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)

- Green: elements needed in 1980s
- Yellow: additional elements needed today

Periodic Table:

- H
- Li, Be
- Na, Mg
- 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

- Red: Element currently producing in NM
- Blue: Element once produced from NM
- Green: Element found in NM
- Yellow: Element not found in NM

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
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
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
- 2nd in uranium resources 15 million tons of ore at 0.277% U₃O₈ (84 million lbs U₃O₈) 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 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

- Petroleum refining
- Chemical processing
- Catalytic converter
- Diesel additives
- Industrial pollution scrubber

Catalysts

- Display phosphors (CRT, PDP, LCD)
- Medical imaging phosphors
- Lasers
- Fiber Optics
- Optical temperature sensors

Electronics

- Polishing compounds
- Optical glass
- UV resistant glass
- Thermal control mirrors
- Colorizers/Decolorizers

Glass

- Capacitors
- Sensors
- Colorants
- Scintillators

Ceramics

- Anti-lock brake system
- Automotive parts
- Communication systems
- Electric drive & propulsion
- Frictionless bearings
- Magnetic storage disk
- Microwave power tubes
- Magnetic refrigeration
- Magnetostrictive alloys

Metal Alloys

- Hydrogen storage (NiMH batteries, Fuel cells)
- Steel
- Lighter flints
- Aluminum/ Magnesium
- Cast iron
- Superalloys

Other

- Water Treatment
- Fluorescent lighting
- Pigments
- Fertilizer
- Medical Tracers
- Coatings

Magnets

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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 ?
REE in Gallinas Mountains, Lincoln County
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

Graphs showing the distribution of altered granite, episyenite, mafic dike, metarhyolite, and Zuni granite.

Graphs for episyenite, mafic dike, Jack Creek granite, and Burro granite.
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

Paragenesis South Red Hills
Backscatter electron image (electron microprobe) of an episyenite sample

Synchysite
Ca(LREE)(CO₃)₂F

Thorite
(Th,U)SiO₄

Xenotime
YPO₄
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 factions 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—2nd 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?