THE CHARACTERIZATION OF ABANDONED URANIUM MINES IN NEW MEXICO

John Asafo-Akowuah¹, Virginia T. McLemore²

¹Department of Mineral Engineering, New Mexico Tech, Socorro, NM 87801
²New Mexico Bureau of Geology and Mineral Resources (NMBGMR), New Mexico Tech, Socorro, NM 87801
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OUTLINE

- Background
- Problem Identification
- Objectives
- Study Area
- Methodology
- Observations
- Conclusions
1948 – 2002, >347 million pounds of U was produced in NM cumulatively amounting >$ 4.7 billion

Aftereffects of Mining and Exploration in NM has resulted in >300 legacy Abandoned Uranium Mines (AUM)

>1000 uranium prospects and occurrences in NM (>100 ppm U)

These mines/prospects typically include two or more actual mine features
Many of these AUM pose little or no environmental or stability threat to the public and environment, but field examination is required to be certain.

New Mexico Mining and Minerals Division (NMMMD) has assessed approximately 57 AUM.

Most larger uranium mines have been or are being reclaimed by the former operating companies.
PROBLEM IDENTIFICATION

- Reclamation efforts have not examined the long-term chemical effects from these mines.
- There is still potential for environmental effects long after remediation of the physical hazards, as found in several areas in NM including Jackpile mine, Laguna subdistrict.
- Some of these observations only come from detailed electron microprobe studies.
- Many more legacy mines in NM, which either have not been safely remediated or closed or their status is unknown.
OBJECTIVES

➢ To develop a relatively quick and inexpensive procedure to inventory and characterize legacy uranium mines

- Determination of criteria for use of existing rock piles for backfill material
- Location of additional sources of backfill material if available
- Estimates of how local weather would affect the remediation
- Determine if there is potential for leaching U, V from waste materials
Lucky Don and Little Davie uranium mines

- Rio Grande Rift Cu-Ag (U) vein deposit type along faults in the Permian San Andres Formation
- Lucky Don produced 1955–1963 U, V from limestone by surface and underground methods
- Little Davie: U, V mined from limestone by surface and underground methods in 1955
- Estimated value of U produced by Lucky Don and Little Davie $70,000
MAP OF STUDY AREA

Mining districts within Socorro County

Ladron Mountains
San Lorenzo
Lemitar Mountains
Water Canyon
Hop Canyon
Luis Lopez

Lucky Don & Little Davie AUM

Socorro
Chupadero
Minas del Chupadero
El Coyote
Martinez
Unknown
Unknown
Unknown
Unknown

TD Campbell
Dewey
Unknown
Unknown

Agua Torres
Examples of Legacy mine features

Loading bin, Lucky Don

Waste pile

Mine face
STUDY AREA

- Jeter mine
  - Rio Grande Rift Cu-Ag (U) vein deposit type along a fault between Proterozoic Capirote granite and the Miocene(?) sediments
  - 1954–1958 U, V were mined from the clay zone in fault gouge along the Jeter fault by surface and underground mining methods
  - Total U produced from Jeter mine amounts to 58,562 pounds worth $500,000
Mining districts within Socorro County

MAP OF STUDY AREA

Jeter Mine

Socorro

Ladron Mountains

San Lorenzo

Lemitar Mountains

Chupadero

Water Canyon

Hop Canyon

Luis Lopez

Granite Well

Juan Torres

Río Salado Group

Santa

Unknown Group

Silver Creek

Silver Creek
OUR APPROACH

SAMPLE CHARACTERIZATION FLOW CHART

Conduct field assessment of mine feature

Geochemistry

- Acid-base Accounting (ABA)
  - If potentially acid generating
  - Long term Kinetic Testing
    - If potentially acid generating
      - Sequential chemical extraction
      - Geotech tests
        - Moisture content
        - Density
        - Atterburg limits
        - Shear box tests
  - If potentially acid generating
    - Paste pH, paste conductivity, fizz test
      - If potentially acid generating
      - Leach tests

Bulk chemical analysis

- Bulk Sample (bucket)
  - Particle size analysis

Collect sample

Specific Gravity

Enter information into NM Mines Database

- Rock chip samples
  - Field observations
    - Mineralogy
      - If significant sulfide minerals or metals present or potentially acid generating
      - Petrography, XRD
        - Mineral identification, element speciation, or understanding weathering textures
        - Electron microprobe
  - If significant concentrations of metals present or potentially acid generating
    - Bulk chemical analysis
  - If potentially acid generating
    - Geotech tests
      - Moisture content
      - Density
      - Atterburg limits
      - Shear box tests
METHODOLOGY

- GPS/scintillometer map
- Waste rock pile sampling
## OBSERVATIONS (Scintillometer Readings)

<table>
<thead>
<tr>
<th>Uranium Mine</th>
<th>Background Radiation (cps)</th>
<th>Min Radiation (cps)</th>
<th>Max Radiation (cps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lucky Don</td>
<td>20-50</td>
<td>100</td>
<td>4,435</td>
</tr>
<tr>
<td>Little Davie</td>
<td>20-50</td>
<td>120</td>
<td>771</td>
</tr>
<tr>
<td>Jeter</td>
<td>10-30</td>
<td>80</td>
<td>1,640</td>
</tr>
<tr>
<td>Uranium Mine</td>
<td>Mine Feature</td>
<td>Depth of Workings (ft)</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------</td>
<td>------------------------</td>
<td></td>
</tr>
<tr>
<td>Lucky Don</td>
<td>6 stub adits, loading bin, waste/rock pile</td>
<td>0–40</td>
<td></td>
</tr>
<tr>
<td>Little Davie</td>
<td>Pit, short adit, waste/rock pile</td>
<td>5–10</td>
<td></td>
</tr>
<tr>
<td>Jeter</td>
<td>Concrete platform, 3 waste pile</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Uranium Mine</td>
<td>Ore Minerals</td>
<td>Paste pH</td>
<td>Field evidence of potential acid drainage</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------------</td>
<td>----------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Lucky Don</td>
<td>tyuyamunite, carnotite, uraninite, Cu minerals,</td>
<td>~8.16</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>uranophane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little Davie</td>
<td>tyuyamunite, carnotite, uraninite, Cu minerals,</td>
<td>~8.24</td>
<td>No</td>
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<tr>
<td></td>
<td>uranophane</td>
<td></td>
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<tr>
<td>Jeter</td>
<td>carnotite, tyuyamunite alunite, pitchblende,</td>
<td>~7.70</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>malachite, Fe-Mn oxides, clay, azuritite, barite,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>calcite</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
OBSERVATIONS (Mineralized samples)

A mineralized sample of host rock from Lucky Don mine (4,435 cps)

A mineralized sample of host rock from Little Davie mine (771 cps)

Samples of waste pile rocks with disseminated carnotite from Lucky Don
### OBSERVATIONS (Chemistry)

<table>
<thead>
<tr>
<th>Waste Rock Pile</th>
<th>Uranium (ppm)</th>
<th>Vanadium (ppm)</th>
<th>Thorium (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jeter 1</td>
<td>23.7</td>
<td>93</td>
<td>14.1</td>
</tr>
<tr>
<td>Jeter 29</td>
<td>75.1</td>
<td>101</td>
<td>12.4</td>
</tr>
<tr>
<td>Jeter 31</td>
<td>138</td>
<td>74</td>
<td>13.8</td>
</tr>
<tr>
<td>Little Davie</td>
<td>160.5</td>
<td>457</td>
<td>1.32</td>
</tr>
<tr>
<td>Lucky Don</td>
<td>126.5</td>
<td>563</td>
<td>1.96</td>
</tr>
</tbody>
</table>

- **Yellow** square indicates **Represent U,V >100**
- **Red** square indicates **Represent U, V >400**

Elevated U and V values (>100 ppm)
Samples have more V concentrations than U and Th
OBSERVATIONS (Geochemical value plot for U, Th & V)

Geochemical Value Plot for U, V and Th

GEOCHEMICAL VALUE

JETER1 JETER29 JETER31 LD001 SOC2

Th (ppm) U (ppm) V (ppm)
OBSERVATIONS (Electron microprobe)

Backscattered electron (BSE) image of U and V grains
Backscattered electron (BSE) image of a) CaCO₃ grain b) Fe-oxide grains
OBSERVATIONS (Electron microprobe)

Backscattered electron (BSE) image of U and V grains
PRELIMINARY CONCLUSIONS

- No evidence of potential acid drainage from field observations
- No pyrite observed in XRD and electron microprobe analysis
- No acid drainage potential from paste pH measurements (pH>5)
- Elevated radioactivity (scintillometer mapping) and U and V values (>100 ppm) from chemical analyses in some waste rock piles
- Waste piles with high radioactivity from scintillometer should be covered
FUTURE WORK

- Proper evaluations for reclamation will be performed after all laboratory analyses data have been completed.
- Further field studies needed to determine the mineral potential of area.
THANK YOU

QUESTIONS