THE CHARACTERIZATION OF ABANDONED URANIUM MINES (AUM) IN NEW MEXICO

John Asafo-Akowuah[1] and Virginia T. McLemore[2]

[1]Department of Mineral Engineering, New Mexico Tech, Socorro, NM 87801

[2]New Mexico Bureau of Geology and Mineral Resources (NMBGMR), New Mexico Tech, Socorro, NM 87801

NEW MEXICO TECH
SCIENCE • ENGINEERING • RESEARCH UNIVERSITY

2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

SME CMA COLORADO MINING ASSOCIATION

DENVER, COLORADO | FEBRUARY 19-22, 2017

Creating VALUE in a cyclical environment

2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

SME CMA

DENVER, COLORADO | FEBRUARY 19-22, 2017

ACKNOWLEDGEMENTS

- Funding Sources
  - NMBGMR
  - NEW MEXICO TECH
  - NM Geological Society
  - NEW MEXICO EPSCoR (funded by the National Science Foundation (NSF) award #IIA-1301346)

- Appreciation
  - Navid Mojtabai
  - Ingar Walder
  - Bonnie Frey
  - Lynn Heizler
  - Ashlynne Winton
  - William Zutah
  - Tiffany Lutherback

New Mexico EPSCoR

NEW MEXICO TECH
SCIENCE • ENGINEERING • RESEARCH UNIVERSITY

New Mexico Bureau of Geology and Mineral Resources
NEW MEXICO TECH
Earth Science for the 21st Century

Creating VALUE
in a cyclical environment

2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

SME CMA COLORADO MINING ASSOCIATION

DENVER, COLORADO | FEBRUARY 19-22, 2017

OUTLINE

- Background
- Problem Identification
- Objectives
- Study Area
- Methodology
- Observations
- Conclusions

Creating VALUE in a cyclical environment
2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE
SME CMA COLORADO MINING ASSOCIATION
DENVER, COLORADO | FEBRUARY 19-22, 2017

BACKGROUND

- 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

BACKGROUND—continued

- 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

Creating VALUE in a cyclical environment

2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

SME CMA COLORADO MINING ASSOCIATION

DENVER, COLORADO | FEBRUARY 19-22, 2017

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

Creating VALUE in a cyclical environment
2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE
SME CMA
DENVER, COLORADO | FEBRUARY 19-22, 2017

STUDY AREA

- **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

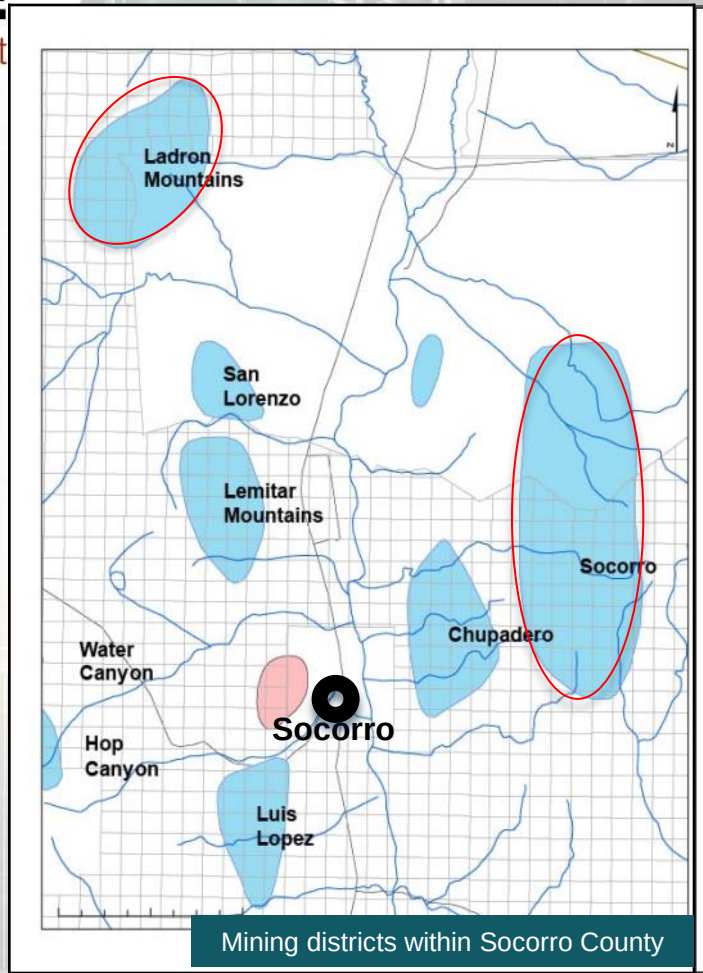
MAP OF STUDY AREA

Creating VALUE in a cyclical environment

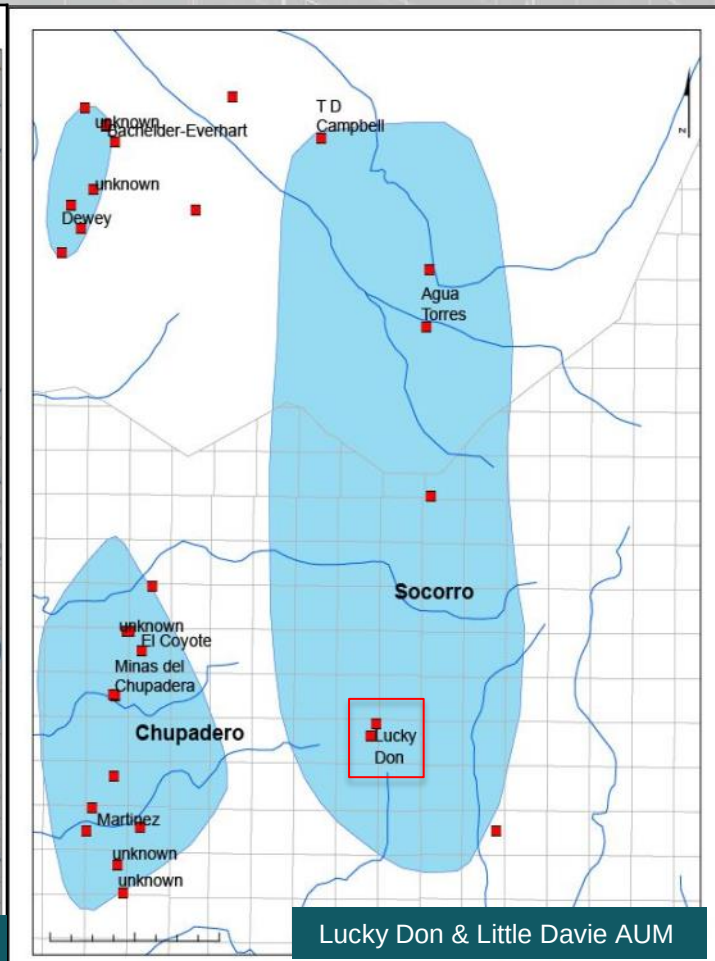
2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

SME CMA COLORADO MINING ASSOCIATION

DENVER, COLORADO | FEBRUARY 19-22, 2017



Mining districts within Socorro County



Lucky Don & Little Davie AUM

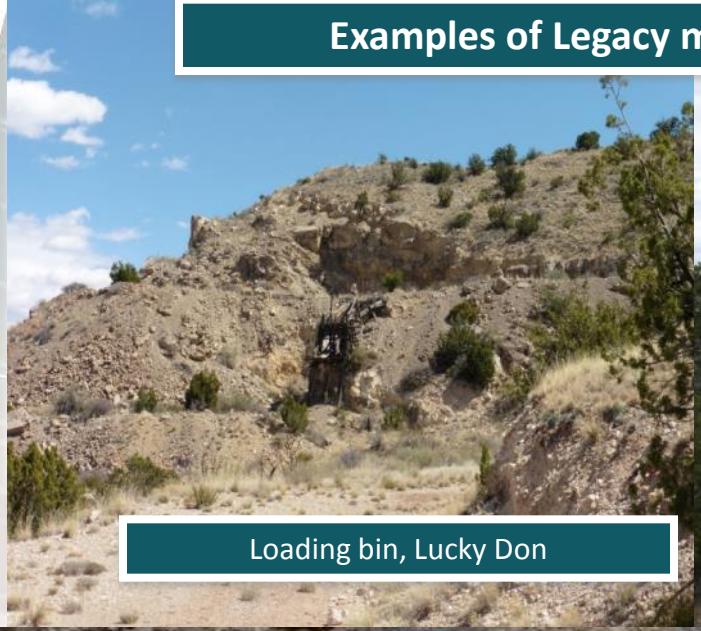
Creating VALUE
in a cyclical environment

2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

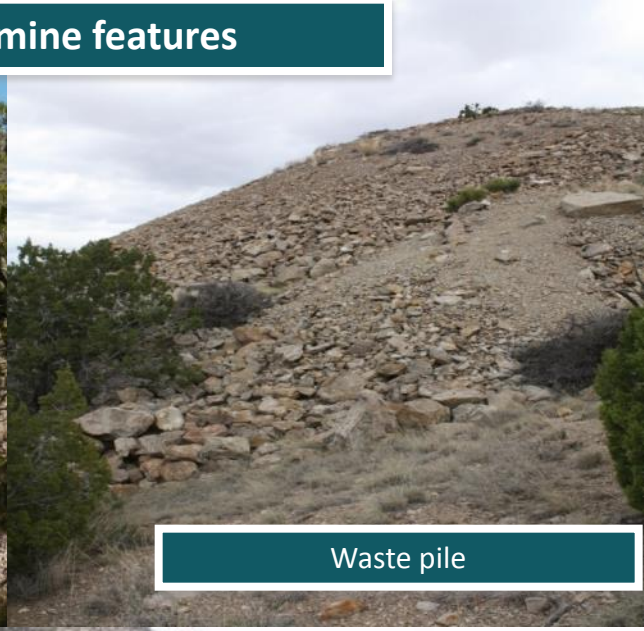
SME CMA COLORADO MINING ASSOCIATION

DENVER, COLORADO | FEBRUARY 19-22, 2017

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

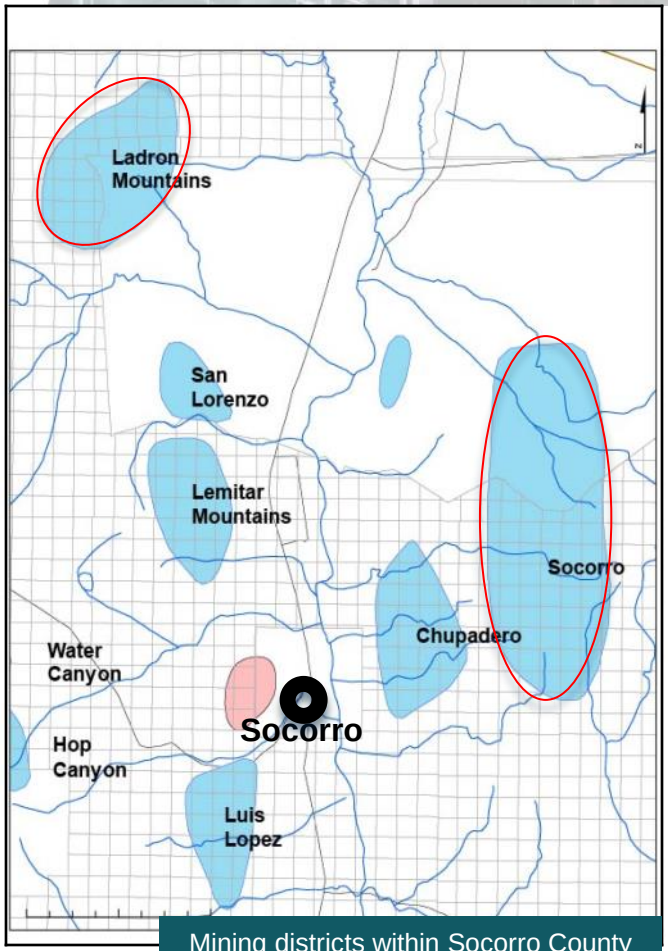
MAP OF STUDY AREA

Creating VALUE in a cyclical environment

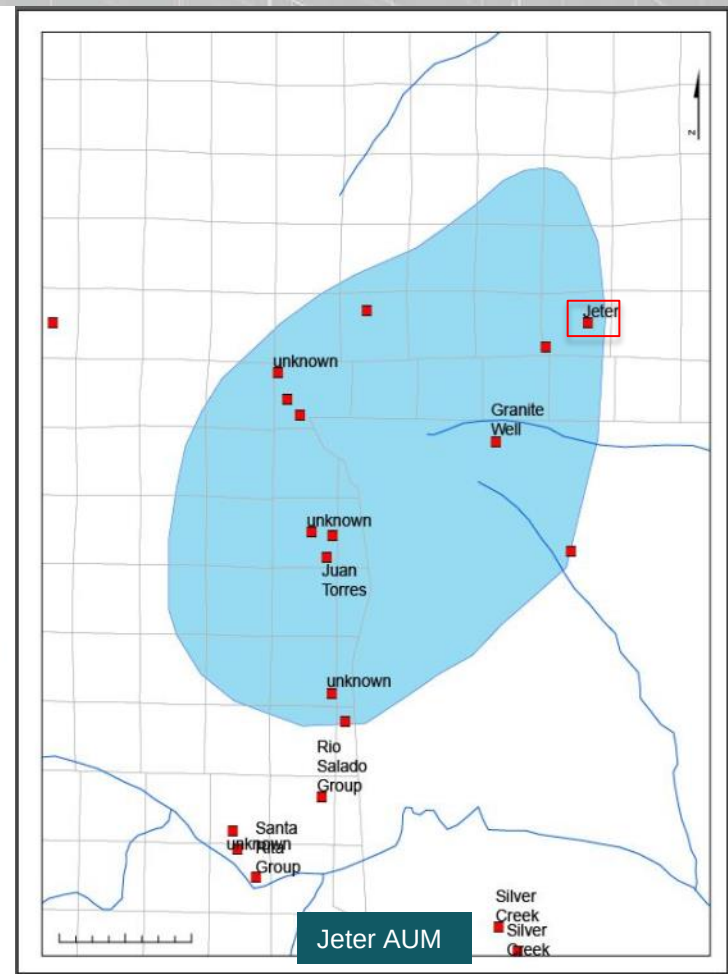
2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

SME CMA COLORADO MINING ASSOCIATION

DENVER, COLORADO | FEBRUARY 19-22, 2017



Mining districts within Socorro County



Jeter AUM

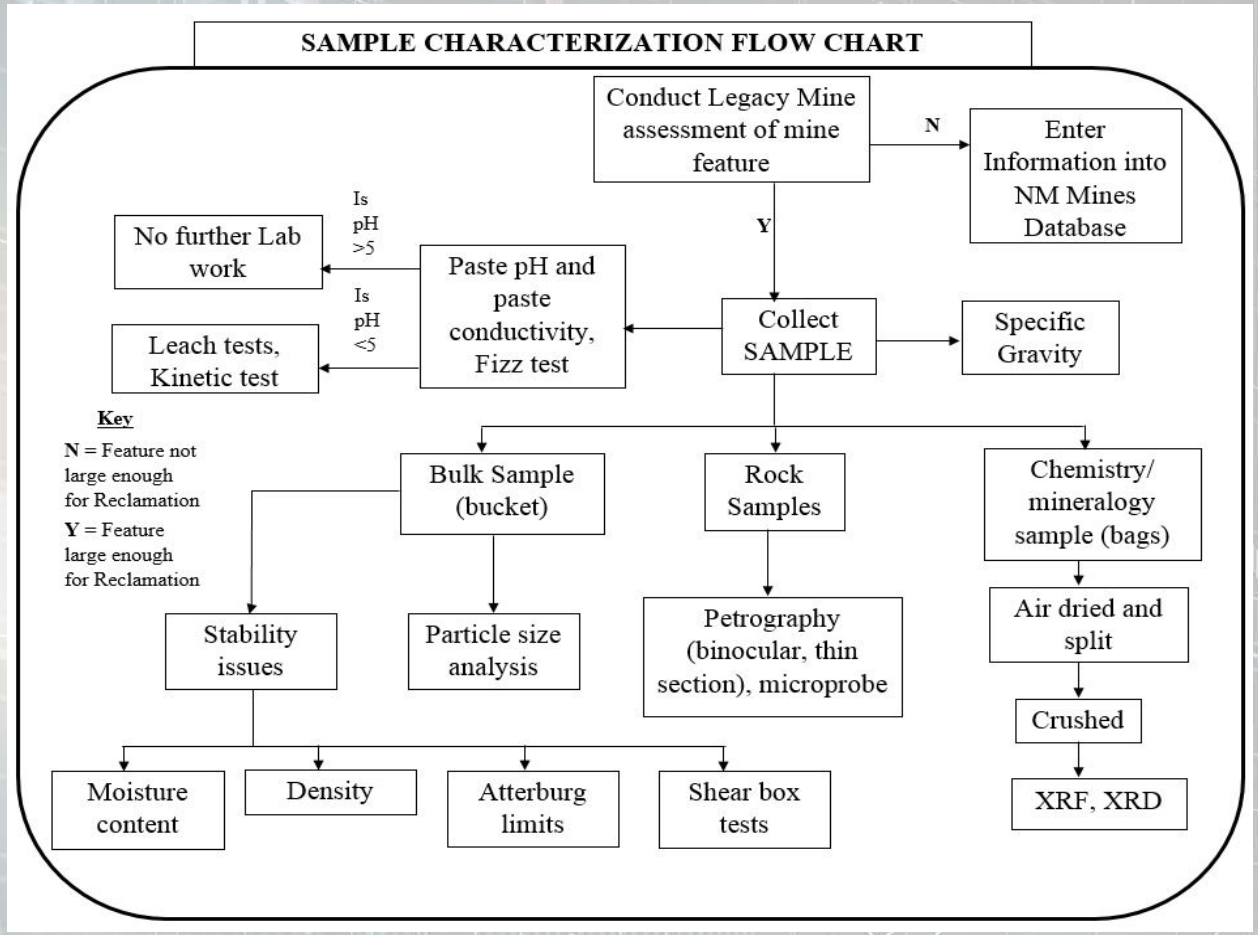
Creating VALUE in a cyclical environment

2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

SME CMA COLORADO MINING ASSOCIATION

DENVER, COLORADO | FEBRUARY 19-22, 2017

OUR APPROACH

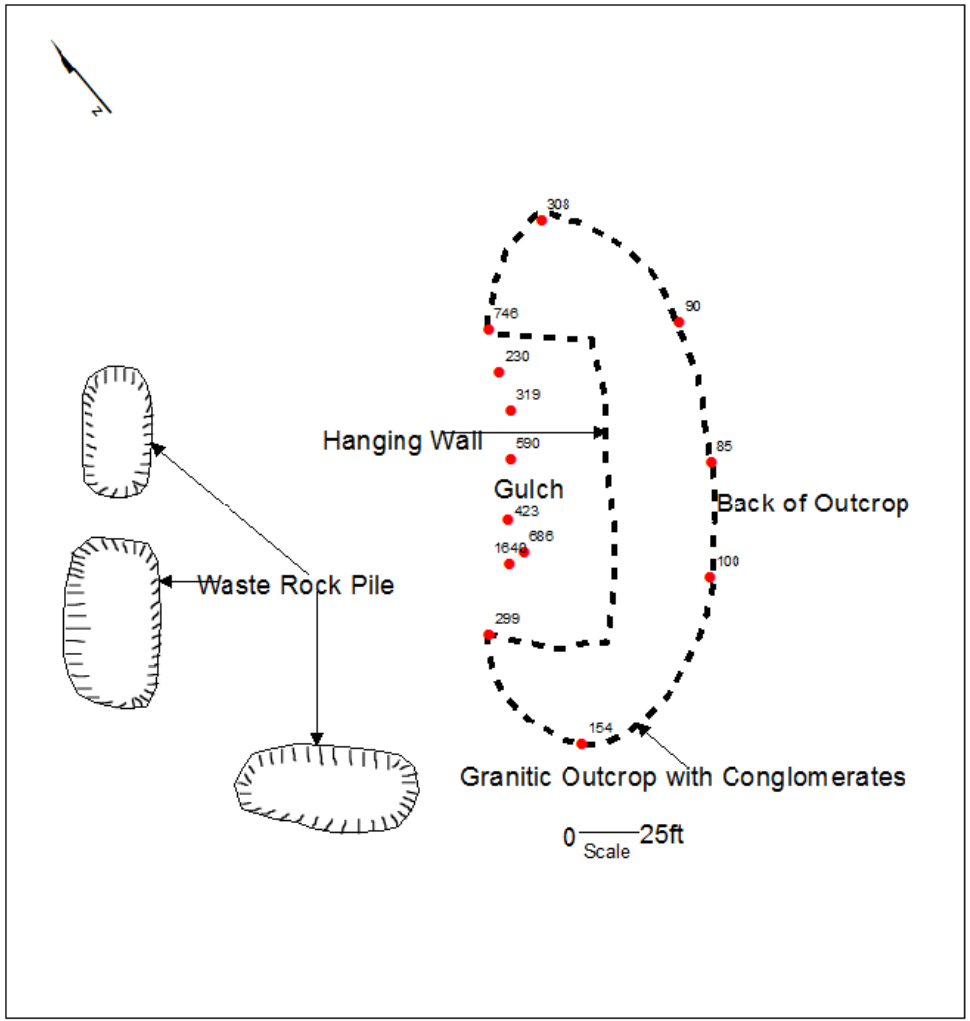


Creating VALUE in a cyclical environment
2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE
SME CMA COLORADO MINING ASSOCIATION
DENVER, COLORADO | FEBRUARY 19-22, 2017

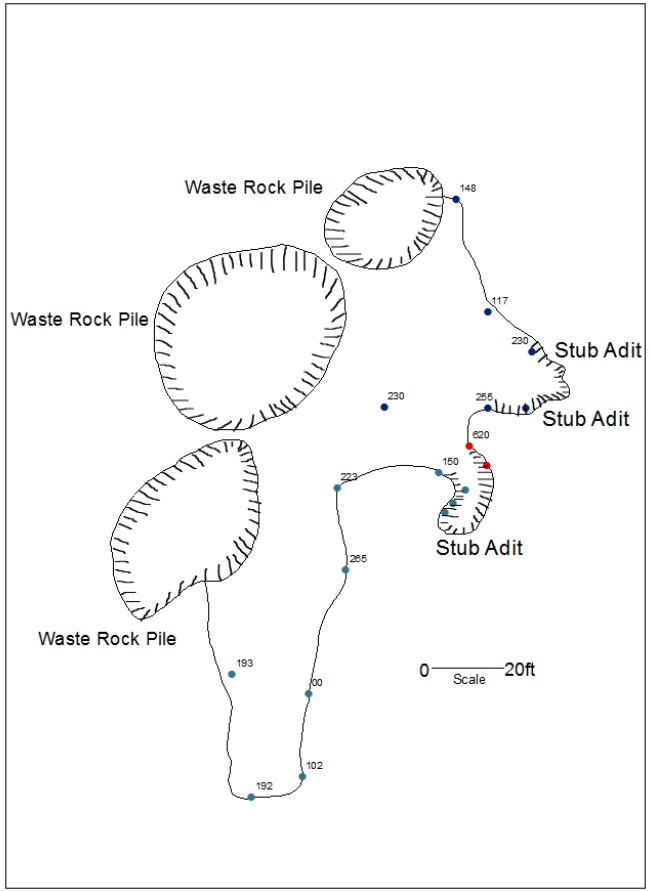
METHODOLOGY

- GPS/scintillometer map
- Waste rock pile sampling

SKETCH OF JETER MINE



SKETCH OF STUB ADITS AND WASTE ROCK PILES



OBSERVATIONS

(scintillometer **mapping)**

Abandoned Uranium Mine	Background Radiation (cps)	Min Radiation (cps)	Max Radiation (cps)
Lucky Don	20-50	100	4,435
Little Davie	20-50	120	771
Jeter	10-30	80	1,640

Creating VALUE in a cyclical environment
2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE
SME CMA COLORADO MINING ASSOCIATION
DENVER, COLORADO | FEBRUARY 19-22, 2017

FIELD OBSERVATIONS

Abandoned Uranium Mine	Mine Feature	Depth of Workings (ft)
Lucky Don	6 stub adits, loading bin, waste/ rock pile	0–40
Little Davie	Pit, short adit, waste/ rock pile	5–10
Jeter	Concrete platform, 3 waste pile	300

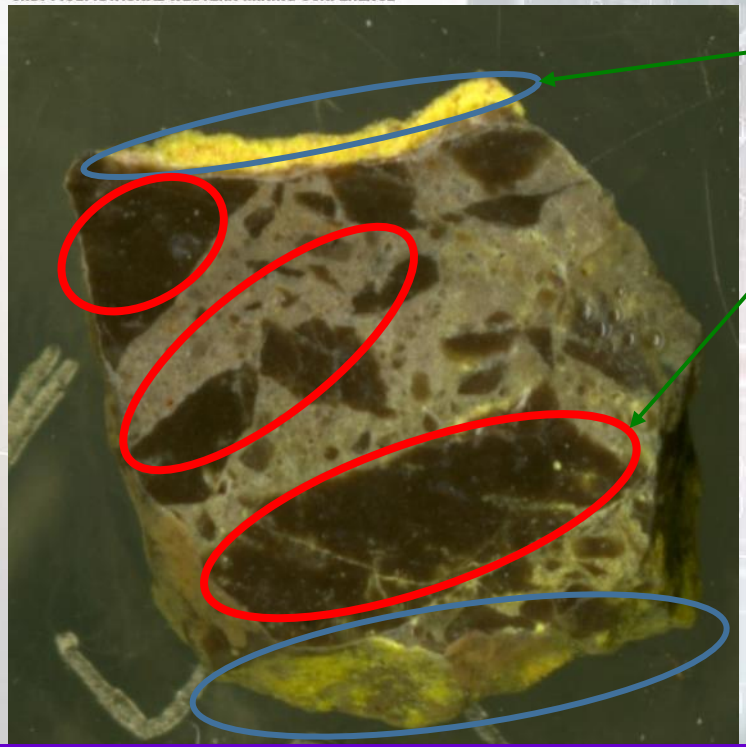
OBSERVATIONS (ore minerals & paste pH)

Abandoned Uranium Mine	Ore Minerals	Paste pH	Field evidence of potential acid drainage
Lucky Don	tyuyamunite, carnotite, uraninite, Cu minerals, uranophane	~8.16	No
Little Davie	tyuyamunite, carnotite, uraninite, Cu minerals, uranophane	~8.24	No
Jeter	carnotite, tyuyamunite alunite, pitchblende, malachite, Fe-Mn oxides, clay, azuritite, barite, calcite	~7.70	No

Creating VALUE in a cyclical environment

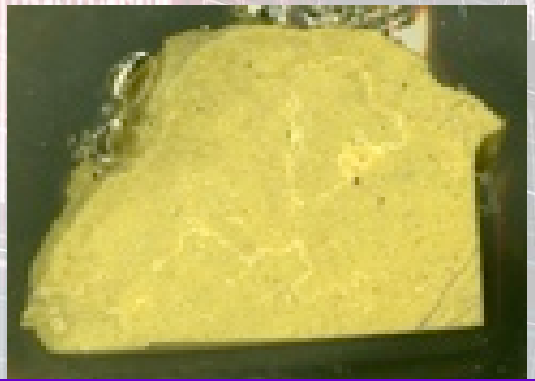
2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

OBSERVATIONS (Mineralized samples)



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

Samples of waste pile rocks with disseminated carnotite from Lucky Don



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

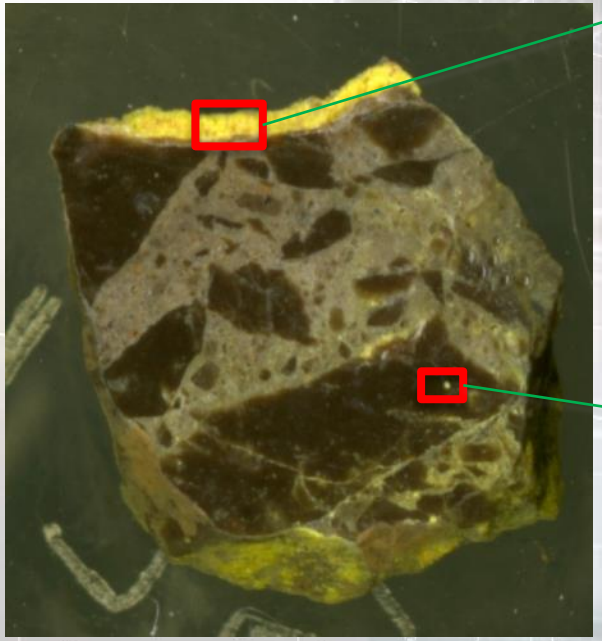
Creating VALUE in a cyclical environment

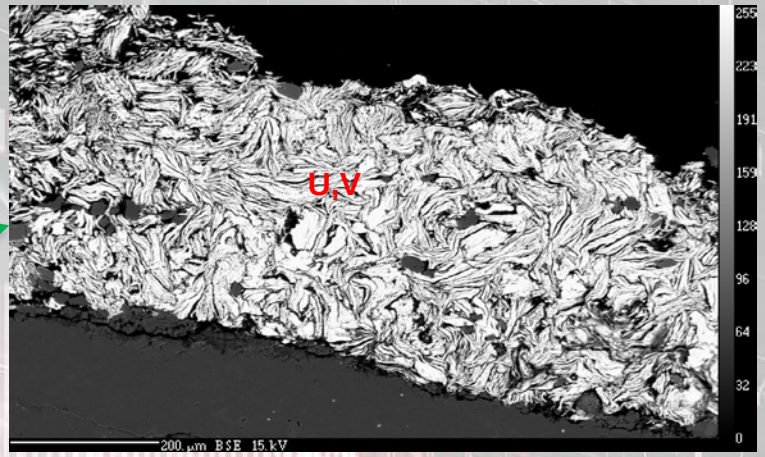
2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

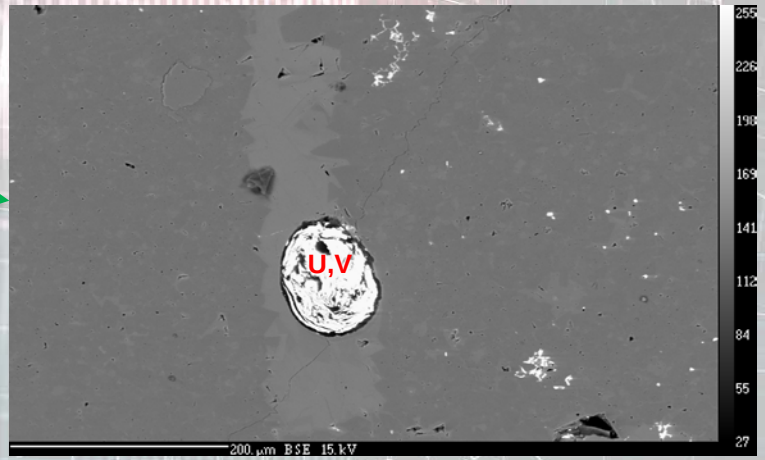
SME CMA COLORADO MINING ASSOCIATION

DENVER, COLORADO | FEBRUARY 19-22, 2017

OBSERVATIONS (Electron microprobe)







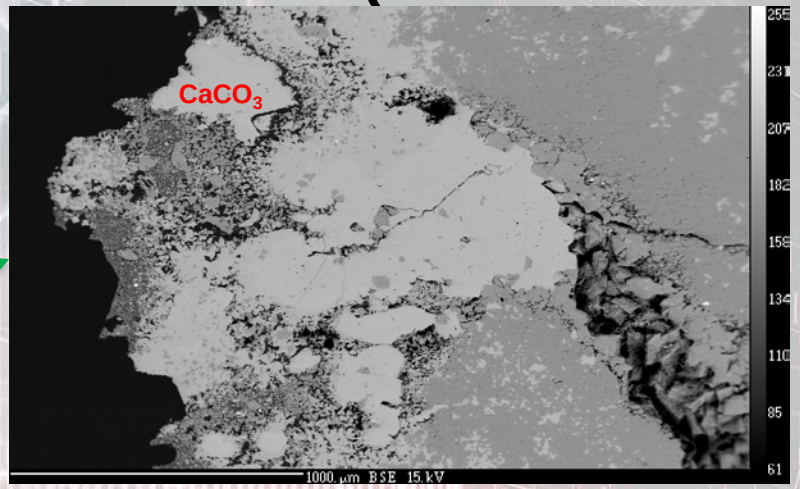
Creating VALUE in a cyclical environment

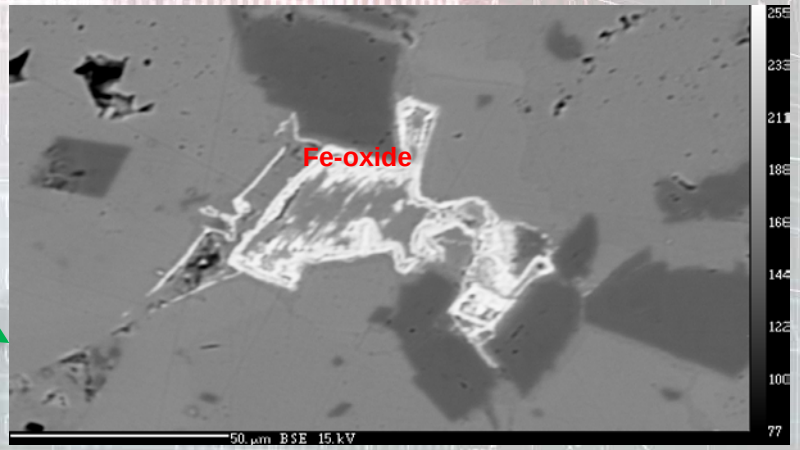
2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

SME CMA COLORADO MINING ASSOCIATION

DENVER, COLORADO | FEBRUARY 19-22, 2017

OBSERVATIONS (Electron microprobe)





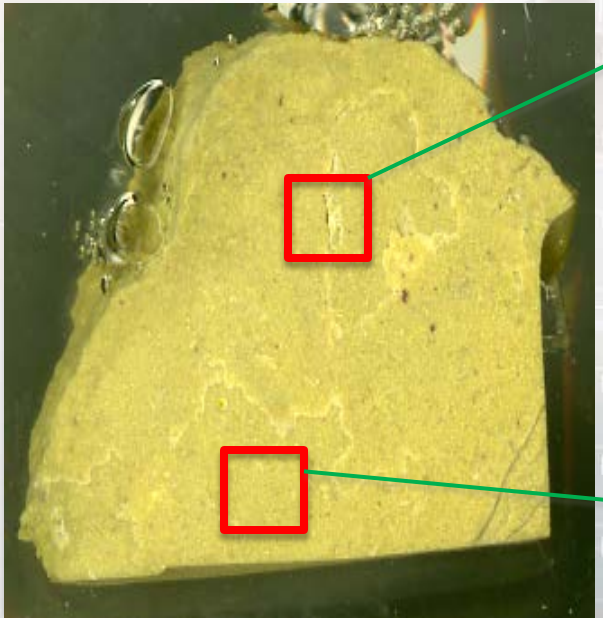
Creating VALUE
in a cyclical environment

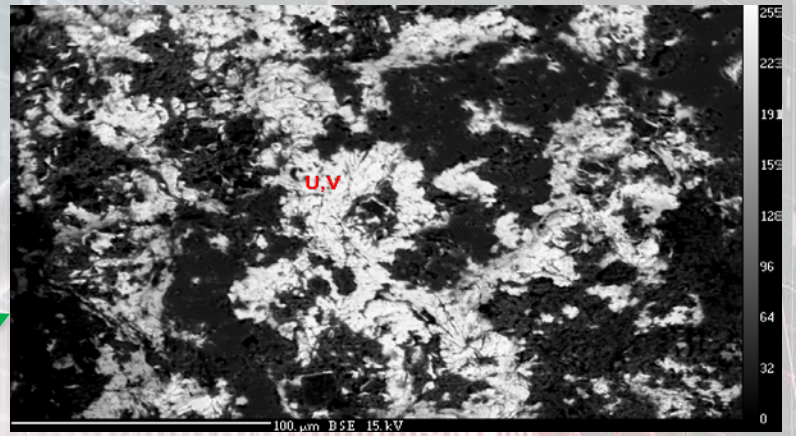
2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

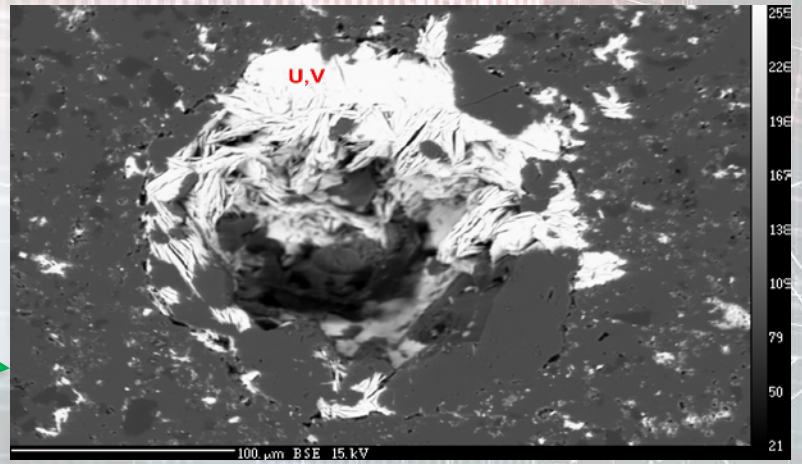
SME CMA COLORADO MINING ASSOCIATION

DENVER, COLORADO | FEBRUARY 19-22, 2017

OBSERVATIONS (Electron microprobe)







Creating VALUE in a cyclical environment

2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

SME CMA COLORADO MINING ASSOCIATION

DENVER, COLORADO | FEBRUARY 19-22, 2017

OBSERVATIONS (chemistry)

Waste Rock Pile	Uranium (ppm)	Vanadium (ppm)	Thorium (ppm)
Jeter 1	23.7	93	14.1
Jeter 29	75.1	101	12.4
Jeter 31	138	74	13.8
Little Davie	160.5	457	1.32
Lucky Don	126.5	563	1.96

Elevated U and V values (>100ppm)

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 should be covered

Creating VALUE in a cyclical environment
2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE
SME CMA
DENVER, COLORADO | FEBRUARY 19-22, 2017

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

Creating VALUE
in a cyclical environment

2017 SME ANNUAL CONFERENCE & EXPO
CMA 119th NATIONAL WESTERN MINING CONFERENCE

SME CMA COLORADO MINING ASSOCIATION

DENVER, COLORADO | FEBRUARY 19-22, 2017

THANK YOU!

QUESTIONS