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Geochemistry of Critical Minerals in Mine Wastes at Hillsboro and Steeple Rock districts, New Mexico.

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TERMINOLOGIES

- **Critical Minerals;** According to the Energy Act of 2020, a "critical mineral" is a non-fuel mineral or mineral resource that is crucial to the U. S's economic and national security with a potential disruption in its supply.

- **Mine Waste**
  - **Waste Rock Piles:** An accumulation of all unprocessed rock materials that are produced owing to mining operations.
  - **Tailings:** The waste stream that results after the valuable commodity has been extracted from the ore material.

- **Fine Samples ;** undersize of sieve size 4.75mm.

- **Chip samples;** oversize of sieve size 4.75mm.

OBJECTIVES

- beta-test” USGS procedures for sampling mine wastes.
- Determine the acid generating potential of mine waste in NM.
- Characterize and estimate the critical minerals endowment of mine wastes in two mining districts in NM (i.e., Copper Flat at Hillsboro and Carlisle-Center mines in Steeple Rock district).

THE STUDY AREAS

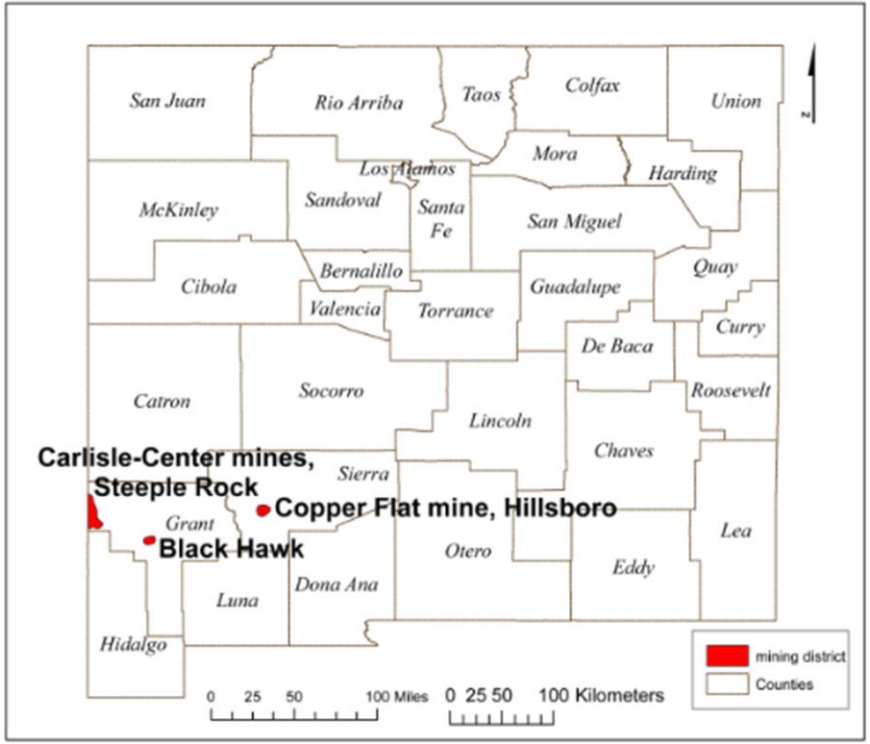

FIGURE 1 Location of the Copper Flat at Hillsboro, Black Hawk in Burro Mountains, and Carlisle-Center mine in Steeple Rock areas, southwestern NM.

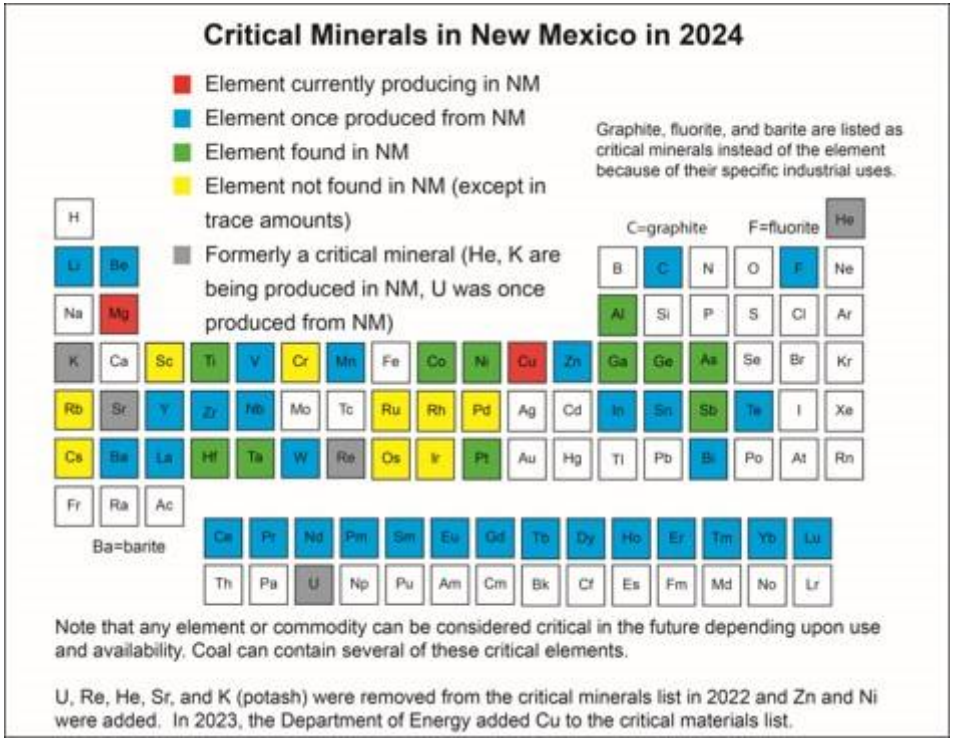

Figure 2 Status of Critical minerals in New Mexico.

GEOLOGY & MINE HISTORY

Carlisle-Center

- Volcanic-epithermal system with little sulfidation and has Au-Ag veins.
- 2 groups of alteration assemblages: acid-pH and neutral-pH.
- Six different types of mineral deposits; base-metal (Ag, Au), Au-Ag (base metals), Cu-Ag, fluorite, Mn, and high-sulfidation disseminated Au deposits.
- As, Bi, Te, fluorite and Zn. Exploration in the district began about 1860.
- Between 1880 and 1994, the district produced metals worth an estimated $10 million.

Copper Flat

- The district's core is dominated by a quartz monzonite stock (74.4±2.6 Ma) with a breccia pipe, and latite dikes extend outward from it.
- Quartz veins with Cu, Au, Mo, and Ag. disseminations make up the Copper Flat porphyry copper deposit.
- Te, As, Bi, Mg, Mn, and Zn.
- First copper smelter was built in 1892.
- Exploration in the 1950s and 1960sThe mine ran for three months in 1981.

METHODS

The use of sampling techniques developed by USGS staff, the BLM (Bureau of Land Management, 2014) and EPA.

Preparation of a Site Health and Safety Plan (HASP).

General geologic mapping (GIS), sampling of waste and rock piles.

Laboratory studies; Geochemistry, XRD, Paste pH Particle size analysis, Specific gravity.

The use of geologic and geochemical data to determine potential of acid production within the wastes, estimation of the volumes and tonnages of waste and rock piles.

Sampling of Waste Rock Pile

- Distinguishing features of Mine (e.g., benches, separate piles, tailings color, etc.).
- More than 26 samples collected and analyses.
- Composite and select samples were collected.
- Flags were used to indicate sampling points.
- Chip samples were also collected.
- Sampling holes were about 2ft deep.

A) Sample of the slope face of waste rockpile in Hillsboro.

B) Sieving to make a composite sample.

Sampling of Tailings

C) Identify difference between cover material and tailings.

Tailings, yellowish.

Cover material, brownish.

D) Profile Sampling of tailings.

- Identify boundaries of tailing and cover material.
- About 14 samples collected and analyzed.
- Composite and select samples were collected.
- Flags were used to indicate sampling points.
- Use of hand trowel to prevent dilution.
- Thin layer tailings at Hillsboro.

LABORATORY ANALYSIS

- Geochemistry by USGS
- Particle size analysis
- Paste pH
- X-Ray Power Defraction, XRD

XRD RESULTS

Copper Flat

- Samples from the waste rock pile include clay minerals especially for OH clays, the rest are mostly rock forming minerals.
- Notable for Alunite, an indicative of acidic precipitation of SO_4.
- Samples from the tailings are notable for the presence of calcite.

Carlisle-Center

- Most samples have abundant quartz and minor micas.
- SR 6 also indicates presence of Mn oxide.
- Another interesting mineral found in some of the samples was Beaverite which, is a Pb-Fe-Cu Sulfate.

PRELIMINARY RESULTS

PARTICLE SIZE ANALYSIS

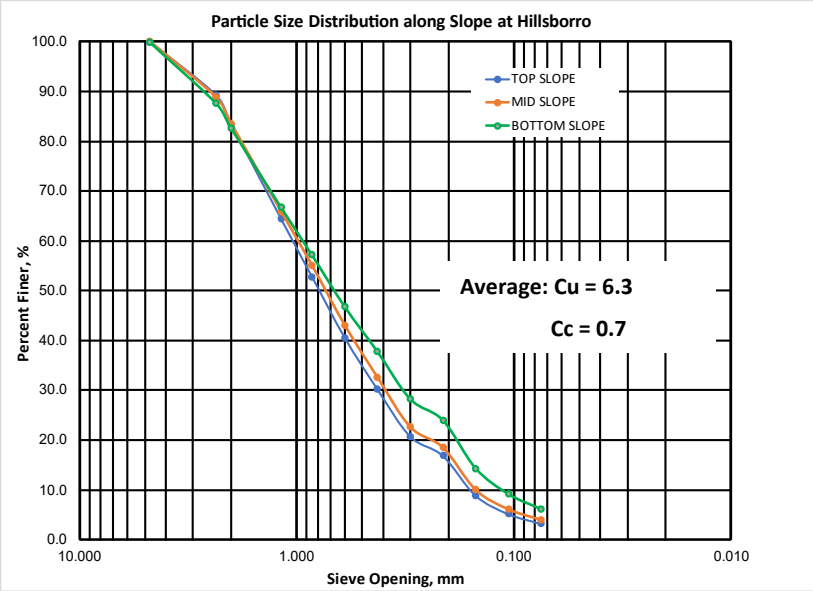

FIGURE 3 A plot of particle size distribution along rock pile slope at Copper Flat mine.

- Fine Particle fractions are evenly distributed along slope.

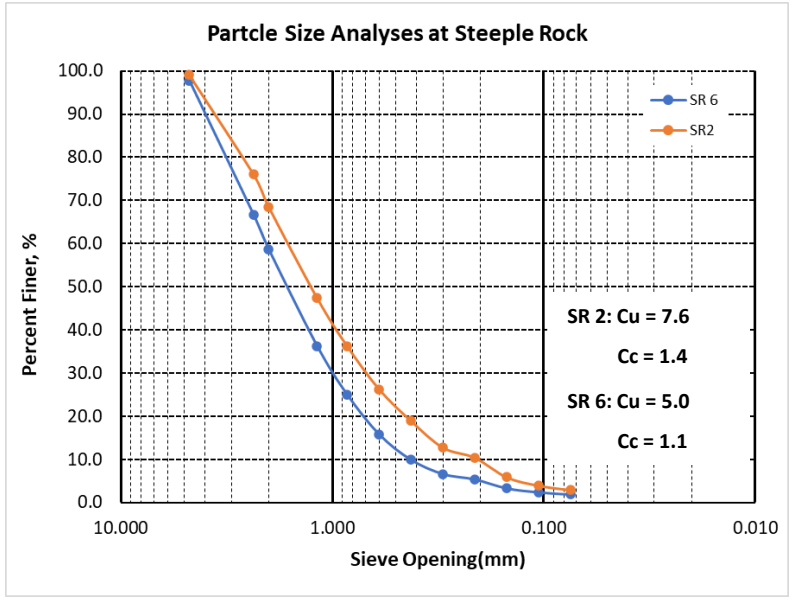

FIGURE 4 A plot of particle size distribution of composite samples from Carlisle-Center.

- Samples collected in the area range from a well graded sand to well graded sand.

ACID ROCK DIAGRAM (ARD)

AP – Acid Potential: S(%) *31.25

NP - Neutralization Potential : C(%)*83.3

NPR – Net Potential Ratio (**NPR = NP/AP)**

- Carlisle-Center samples have acid forming potential.
- Most samples from the waste rock pile at Copper flat are nonacid forming.

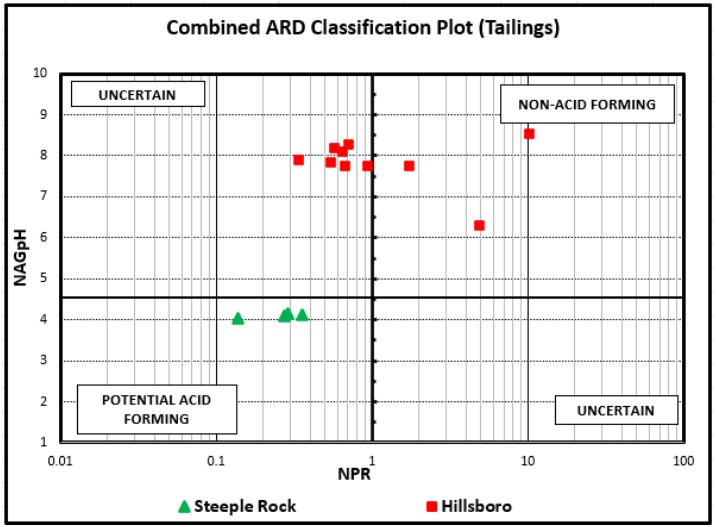

FIGURE 5 Acid Rock Diagram of tailings at mines at Copper Flat mine and Carlisle-Center.

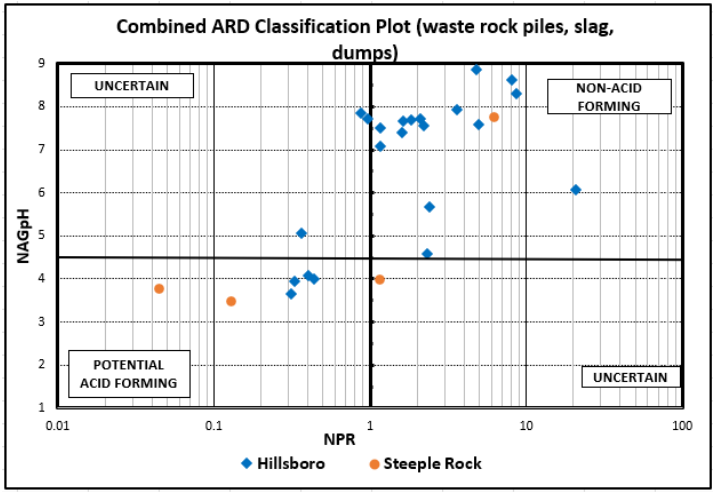

FIGURE 6 Acid Rock Diagram of waste rock pile at mines at Copper Flat mine and Carlisle-Center.

GEOCHEM

- Hillsboro has higher light REE enrichment as compared to Steeple rock.

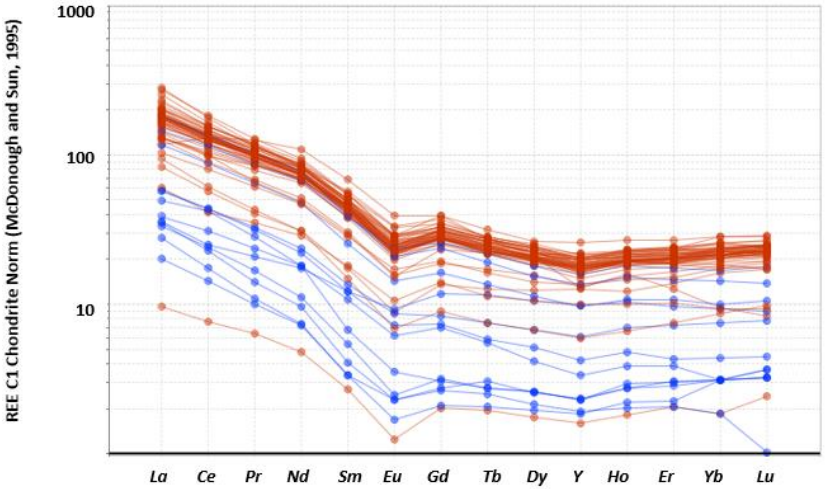

FIGURE 7 A chondrite REE plot of samples from Copper Flat mine and Carlisle-Center.

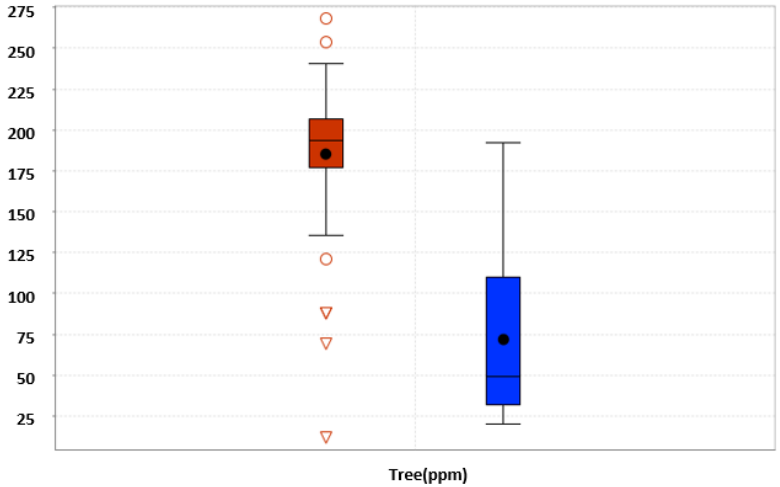

FIGURE 8 TREE concentrations at Hillsboro and Steeple rock.

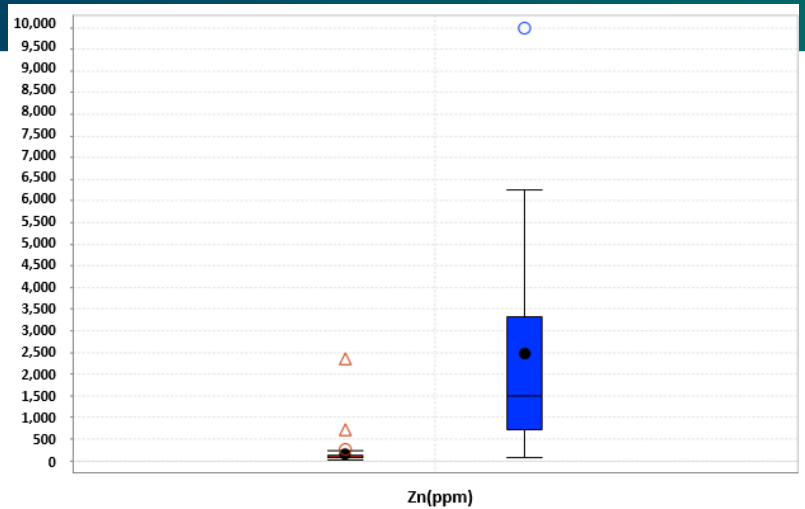

FIGURE 9 Zinc concentrations at Hillsboro and Steeple rock.

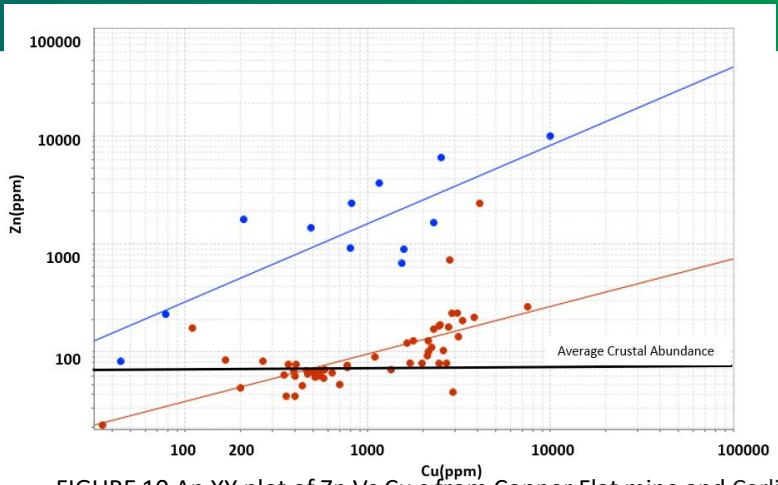

FIGURE 10 An XY plot of Zn Vs Cu s from Copper Flat mine and Carlisle-Center.

- There is positive correlation between Cu and Zn as expected, Steeple rock however has higher Zn values as compared to Hillsboro.
- Tellurium concentrations are higher in Steeple rock than Hillsboro.

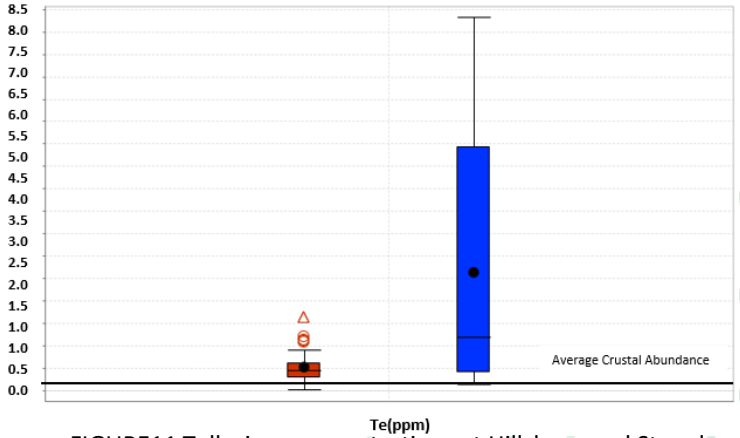

FIGURE11 Tellurium concentrations at Hillsboro and Steeple rock.

PRELIMINARY CONCLUSIONS

Samples from Carlisle-Center are mostly acid forming and can possibly cause acid mine drainage.

Samples from Copper Flat that are nonacid forming may be used as back fill material.

Geochemistry results from Copper Flat shows higher light REE enrichment than Carlisle-Center.

FUTURE WORK

More samples to be collected analyzed and archived from mine waste rock piles in the State.

Analyzing geochemistry on different particle fractions to ascertain any existing correlation between mineralogy and particle size.

Compute the tonnages of mine waste and thus estimate the critical mineral endowment of the study areas.

THANK YOU

QUESTIONS ?

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