MINERAL-RESOURCE POTENTIAL IN NEW MEXICO
2018

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Acknowledgements

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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 a 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.

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<tr>
<th>Increasing Level of Resource Potential</th>
<th>Increasing Level of Certainty</th>
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<td>U/A Unknown Potential</td>
<td><strong>H/H</strong> High Potential</td>
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<tr>
<td></td>
<td><strong>H/M</strong> Moderate Potential</td>
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<td><strong>N/L</strong> Low Potential</td>
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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
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
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)
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 million st reserves at 0.38% Cu)

4. Copper Hill, Picuris district (46.5 million st of ore at 0.42% Cu)

5. Lone Mountain (7.5 million st at 2-3% Cu, 1.2% Pb, 4-5% Zn, 203 opt Ag, 0.01-0.02 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

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
Gold
URANIUM IN NEW MEXICO 2018

• 2nd in uranium resources 15 million tons ore at 0.277% U₃O₈ (84 million lbs U₃O₈) 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.
Uranium production 1948–2014

Value in dollars (millions)

Pounds (millions)

Years

Uranium
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
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

[Map showing distribution of 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?