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GEOCHEMISTRY OF CRITICAL MINERALS IN MINE WASTES IN NEW MEXICO

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Earth Science for the 21st Century

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Acknowledgements

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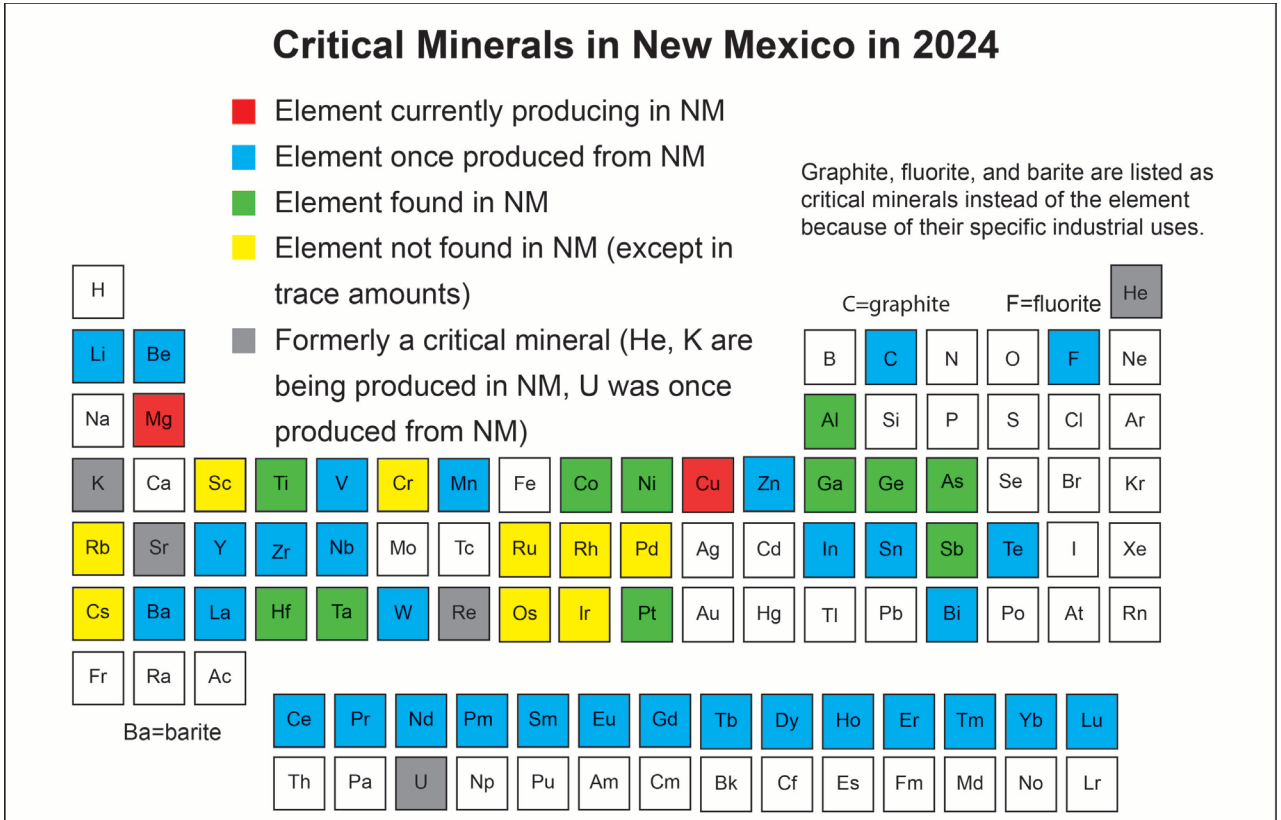
  - U.S. Department of Energy, CORE-CM project DE-FE0032051 (2021-2024)
- Numerous M.S. theses
- Professional staff and many students who worked on these projects, especially collecting samples
- Thanks to New Mexico Copper Corp. and Santa Fe Gold Inc. for access

AML Project (nmt.edu)

Purpose Of NMBGMR Mine Wastes Program

- Test USGS procedures
- Provide data on districts, mines, and mills in New Mexico
  - Help plan and assess reclamation procedures
  - Determine background concentrations
  - Understand geologic processes
  - Identify and quantify critical mineral potential
  - Compare trace-element concentrations in mined versus undisturbed areas
  - Provide background data that can assist with the planning of future mining operations



Note that any element or commodity can be considered critical in the future depending upon use and availability. Coal can contain several of these critical elements.

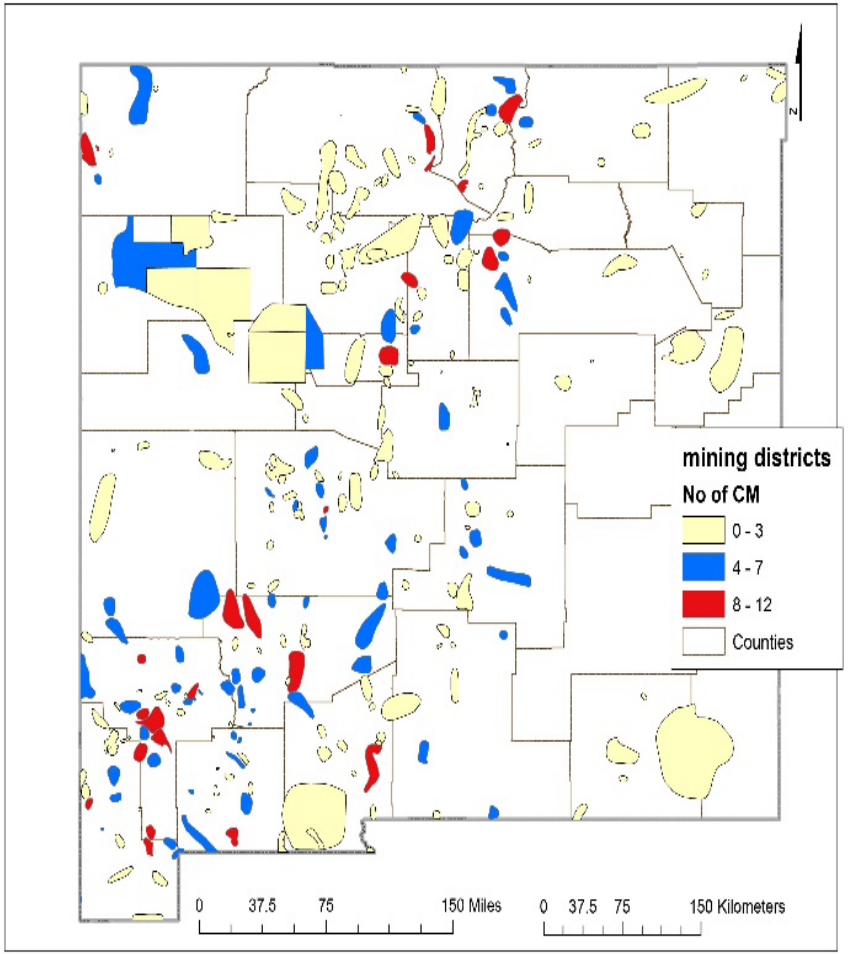
U, Re, He, Sr, and K (potash) were removed from the critical minerals list in 2022 and Zn and Ni were added. In 2023, the Department of Energy added Cu to the critical materials list.

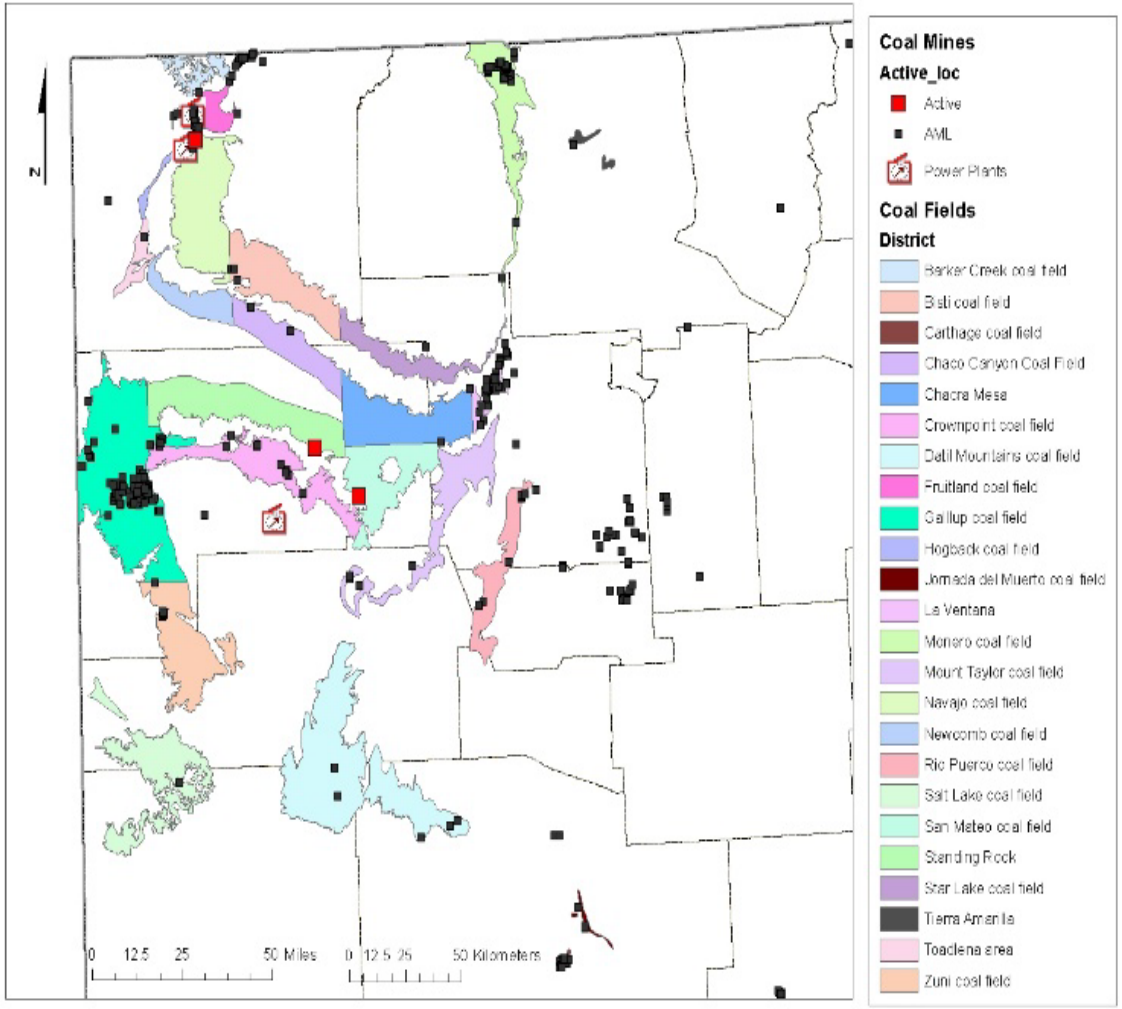
Periodic table showing critical minerals in New Mexico

Copper (Cu) was added as a critical mineral in 2023 by the Department of Energy (DOE)

Map of mining districts in New Mexico that have critical minerals

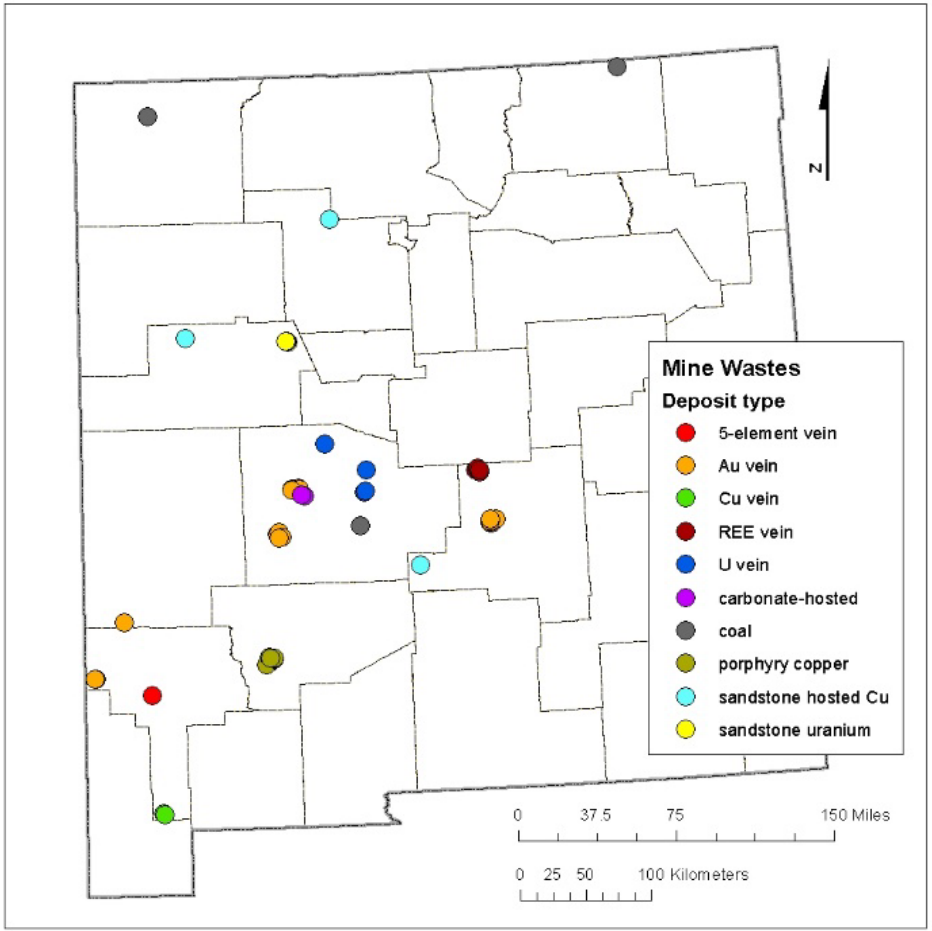
- Coal fields are on next slide
- Other areas in New Mexico, such as high-magnesium dolomites, lithium-bearing playas, and coal fields, are not found in specific mining districts and also have potential for critical minerals (CM)





Coal fields in San Juan Basin, New Mexico

Location of areas sampled in the New Mexico mine waste study



Field Procedures

- Inventory
  - Feature descriptions at each site
- Mapping
  - GPS/sketches/LiDAR
  - Radiometric surveys at Black Hawk
    - Divide rock pile into zones based upon radioactivity
- Water Sampling

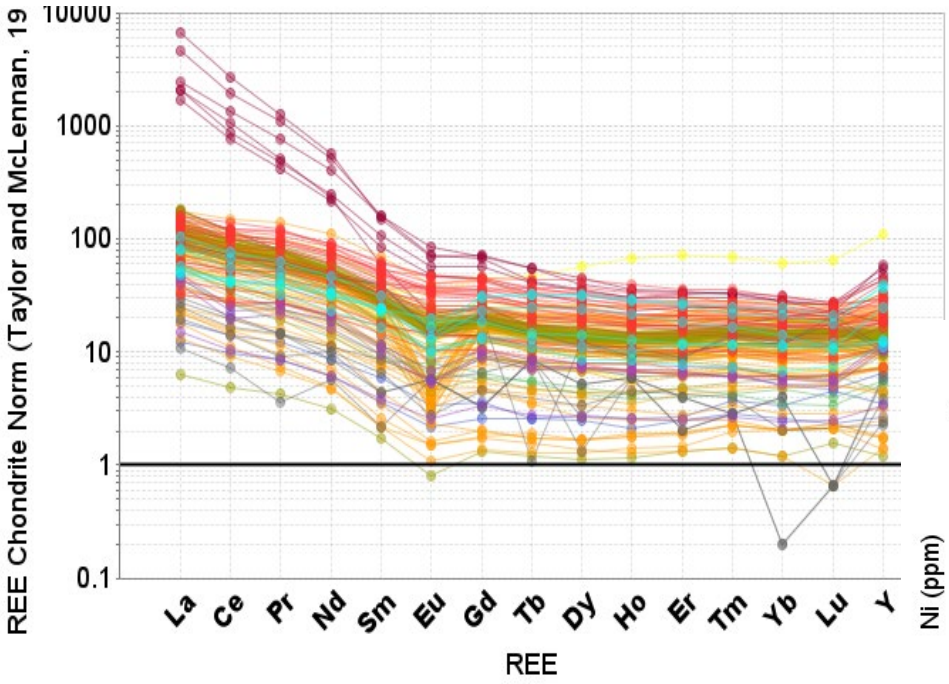
Joseph working hard at Jicarilla district!

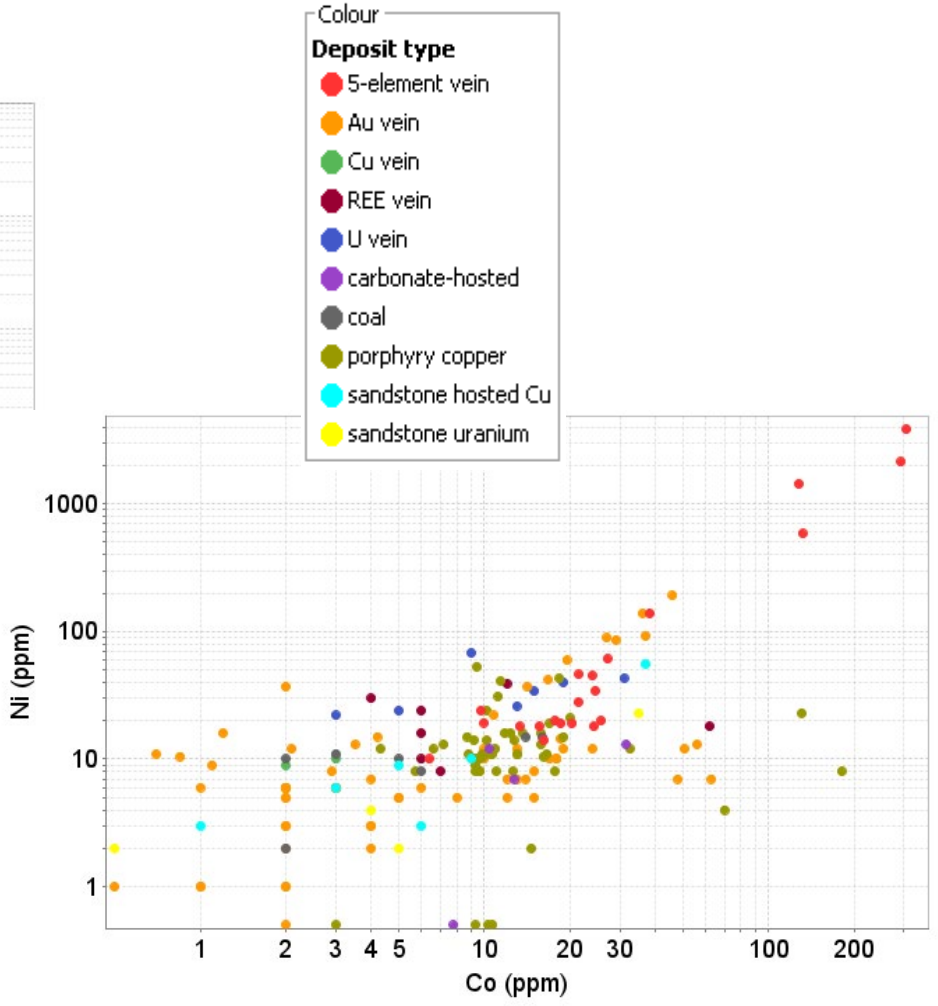
Field Procedures-continued

- Waste Rock Sampling
  - Soil samples, rock chip samples
    - composite of cells within each feature
    - select of certain areas
    - Profiles where feature eroded
  - Sample microbes
  - Select samples
  - Ore samples
  - Slag samples
- Mineralogy, chemistry

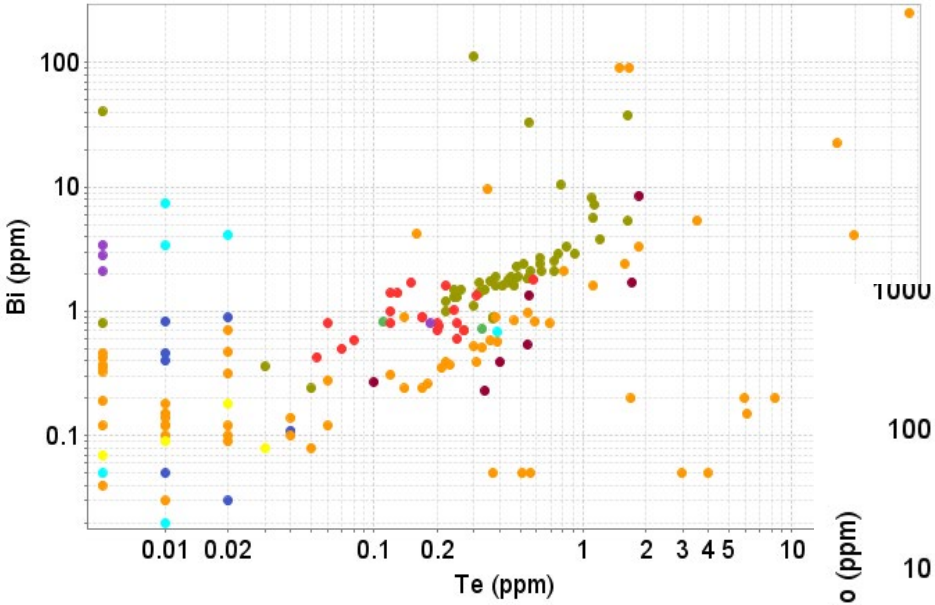
Eroded oxidation profile in a rock pile at Copper Flat

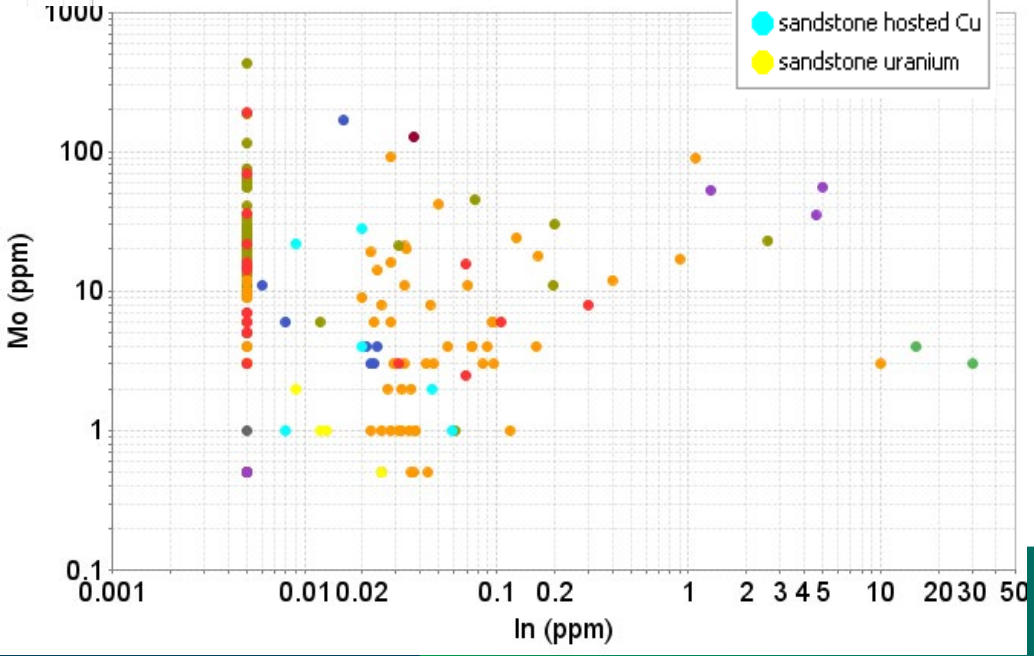
Results


REE Chondrite Norm (Taylor and McLennan, 19
10000
1000
100
10
1
0.1
La
Ce
Pr
Nd
Sm
Eu
Gd
Tb
Dy
Ho
Er
Tm
Yb
Lu
Y
REE


Colour
Deposit type
5-element vein
Au vein
Cu vein
REE vein
U vein
carbonate-hosted
coal
porphyry copper
sandstone hosted Cu
sandstone uranium
Ni (ppm)
1000
100
10
1
1
2
3
4
5
10
20
30
100
200
Co (ppm)

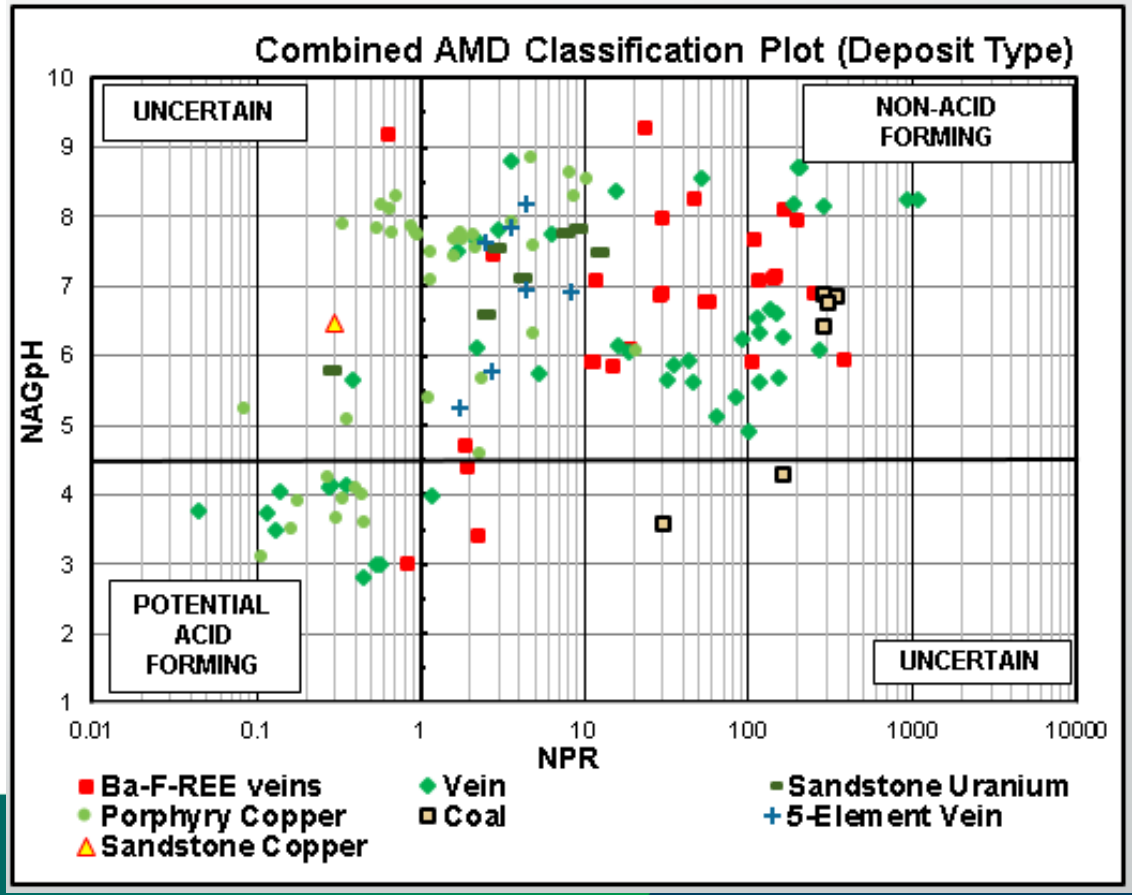
Results-continued





Colour
Deposit type
- 5-element vein
- Au vein
- Cu vein
- REE vein
- U vein
- carbonate-hosted
- coal
- porphyry copper
- sandstone hosted Cu
- sandstone uranium

Acid Rock Drainage (ARD) plot of waste rock pile at mines examined during the NMBGMR mine wastes project



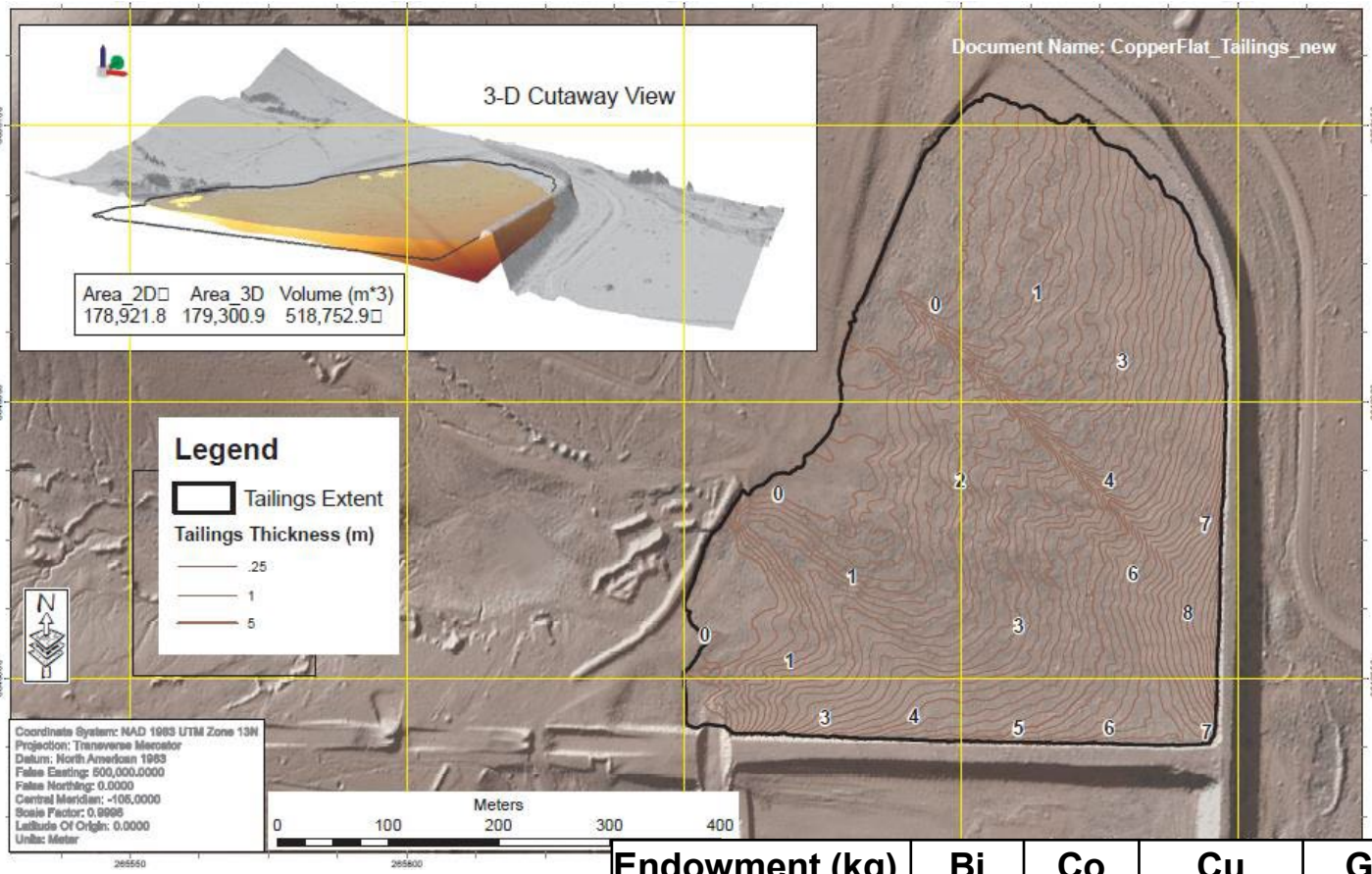
AP(kg $CaCO_3$/tonnes)=31.25xS(%)

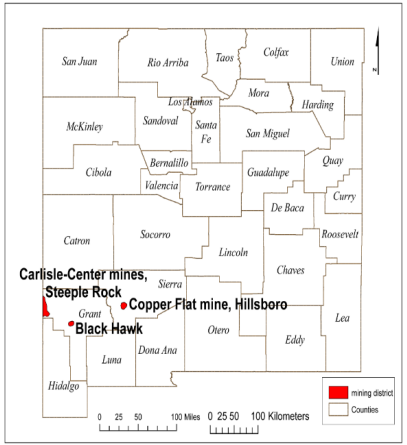
NP(total C)=83.3 x C (%)

NNP=NP– AP

NPR=NP/AP

Endowment at Copper Flat Tailings, Hillsboro district





Endowment (kg)	Bi	Co	Cu	Ga	Te	Zn	Zr
Minimum	960	4,230	256,700	13,350	180	29,900	174,000
Maximum	1,700	7,900	574,200	15,600	360	53,400	210,600
Mean	1,280	6,880	402,900	14,240	300	44,000	194,400

Assumes a bulk density of 1430 kg/m^3

Important note

- Production of critical minerals from mine wastes will likely depend on if the mine wastes can be reprocessed for the major commodity (Au, Ag, base metals)
  - Economic production of solely critical minerals is probably not possible in most cases
- There will likely still be a remaining waste

Preliminary conclusions

- A sampling protocol has been developed that can estimate the chemical composition of mine wastes
- Larger mine features are divided into subareas for sampling
- Composite samples are collected from cells within the sample areas and homogenized into a single sample
- Elevated critical minerals are found in some of the mine features in New Mexico and these features should be evaluated for potential re-mining or reprocessing
- The available critical minerals are dependent upon types of deposits
- Possible re-mining of mine wastes could clean up these sites and pay for reclamation

Questions?