CRITICAL MINERALS AND ABANDONED MINES (AML) IN NEW MEXICO

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ACKNOWLEDGEMENTS

- **AML Funding**
  - Energy Minerals and Natural Resources Department (Abandoned Mine Lands Bureau), U.S. Department of the Interior, Office of Surface Mining and Reclamation (OSMRE)
  - New Mexico EPSCoR, National Science Foundation, NSF, award #IIA-1301346)
  - New Mexico Geological Society
  - NMBGMR and NMIMT Mineral Engineering Department

- **Mineral-resource potential funding**
  - SLO and BLM
PREVIEW

• Definitions
• Define the problem
• Purpose of NMBGMR AML mines program
• Sources of information on mine feature locations
• Inventory
• Critical minerals in NM
DEFINITIONS
CRITICAL MINERALS

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
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
Disruptions in supply chains may arise for any number of reasons, including natural disasters, labor strife, trade disputes, resource nationalism, conflict, and so on.
DEFINITION OF AML (ABANDONED MINE LANDS)

- Lands that were excavated and left unreclaimed where no individual or company has reclamation responsibility and there is no closure plan in effect
- Excavations, either caved in or sealed, that have been deserted and where further mining is not intended in the near future, generally >10 yr old
- Includes mines and mine features left unreclaimed on Federal, State, private and Native American lands because the current owner was not legally responsible for reclamation at the time the mine was created
- Also called inactive, legacy, and orphaned mines
View east showing the Longtail and Rose repository areas, Rosedale district. November 29, 2007.
DEFINE THE PROBLEM

- Identify areas in NM with AML and tailings that have potential high physical risk and risk to the environment
- Identify AML and legacy sites that have potential critical and other minerals
- Identify areas in NM with critical minerals
- At some point in the future we will be re-processing these mine wastes because they do have concentrations of minerals, including critical minerals, that will be economic in the future
PURPOSE OF NMBGMR AML PROGRAM

Rosedale mill launder, now buried under cover of the Longtail tailings (from Sherman and Sherman, 1975:179)

Looking NE across reclaimed Rosedale tailings, 2012.
PURPOSE OF NMBGMR AML PROGRAM

Provide data on districts, mines, and mills in New Mexico

– Help plan and assess reclamation procedures
– Determine background concentrations
– Understand geologic processes
– Compare trace-element concentrations in mined versus undisturbed areas
– Provide background data that can assist with the planning of future mining operations

Summit mine, Steeple Rock district, Grant County (operated 2009-2014, now on stand by)
SOURCES OF INFORMATION ON MINE FEATURE LOCATIONS
GIS DATA

- Coal fields and Mining districts
- Coal mines and reserve data
- **Mines and mills**
- Geochemistry
- **Photographs** (both recent and historic)
- Bibliography
- **Mine maps**
- **Mine production**
- Mine reserves
- **Drill data** (Petroleum records)
- Well logs (Coal library and Petroleum records)
Mines Records by Location and Name (~20,000 records)

M604

T5S, R16W, Sec. 6, N. M. P. M.
District Rodeo County San Miguel
Property or claim name
Great Lowden Lode + mill site

Number of claims 
Lode 
Placer 
Other M.S. 
Survey No. 1076-B
Year Patented 
Rejected 
Owner’s Name: Address: Date: 
W H Martin Co.

Operator: 
Production: Total 
From 
To 
Present Rate per 

Location if Twp. and Range not given:

Classification:
Chief Mineral
Accessory Minerals

Status Date

County Clerk’s Record:
Book Page
Source of Information:
* Locke, Augustus, Short Rep. on the Rodeo Mine, Jan. 1, 1921
* T. Lindsley papers, Letters on the Rodeo Mine, Aug. 1, 1913, U. Wyoming
Prospect- and Mine-Related Features from U.S. Geological Survey 7.5- and 15-Minute Topographic Quadrangle Maps of the United States

Dates

Publication Date: 2017-12-01  
Start Date: 1888  
End Date: 2008

Citation


Summary

These data are part of a larger USGS project to develop an updated geospatial database of mines, mineral deposits and mineral regions in the United States. Mine and prospect-related symbols, such as those used to represent

https://mrdata.usgs.gov/,  
https://www.sciencebase.gov/catalog/item/5a1492c3e4b09fc93dcfd574
USBM and USGS mineral resource assessments
NMBGMR mapping projects, bulletins, and open file reports
Other reports, company reports, published and unpublished.
BLM mineral patents and mining claims records

https://glorecords.blm.gov/search/default.aspx;
https://reports.blm.gov/reports.cfm?application=LR2000
NMMMD active mines and permits

http://www.emnrd.state.nm.us/MMD/MARP/MARPPermitsRevModClose.html;
http://www.emnrd.state.nm.us/MMD/gismapminedata.html
New Mexico Mines Database
Relational database in ACCESS that will ultimately be put on line with GIS capabilities

• ACCESS is commercial software and this design is compatible with other formats
• Metadata (supporting definitions of specific fields) can be inserted into the database
• ACCESS is flexible and data can be easily added to the design
• Easily imported into ArcGIS
MINING DISTRICTS AND COAL FIELDS

- 274 coal fields and mining districts in NM
  - ~30 districts have had zero production
- Each district is classified by predominant commodity
- Each district can have more than 1 commodity type
- 28 coal fields
- 40 industrial minerals districts
- 173 metals districts
- 32 uranium districts

Chino copper mine
San Juan coal mine
MINING DISTRICTS IN NEW MEXICO
COAL FIELDS IN NEW MEXICO
MINES

- Each mine is classified by predominant commodity
- Each mine can have more than 1 commodity type
- 9000 mines in the database that include active, inactive, abandoned, and exploration sites
- Not all mines have workings
- Some mines have multiple workings

Questa mine, Taos County
MINE INVENTORY
STEPS

- Inventory the mines and mine features
  - History of the site (production, commodities, mine methods, processing facilities)
- Preliminary characterization
  - Paste pH, mineralogy, chemistry
- Prioritize mine features
- Detailed characterization
  - Detailed mineralogy and chemistry
  - ABA/NAG tests
  - Particle size analyses
  - Shear tests
Available Data

- Location (= GIS, point and polygon data, QA/QC)
- Production, reserves, resource potential significant deposits, drillhole data
- Geologic
- Geochemical (rock, water, etc.)
- Environmental
- Water well data
- Historical and recent photographs
- Mining methods, maps
- Ownership
- Other data
Environmental Data

- Commodities produced and present
- Potential hazardous materials
- Evidence of potential acid drainage
- Hydrology
- Receiving stream
- Reclamation
- Mitigation status
- Sensitive environments
- Chemical data (both solids and water)
### INVENTORY SHEETS

#### Mine Entry

<table>
<thead>
<tr>
<th>Mine ID</th>
<th>Mine Name</th>
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<table>
<thead>
<tr>
<th>District</th>
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<table>
<thead>
<tr>
<th>Active Location</th>
<th>Too Dangerous to Approach</th>
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<thead>
<tr>
<th>Historic/Legacy Location</th>
<th>Aggregate mine</th>
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<table>
<thead>
<tr>
<th>Latest year of information</th>
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#### LOCATION

<table>
<thead>
<tr>
<th>County</th>
<th>USGS Quadrangle</th>
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<table>
<thead>
<tr>
<th>Location Assurance</th>
<th>Location Reference</th>
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<table>
<thead>
<tr>
<th>Latitude</th>
<th>Longitude</th>
<th>Coordinate system</th>
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<table>
<thead>
<tr>
<th>Township</th>
<th>Range</th>
<th>Section</th>
<th>Subsection</th>
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<table>
<thead>
<tr>
<th>UTM Nothing</th>
<th>UTM Easting</th>
<th>UTM Zone</th>
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<thead>
<tr>
<th>Elevation</th>
<th>Elev. Source</th>
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<table>
<thead>
<tr>
<th>Location Notes</th>
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</table>

#### GENERAL MINE HISTORY

<table>
<thead>
<tr>
<th>Commodity Category</th>
<th>Production Category</th>
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<table>
<thead>
<tr>
<th>Year of Initial Production</th>
<th>Year of Last Production</th>
<th>Year of Discovery</th>
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<tr>
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<table>
<thead>
<tr>
<th>Commodities Produced</th>
<th>Commodities Present Not Produced</th>
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</table>

#### FEATURE DESCRIPTION

<table>
<thead>
<tr>
<th>Access</th>
<th>Visibility</th>
<th>Known Multiple Entrances</th>
<th>Depth</th>
<th>Length/height</th>
<th>Width</th>
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<thead>
<tr>
<th>Disturbed acres</th>
<th>Reclaimed acres</th>
<th>Mixing Methods</th>
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<table>
<thead>
<tr>
<th>Condition Mine Feature</th>
<th>General Slope</th>
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<table>
<thead>
<tr>
<th>Aspect (trending direction)</th>
<th>slope of feature</th>
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<table>
<thead>
<tr>
<th>Surface Land Status</th>
<th>Minerals Land Status</th>
<th>Ownership</th>
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<tr>
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#### CULTURAL SIGNIFICANCE

- Note UTM for sites in field notes! They've entered into another database.

<table>
<thead>
<tr>
<th>Cultural resources</th>
<th>Description</th>
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<tbody>
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<table>
<thead>
<tr>
<th>Archeology site no:</th>
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#### GEOLOGY

<table>
<thead>
<tr>
<th>Host Formation:</th>
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<table>
<thead>
<tr>
<th>Geology:</th>
<th>Rock type:</th>
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<tr>
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<table>
<thead>
<tr>
<th>Stability</th>
<th>Minerals:</th>
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</thead>
<tbody>
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<table>
<thead>
<tr>
<th>Nonore mineralogy:</th>
<th>Size of deposit:</th>
</tr>
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<tbody>
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</table>

<table>
<thead>
<tr>
<th>Alteration</th>
<th>Soils:</th>
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<tbody>
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</table>

#### TERRAIN

<table>
<thead>
<tr>
<th>Type of terrain:</th>
<th>Land use:</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

<table>
<thead>
<tr>
<th>Mine</th>
<th>District</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>5/20/2017</td>
</tr>
</tbody>
</table>
MINERALOGY AND CHEMISTRY

- Petrography
- Whole rock geochemistry
  - Critical minerals
- Paste pH
- Mineralogy
  - XRD
  - Electron microprobe
  - Chemical analyses of minerals, esp. pyrite
SOIL PETROGRAPHY—FIRST STEP IN DETERMINING MINERALOGY
Pyrite characterization

Evaluate the distribution, form, size, amount, surface area of pyrite in the rock piles
a) Backscattered electron images of quartz grain replacing Fe-oxide in sample Jic410. This is likely supergene replacement.
b) Backscattered electron images of Fe grain in sample Jic412. Note how altered and pitted the grain is.
c) Backscattered electron images of pyrite grain in sample Jic412 c. Note how pristine the pyrite grain is.
Acid Rock Drainage (ARD) plot of waste rock pile at mines examined during the NMBGMR AML project.
# HAZZARD RANKING


<table>
<thead>
<tr>
<th>NOAMI Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A site with potential to cause environmental, public health and public safety concerns</td>
</tr>
<tr>
<td>B</td>
<td>A site with limited potential to cause environmental concerns but with potential for public health and safety concerns</td>
</tr>
<tr>
<td>C</td>
<td>A site with public safety concerns but little or no public health or environmental concerns</td>
</tr>
<tr>
<td>D</td>
<td>A site with no expected environmental, public health or public safety concerns</td>
</tr>
<tr>
<td>O</td>
<td>Information is not available</td>
</tr>
<tr>
<td>R</td>
<td>Remediated</td>
</tr>
</tbody>
</table>
GENERAL COMMENTS

- Many of the critical minerals do not require the tonnages we are used to mine for metals like Fe, Cu, Pb, Zn—i.e. smaller deposits
- Some of these minerals are found in only 1-3 deposits in the world
- Some of these minerals are found in areas of the world that may not be economically unstable or particularly friendly to the U.S.
  - Minerals that provide major revenue to armed fractions for violence, such as that occurring in the Democratic Republic of Congo (GSA, Nov. 2010)
- Some of these minerals come only from the refining of metal deposits and are dependent upon that production
  - Many Cu and Au deposits utilize heap leach technology, which leaves other potential minerals unrecovered in the heap leach
WHERE ARE CRITICAL MINERALS FOUND IN NEW MEXICO?
WHERE ARE CRITICAL MINERALS FOUND?

- Minerals are found in specific mineral deposits containing predominantly one or more of the mineral—Cu, Pb, Zn, Ni, PGM, Fe, Mo, REE, Be, etc.
- Minerals are found as a by-product or trace element in another type of mineral deposit and would be recovered only if metallurgical technologies are available and economically feasible—Cd, Se, Mo, Te, Au, Ag, etc.
- Minerals are extracted from the material remaining after refining of metals (anode slimes)—Ga, Ge, In, etc.
Rare earth elements (REE) in NM

Exploration is or has occurred in the Lemitar, Gallinas, and Cornudas Mountains

Drilling at Pajarito Mountain, Spring 2014

Mining claims staked in the Caballo Mountains
Uranium in New Mexico
Mining districts in New Mexico with tellurium minerals or chemical assays >20 ppm Te
Lone Pine, Wilcox district, Catron County—volcanic epithermal vein
Mining districts in New Mexico that contain beryllium (Be). More details are in McLemore (2010).
Porphyry copper deposits

- **Current**
  - Gold
  - Silver
  - Molybdenum

- **Possible**
  - Tellurium
  - Gallium
  - Germanium
  - Indium
  - Others
POTENTIAL CRITICAL MINERALS IN COAL

- REE
- Be
- Se
- Humate
- Other critical minerals??
SOME OF THE CHALLENGES IN PRODUCING THESE TECHNOLOGIES

- How much of these minerals do we need?
- Are there enough materials in the pipeline to meet the demand for these technologies and other uses?
- Can any of these be recycled?
- Are these minerals/elements environmental friendly—what are the reclamation challenges?

+ REE are nearly always associated with U and Th and the wastes from mining REE will have to accommodate radioactivity
QUESTIONS?