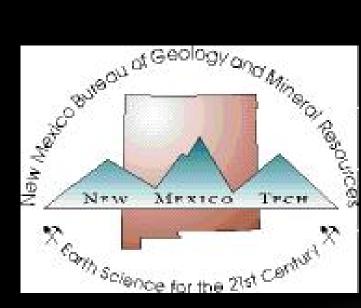
# MINING ISSUES FACING NEW MEXICo-2018





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



# 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

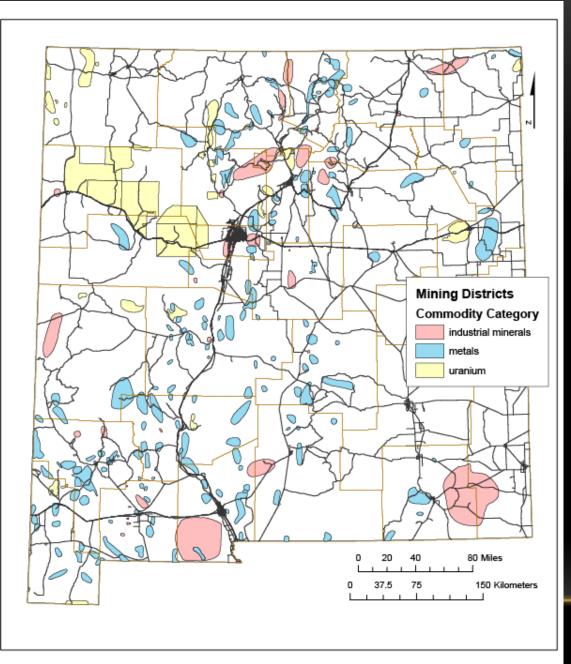
# WHAT, WHERE, AND HOW MUCH MINERALS ARE PRODUCED IN NEW MEXICO?

### INTRODUCTION

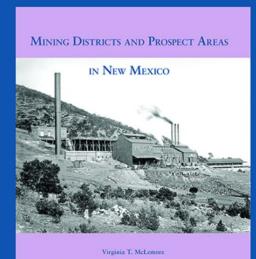
- NM has some of the oldest mining areas in the United States
- Native Americans mined turquoise from Cerrillos Hills district more than 500 yrs before the Spanish settled in the 1600s
- One of the earliest gold rushes in the West was in the Ortiz Mountains (Old Placers district) in 1828, 21 yrs before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



One of the turquoise mines in the Cerrillos Hills district



# MINING DISTRICTS IN NEW MEXICO



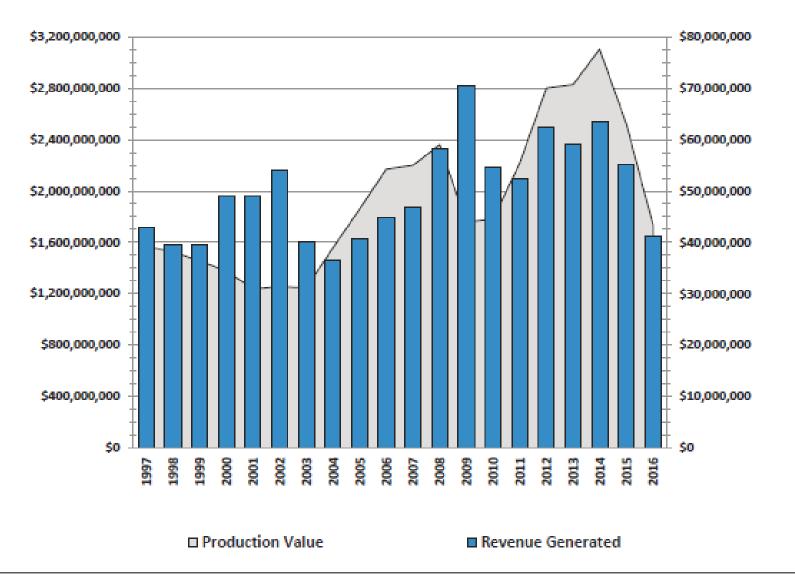
New Mexico Bureau Geology and Mineral Resources A Division of New Mexico Institute of Mining and Technology

Resource Map 24

# **PRODUCTION SUMMARY—2016**

- Value of mineral production in 2016 was \$1.7 billion (does not include oil and gas)—ranked 20<sup>th</sup> 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

FIGURE 1 New Mexico Mineral Production Value and Revenue Generated: 1997-2016

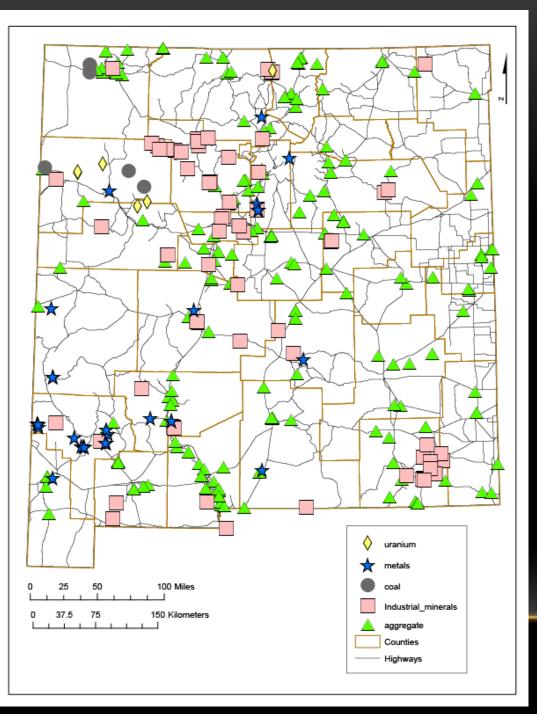


HTTP://WWW.EMNRD.STATE.NM.US/MMD/PUBLICATIONS/DOCUMEN TS/FINAL\_MMD\_2017\_ANNUAL\_REPORT\_000.PDF

Revenue Generated (\$)

# 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
- 11<sup>th</sup> in production in U.S. in 2016
- 11<sup>th</sup> in estimated recoverable coal reserves— 7 billion tons of recoverable reserves (2005 figures)
- Coal production is expected to decrease in the near future



NEW MEXICO BUREAU OF GEOLOGY AND MINERAL RESOURCES | NEW MEXICO GEOLOGICAL SOCI Memoir 50B | Special Publication 13B

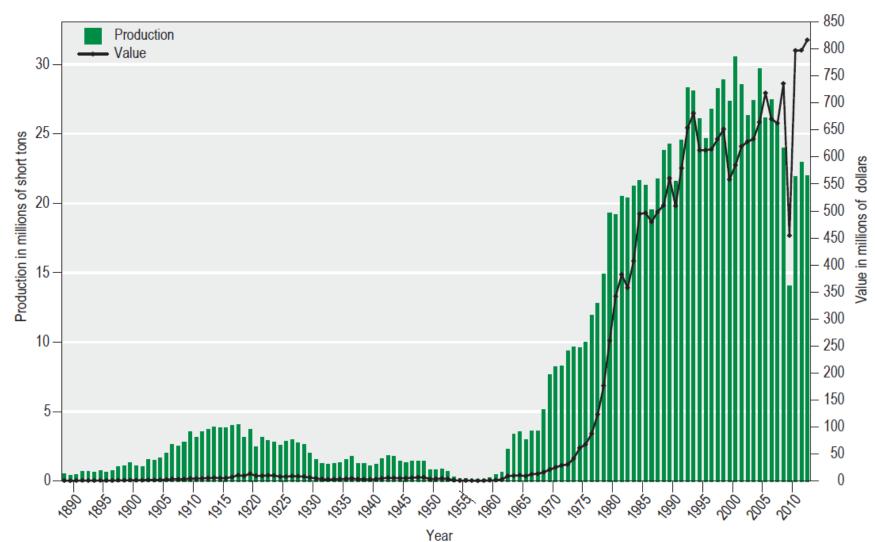


Figure 4. Coal production and value 1899-2014.

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



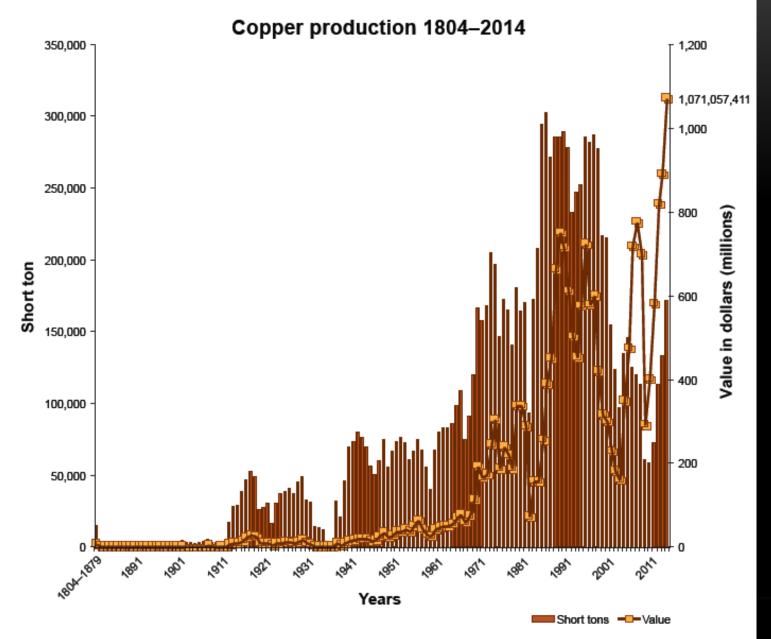


FIGURE 3. Copper production in New Mexico from 1882 to 2014.

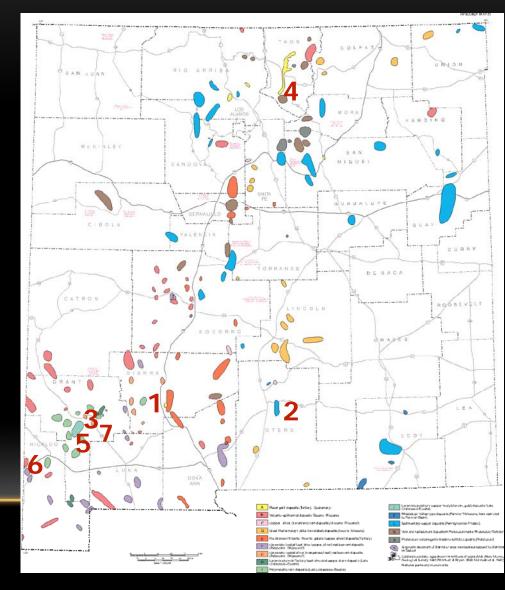
# COPPER RESERVES—2016

#### 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)

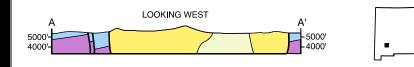
- 1. Copper Flat (98.1 million short tons at 0.31% Cu, 0.009% Mo, 0.003 oz/short ton Au, and 0.07 oz/ short ton Ag)
- 2. Orogrande
- 3. Hanover Mountain (80 mill st reserves at 0.38% Cu )
- 4. Copper Hill, Picuris district (46.5 mill st of ore at 0.42% Cu)
- 5. Lone Mountain (7.5 mill st at 2-3% Cu,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

# POTENTIAL COPPER DEPOSITS



**Copper Flat, Themax Resources** Planned production per year for ~15 yrs 50.76 mill lbs Cu **EXPLANATION** 1.01 mill lbs Mo Tertiary sediments with interbedded basalt Tertiary volcanics Animas COPPER FI Quartz diorite 12,750 oz Au Cretacec rocks Copper Flat quartz monzonite Warm Springs guartz monzonite ate Andesite 455,390 oz Ag Paleozoic sediments Precambrian rocks Dikes and gold veins Start in 2020? Fault 2 mi. 7W 6W Hillsboro

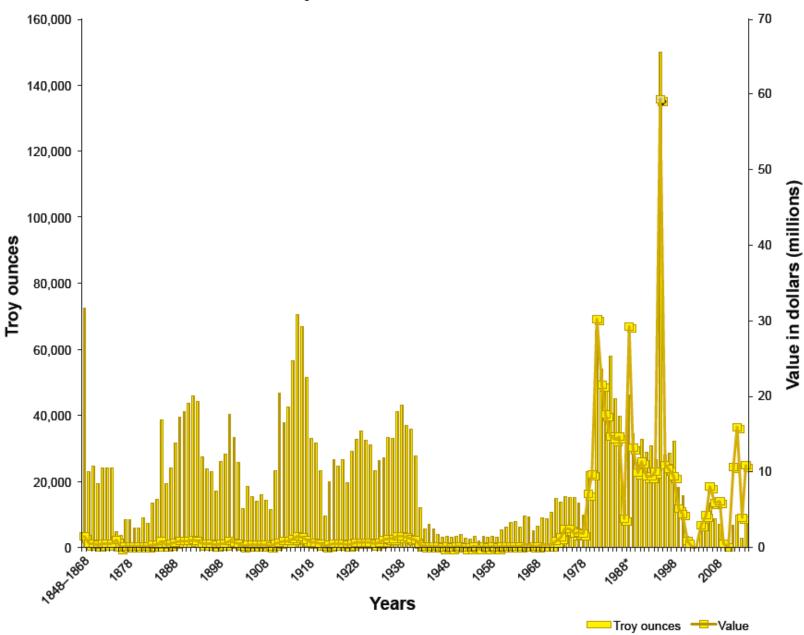




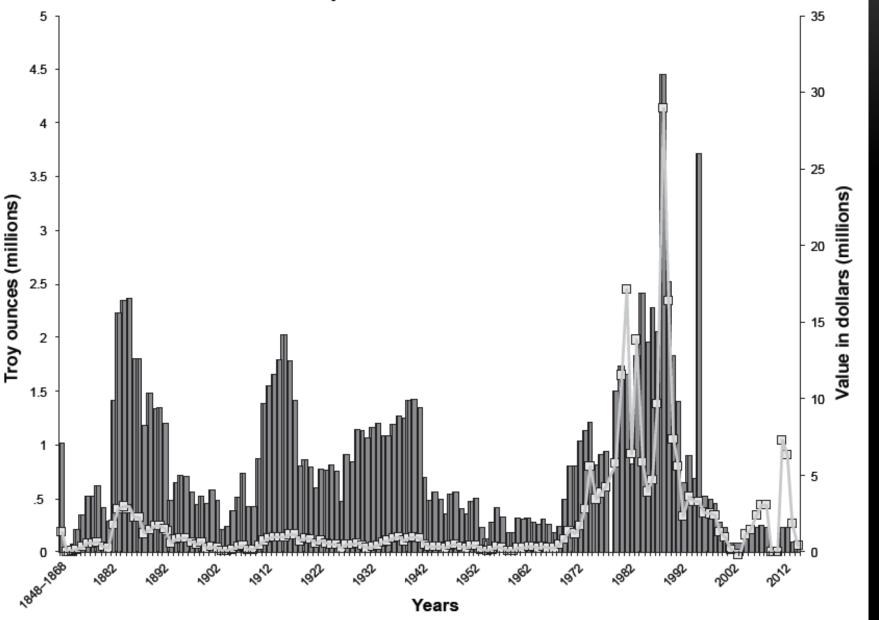
# **GOLD AND SILVER PRODUCTION**

- In 2004-2016 as a byproduct of copper production from the Ivanhoe concentrator (Freeport-McMoRan)
- 2009 Summit mine opened (currently on standby)
- 9<sup>th</sup> in gold production
- 10<sup>th</sup> in silver production

Gold production 1848–2014



Silver production 1848–2014



Troy ounces - YEAR Troy ounces value

## SUMMIT GOLD MINE

Steel S

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

The ore was

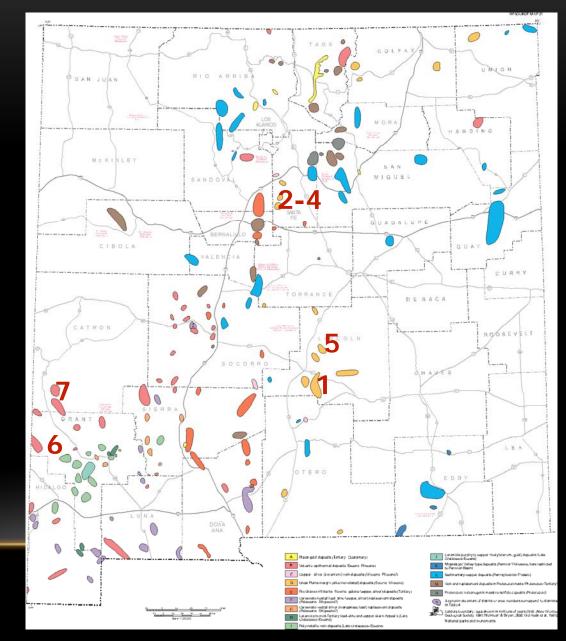
Lordsburg and

sold as silica flux

milled at

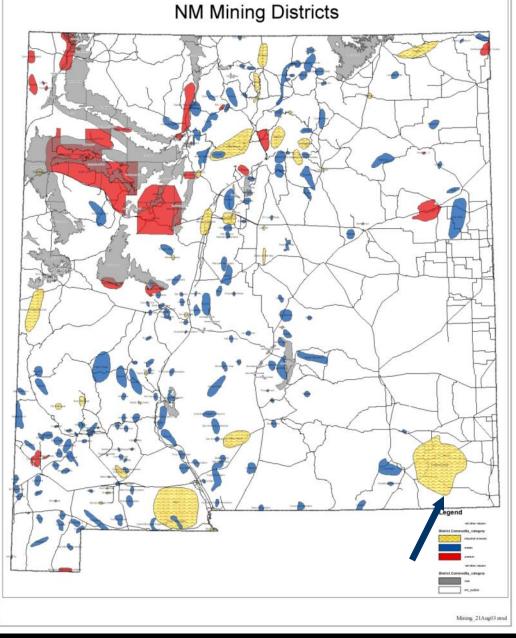
#### **GOLD AND SILVER**

- 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

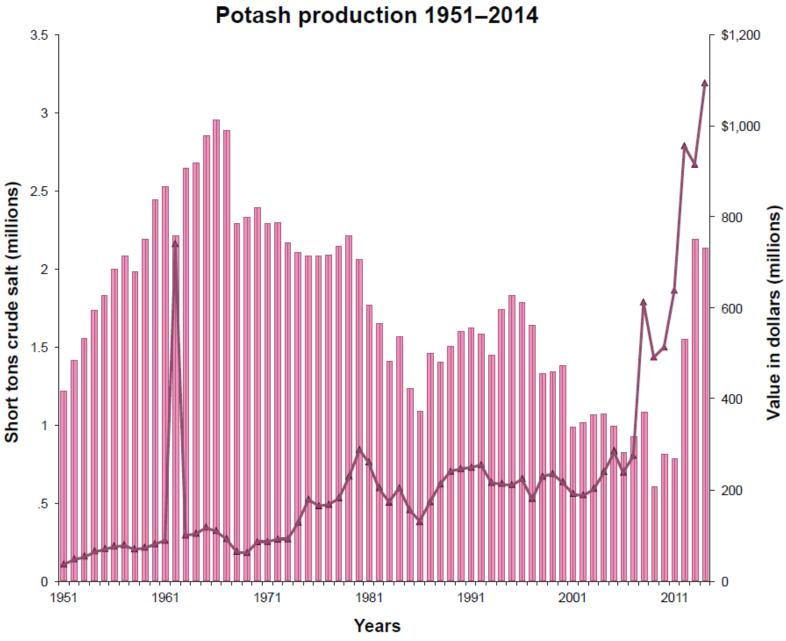
#### Reserves in Carlsbad District

Potash (>553 million tons)

Potash is used in fertilizers among other uses

Intrepid closed one mine

Competition from Canadian deposits



short tons crude salts ----value

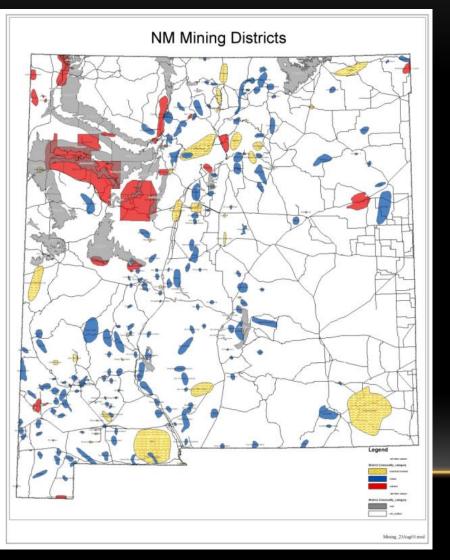


### 1<sup>ST</sup> IN POTASH IN 2016 (MOSAIC, INTREPID MINING)

### 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)

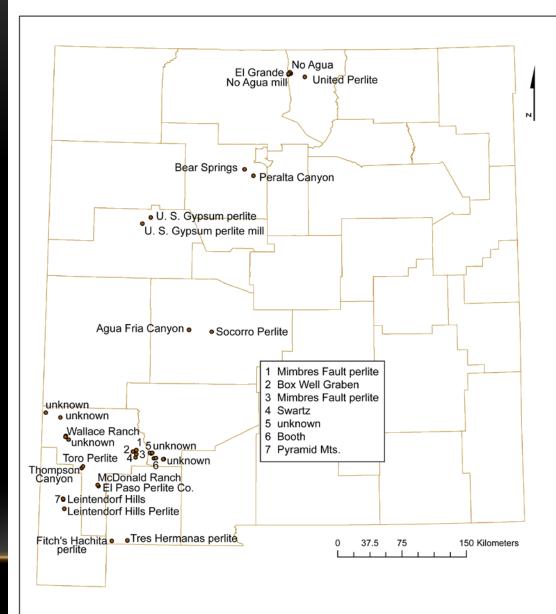
### ADDITIONAL INDUSTRIAL MINERALS IN NEW MEXICO



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

#### PERLITE IN NEW MEXICO

#### **Competition from Greece**



### OTHER INDUSTRIAL MINERALS DEPOSITS

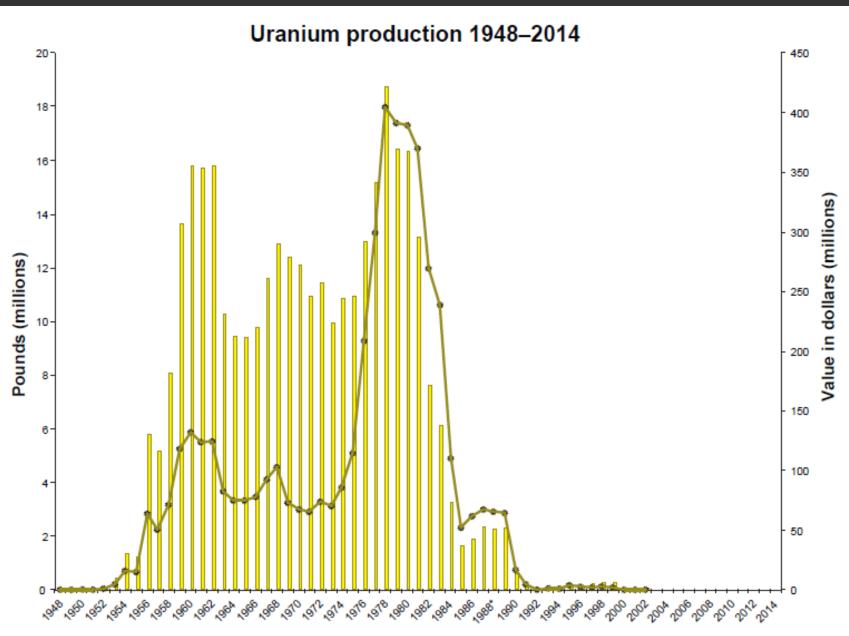
- Aggregates
- Gypsum for wallboard
- Brick and clay in El Paso, Albuquerque areas
- Cement in Tijeras Canyon
- Humate in the San Juan Basin
- Sulfur, helium, carbon dioxide
- Travertine (dimension stone), Meso del Oro, west of Belen
  - 477.6 million tons of travertine

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

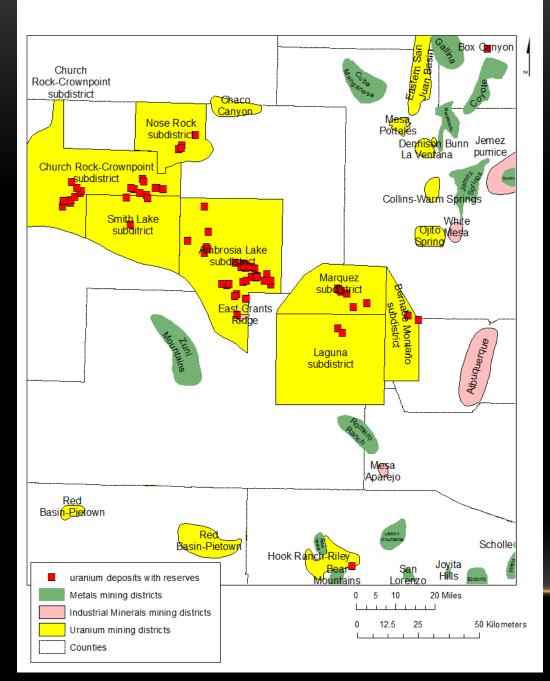
http://panelrey.com/en/news-pr/entering-its-third-decade-panel-rey-will-be-opening-new-production-plant

### **URANIUM IN NEW MEXICO 2016**

- 2<sup>nd</sup> in uranium resources 15 million tons ore at 0.277% U<sub>3</sub>O<sub>8</sub> (84 million lbs U<sub>3</sub>O<sub>8</sub>) 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



Years



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





# WHAT ARE THE MINING ISSUES FACING NEW MEXICO?



Gold King adit



### Animas River after Gold King spill

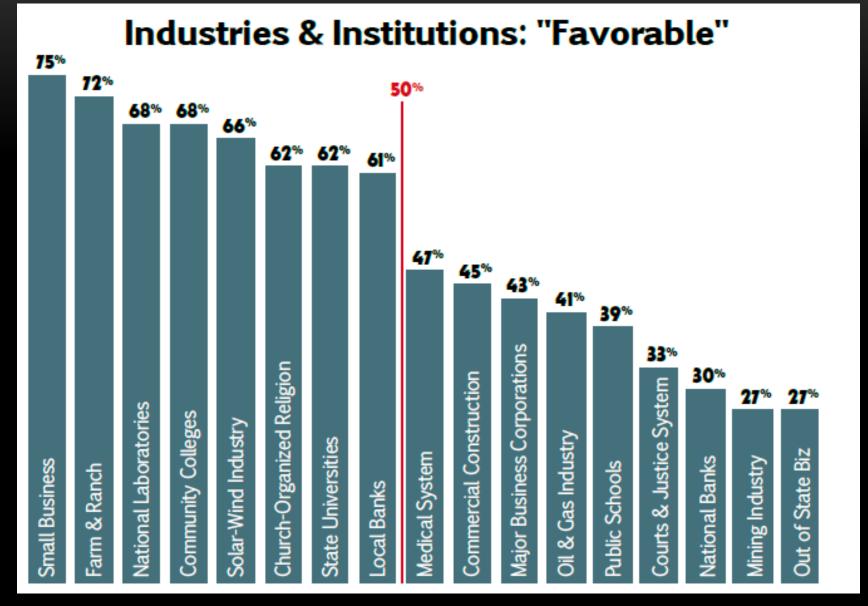
# MINING ISSUES FACING NEW MEXICO

- 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

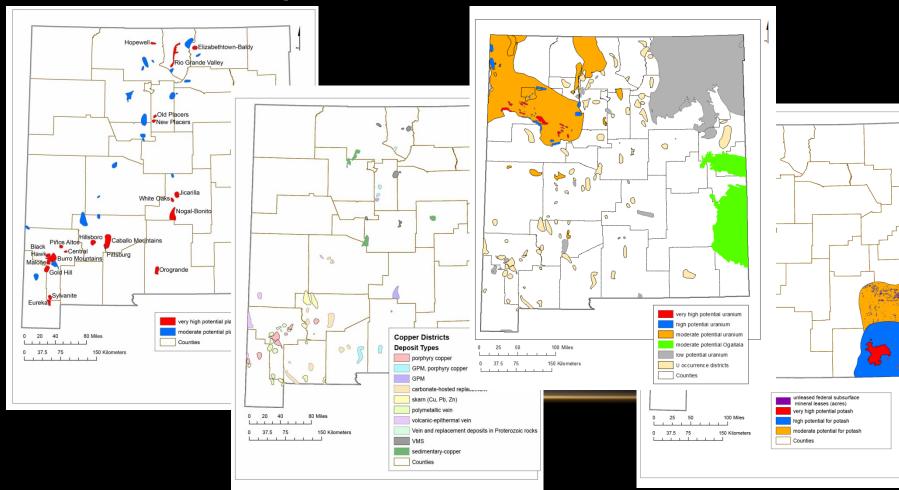
- In some areas conflicts arise between mining and other activities
  - Grants uranium district
  - Otero Mesa
  - Water

 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 mineralresource 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

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

# ADDITIONAL RESEARCH



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

# METHODOLOGY

lacksquare

lacksquare









# Physical collection and organization

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

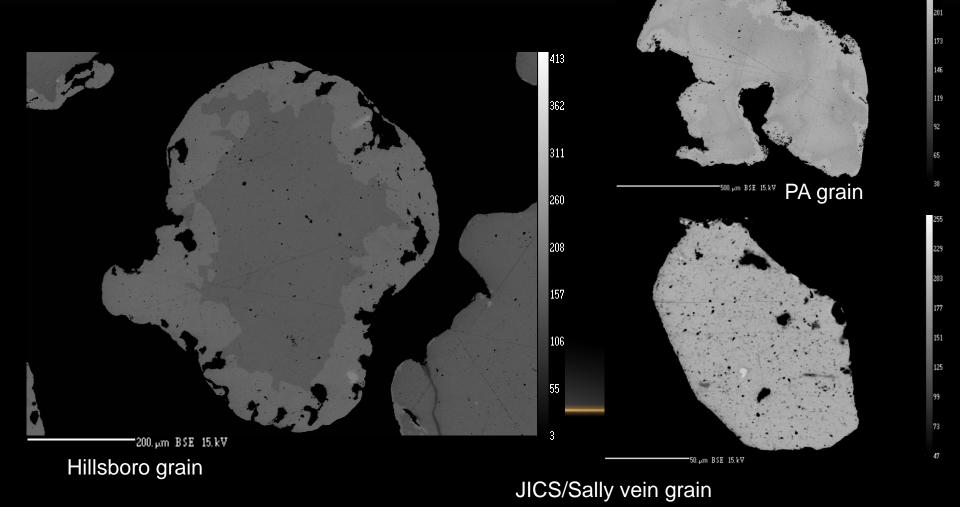
**Orogrande GPEP1** Lat: 32.399175 32° 23' 57.03" N

Long: -106.125924 106° 7' 33.33" W

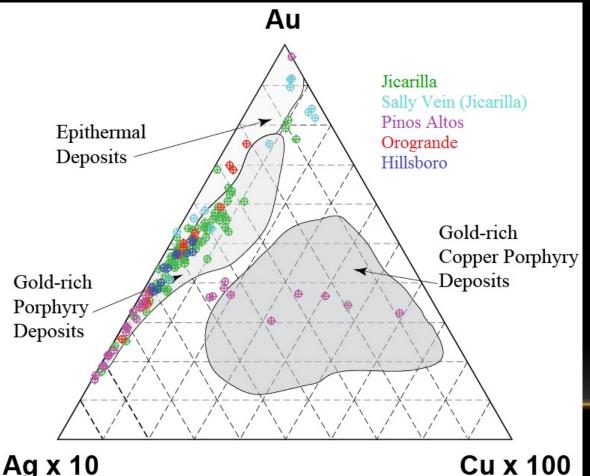
Sample Name	Length (mm)	Size of Particles (d.)	Sphericity	Roundness
OROGPEP1a	1.24	4	3.5	0.5
OROGPEP1b	1.32	4	3.5	1.5
OROGPEP1c	0.86	3	2.5	2.5
OROGPEP1d	0.95	3	2.5	0.5
OROGPEP1e	0.8	3	3.5	1.5
OROGPEP1f	1.07	4	4.5	2.5
OROGPEP1g	0.45	3	4.5	4.5
OROGPEP1h	0.74	3	3.5	1.5
OROGPEP1i	0.59	3	1.5	4.5
OROGPEP1j	0.53	3	2.5	1.5
OROGPEP1k	0.49	2	4.5	0.5
OROGPEP11	0.56	3	3.5	2.5
OROGPEP1m	0.46	2	2.5	2.5
OROGPEP1n	0.23	1	2.5	2.5
OROGPEP10	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



# 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

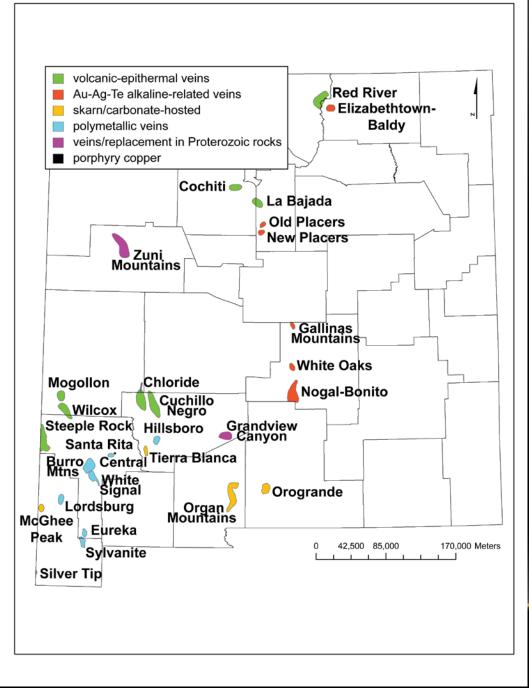
### **CRITICAL MINERALS**

- 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

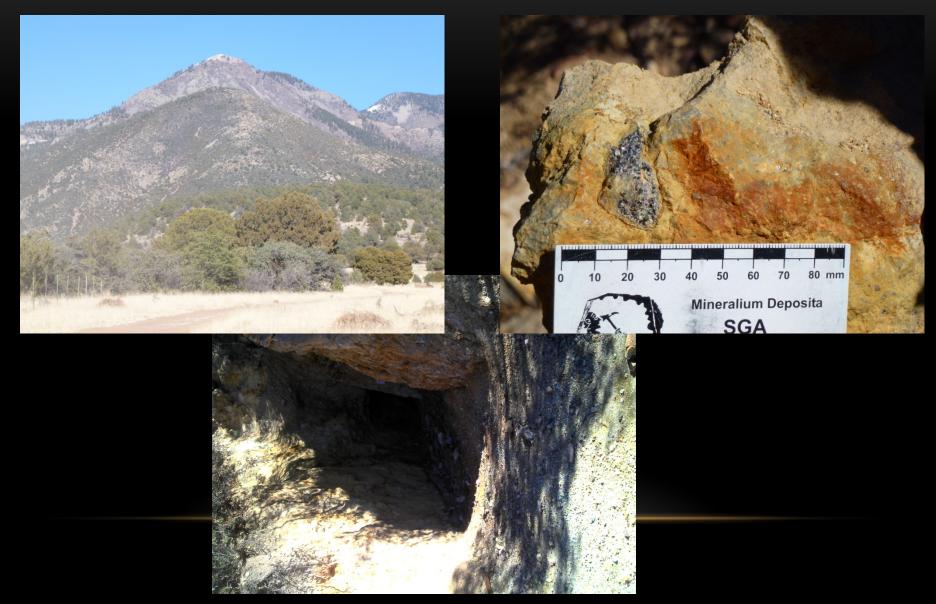
# **Uses of Te**

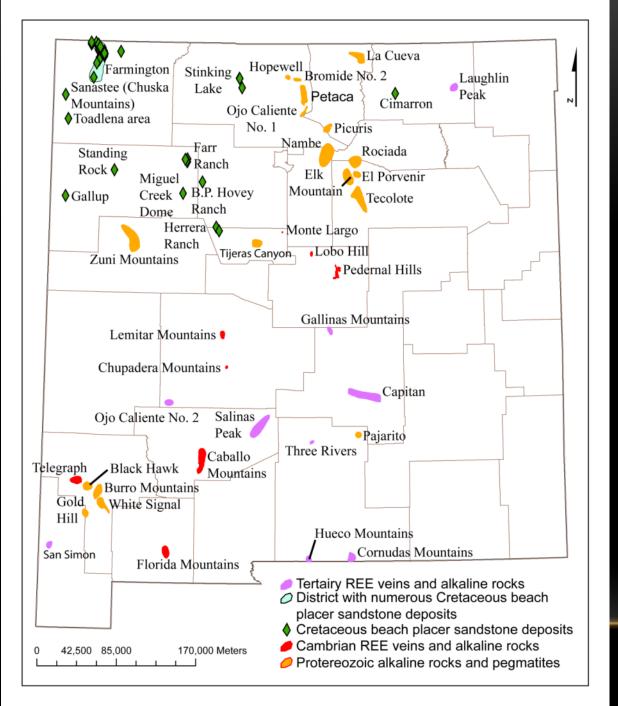
- Alloying additive in steel to improve machining characteristics
- Processing of rubber
- As a component of catalysts for synthetic fiber production
- As pigments to produce various colors in glass and ceramics
- Thermal imaging devices
- Thermoelectric cooling devices, such as summertime beverage coolers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



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

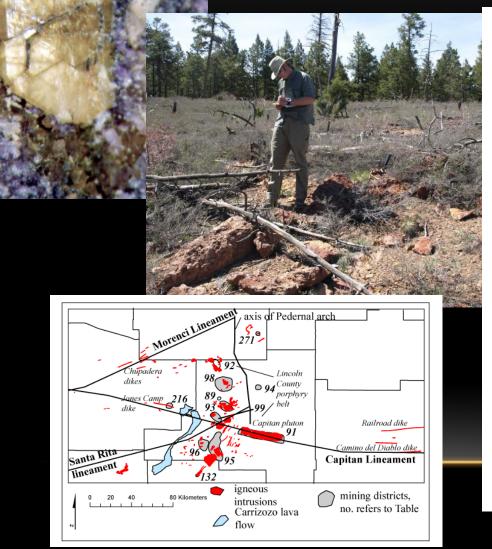
### Lone Pine, Wilcox district, Catron Countyvolcanic epithermal vein

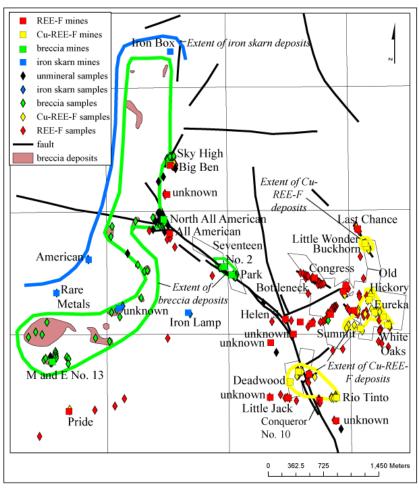




### OCCURRENCES OF RARE EARTH ELEMENTS (REE) IN NEW MEXICO

### 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

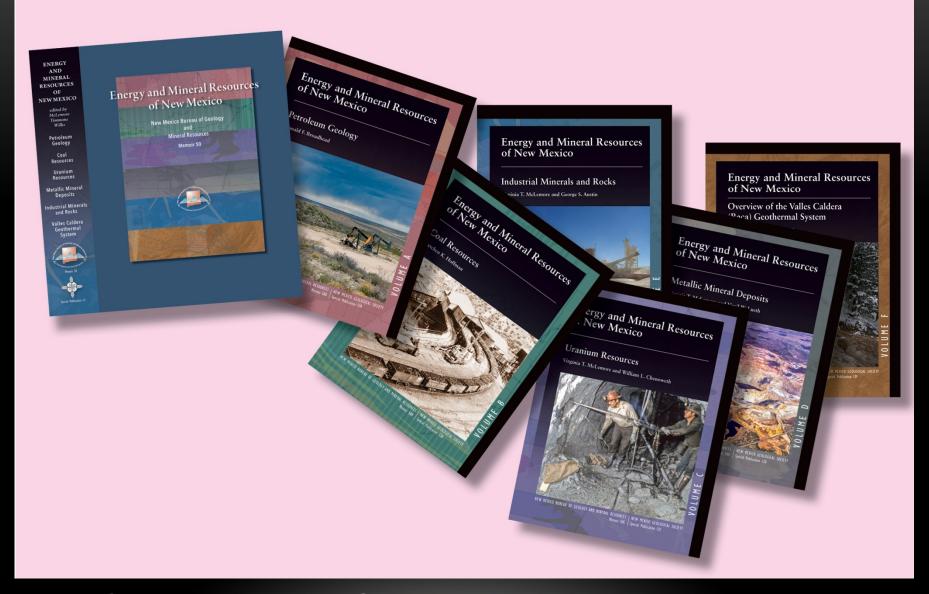
## MORE INFORMATION

 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

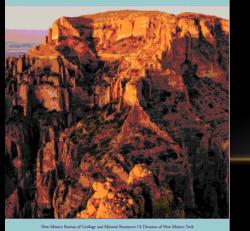
### SILVER AND GOLD IN NEW MEXICO

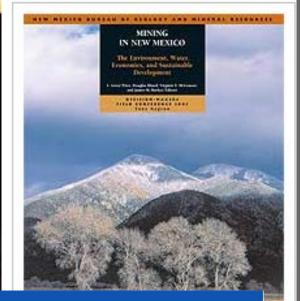


Weight a TO Mallarengia: New Venner Rowser of Candidan and Dissess R. 

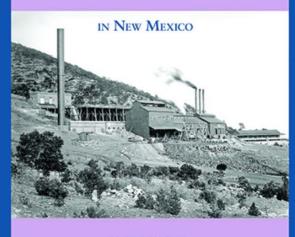
August 2010 Volume 32, Number 3

### New Mexico GEOLOGY





#### MINING DISTRICTS AND PROSPECT AREAS



#### 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 Potash-Past, Present, and Future

Paintiful the provide section around well nardova i vra dili angenti dyenitaria antitaria sin nayatan atten, diatita din store Frank a uni Gardy a tallandy In repair may fighteres b inst esserial descerts give estimated WA Managements was in Section (pression in the "Winster 1998) destinanceing.

ding sitistinger, 28. seightephare 29. Theodore, geneticentiers die Sp publi générairegé at knart Trevalstricat is konisi at planaatisi, di atribut, arg neritas gius, nel amprieratio. New Basics production inform out in a series that the approxima-tion and the series of the series of Paths. The second states, high-pairs reasons independents for a final data fin 1956 by the Dataset of State Institutes in Uncertainty of State Institutes in State State Institutes in the state of State The Prants Area in State Institutes and The Prants Area in State Institutes and

hindinala da ana magaily da Iaraw di ad Manyawa. Marti Iarawa na Milandy Iaraji angé the fulfility, and the number of the fulfility of the figure is the figu ani françista quanti teleyîşiren rengela, MarkePenik anî îmeyît

Her Maincisis for the object problem effective induced. New Maine with digits in cold press problems in 2008 m 125,000 m and some of pairs. Som mid a forden men vor the some constable Wy and affill peak

dan balang dam mengen (2001 per protocian and applicatify consisting produced included. Many particular in the ULL only, however, integrand from in the dormer, Carolia nedaran la 2000 pantapatan su daniy inanan si 1910 paranedaran History of Polash Production in New Sidon Imparts from Carolo, Filtera, and Frank, for Delay survey and profes

Print we signify in skel from he will and in section within the speet, and anti-constraint and fore count with the in the results of yearing a feature in per alternischingen die Gewanie. 1858. The United Datase pair de Industry was informationally World Ward on the weath of a Canana anthropolitical datase

#### Spin State and a participation of the set

New Marine, Anne an a La 1983 ar rea la 2008. Tha rearge officia an grafe la New Marine has discussed from 23-30 processories and factor de 1850 are dan Manan sebalapin pinin an newsraga Lifepon yang antar niti da wana newsrana sebalapin the priority course backs starts French. Accessive Start Institution, and some

Frinkepreiserin die New Marine in 70 geneen of Marine in State and Scholars

verangin der Brennellin anderen Perstenden im 1997 Diese Persität Oberlich, Tare Persit, indigenden Channel, Tana Arani, Integration Practic In Chantel, Street Market Frank and Childred Franking of her where is new Read our Engine producing match gridely and here the product of 1980. Frank was frances that Tab adverse Canala, by New Maska prints, a spa in 1952. Have determined and imple-prediction well during 1951s, with rinaarisynaatoynay aantiki iyyihaaly Tararisharisahaala myiy. equation de Valuel Pais a come aving la 1662 de 1966 U.S. conservation par marrie and an evaluated. New 2000 to 2001 could an evaluate the second and an evaluation.

nesatiy can bi temelopotorias. Thenetoon Xee Matao potorias va 1 Maillen naticias of products Her blain prick poly des rengel 1551-66 rein als rikeraal proje was anglept is in put history. rativia 1986, Openiarian dan Internet daritip of war and Cardin. printellegente en stadio considii de marie preferencia (1971, Carolin Referei pepeli enticative pentres-ricar PO-milia. Nan vari Ditper merinten in 2004, significantly lighter

with the domain integration from production (1) gas anothers. The theory production of the second second second second second second transition of the second secon

we resta devolve million to all a sy union. By 1956 datas comparies

Published by the New Metion Barras of Geology and Misseal Resonance + A Division of New Metion Tesh



Geothermal Energy

FALL 2010 ISSUE 28



#### 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

NEW MEXICO BUREAU OF GEOLOGY & MINERAL RESOURCES A DIVISION OF NEW MEXICO THE

### Sampling and Monitoring for the Mine Life Cycle



SME

#### Sampling and Monitoring for the Mine Life Cycle

#### Edited by Wights 1. Not more, Addison 1. Smith, and Carol C. Rosawill

2014, 208 pages plus CD, 2 bis 669+0: 978-0-87335-355-7 Book order no. 355-7

SRI Member SS9 Student Member SRIP Hanmember/List

Available as an elbox from www.smenet.org/ebooks

erwent.org/etce tookellerwent.org

Society for Mining, Metallurgy & Exploration Inc. 12000 E. Adem Arcraft Circle, Englewood, Colorado 80112

### Sampling and Monitoring for the Mine Life Cycle

#### Edited by Weyleis T. Hitlemore, Kathleen S. Smith, and Carol C. Rossell

Sampling and Wantschip for the Mise Life Cycle provide can overview of sampling for white streaming purposes and mostle drop of antwomental diversity of a statutes of which go the Life Youcas on antwomental sampling and montacking of surface water, and also considers groundwate, process water streams, not, sell, and other metits including air and bottogical organisms. The tendbook foculate an appendix of technical summaries written by subjectmatter experts that describe field measurements, collection methods, and analytical techniques and processor relates to ewinomental sampling and monitoring.

The staffs of a series of handbooks on technologies for management of metal move and metallurgical process dhelpage, this tendbook supplements and enter companies and completelles involved in environmental sampling and ministrating at the nine site. It offers from multi-information sources to providing an approach to add mos all types of mining influenced wider and other sampling media throughout the nine life cycle.

Sampling and Mohitmah for the Mine Life Cycle is crystical into a main leaf and its agreedices that are an integral point of the functionk. Soldware and Hustmahl two are included to point and sold thand defail aloud report later concepts, to present examples and third case studies, and to suggest resources for further internation. Cateroise references are included.

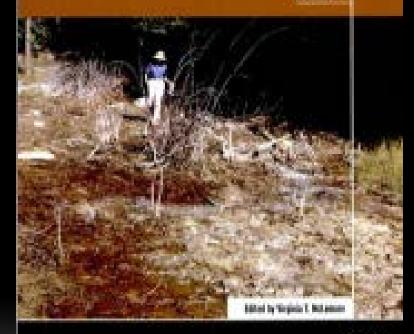
#### Contents

- Intrinities them
- · Sampling and Monitoring During the Mining Phases
- Sampling Considerations in the Mining Environment
- Decision Making, Rick, and Uncertainty
- The Planning Process
  Sampley and Monitoring Program Implementation
- Date Management, Assessment, and Analysis for Decision Making
- Additional Rey Issues and Future Research Needs
- Selected Online Resources
  Summary of Selected ASTM Methods
- Summary of Field Sampling and Analytical Methods
- Examples of Lamping Plans and Quality Assurance Project Plans
  Case Studies of Sampling and Manifesting
- Applications and Examples of Geo-Environmental Models.



#### Hasegeners' lectrologies for Metal Mining Influenced Webs:

# Basics of Metal Mining Influenced Water





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

# **QUESTIONS?**