MINING ISSUES FACING NEW MEXICO-2018

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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
- New Mexico Mining Association

OUTLINE

- What, where, and how much minerals are produced in New Mexico?
- What are the Mining Issues Facing New Mexico?
- How are we responding?
  - Research

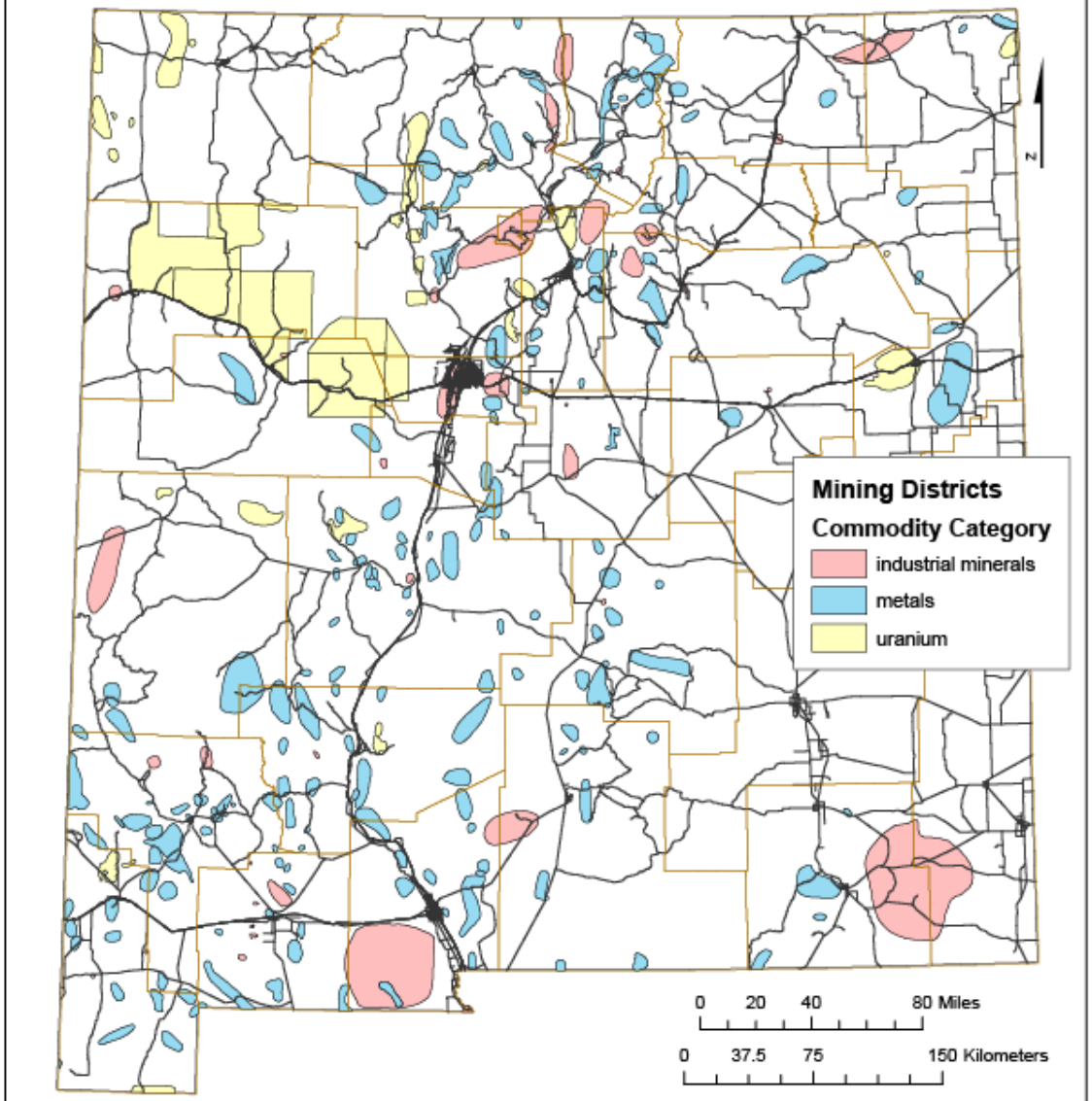
WHAT, WHERE, AND HOW MUCH MINERALS ARE PRODUCED IN NEW MEXICO?

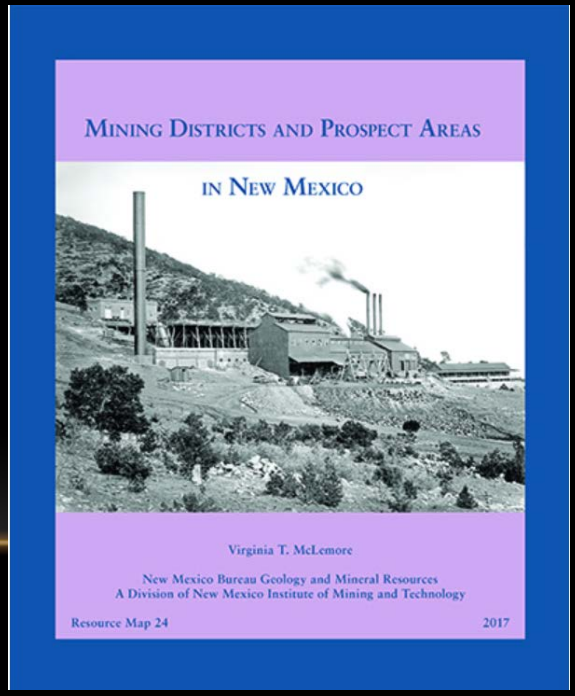
INTRODUCTION

- 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

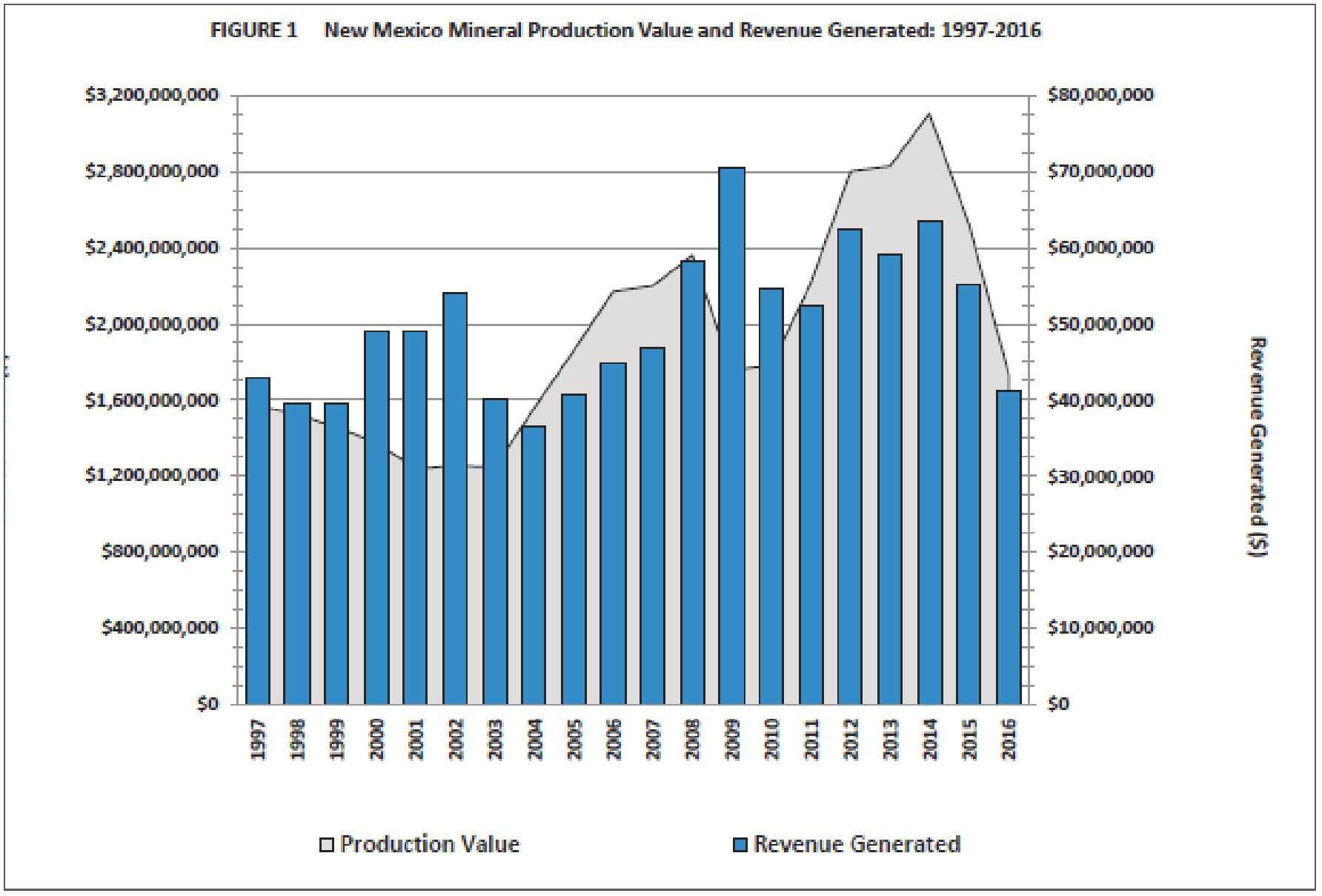
MINING DISTRICTS IN NEW MEXICO





PRODUCTION SUMMARY—2016

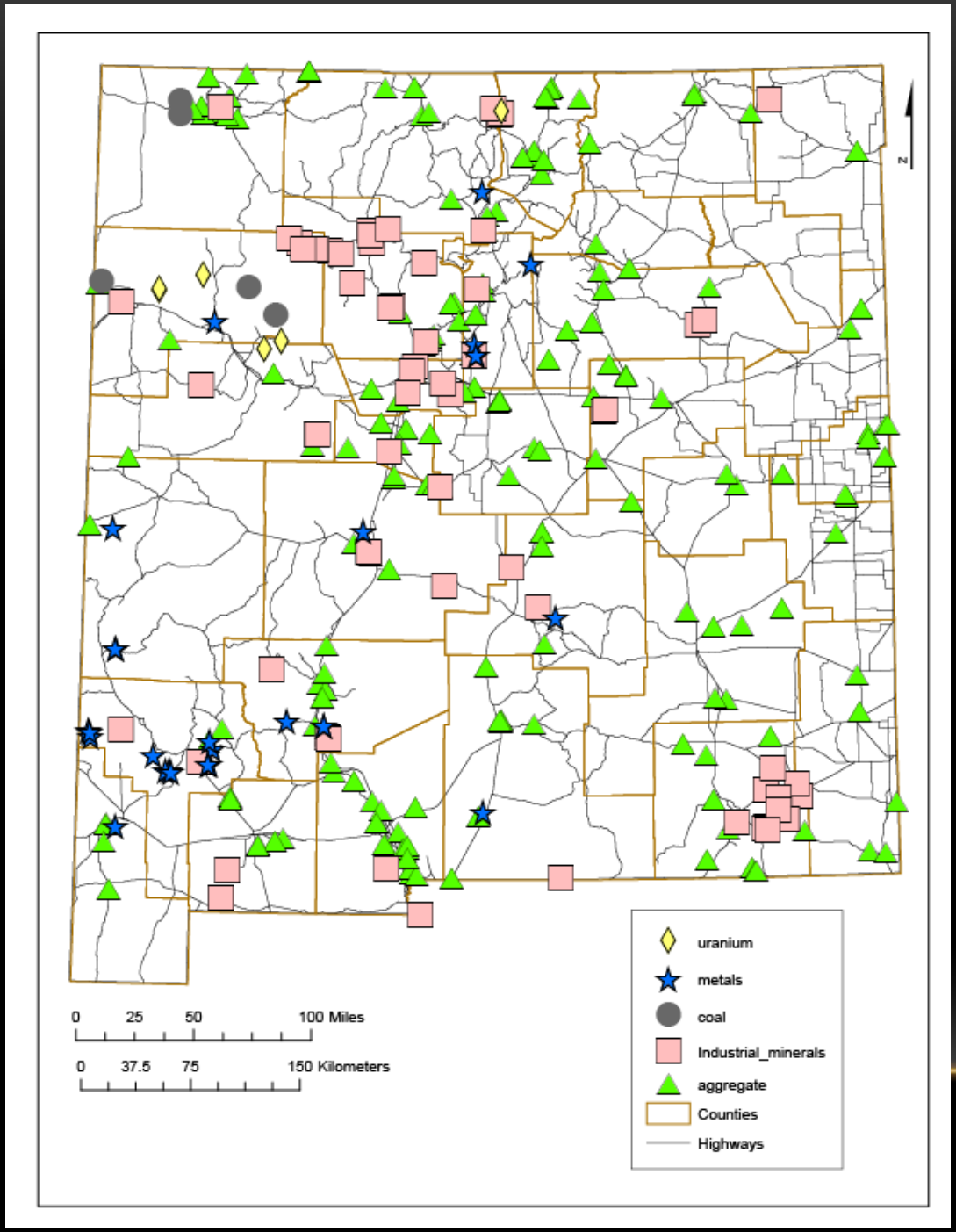
- Value of mineral production in 2016 was $1.7 billion (does not include oil and gas)—ranked 20th in the US (30% decrease from 1915)
- Employment in the mining industry is 4,943
- Exploration for garnet, gypsum, limestone, nepheline syenite, agate, specimen fluorite, gold, silver, iron, beryllium, uranium, copper, potash, rare earth elements, humate, clays
- ***MINERALS PRODUCTION IS DECREASING, ESPECIALLY COAL***



HTTP://WWW.EMNRD.STATE.NM.US/MMD/PUBLICATIONS/DOCUMENTS/FINAL_MMD_2017_ANNUAL_REPORT_000.PDF

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



ACTIVE MINES AND EXPLORATION SITES IN NEW MEXICO 2000-2018

COAL

- Fuels 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 2016
- 11th in estimated recoverable coal reserves—7 billion tons of recoverable reserves (2005 figures)
- ***Coal production is expected to decrease in the near future***

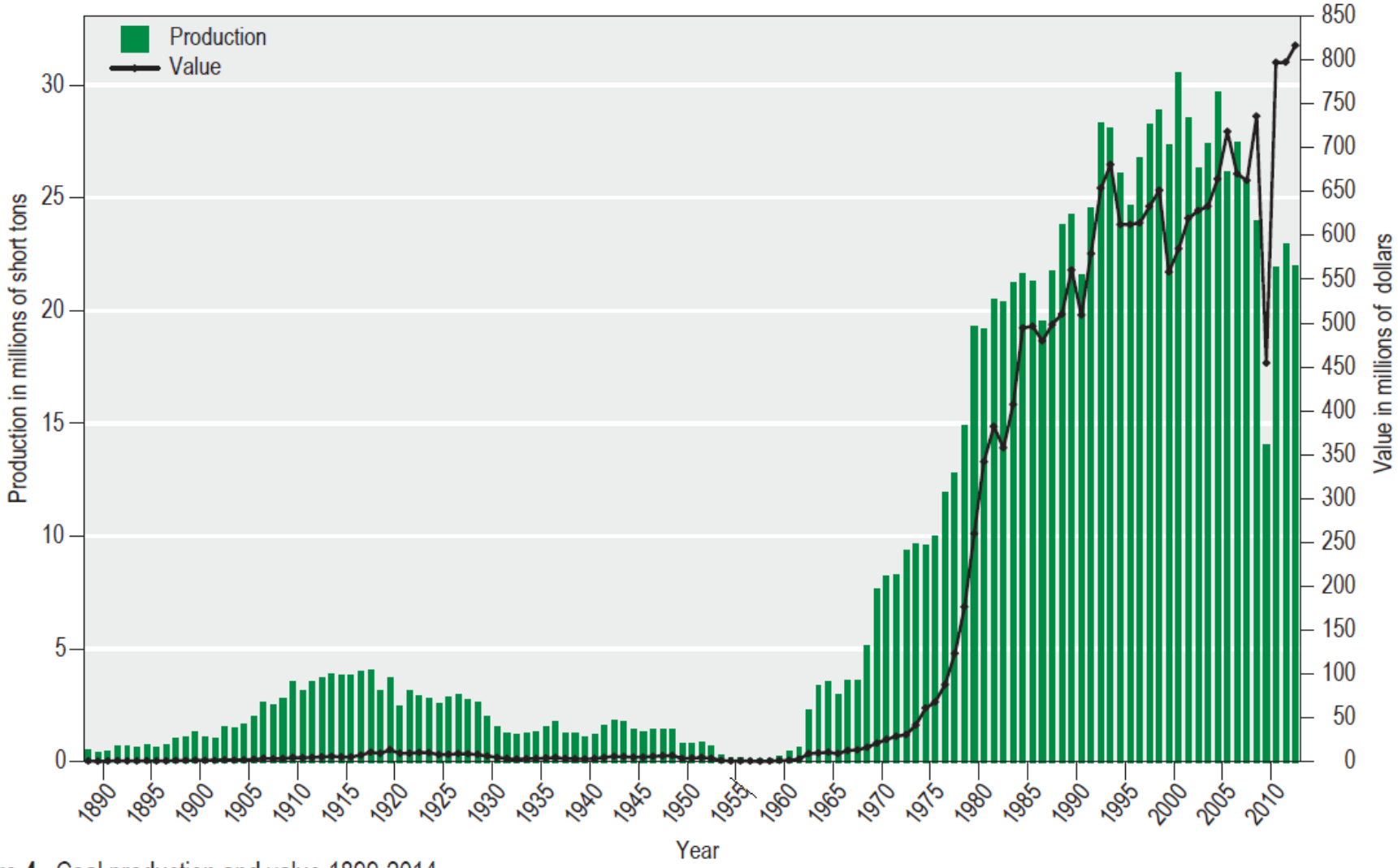


Figure 4. Coal production and value 1899-2014.

METALS—2ND IN COPPER PRODUCTION IN 2016 (CHINO, TYRONE)

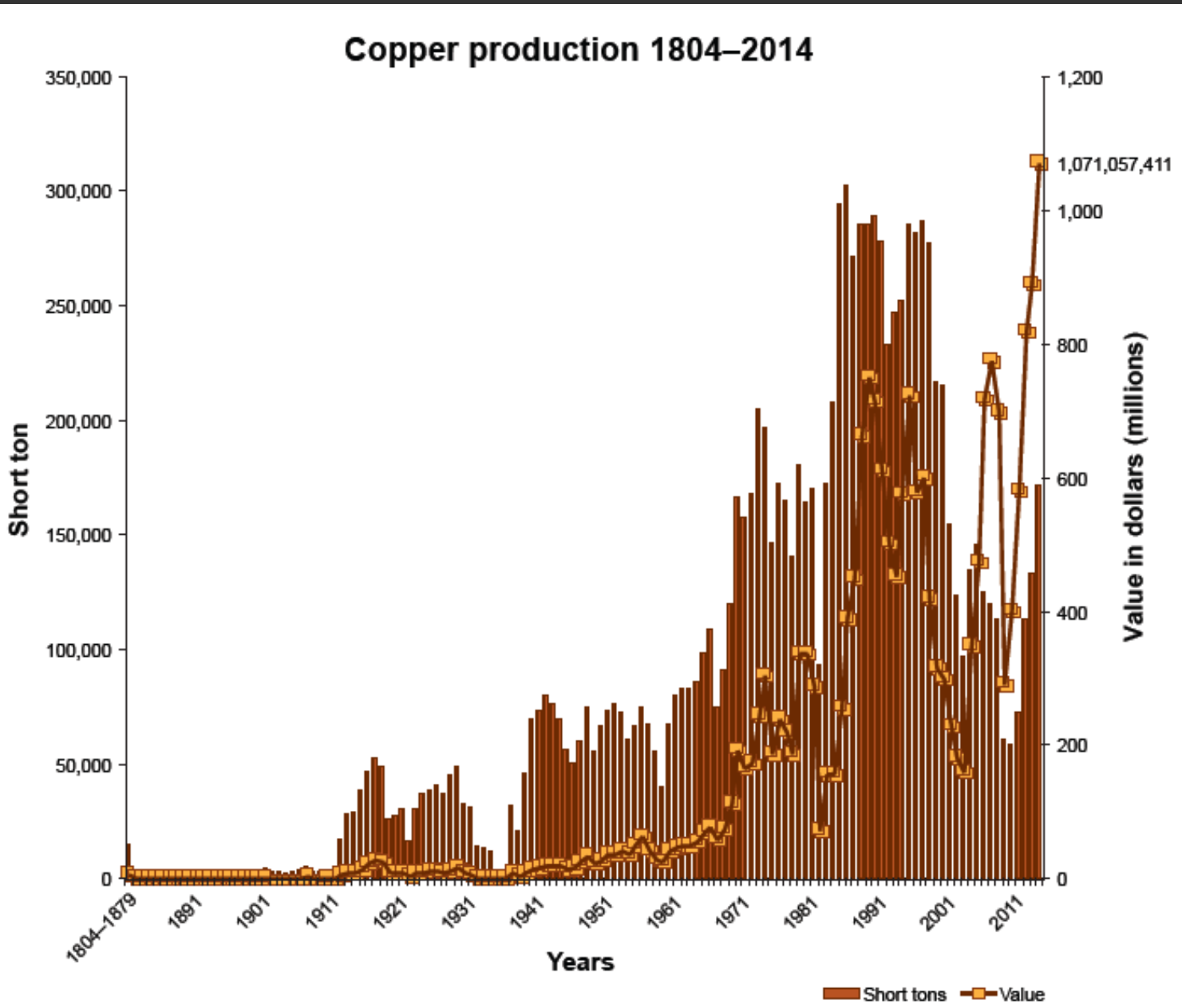


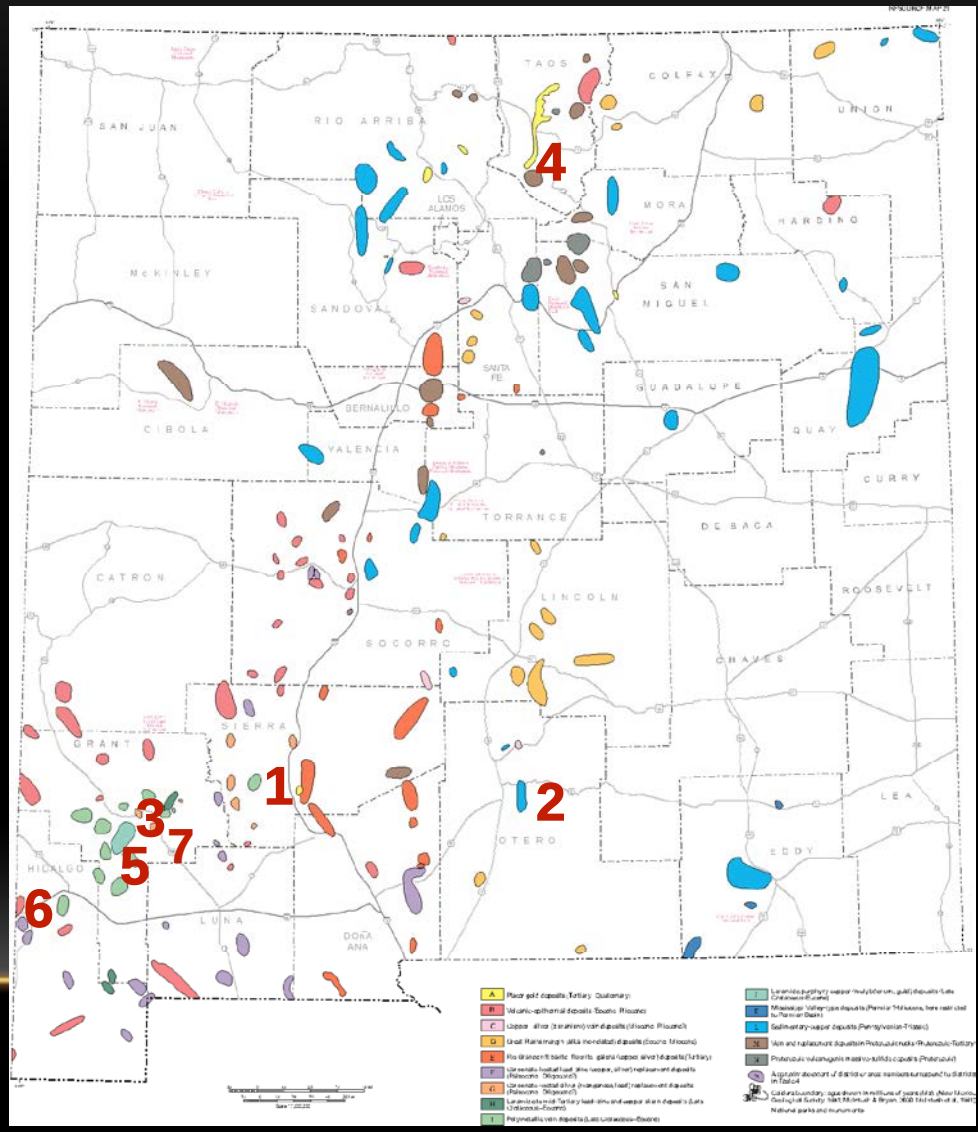
FIGURE 3. Copper production in New Mexico from 1882 to 2014.

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

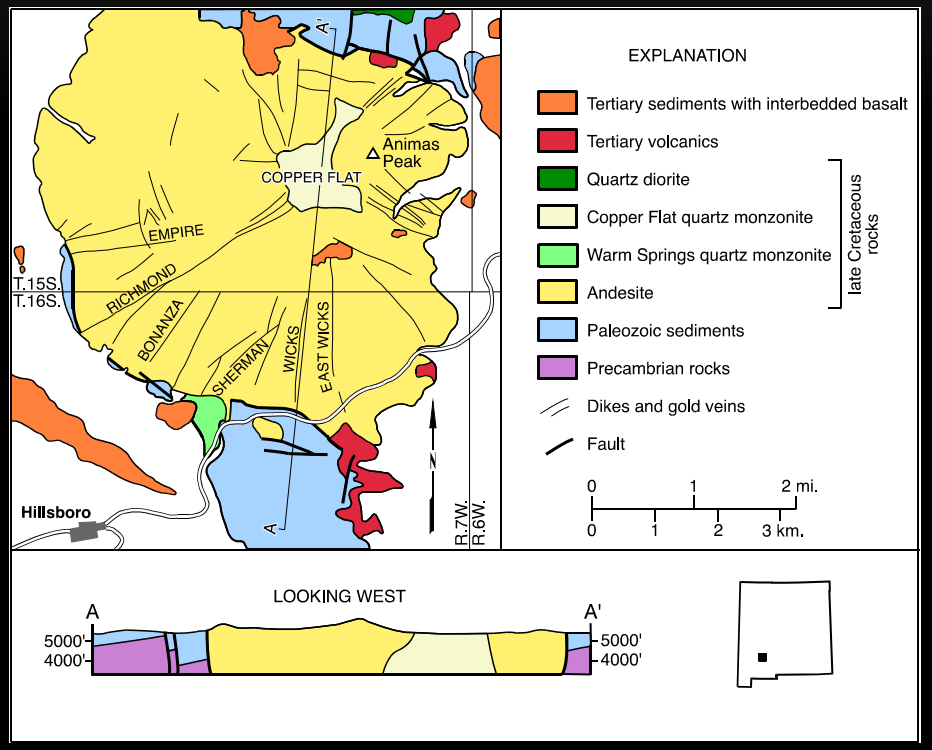
50.76 mill lbs Cu

1.01 mill lbs Mo

12,750 oz Au

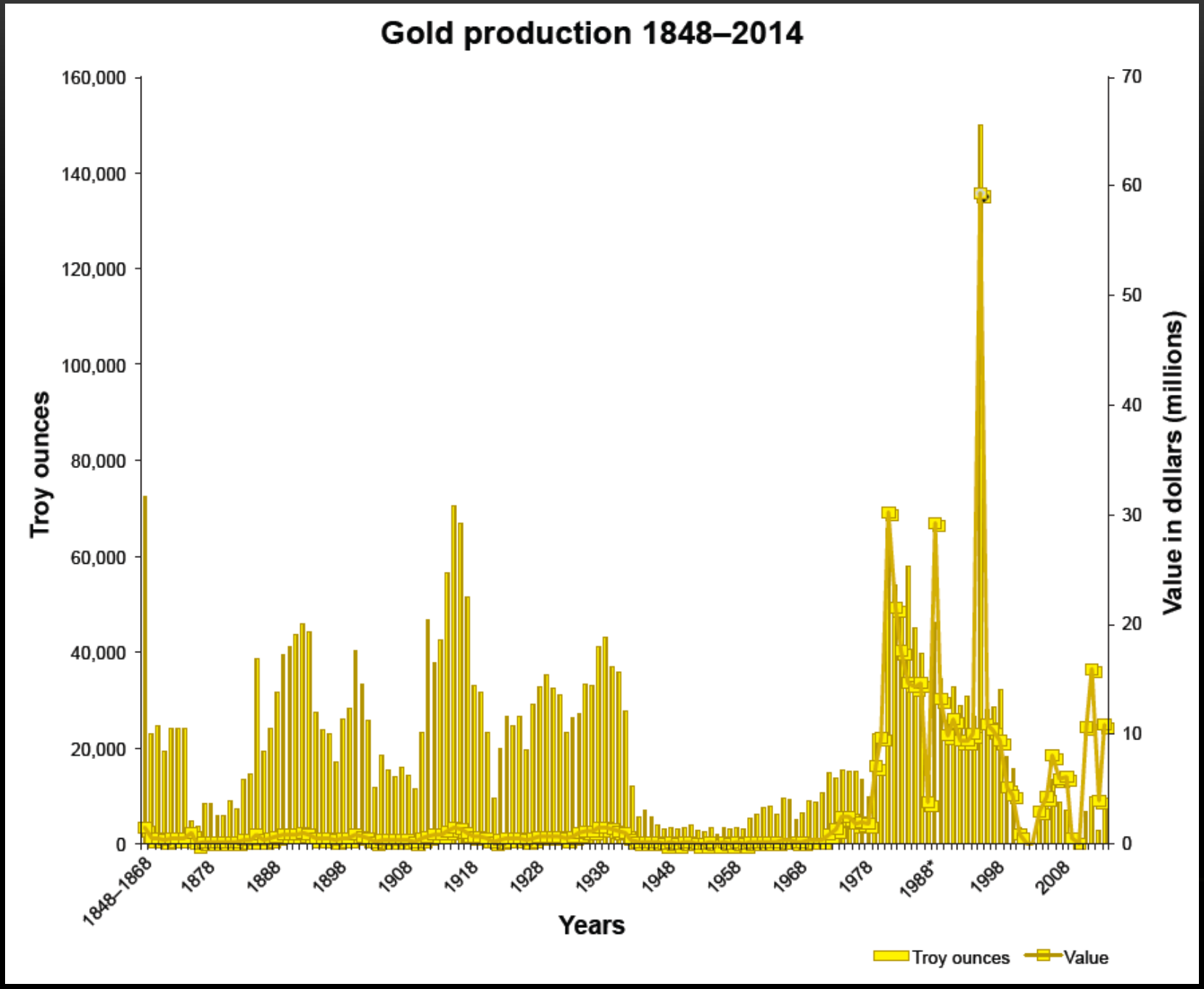
455,390 oz Ag

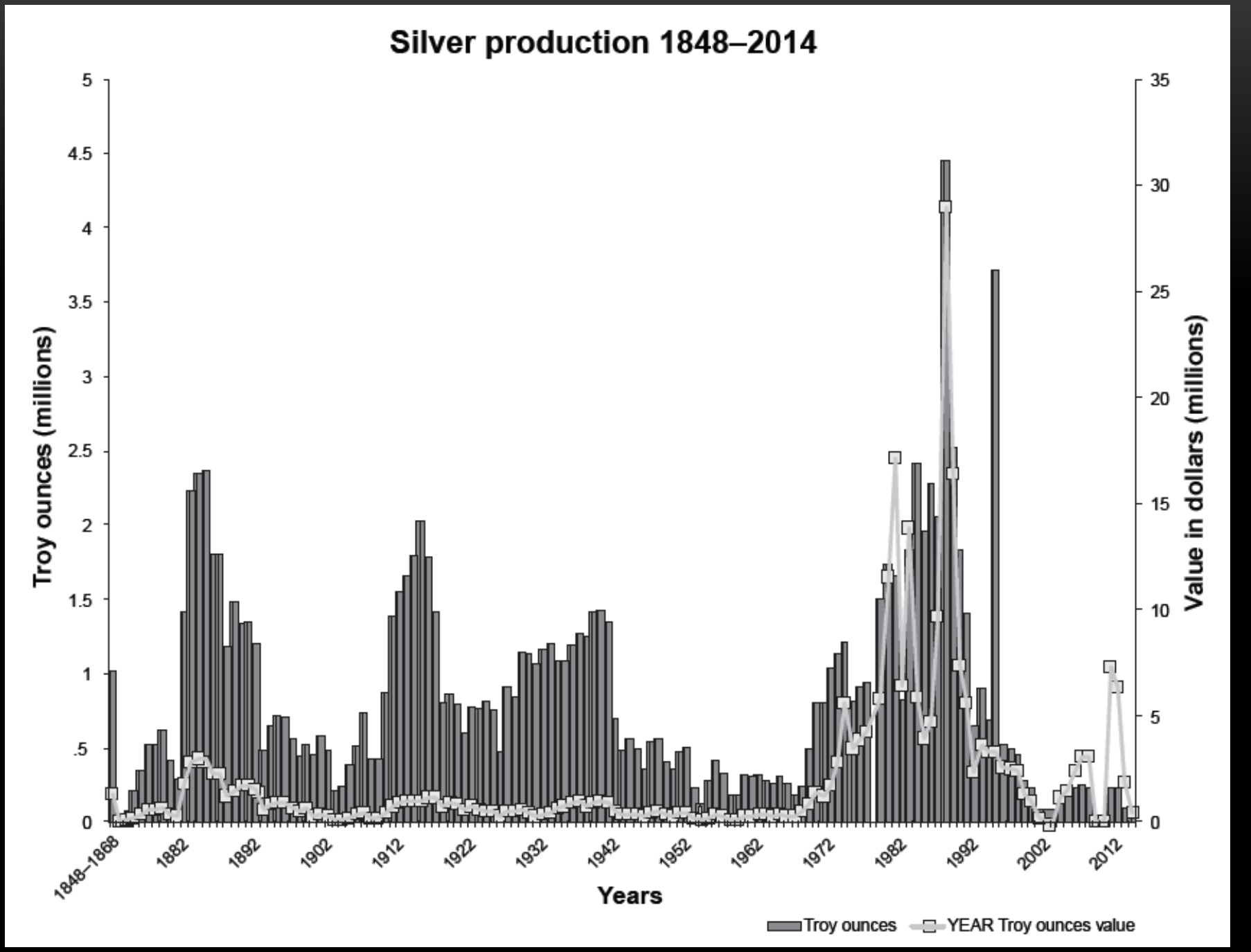
Start in 2020?



GOLD AND SILVER PRODUCTION

- In 2004-2016 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

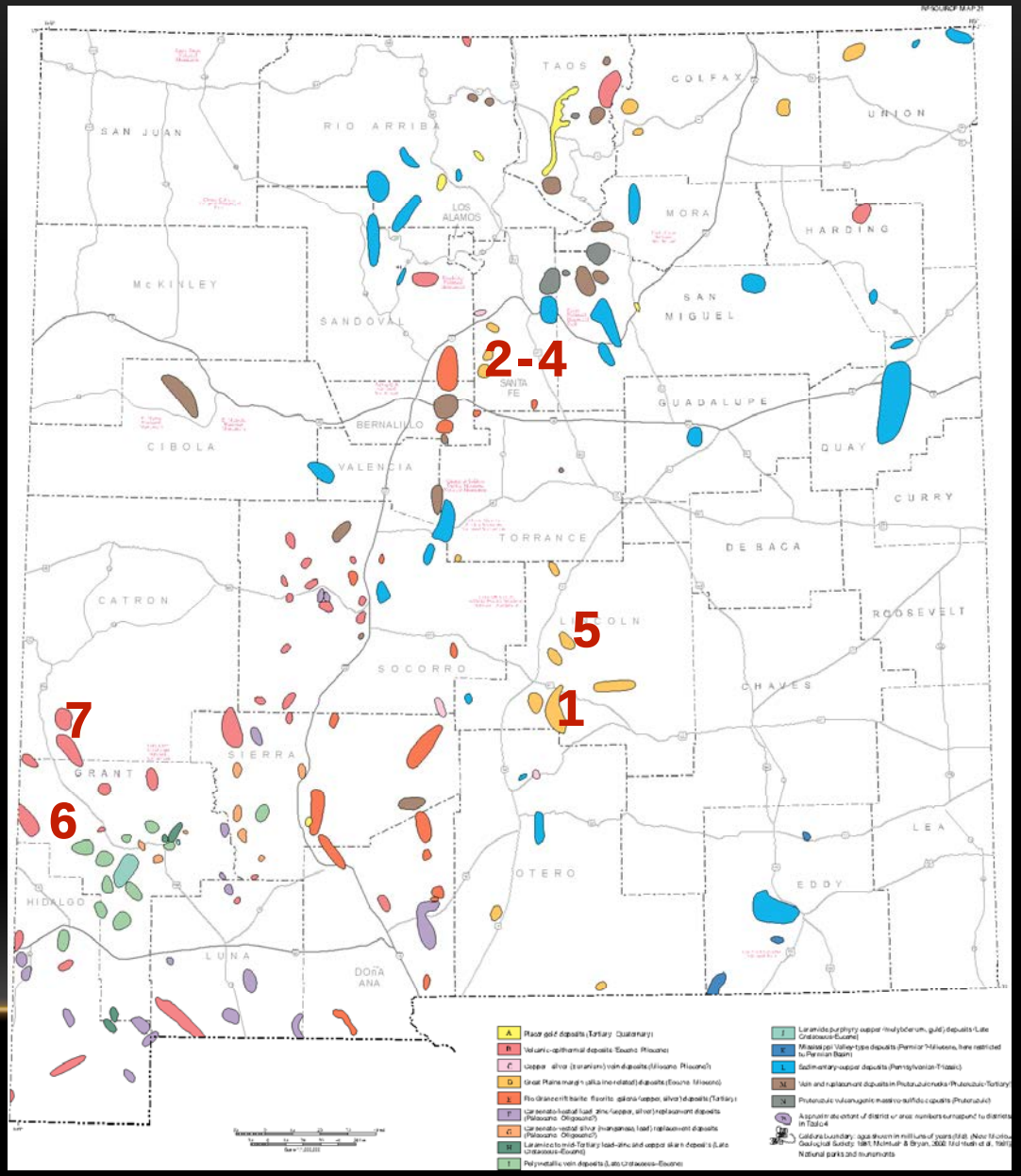

Gold production 1848–2014
Troy ounces
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Value in dollars (millions)
70
60
50
40
30
20
10
0
1848–1868
1878
1888
1898
1908
1918
1928
1938
1948
1958
1968
1978
1988*
1998
2008
Years
Troy ounces
Value


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

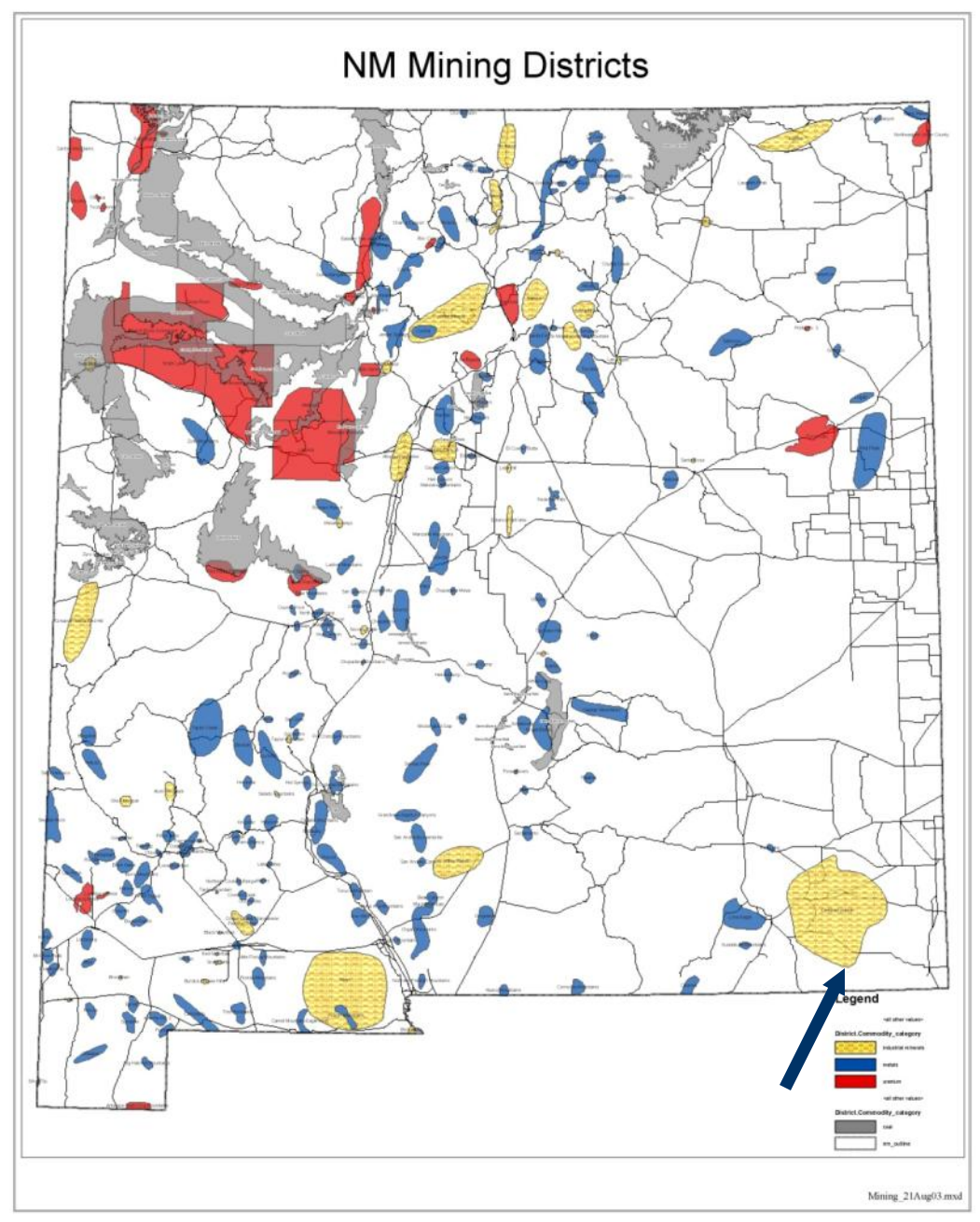
GOLD AND SILVER

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 nonmetallics



POTASH PRODUCTION

1951-2015 109 million tons worth >$15 billion

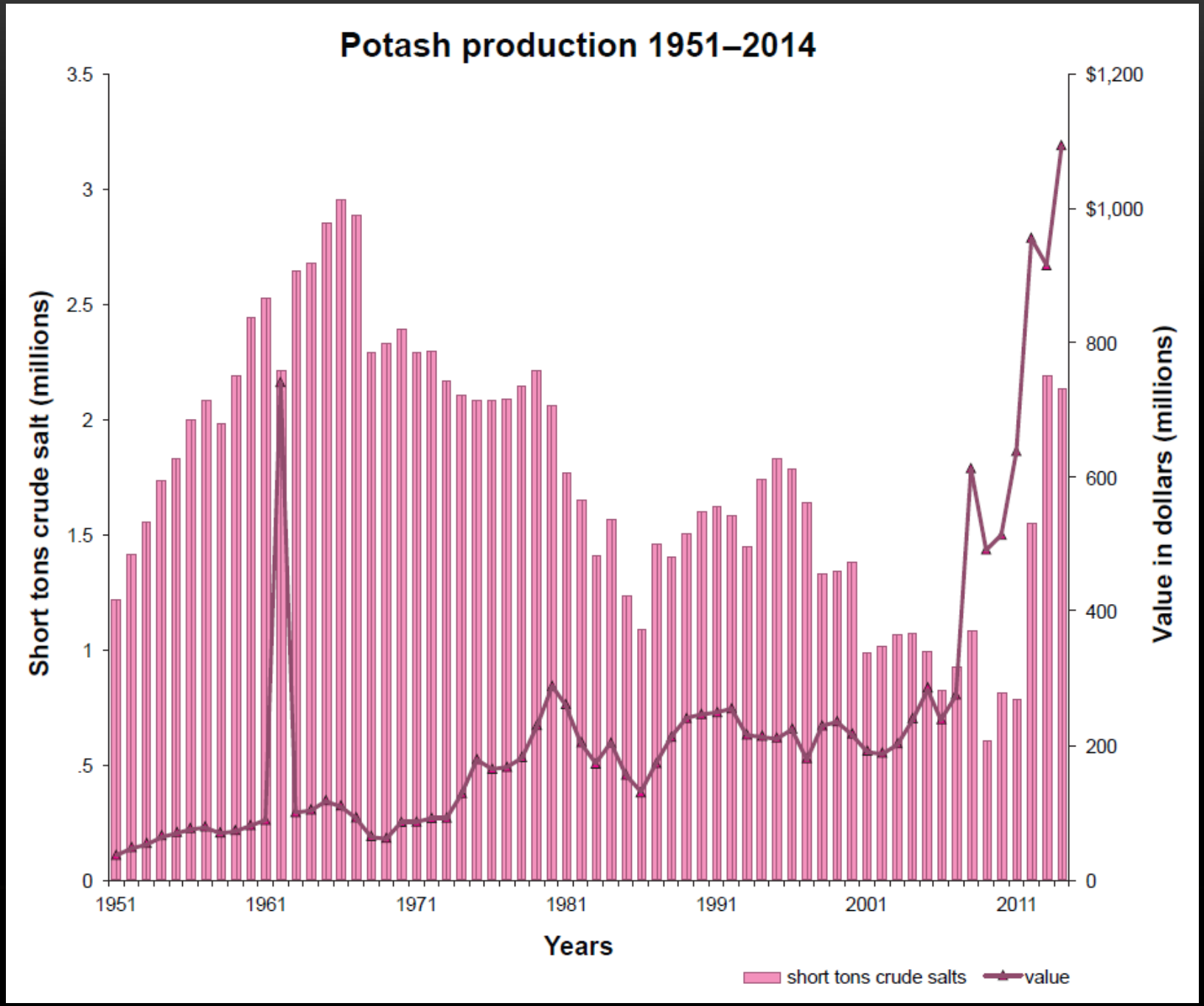
Reserves in Carlsbad District

Potash (>553 million tons)

Potash is used in fertilizers among other uses

Intrepid closed one mine

Competition from Canadian deposits

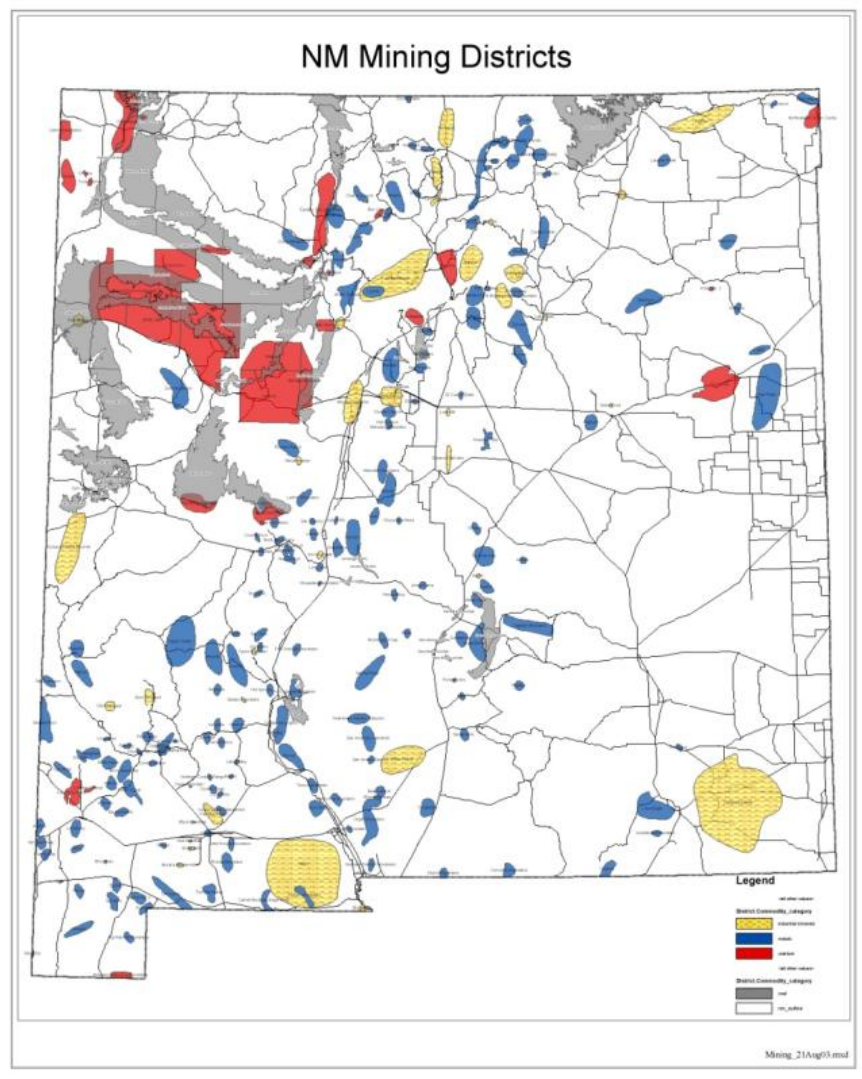

Potash production 1951–2014
Short tons crude salt (millions)
Value in dollars (millions)
Years
3.5
3
2.5
2
1.5
1
.5
0
$1,200
$1,000
800
600
400
200
0
1951
1961
1971
1981
1991
2001
2011
short tons crude salts
value

1ST IN POTASH IN 2016 (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)

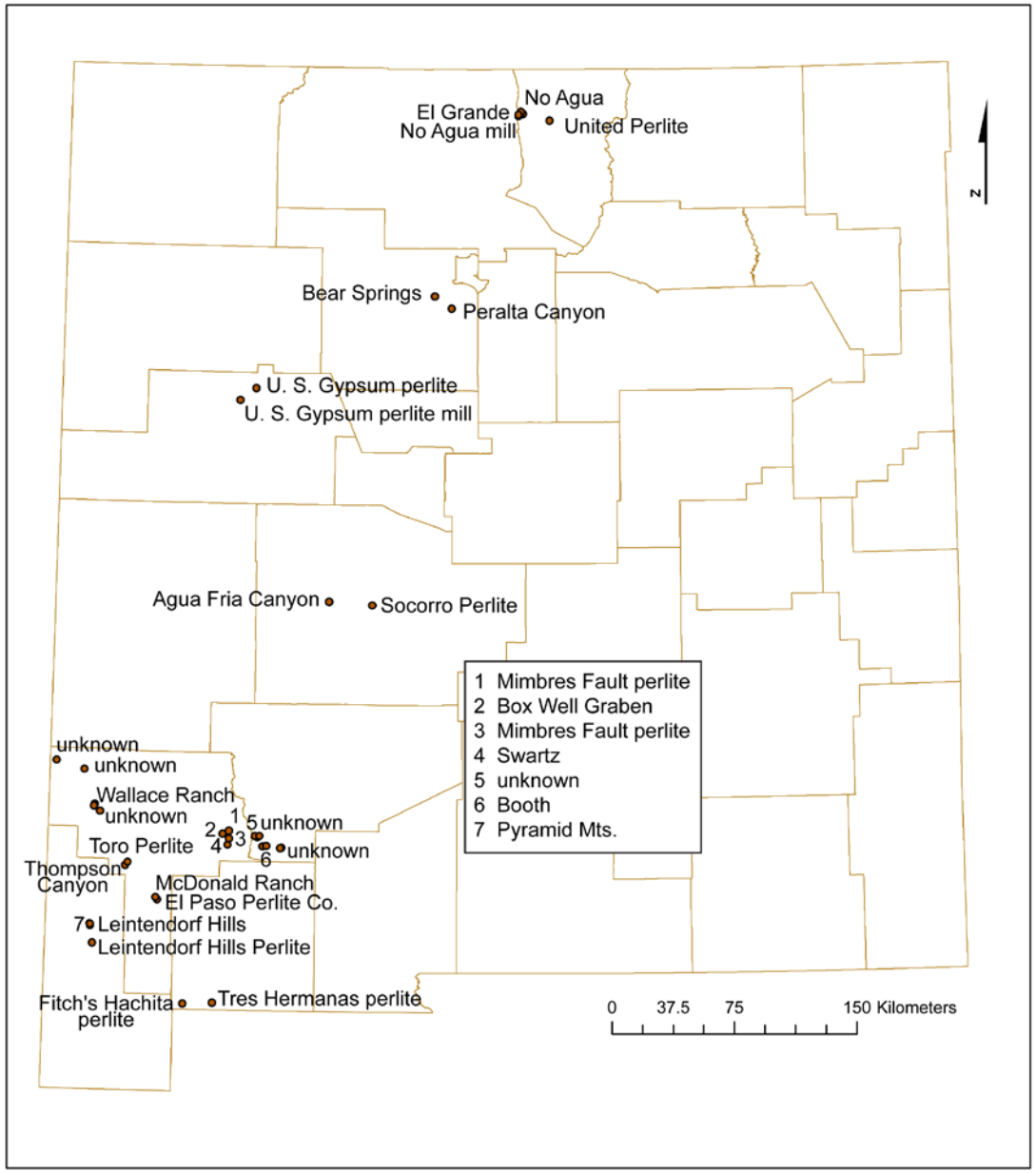
ADDITIONAL INDUSTRIAL MINERALS IN NEW MEXICO



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

PERLITE IN NEW MEXICO

Competition from Greece



OTHER INDUSTRIAL MINERALS DEPOSITS

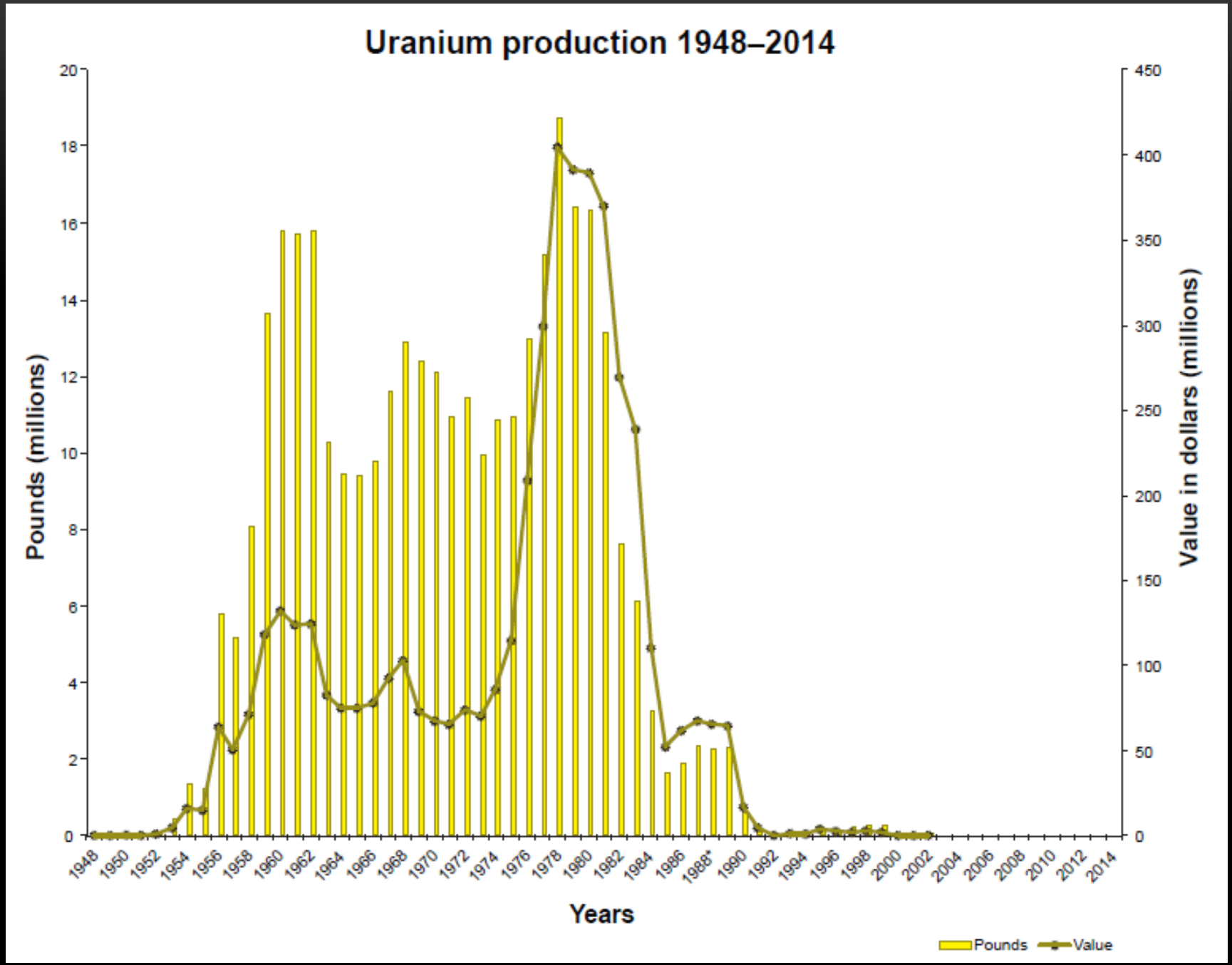
- Aggregates
- Gypsum for wallboard
- Brick and clay in El Paso, Albuquerque areas
- Cement in Tijeras Canyon
- Humate in the San Juan Basin
- Sulfur, helium, carbon dioxide
- Travertine (dimension stone), Meso del Oro, west of Belen
  - 477.6 million tons of travertine

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
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988*
1990
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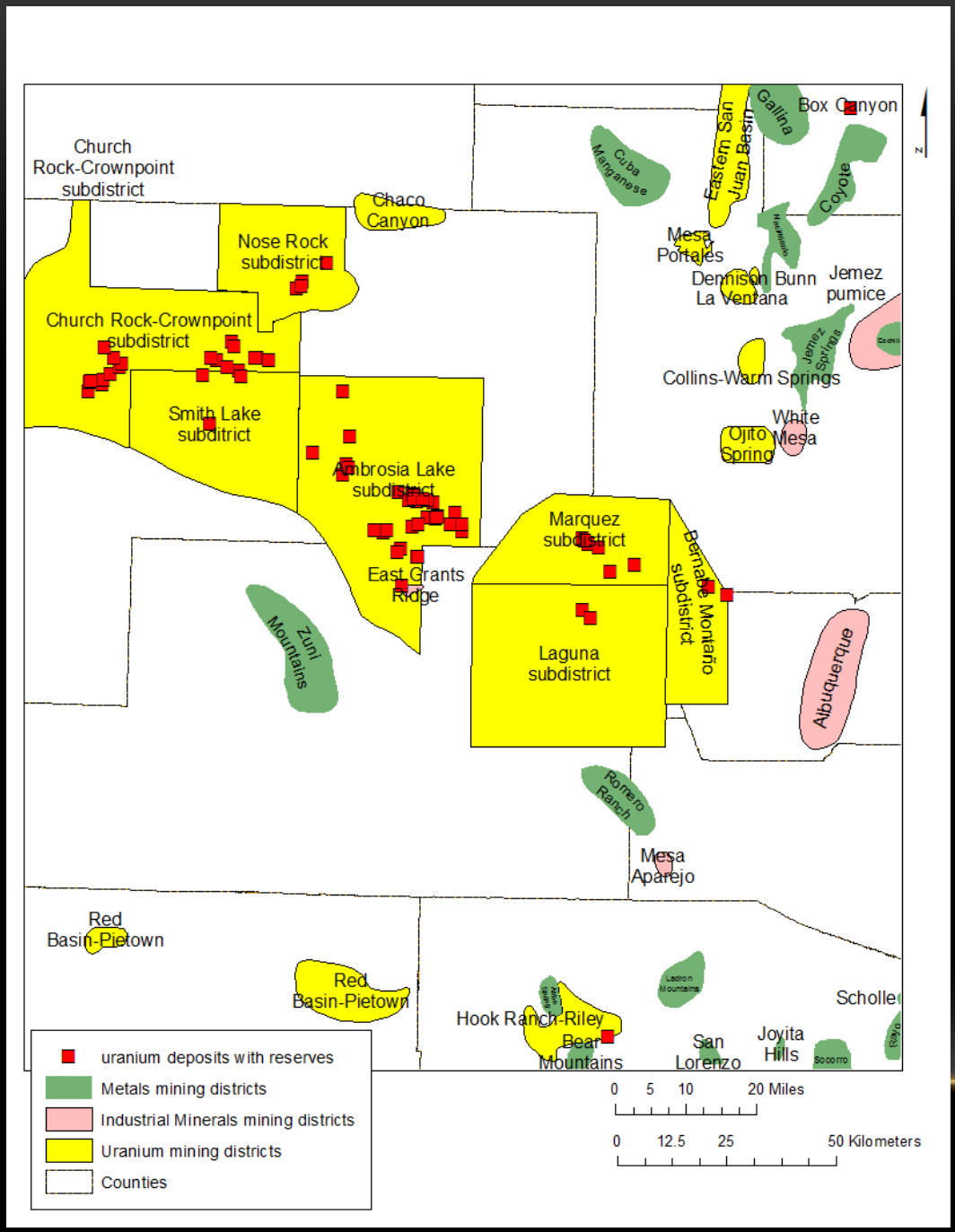
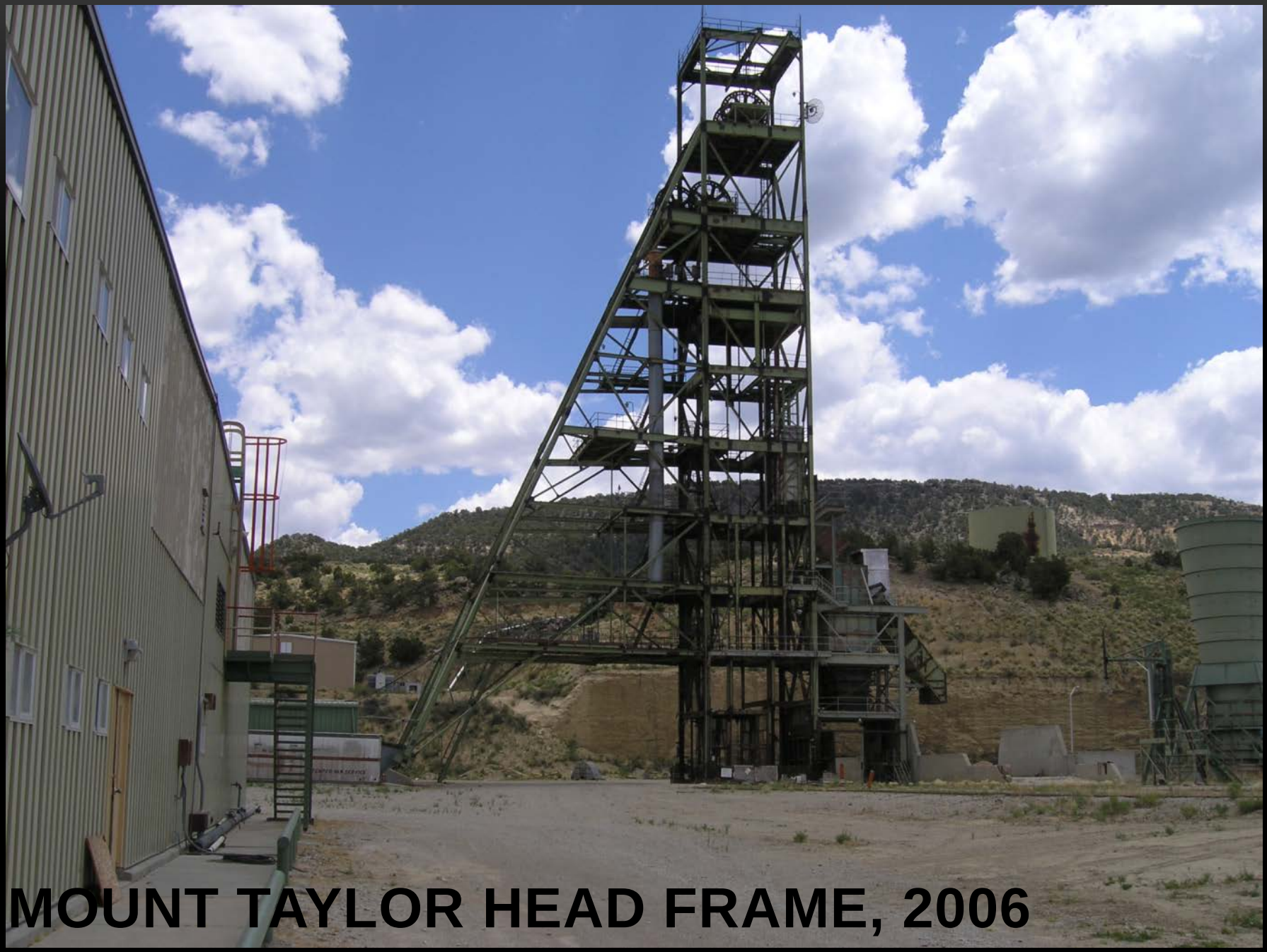
2006
2008
2010
2012
2014



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

WHAT ARE THE MINING ISSUES FACING NEW MEXICO?

Gold King adit

Animas River after Gold King spill

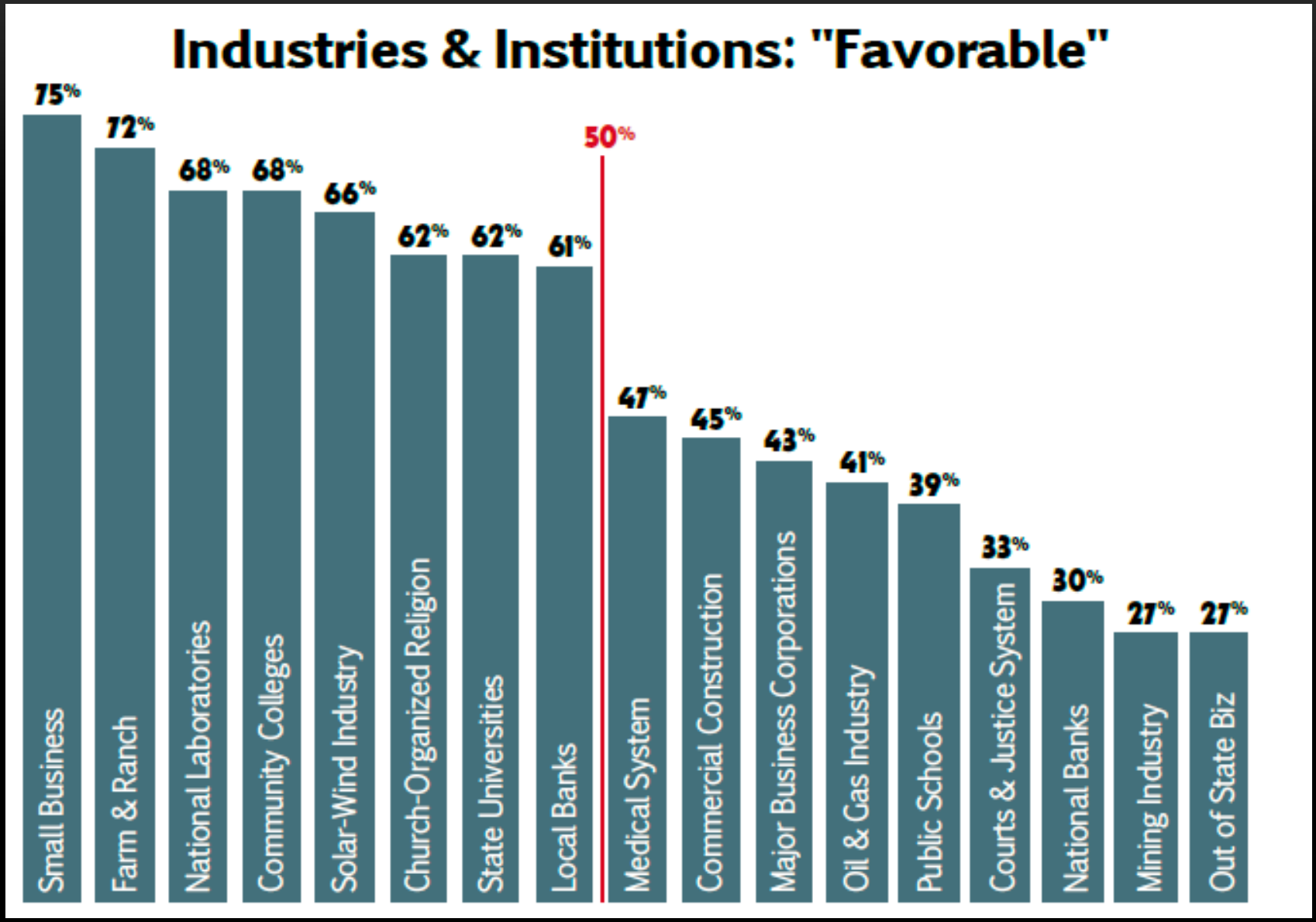
MINING ISSUES FACING NEW MEXICO

- Some current mines are reaching the end of their life and will close over the next decade
- 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

- Legacy issues of past mining activities form negative public perceptions of mining
  - Abandoned or legacy mines, especially Grants uranium district and Questa mine (superfund sites)
  - Gold King spill

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 that 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
- Global competition is closing some of our mines
- Lower prices=closed mines, little exploration

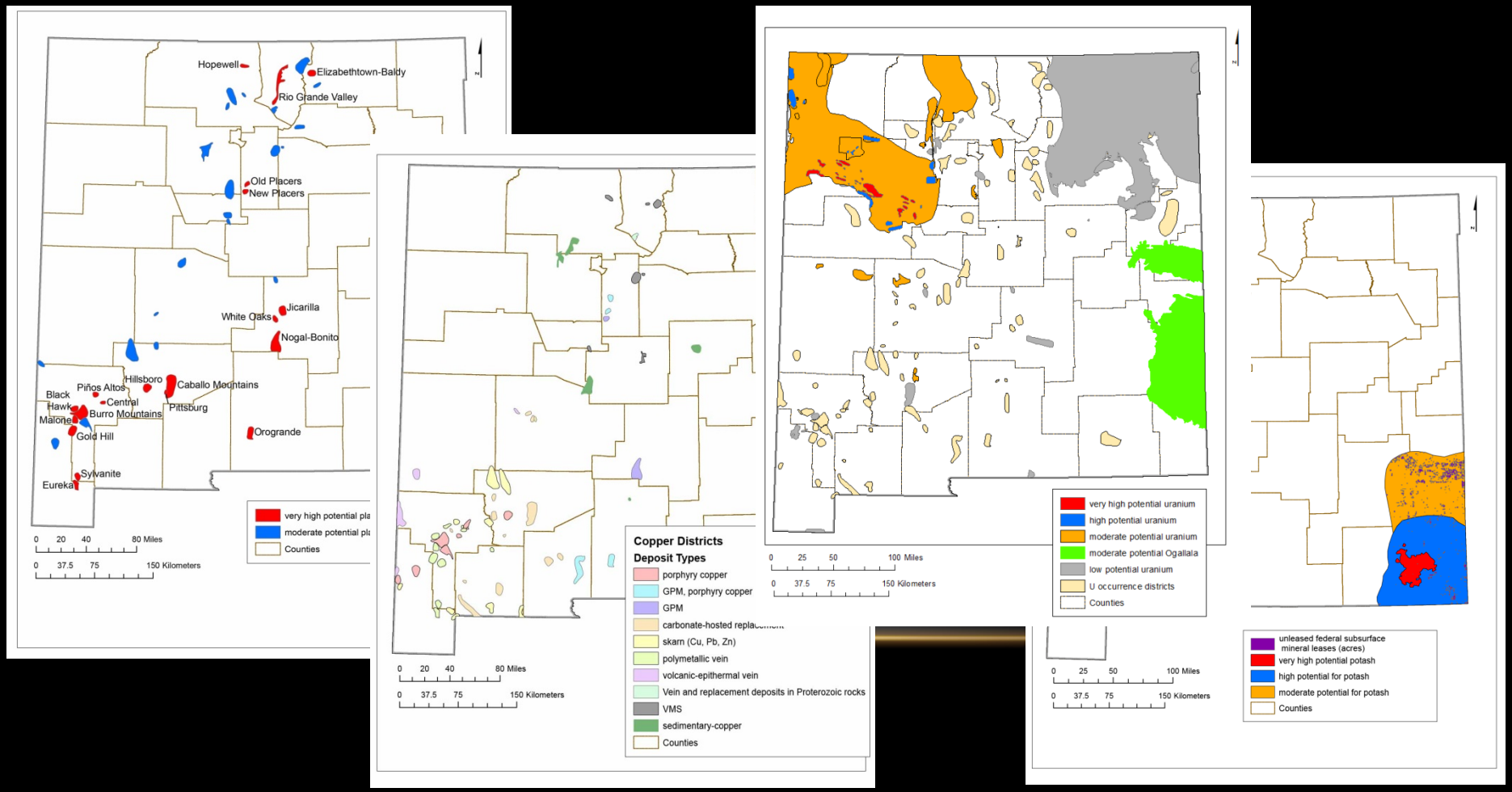
MINING ISSUES FACING NEW MEXICO

- In some areas conflicts arise between mining and other activities
  - Grants uranium district
  - Otero Mesa
  - Water
- **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**

HOW IS THE STATE RESPONDING?

HOW IS THE STATE RESPONDING?

- NMBGMR is evaluating the mineral-resource potential of commodities in NM



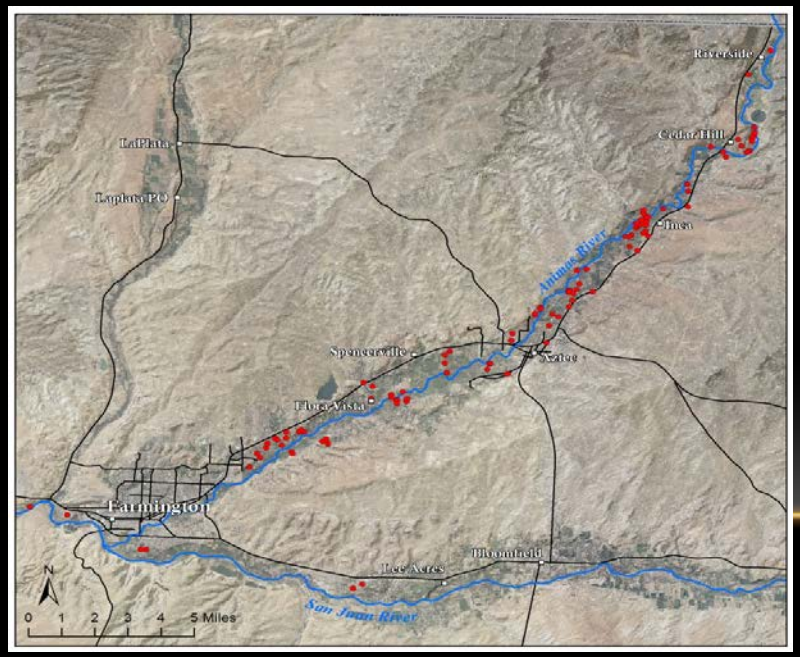
HOW IS THE STATE RESPONDING?

Modifications to the 1993 NM Mining Act

NMMMD and the NM Mining Commission increased the minimum acreage for a minimal impact mine from 10 acres to 40 acres for five industrial minerals (humate, garnet, perlite, dolomite, zeolites), except in Bernalillo, Dona Ana, and Santa Fe Counties

HOW IS NMBG/NMT RESPONDING?

NMED, NMBGMR with other universities and state agencies are cooperating and monitoring the Animas River watershed and the potential effects to New Mexico



HOW IS NMBGMR/NMT RESPONDING?

NMBGMR and NM Tech is working with the state and federal AML (abandoned mine land) programs to evaluate other areas in New Mexico for potential environmental concerns

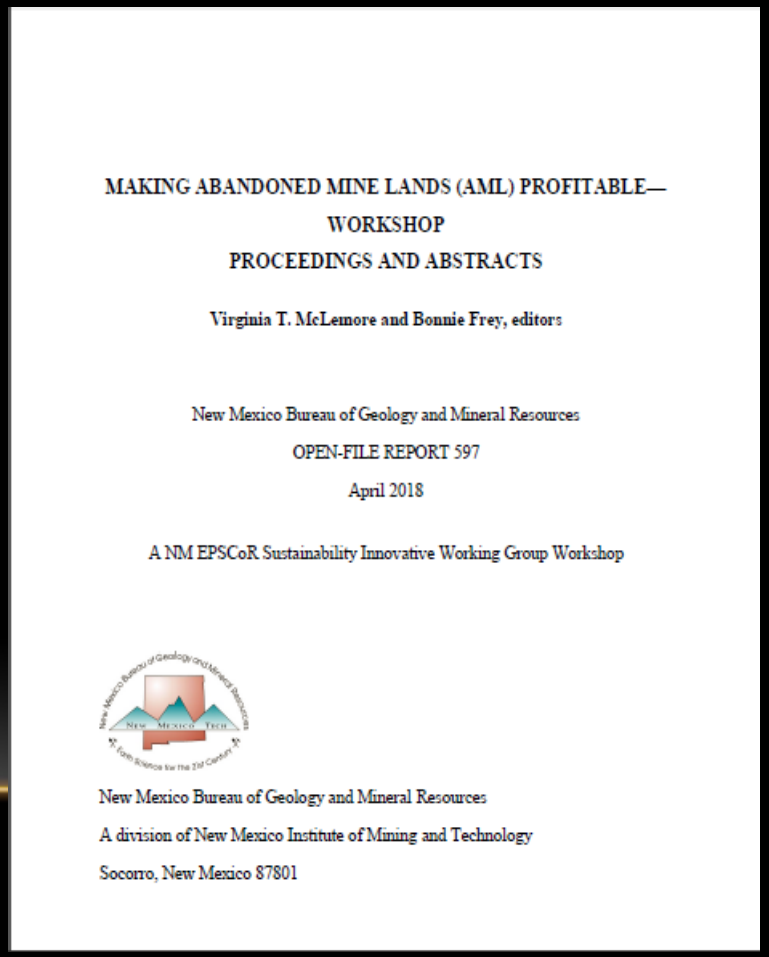
AML project http://geoinfo.nmt.edu/geoscience/hazards/mines/aml/home.html

HOW IS NMBG/NMT RESPONDING?

- NMBGMR, NMT, UNM, and other universities is examining environmental issues with uranium mines in NM
  - New Mexico's Experimental Program to Stimulate Competitive Research (NM EPSCoR)

HOW IS NMBG/NMT RESPONDING?

- NMBGMR, NMT, UNM, and other universities conducted a workshop on Making AML wastes profitable



MAKING ABANDONED MINE LANDS (AML) PROFITABLE—
WORKSHOP
PROCEEDINGS AND ABSTRACTS

Virginia T. McLemore and Bonnie Frey, editors

New Mexico Bureau of Geology and Mineral Resources
OPEN-FILE REPORT 597
April 2018

A NM EPSCoR Sustainability Innovative Working Group Workshop

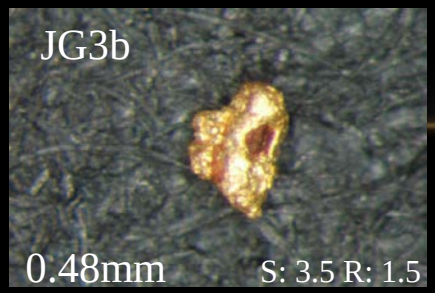
New Mexico Bureau of Geology and Mineral Resources
A division of New Mexico Institute of Mining and Technology
Socorro, New Mexico 87801

https://geoinfo.nmt.edu/publications/openfile/details.cfml?Volume=597

ADDITIONAL RESEARCH

USING TRACE ELEMENT ANALYSIS OF PLACER GOLD TO DETERMINE SOURCE AND TYPE OF ORIGINAL DEPOSIT

METHODOLOGY



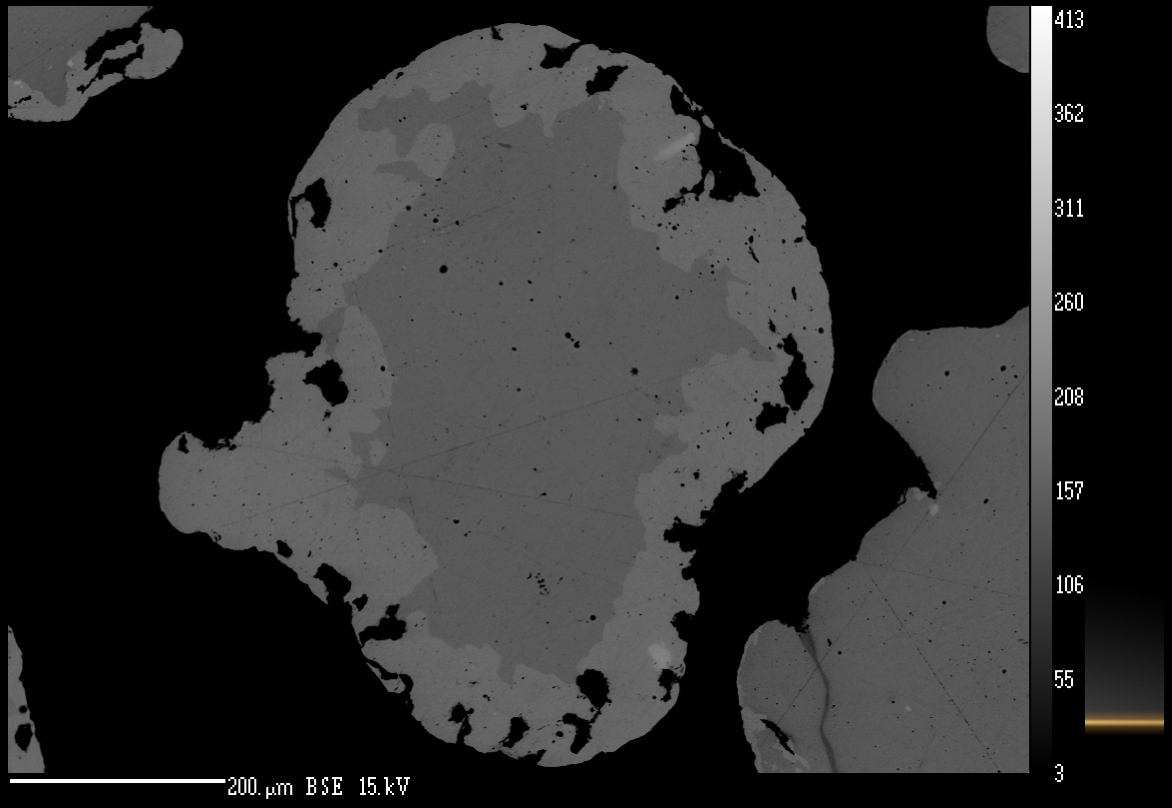
- Physical collection and organization
  - Sphericity & Roundness
  - Morphological studies
- Microprobe analysis
  - Backscattered electron (BSE) imaging
  - Quantitative Analysis

Orogrande GPEP1
Lat: 32.399175 32° 23' 57.03" N
Long: -106.125924 106° 7' 33.33" W

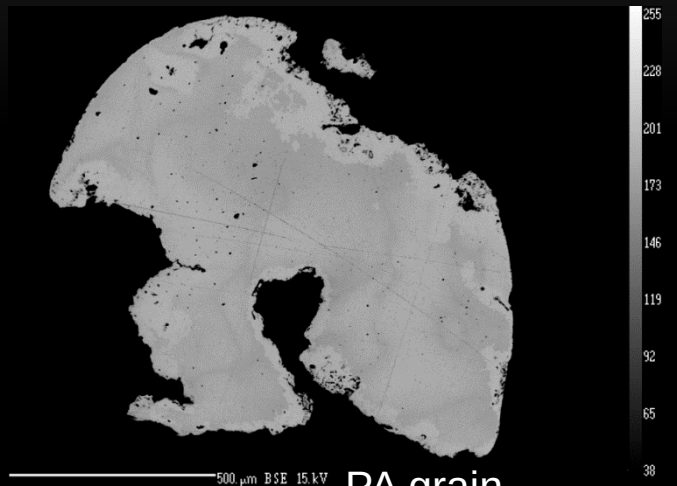
Sample Name	Length (mm)	Size of Particles (d.)	Sphericity	Roundness
OROGPEP1a	1.24	4	3.5	0.5
OROGPEP1b	1.32	4	3.5	1.5
OROGPEP1c	0.86	3	2.5	2.5
OROGPEP1d	0.95	3	2.5	0.5
OROGPEP1e	0.8	3	3.5	1.5
OROGPEP1f	1.07	4	4.5	2.5
OROGPEP1g	0.45	3	4.5	4.5
OROGPEP1h	0.74	3	3.5	1.5
OROGPEP1i	0.59	3	1.5	4.5
OROGPEP1j	0.53	3	2.5	1.5
OROGPEP1k	0.49	2	4.5	0.5
OROGPEP1l	0.56	3	3.5	2.5
OROGPEP1m	0.46	2	2.5	2.5
OROGPEP1n	0.23	1	2.5	2.5
OROGPEP1o	0.32	2	3.5	2.5
OROGPEP1p	0.32	2	0.5	2.5
OROGPEP1q	0.41	2	4.5	3.5
OROGPEP1r	0.41	2	1.5	1.5

SOURCE OF PLACER GOLD DEPOSITS

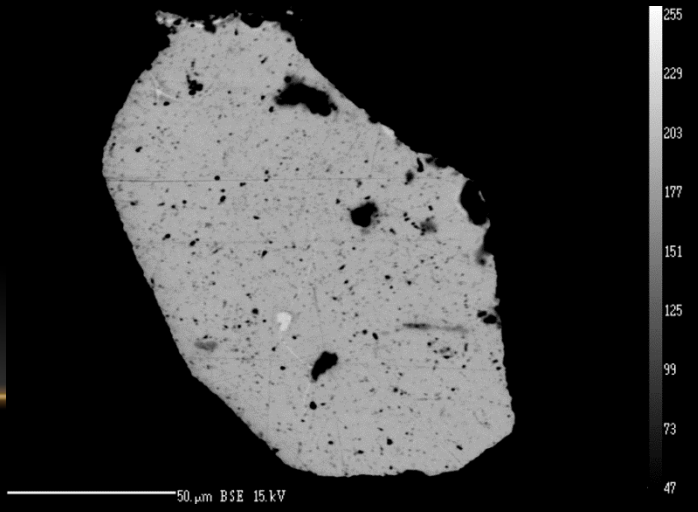
backscattered electron (BSE) imaging to determine chemical zonation in gold particles



Hillsboro grain



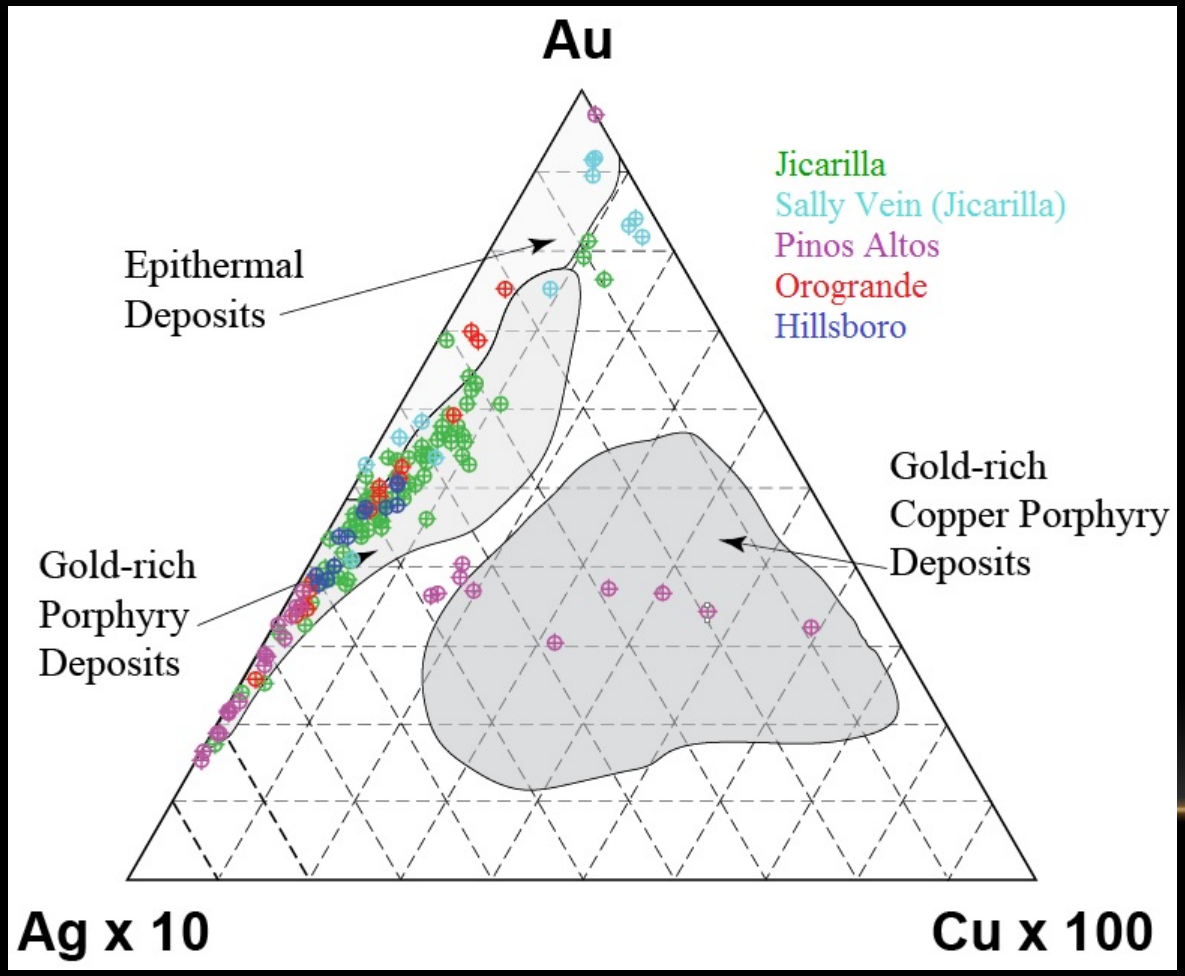
PA grain



JICS/Sally vein grain

New Mexico placer gold districts

- New Mexico's placer gold didn't travel far from source
- Chemical compositions of placer gold samples can be correlated with specific



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

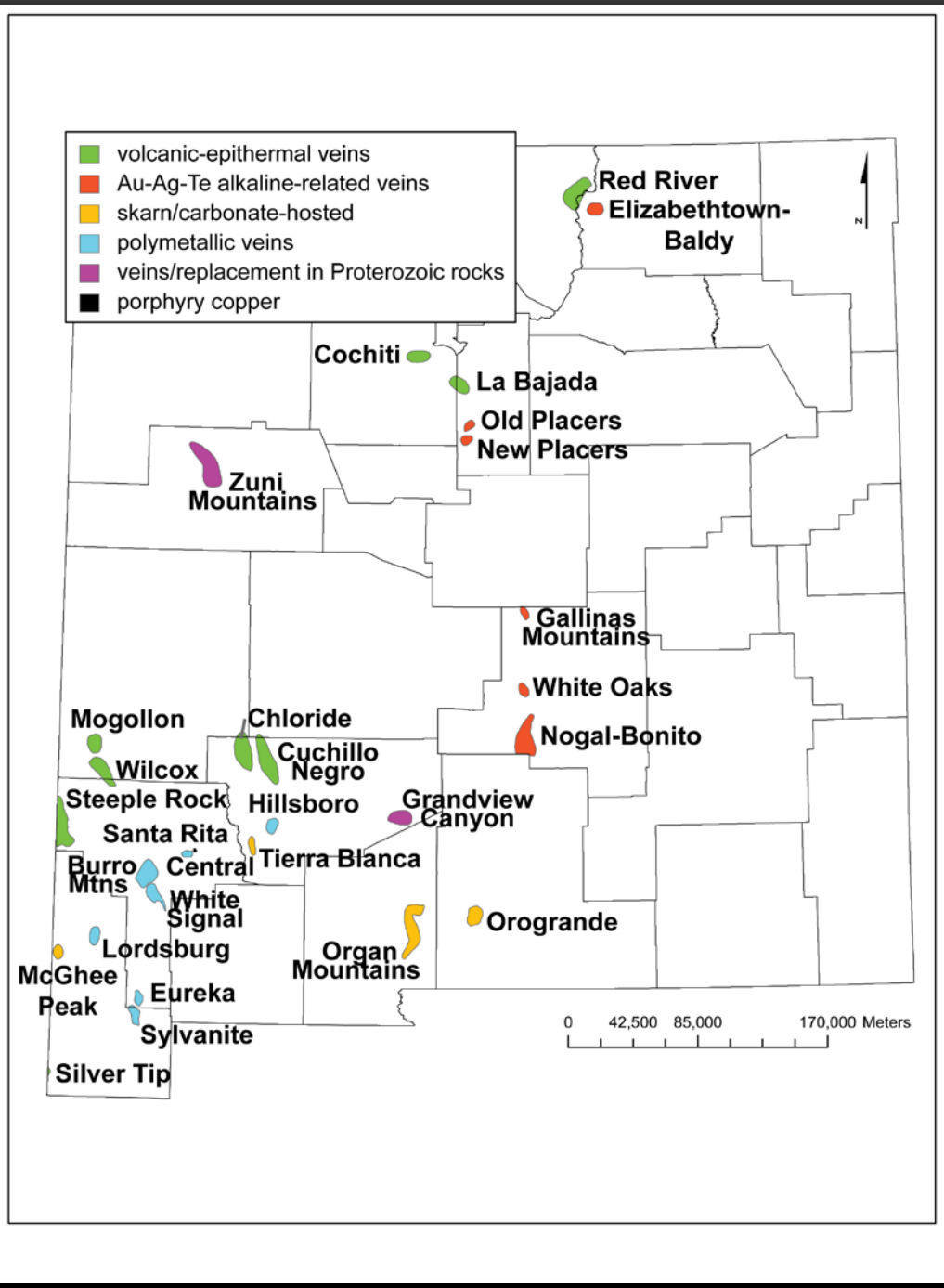
CRITICAL MINERALS

- 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)

TELLURIUM IN MAGMATIC SYSTEMS NEW MEXICO

Uses of Te

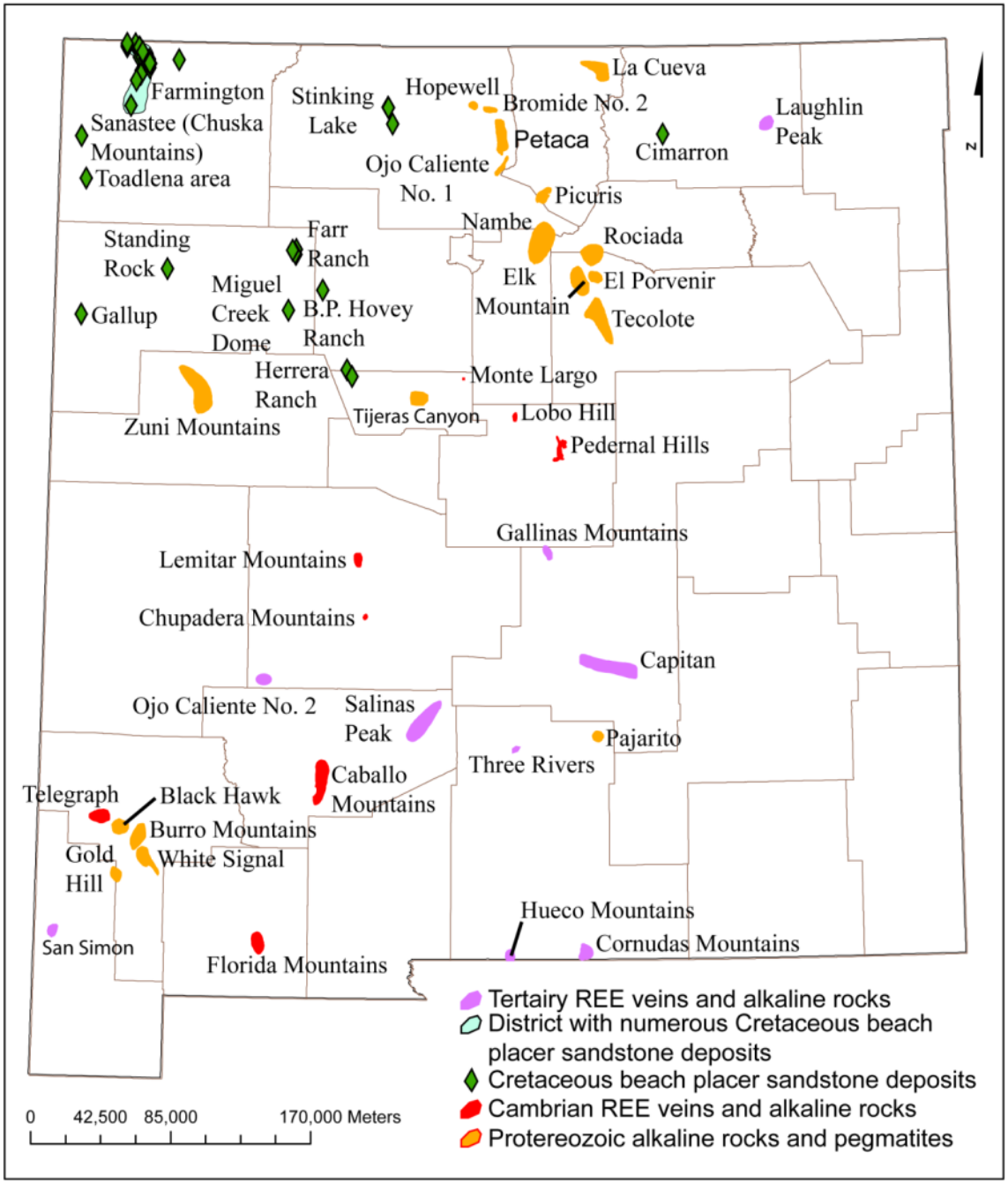
- Alloying additive in steel to improve machining characteristics
- Processing of rubber
- As a component of catalysts for synthetic fiber production
- As pigments to produce various colors in glass and ceramics
- **Thermal imaging devices**
- Thermoelectric cooling devices, such as summertime beverage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



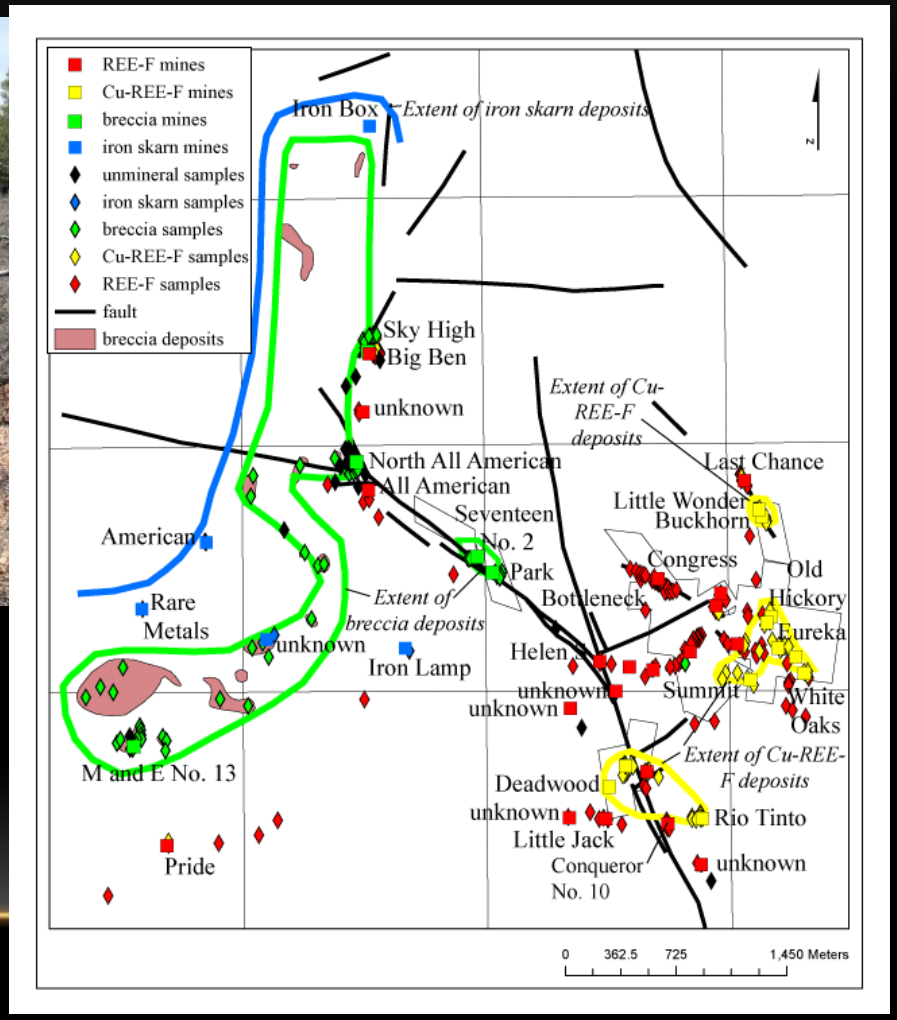
Mining districts in New Mexico with tellurium minerals or chemical assays >20 ppm Te

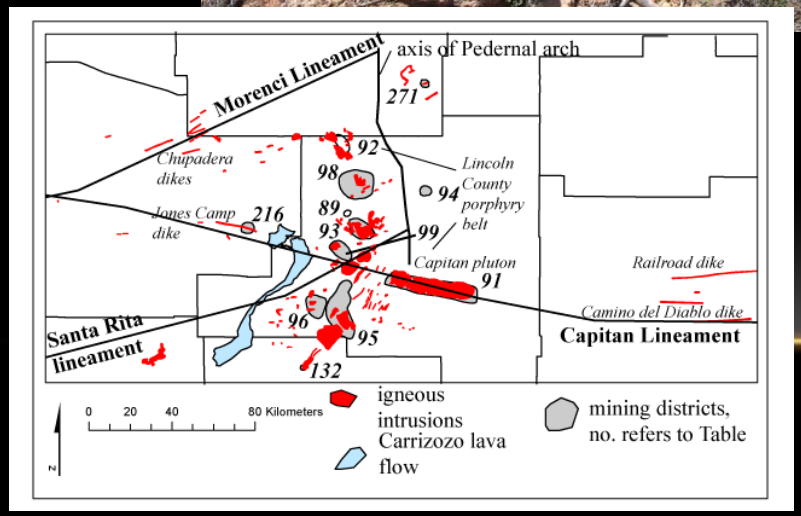
Lone Pine, Wilcox district, Catron County—volcanic epithermal vein

OCCURRENCES OF RARE EARTH ELEMENTS (REE) IN NEW MEXICO



REE in Gallinas Mountains, Lincoln County





SUMMARY

- New Mexico has a wealth of mineral resources
- Exploration and permitting takes many years before a deposit can be mined, >7 yrs
- Legacy issues are being addressed
- Negative perceptions are major issue
- Global competition is a major threat
- NMBG/NMT research is addressing some of these issues, as well as training future geologists and engineers

MORE INFORMATION

- NM Mines and Minerals Division

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

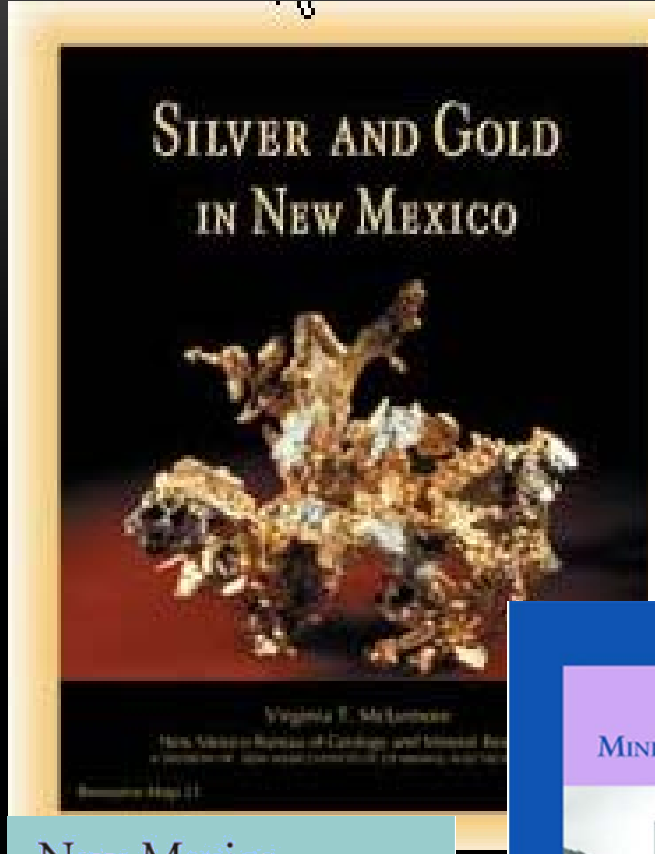
  Virginia McLemore web page

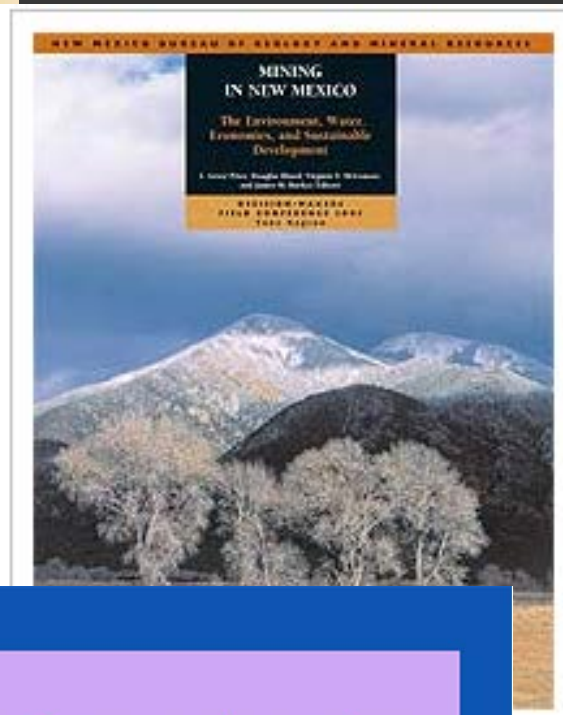
  http://geoinfo.nmt.edu/staff/mclemore/home.html

- New Mexico Bureau of Geology and Mineral Resources

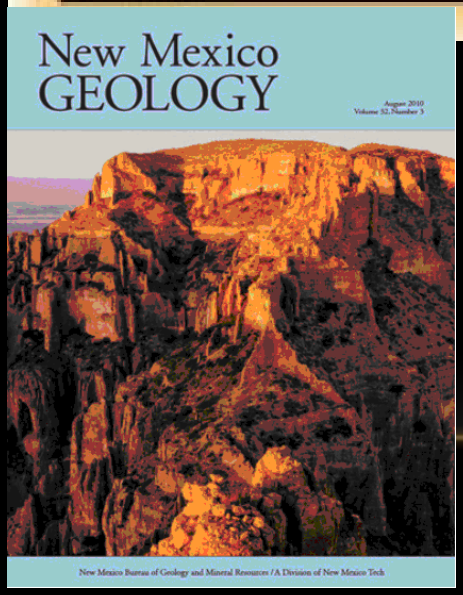
  http://geoinfo.nmt.edu/

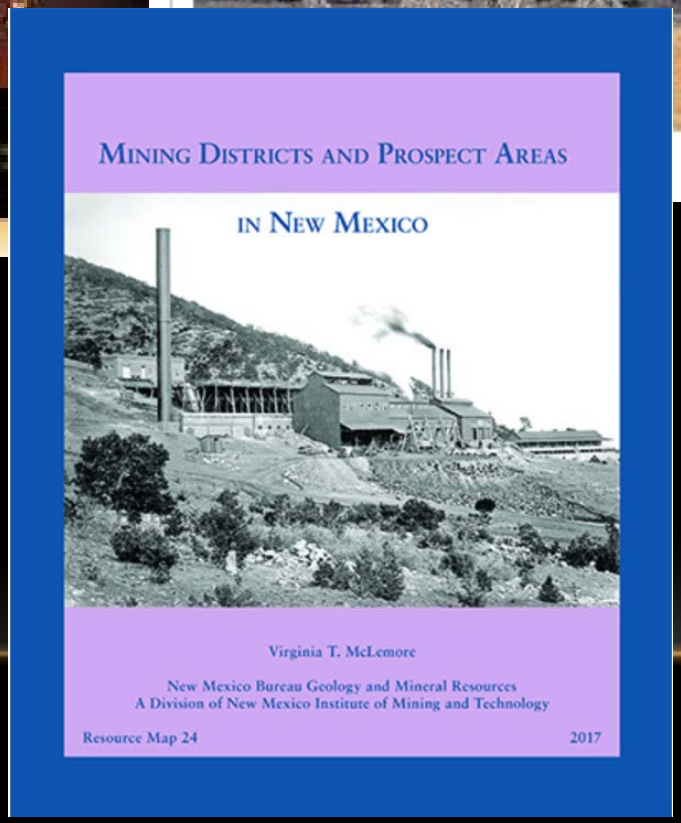
MEMOIR 50—ENERGY AND MINERAL RESOURCES OF NEW MEXICO


Silver and Gold
in New Mexico


Mining
in New Mexico


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


New Mexico
Geology


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


Lite Geology
Geothermal Energy
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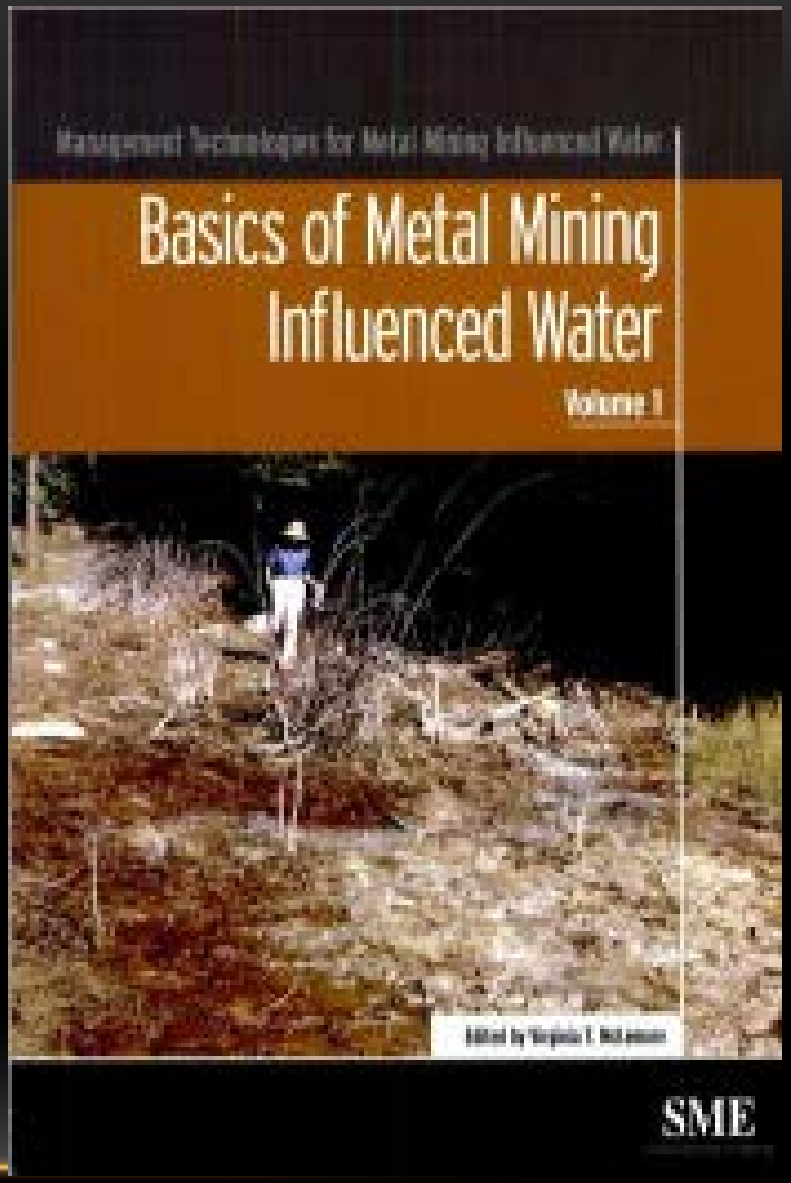

http://www.smenet.org/publications/

QUESTIONS?