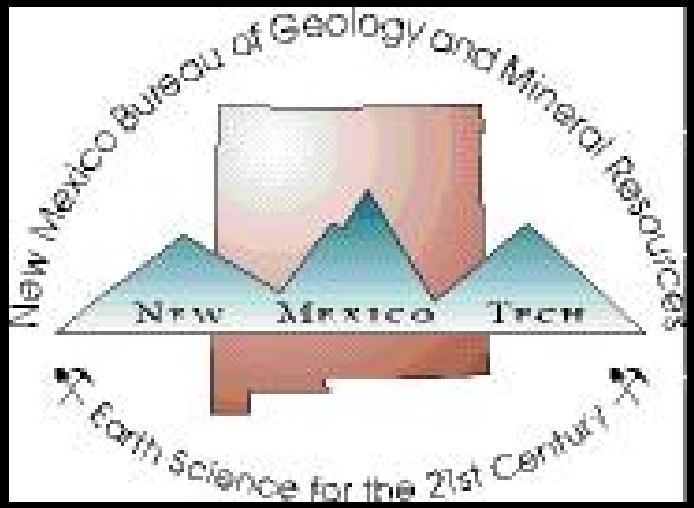
STATUS OF THE MINING INDUSTRY IN NEW MEXICO—2019



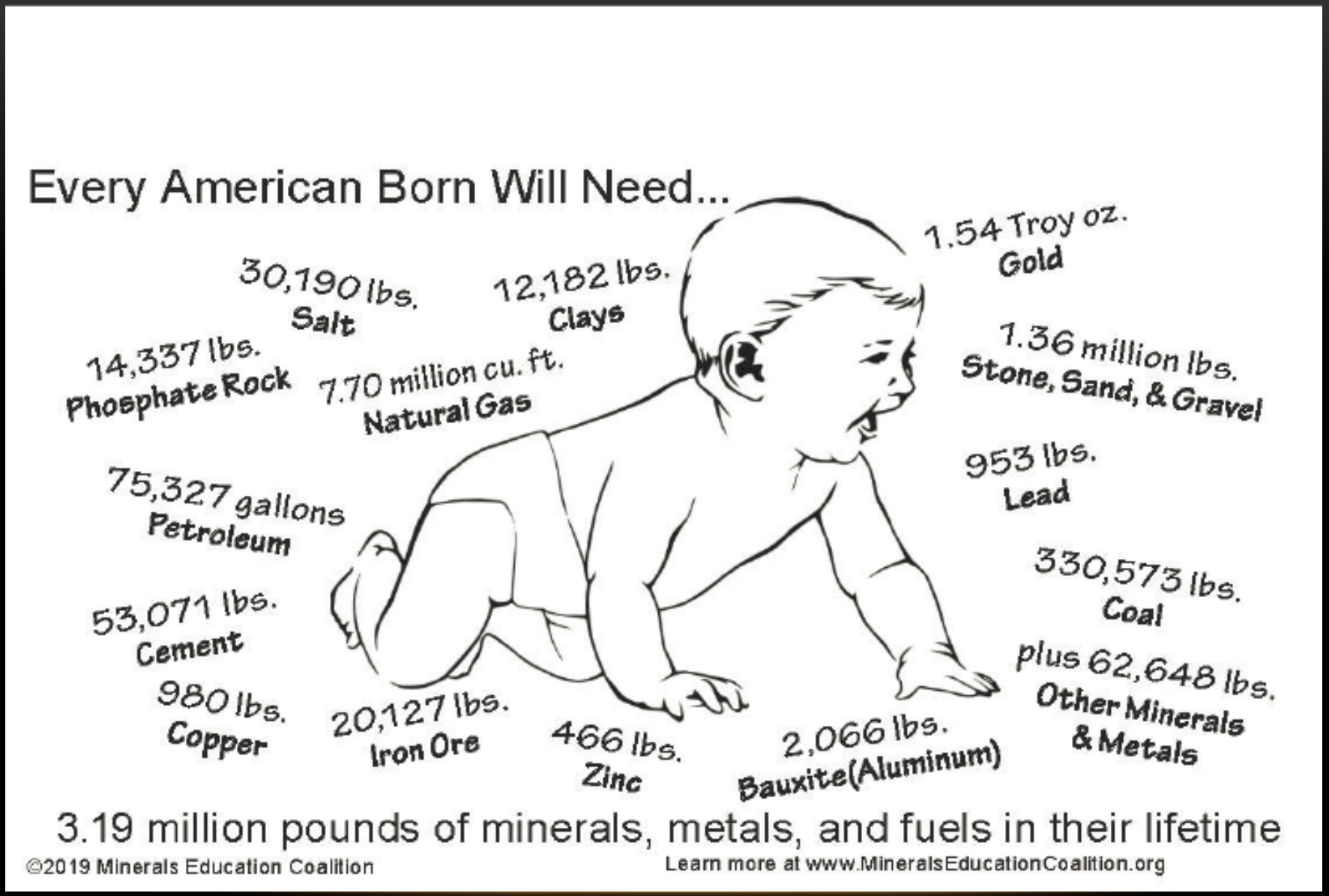
Virginia T. McLemore

New Mexico Bureau of Geology and Mineral Resources, New Mexico Tech, Socorro, NM

New Mexico Tech

ACKNOWLEDGEMENTS

- New Mexico Energy, Minerals and Natural Resource Department
- Company annual reports
- Personal visits to mines
- Historical production statistics from U.S. Bureau of Mines, U.S. Geological Survey, N.M. Energy, Minerals and Natural Resource Department (NM MMD), company annual reports
- Students at NM Tech



https://mineralseducationcoalition.org/wp-content/uploads/2019-Mineral-Baby.pdf

OUTLINE

- What, where, and how much minerals are produced in New Mexico?
  - Where are potential future resources?
- Are there critical minerals in New Mexico?
- What are the Mining Issues Facing New Mexico?

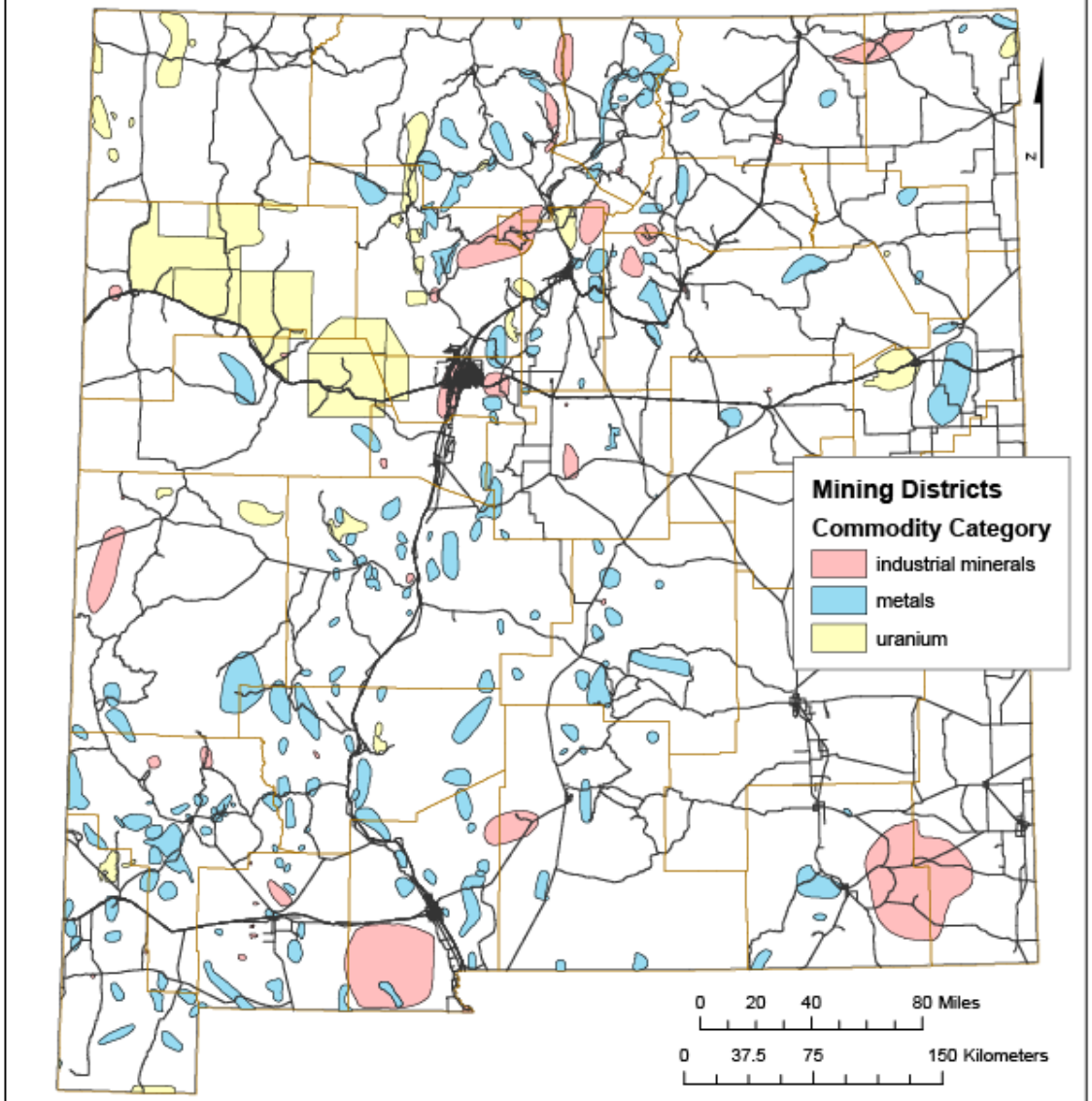
WHAT, WHERE, AND HOW MUCH MINERALS ARE PRODUCED IN NEW MEXICO?

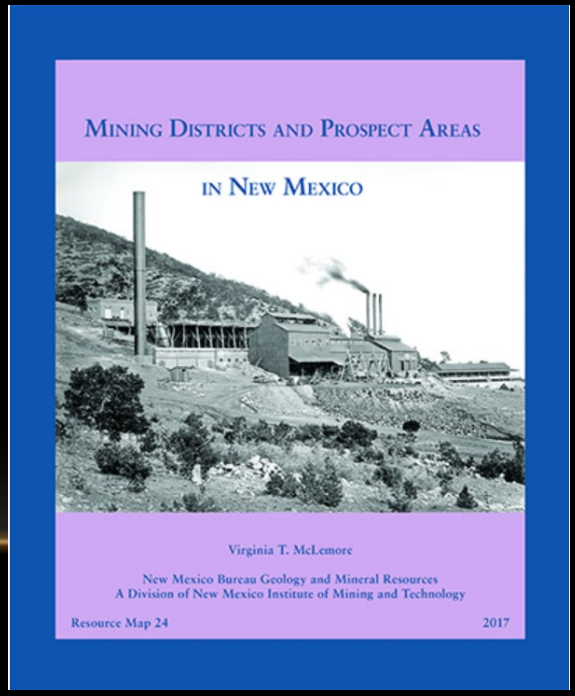
INTRODUCTION

- 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

MINING DISTRICTS IN NEW MEXICO

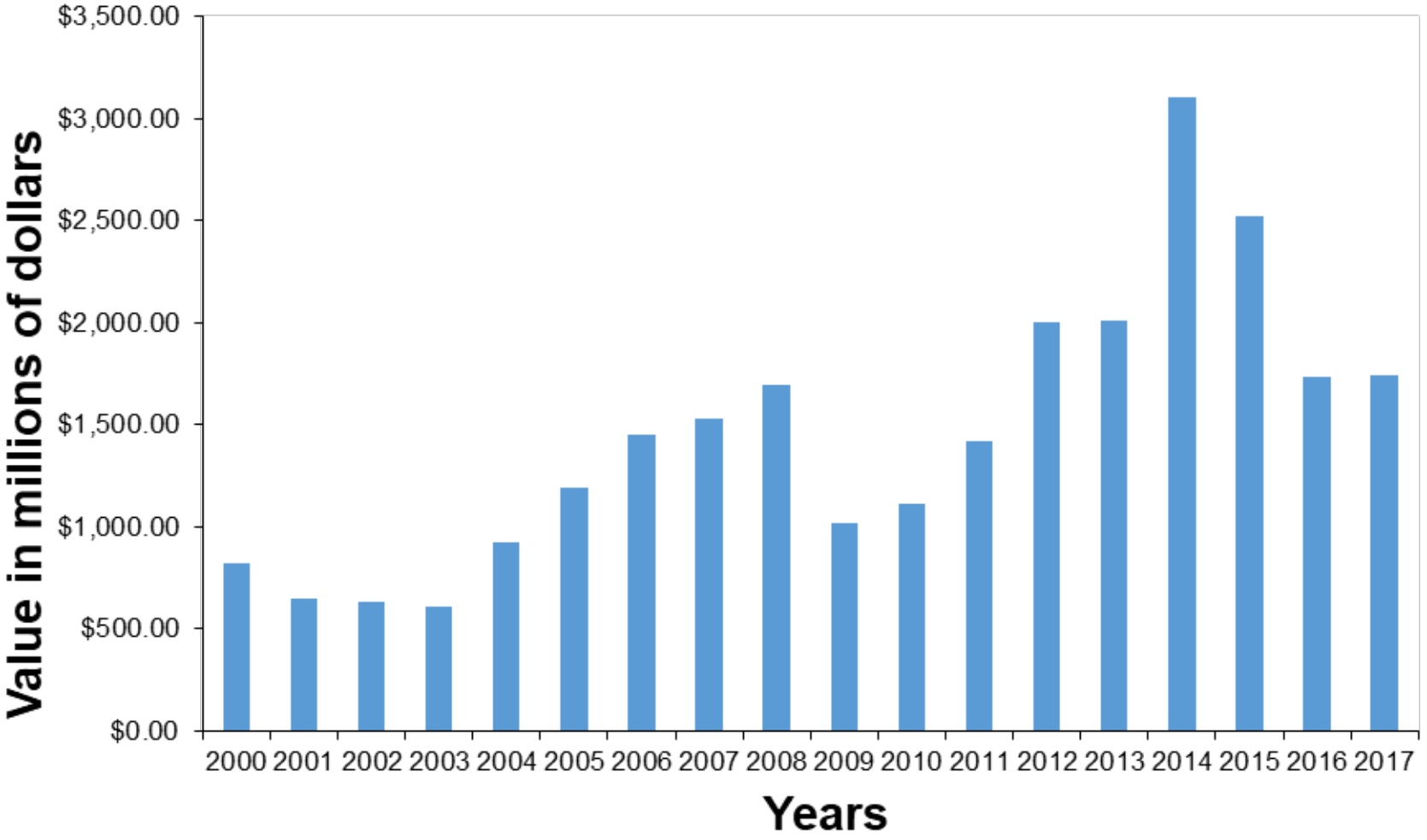




PRODUCTION SUMMARY—2017

- Value of mineral production in 2017 was $1.7 billion (does not include oil and gas)—ranked 18th in the US
- Employment in the mining industry is 4,685
- 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***

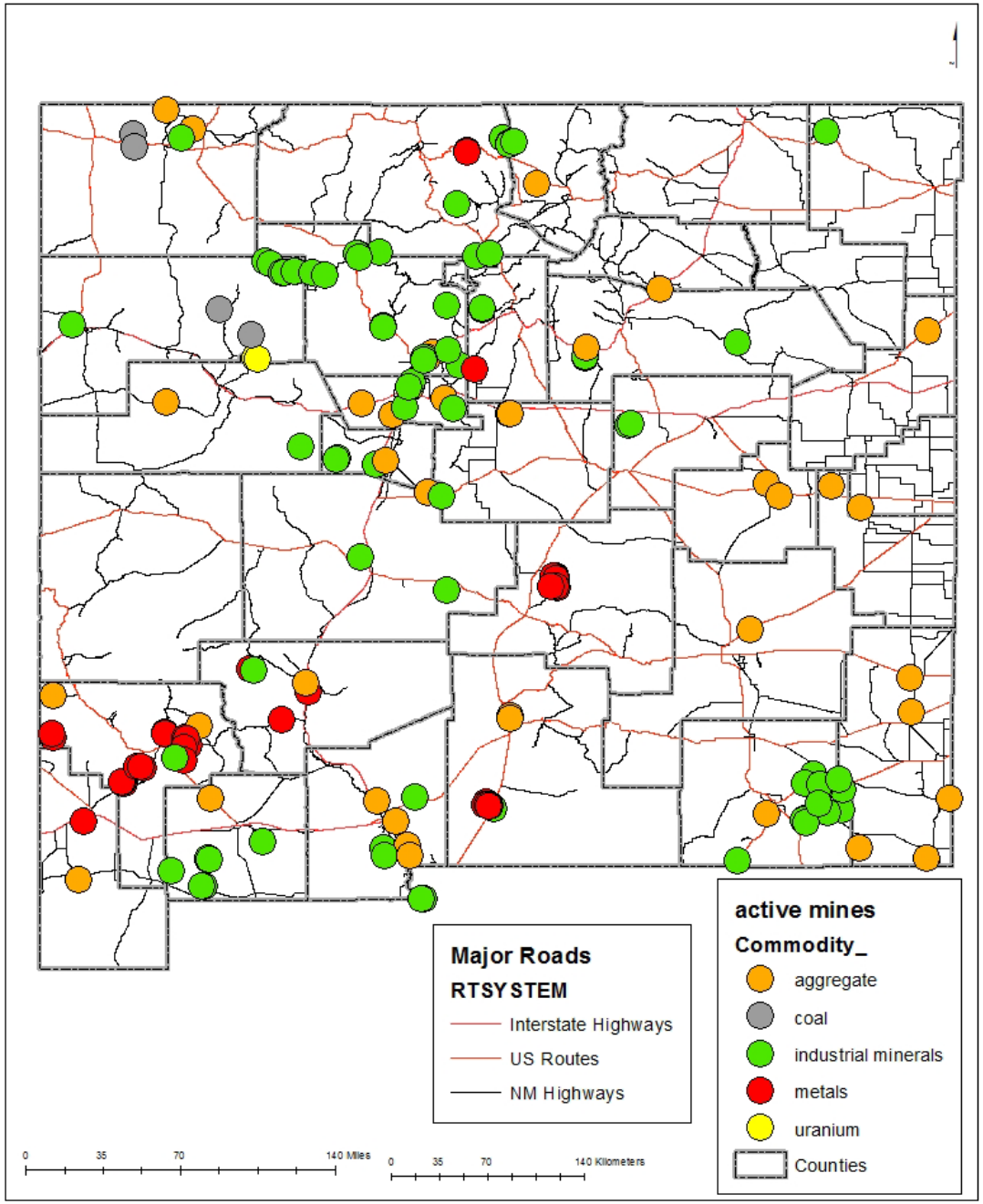
VALUE OF MINERAL PRODUCTION IN NEW MEXICO 2000-2017 (MMD)



ACTIVE MINES 2019

- ~282 active registered mines (NMMMD)
- 4 coal
- 3 potash, 4 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
- ~236 aggregate/stone

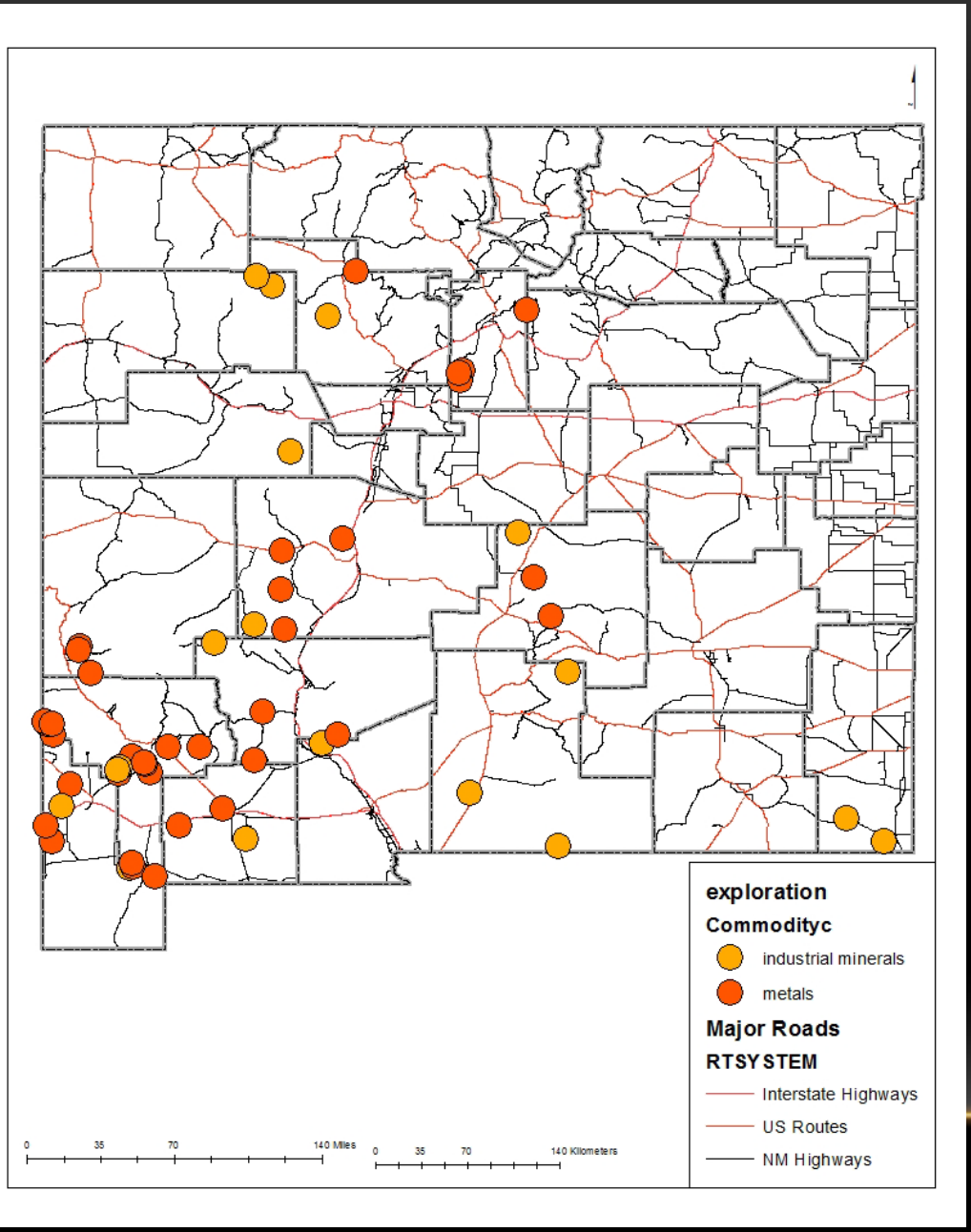
ACTIVE MINES IN NEW MEXICO 2016-2019



Not all aggregate mines are shown

From NM Mining and Minerals Div. database

SELECTED ACTIVE EXPLORATION SITES IN NEW MEXICO 2016-2019 (EXCLUDING U)



From NM Mining and Minerals Div. and NMBGMR databases, company web sites

Most of these exploration sites have been known for >20 yrs

Industrial minerals deposits sometimes can be permitted within a few yrs but not metal mines

COAL

- Fuels 3 electrical generating plants
- 3 surface mines and 1 underground mine in San Juan Basin
- Resources at Raton, Carrizozo
- 11th in production in U.S. in 2017
- 11th in estimated recoverable coal reserves—7 billion tons of recoverable reserves (2005 figures)
- San Juan generating station in the Farmington is scheduled to close in the near future
- ***Coal production is expected to decrease in the near future***

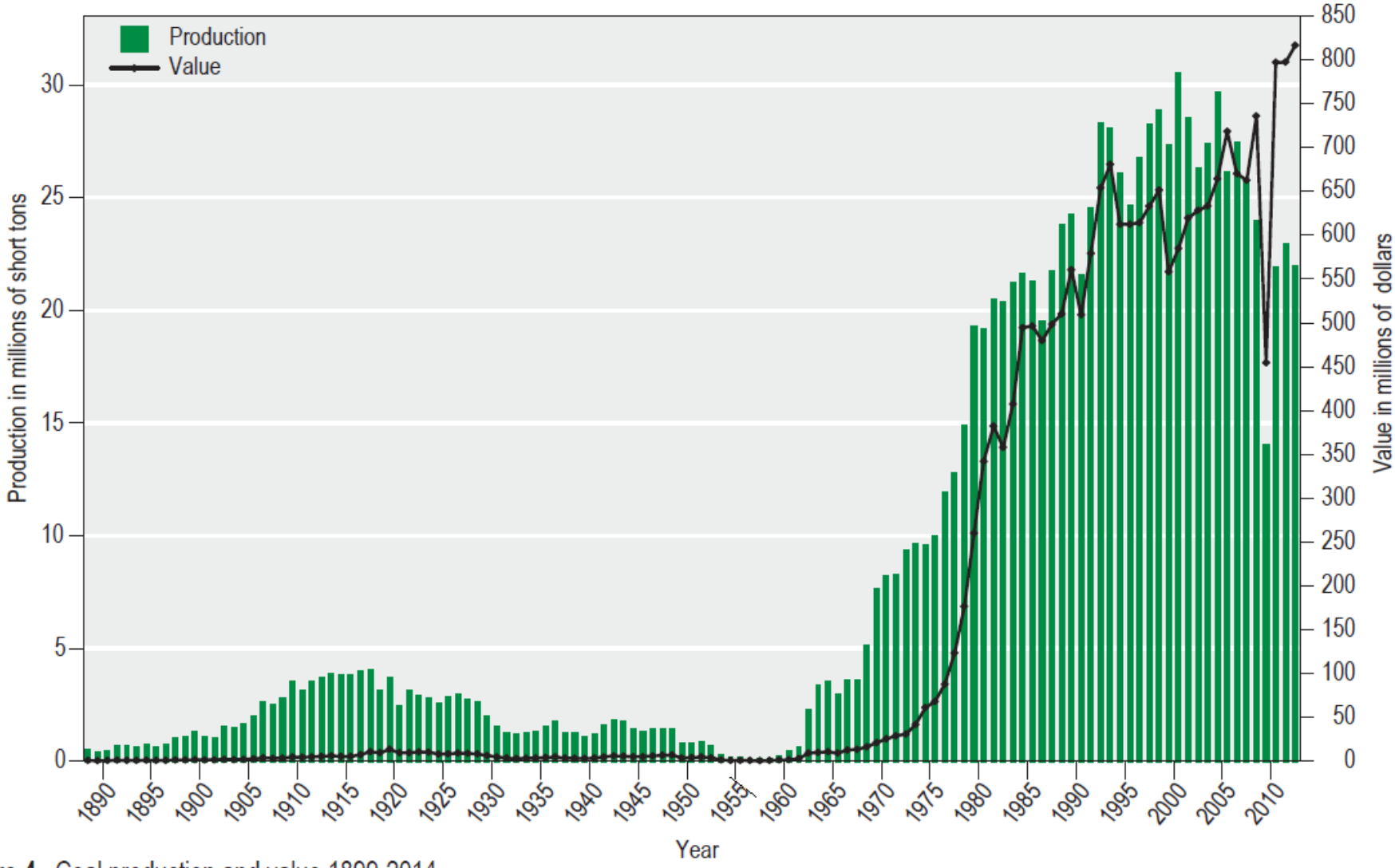
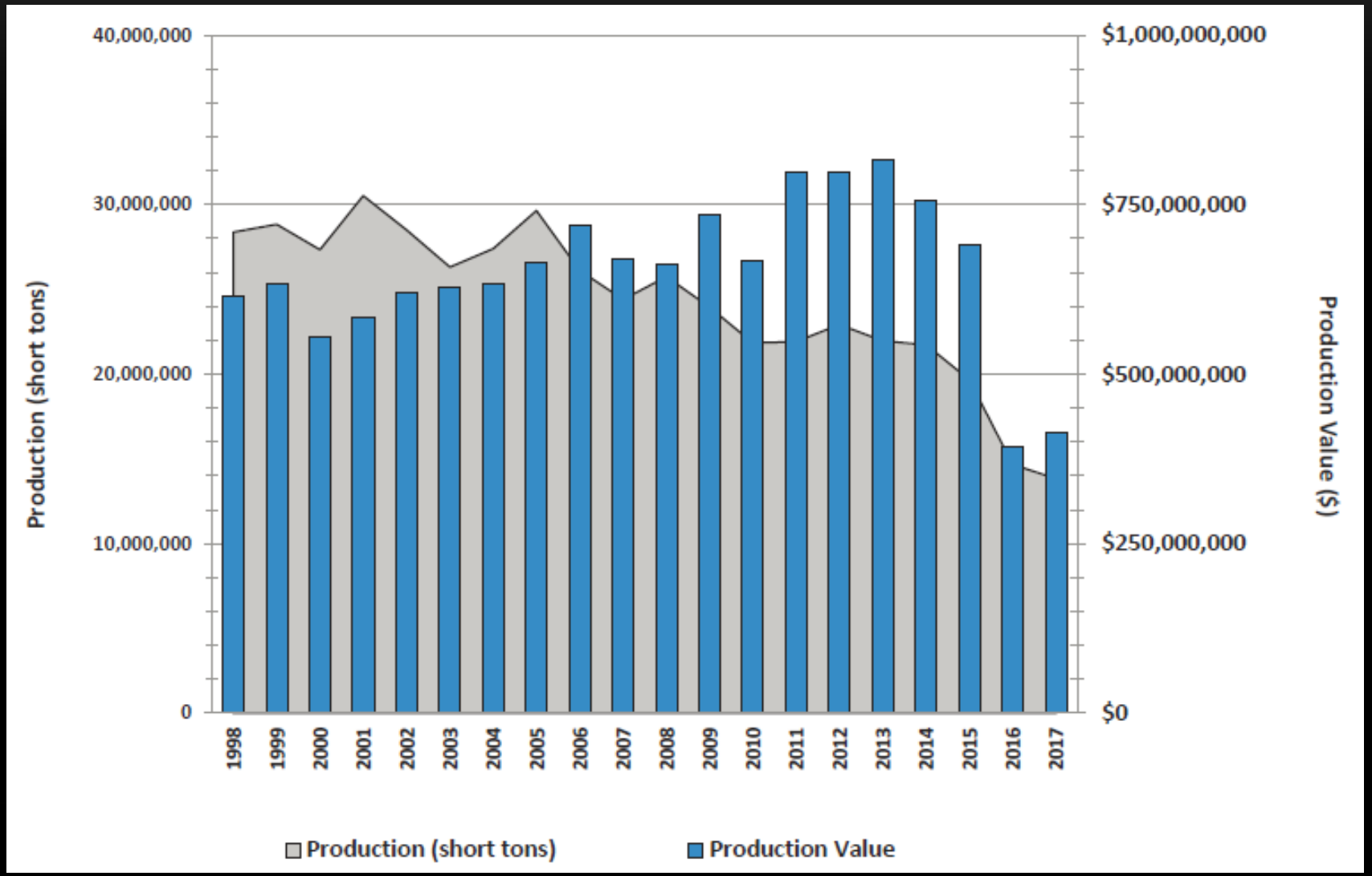


Figure 4. Coal production and value 1899-2014.

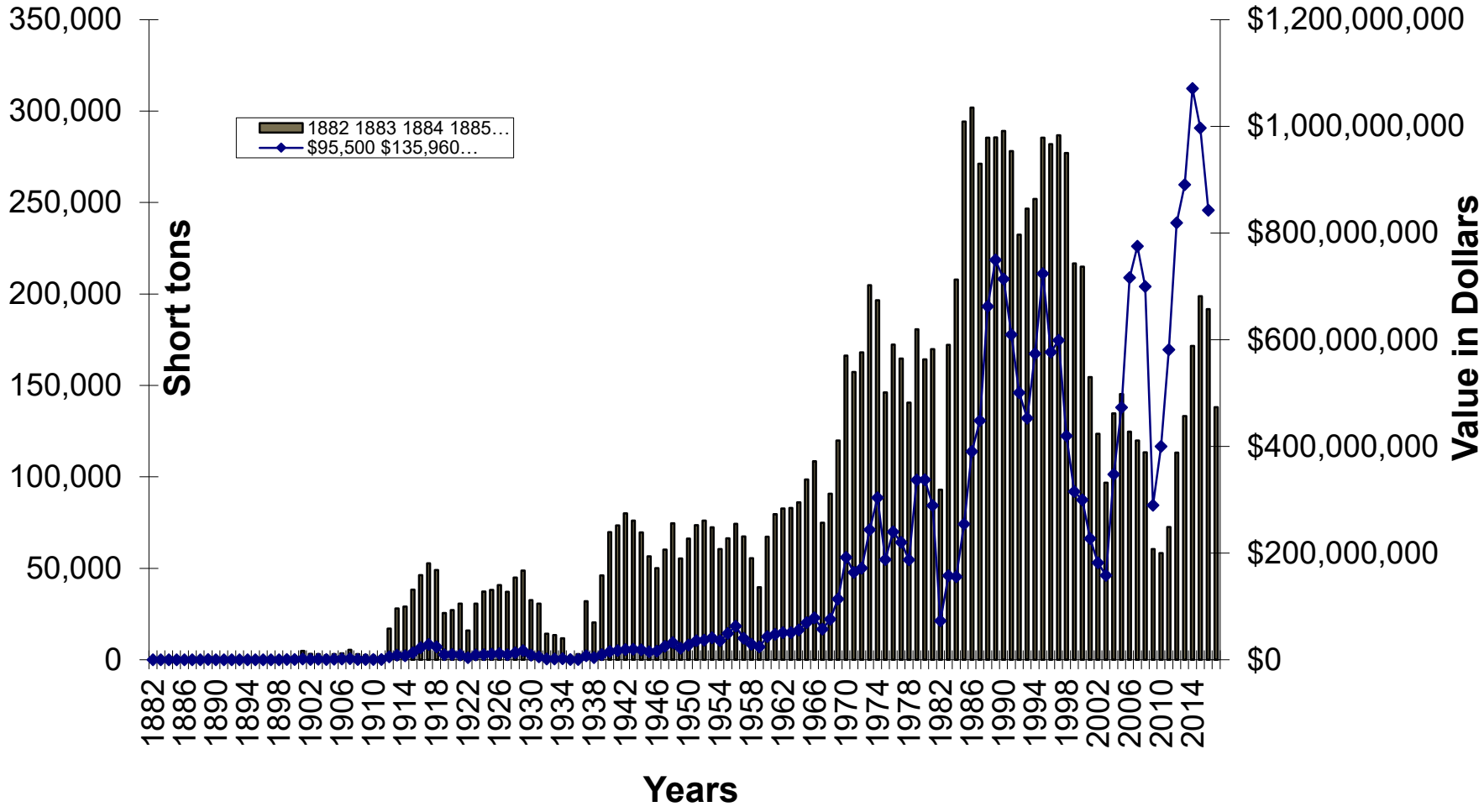
COAL PRODUCTION IN NEW MEXICO 1998-2017



http://www.emnrd.state.nm.us/ADMIN/documents/bw2018AR30Feb.pdf

METALS—3RD IN COPPER PRODUCTION IN 2017 (CHINO, TYRONE)

Copper Production 1882-2017

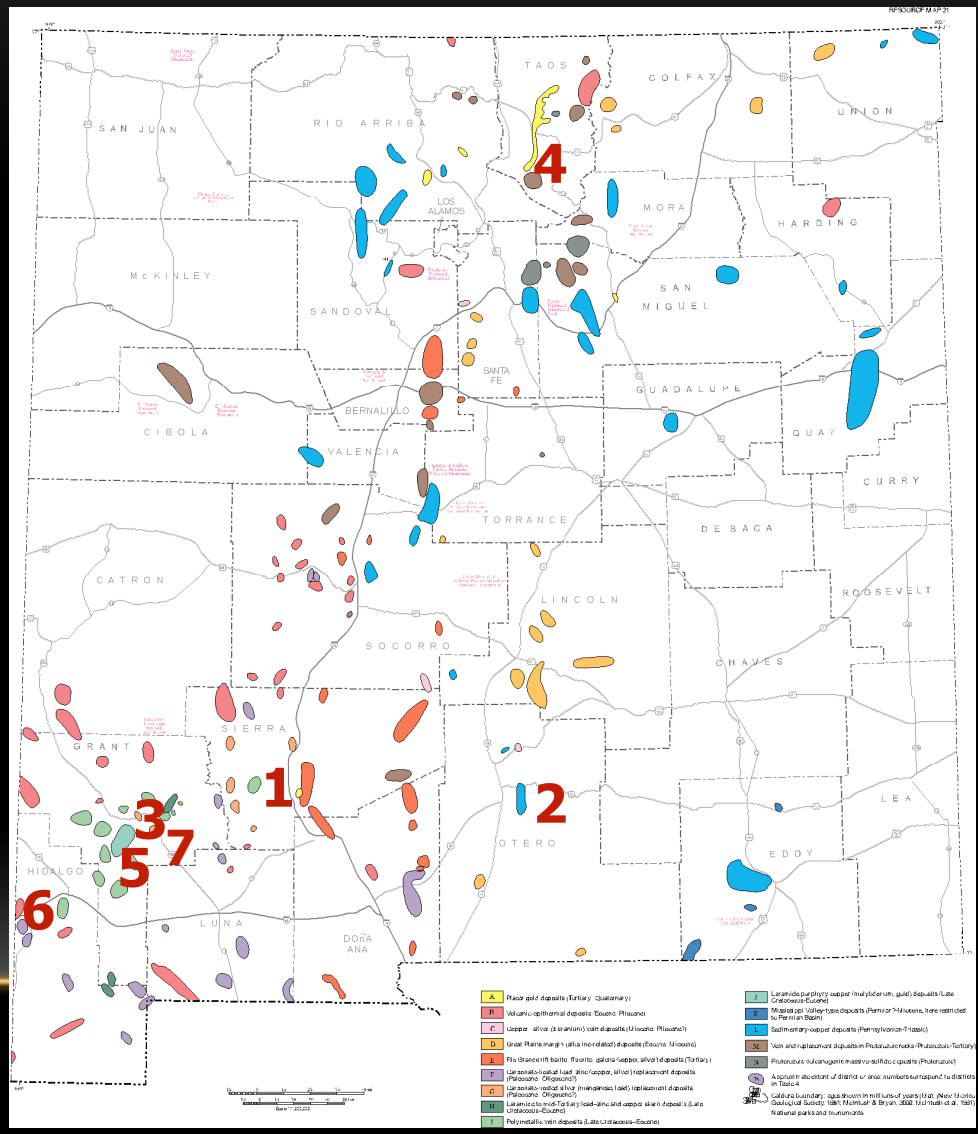


COPPER RESERVES—2018

- Grades are decreasing
- Chino (incl. Hanover, Cobre)
  - milling reserves are 274 million metric tons of 0.54% copper, 0.04 g/t gold, 0.93 g/t silver and 0.01% molybdenum
  - leaching reserves are 121 million tons of 0.29% Cu
- Tyrone (incl. Little Rock)
  - leaching reserves are estimated as 55 million metric tons of ore grading 0.25% Cu
  - Expected to close 2020s

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

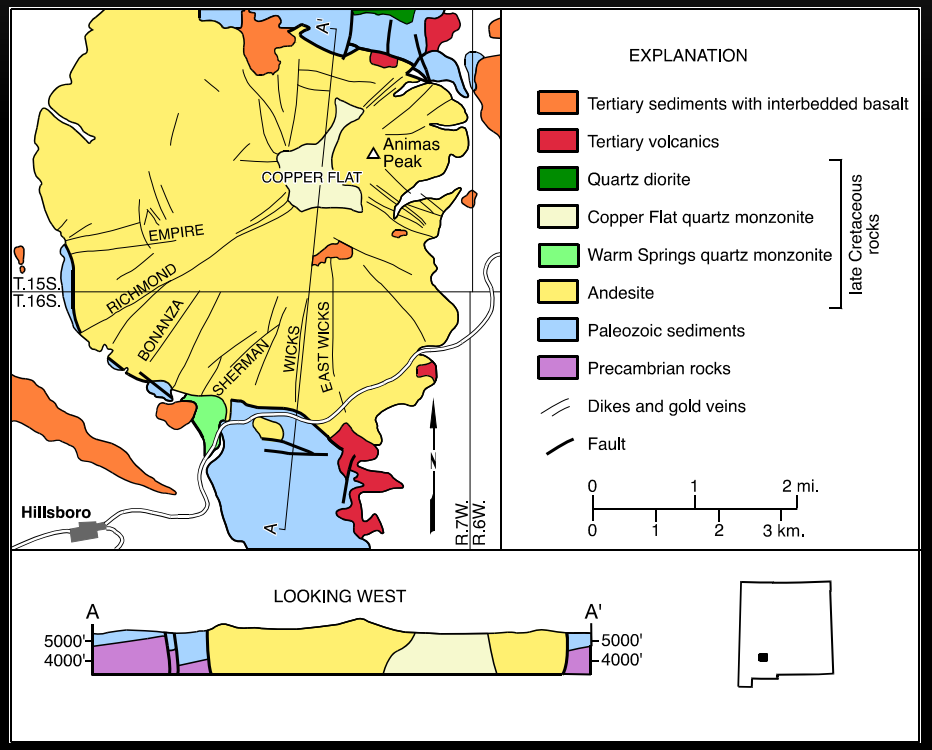
50.76 mill lbs Cu

1.01 mill lbs Mo

12,750 oz Au

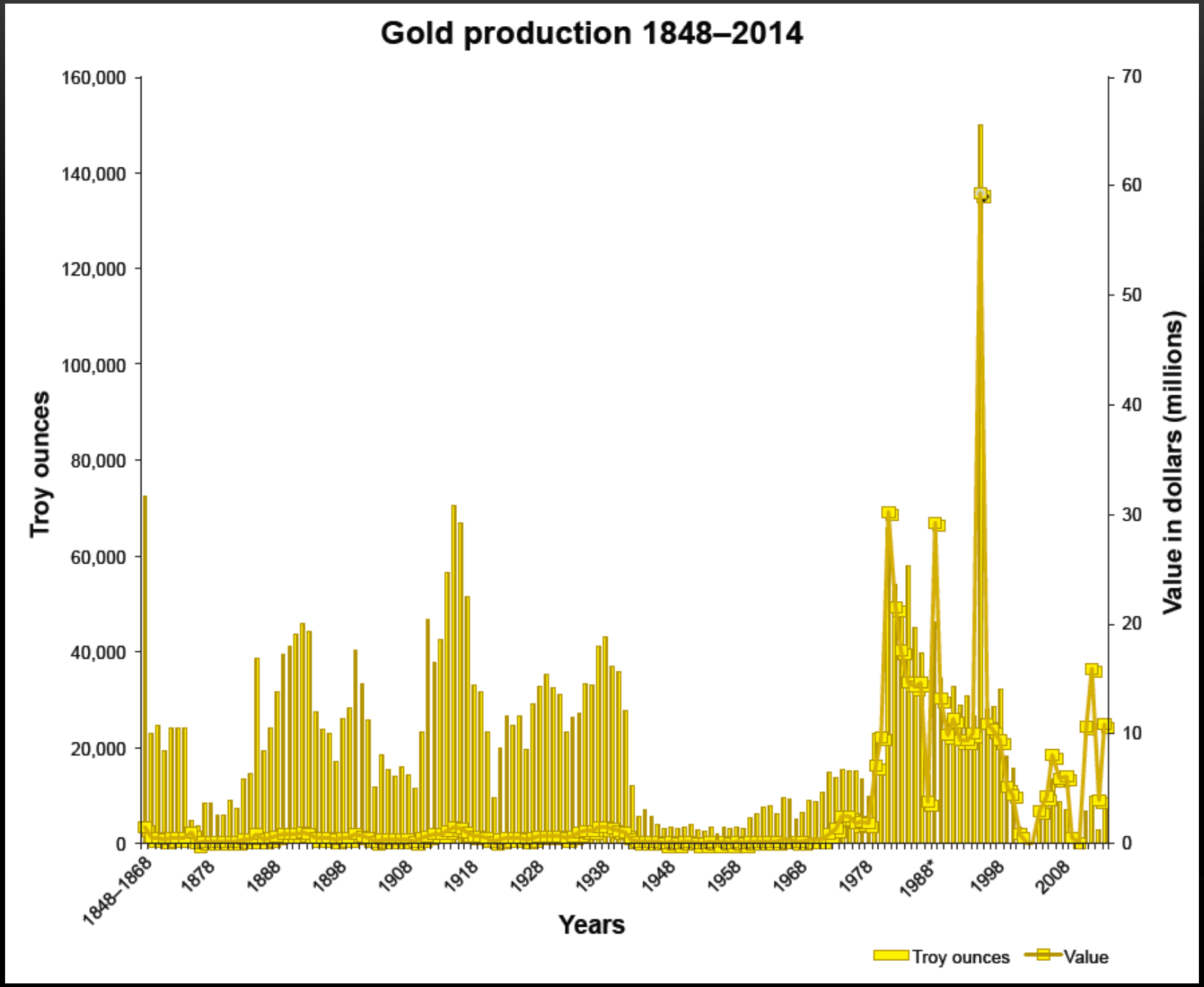
455,390 oz Ag

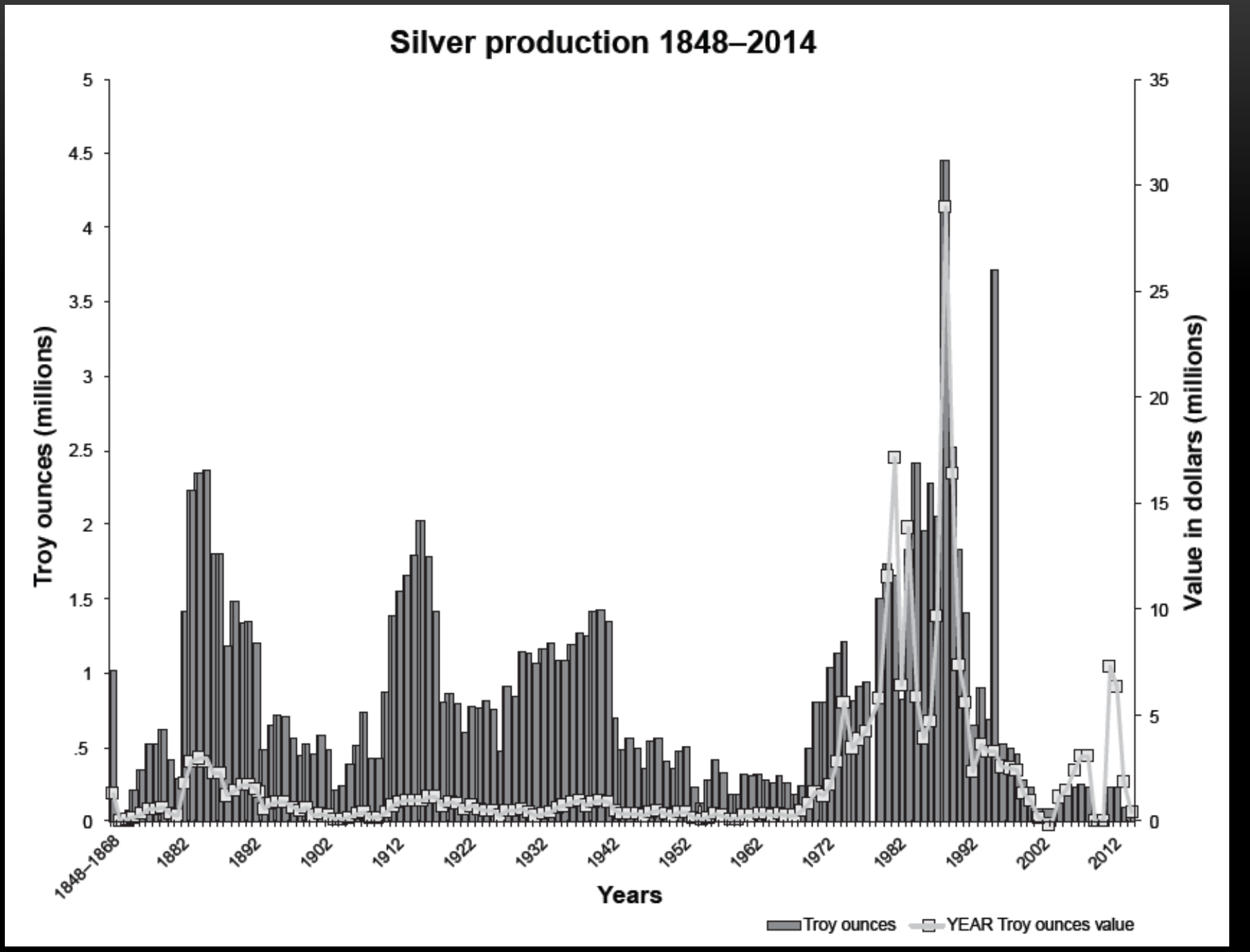
Start in 2020s?



GOLD AND SILVER PRODUCTION

- In 2004-2017 as a byproduct of copper production from the Ivanhoe concentrator (Freeport-McMoRan)
- 2009 Summit mine opened (currently on standby)
- 9th in gold production
- 10th in silver production


Gold production 1848–2014
Troy ounces
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Value in dollars (millions)
70
60
50
40
30
20
10
0
1848–1868
1878
1888
1898
1908
1918
1928
1938
1948
1958
1968
1978
1988*
1998
2008
Years
Troy ounces
Value


Silver production 1848–2014
Troy ounces (millions)
Value in dollars (millions)
Years
5
4.5
4
3.5
3
2.5
2
1.5
1
.5
0
35
30
25
20
15
10
5
0
1848–1868
1882
1892
1902
1912
1922
1932
1942
1952
1962
1972
1982
1992
2002
2012
Troy ounces
YEAR Troy ounces value

SUMMIT GOLD MINE

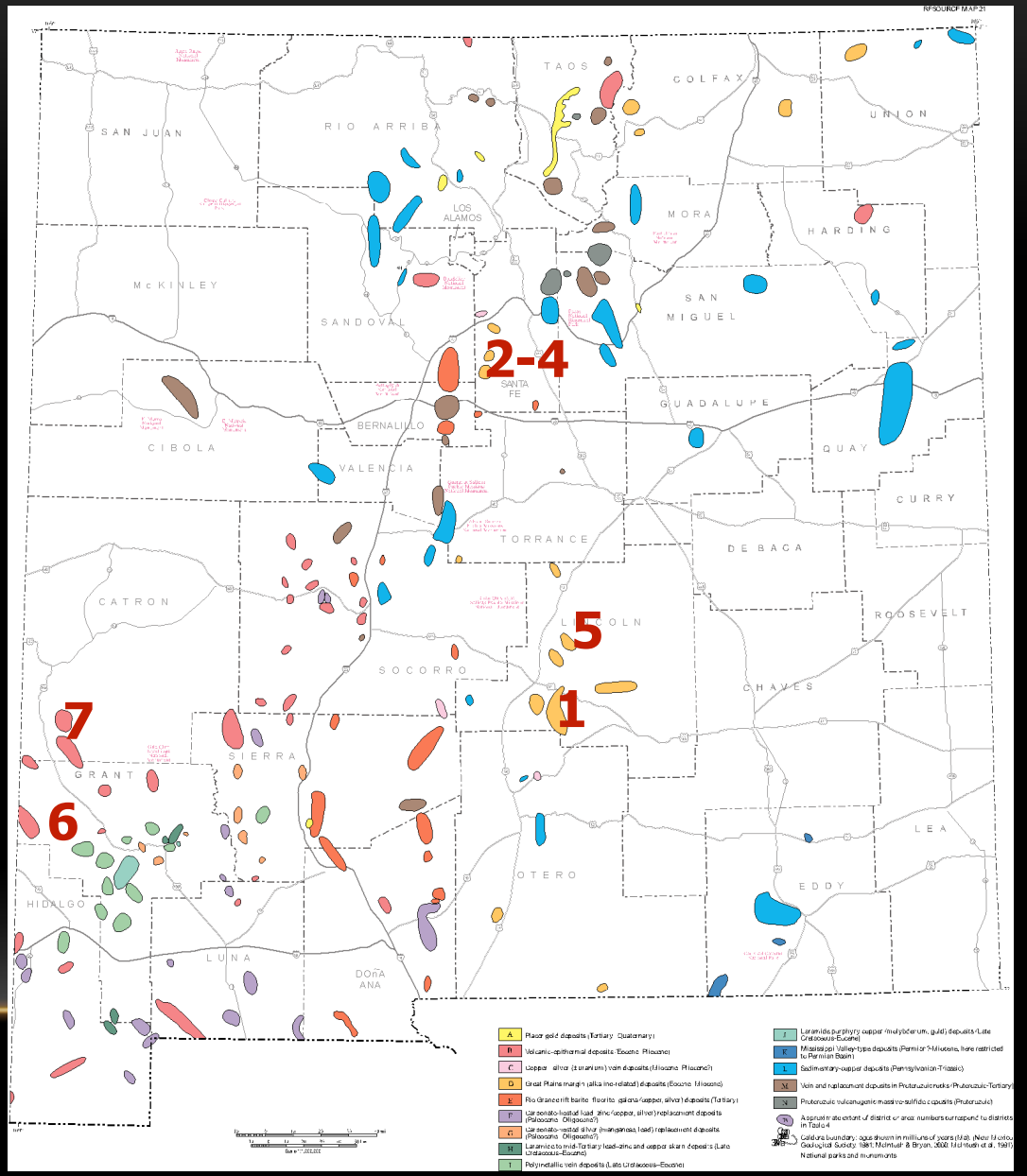
In 2009, Santa Fe Gold opened the Summit mine in the Steeple Rock district

The ore was milled at Lordsburg and sold as silica flux

New owners have not announced future plans

GOLD AND SILVER

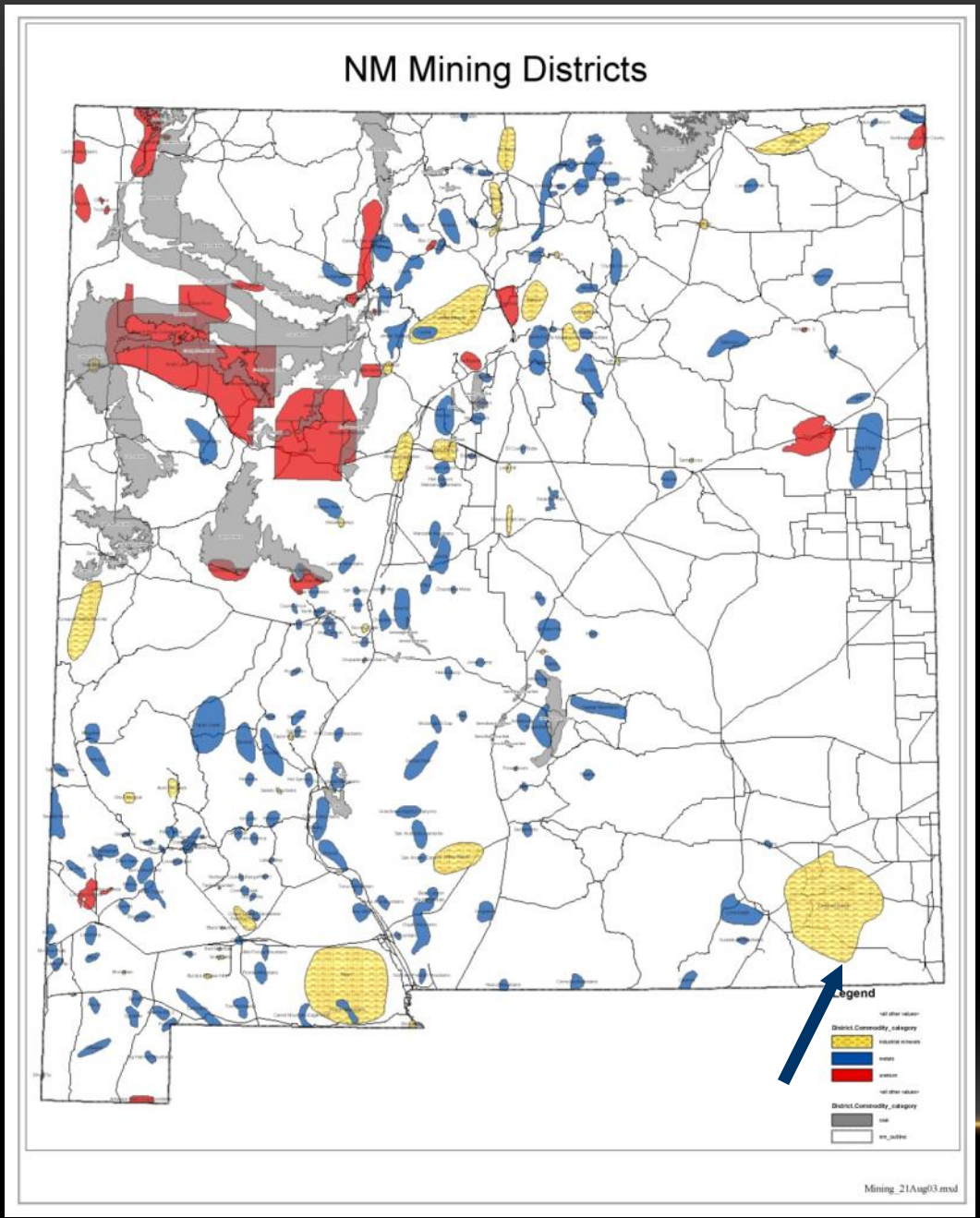
1. Vera Cruz, Lincoln Co
2. Carache Canyon, Santa Fe Co
3. Lukas Canyon, Santa Fe Co
4. San Lazarus, Santa Fe Co
5. Jicarilla Au placers
6. Steeple Rock district
7. Mogollon



INDUSTRIAL MINERALS

Any rock, mineral, or other naturally occurring material of economic value, excluding metals, energy minerals, and gemstones, generally nonmetallic

Many critical minerals are considered industrial minerals



POTASH PRODUCTION

1951-2017 109 million tons worth >$15 billion

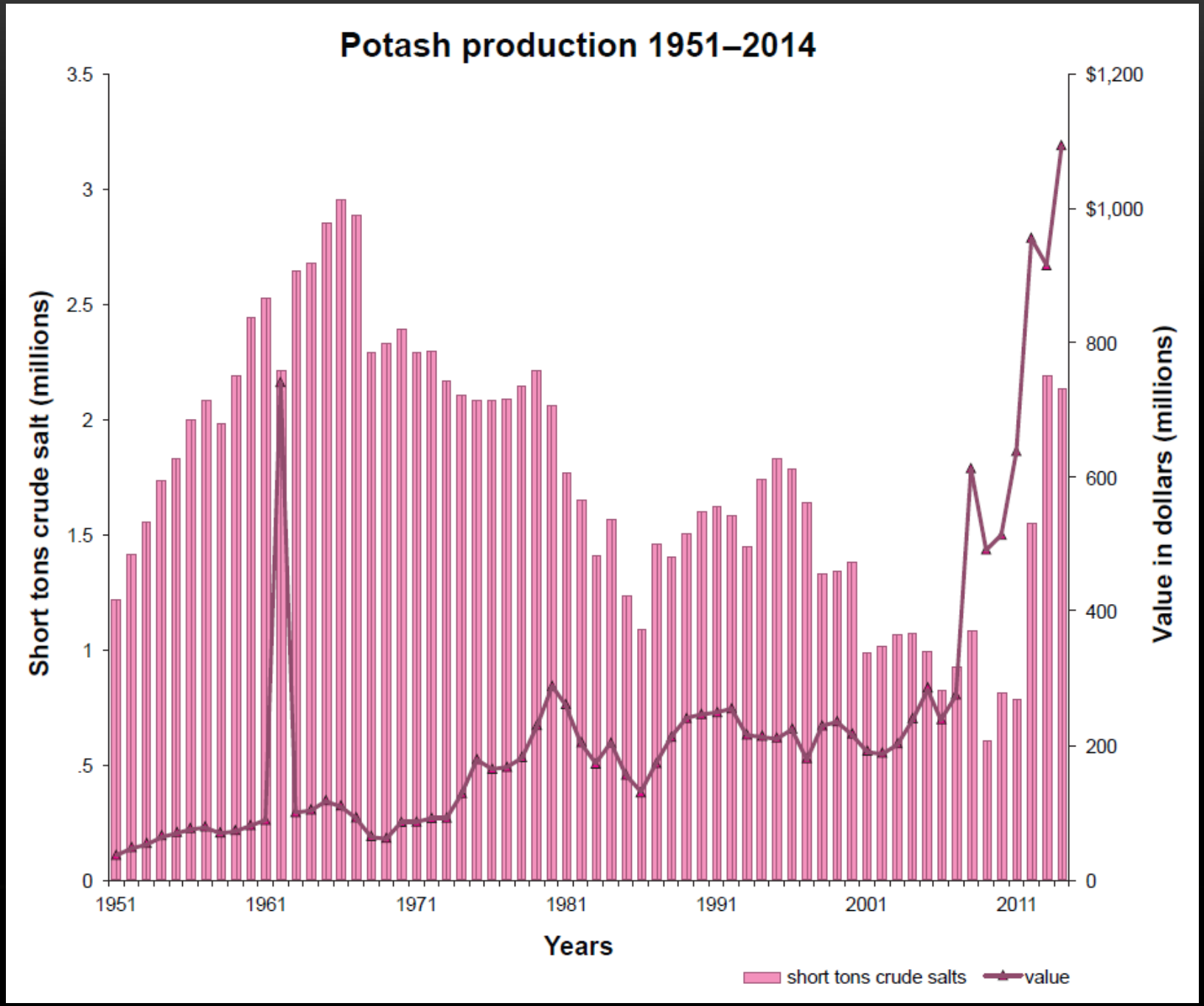
Reserves in Carlsbad District

Potash (>553 million tons)

Potash is used in fertilizers among other uses

Intrepid closed one mine

Competition from Canadian deposits

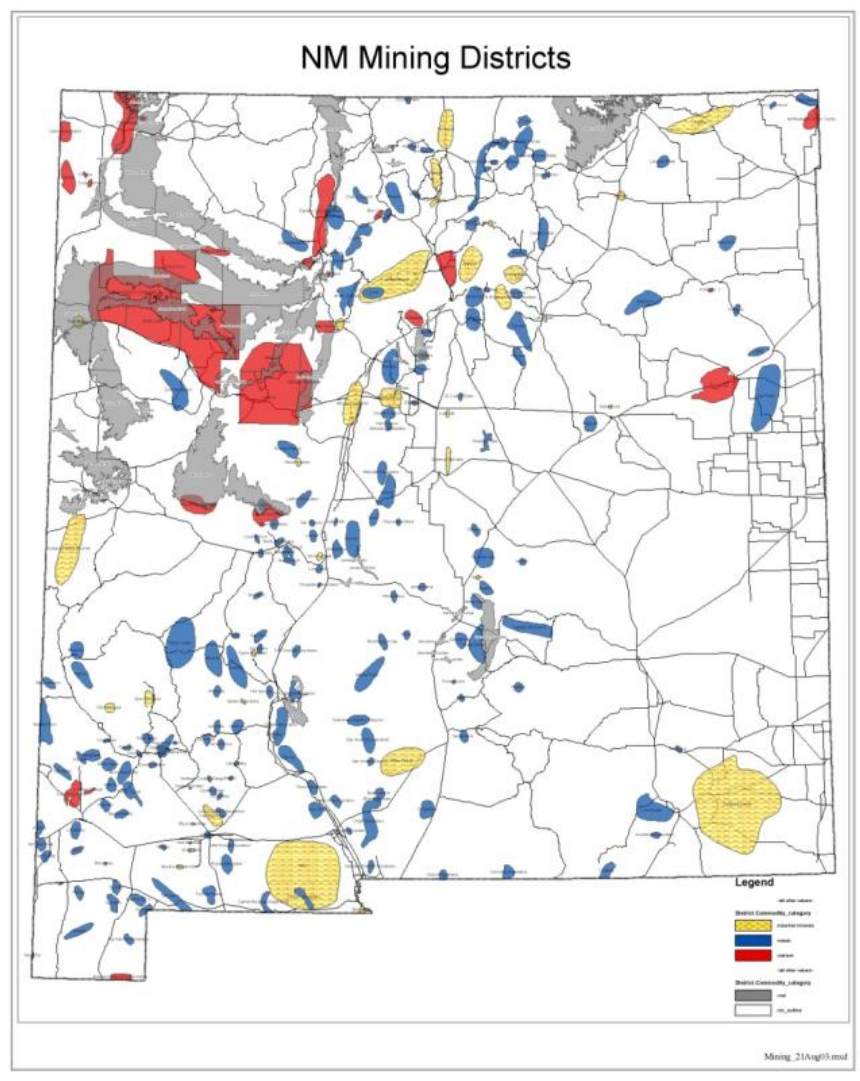

Potash production 1951–2014
Short tons crude salt (millions)
Value in dollars (millions)
Years
3.5
3
2.5
2
1.5
1
.5
0
$1,200
$1,000
800
600
400
200
0
1951
1961
1971
1981
1991
2001
2011
short tons crude salts
value

1ST IN POTASH IN 2017 (MOSAIC, INTREPID MINING)

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)

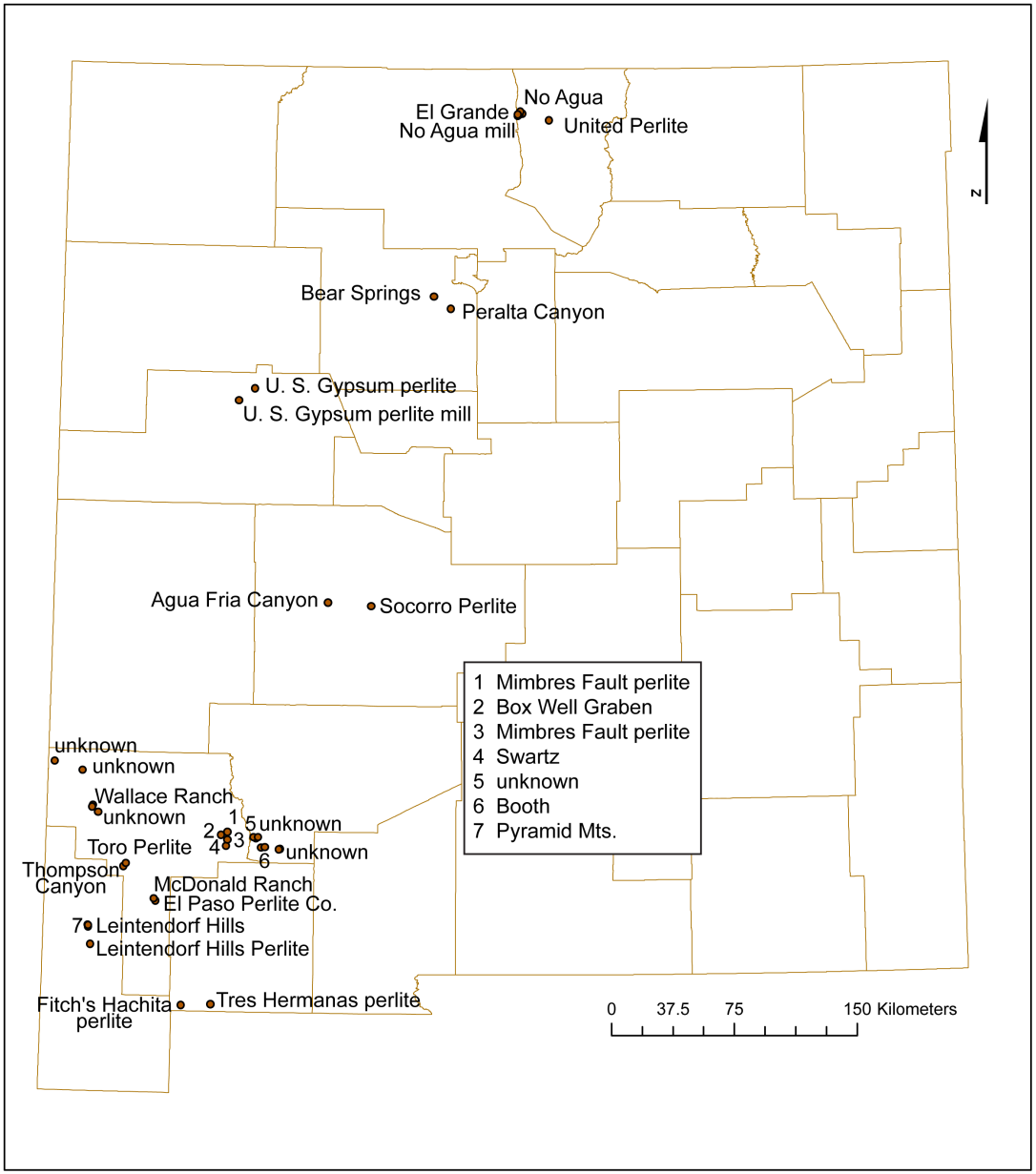
ADDITIONAL INDUSTRIAL MINERALS IN NEW MEXICO



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

PERLITE IN NEW MEXICO

Competition from Greece



OTHER INDUSTRIAL MINERALS DEPOSITS

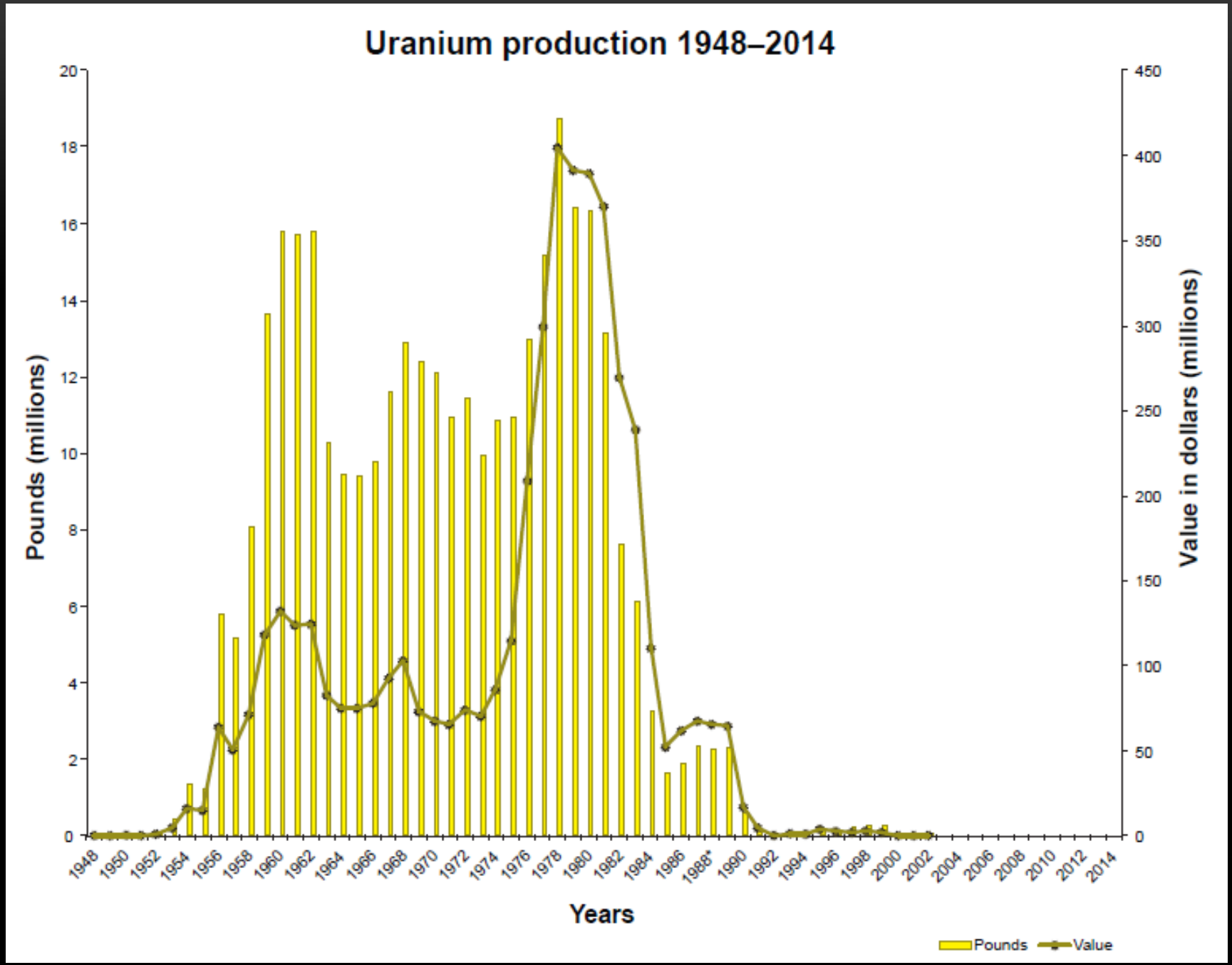
- Aggregates
- Gypsum for wallboard
- Brick and clay in El Paso, Albuquerque areas
- Cement in Tijeras Canyon
- Humate in the San Juan Basin
- Sulfur, helium, carbon dioxide
- Travertine (dimension stone), Meso del Oro, west of Belen
  - 477.6 million tons of travertine

Panel Rey is building a wallboard plant in Ciudad Juarez, Chihuahua, Mexico which could impact the New Mexico gypsum industry

http://panelrey.com/en/news-pr/entering-its-third-decade-panel-rey-will-be-opening-new-production-plant

URANIUM IN NEW MEXICO 2016

- 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


Uranium production 1948–2014
Pounds (millions)
Value in dollars (millions)
Years
Pounds
Value
0
2
4
6
8
10
12
14
16
18
20
0
50
100
150
200
250
300
350
400
450
1948
1950
1952
1954
1956
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1966
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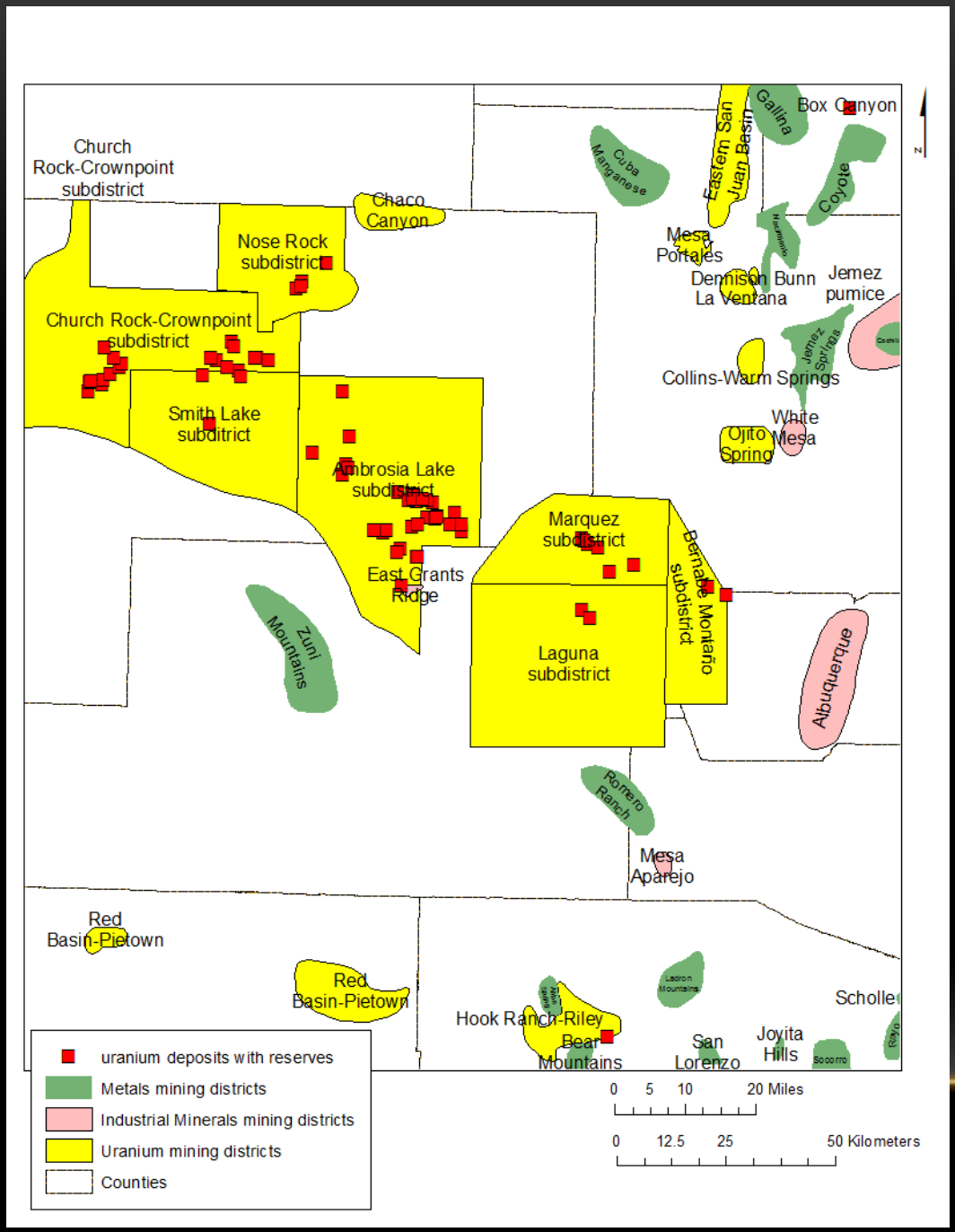
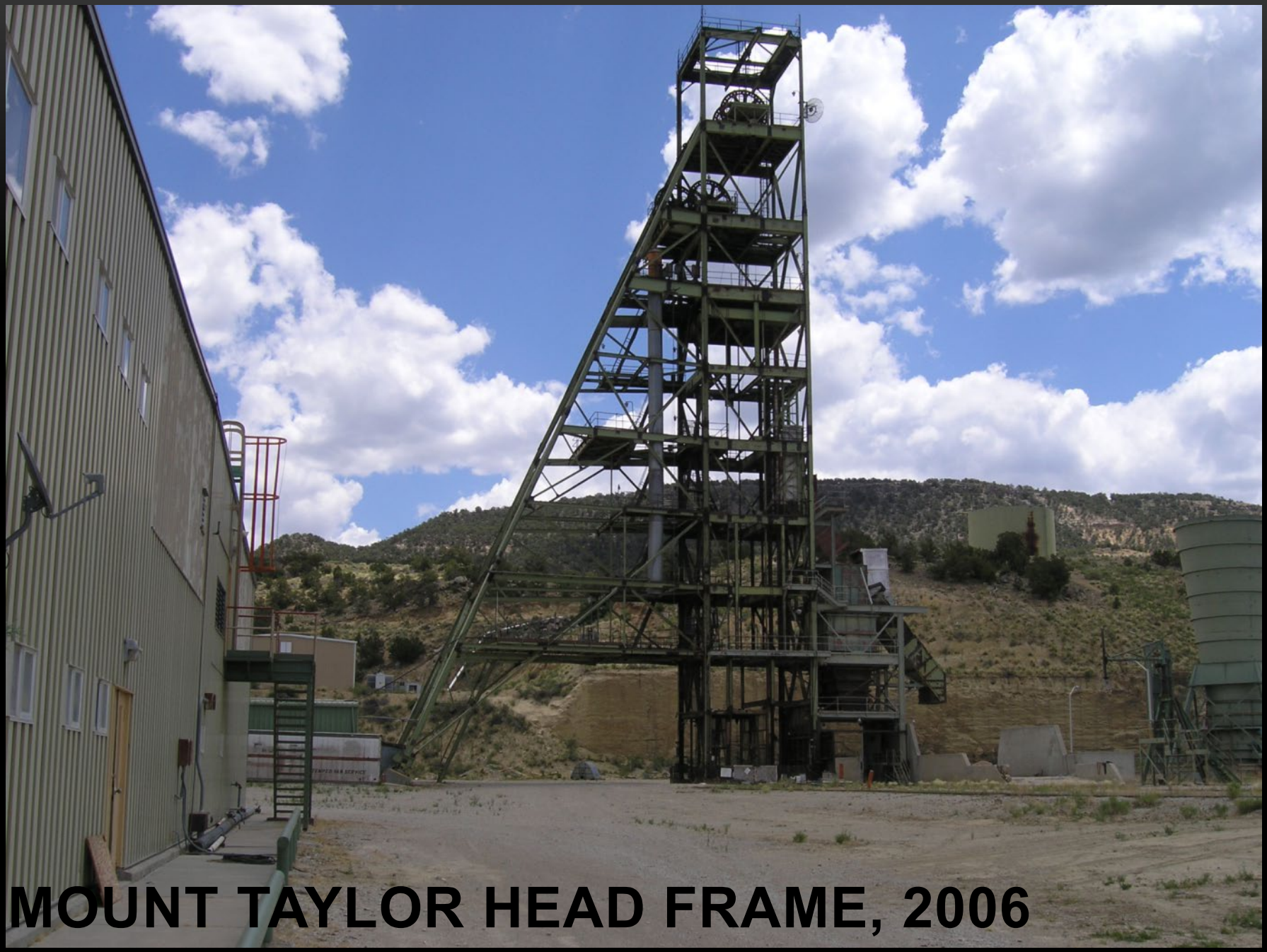
2012
2014



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



MOUNT TAYLOR HEAD FRAME, 2006


6
3

CRITICAL MINERALS IN NEW MEXICO

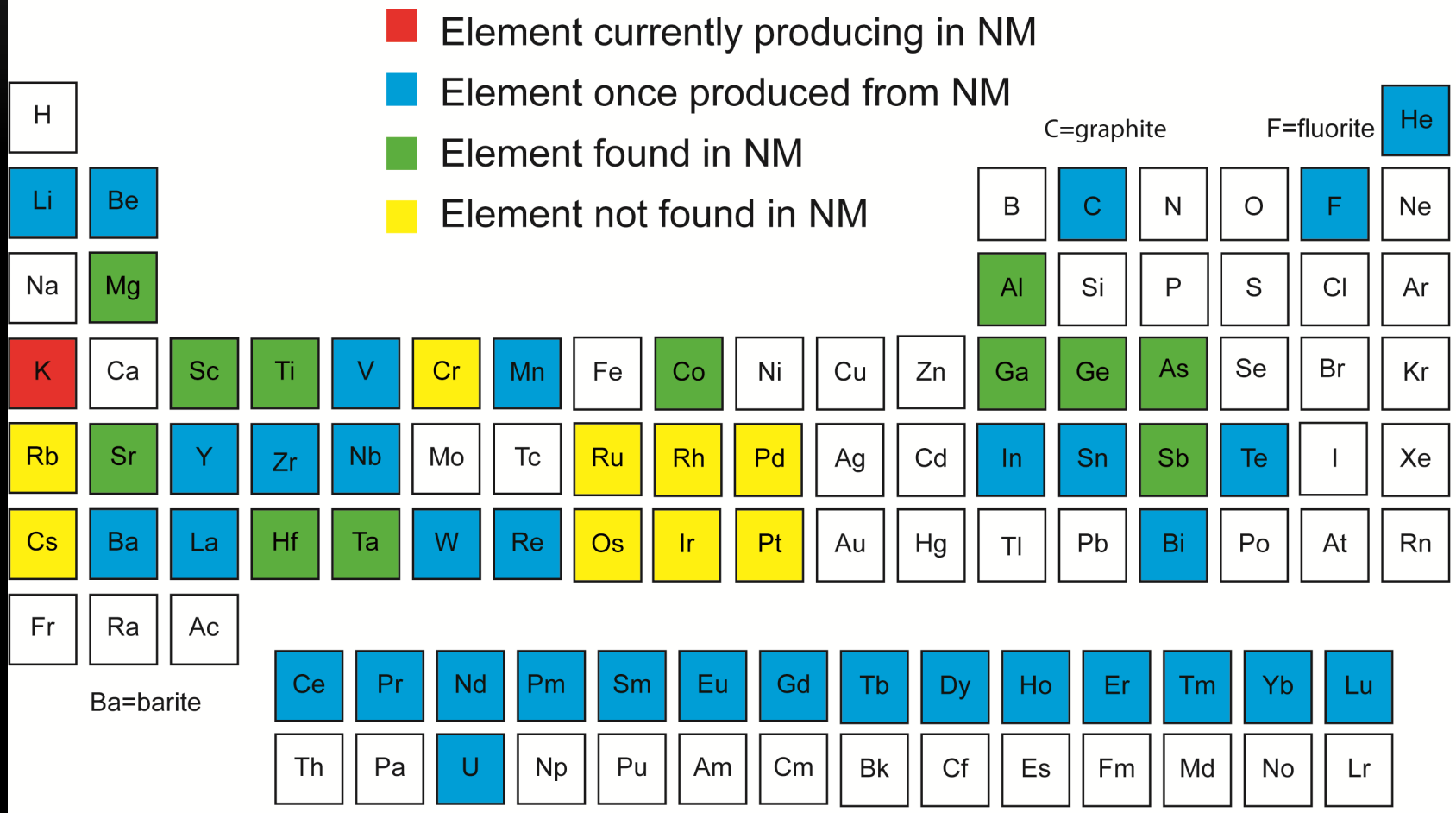
CRITICAL MINERALS

- *is a mineral (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*
- 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

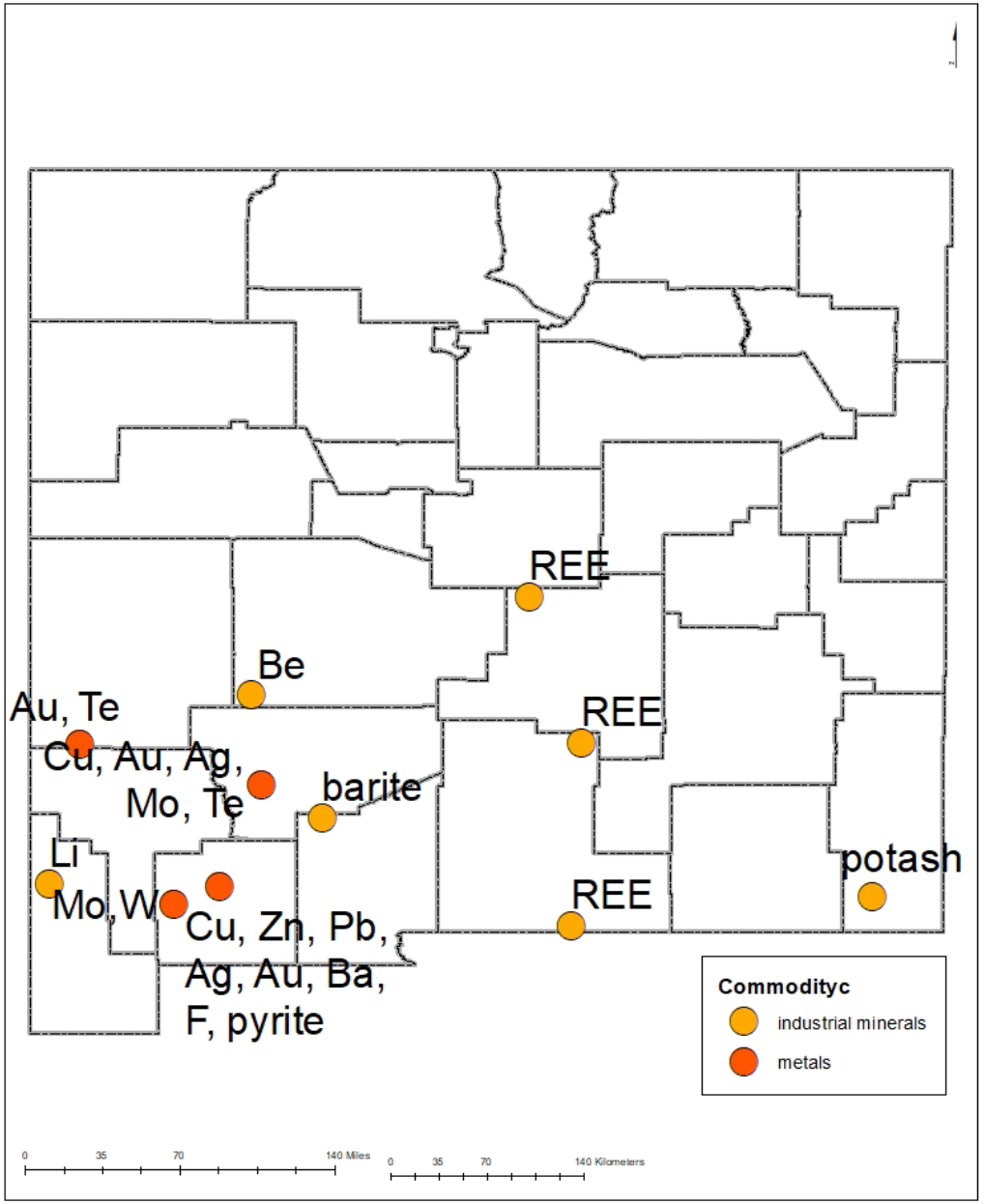
CRITICAL MINERALS

- 35 critical minerals were identified
- New Mexico has many of these critical minerals
  - Potash is currently being produced in Carlsbad
  - Copper deposits in Grant County contain rhenium, indium, and germanium
  - Uranium deposits in the Grants district
  - 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)

Critical Minerals in New Mexico



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.



SELECTED EXPLORATION SITES OF CRITICAL MINERALS IN NEW MEXICO 2016-2019

From NM Mining and Minerals Div. and NMBGMR databases, company web sites

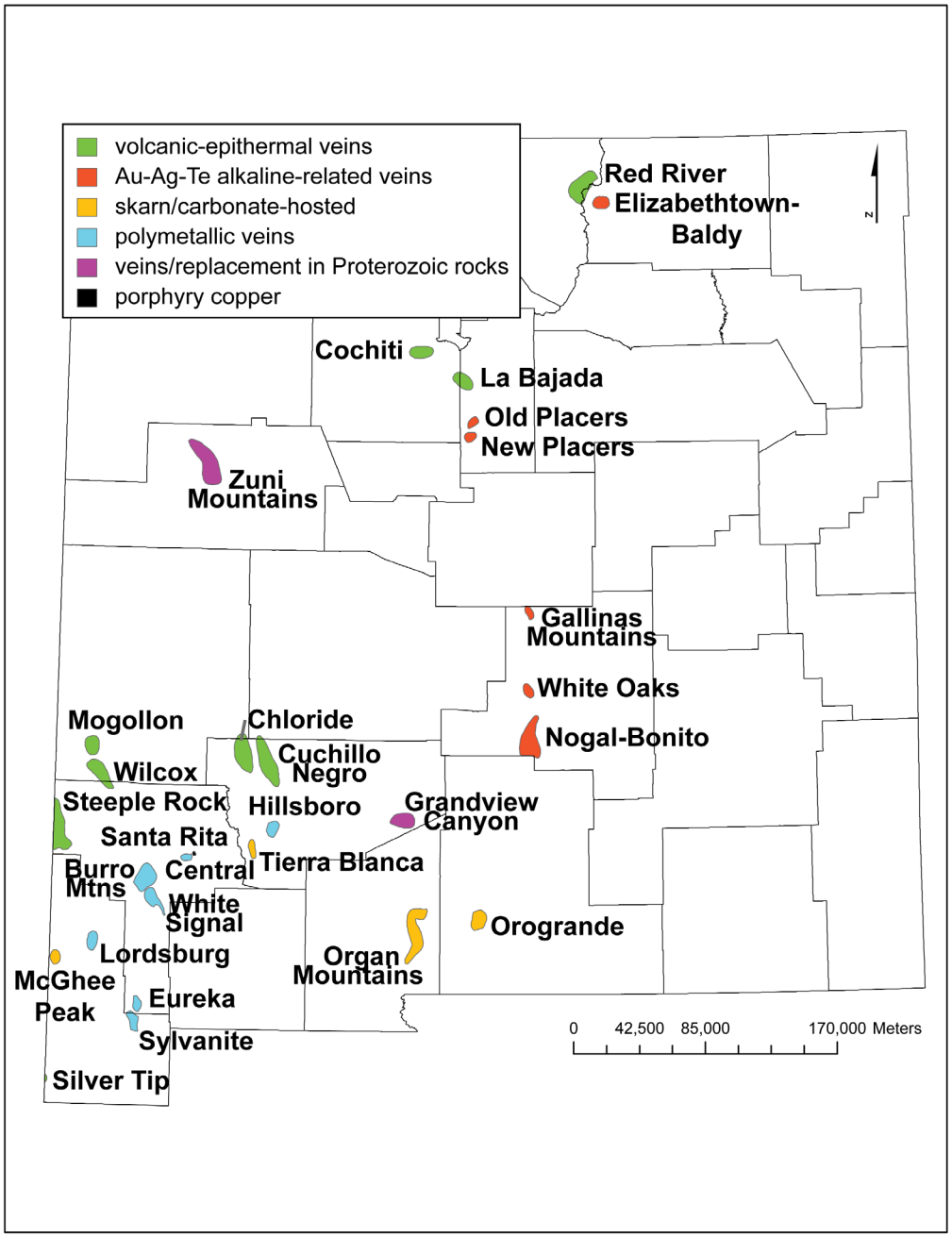
CRITICAL MINERALS ASSOCIATED WITH URANIUM DEPOSITS

- Vanadium and molybdenum were produced with uranium in the past and could resume by-product production in the future
- Uranium deposits contain anomalously high rare earth elements (REE) in ore—companies should examine their deposits and determine if a Ce circuit is feasible and economic

TELLURIUM IN MAGMATIC SYSTEMS NEW MEXICO

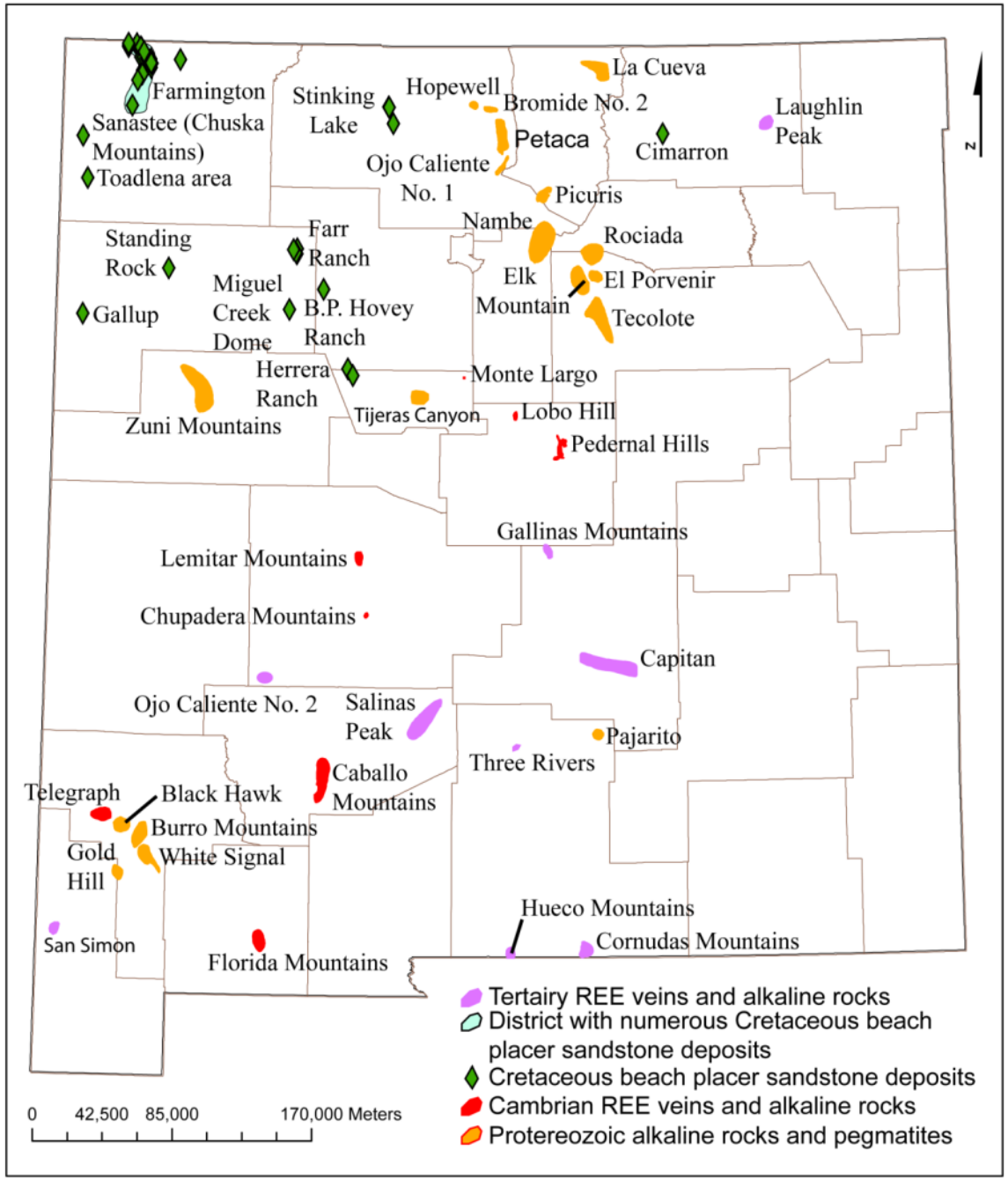
Uses of Te

- 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**



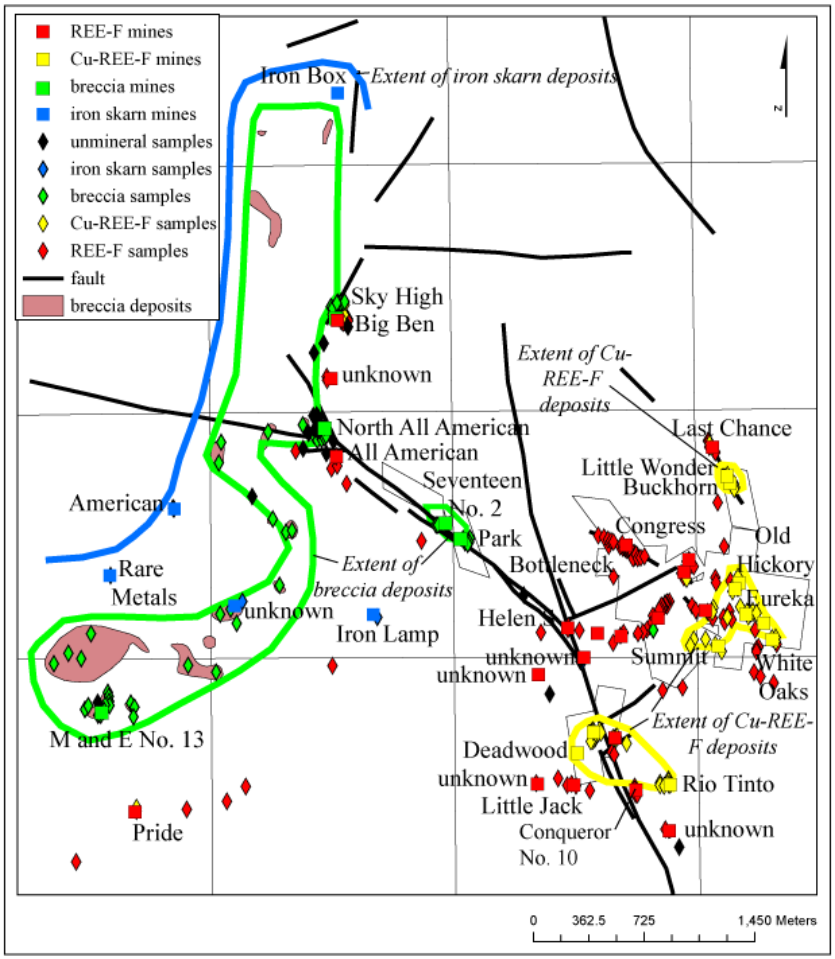
Mining districts in New Mexico with tellurium minerals or chemical assays >20 ppm Te

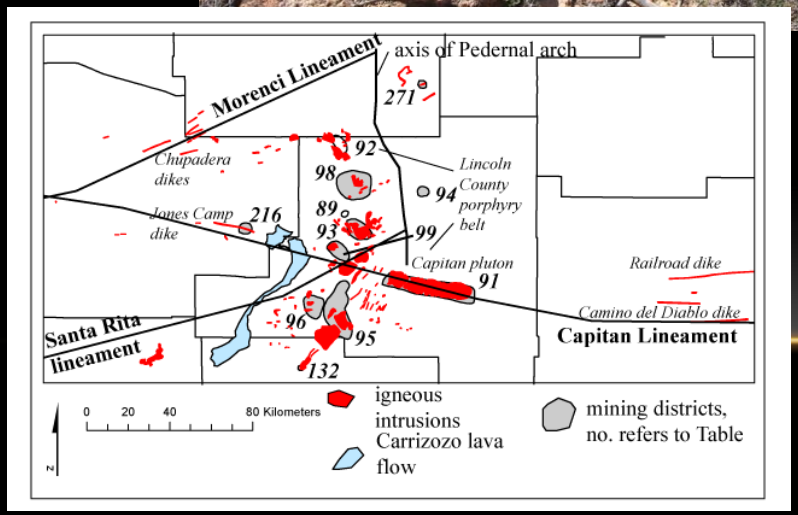
Lone Pine, Wilcox district, Catron County—volcanic epithermal vein



OCCURRENCES OF RARE EARTH ELEMENTS (REE) IN NEW MEXICO

REE in Gallinas Mountains, Lincoln County





WHAT ARE THE MINING ISSUES FACING NEW MEXICO?

Gold King adit

Animas River after Gold King spill

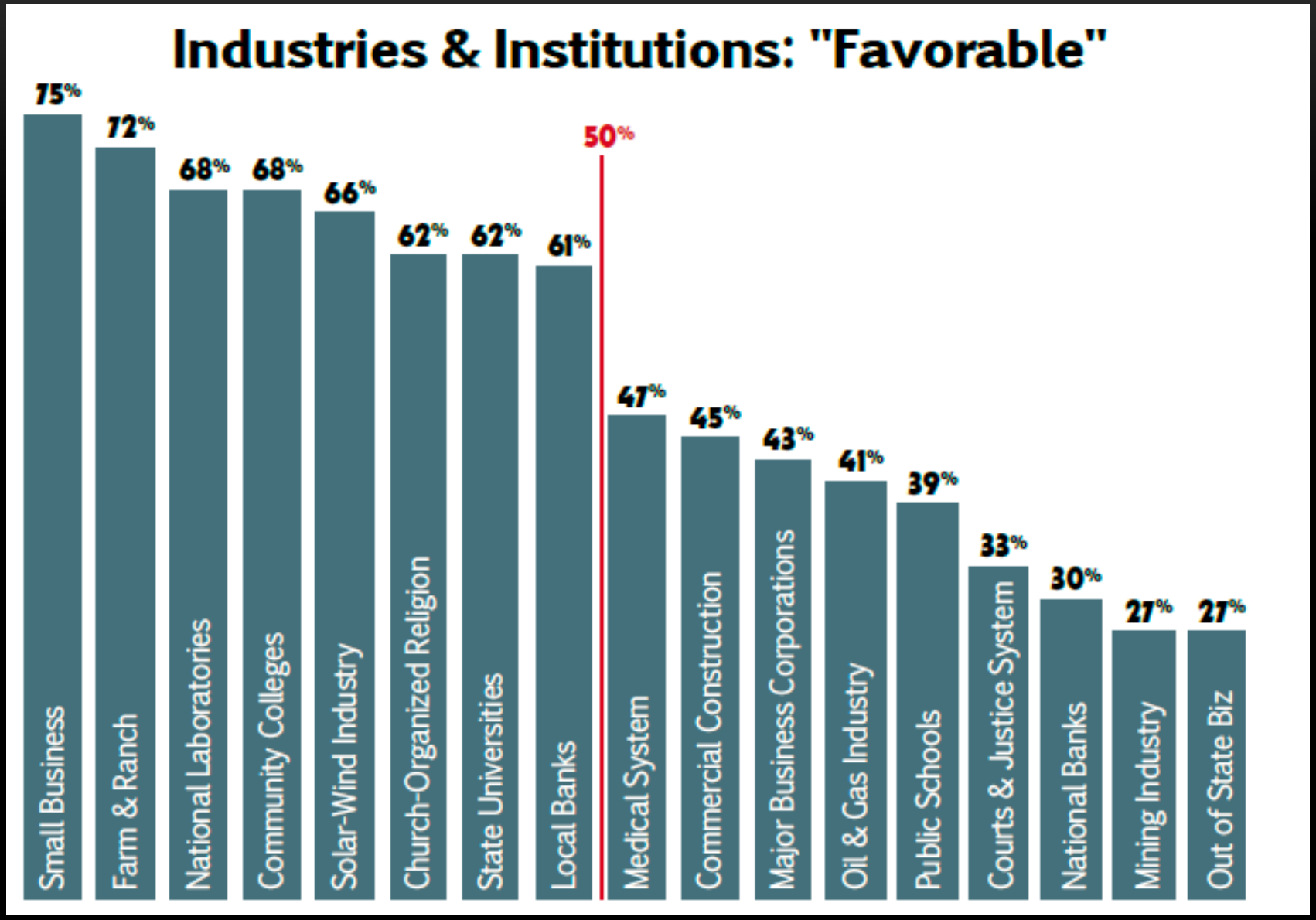
MINING ISSUES FACING NEW MEXICO

- **Some current mines are reaching the end of their life and will close over the next decade=decreasing minerals production**
- **There are not many new mines to replace them**
- Results in unemployment and decrease in revenues
  - Affects rural economies
  - Affects state revenues

MINING ISSUES FACING NEW MEXICO

- Mining requires water and their environmental effects must not impact water supplies
- Legacy issues of past mining activities form negative public perceptions of mining
  - Abandoned or legacy mines, especially Grants uranium district and Questa mine
  - Gold King spill
  - Not in my backyard!!!!!!

Mining is viewed as favorable by only 27% of New Mexicans



http://garritypr.com/sites/default/files/uploads/documents/2017_Garrity_Perception_Survey.pdf

MINING ISSUES FACING NEW MEXICO

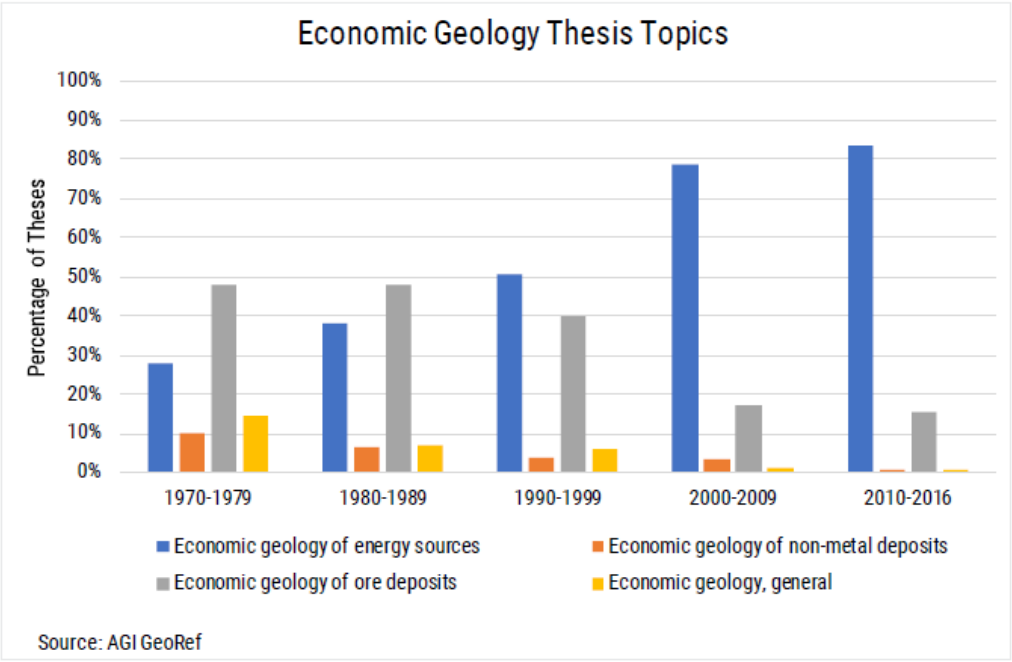
- Many inactive mines still have the potential to contaminate the environment or present a hazard to health and safety
  - Gold King spill
  - AML sites (Abandoned mine lands)
  - Grants uranium district

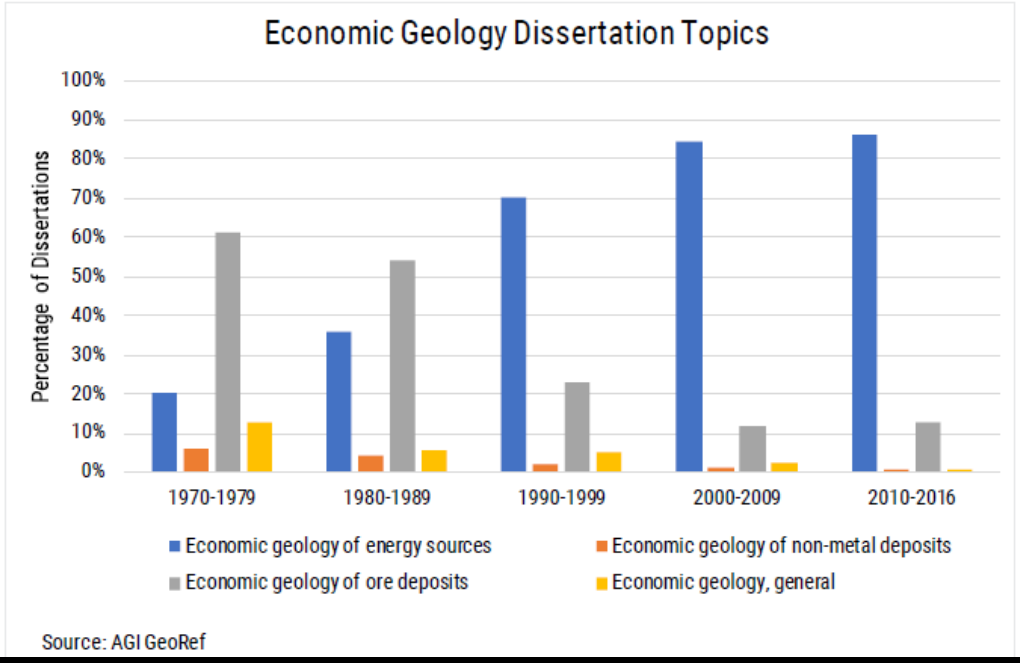
MINING ISSUES FACING NEW MEXICO

- Global competition is closing some of our mines
- Exploration for new deposits often results in drill targets based upon regulatory minimal impact regulations rather than optimum geological criteria
- Permitting for exploration can take longer than exploration funds are available
- Lower prices=closed mines, little exploration

MINING ISSUES FACING NEW MEXICO

- In some areas conflicts arise between mining and other activities
  - Grants uranium district
  - Otero Mesa
  - Pecos/Tererro mine
  - **Water, don't want a mine in their backyard**
- **Shortage of young geologists and engineers to explore for, develop, mine, permit these commodities and evaluate their effect on the environment—math, science skills critical**





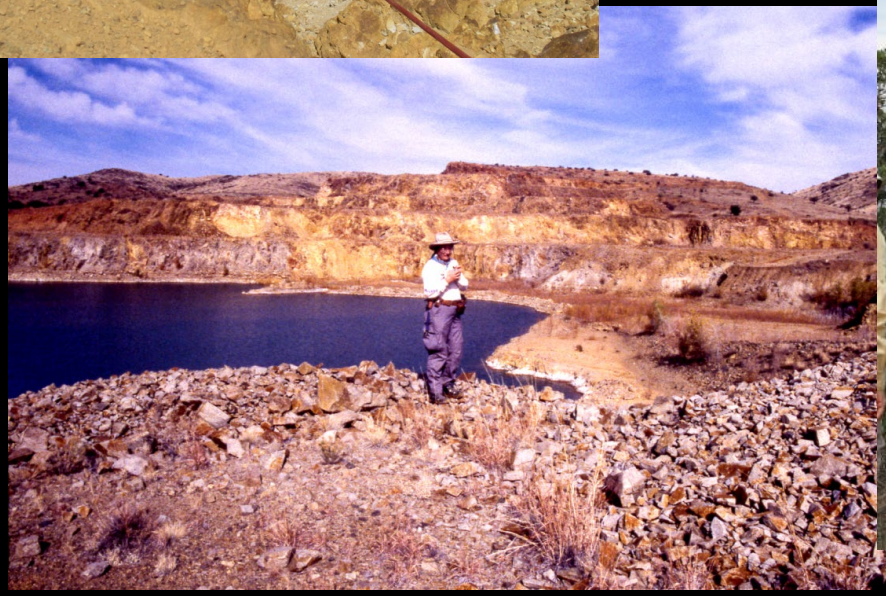
Number of theses and dissertations on non-energy economic geology has decreased

http://www.multibriefs.com/briefs/aipg/DataBrief_2019_008_EconomicGeologyThesesDissertations.pdf

SUMMARY

- New Mexico has a wealth of mineral resources
- Exploration and permitting takes many years before a deposit can be mined, >10 yrs
- Legacy issues are being addressed
- Negative public perceptions are major issue as is funding
- Global competition is a major threat
- NMBG/NMT research is addressing some of these issues, as well as training future geologists and engineers

ADDITIONAL RESEARCH



MORE INFORMATION

- NM Mines and Minerals Division

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

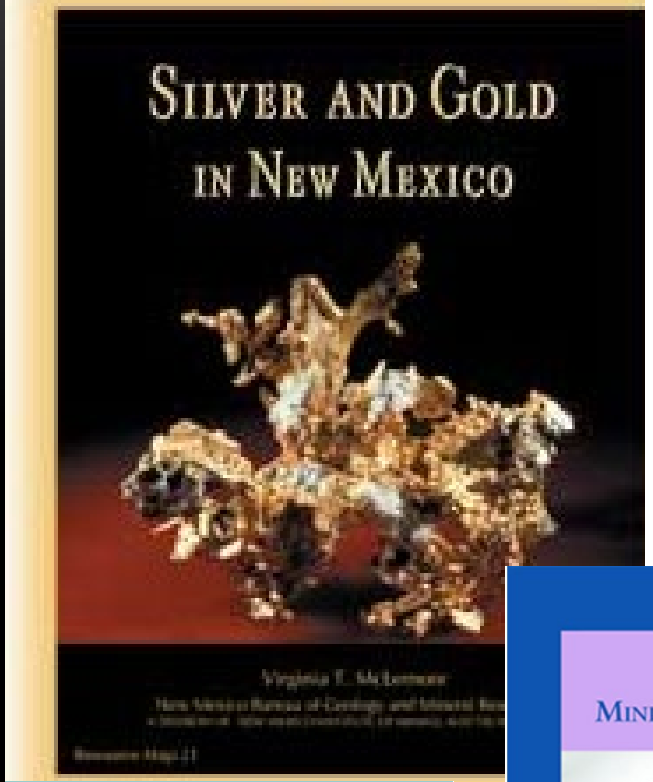
  Virginia McLemore web page

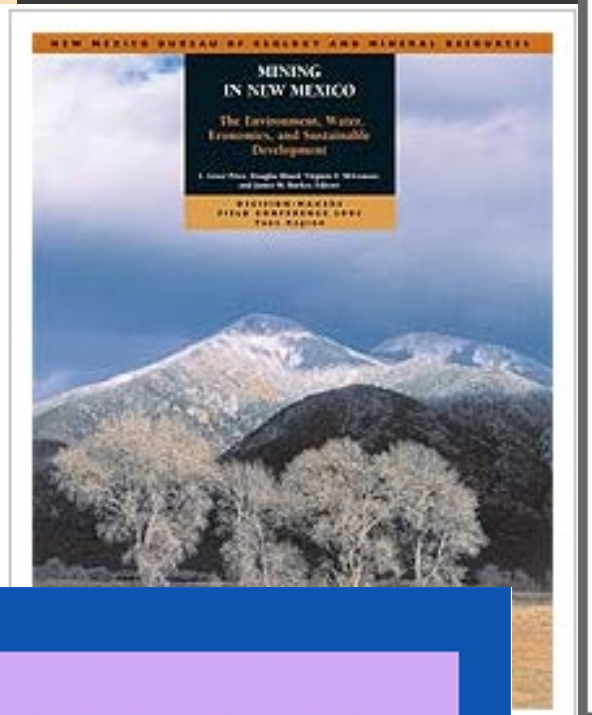
  http://geoinfo.nmt.edu/staff/mclemore/home.html

- New Mexico Bureau of Geology and Mineral Resources

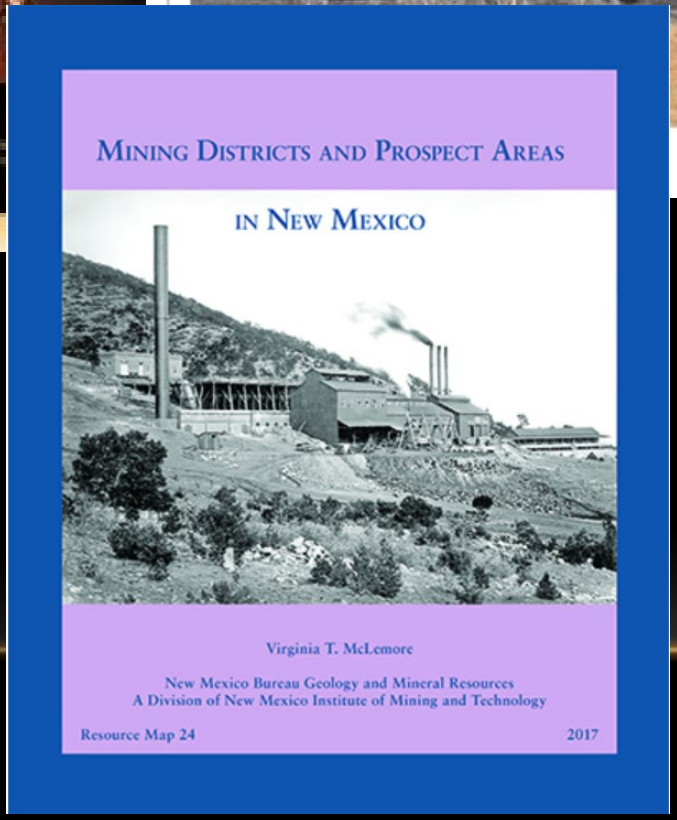
  http://geoinfo.nmt.edu/

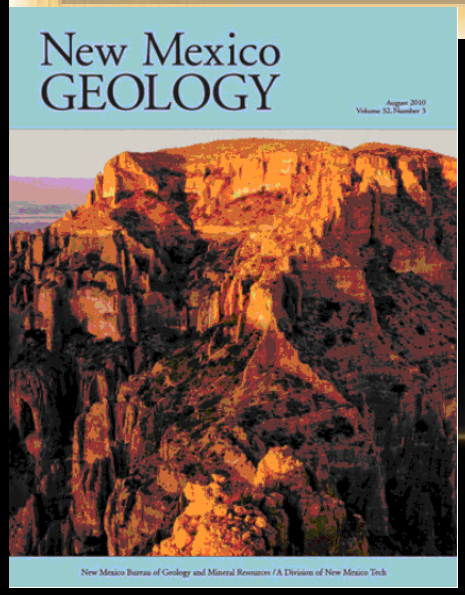
MEMOIR 50—ENERGY AND MINERAL RESOURCES OF NEW MEXICO


Silver and Gold
in New Mexico


Mining
in New Mexico
The Environment, Water, Economics, and Sustainable Development


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


Mining Districts and Prospect Areas
in New Mexico
Virginia T. McLemore
New Mexico Bureau Geology and Mineral Resources
A Division of New Mexico Institute of Mining and Technology
Resource Map 24
2017


New Mexico
Geology


Lite Geology
Geothermal Energy
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QUESTIONS?