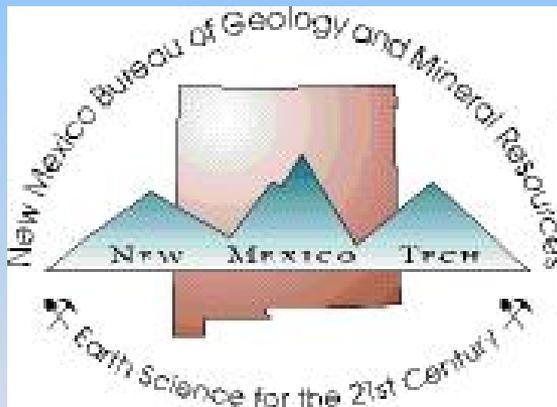


# THE STATUS OF CRITICAL MINERALS IN NEW MEXICO 2020



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# Definition of Critical Minerals

are

- (1) identified to be a nonfuel mineral or mineral material essential to the economic and national security of the United States,
- (2) from a supply chain that is vulnerable to disruption, and
- (3) that serves an essential function in the manufacturing of a product, the absence of which would have substantial consequences for the U.S. economy or national security

# Critical Minerals

- President Trump signed an executive order (Presidential Executive Order (EO) No. 13817) that requires the Departments of Interior and Defense to develop a list of critical minerals and develop plans for evaluation
- May 18, 2018 U.S. Department of Interior published the final list of critical minerals

# Elements in Computer Chips (National Research Council, 2007)

elements needed in 1980s  
 additional elements needed today

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac															
			Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
			Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	

# Critical Minerals

- 35 critical minerals were identified
- New Mexico has many of these critical minerals
  - Potash is currently being produced in Carlsbad
  - Porphyry copper deposits in Grant County contain rhenium, indium, germanium, others
  - Uranium deposits in the Grants district, also contain vanadium and perhaps REE
  - Exploration for other critical minerals include REE, tellurium, lithium, beryllium, cobalt
  - Other critical minerals were once produced from New Mexico (tin, vanadium, manganese, fluorspar, barite, graphite, REE, tellurium, beryllium)

# Understanding the resource potential of critical minerals in New Mexico is important

- inclusion in a national assessment of critical minerals
- identified before land exchanges, withdrawals or other land use decisions are made by government officials
- directly benefit the economy of New Mexico
- training of our future workforce since students at are hired to work on this project
  - Including minority students, thereby contributing to diversity in the geoscience workforce

# Critical Minerals in New Mexico

- Element currently producing in NM
- Element once produced from NM
- Element found in NM
- Element not found in NM

H																	C=graphite	F=fluorite	He
Li	Be											B	C	N	O	F	Ne		
Na	Mg											Al	Si	P	S	Cl	Ar		
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
Fr	Ra	Ac																	
Ba=barite			Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu			
			Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr			

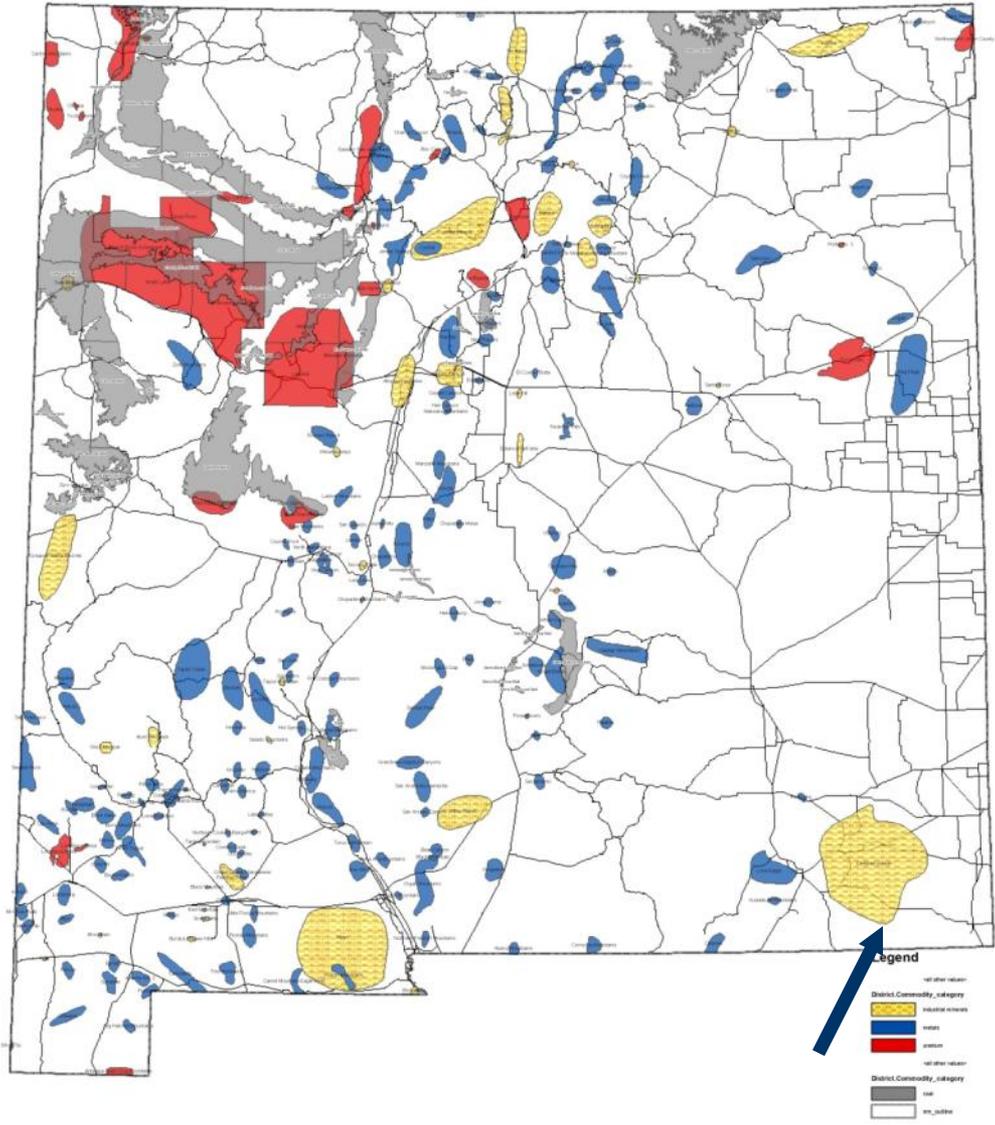
Note that any element or commodity can be considered critical in the future depending upon use and availability. Coal contains several of these critical elements.

# Potash

- Uses—fertilizers, chemical industry
- New Mexico is the leading state in the U.S. for potash production and reserves (Utah produces potash, resources found in Arizona)
- U.S. imports 90% of potash used, 85% from Canada



## NM Mining Districts



# POTASH PRODUCTION

1951-2017 >114 million tons  
worth >\$16 billion

## Reserves in Carlsbad District

Potash (>553 million tons)  
*Potash is used in fertilizers  
among other uses*  
*Intrepid closed one mine*

***Competition from  
Canadian deposits, low  
prices, over supply***

# Potash production 1951–2014



# Developments in potash

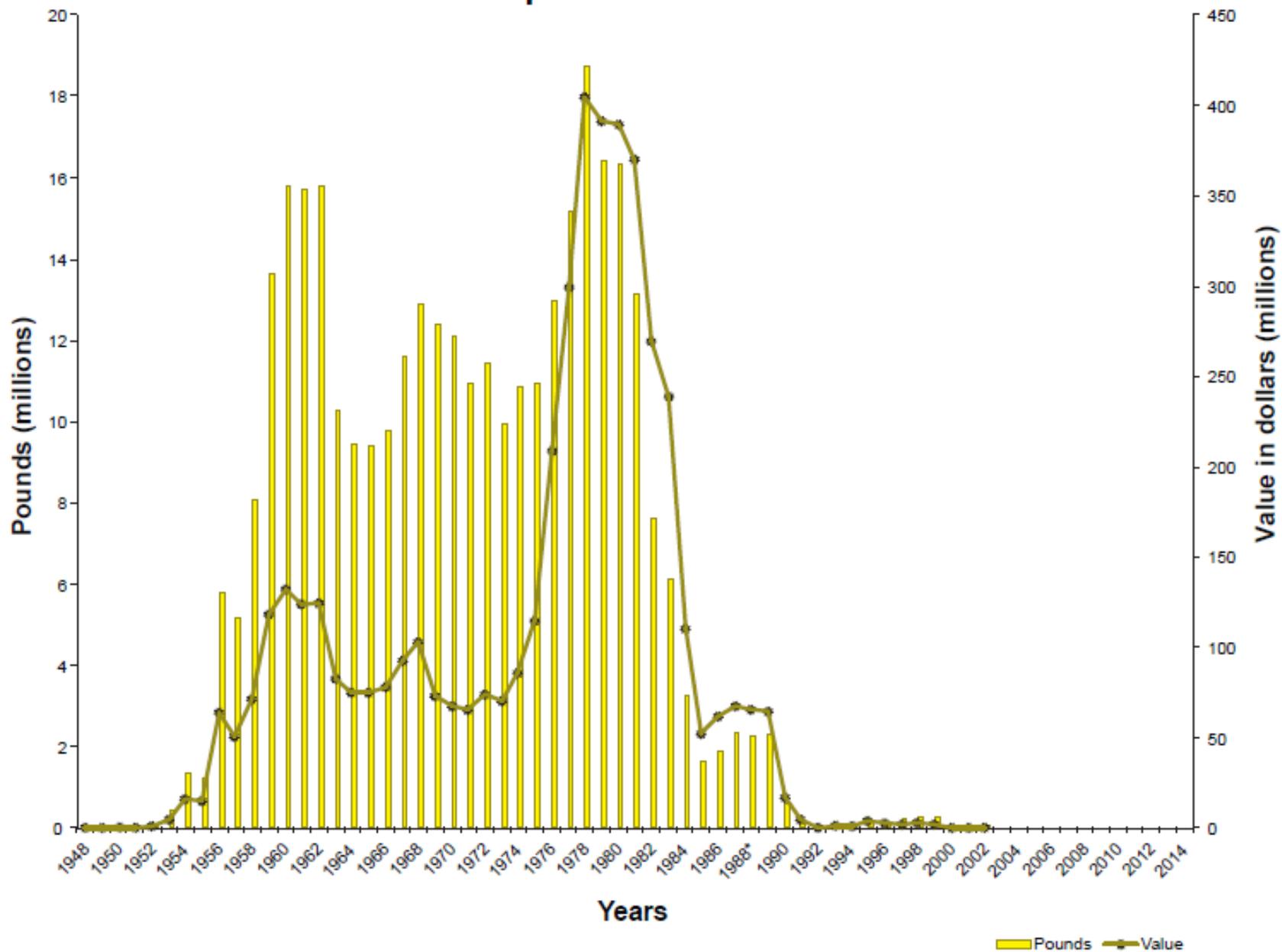
- Intercontinental Potash Corp. (IPC) plans to mine polyhalite at the Ochoa deposit SE of the district—ON HOLD
- Intrepid Mining NM LLC is using solution mining techniques at the HB Solar Solution mine (old potash workings)

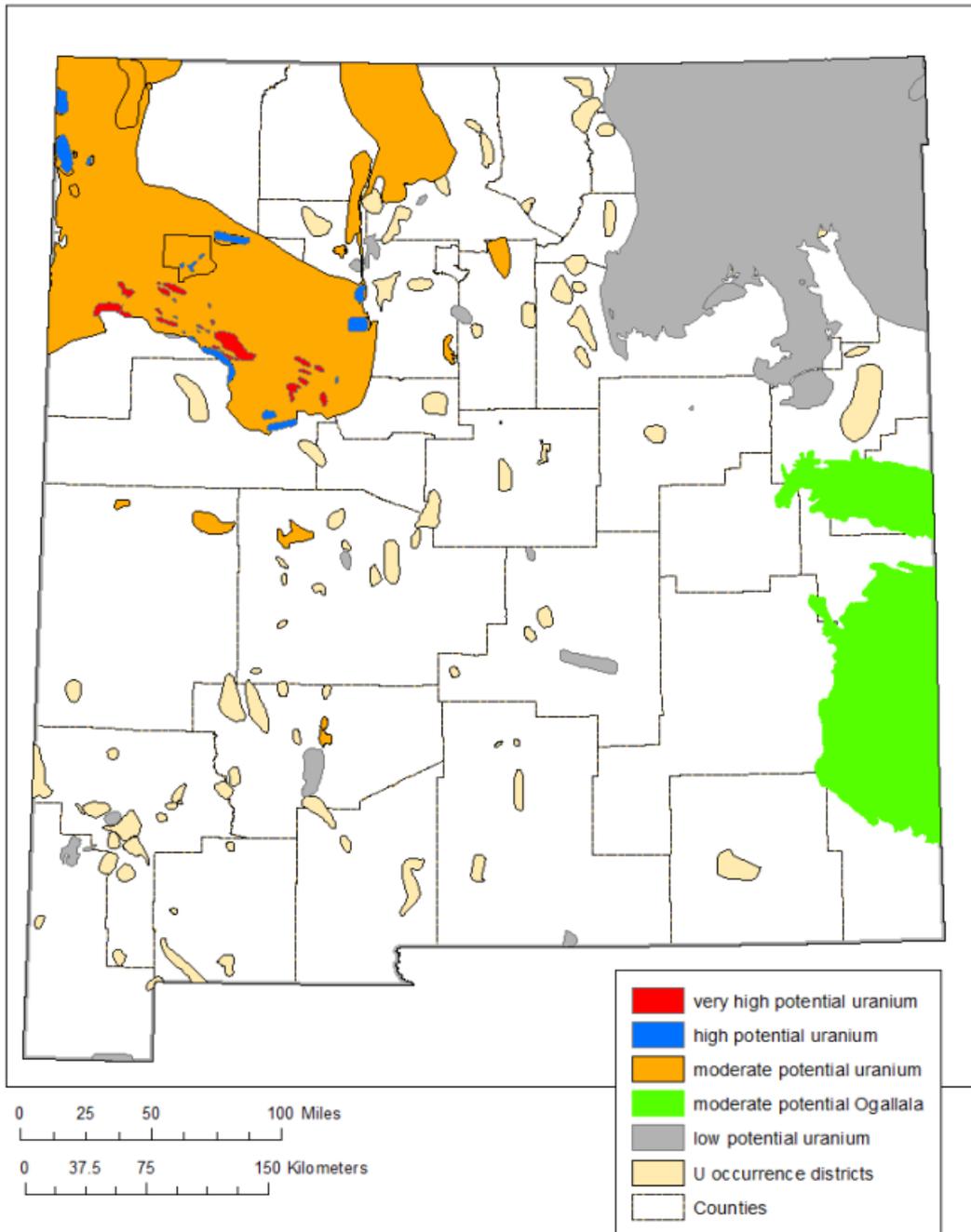
# Uranium



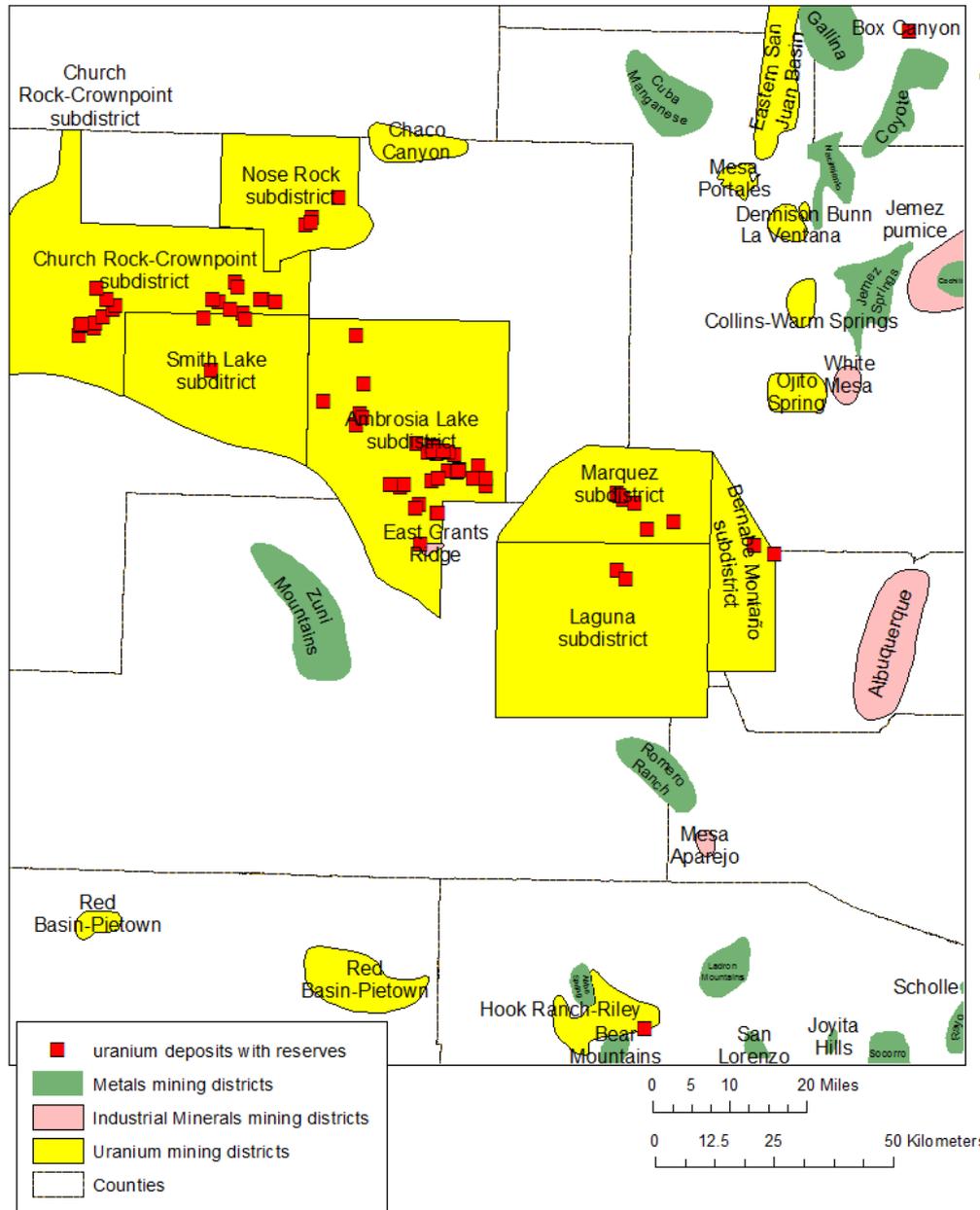
- Uses—defense, 99 nuclear energy power reactors (20% electricity in U.S.), fuel for space missions
- 2<sup>nd</sup> in uranium resources 15 million tons ore at 0.277%  $U_3O_8$  (84 million lbs  $U_3O_8$ ) at \$30/lb (DOE estimates in 2002)
- Numerous companies have acquired properties (Energy Fuels Inc., Laramide Resources, Rio Grande Resources among others)
  - Mt. Taylor is being reclaimed
  - Roca Honda is under permitting

# Uranium production 1948–2014





Uranium potential in New Mexico (most U-sandstone deposits also contain vanadium)



Deposits with uranium resources in New Mexico (McLemore and Chenoweth, 2017). Only major mines and deposits are included here.

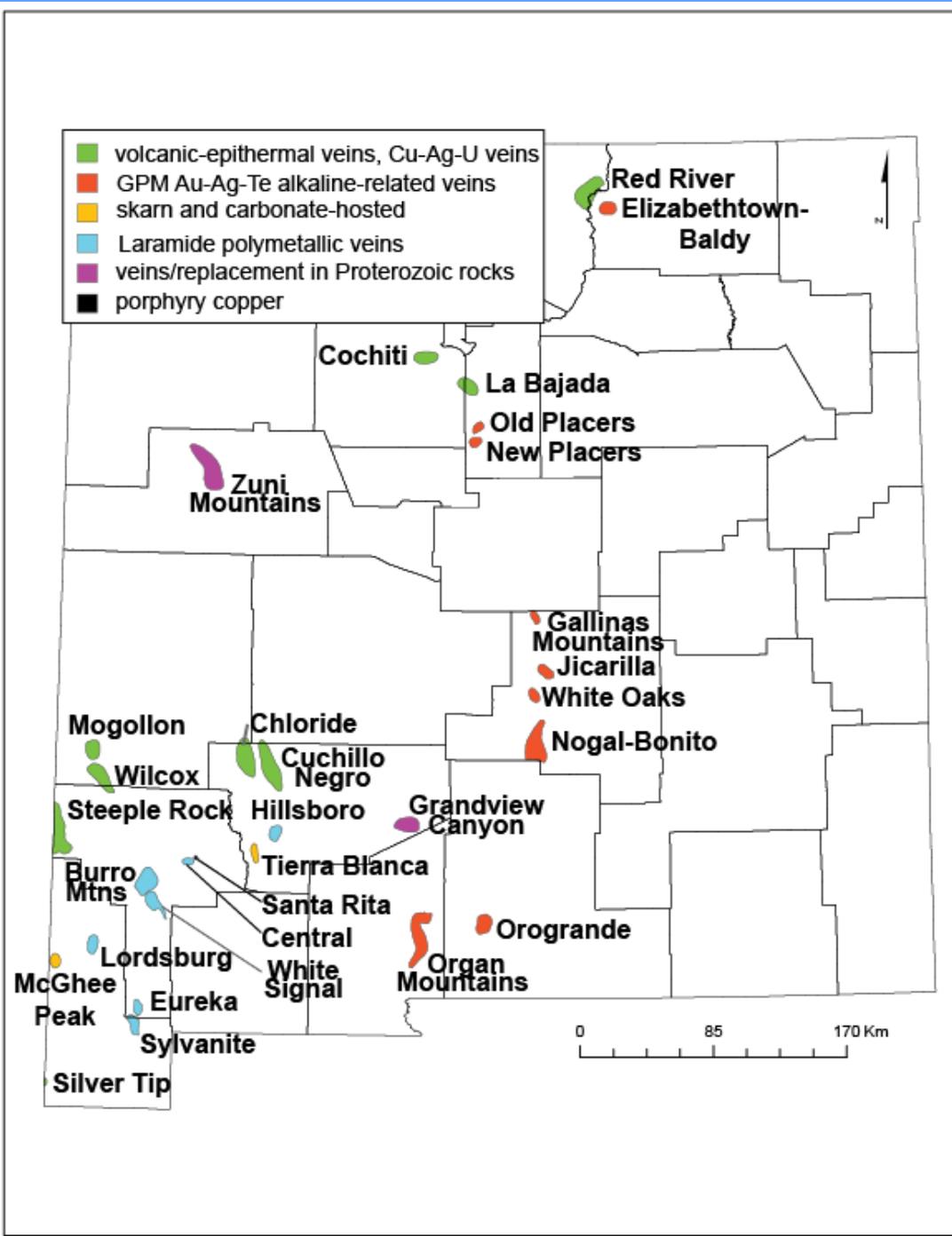
# Uses of Tellurium



- Alloying additive in steel to improve machining characteristics
- Processing of rubber
- As a component of catalysts for synthetic fiber production
- As pigments to produce various colors in glass and ceramics
- **Thermal imaging devices**
- Thermoelectric cooling devices, such as summertime beverage coolers
- Thermoelectronics
- **Solar panels/cells**

# Tellurium

- Production—byproduct of copper refining (refinery in Texas)
- Lone Pine, Catron County produced 5 tons of Te from Au-Te volcanic-epithermal veins



Mining districts in New Mexico with tellurium minerals or chemical assays >20 ppm Te

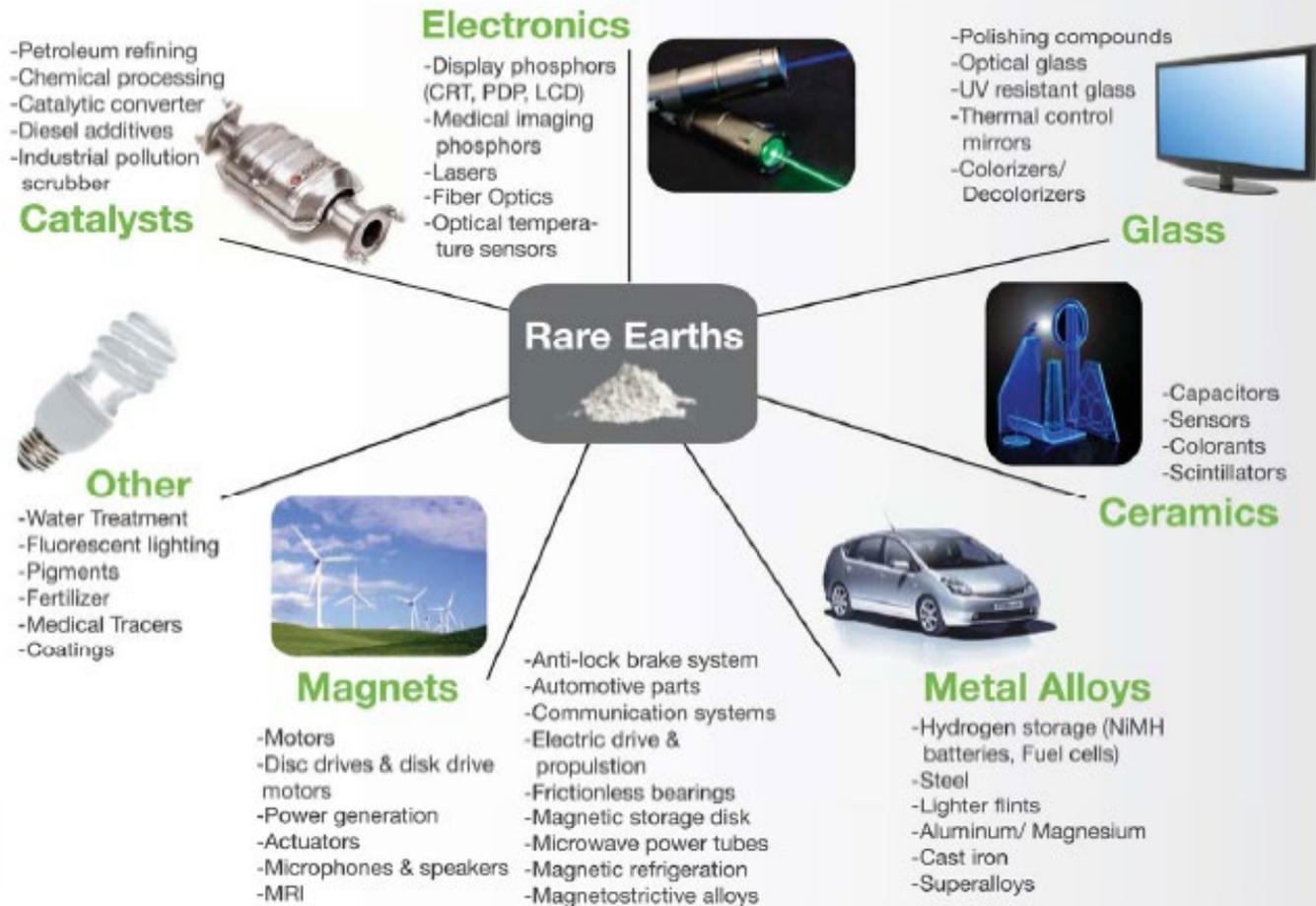
# Lone Pine, Wilcox district, Catron County— volcanic epithermal vein

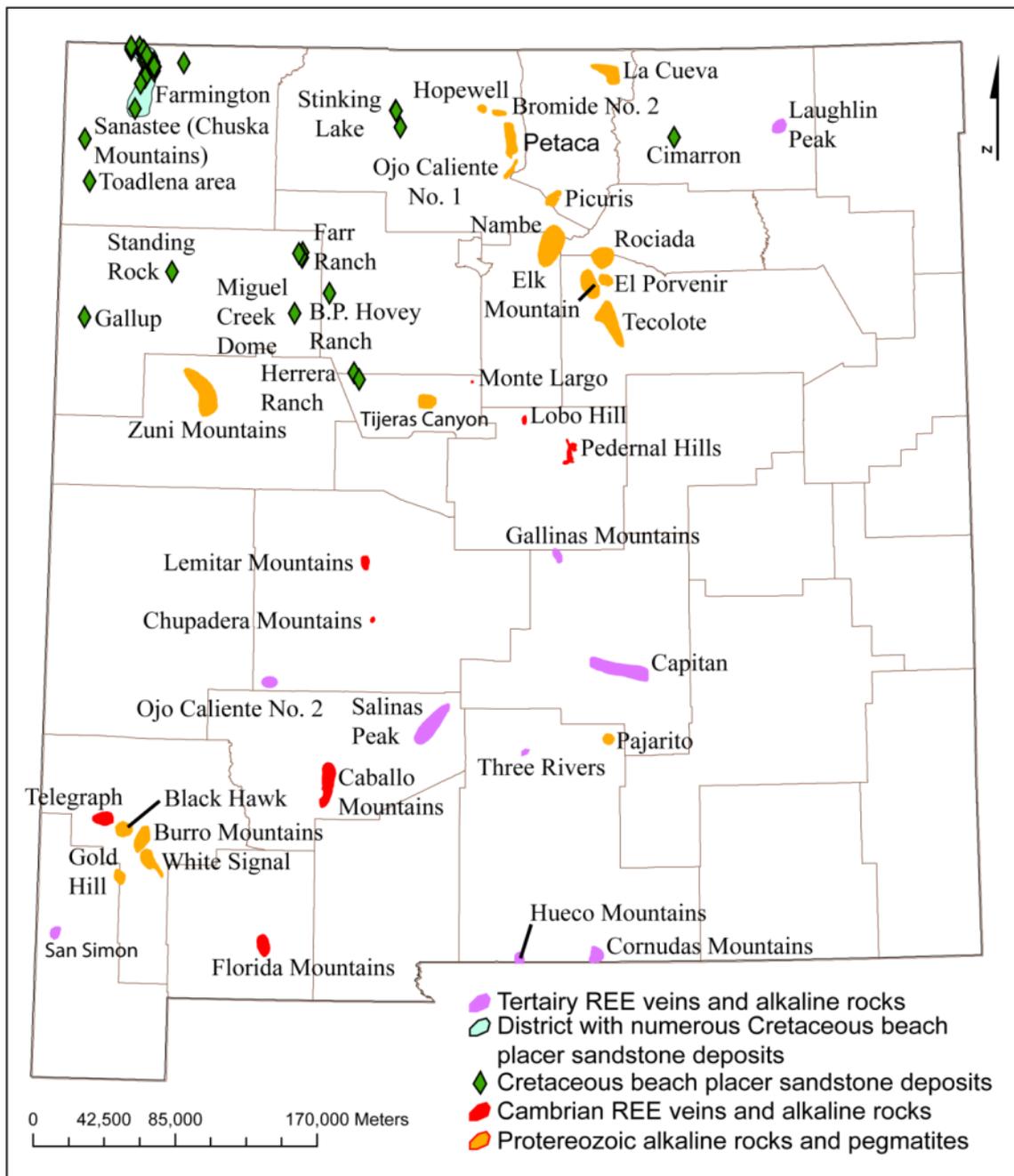


# Rare Earth Elements



## Applications For Rare Earth Elements





# Occurrences of Rare Earth Elements (REE) in New Mexico

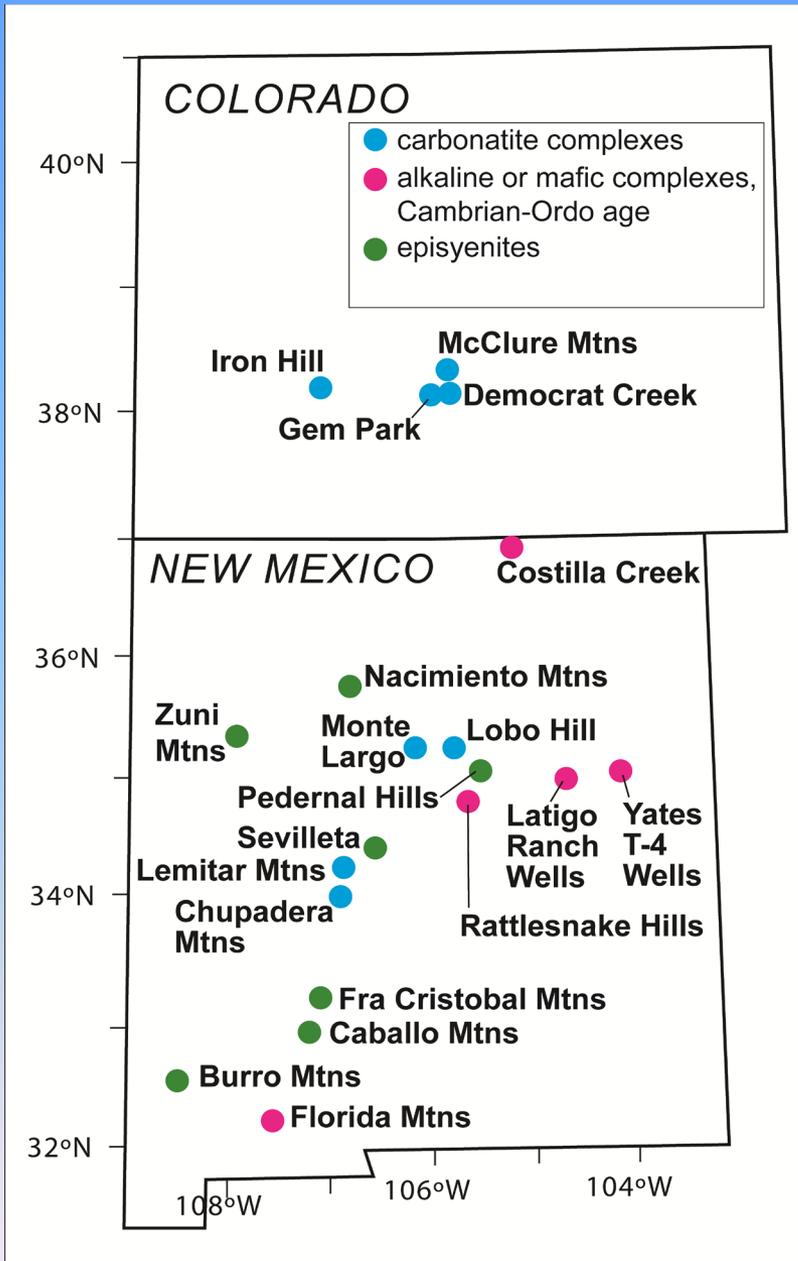
# REE Deposits

- Carbonatites
- Pegmatites
- Episyenites
- Proterozoic alkaline rocks (Pajarito Mountain)
- Alkaline-related REE-U-Th veins
- Cretaceous beach-placer sandstone deposits
- Coal ?
- Sandstone uranium deposits ?





# Carbonatites and Episyenites (or metasomatic rocks) in New Mexico and Colorado



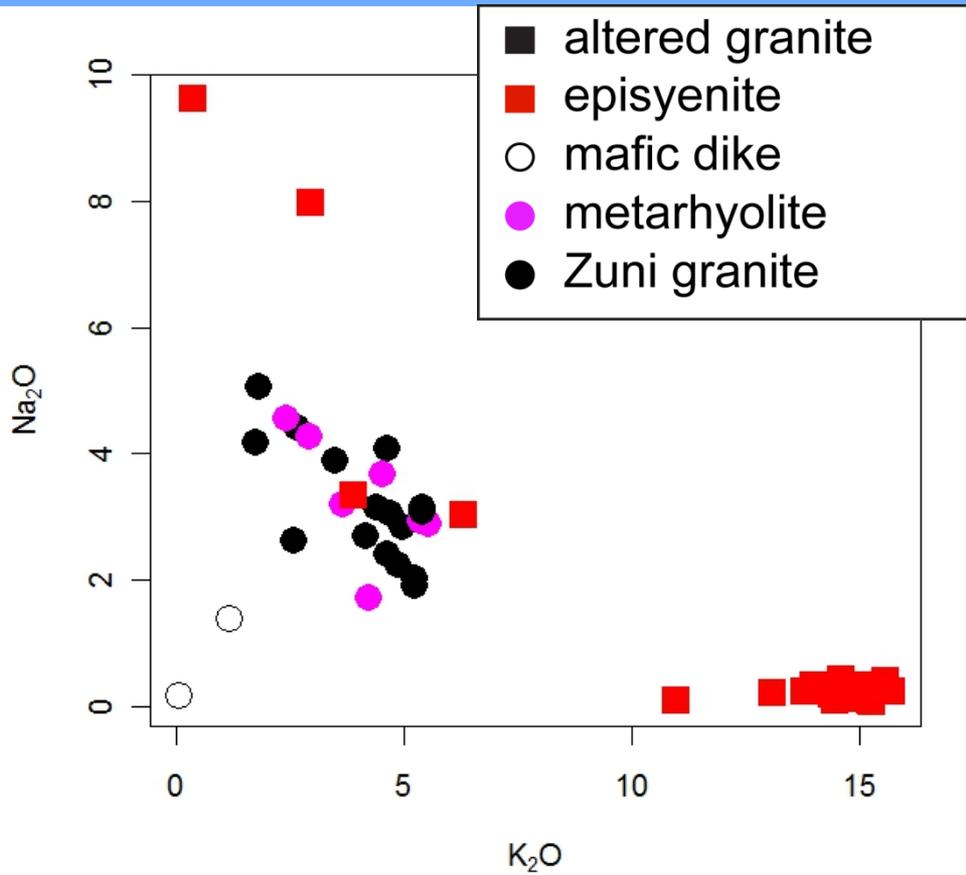


*Episyenite* is a term used to describe altered rocks that were desilicated and metasomatized by alkali-rich fluids solutions

Episyenites in  
Longbottom Canyon,  
Caballo Mountains

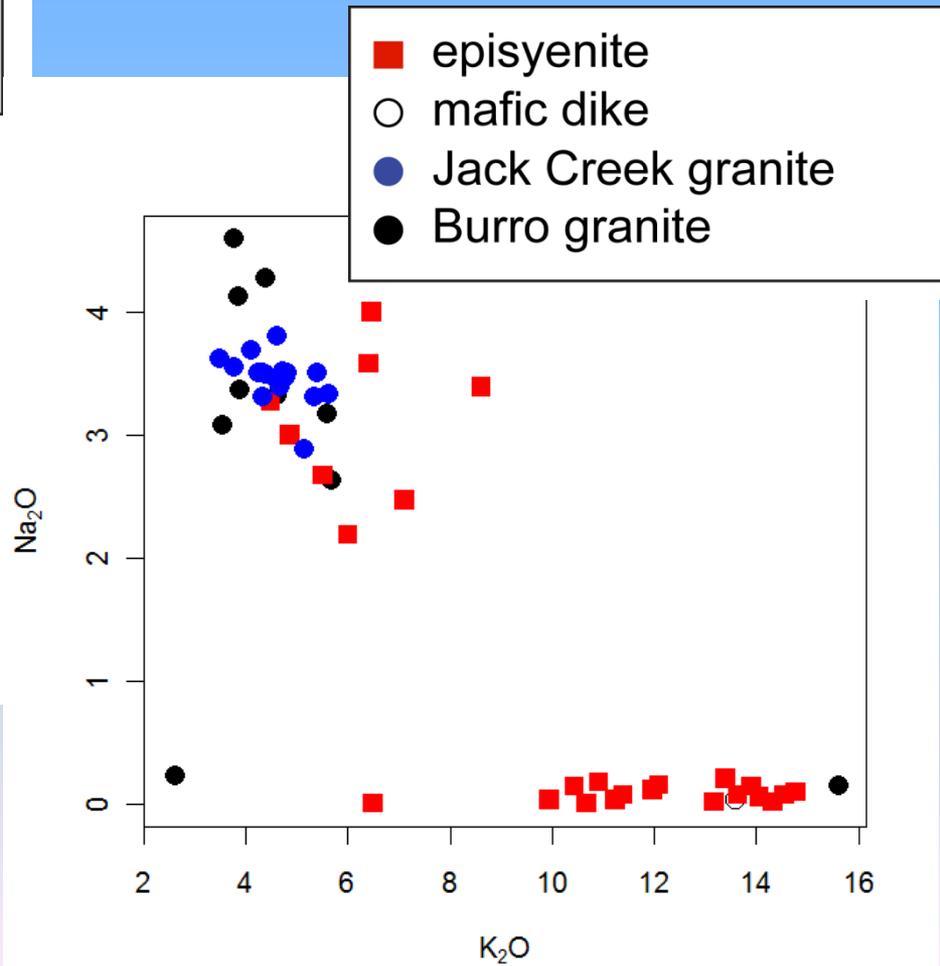


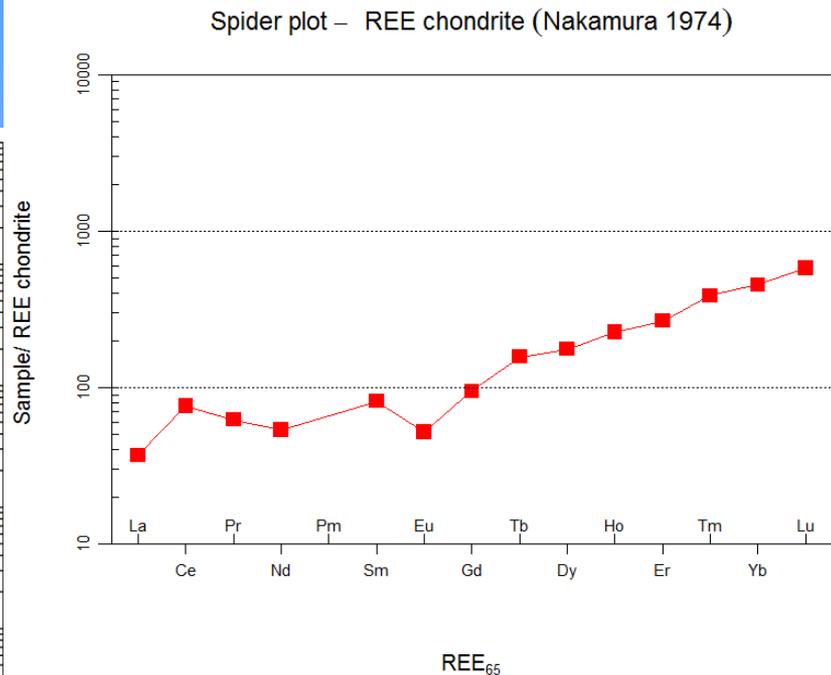
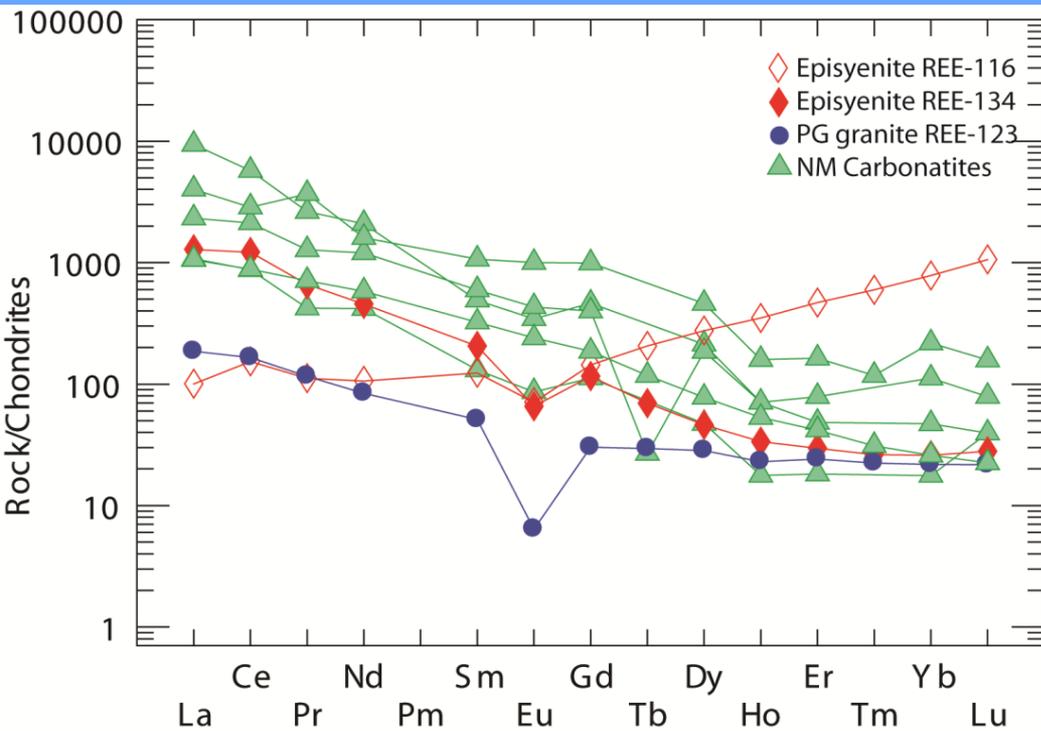
# HIGH $K_2O$



Zuni Mountains

Burro Mountains



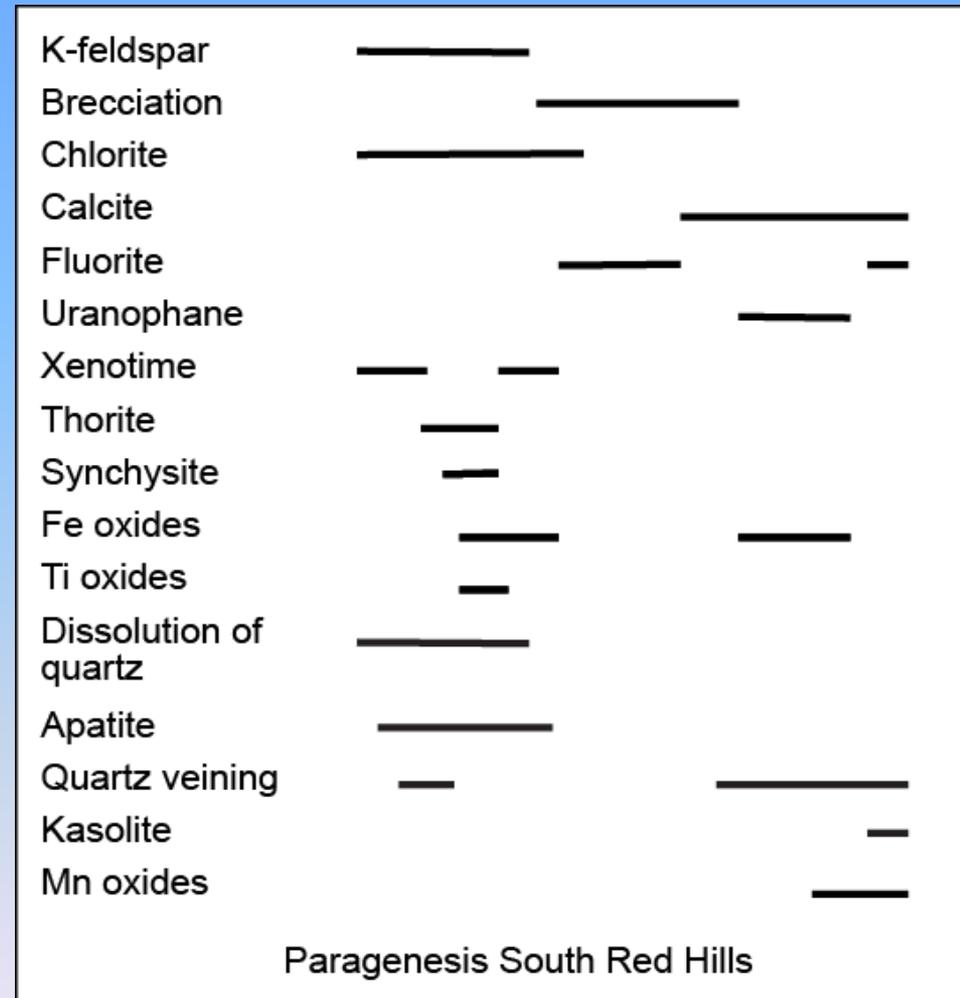


**Some episyenites are HREE-enriched**  
 As much as 133 ppm Yb, 179 ppm Dy

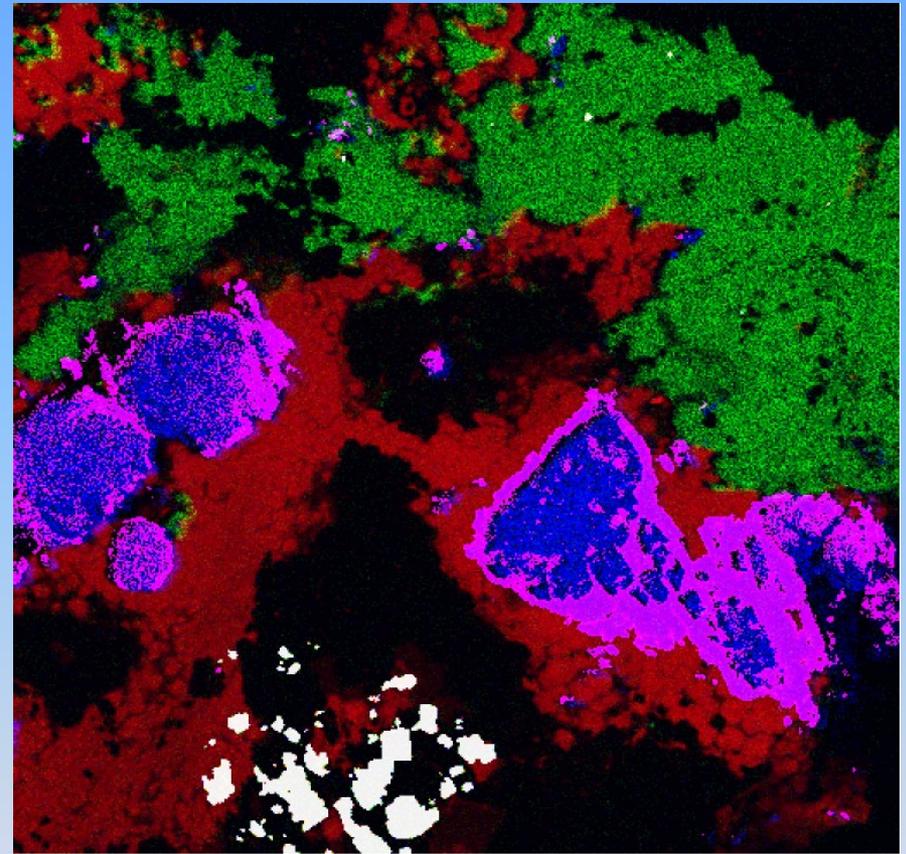
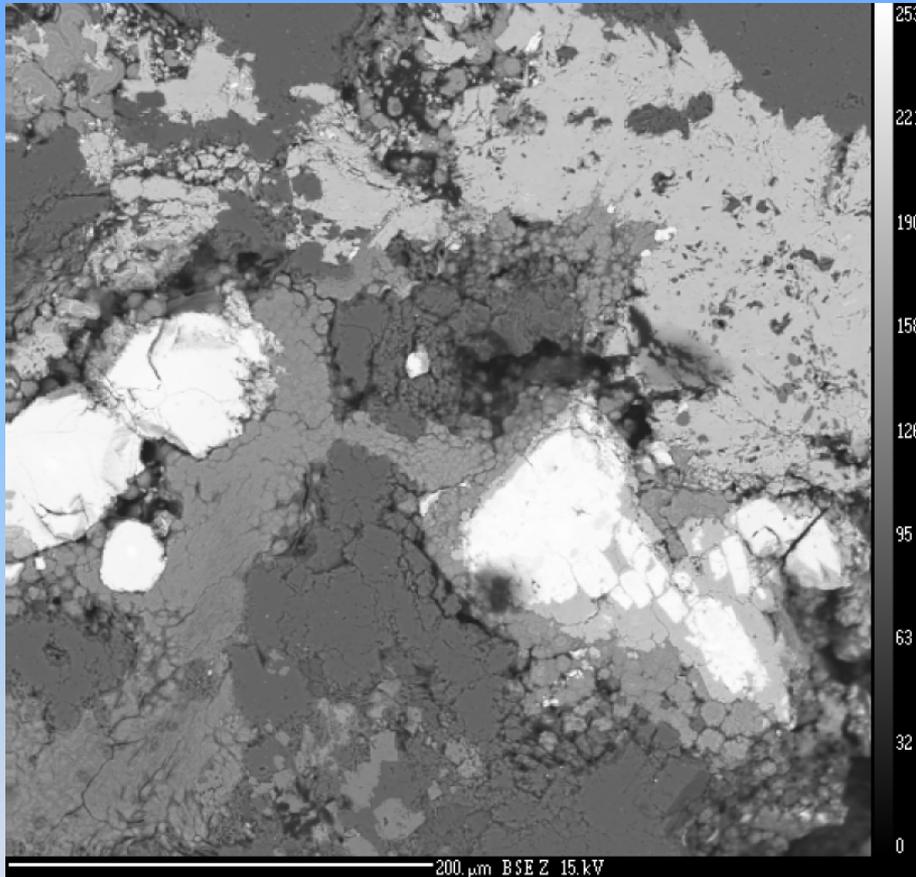
**They are interpreted to be related to carbonatite or alkaline fluids altering the host granite, similar to fenitization**

# Complex mineralogy

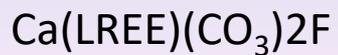
- Synchysite (63 wt.% LREE)
- Aeschynite (9 wt.% HREE)
- Xenotime (16 wt.% HREE)
- Thorite
- Uranophane
- Bastnaesite



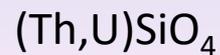
# Backscatter electron image (electron microprobe) of an episyenite sample



Synchysite



Thorite

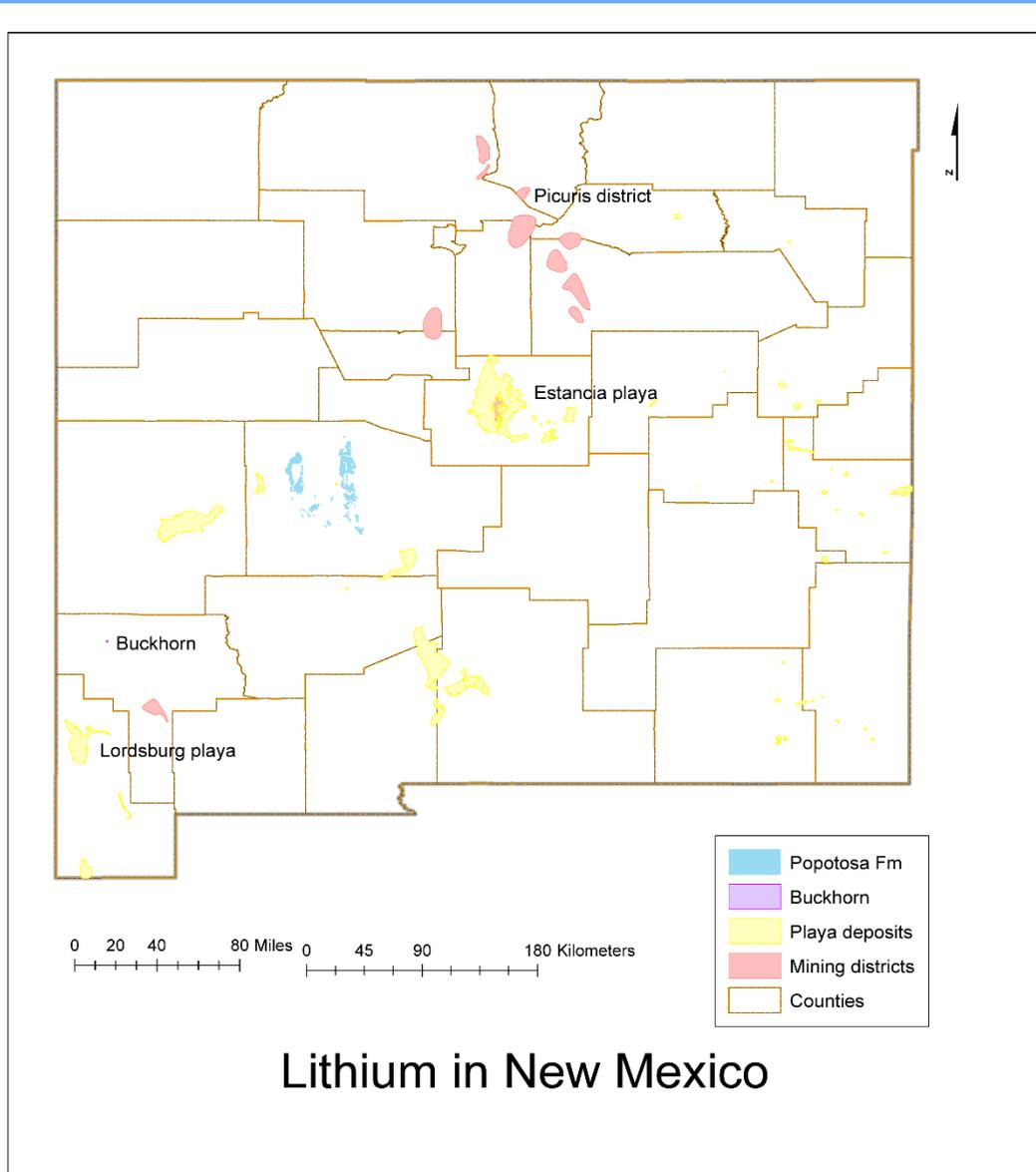


Xenotime



Lithium

# Lithium in New Mexico



- Mined in the past from pegmatites—some potential remaining
- Exploration in playa lakes, brines in Lordsburg, Tularosa Basin

# Critical minerals found in porphyry copper deposits in New Mexico

- Rhenium
- PGEs
- Tellurium
- Indium
- Germanium
- Gallium
- Aluminum (alunite, kaolinite)



Chino, Tyrone, Copper Flat in permitting, other potential deposits

# What are the challenges in producing critical minerals?

- Meeting the demand (quick change in supply and demand difficult for mines to meet)
- Permitting
- Fear that producing a byproduct could jeopardize production of major commodity
- Environmental issues
  - Many are associated with U/Th (radioactivity)
- Financing for both exploration/mining and development of new products
- Social license to operate
- Local infrastructure challenges

# GENERAL COMMENTS

- Many of the critical minerals do not require the tonnages we are used to mine for metals like Fe, Cu, Pb, Zn—i.e. smaller deposits
- Some of these minerals are found in areas of the world that may not be economically unstable or particularly friendly to the U.S.
  - Minerals that provide major revenue to armed fractions for violence, such as that occurring in the Democratic Republic of Congo (GSA, Nov. 2010)

# GENERAL COMMENTS—CONTINUED

- Some of these minerals are found in only 1-3 deposits in the world
- Development of uranium deposits in NM is not favorable among many people
- Some of these minerals come only from the refining of metal deposits and are dependent upon that production
  - Many Cu and Au deposits utilize heap leach technology, which leaves other potential minerals unrecovered in the heap leach

# **Earth Mapping Resources Initiative (MRI) program and National Geological and Geophysical Data Preservation Program (NGGDPP)**

- Cooperation with the U.S. Geological Survey mapping for REE deposits
  - Gallinas Mountains
  - Cornudas Mountains
- Database preservation program
  - New Mexico Mines Database—including districts, mines, and prospects with critical minerals
  - Logging and photographing drill core with critical minerals
  - Database of chemical analyses of areas with critical minerals potential

# Summary

- New Mexico is currently producing potash
- New Mexico has produced many of the critical minerals and has potential for future production
  - Uranium—2<sup>nd</sup> in the US in resources
- Exploration for several critical minerals ongoing in NM
  - REE, Te, Co, Li, Be
- Coal deposits in NM could have potential for critical minerals

**Field work during  
a pandemic!**

**QUESTIONS?**

