A STUDY OF ABANDONED MINE LANDS IN NEW MEXICO

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1. Abstract

Abandoned mine lands (AML) are lands that were mined and left unreclaimed where no individual or company has reclamation responsibility and there is no closure plan in effect. The New Mexico Bureau of Geology and Mineral Resources and the Mineral Engineering Department at New Mexico Tech are conducting research to develop a better procedure to inventory and characterize legacy, inactive, or abandoned mine features in New Mexico. The object of this study was to inventory a number of abandoned mine features in the Wilcox district in Catron County, the Eureka district in Grant County, the North Magdalena, Rosedale and Socorro districts in Socorro County, and the Estey, Jicarilla and Gallinas Mountains districts in Lincoln County, New Mexico. This inventory was conducted by means of recording field observations according to the procedure already used by the program, soil petrography of composite dump samples, and paste pH analysis of said samples. This work served to identify environmental hazards in these districts, which contributed to the goals of the AML program.

2. Introduction

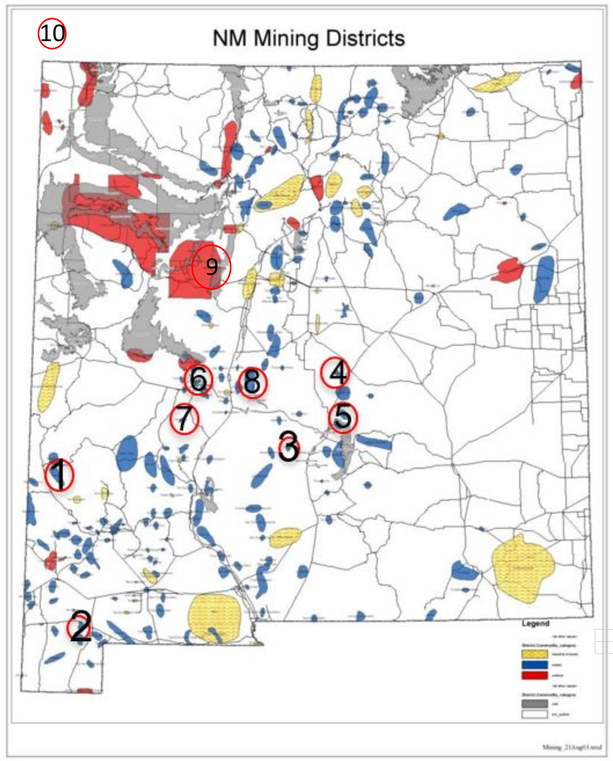
The Gallinas Mountains mining district in Lincoln County, NM contains a number of abandoned mines, where rare earth elements (REEs) were historically mined. Our objective was to perform soil petrography and paste pH analyses on collected samples from several abandoned mine features in the district and compare the results to those from other districts. By doing this, we hope to learn more about physical and chemical hazards associated with the sites, as well as any mineral resource potential

Abandoned mine lands (AML) are lands that were excavated, left un-reclaimed, where no individual or company has reclamation responsibility, and there is no closure plan in effect. They include mines and mine features left unreclaimed on Federal, State, private and Native American lands because the current owner was not legally responsible for reclamation at the time the mine was created. Government agencies reclaiming AML sites in the past have just reclaimed the physical hazards without any characterization of the material they use to determine if they have any acid generating potential material or elements of environmental concern that could cause environmental issues, especially to groundwater. This project uses a procedure developed at New Mexico Tech to inventory mine features and quickly, effectively, and cheaply characterize mine wastes within the Gallinas Mountains mining district.

3. Research purpose

- Abandoned mine lands present both physical and chemical hazards
- Physical hazards include mine workings, rock piles, tailings, and heap leach facilities
- Chemical hazards include acid rock drainage and contamination by metals and other constituents
- Since there is no complete inventory, we do not know the extent of any problems
- The primary goal of this research is to examine hazards associated with AML sites, rank them according to the NOAMI hazard ranking system, and examine correlations between types of deposit and hazards
- Additionally, any mineral resource potential found at abandoned sites has possible economic implications, due to the demand for gold, REEs and other commodities

Features in two of the districts examined, North Magdalena, left, and Rosedale, right



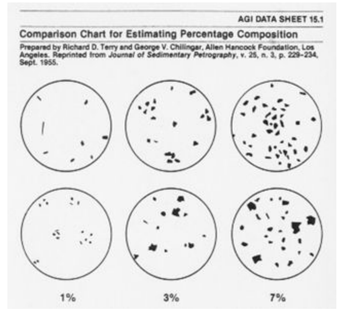
Mining districts in New Mexico

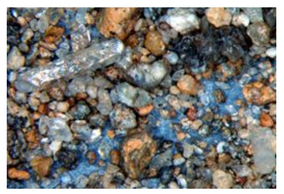
Number	District	Deposit Types	Commodities Produced
1	Wilcox (Lone Pine)	volcanic-epithermal, fluorite veins	Au, Ag, Cu, F, Te, Mn
2	Eureka (Little Hatchet)	polymetallic vein, Pb-Zn and Cu skarn, placer gold, sandstone uranium	Au, Ag, Cu, Pb, W, Zn, As, turquoise
3	Estey	sedimentary-copper	Cu, Ag
4	Gallinas Mountains	Great Plains Margin, sedimentary-copper, placer gold	Au, Ag, Cu, F, Fe, Zn, REE, Pb
5	Jicarilla	GPM, placer gold	Au, Ag, Fe, Cu, Pb
6	North Magdalena	carbonate-hosted Pb-Zn (Cu, Ag) replacement,volcanic-epithermal vein	Ag, Pb, Ba, Cu, Au
7	Rosedale	volcanic-epithermal vein, placer gold	Au, Ag
8	Socorro	Rio Grande Rift copper-silver (uranium) vein, sandstone uranium	U, V
9	Laguna	Sandstone uranium	U, V
10	Silverton, CO	volcanic-epithermal	Au, Ag, Cu, Zn

Description of mining districts studied

4. Materials and Methods

- A field inventory form was designed to collect data on all mine features during the field examination, which were later entered into the New Mexico Mines Database
- Selected waste rock piles at the sites were mapped using a handheld GPS and/or measuring tape. Composite samples of waste rock piles were collected and soil petrography and paste pH analyses were measured for each sample, to evaluate major and trace elements.
- The samples were examined to determine alteration type, any notable weathering features, and overall mineralogy. The grain shape was noted, after which the sample was moistened with distilled water and its color was determined. The samples were then tested to determine their paste pH. Fine size fraction from the sample were placed in a beaker with distilled water and the mixture was stirred until it formed a paste, the probe from the pH meter was dipped into the paste, and the data was recorded.
- Whole-rock geochemistry was performed on the samples by an outside laboratory.





A size comparison chart used for petrography, left, and a view of a composite dump sample, right

5. Results

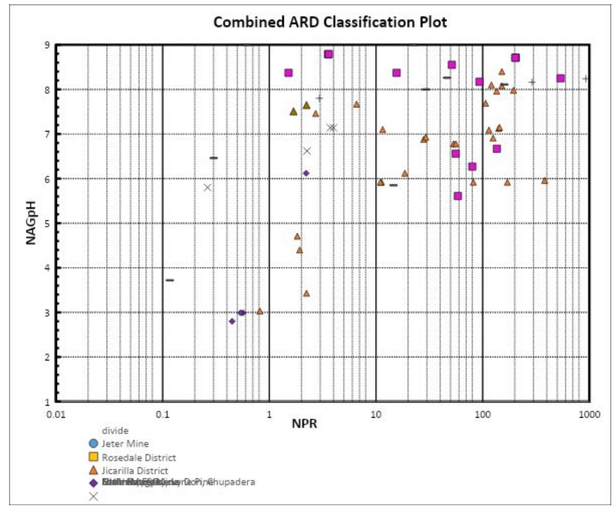
- Samples that have higher concentrations of pyrite are more likely to have a higher acid generation capacity.
- A few mine sites examined have the potential to generate acid drainage and additional mine sites are physically dangerous and require proper safeguarding.
- The samples contained a small amount of organic material, such as grass and seeds.
- Paste pH work of the samples revealed most of the sites are slightly alkalinic with non-acid forming potential, although the Red Cloud mine showed mild acidity.

Number	District	Sulfur	Carbon	paste pH
1	Wilcox (Lone Pine)	0.01-1.14	0.51-0.05	0.31-35.63
2	Eureka (Little Hatchet)	2.95-4.03	2.47-2.55	92.19-129.54
3	Estey	2.48	0.28	77.5
4	Gallinas Mountains	0.01-0.78	0.18-2.26	0.31-24.38
5	Jicarilla	0.01-0.43	0.07-2.27	0.31-26.56
6	North Magdalena	0.01-0.81	0.46-2.02	0.31-25.31
7	Rosedale	0.01-0.48	0.02-0.22	0.31-15
8	Socorro	0.01-0.48	0.02-5.45	0.31-7.56
9	Laguna	0.04-0.13	0.06-0.11	1.25-28.44
10	Silverton, CO	0.53-2.26	0.21-0.44	16.56-70.63

Paste pH and geochemistry results

6. Conclusions

- Samples that have higher concentrations of pyrite are more likely to have a higher acid generation capacity. Generally, Acid Potential (AP) depends on the amount of pyrite and other sulfide minerals and Neutralizing Potential (NP) depends upon the amount of calcite and other acid-neutralizing minerals. But, no single component controls the ABA and NAG tests.
- A few mine sites examined have potential to generate acid drainage and additional mine sites are physically dangerous and require proper safeguarding.
- Most of the waste rock piles surrounding the mine features are suitable for backfill material.
- Sulfide oxidation can be slow in some areas and metal release can be low, but other areas are the opposite—characterization of mine wastes is important.



Acid Rock Drainage (ARD) plot of waste rock pile at mines examined during the NMBGMR AML project. The results for the waste rock piles from the Little Davie, Lucky Don, Chupadera, and Jeter uranium mines (Socorro County), St. Anthony uranium mine (Cibola County), Rosedale and Jicarilla gold mines (Socorro and Lincoln Counties) and Silverton gold-silver mines (Colorado) are shown for comparison (unpublished work in progress). Results of these mines will be published in future reports.

$$AP = S(\%) \times 31.25$$
$$NP = C(\%) \times 83.3$$
$$NNP = NP - AP$$
$$NPR = \frac{NP}{AP}$$

Acid Potential (AP)
Neutralization Potential (NP)
Net Neutralization Potential (NNP)
Net Potential Ratio (NPR)

NOAMI Class	Description
A	A site with potential to cause environmental, public health and public safety concerns
B	A site with limited potential to cause environmental concerns but with potential for public health and safety concerns
C	A site with public safety concerns but little or no public health or environmental concerns
D	A site with no expected environmental, public health or public safety concerns
O	Information is not available
R	Remediated

Hazard ranking scale developed by the National Orphaned/Abandoned Mines Institute (NOAMI), Canada

7. Acknowledgments

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