THE CHARACTERIZATION OF LEGACY MINES IN JICARILLA MOUNTIANS, NEW MEXICO

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ABSTRACT

Gold-silver production in the Jicarilla district, Lincoln County occurred 1850-1957 from hundreds of pits, adits, and shafts. Many of these mines were abandoned with little or no remediation. It is important to recognize that these early miners were not breaking any laws, because there were no laws to break. Many state and federal agencies have mitigated the physical safety hazards by closing these mine features, but very few of these reclamation efforts have examined the long-term chemical effects. Many of these mine features do not pose any physical or environmental hazard and many more, pose only a physical hazard, which is easily but costly to remediate. The objective of this research is to develop a better procedure to inventory and characterize abandoned mine features, not only in the Jicarilla district, but this procedure can be applied to other districts. Hazard ranking of mine openings and features, using appropriate ranking methodology will be utilized for most sites. Also we want to suggest remedial activities that would manage or mitigate dangers to the environment and public health, while taking into consideration historical, cultural and wildlife issues and mineral resource potential

INTRODUCTION

Mining operations in the Jicarilla Mountains, Lincoln County began about 1850 (McLemore et al., 1991). Production has been minor and amounts to 2609 oz lode Au, 7347 oz placer Au, 37,561 oz Ag, and 8000 short tons of Fe ore (McLemore, 2017). Three types of deposits are found in the district, namely: placer gold deposits, Great Plains Margin gold-quartz veins and iron skarns deposits

MAP SHOWING STUDY AREA

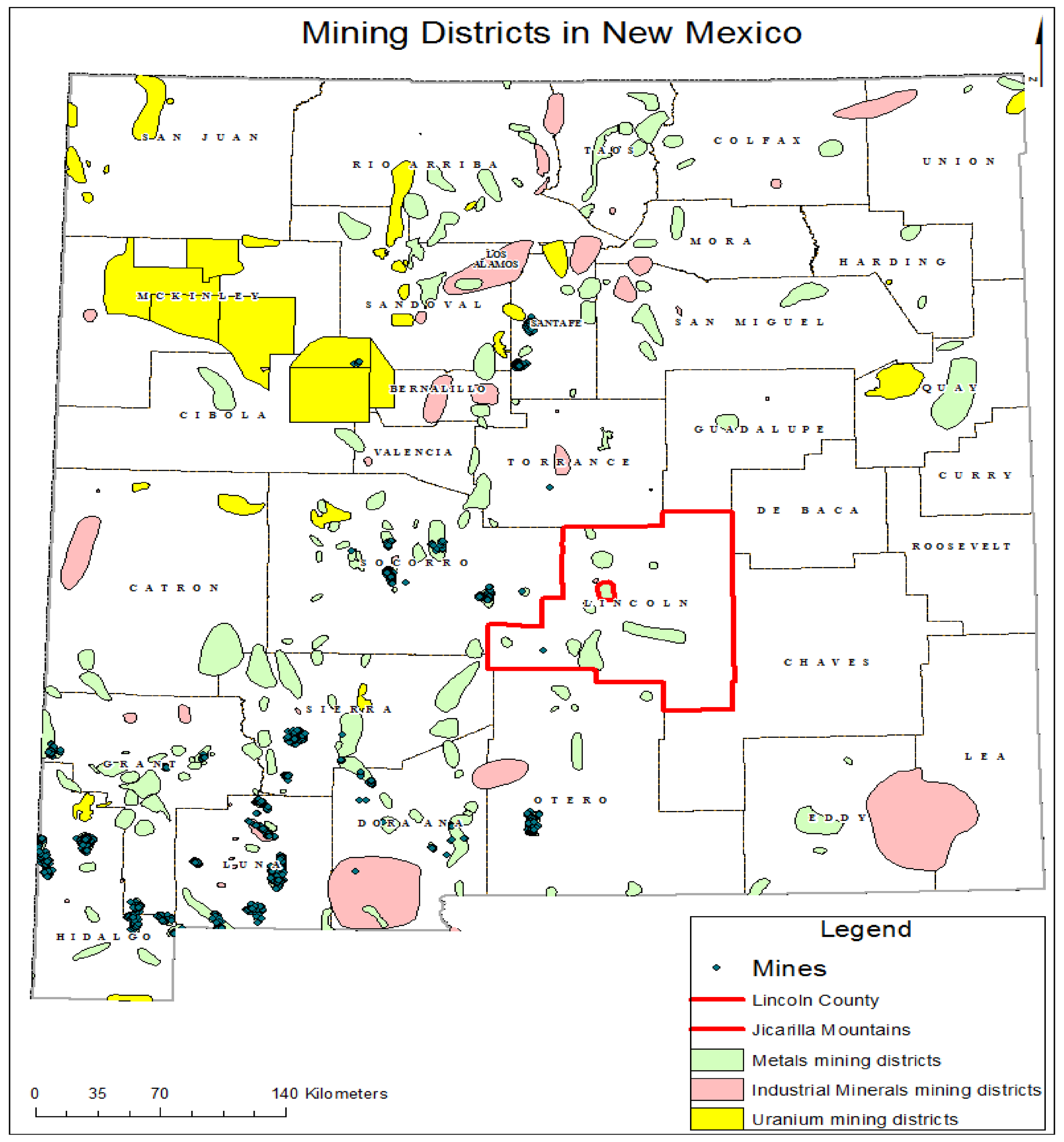


Figure 1. Map showing study area, mining districts in New Mexico and legacy mines (source NMBGMR).

GEOLOGY

The Jicarilla Mountains were formed by a late-Eocene or early-Oligocene granodiorite to dacite porphyry laccolith that intruded a sequence of Permian sedimentary rocks. Younger dikes, sills, and laccoliths intruded both the older granodiorite to dacite porphyry and the sedimentary rocks; compositions range from quartz syenite to syenite to granodiorite to quartz monzonite (V.T. McLemore, unpublished mapping). Contact metamorphism has locally transformed limestone to calc-silicate rocks, and some of the metamorphosed rock has been replaced by magnetite. Minor vein deposits of hematite and sulfides, and small disseminations of pyrite have been precipitated from hydrothermal solutions. Some of the pyrite and hematite contains minor (< 1 ppm) gold.

Placer-gold deposits are of local derivation, and are found in three separate sedimentary units: an older alluvium (possibly correlated with the Pliocene Ogallala Formation), younger alluvium formed on top of the igneous intrusions, and modern arroyos (V.T. McLemore, unpublished mapping).

PURPOSE

The objective of our research is to develop a relatively quick and inexpensive procedure to inventory and characterize legacy mines in New Mexico, using Jicarilla Mountain as a case study. Appropriate hazard ranking of mine openings and features, using field inspection and laboratory analyses will be utilized for most sites. Also we want to suggest remedial activities that would manage or mitigate dangers to the environment and public health, while taking into consideration historical, cultural and wildlife issues and mineral resource potential.

METHODOLOGY

Sampling

The rationale behind field sampling was to characterize waste rock piles, determine the presence of trace elements from the waste rock piles and determine the suitability of waste rock material to be used as backfill. Pits, shafts and adits are generally surrounded by the waste rock material. Two types of samples were collected from the study area, rock chip samples from outcrops near the waste rock piles and composite samples from the surface of the waste rock piles collected to provide a maximize surface area coverage and to obtain a homogenized samples of the rock pile in a single sample. Evenly spaced metal pegs with flagging tapes were positioned across an entire rock pile at each site marking a sample location.

Laboratory Analyses

Sample analytical techniques being employed in this study are in the sample characterization chart (Figure 2)

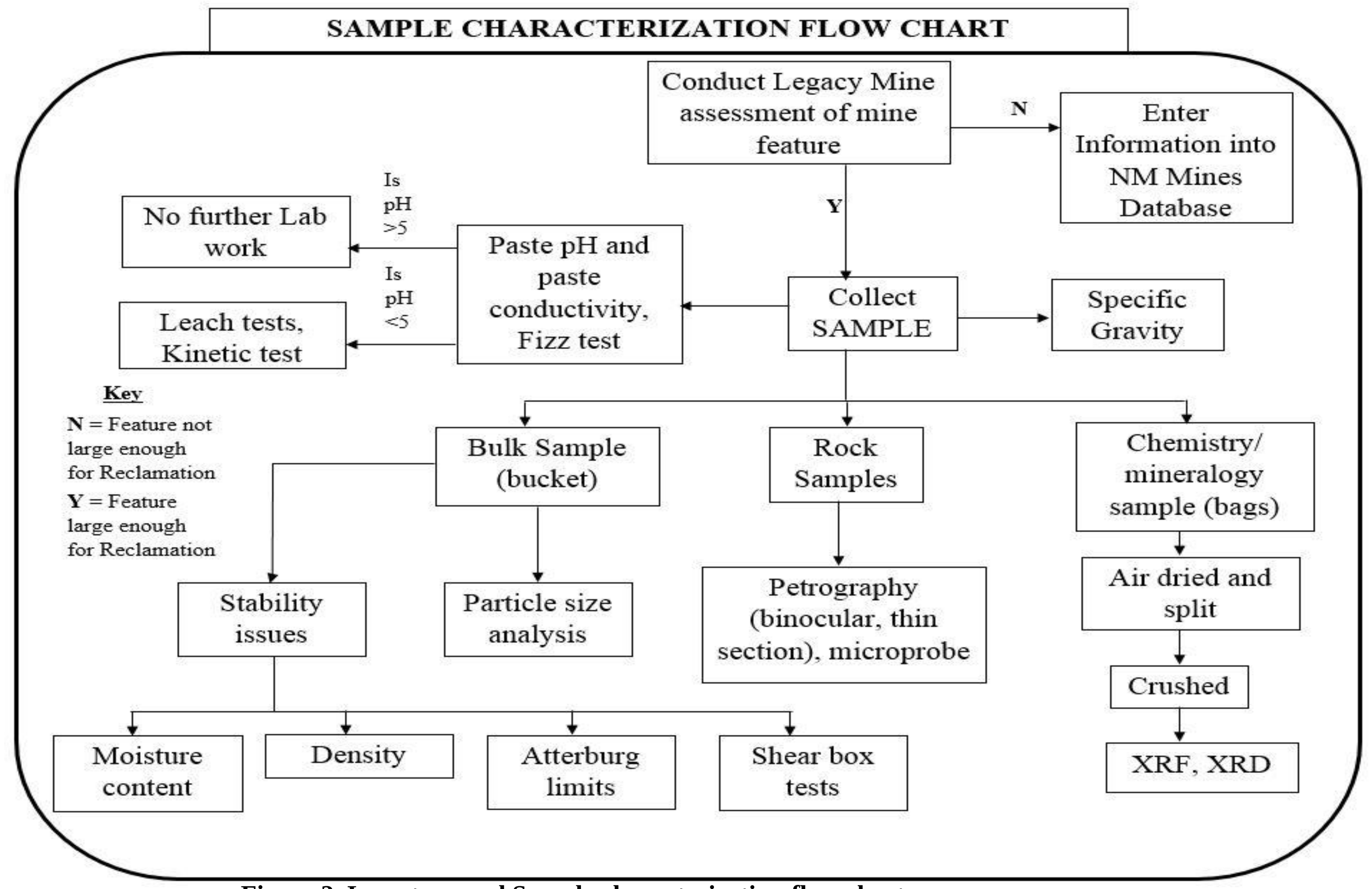


Figure 2. Inventory and Sample characterization flow chart

Field Relationships

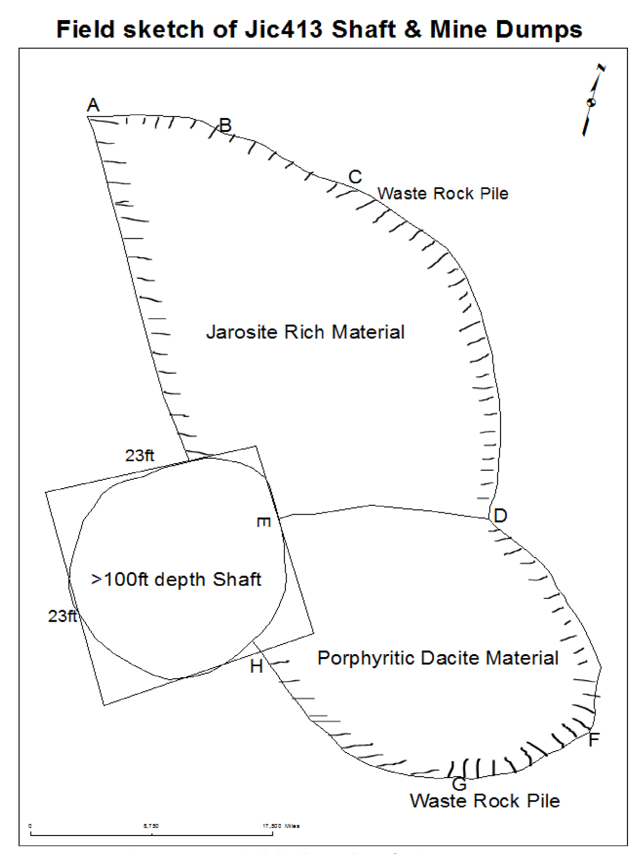


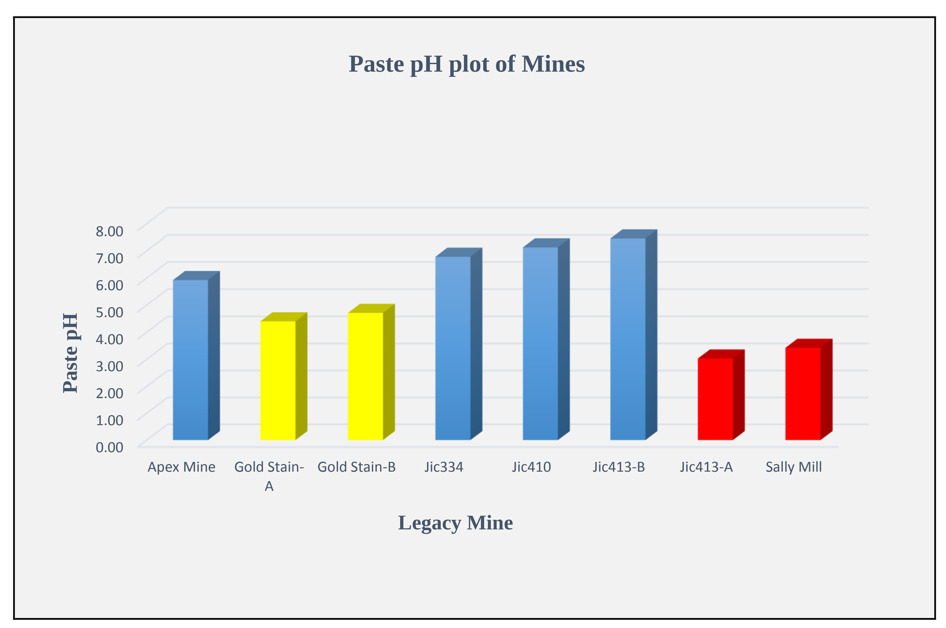
Figure 3. Field sketch of Jic413

LABORATORY ANALYSES

Paste pH and XRF Analyses

Waste Rock Pile	Average Paste pH	Total Dissolve Solids (ppm)	Au (ppm)
Apex mine	5.92	1.49E+08	0.030
Gold Stain mine-A	4.40	1.02E+08	0.341
Gold Stain mine-B	4.71	6.94E+07	0.229
Jic410	7.13	1.89E+08	0.067
Jic413-A	3.03	3.13E+08	0.820
Jic413-B	7.46	2.60E+08	1.290
Jic334	6.78	9.93E+07	0.049
Sally mine	3.43	1.95E+08	1.400

Represent pH 4-3 Represent pH 5-4 Au >1ppm



Paste pH

Paste pH and paste conductivity are used to determine geochemical behavior of waste rock materials subjected to weathering under field conditions and to estimate or predict the pH and conductivity of the pore water resulting from dissolution of secondary mineral phases on the surface of oxidized rock particles. The paste conductivity values were converted to total dissolve solids (TDS).

XRD Technique

X-ray diffraction analysis was conducted on composite waste rock samples to determine the mineralogy. Samples were grinded into a well homogenized material with mortal and pestol to form a fine powder (~75µ/0029 mesh), poured into aluminum sample holder and mounted in the silicon standard in the XRD instrument. A five minute absolute scan analysis was run. Sample analyses was done using appropriate software program.

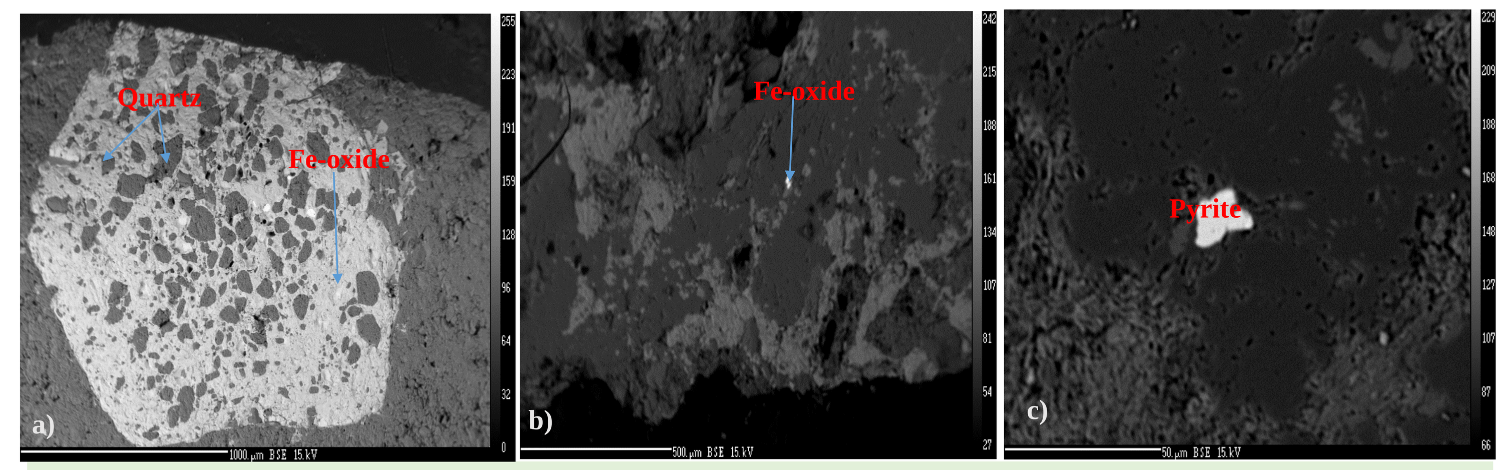
Electron Microprobe Analyses

Grab samples from waste rock piles were mounted in epoxy and polished to prepare polish sections. These polish sections are then coated with carbon and analyzed using the electron microprobe. Qualitative and quantitative method of analyses was conducted using the Cameca SX681 Electron Microprobe Spectrometer on the samples. Heavy minerals were first viewed in backscatter electron image (BSE). Quantitative and qualitative analyses were used to determine textures and chemical composition of the minerals.

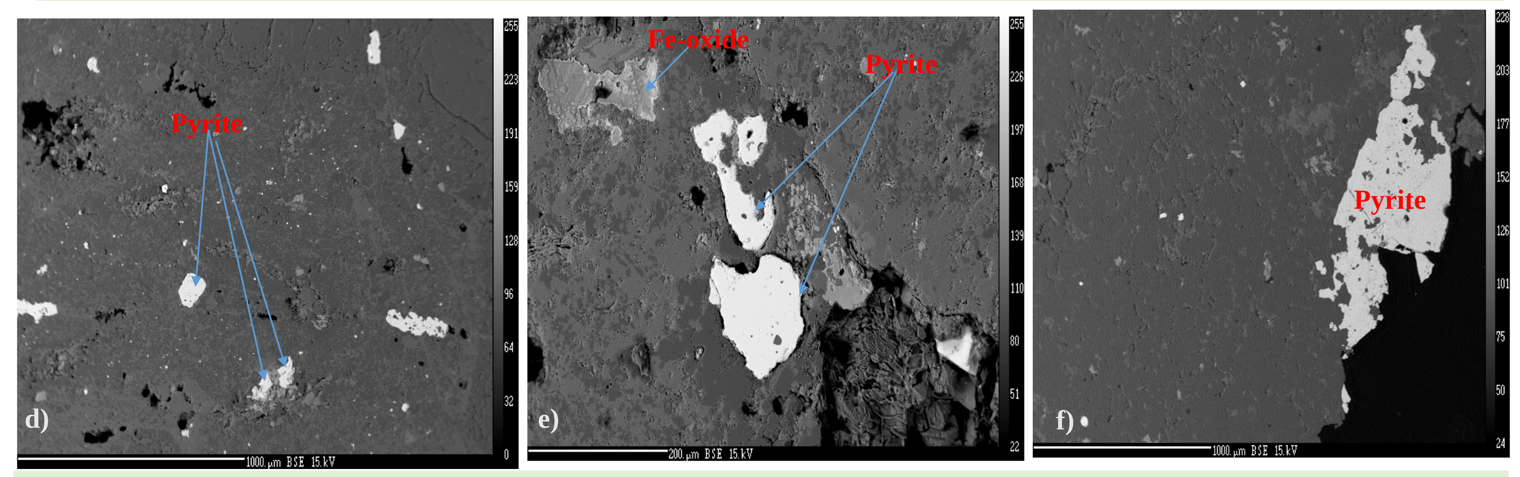
Electron Microprobe: Quantitative Analyses

Sample Number	S(%)	Fe(%)	Cu(%)	As (%)
Gold Stain-A-01	53.07	47.36	0.08	0.03
Gold Stain-A-02	33.63	31.11	32.90	0.02
Gold Stain-A-03	54.67	45.84	0.03	0.02
Gold Stain-B-01	52.56	47.50	0.01	0.02
Gold Stain-B-02	52.52	47.59	0.01	0.02
Gold Stain-B-03	52.68	47.09	0.02	0.03
Jic413A-01	53.69	47.39	0	0.02
Jic413A-02	53.02	47.47	0	0.03

Electron Microprobe: Backscattered electron (BSE) images of samples



Figures a) Backscattered electron images of quartz grain replacing Fe-oxide in sample Jic410. This is likely supergene replacement.
b) Backscattered electron images of Fe grain in sample Jic412. Note how altered and pitted the grain is.
c) Backscattered electron images of pyrite grain in sample Jic412 c. Note how pristine the pyrite grain is.



Figures d, e & f) Backscattered electron images of pyrite and Fe-oxide grains distribution in sample Jic802. Note how pristine the pyrite is in Figure d, but pitted in Figure e and f.

PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

Jarosite (iron sulfate) was observed in sample Jic413A from a waste rock pile; pyrite was observed in numerous waste rock piles (Gold stain-A, Gold Stain-B, Jic413-A and Sally Mine) during field investigations. Laboratory results from paste pH of samples from these mine waste rock piles have pH <5 suggesting a possible acid-generating environment. XRD and electron microprobe analyses identified pyrite grains in these waste rock piles, some with quantitative analyses indicating arsenic (As) percentages between 0.02-5%. Pitted textures in microprobe analyses are consistent with arsenic being leached from pyrite. Pyrite and jarosite were not observed in waste rock pile samples with pH >5. Elevated values of Au from XRF in some waste rock piles suggest possible Au mineralization potential.

Leaching tests are recommended to confirm if acid and/or metals could be leached into the environment from waste rock piles. Proper evaluations for reclamation will be performed after all laboratory analyses have been completed. Also further field studies needed to determine the mineral potential of rock piles with elevated Au values.

ACKNOWLEDGEMENTS

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