MINERAL-RESOURCE POTENTIAL IN NEW MEXICO 2018

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Acknowledgements

- New Mexico Bureau of Geology and Mineral Resources
- U.S. Bureau of Land Management (BLM)
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- Assisted by Mark Mansell, Amy Trivett, Gretchen Hoffman, Adam Read and students

Outline

- Introduction
- Methods
- Required data
- Mineral-resource potential
- Summary

INTRODUCTION

- NM has some of the oldest mining areas in the United States
- Native Americans mined turquoise from Cerrillos Hills district more than 500 yrs before the Spanish settled in the 1600s
- One of the earliest gold rushes in the West was in the Ortiz Mountains (Old Placers district) in 1828, 21 yrs before the California Gold Rush in 1849

One of the turquoise mines in the Cerrillos Hills district

Purpose of evaluations of mineral-resource potential

- Estimating mineral-resource availability
  - Determine potential for critical minerals
- Delineate areas requiring more geologic investigation
- Required by government officials in order to make decisions regarding use, acquisition, and restriction of public and state lands

Definitions

- *Minerals* refer to any rock, mineral, or other naturally occurring material of economic value, including metals, industrial minerals, energy minerals, gemstones, and aggregates
- *Mineral-resource potential* of an area is the probability or likelihood that a mineral will occur in sufficient quantities so that it can be extracted economically under current or future conditions, including the occurrence of undiscovered concentrations of metals, nonmetals, industrial materials, and energy resources
- Mineral-resource potential is not a measure of the quantities of the mineral resources, but is a measure of the *potential* of occurrence

DEFINITIONS OF LEVEL OF RESOURCE POTENTIAL

N **No mineral-resource potential** is a category reserved for a specific type of resource in a well-defined area with no evidence of mineral resources.

L **Low mineral-resource potential** is assigned to areas where geologic, geochemical, and geophysical characteristics indicate geologic environment where the existence of economic mineral resources is unlikely and is assigned to areas of no or dispersed mineralized rocks.

M **Moderate mineral-resource potential** is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for mineral-resource occurrence.

H **High mineral-resource potential** is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence and development. Assignment of high mineral-resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

DEFINITIONS OF LEVEL OF CERTAINTY

A Available information is not adequate for the determination of the level of mineral-resource potential.

B Low, available information suggests the level of mineral-resource potential.

C Moderate, available information gives a good indication of the level of mineral-resource potential.

D High, available information clearly defines the level of mineral-resource potential.

↑ ***INCREASING LEVEL OF RESOURCE POTENTIAL***	U/A Unknown Potential	H/B High Potential	H/C High Potential	H/D High Potential
		M/B Moderate Potential	M/C Moderate Potential	M/D Moderate Potential
		L/B Low Potential	L/C Low Potential	L/D Low Potential
		L/B Low Potential	L/C Low Potential	N/D No Potential
				N/D No Potential
INCREASING LEVEL OF CERTAINTY →				

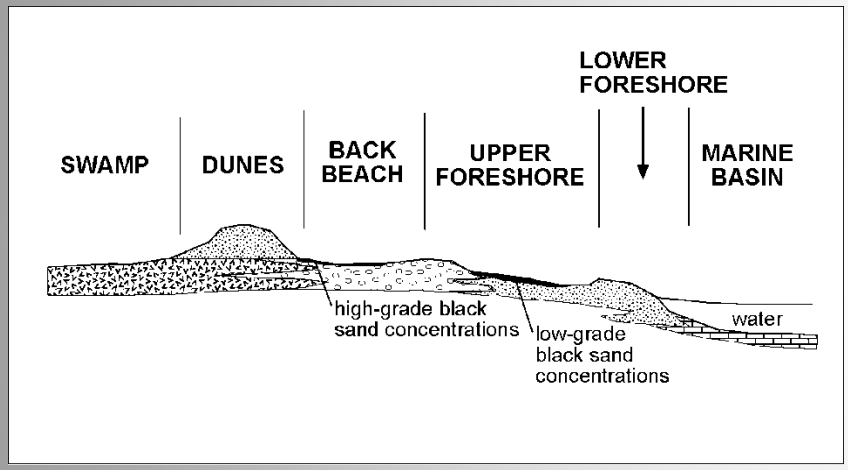
Methods

- Evaluation of mineral-resource potential involves a complex process based on geologic analogy and probability of promising or favorable geologic environments with geologic settings (geologic models) that contain known economic deposits, as described in Goudarzi (1984) and McLemore (1985)
  - Mineral deposit models
  - Known mineral deposits
- Subjective assessments or judgments depend upon available information concerning the area, as well as current knowledge and understanding of known mineral deposits

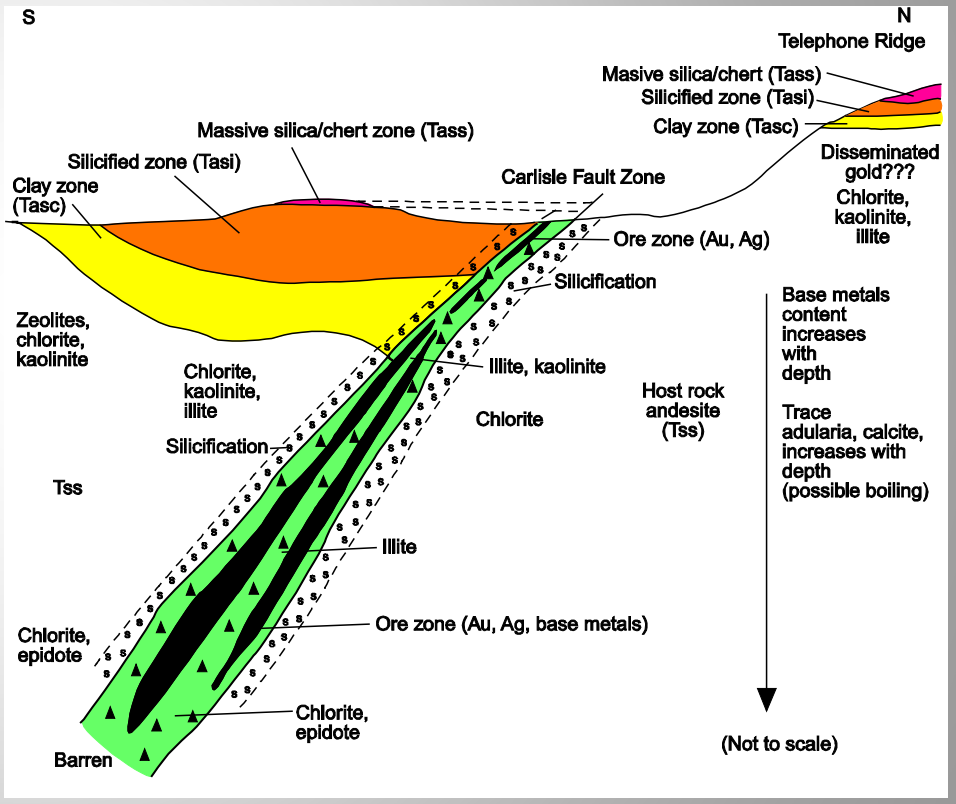
Sources of data

- Mining districts
- Active and inactive mines
- Exploration areas
- Areas of mining claims
- Favorable geologic terrains for specific mineral deposit types
- Lithology, structure, alteration
- Geophysical and geochemical data
  - NURE data

Distribution of mineral deposits is highly dependent on the geological processes necessary for concentration of the commodity in question



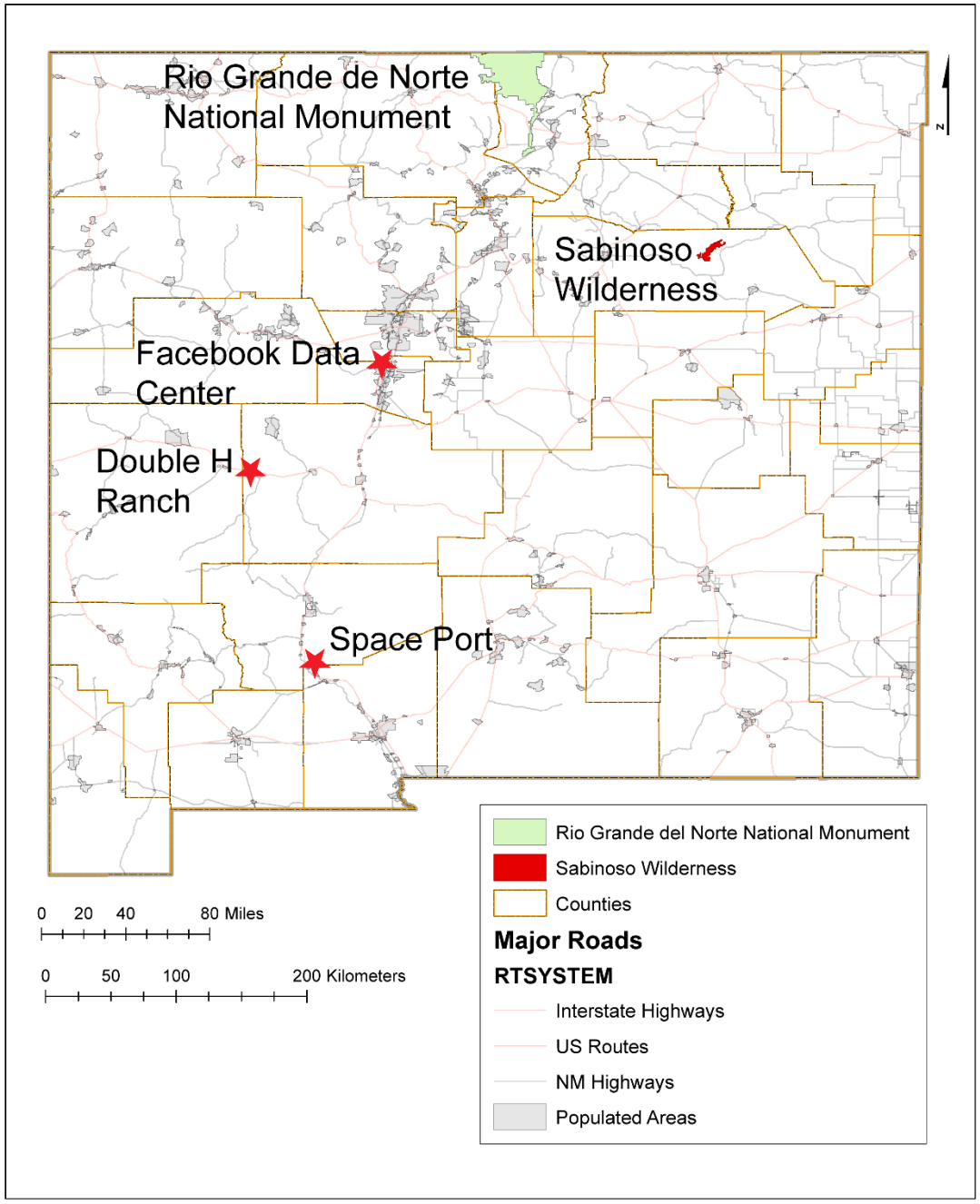
REE-Zr-Ti beach-placer sandstone deposits, San Juan Basin, NM



Volcanic-epithermal gold veins, Steeple Rock, NM

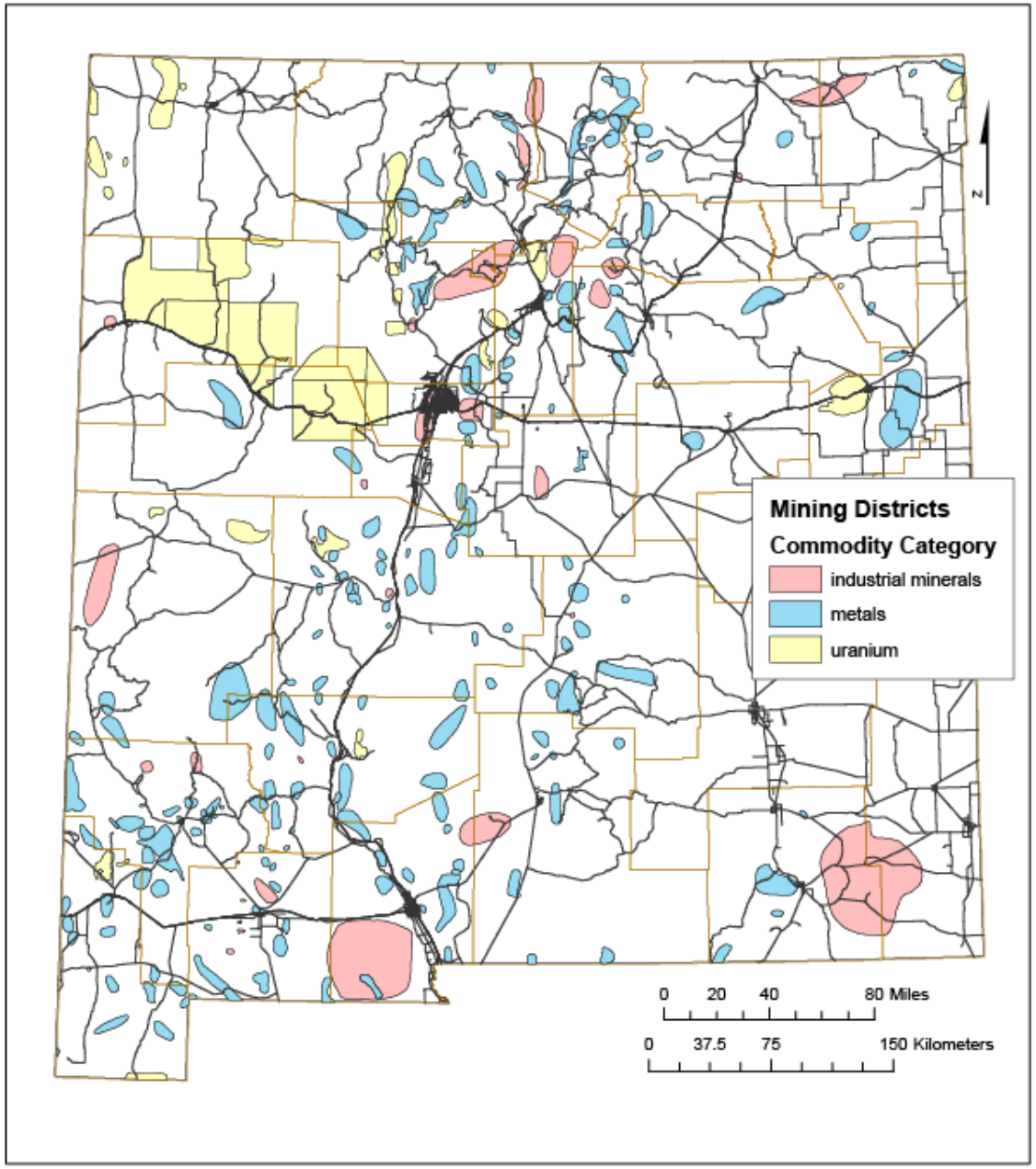
Reasonably foreseeable development (RFD)

- Reasonably foreseeable development (RFD) is defined as the potential for the occurrence and likelihood for future development (i.e. mining) of mineral resources.
- The evaluation of RFD involves the evaluation of the potential of the occurrence of the resource based on geologic factors (i.e. mineral resource classification described above) and the evaluation of the potential for future exploitation of that resource based upon economic factors.

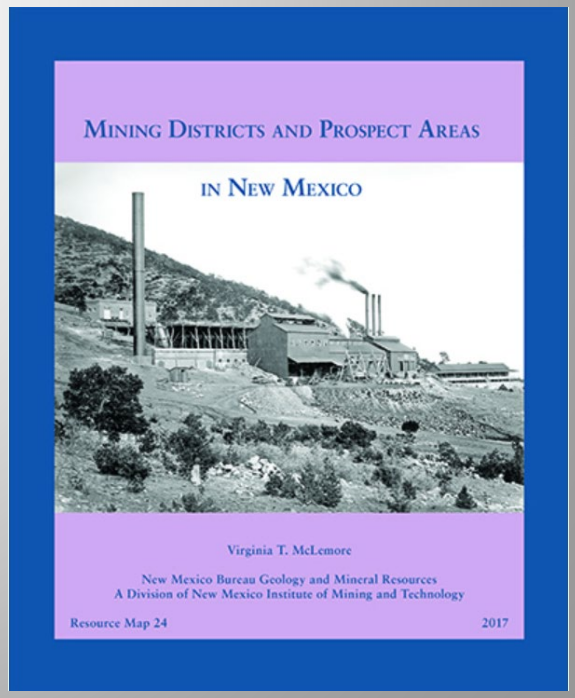


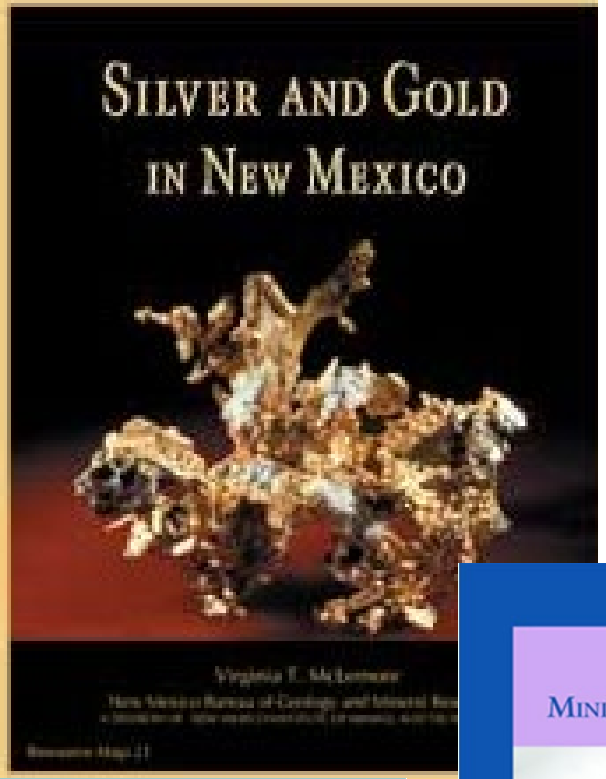
Recent Projects requiring Mineral-Resource Assessments

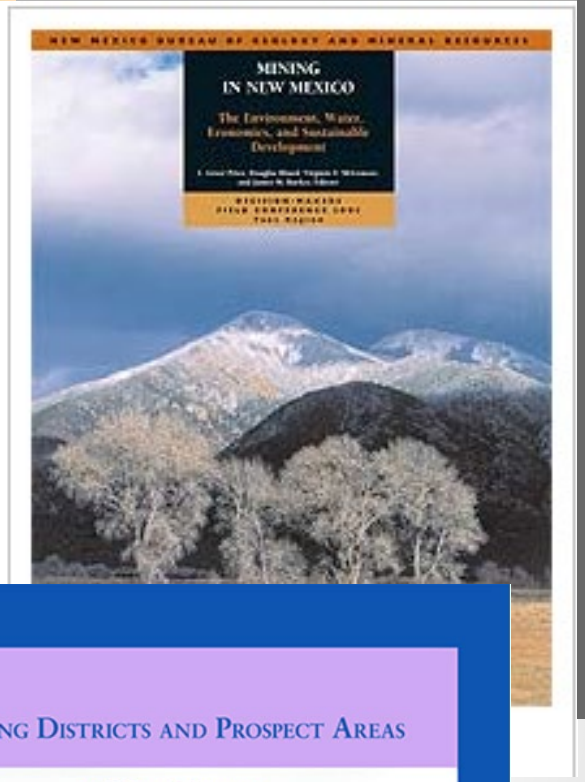
Required data



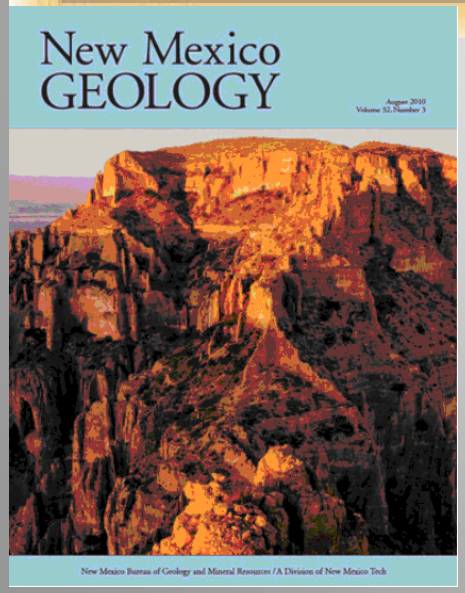
Mining districts in New Mexico

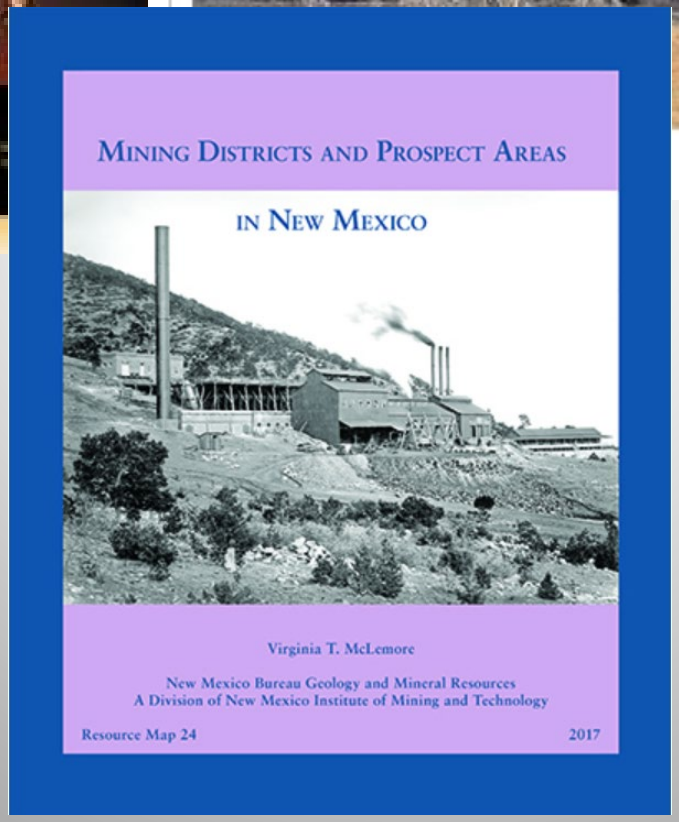



Silver and Gold
in New Mexico


New Mexico Bureau of Geology and Mineral Resources
Mining
in New Mexico
The Environment, Water, Economics, and Sustainable Development

New Mexico
Earth
Matters
New Mexico Potash—Past, Present, and Future


New Mexico
Geology
August 2010
Volume 32, Number 3
New Mexico Bureau of Geology and Mineral Resources / A Division of New Mexico Tech


Mining Districts and Prospect Areas
in New Mexico
Virginia T. McLemore
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Resource Map 24
2017

Lite Geology
Geothermal Energy
FALL 2010 ISSUE 28
Flowers growing in a geothermal greenhouse at Masson Radium Springs Farm, New Mexico
In This Issue ...
Geothermal Energy • How Do Geysers Work?
Classroom Activity: Infrared Yellowstone Lesson Plans • Geothermal Crossword Puzzle
Geothermal Applications in New Mexico
Geothermal Greenhouse Heating at Radium Springs, New Mexico
Heating New Mexico Tech's Campus with Geothermal Energy
Most Wanted Mineral: Opal • Through the Hand Lens
New Mexico's Enchanting Geology • Short Items of Interest
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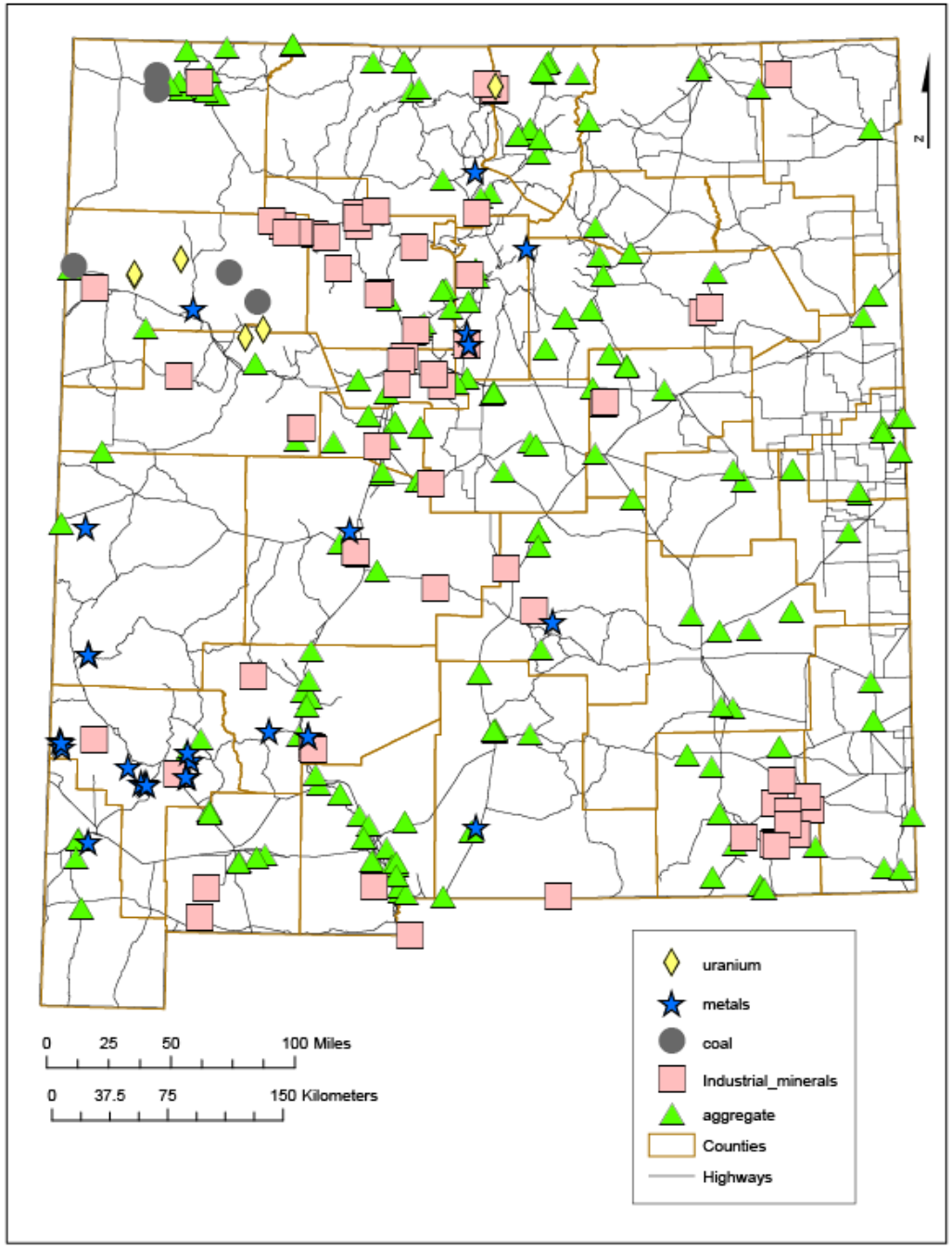
Types of deposits—Memoir 50 (Energy and mineral resources of New Mexico)



Active mines and exploration sites in New Mexico 2010-2018

Active mines 2018

- ~230 active registered mines (NMMMD)
- 4 coal
- 3 potash, 5 potash plants
- 2 copper open pits, 1 concentrator (mill), 2 solvent/electro-winning (SX-EW) plants
  - 2 additional mines in permitting stage
  - Several exploration
- 1 gold mine and 1 mill (on standby)
- 2 iron mines
- 32 industrial minerals mines, 18 mills
- ~177 aggregate/stone

Production Summary—2016

- Value of mineral production in 2016 was $1.7 billion (does not include oil and gas)—ranked 20th in the US (30% decrease from 2015)
- Employment in the mining industry is 4,943
- Exploration for garnet, gypsum, limestone, nepheline syenite, agate, specimen fluorite, gold, silver, iron, beryllium, uranium, copper, potash, rare earth elements, humate, clays
- ***MINERALS PRODUCTION IS DECREASING, ESPECIALLY COAL***

Geology/Geochemistry/Geophysics/Other

NM_MiningDistricts_18 - ArcMap

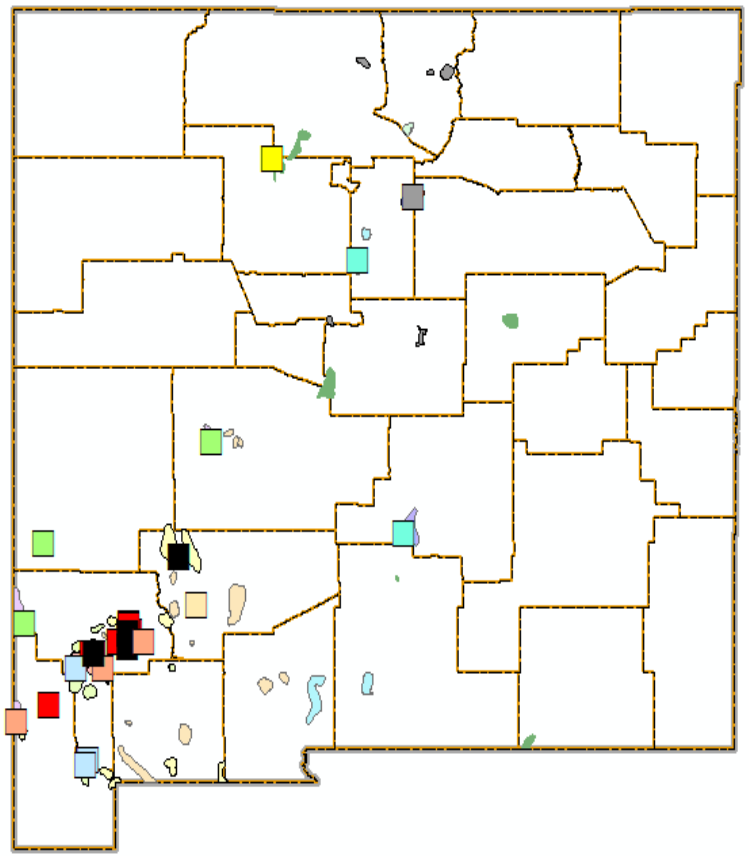
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

Georeferencing Jic4.tif Drawing

Editor

Table Of Contents

- high aggregate
- high potential sand and gravel
- Cobalt
- Cu potential
  - coppermines
    - Type_of_de
      - porphyry copper
      - porphyry copper-gold
      - porphyhy copper-molybdenum
      - Laramide vein
      - Great Plains margin
      - volcanic-epithermal vein
      - volcanogenic massive sulfide
      - sedimentary-copper
      - mill
  - very high copper potential
  - high copper potential
  - moderate copper potential



-105.311 37.182 Decimal Degrees

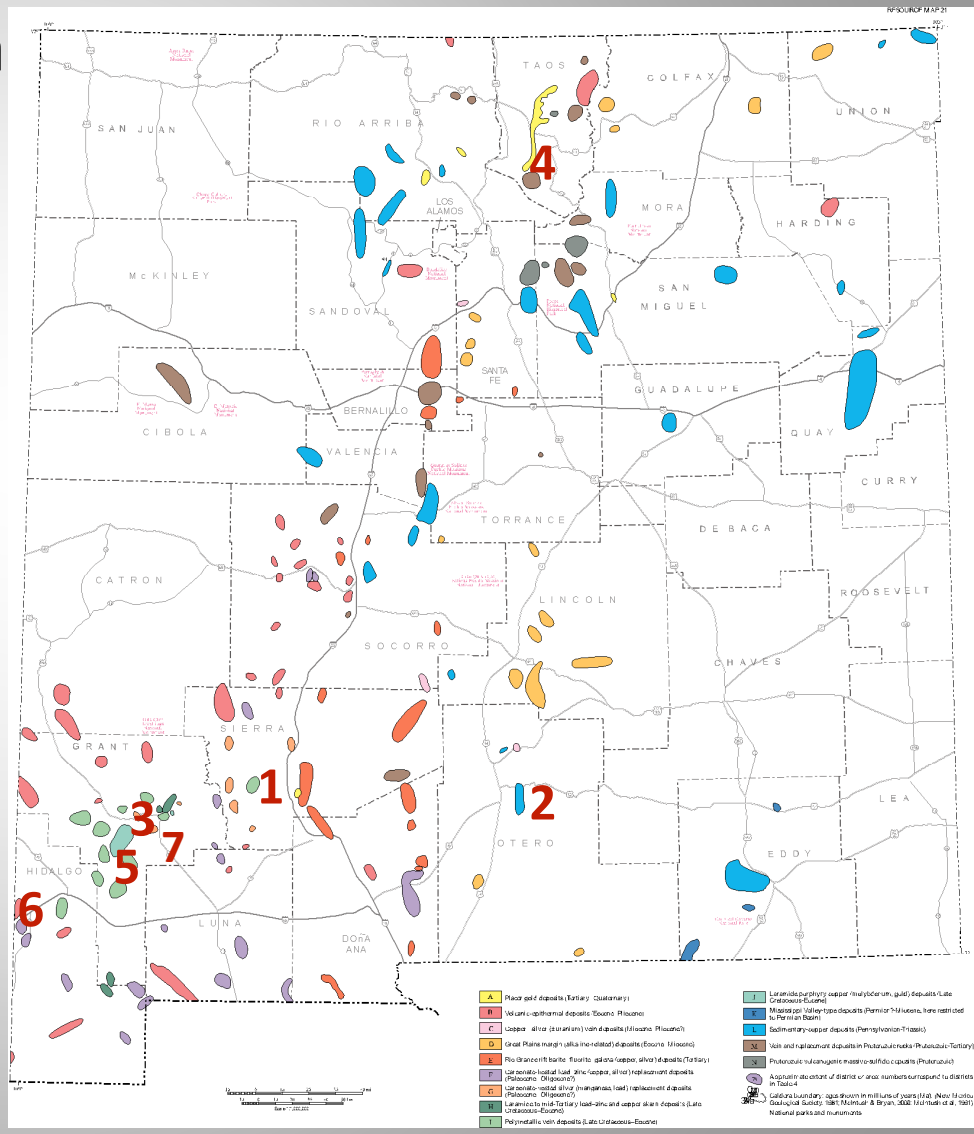
Mineral-Resource Potential

Copper reserves—2016

- Chino
  - milling reserves are 135 million tons of 0.59% copper, 0.04 g/t gold and 0.01% molybdenum
  - leaching reserves are 91 million tons of 0.28% Cu
- Tyrone
  - leaching reserves are estimated as 6 million tons of ore grading 0.51% Cu
  - Expected to close 2019
- Cobre
  - leaching reserves are 13 million tons of 0.57% Cu
- Niagara deposit
  - contains 500 million tons of ore grading 0.29% Cu (leaching)

Potential Copper Deposits

1. Copper Flat (98.1 million short tons at 0.31% Cu, 0.009% Mo, 0.003 oz/short ton Au, and 0.07 oz/ short ton Ag)
2. Orogrande
3. Hanover Mountain (80 mill st reserves at 0.38% Cu)
4. Copper Hill, Picuris district (46.5 mill st of ore at 0.42% Cu)
5. Lone Mountain (7.5 mill st at 2-3% Cu, 1.2% Pb, 4-5% Zn, 203 opt Ag, .01-.02 opt Au)
6. McGhee Peak, Pelloncillo Mountains
7. Mimbres



Copper Flat, Themax Resources

Planned production per year for ~15 yrs

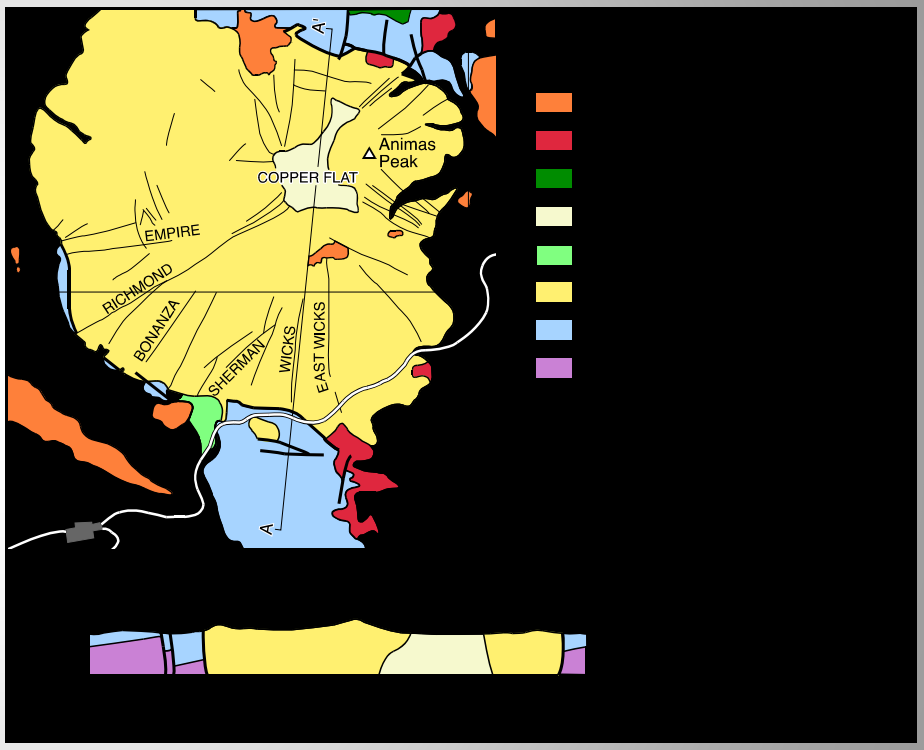
50.76 mill lbs Cu

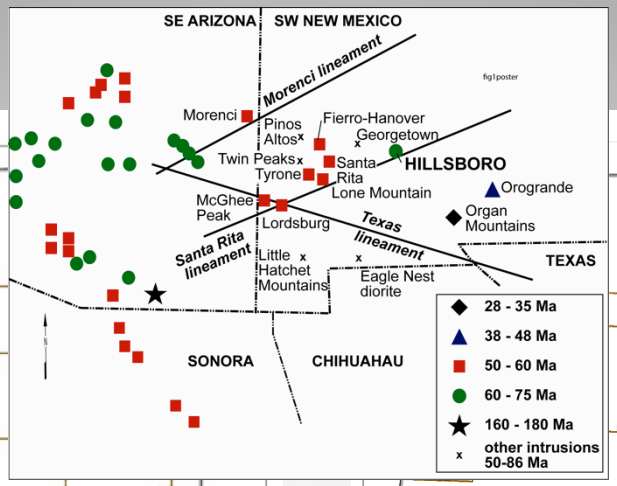
1.01 mill lbs Mo

12,750 oz Au

455,390 oz Ag

Start in 2020?




SE ARIZONA
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Morenci lineament
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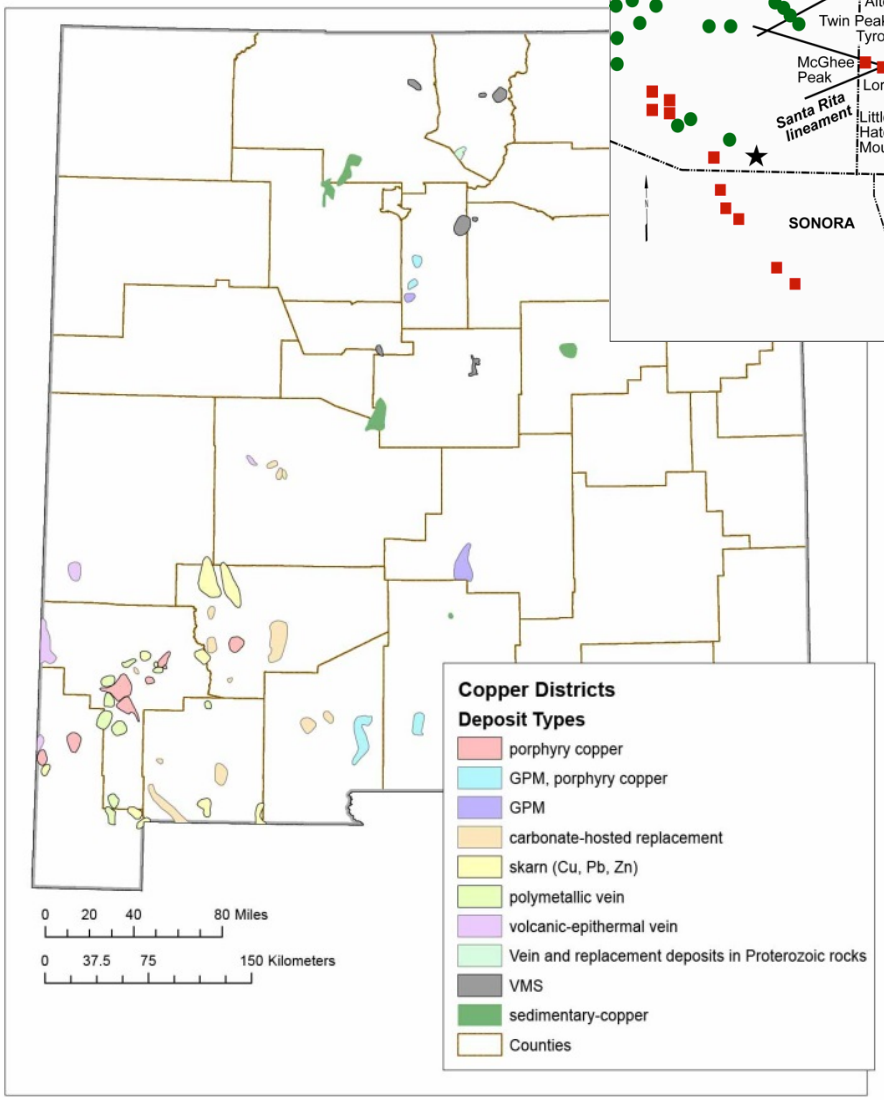
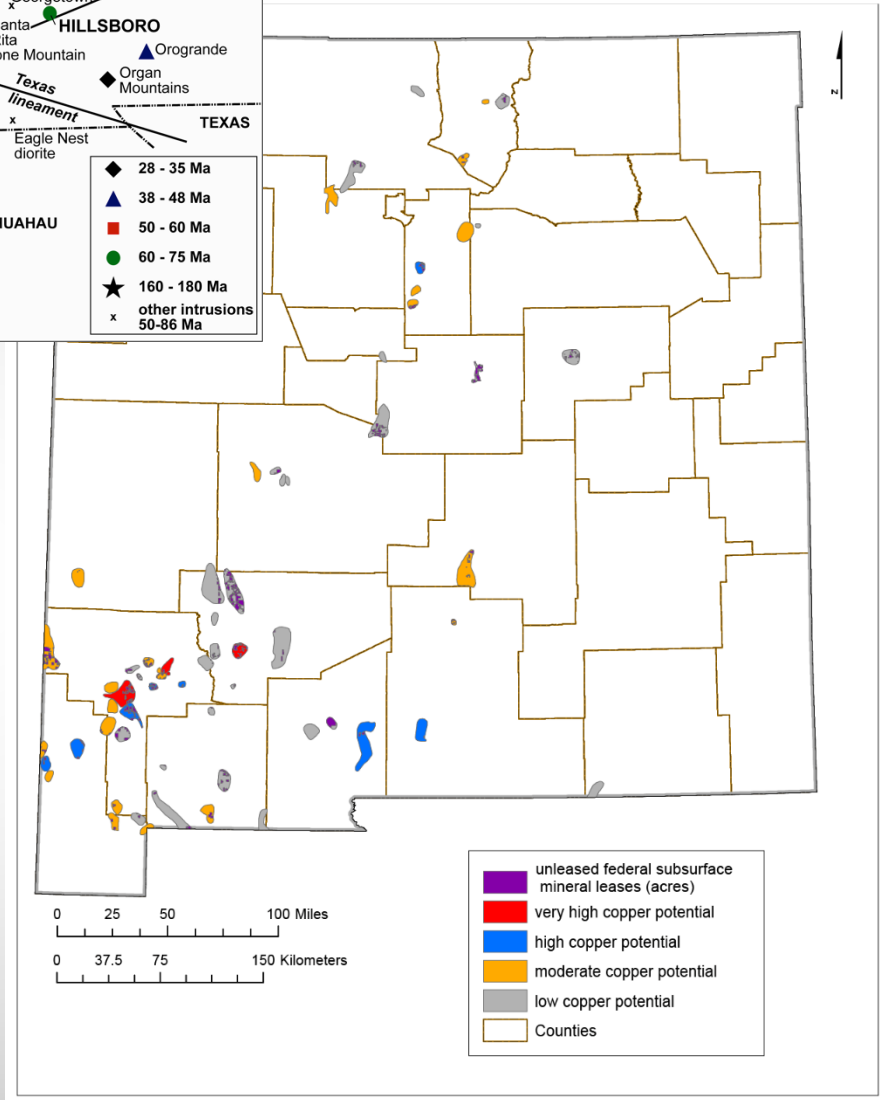
Pinos Altos
Fierro-Hanover
Georgetown
Twin Peaks
Tyrone
Santa Rita
HILLSBORO
Lone Mountain
Orogrande
McGhee Peak
Organ Mountains
Lordsburg
Texas lineament
Santa Rita lineament
Little Hatchet Mountains
Eagle Nest diorite
TEXAS
SONORA
CHIHUAHAU
28 - 35 Ma
38 - 48 Ma
50 - 60 Ma
60 - 75 Ma
160 - 180 Ma
other intrusions 50-86 Ma

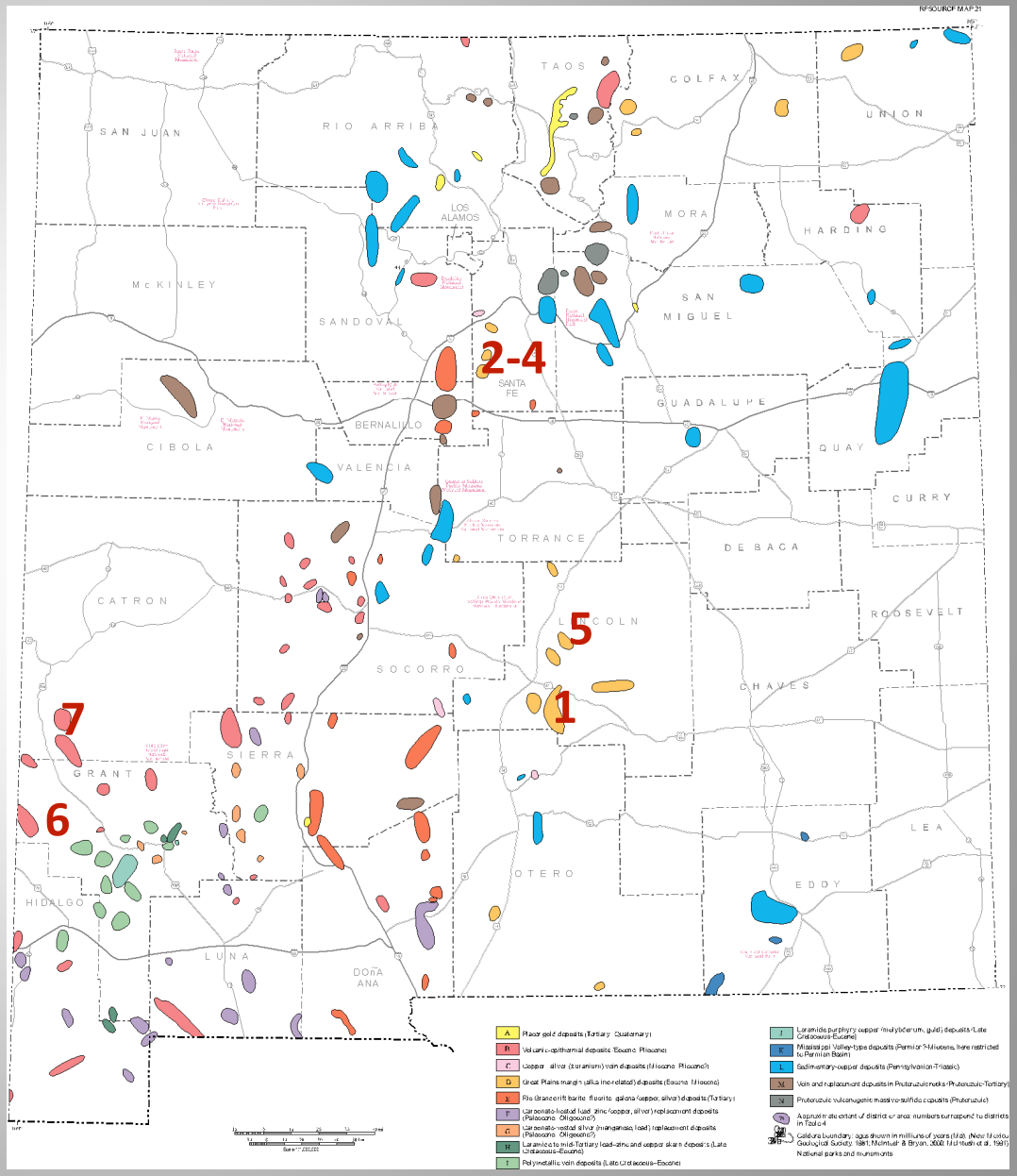

Copper Districts
Deposit Types
porphyry copper
GPM, porphyry copper
GPM
carbonate-hosted replacement
skarn (Cu, Pb, Zn)
polymetallic vein
volcanic-epithermal vein
Vein and replacement deposits in Proterozoic rocks
VMS
sedimentary-copper
Counties
0 20 40 80 Miles
0 37.5 75 150 Kilometers

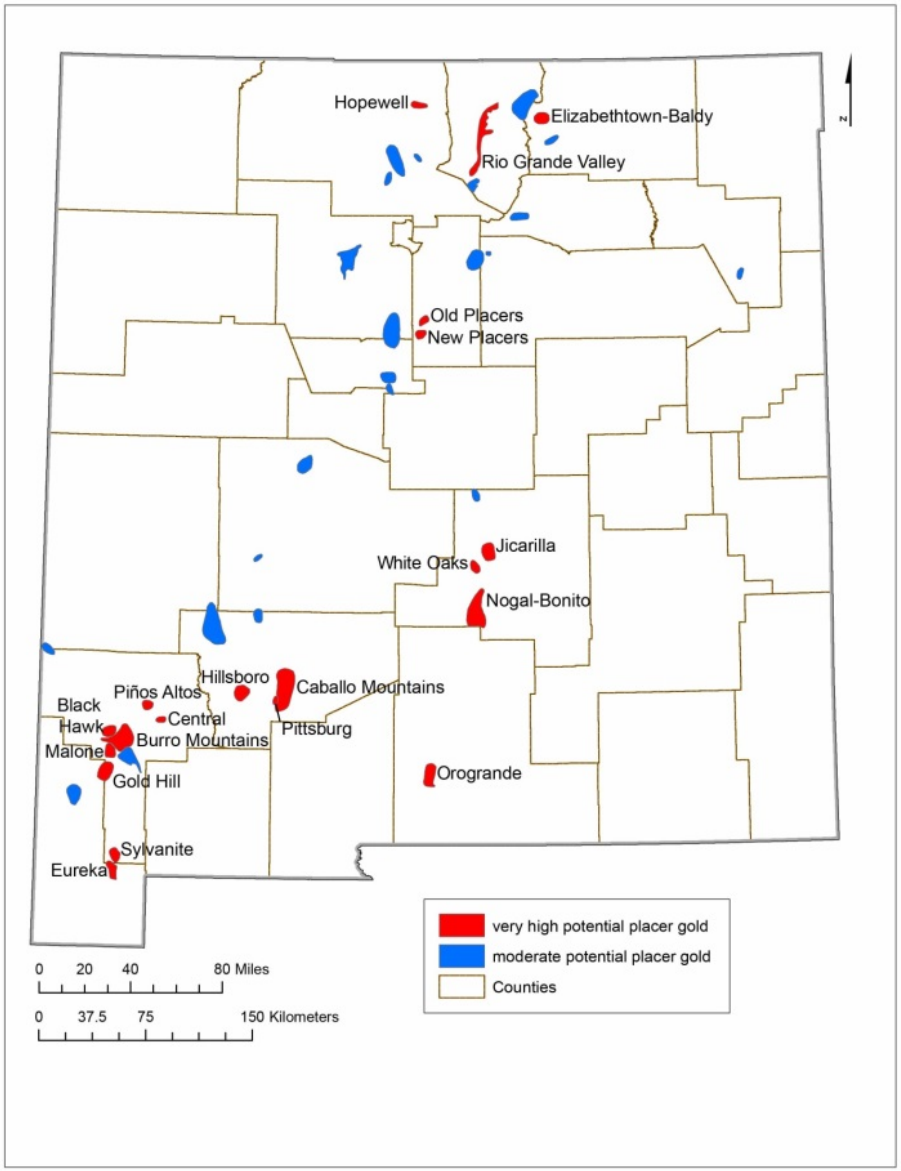

unleased federal subsurface mineral leases (acres)
very high copper potential
high copper potential
moderate copper potential
low copper potential
Counties
0 25 50 100 Miles
0 37.5 75 150 Kilometers

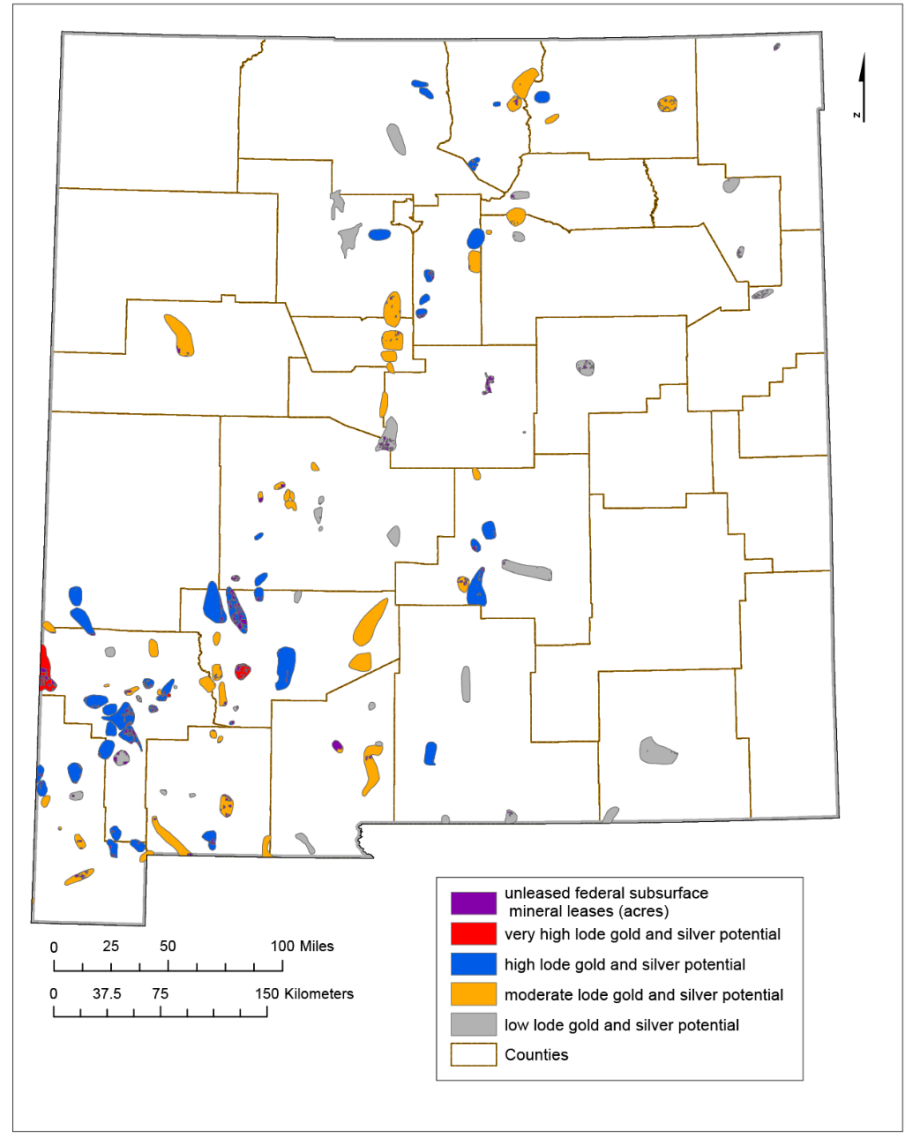
Copper

Gold and Silver

1. Vera Cruz, Lincoln Co
2. Carache Canyon, Santa Fe Co
3. Lukas Canyon, Santa Fe Co
4. San Lazarus, Santa Fe Co
5. Jicarilla Au placers
6. Steeple Rock district
7. Mogollon



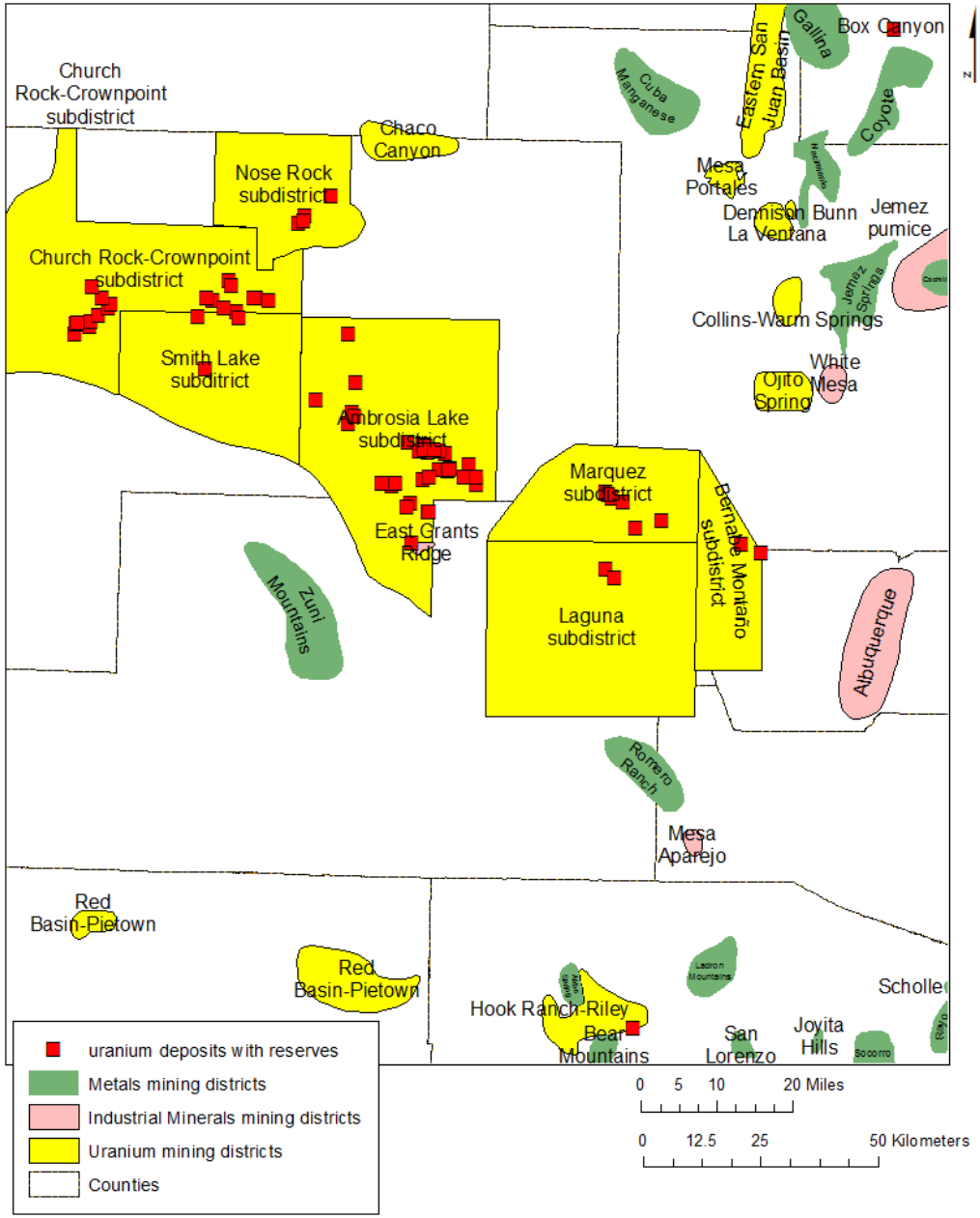

Hopewell
Elizabethtown-Baldy
Rio Grande Valley
Old Placers
New Placers
Jicarilla
White Oaks
Nogal-Bonito
Hillsboro
Caballo Mountains
Piños Altos
Black Hawk
Central
Burro Mountains
Pittsburg
Malone
Gold Hill
Orogrande
Sylvanite
Eureka
very high potential placer gold
moderate potential placer gold
Counties
0 20 40 80 Miles
0 37.5 75 150 Kilometers


unleased federal subsurface mineral leases (acres)
very high lode gold and silver potential
high lode gold and silver potential
moderate lode gold and silver potential
low lode gold and silver potential
Counties
0 25 50 100 Miles
0 37.5 75 150 Kilometers

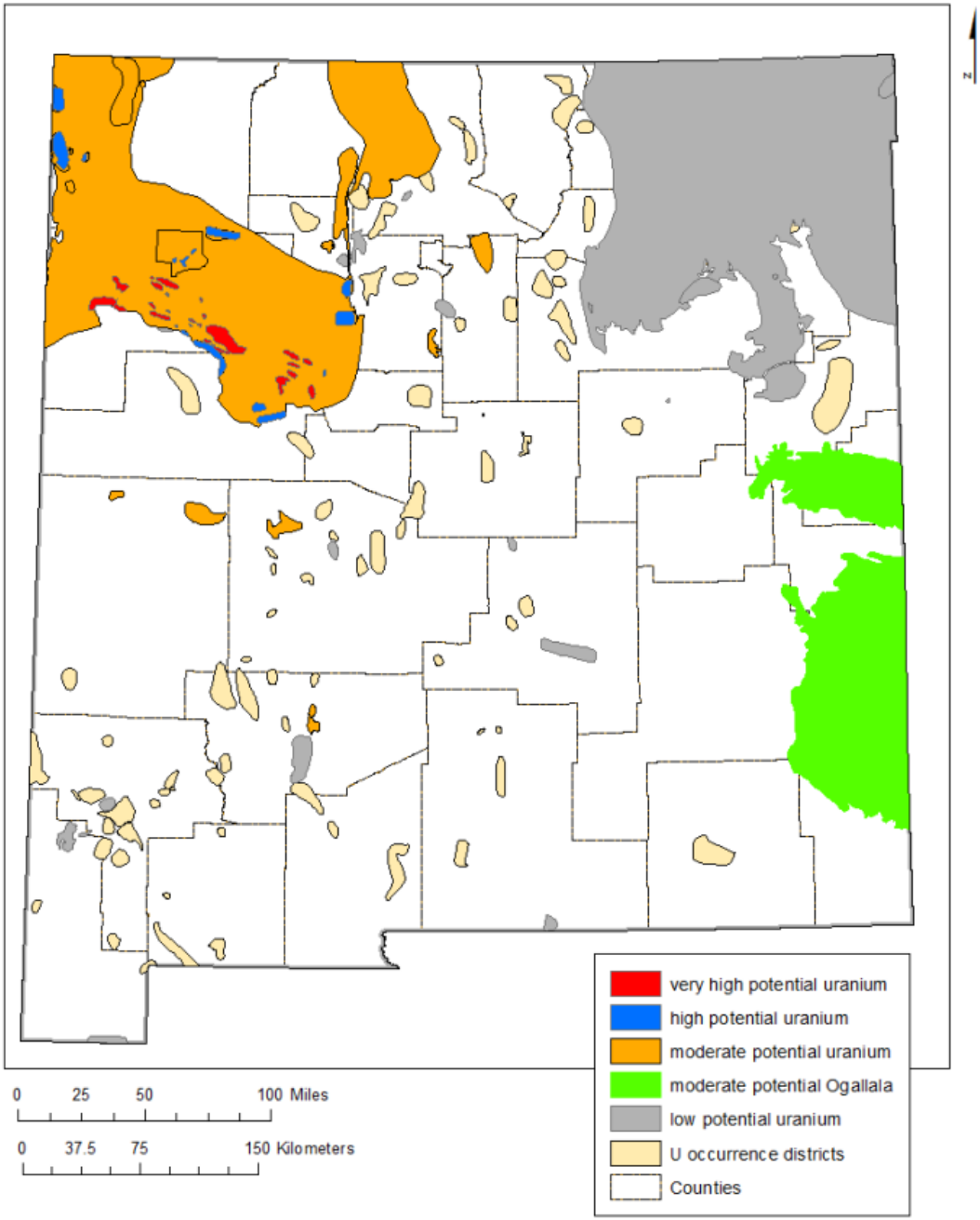
Gold

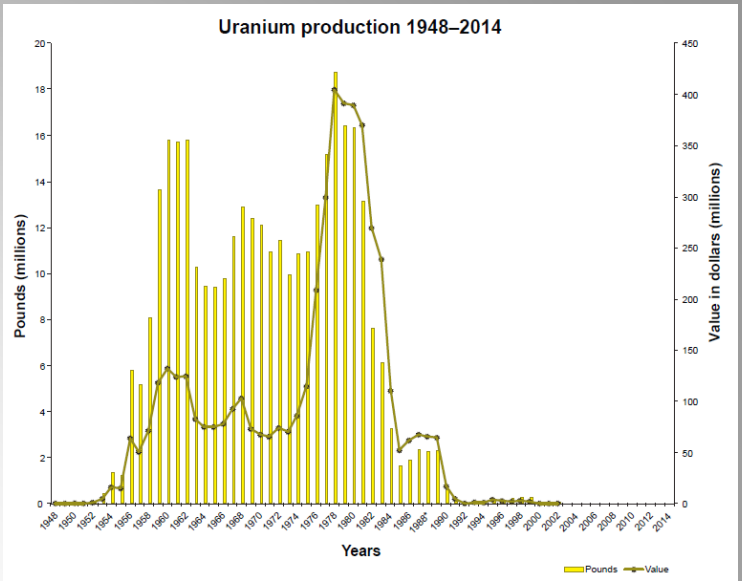
URANIUM IN NEW MEXICO 2018

- 2nd 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 (Strathmore, Energy Minerals, Laramide Resources, among others)
- Energy Fuels acquired Strathmore in 2013 and is now permitting the Roca Honda mine
- HRI, Inc. awaiting permits for in situ leach in Church Rock, Ambrosia Lake areas
- Several exploration permits approved or in progress

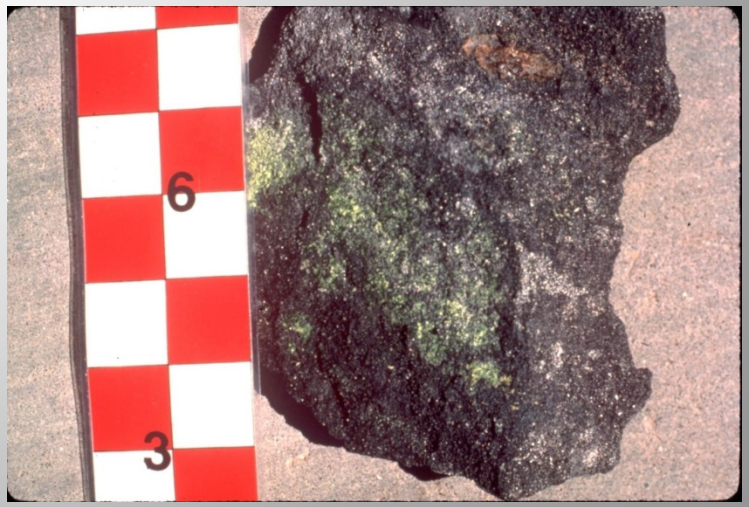


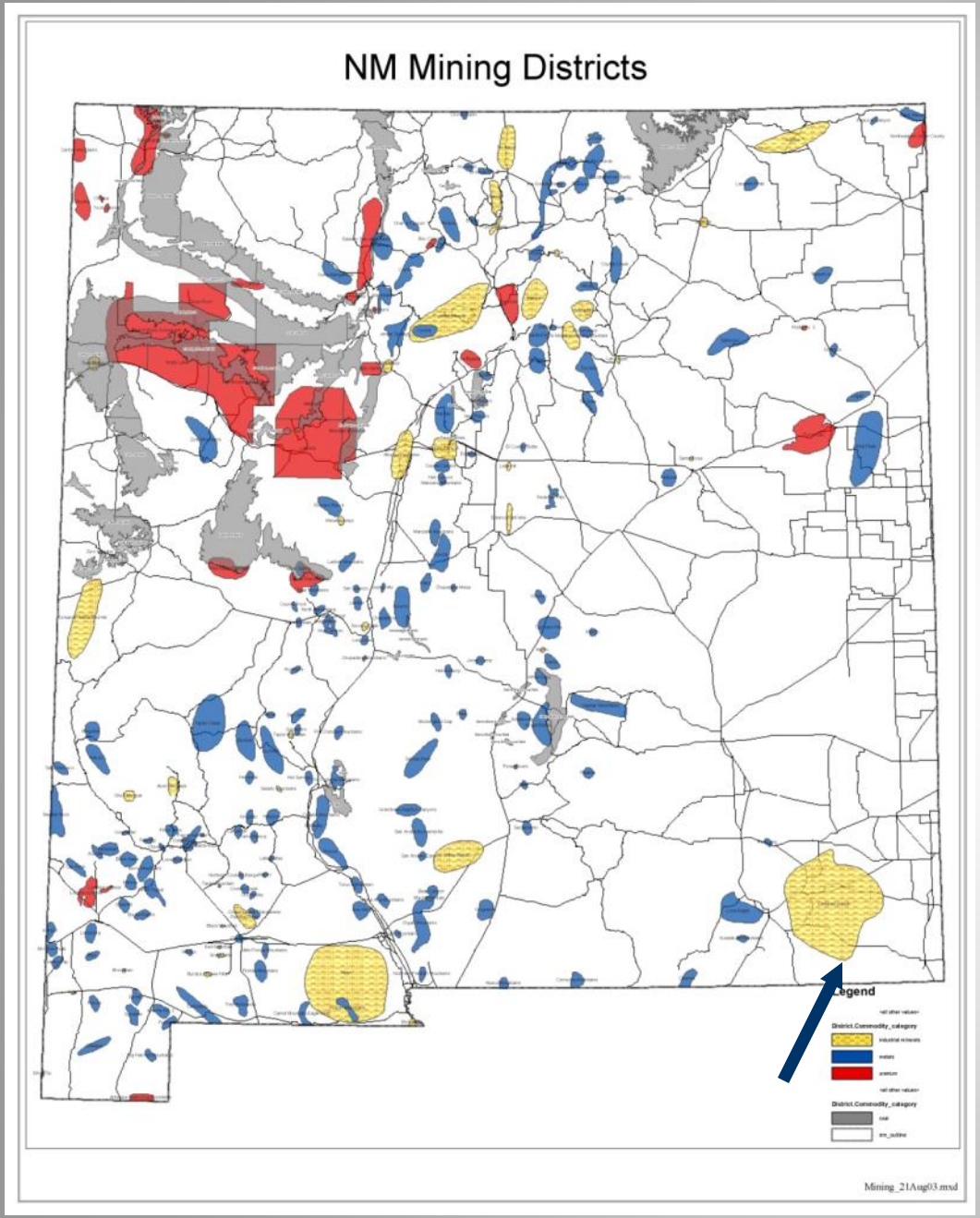
Deposits with uranium resources in New Mexico (McLemore and Chenoweth, 2017). Only major mines and deposits are included here.


N
very high potential uranium
high potential uranium
moderate potential uranium
moderate potential Ogallala
low potential uranium
U occurrence districts
Counties
0 25 50 100 Miles
0 37.5 75 150 Kilometers


Uranium production 1948–2014
Pounds (millions)
Value in dollars (millions)
Years
Pounds
Value

Uranium


6
3



POTASH PRODUCTION

1951-2015 109 million tons worth >$15 billion

Reserves in Carlsbad District

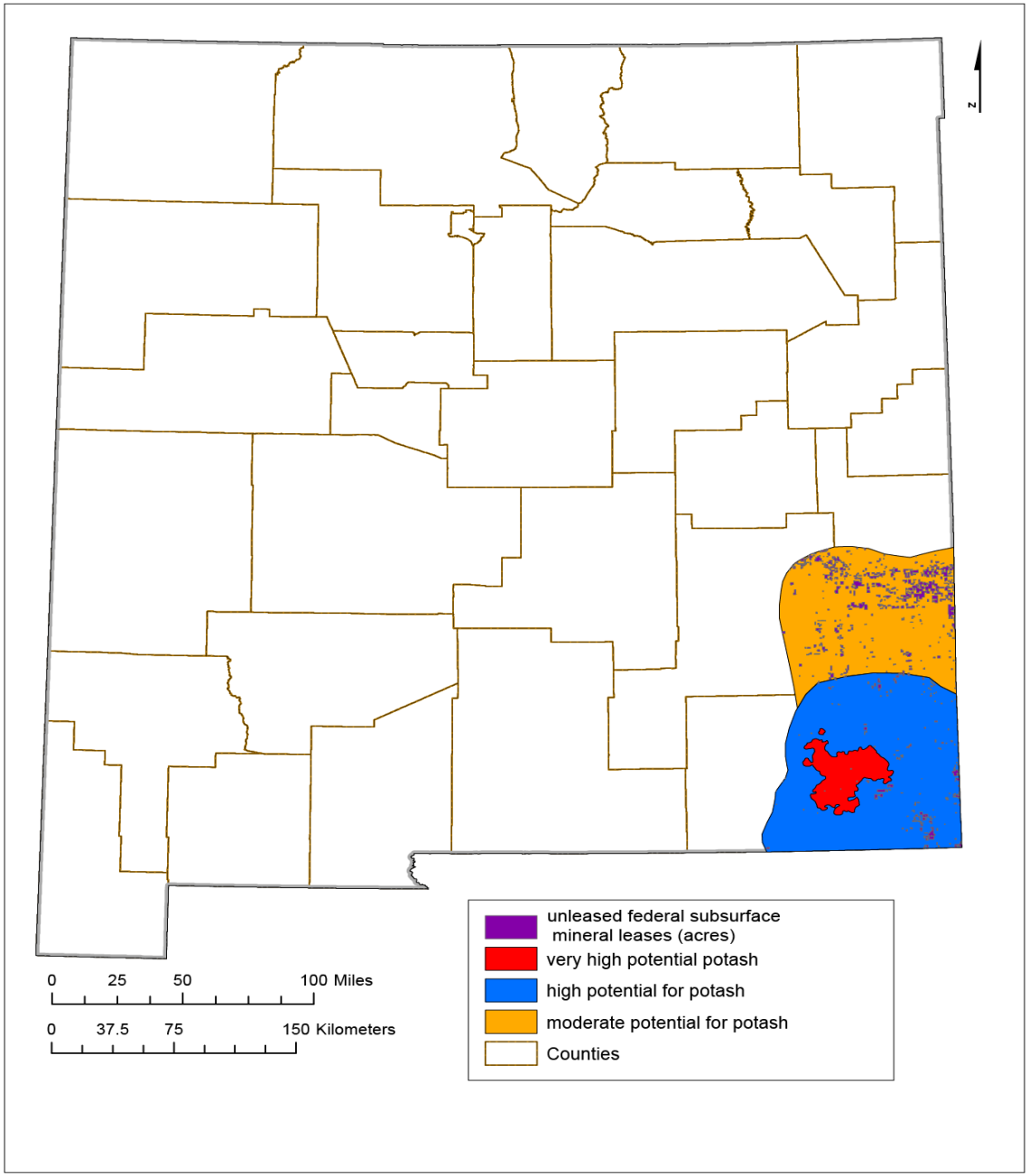
Potash (>553 million tons)

Potash is used in fertilizers among other uses

Intrepid closed one mine

Competition from Canadian deposits

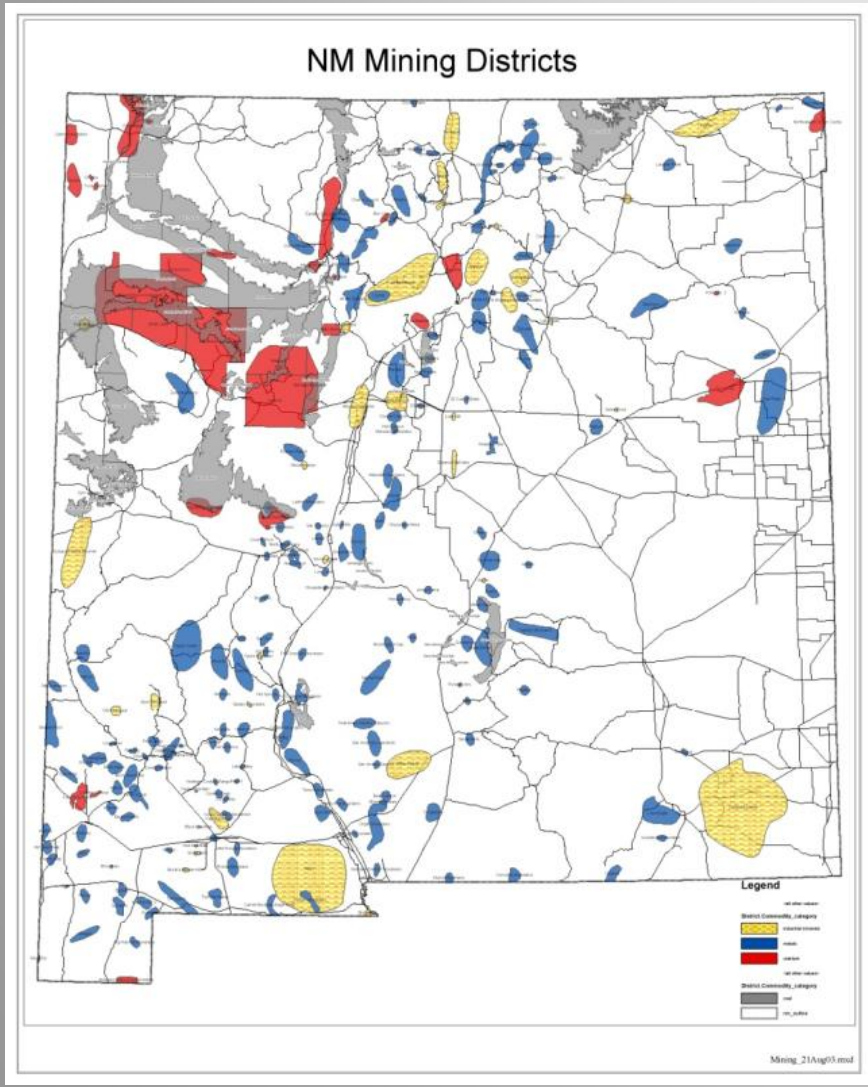
Potash potential



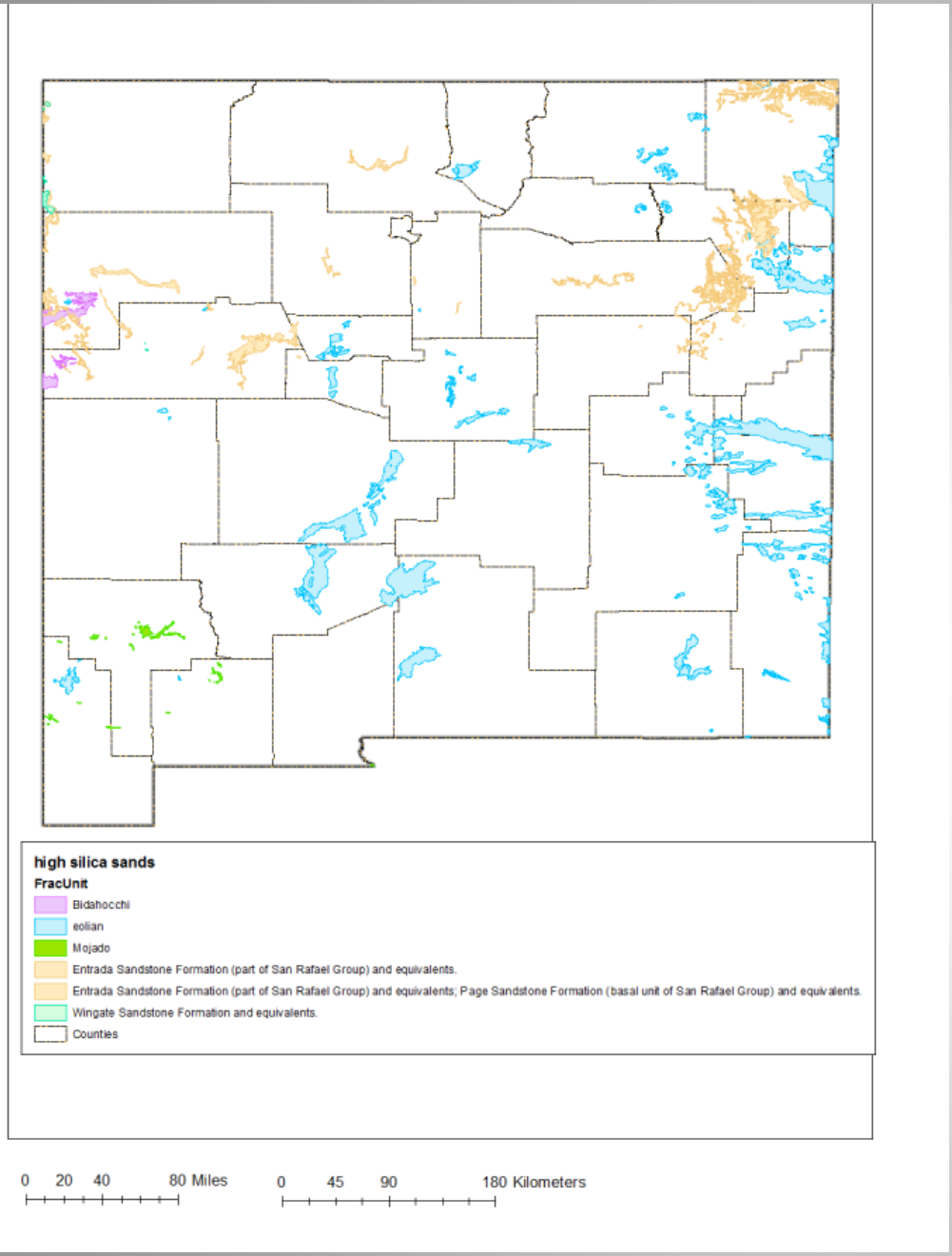
Recent developments in potash

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

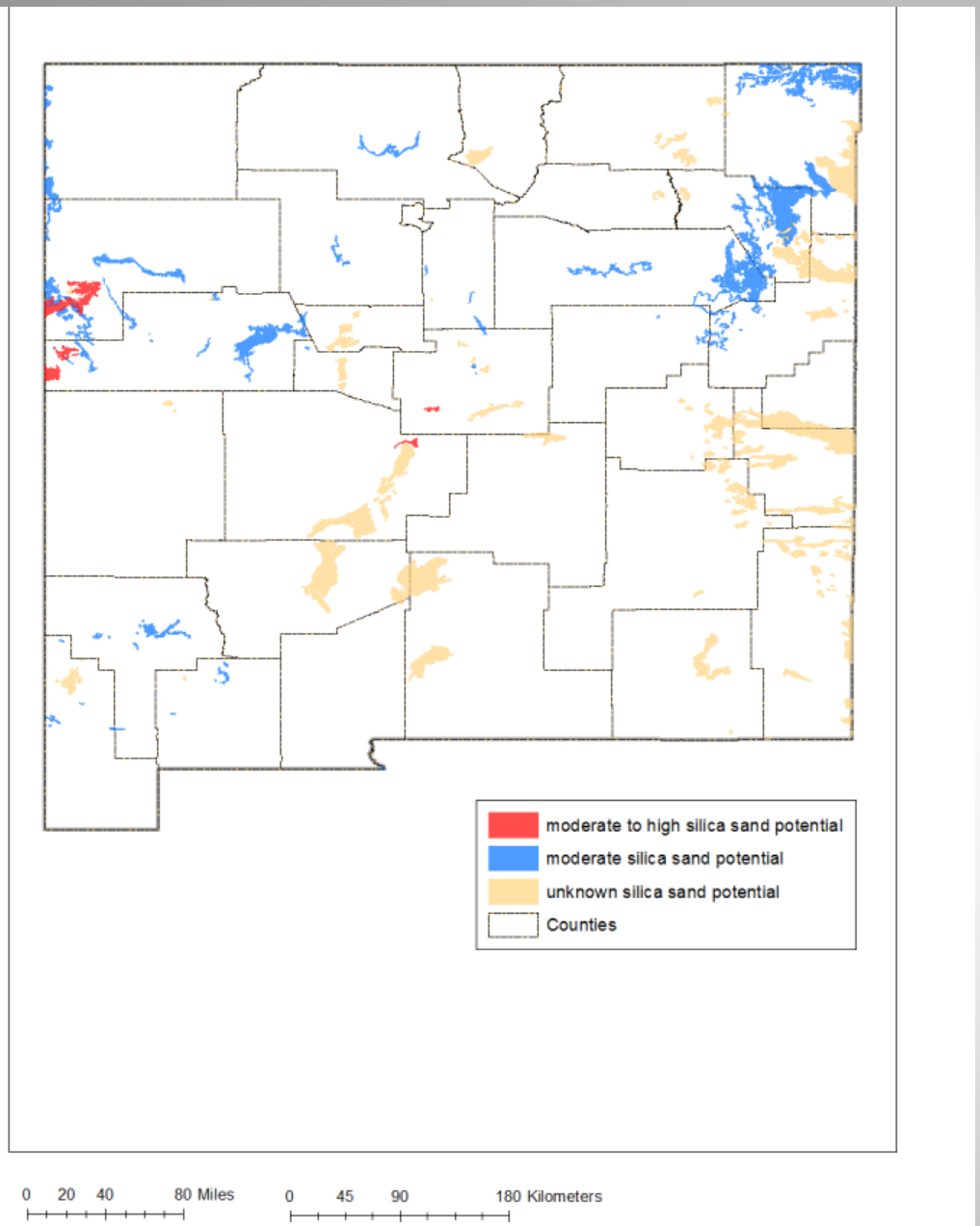
Additional Industrial minerals in New Mexico



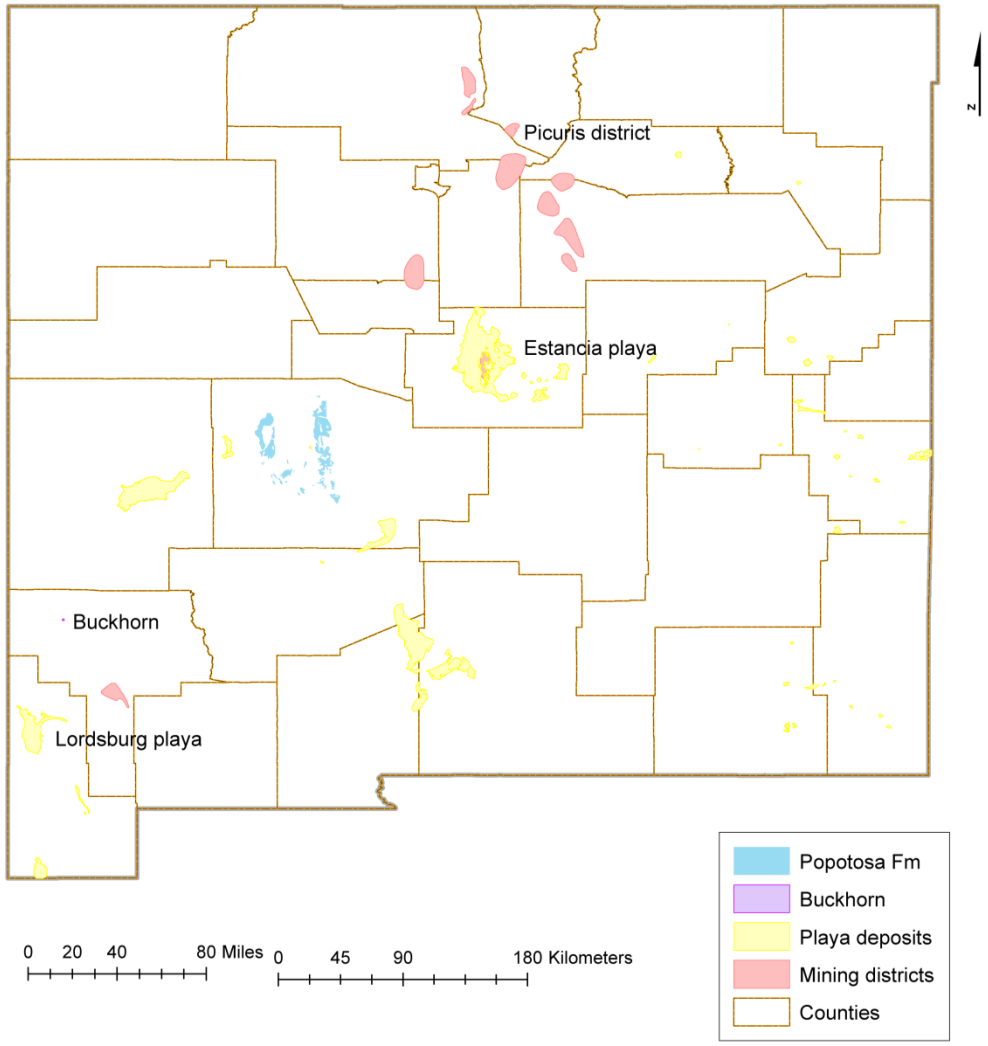
- 1st in zeolite (St. Cloud, Sierra County)
- 5th in pumice (6 operations)
- 1st in perlite (4 operations)
- 11th in salt (4 operations, Carlsbad)



Industrial sand (frac sand)—potential geologic units



Industrial sand (frac sand)—mineral-resource potential



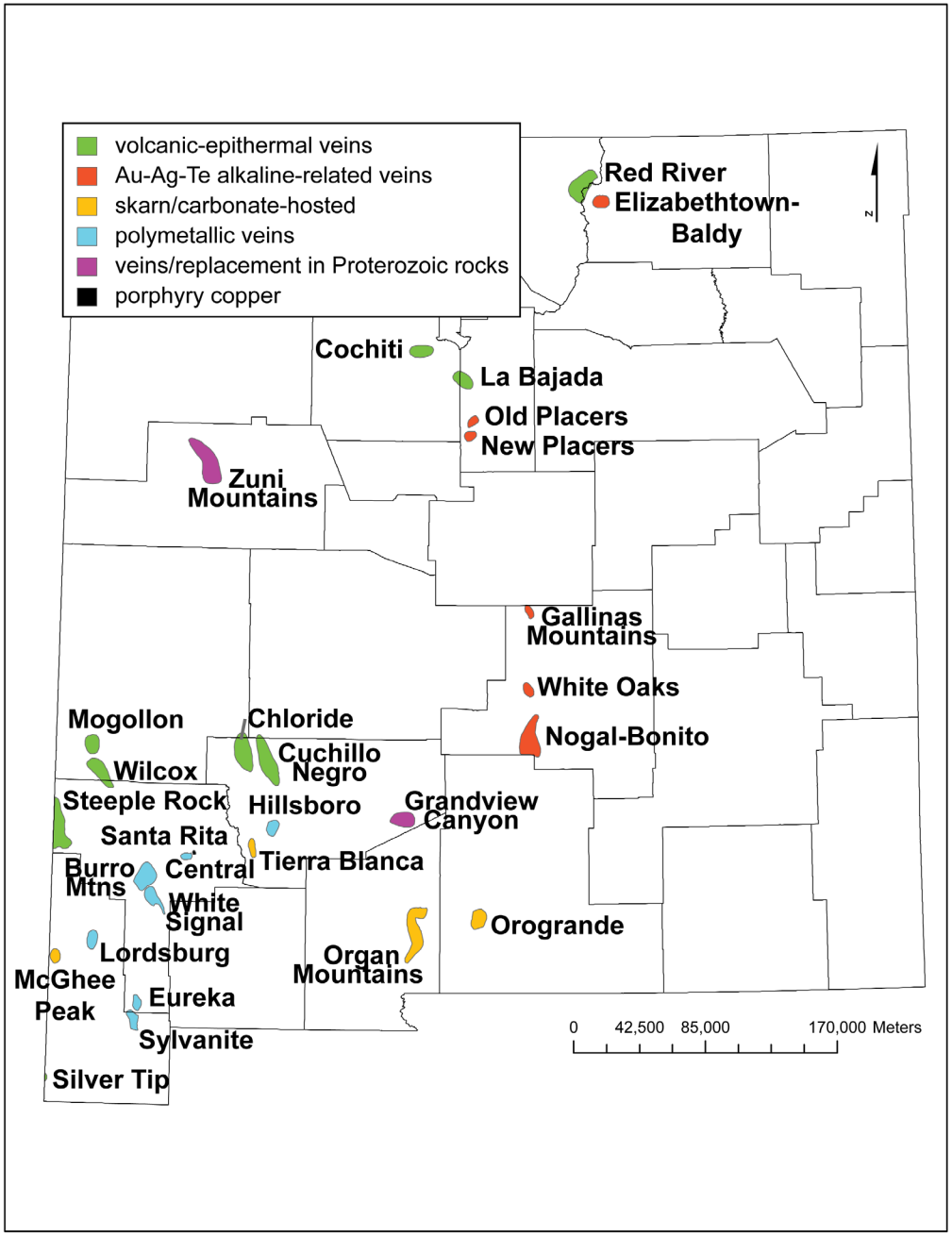
Lithium in New Mexico

Lithium in New Mexico

Other industrial minerals deposits

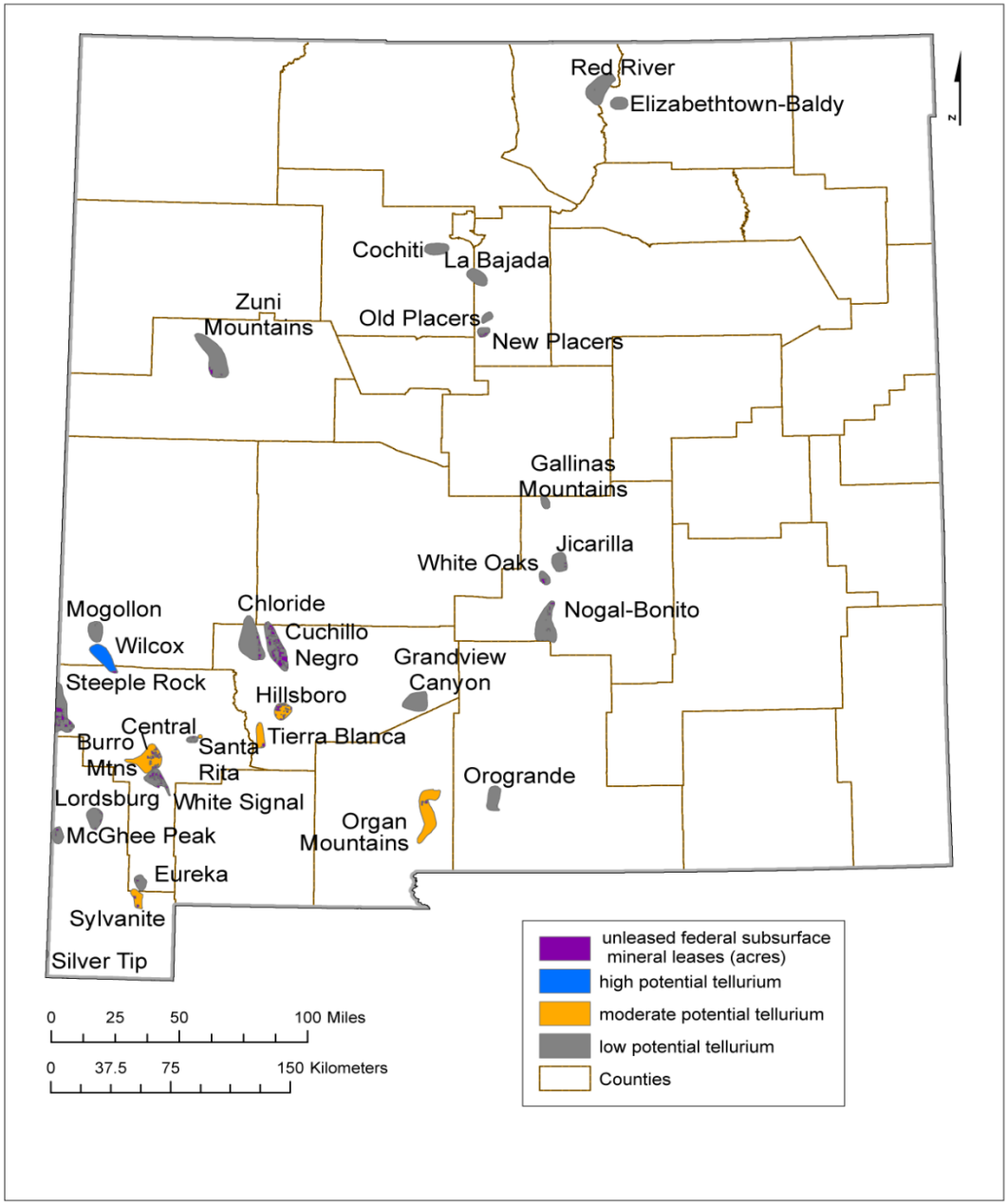
- Aggregates
- Gypsum for wallboard
- Brick and clay in El Paso, Albuquerque areas
- Cement in Tijeras Canyon
- Humate in the San Juan Basin
- Sulfur, helium, carbon dioxide
- Travertine (dimension stone), Meso del Oro, west of Belen
  - 477.6 million tons of travertine

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

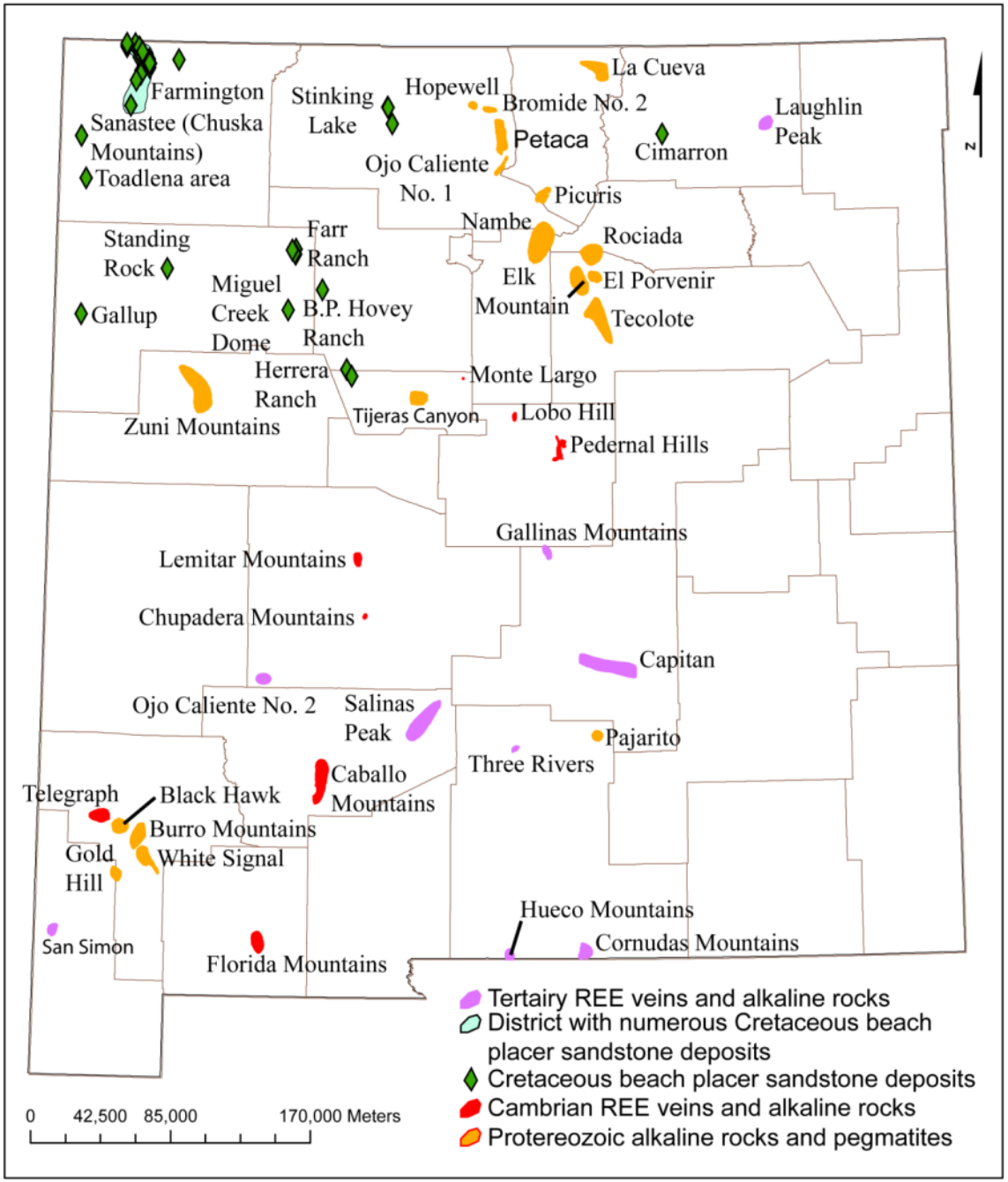


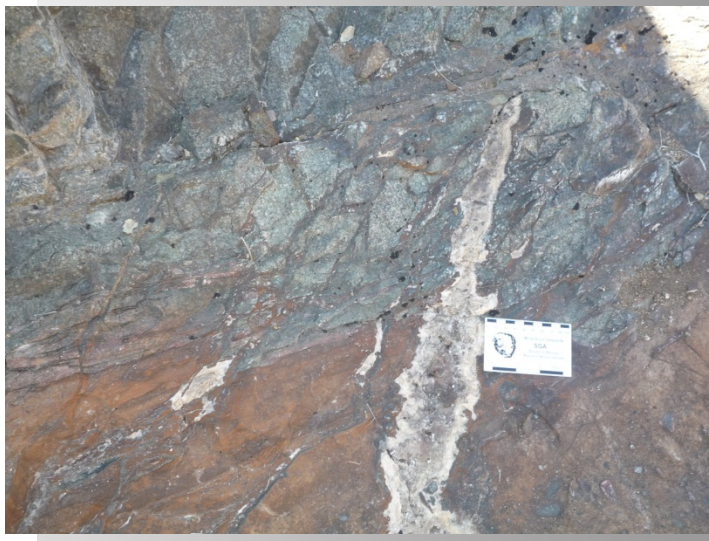
Native tellurium from the Lone Pine, NM (4 cm)

Tellurium potential

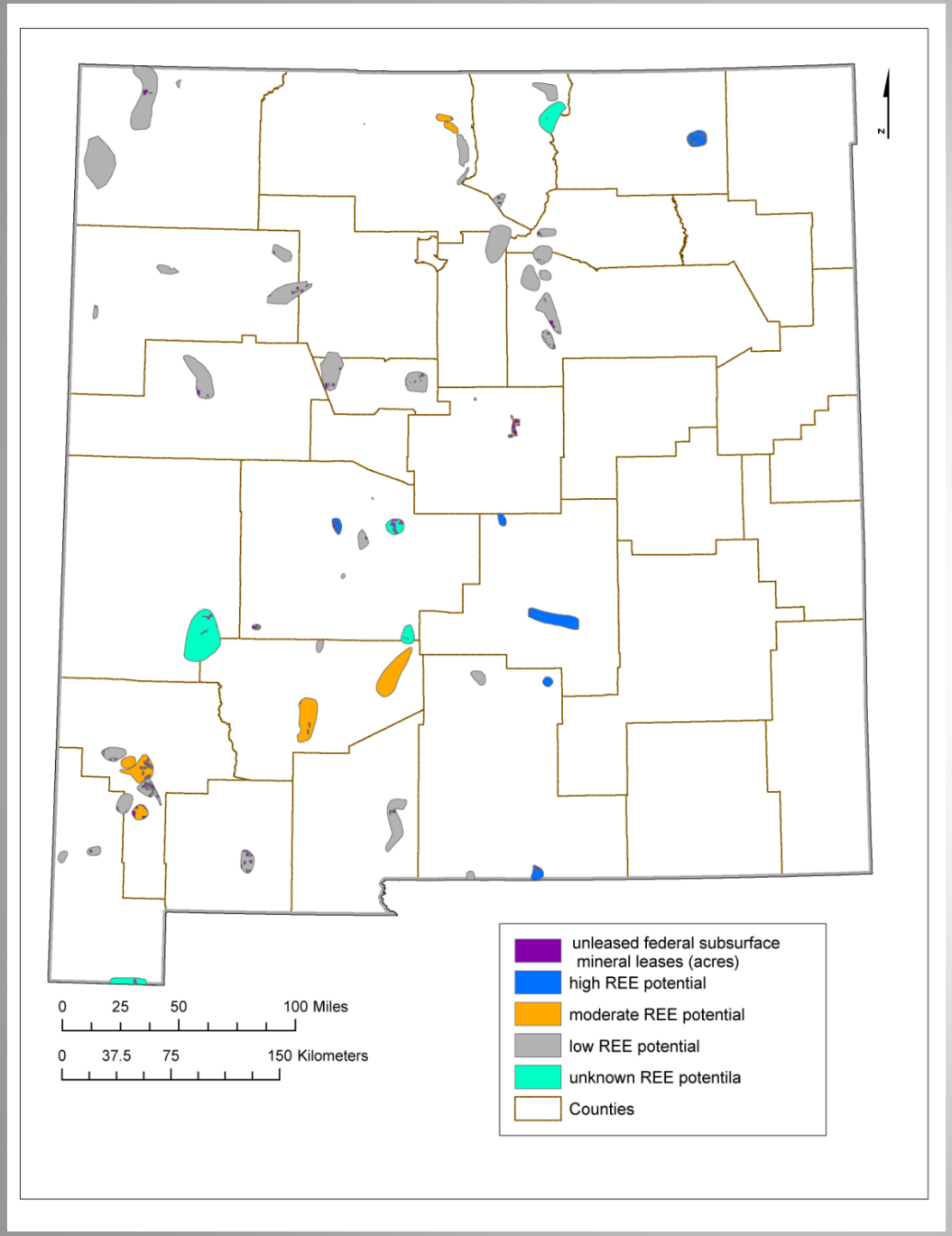


Occurrences of Rare Earth Elements (REE) in New Mexico





Lemitar carbonatite, NM



Rare earth elements potential

Summary

- New Mexico has a wealth of mineral resources
- Using ArcGis, geologic and mineral deposit data, we can evaluate the mineral-resource potential of an area
- The evaluation process is complex and is based upon geologic analogy of promising or favorable geologic environments with geologic settings of known economic deposits
- Enables decision makers the ability to make decisions on land use and can be used to identify areas requiring additional study

More Information

- NM Mines and Minerals Division

  http://www.emnrd.state.nm.us/MMD/

  Virginia McLemore web page

  http://geoinfo.nmt.edu/staff/mclemore/home.html

- New Mexico Bureau of Geology and Mineral Resources

  http://geoinfo.nmt.edu/

QUESTIONS?