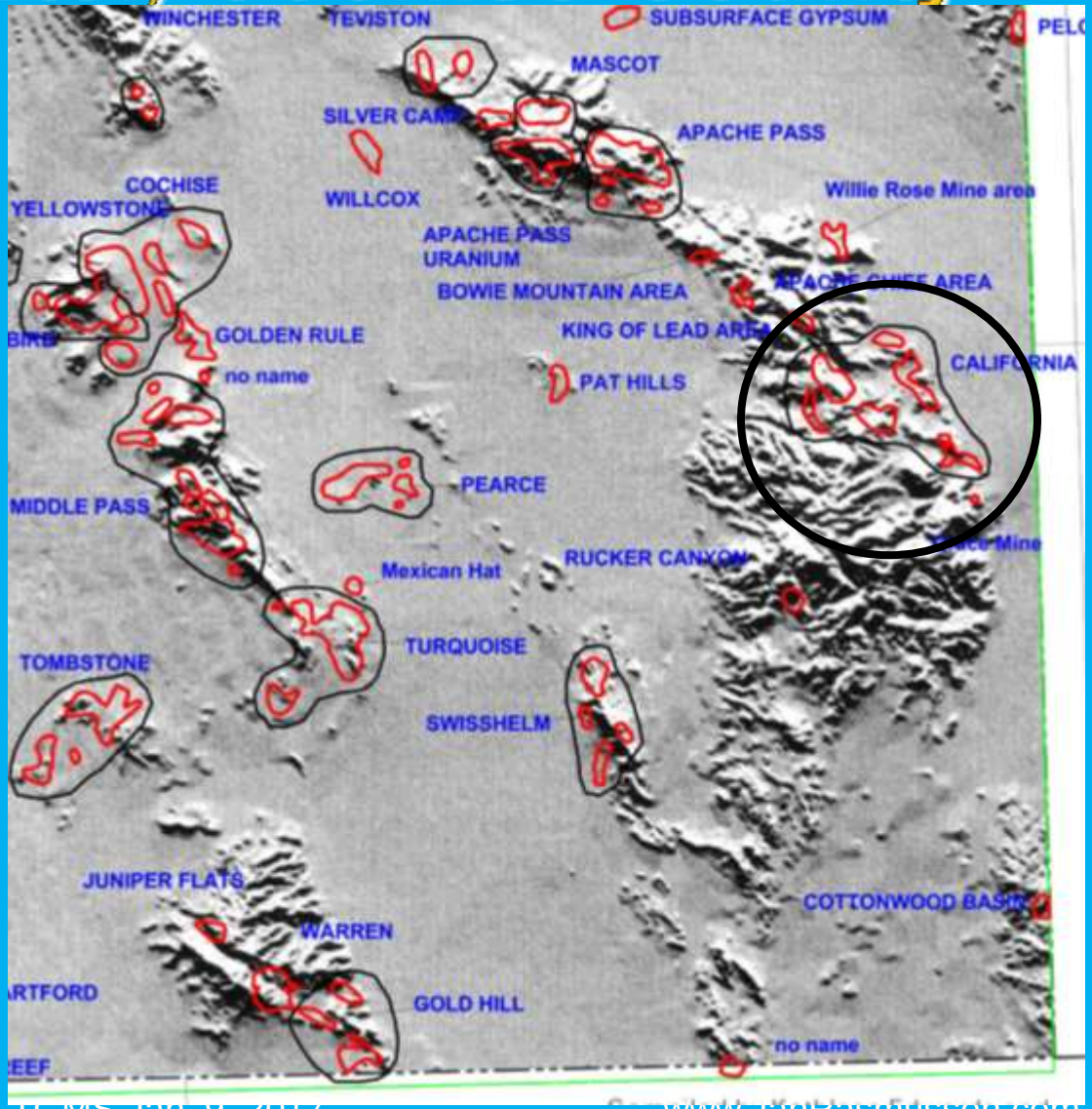
Red Cloud normal fault zone, vertical channels containing wulfenite

Red Cloud Mine wulfenite

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

Hilltop Mine, California district, Chiricahua Mts., Cochise County

Wulfenite, Hilltop Mine, California district, Chiricahua Mts., Cochise Co., from Arthur Montgomery collection 1972, Rock Currier photo, www.mindat.org

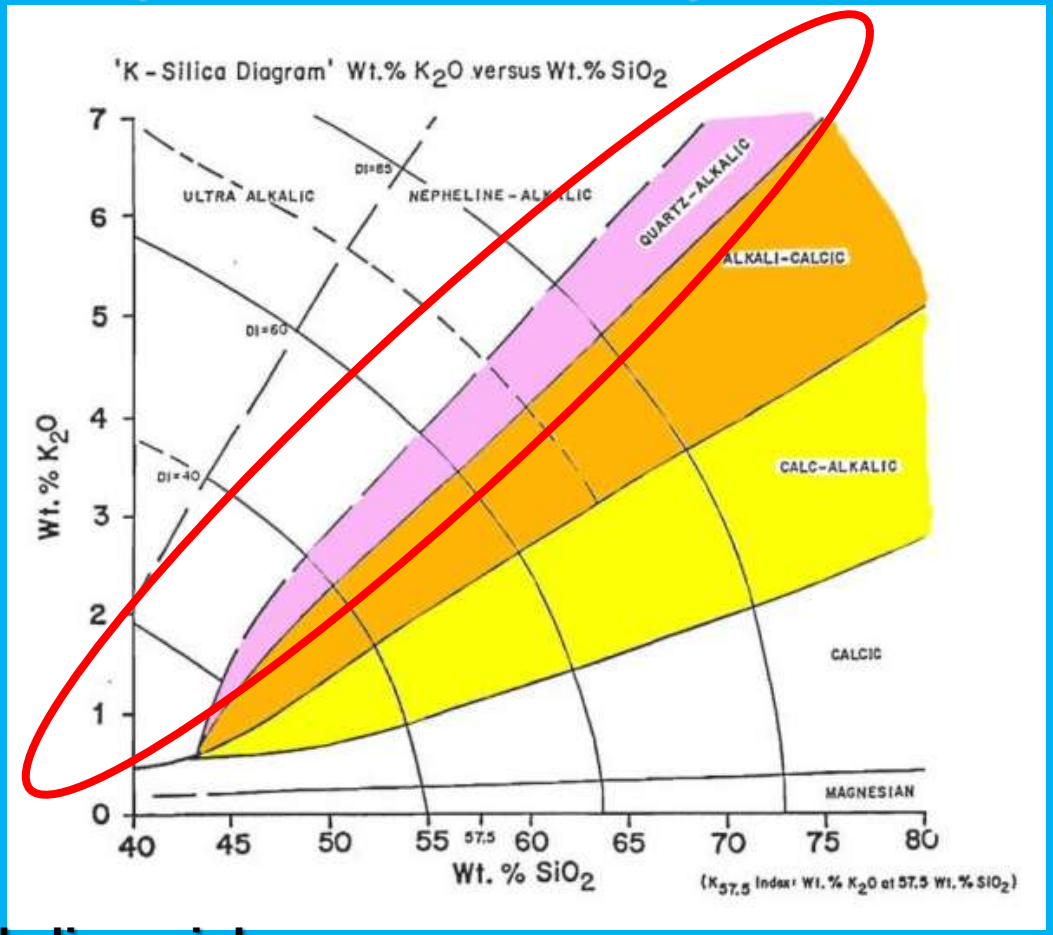


Hilltop Mine, Chiricahua Mts.

- 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 ob base metal sulfide ore produced intermittently from early 1910s to 1954

AZ Mining & Mineral Museum MM-T549, 11.5 cm

Quartz Alkalic – Gold
Jurassic, Laramide, mid-Tertiary



%K_2O

%SiO_2

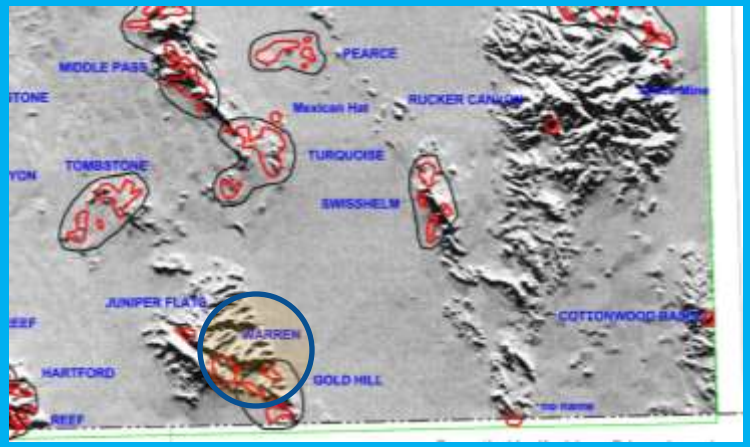
Whole rock geochemistry of associated plutonic rock (granite or quartz monzonite)

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

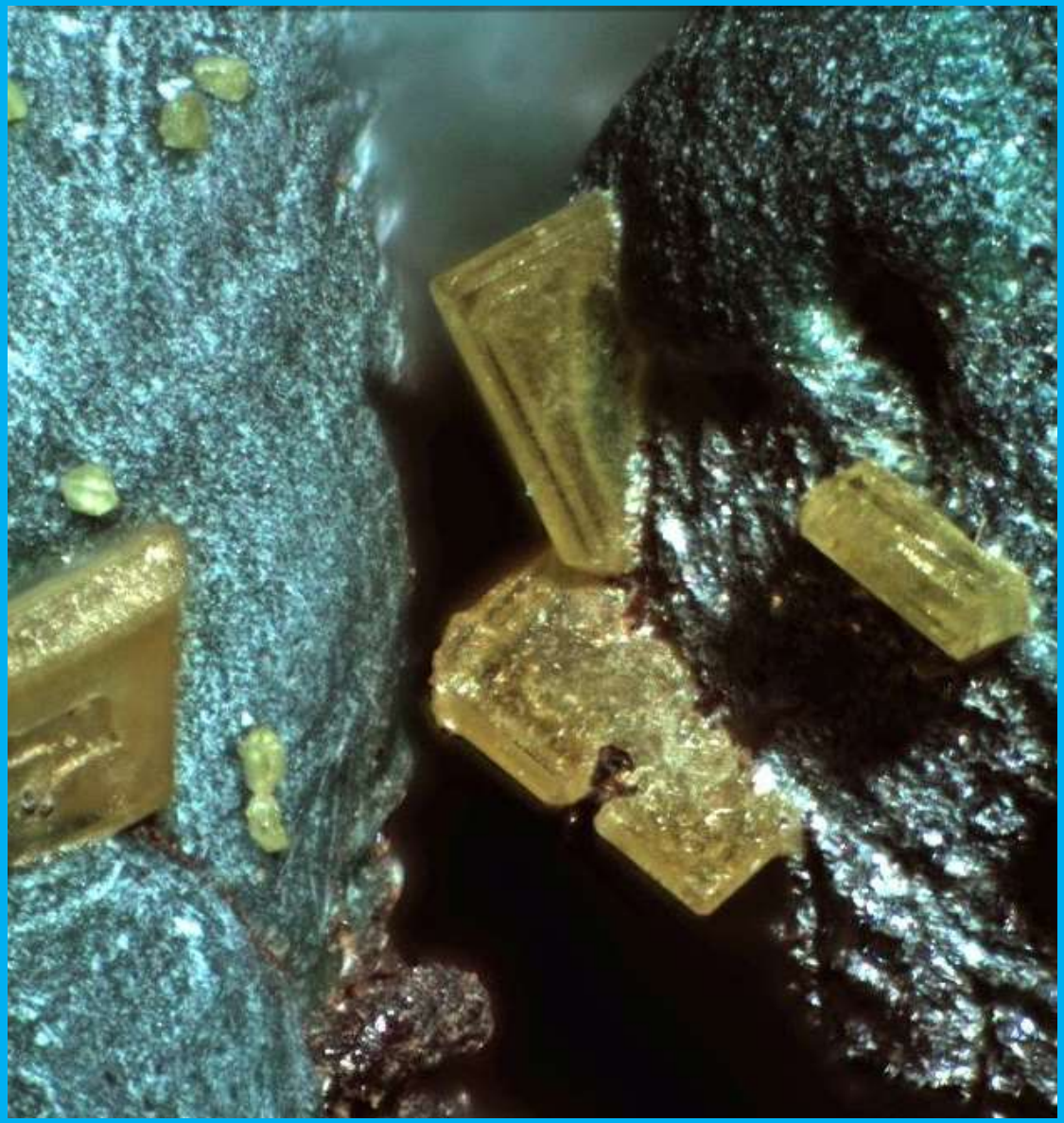
Keith & Wilt, 1986

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



Quartz Alkalic - Laramide

- Old Yuma Mine
- ~ 72 Ma
- Amole pluton
- Amole district
- Tucson Mts.

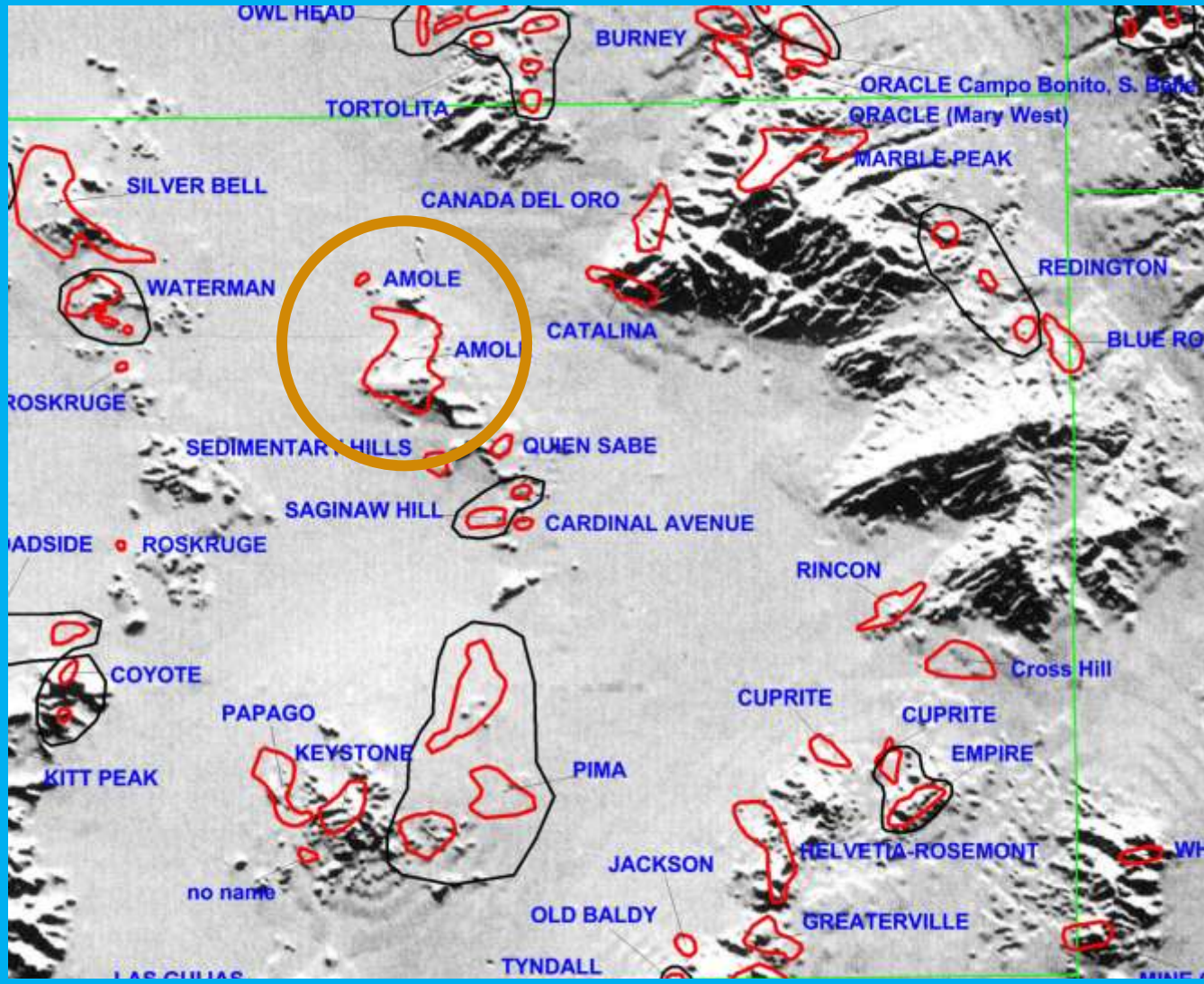
Old Yuma Mine, Amole district, Jim & Gail Spann

Old Yuma Mine, Amole district, Tucson Mts.

- Quartz Alkalic
- Laramide
- Au, Pb, Zn

Wulfenite, owners John & Karen Cesar

Vanadinite, owner Dick Morris



Old Yuma Mine, Tucson Mts.

- Quartz Alkalic Laramide
- Au, Pb, Zn
- Partly oxidized base metal sulfides with spotty wulfenite & vanadinte, 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

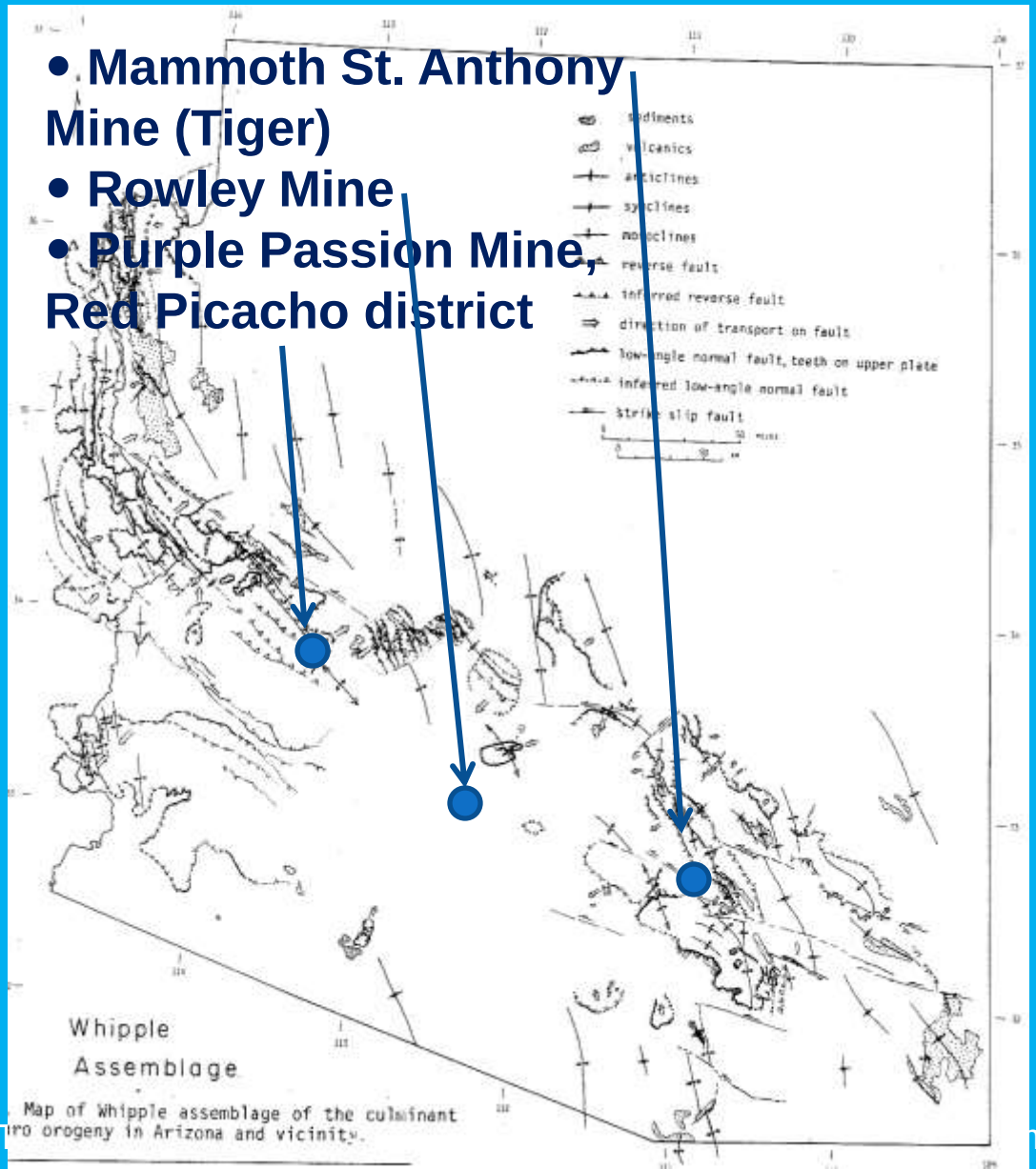
AZ Mining & Mineral Museum, MM-M120, 9 cm, donors Les & Paula Presmyk

Old Yuma Mine, Tucson Mts.

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

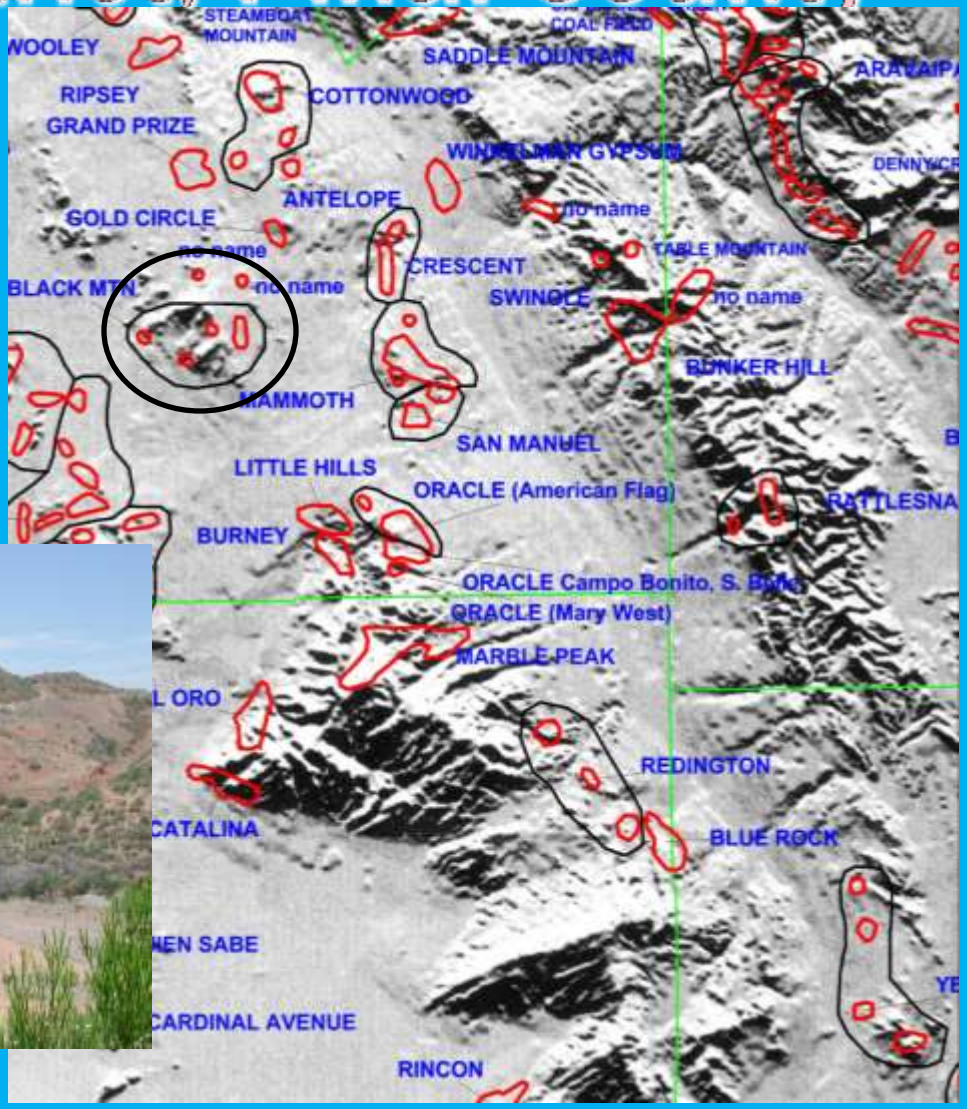
Quartz Alkalic - Mid-Tertiary

- 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, Mammoth district, Pinal County

- Quartz alkalic –
- Pb-Zn-Ag zones
- mid-Tertiary



Collins Cut, Tiger, AZ

Mohawk shaft, Tiger, Arizona

Mammoth-St. Anthony Mine (Tiger)

- Quartz Alkalic - mid-Tertiary

Flagg Mineral Foundation

Mammoth-St. Anthony Mine (Tiger)

- 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

- 6,314,822 pounds MoO_3 produced 1881-1947.

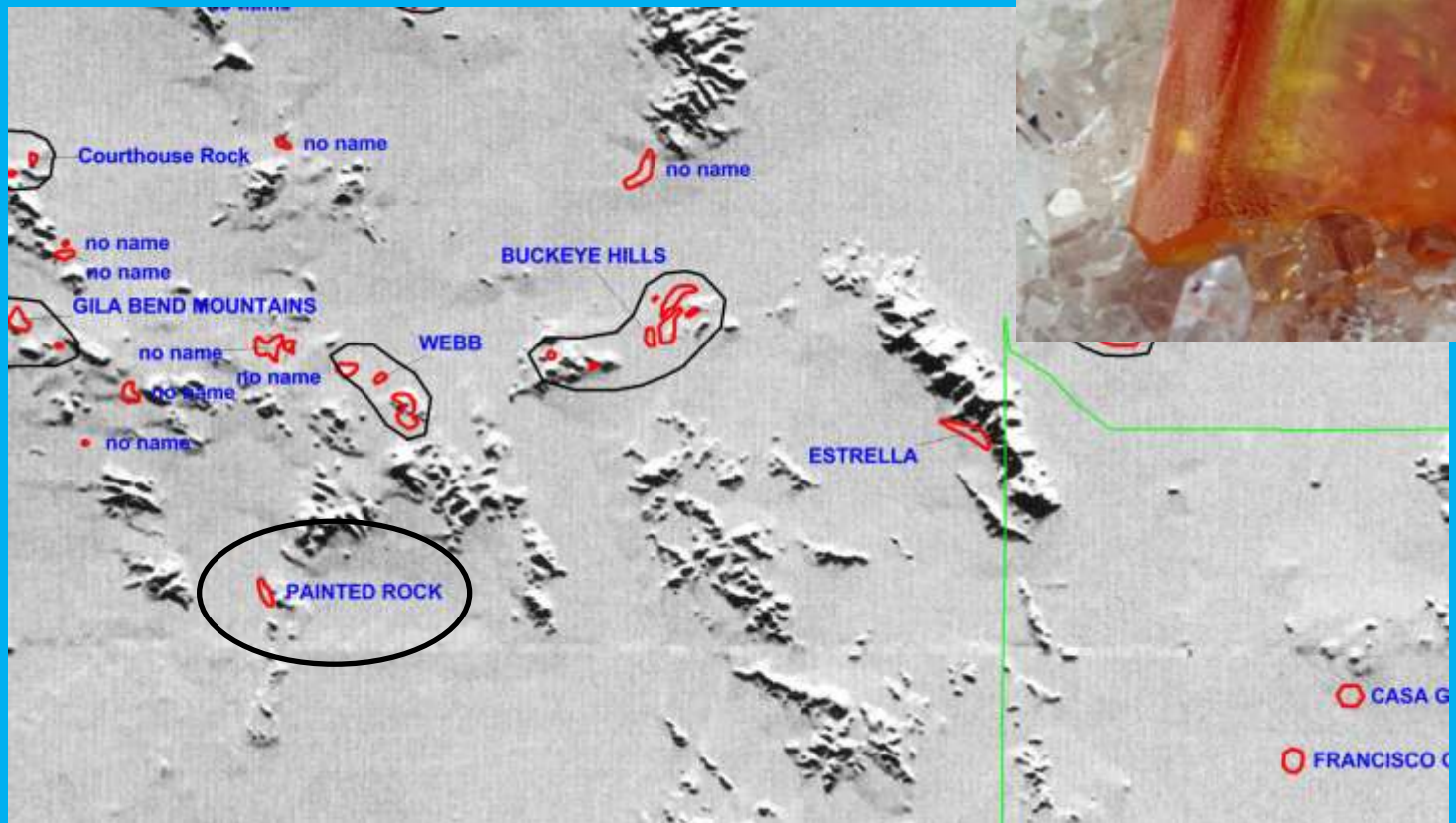
Wulfenite & cerussite, Flagg Mineral Foundation

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, {hoto Matteo Chinellato, www.mindat.org

Rowley Mine

- 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

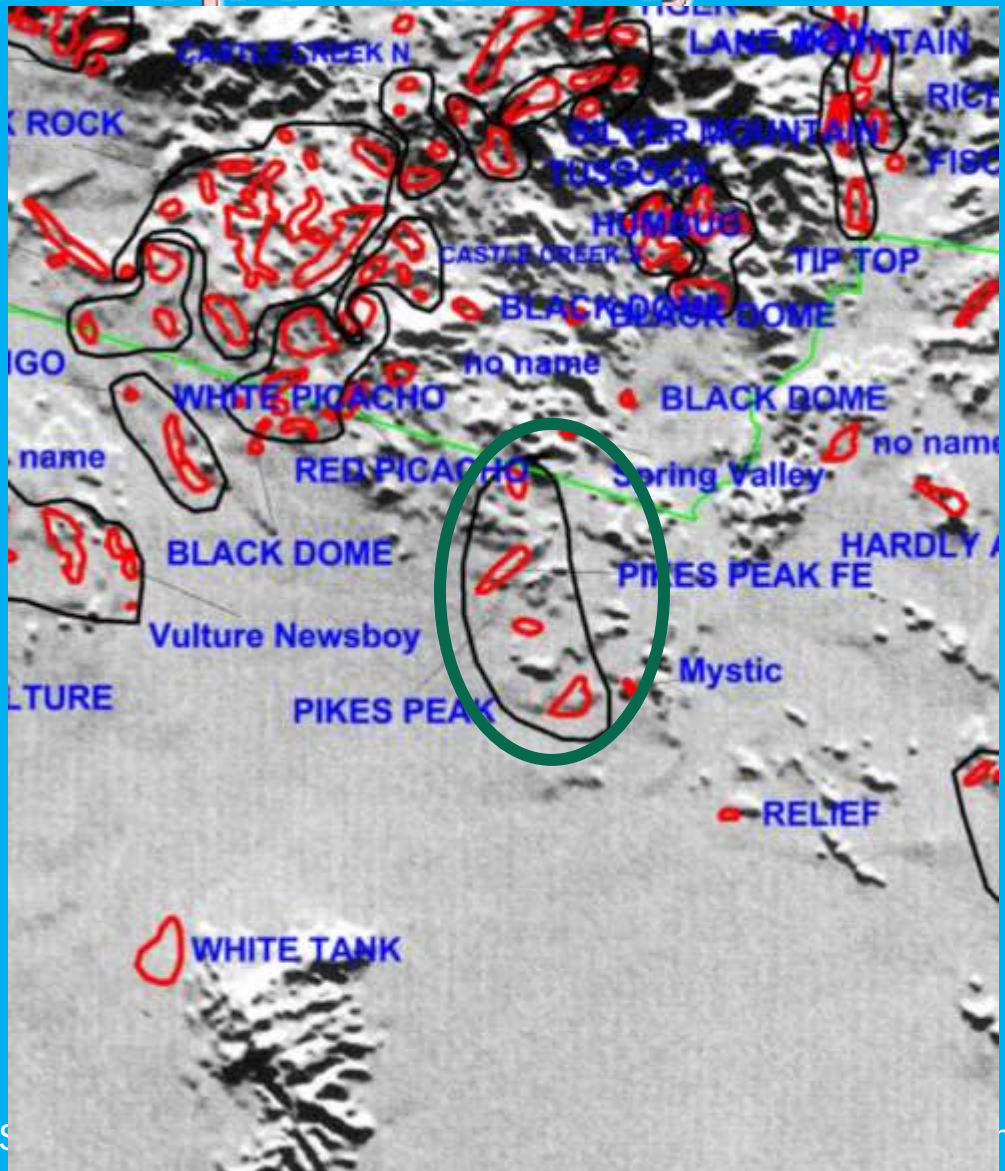
- Shipped 130 tons of wulfenite concentrate to California (18.26 % MoO_3),

Wulfenite on barite, AZ Mining & Mineral Museum, MM-9981, 4.5 cm, donors Floyd & Alice Getsinger

Purple Passion Mine, Red Picacho district, Maricopa County

- Quartz alkalic? In Pb-Zn-Ag zones - on fluorite near galena
- mid-Tertiary?

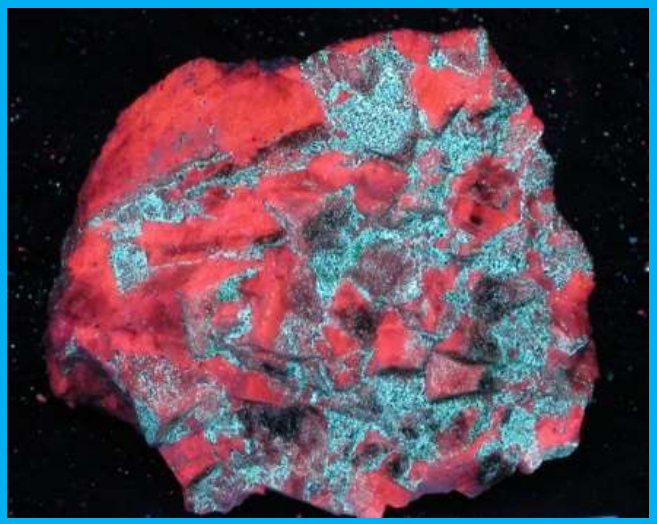
Wulfenite spicules, 2 mm long, Purple Passion mine, Red Picacho district; Steve Stuart, 2004, www.mindat.org



Purple Passion Mine, Maricopa Co.

mid-Tertiary? Quartz Alkalic?

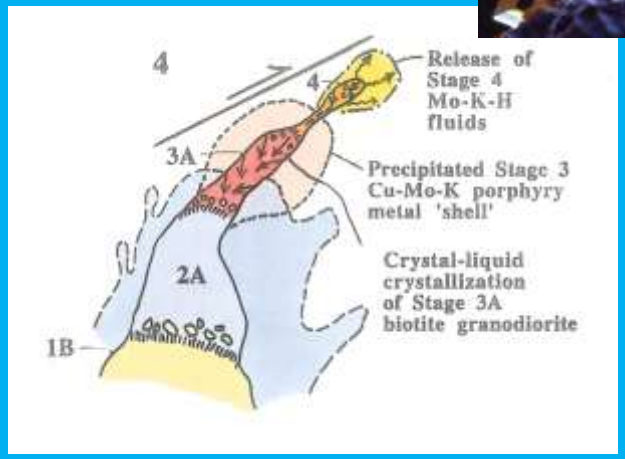
- **Red Picacho district (Purple Passion mine)**
- Blades and unusual needle crystals. Some needles of wulfenite grow on the surfaces of wulfenite blades.
- 3 and 4-colored fluorescent material
- Wulfenite occurs on quartz (clear, smoky, milky and amethyst) and on fluorite, calcite or galena.
- Other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

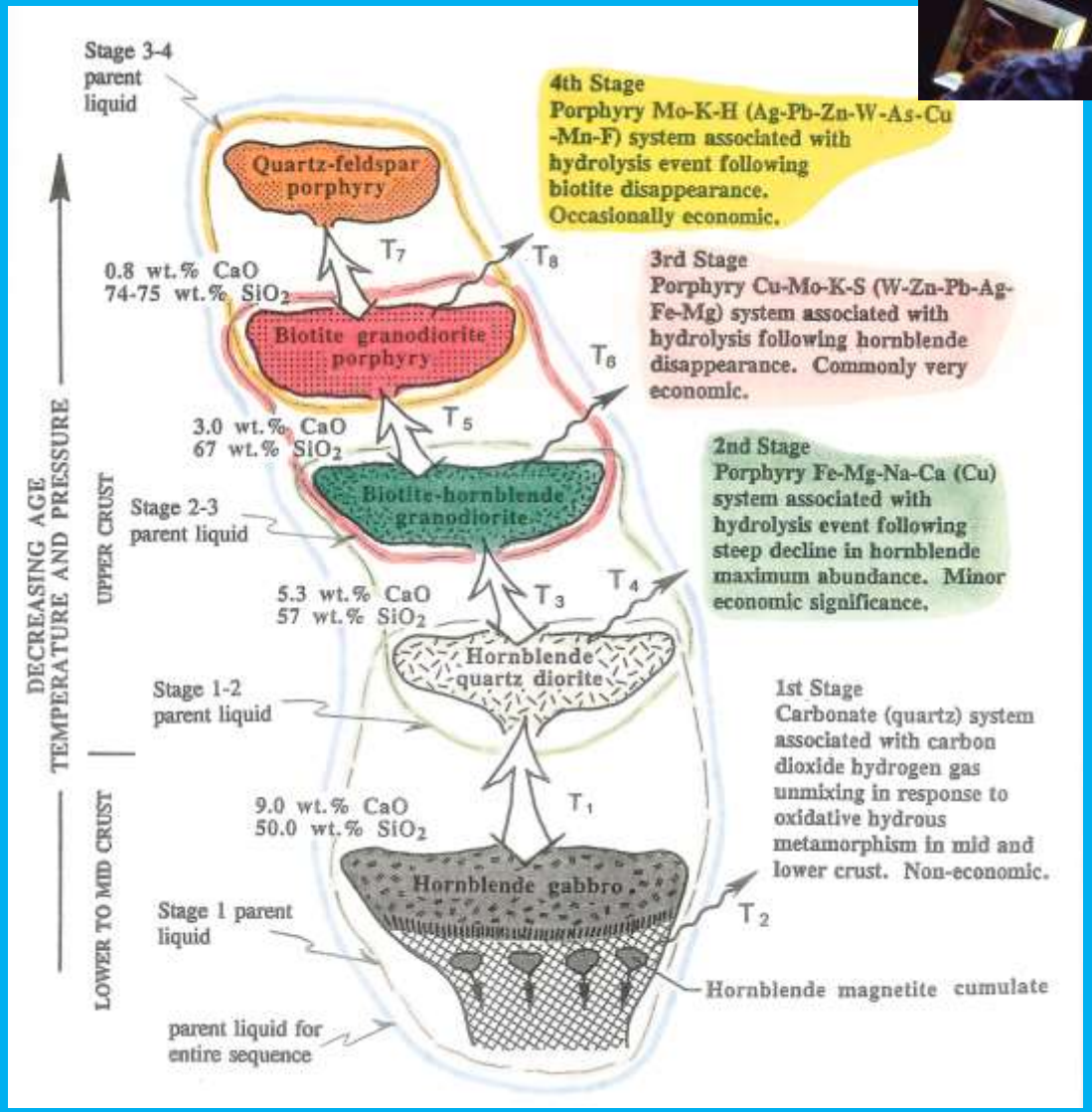


Photos courtesy of William Gardner

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





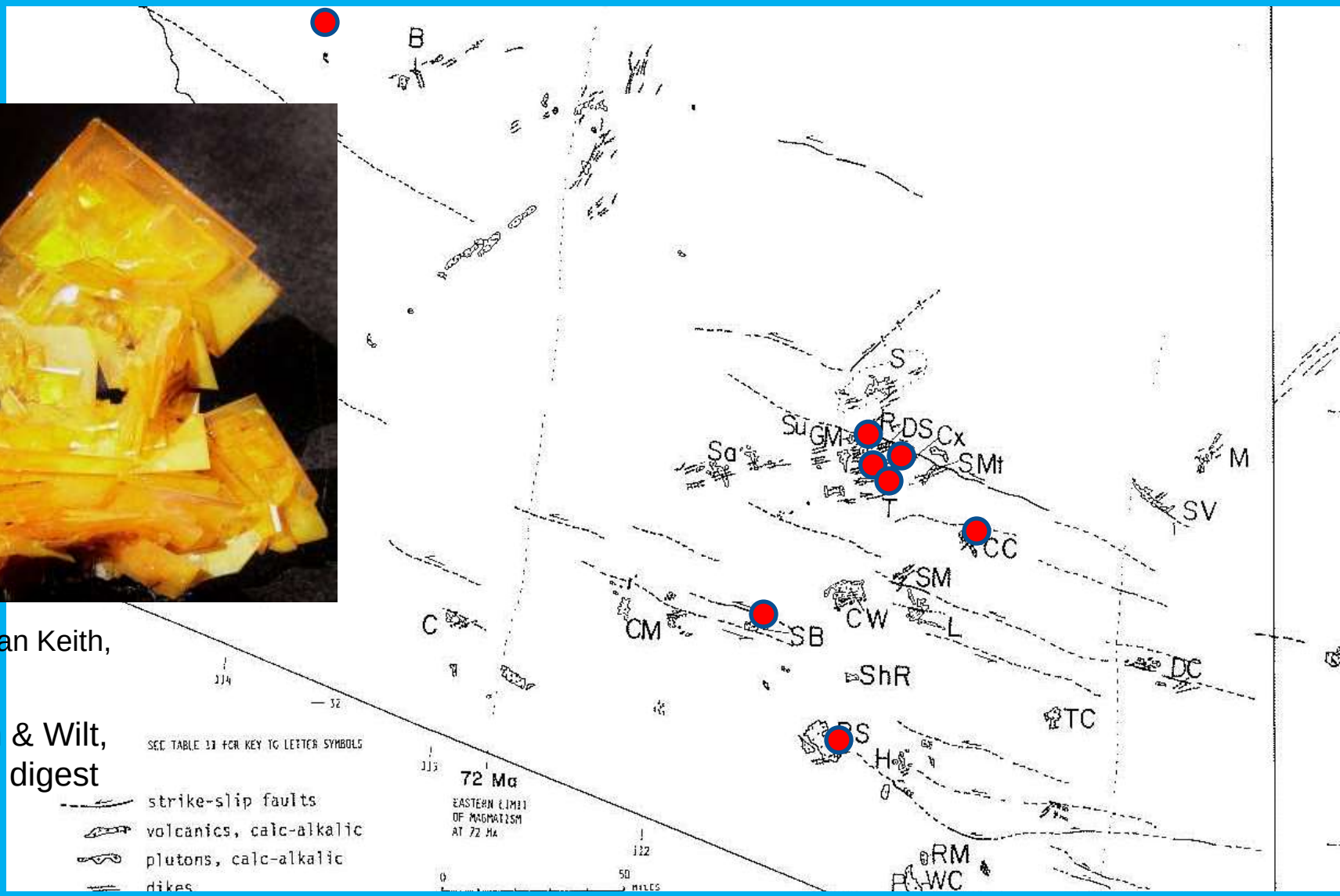
From Keith, 2003, MagmaChem model book

Stage 4 Oxidized Pb-Zn zones of Porphyry Copper deposits

Chilito Mine, Christmas Mine, 79 Mine, Banner district

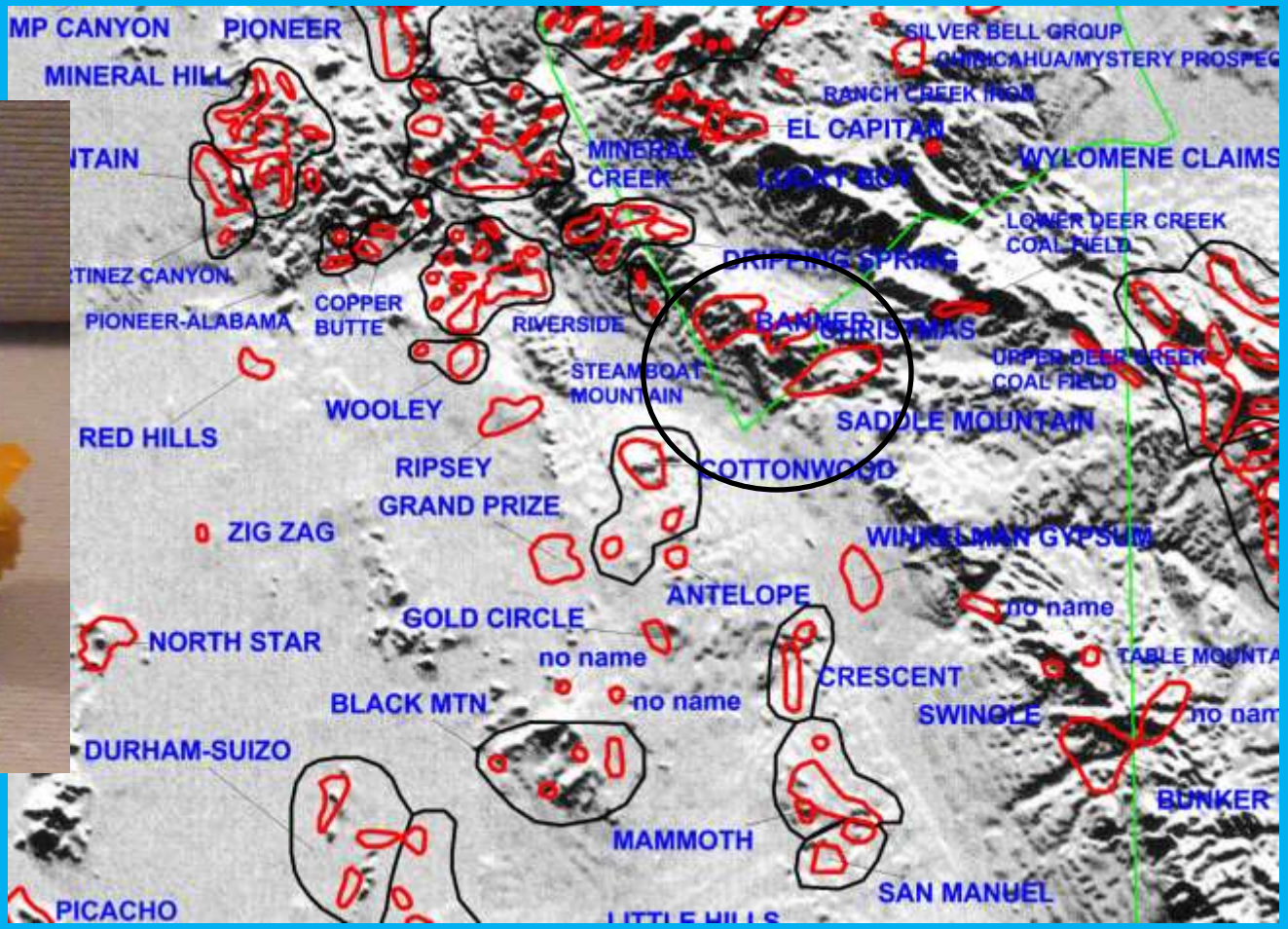
Owner Stan Keith, 1-2 in.

From Keith & Wilt, 1986, AGS digest



Banner district - Calc-alkalic – "outer"/ later (Stage 4) Pb-Zn zones

Owner Stan Keith,
1-2 in.



79 Mine (Banner district)

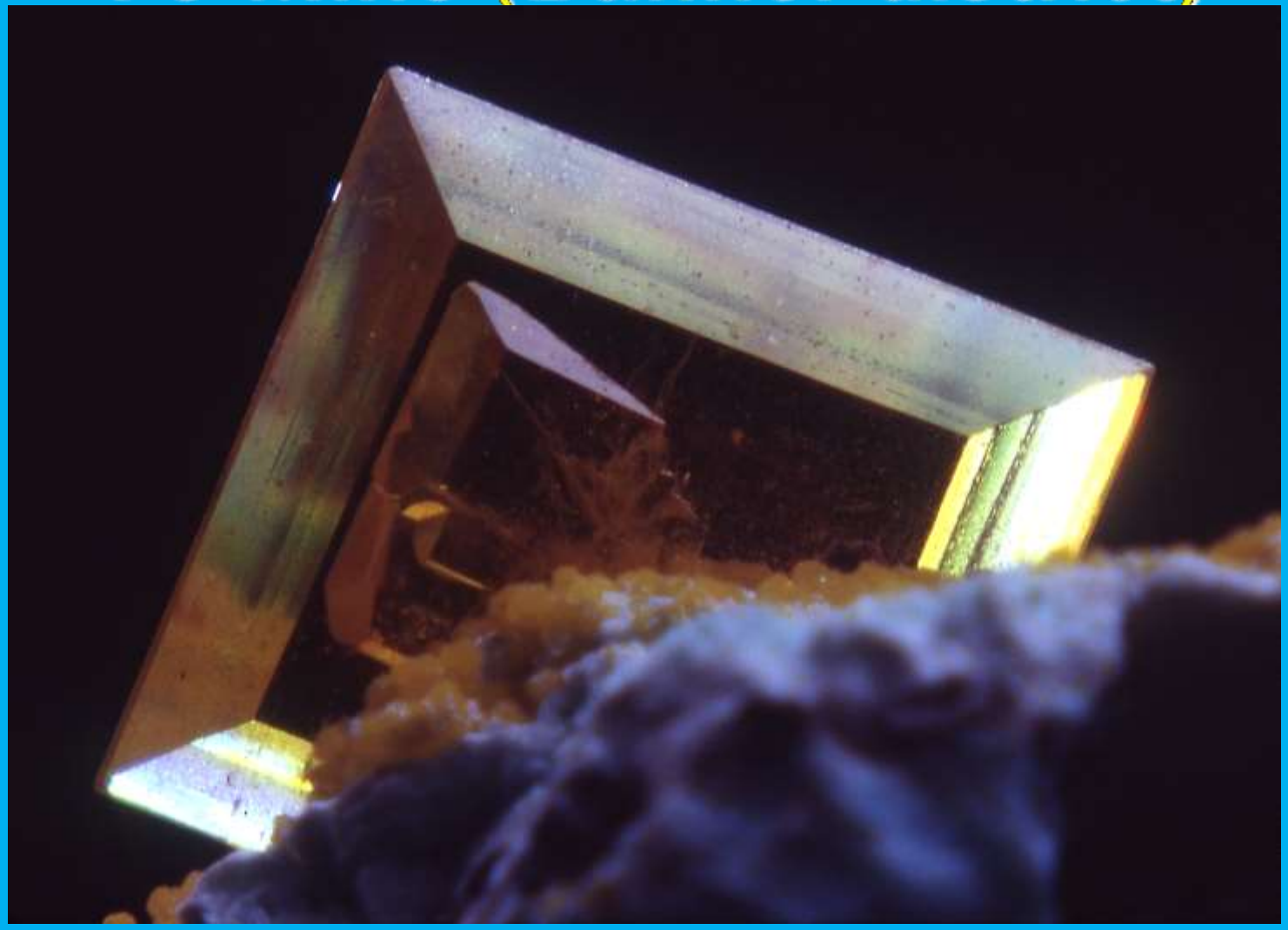
- Galena, sphalerite, pyrite, cerussite, with a large variety of secondary minerals
- In permeable zones such as breccias, fractures, and shear zones
- Especially as bedded and vein replacements, in favorable rock types, such as contact metamophosed Pennsylvanian Naco limestone and silicified rhyolite porphyry dikes of probable Tertiary 62 Ma) age

AZ Mining & Mineral Museum, MM-S698, 10.8 cm

79 Mine (Banner district)

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.

79 Mine (Banner district)



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

Finch Mine (Banner district)

Wulfenite covered by quartz, Finch Mine, Banner district, Dripping Spring Mts., Gila Co.

6 mm crystals, Paul Jaeger photo, specimen, www.mindat.org

Queen Creek Mine (S of Superior)

- 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.

Magma Mine

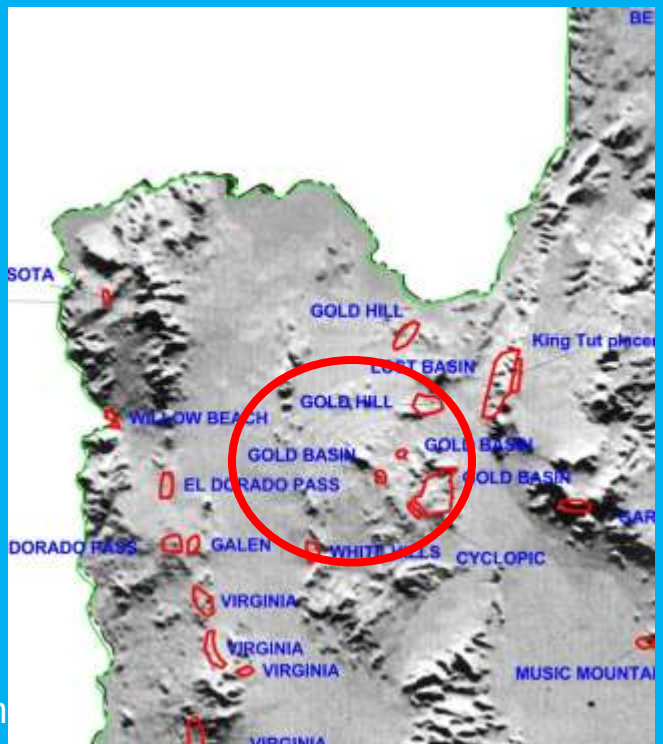
Wulfenite and Dioptase, Magma Mine, Superior/ Pioneer district, Pinal Co.
FOV ~6 mm, specimen ex Roland Fogg Collection, photo by & specimen of Trevor Boyd, www.mindat.org

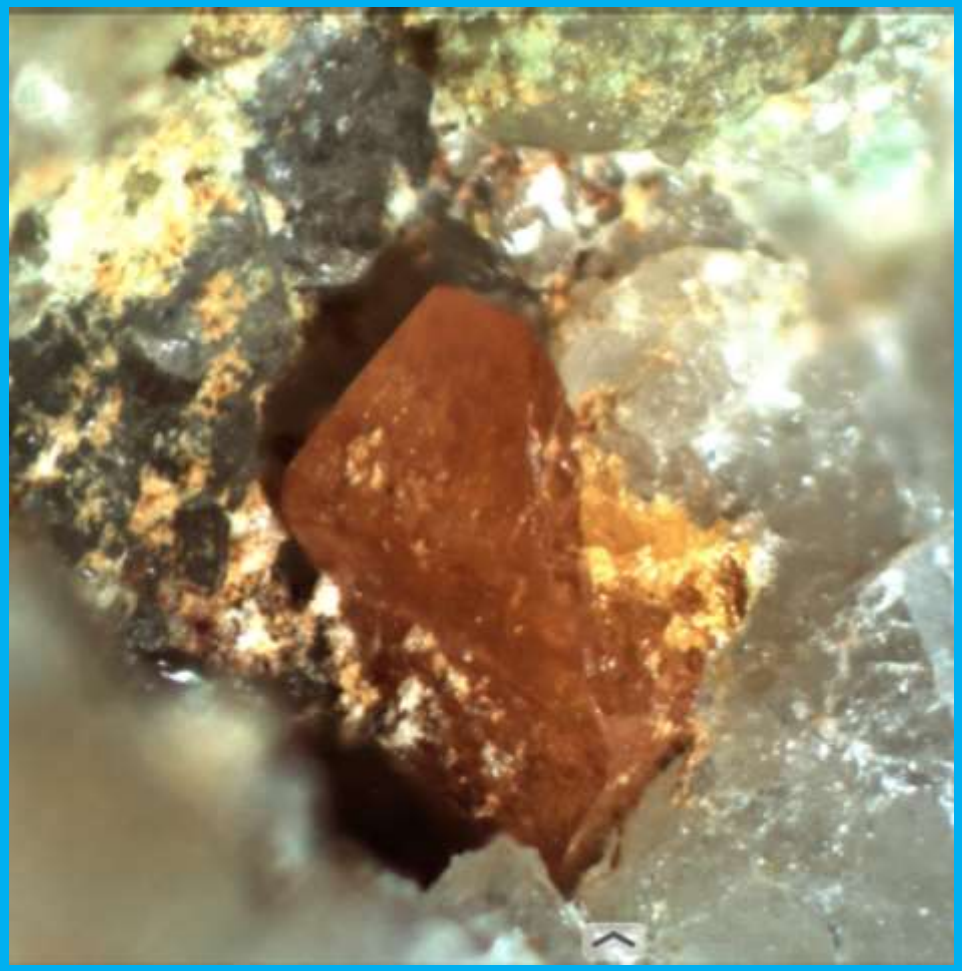
Silver Bell Mine, Pima County

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

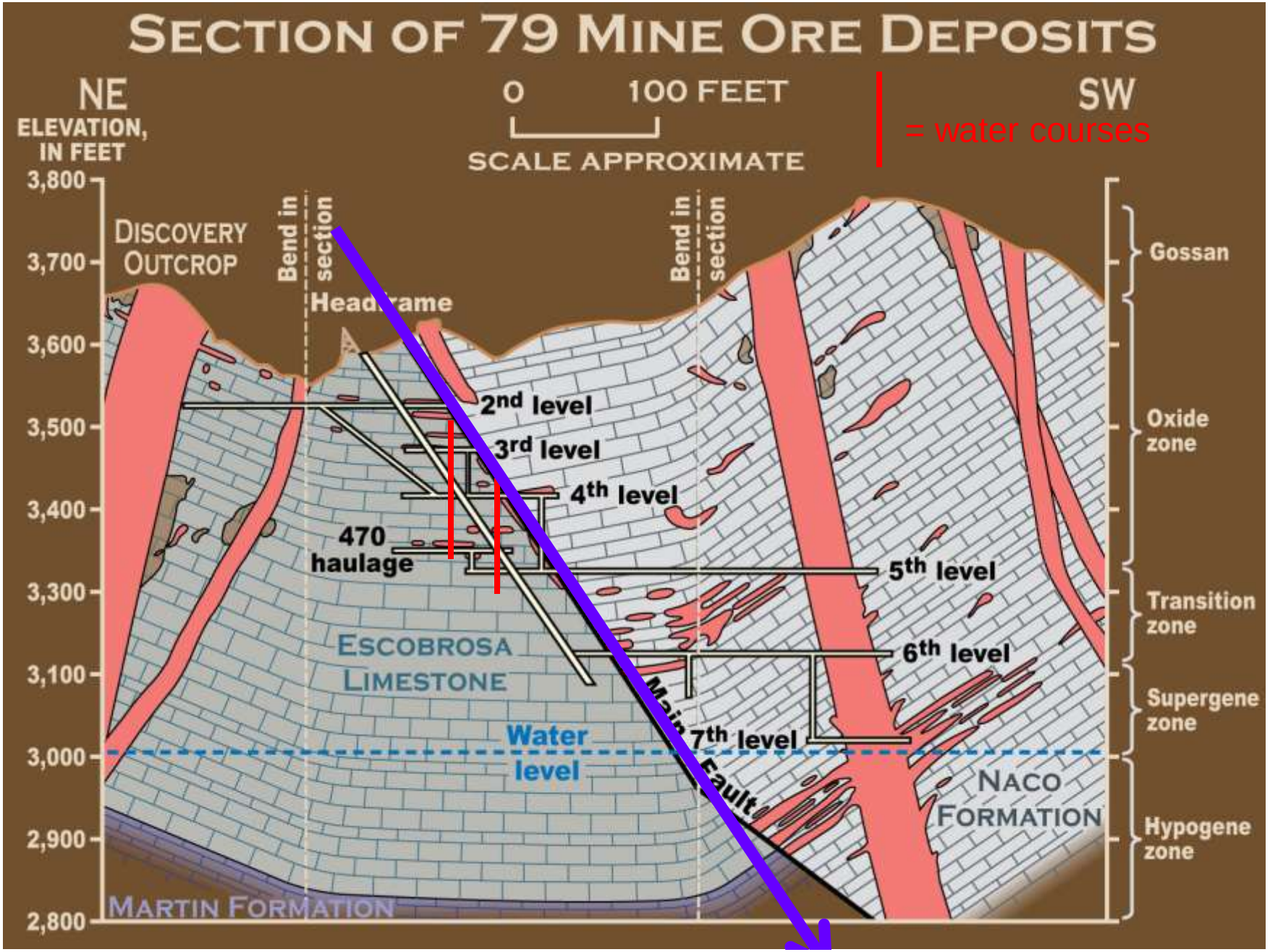
Wulfenite Formation

- 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

79 Mine, Banner district

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

Callahan, modified from Keith, 1972, Mineralogy and paragenesis of the 79 Mine lead-zinc-copper deposit: Mineralogical Record, v. 3, no. 4, p. 247-264



Water Courses

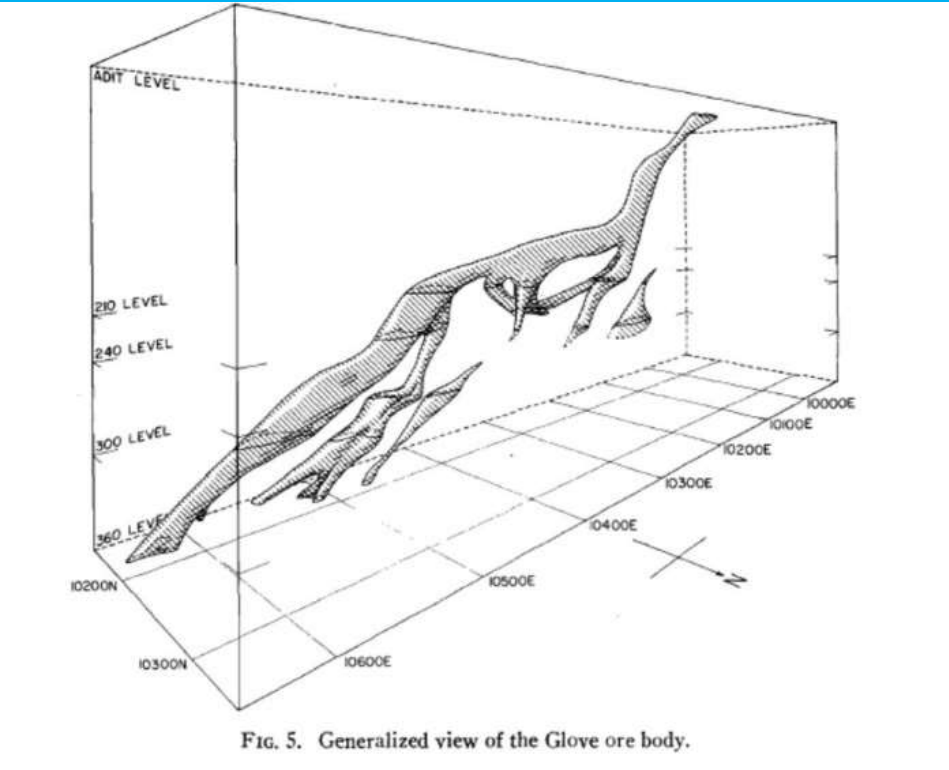


FIG. 5. Generalized view of the Glove ore body.

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?)

Purple Passion

Red Cloud

Glove

Hilltop

Defiance

Glove

Mineral Associations

- anglesite $PbSO_4$
- cerussite $PbCO_3$
- mimetite $Pb_5(AsO_4)_3Cl$
- vanadinite $Pb_5(VO_4)_3Cl$
- pyromorphite $Pb_5(PO_4)_3Cl$
- descloizite $PbZnVO_4(OH)$
- limonite $FeO{\cdot}(OH){\cdot}nH_2O$
- fornacite $Pb_2Cu(AsO_4)(CrO_4)(OH)$
- hemimorphite $Zn_4Si_2O_7(OH)_2{\cdot}H_2O$
- smithsonite $ZnCO_3$
- aurichalcite $(Zn,Cu)_5(CO_3)_2(OH)_6$
- willemite Zn_2SiO_4
- dioptase $Cu_6(Si_6O_{18}){\cdot}6\ H_2O$
- rosasite $(Cu,Zn)_2(CO_3)(OH)_2$
- chrysocolla $(Cu,Al)_2H_2Si_2O_5(OH)_4{\cdot}nH_2O$
- fluorite CaF_2

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

- calcite $CaCO_3$
- quartz SiO_2

never on molybdenite MoS_2

Mineralogical Associations

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

Vanadinite
$Pb_5(VO_4)_3Cl$

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

Red Cloud Mine

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

Vanadinite

$Pb_5(VO_4)_3Cl$

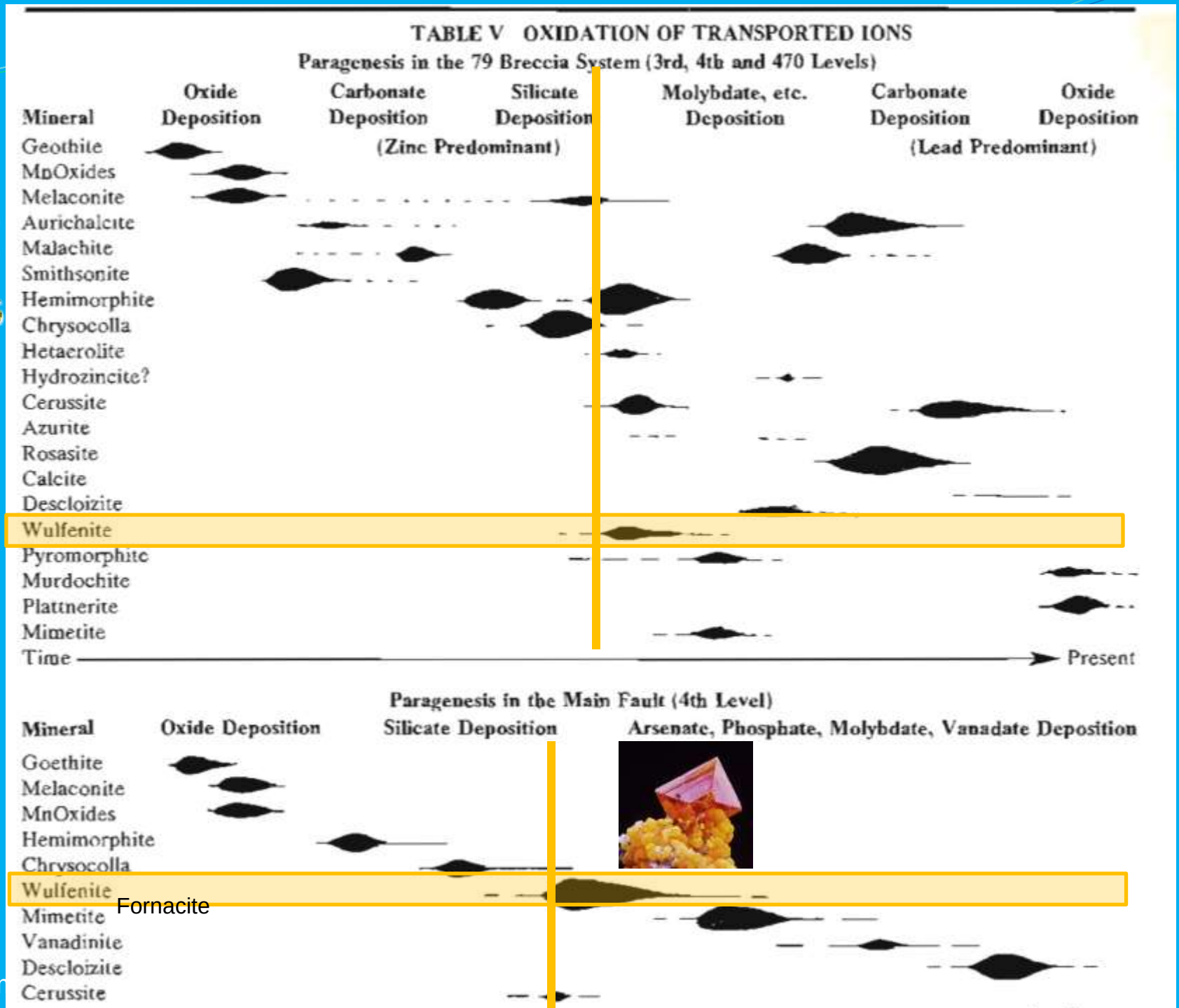
- barrel shaped
- Soft, H=2.75-3
- hexagonal prisms
- Heavy, SG=6.8-7.1
- No cleavage

Edson

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

Mineral Paragenesis – 79 Mine



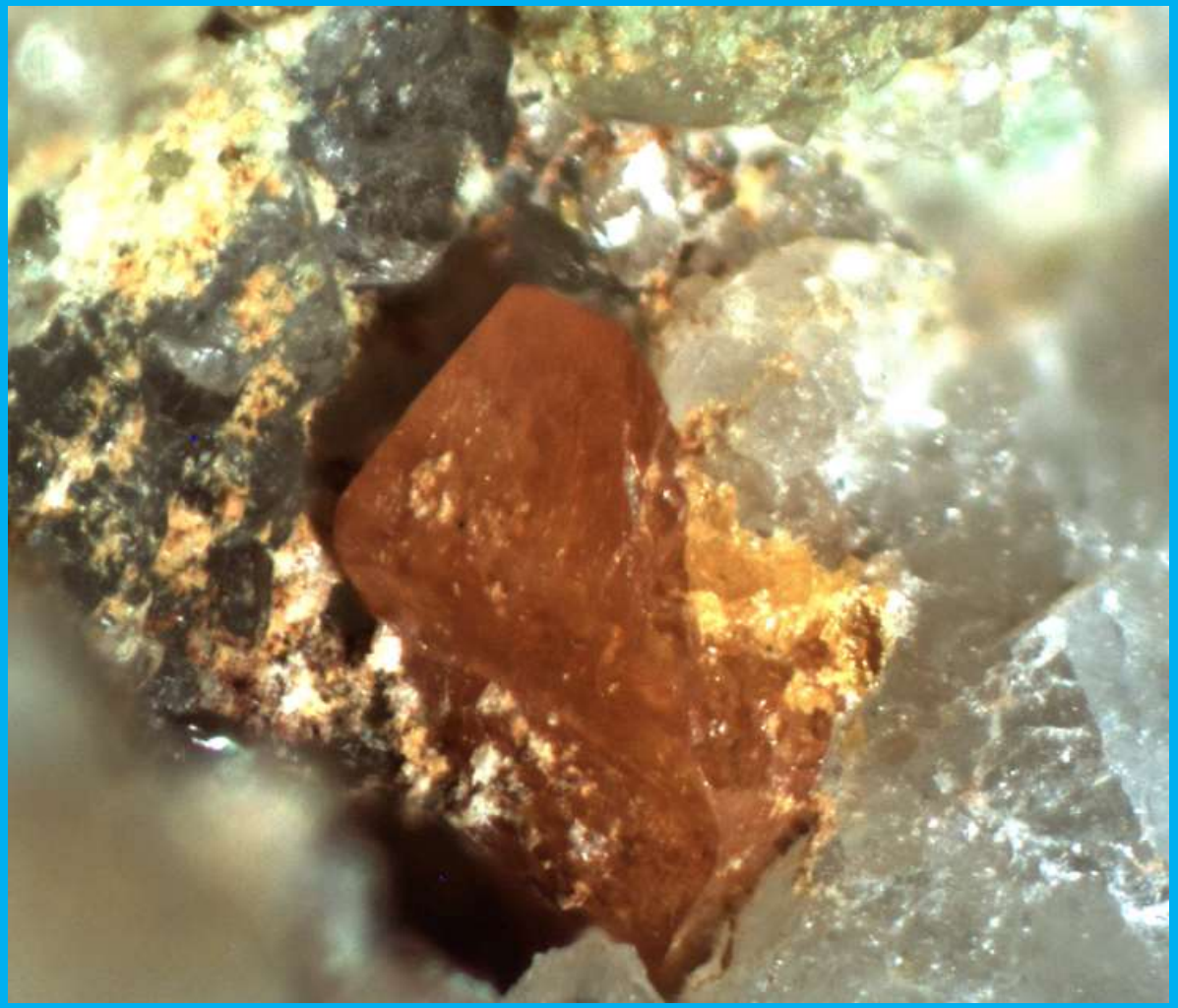
Fornacite

Jan C. Rasm

Paragenesis: Galena PbS, then Anglesite $PbSO_4$

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

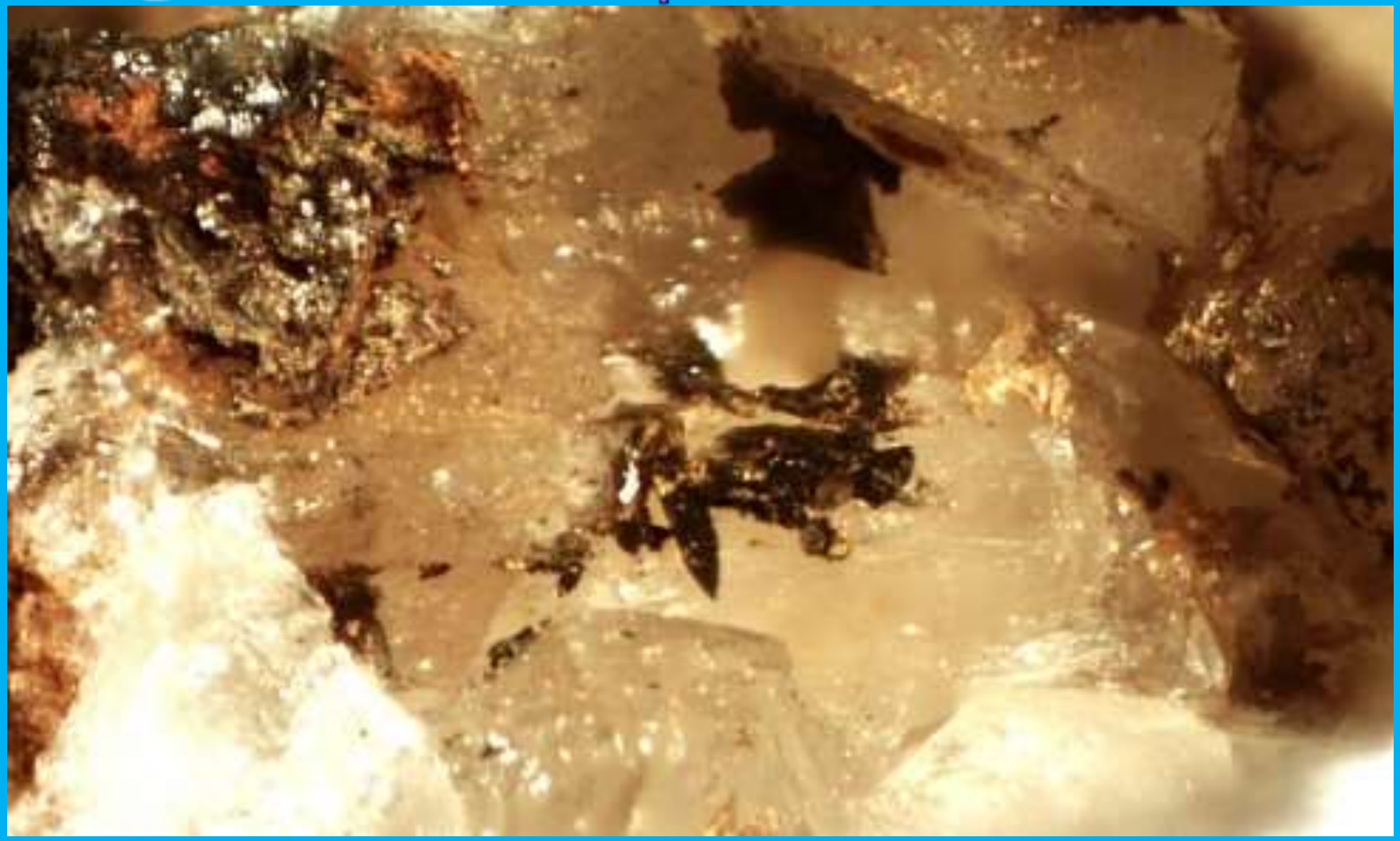
Paragenesis: Galena, then Anglesite



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 $PbSO_4$ 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 $PbCO_3$ before Wulfenite

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

Mimetite $Pb_5(AsO_4)_3Cl$ 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

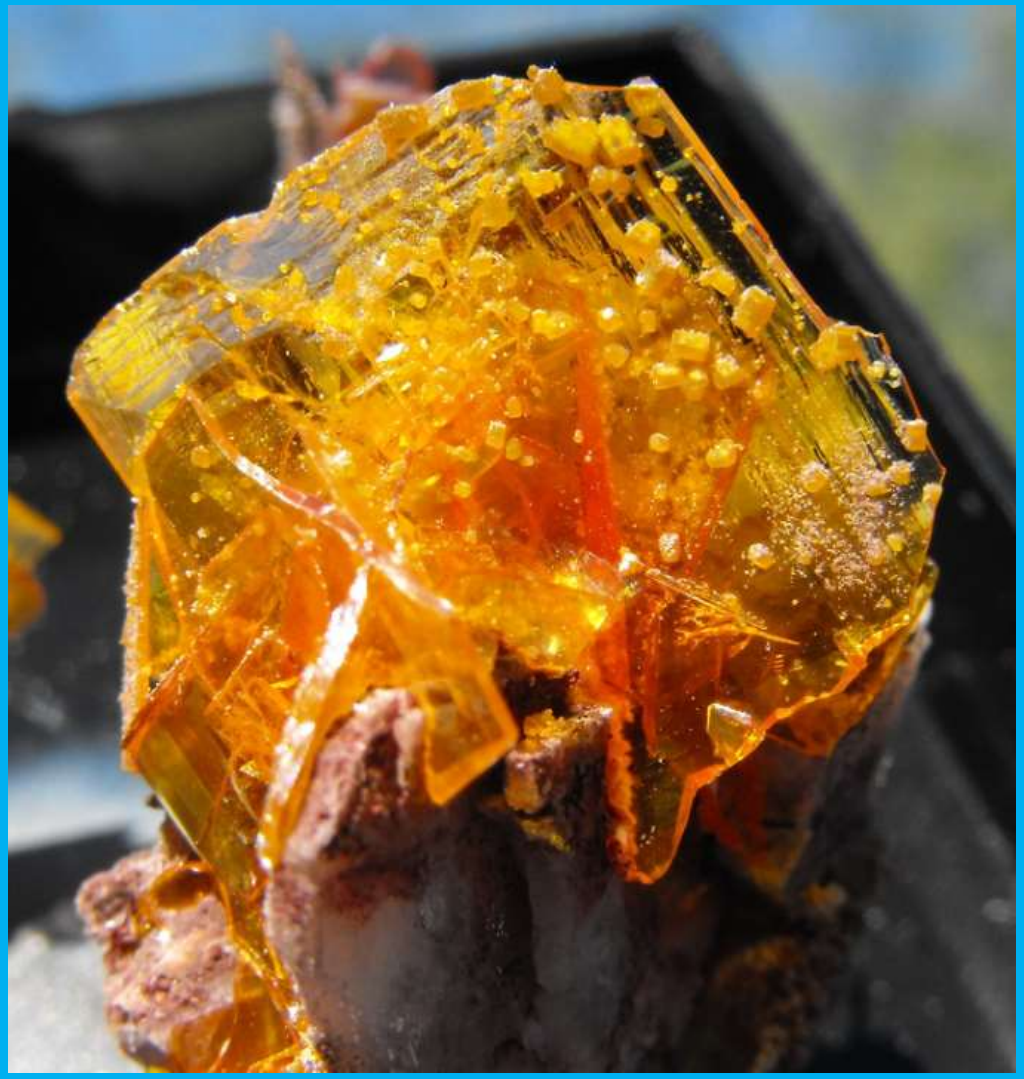
Mimetite later than Wulfenite

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

Hemimorphite $Zn_4Si_2O_7(OH)_2 \cdot H_2O$ 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 $Pb_5(VO_4)_3Cl$ later than Wulfenite



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

Pyromorphite $Pb_5(PO_4)_3Cl$ later than Wulfenite

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

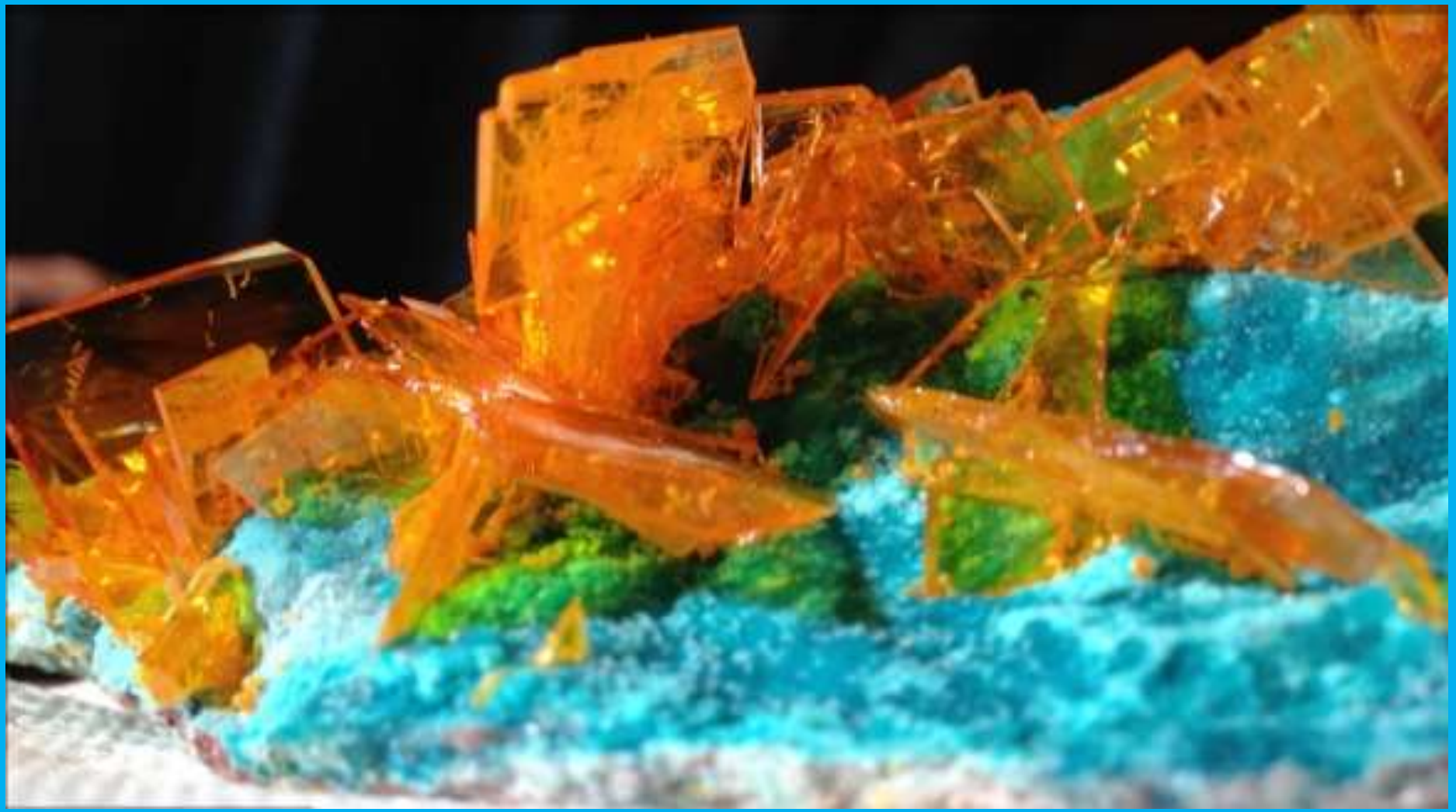
Dioptase $Cu_6(Si_6O_{18})\cdot 6\,H_2O$ later than Wulfenite

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

Quartz 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 $(Cu,Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O$ 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 Zn_2SiO_4 later than Wulfenite

Willemite (Zn_2SiO_4) on Wulfenite , Mammoth-St. Anthony mine, Tiger, Pinal Co.,7.1 cm, Ian Whitlock specimen, photo, www.mindat.org

Aurichalcite $(Zn,Cu)_5(CO_3)_2(OH)_6$, Rosasite $(Cu,Zn)_2(CO_3)(OH)_2$ later than Wulfenite

Aurichalcite $(Zn,Cu)_5(CO_3)_2(OH)_2$) and Rosasite $(Cu,ZnCO_3(OH)_2$ 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 $(Cu,Zn)_2(CO_3)(OH)_2$ & Hemimorphite on Wulfenite

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

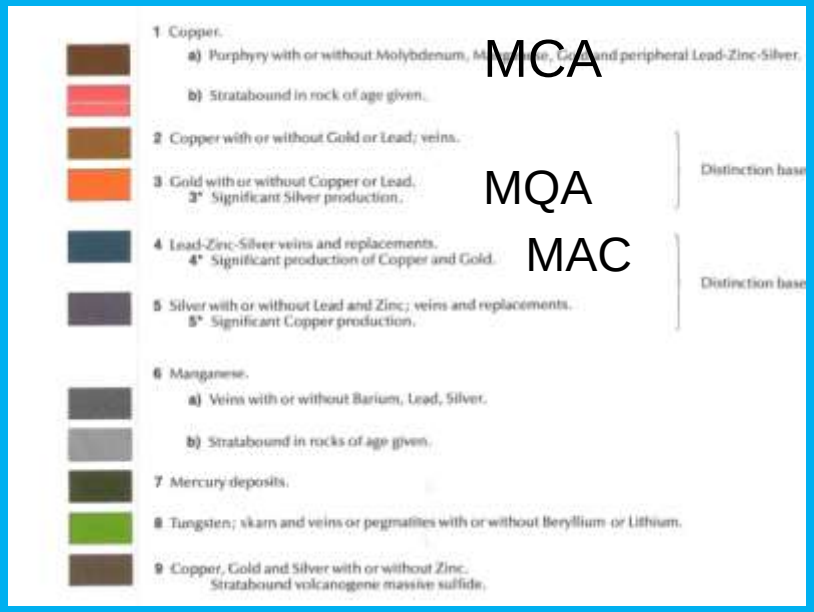
Calcite on Wulfenite, Defiance Mine, Gleeson district, Dragoon Mts., Cochise Co., 6 x4 cm., Cat Lemons sample, photo, www.mindat.org

Summary

- 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?

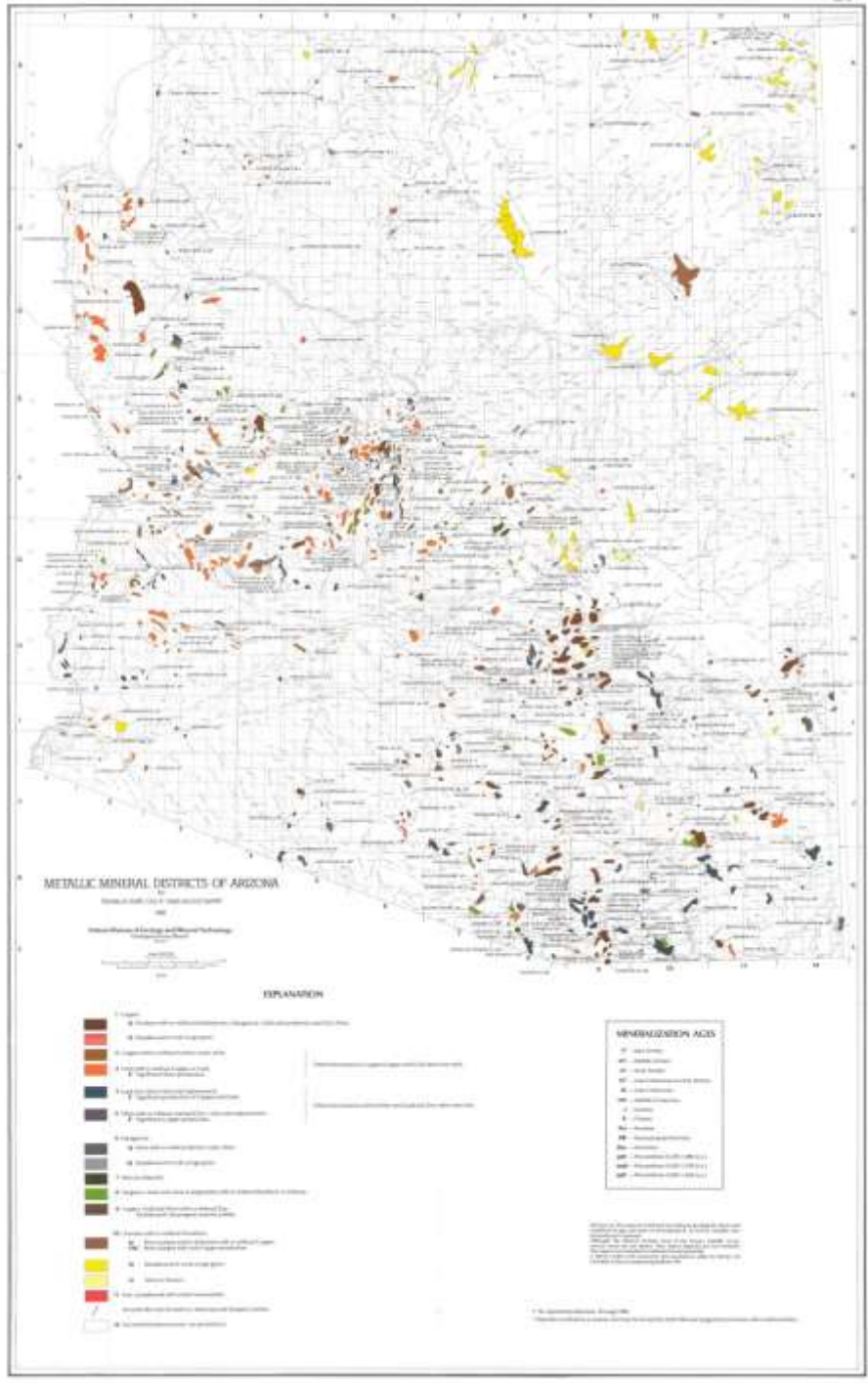
http://repository.azgs.az.gov/sites/default/files/dlio/files/nid1010/azbmbulletin194map18verycleannjn.pdf



MCA

MQA

MAC



Arizona Geological Survey Bull. 194, map 18