Characterization and comparison of mine wastes from legacy mines in NM

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Overview

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Study Area

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Preliminary Conclusions

Future Work

Purpose

Determine and compare the mineralogical and geochemical composition of mine wastes in legacy gold (Au) and uranium (U) mines in the study areas

Determine the possible release of trace elements from the waste rock piles into the environment, and their acid/ neutralizing potential

Determine stability, erosion and weathering of waste rock piles in the study area

Study Area
Jicarilla Mountains

Apex Mine

Gold Stain

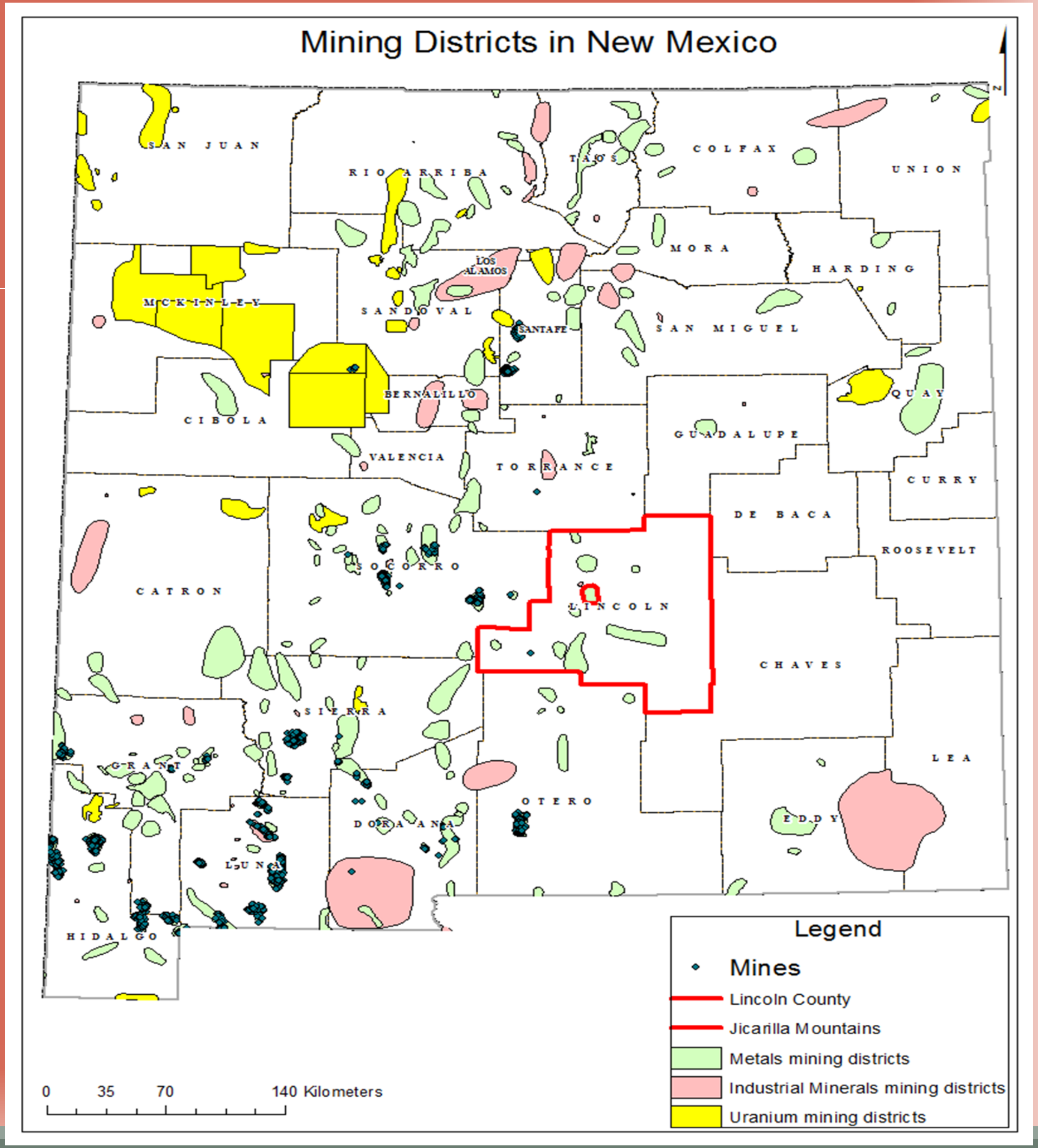
Sally Mine

Jic413

The area is approximately 100 miles south-southeast of Albuquerque, NM

About 18 km north-east of white oaks, NM

About 155 miles north-northeast of El Paso, Texas.



Study Area
Socorro District

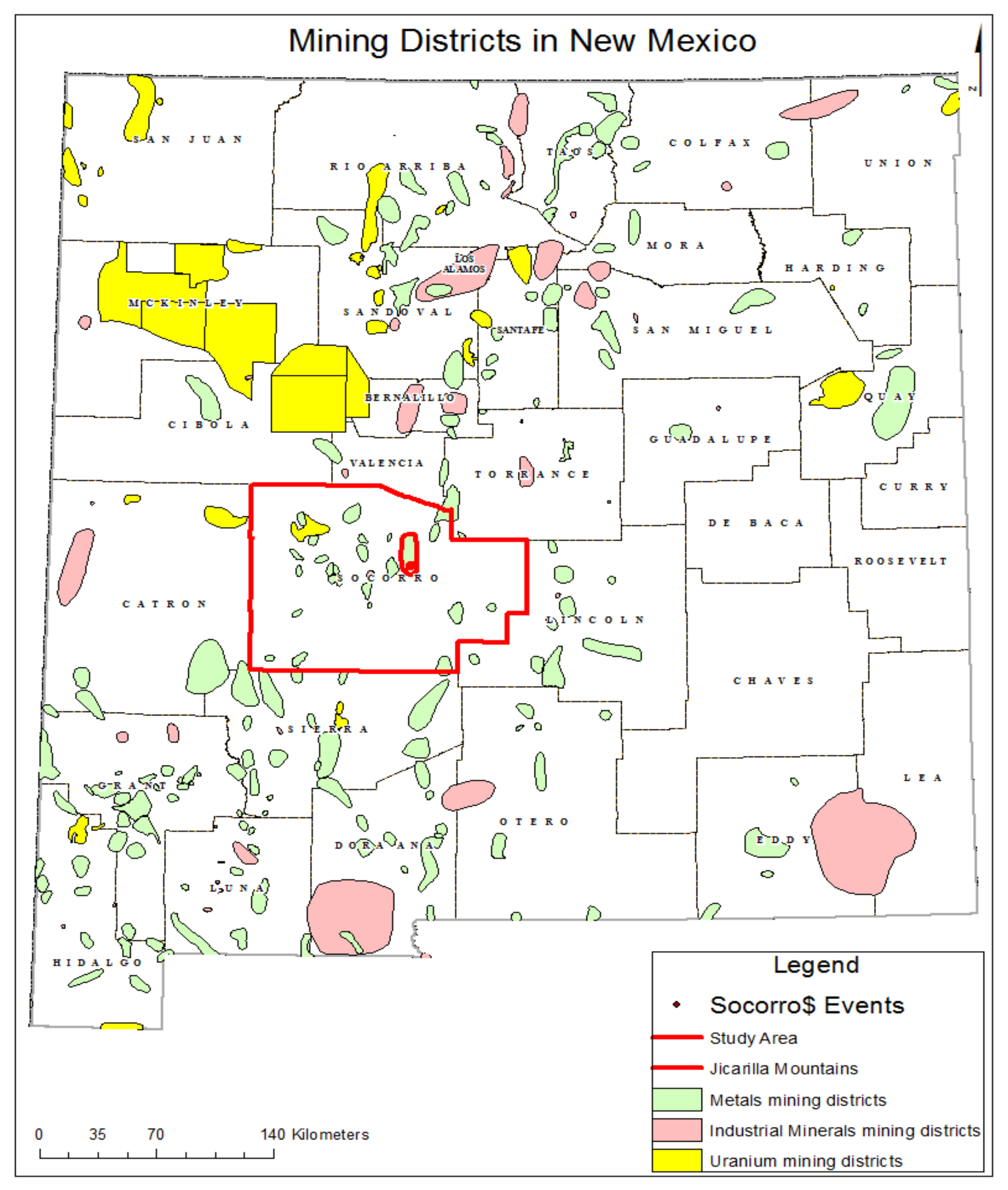
Lucky Don U Mine

Little Davie U Mine

Lucky Don is located in the Bustos Well $7^1/_2$ quadrangle

About 10miles east of San Antonio, NM

Little Davie is located about ¼ mile south-southwest of Lucky Don

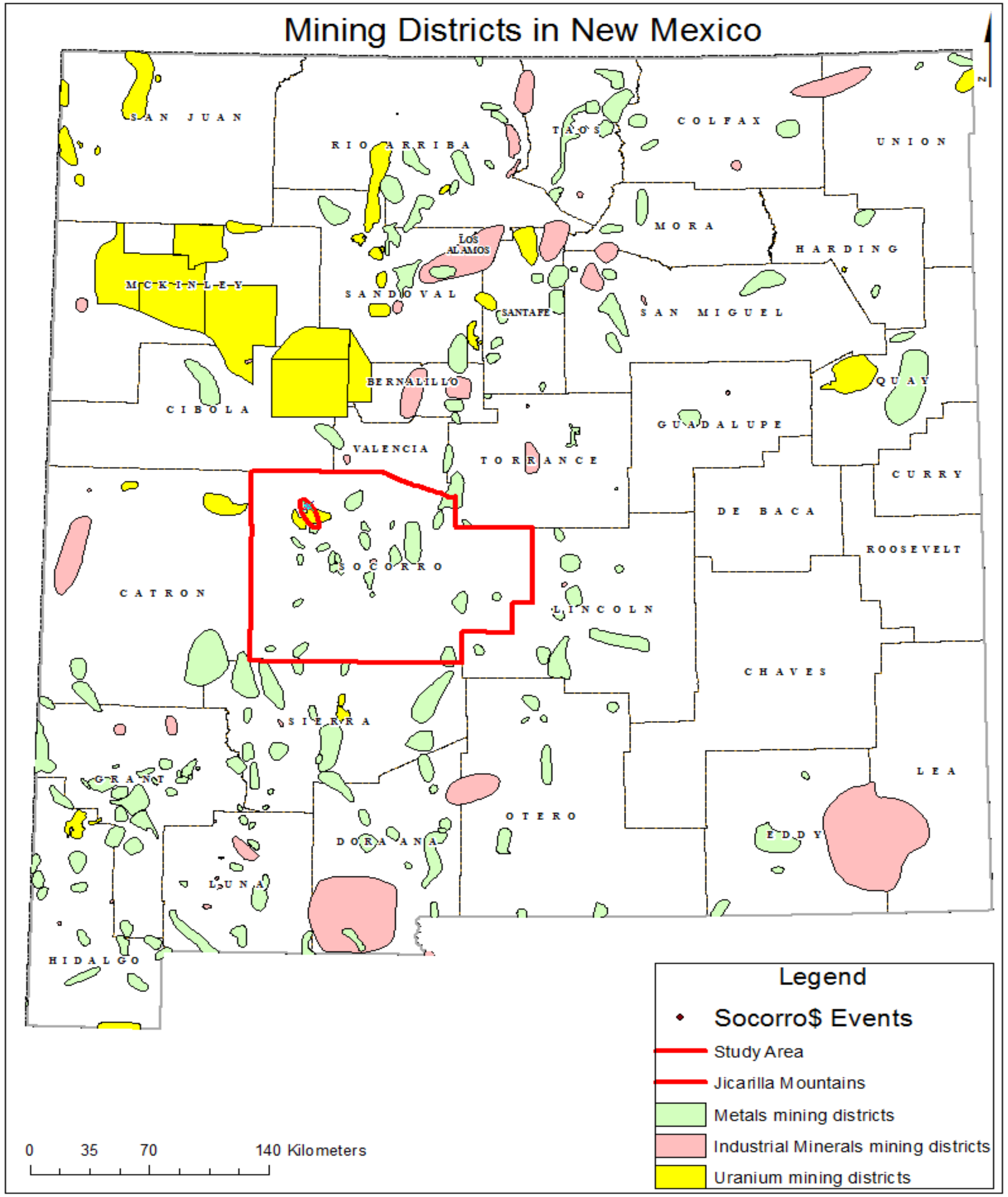


Study Area
Ladron Mountains

Jeter U Mine

About 27 miles north of Socorro.

Lies in section 35, T. 3N, R. 2W



Geology
Jicarilla Mountains

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rocks; compositions range from quartz syenite to syenite to granodiorite to quartz monzonite (V.T. McLemore, unpublished mapping).

Contact metamorphism has locally transformed limestone to calc-silicate rocks, and some of the metamorphosed rock has been replaced by magnetite.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).

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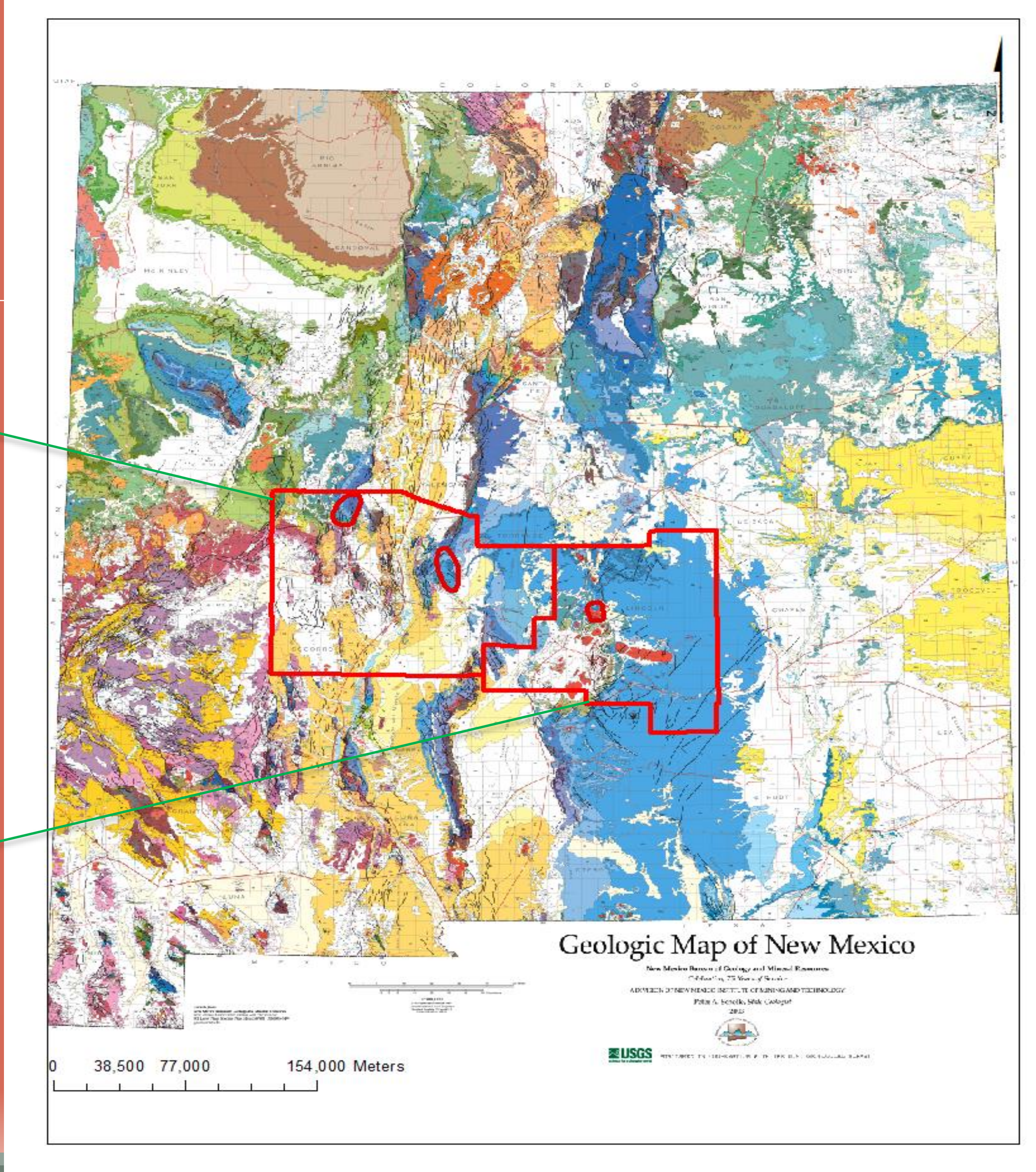
NM Geologic Map



Geology
Lucky Don & Little Davie Mines

Rio Grande Rift Cu-Ag (U) vein type Permian San Andres Formation

The rock formations mostly consist of the Permian Yeso Formation, Glorieta Sandstone, and San Andres Formation

The area is hosted by the Yeso Formation, which consist primarily of beds of sandstone, shale, siltstone, limestone and gypsum

The mineralization appears to be localized by a northeast-trending fault, which parallels the major fault which lies immediately to the west

Lucky Don: 1955-1963: U ,V mined from limestone by surface and underground mining methods

Little Davie: 1955: U ,V mined from limestone by surface and underground mining methods

Estimated value of Uranium produced in Lucky Don and Little Davie Mines $70,000

Geology
Jeter Mines

The mountains consist of a core of granite surrounded by gneiss, and quartzite. This core flanked on the west by west-dipping Carboniferous strata of the Magdalena Group, which include the Sandia sandstone and the overlying Madera limestone

Rio Grande Rift Cu-Ag (U) vein type deposit along fault between Proterozoic capirote granite and the Miocene (?) Sediments

The granite has been intruded by a host of fine-grained gray andesitic dikes. Overlying the granite in the fault zone is a layer of light gray to dark gray carbonaceous tuffaceous mudstone with thin interbedded quartzite. This carbonaceous layer is a very favorable host and contains most of the known ore at Jeter mine.

secondary uranium minerals are abundant along outcrops of the fault zone at the mine. These include paraschoepite, meta-autunite, meta-torbernite, and soddyite. Associated with these minerals are tyuyamunite, malachite, azurite, barite, alunite, pitchblende, Fe-Mn oxides, clay, and manganese oxide

Total Uranium produced from Jeter mine amounts to 58,562 worth $500,000

Methodology

Field Sampling

- Au Mine
  - GPS mapping
  - Waste rock pile sampling
- Legacy U Mine
  - GPS/Scintilometer mapping
  - Waste rock pile sampling

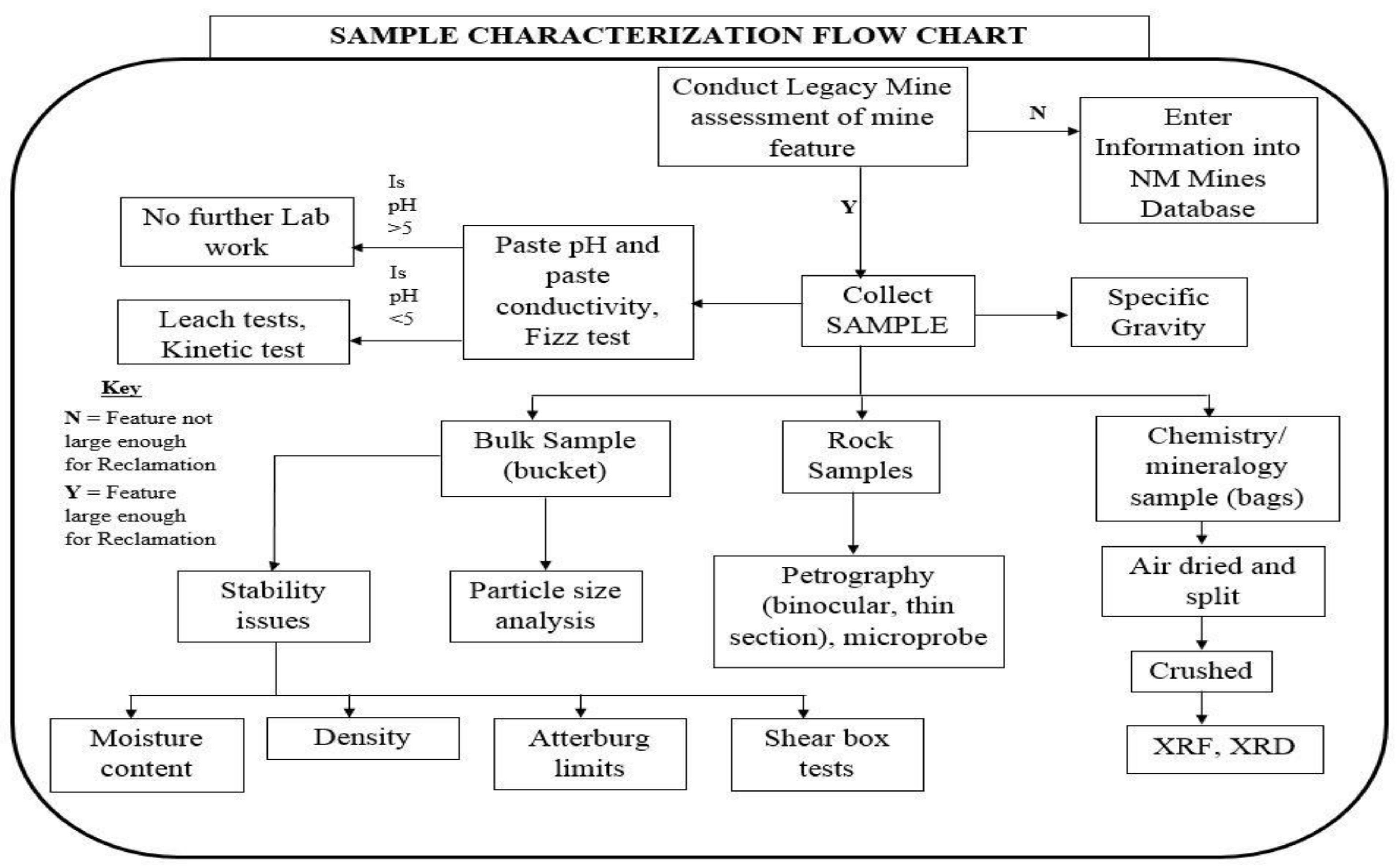
Laboratory Analyses

Paste pH and paste conductivity

Chemistry – Petrograhy, Whole rock chemistry, XRD and Electron microprobe

Stability – Particle size

Approach



SAMPLE CHARACTERIZATION FLOW CHART
Conduct Legacy Mine assessment of mine feature
N
Enter Information into NM Mines Database
Y
Collect SAMPLE
Specific Gravity
Paste pH and paste conductivity, Fizz test
Is pH >5
No further Lab work
Is pH <5
Leach tests, Kinetic test
Key
N = Feature not large enough for Reclamation
Y = Feature large enough for Reclamation
Bulk Sample (bucket)
Rock Samples
Chemistry/ mineralogy sample (bags)
Stability issues
Particle size analysis
Petrography (binocular, thin section), microprobe
Air dried and split
Crushed
XRF, XRD
Moisture content
Density
Atterburg limits
Shear box tests

Loading bin, Lucky Don

Waste pile, Lucky Don

Mine face, Lucky Don

Sampling

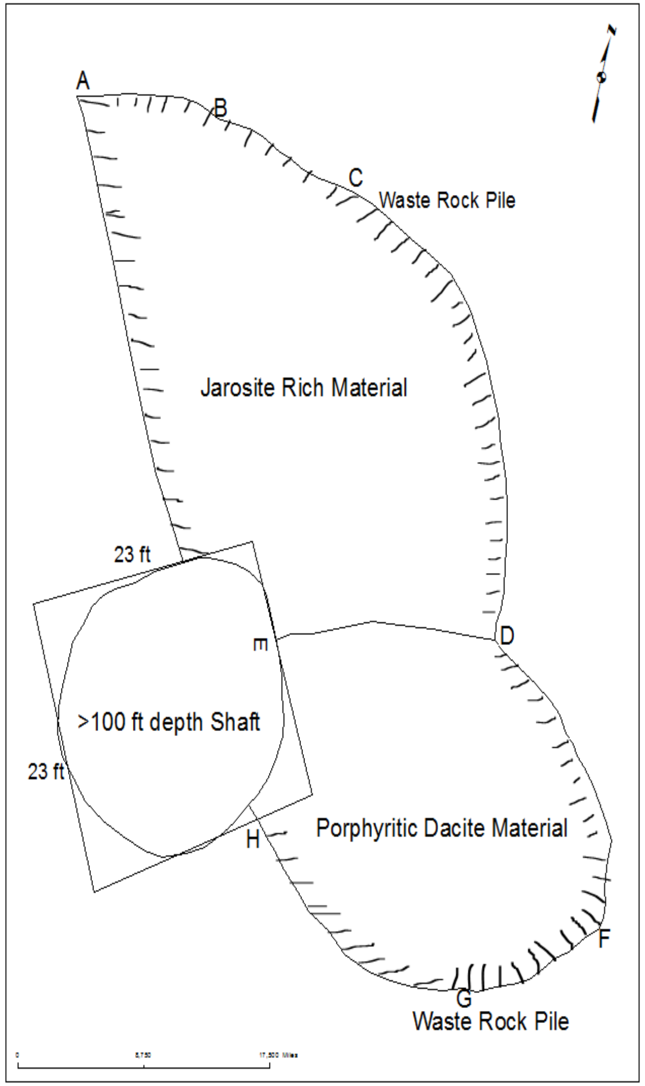
Sampling Rationale

Characterize waste rock piles

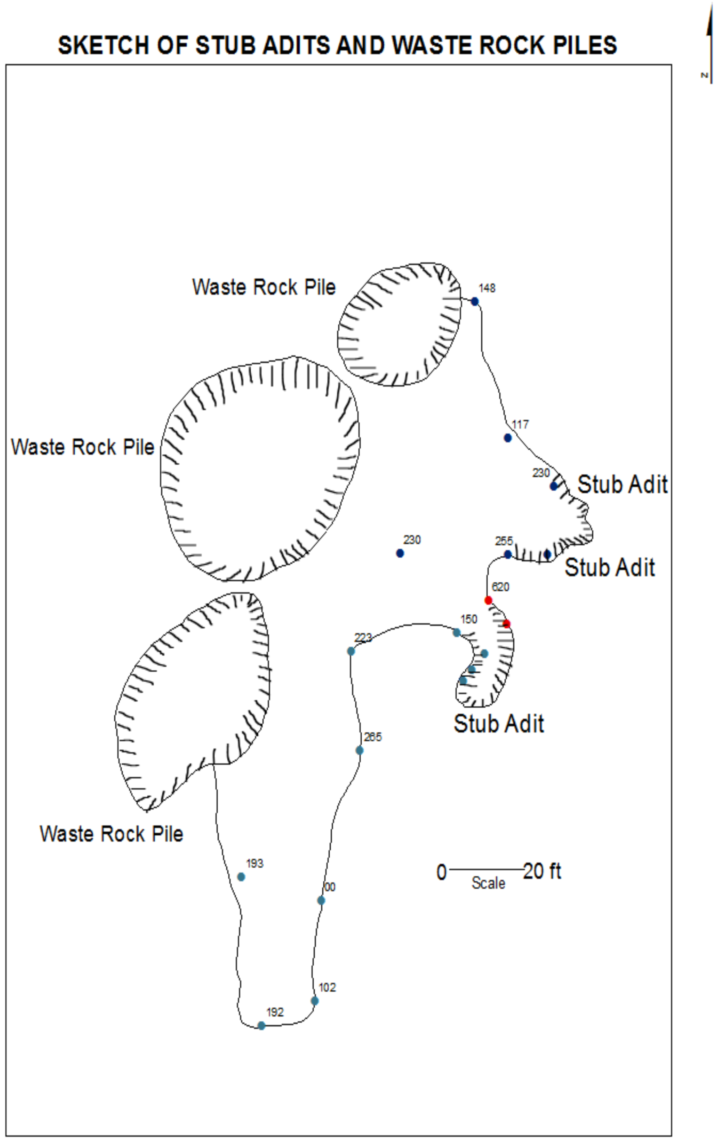
Determine the presence of trace elements from the waste rock piles

Determine the suitability of waste rock material to be used as backfill

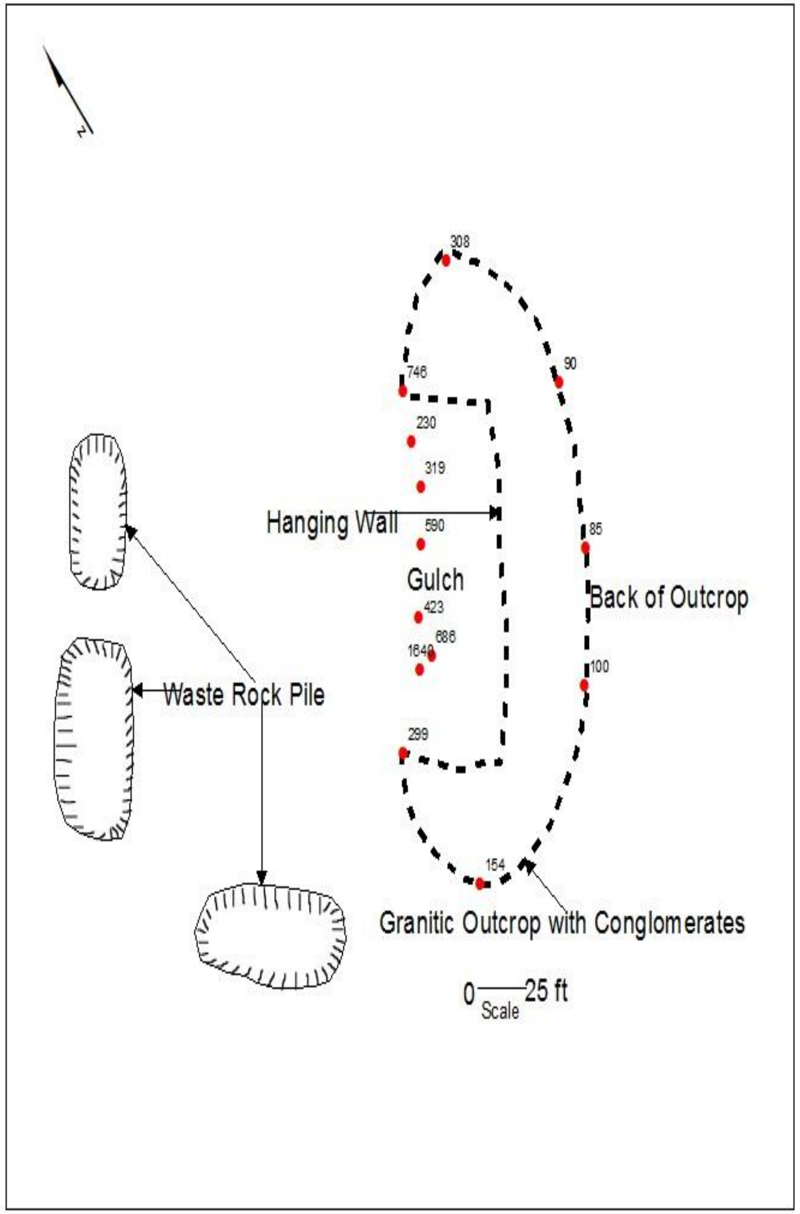
Field sketch of Jic413 Shaft & Mine Dumps



SKETCH OF STUB ADITS AND WASTE ROCK PILES



SKETCH OF JETER MINE



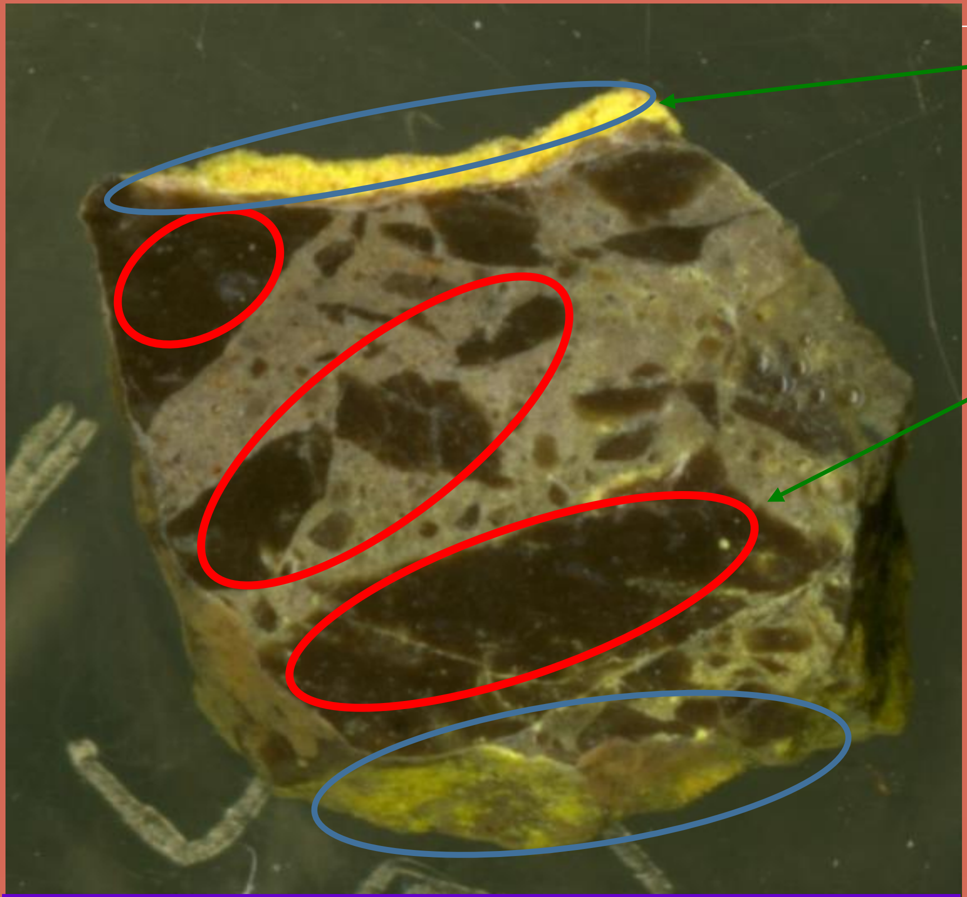
Field Observations - U

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

Field Observations - U

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

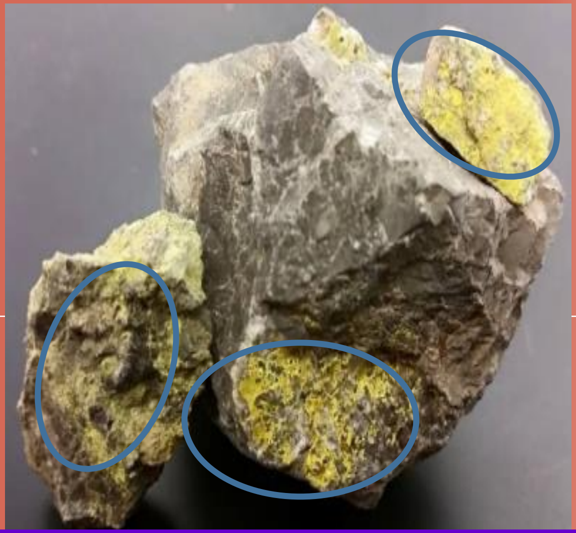
Field Observations – U Mineralized Sample



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

Carnotite

U,V
(uraninite ?)



Samples of waste pile rocks with disseminated carnotite from Lucky Don

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

Field Observations – U Mines

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

Laboratory Analyses

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.

Weighing samples for paste pH

Whole Rock Chemistry

Sample were sent to ALS laboratory in Reno, Nevada fire assay and ICP-AES, fused bead, acid digestion and ICP-MS analytical methods was used to determine the whole rock chemistry of the samples

Laboratory Analyses (continued)

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.

Elements Analyzed: Au, Cu, As, Fe, S

Cameca SX681

Paste pH, Fire assay and ICP-AES – Au Mines

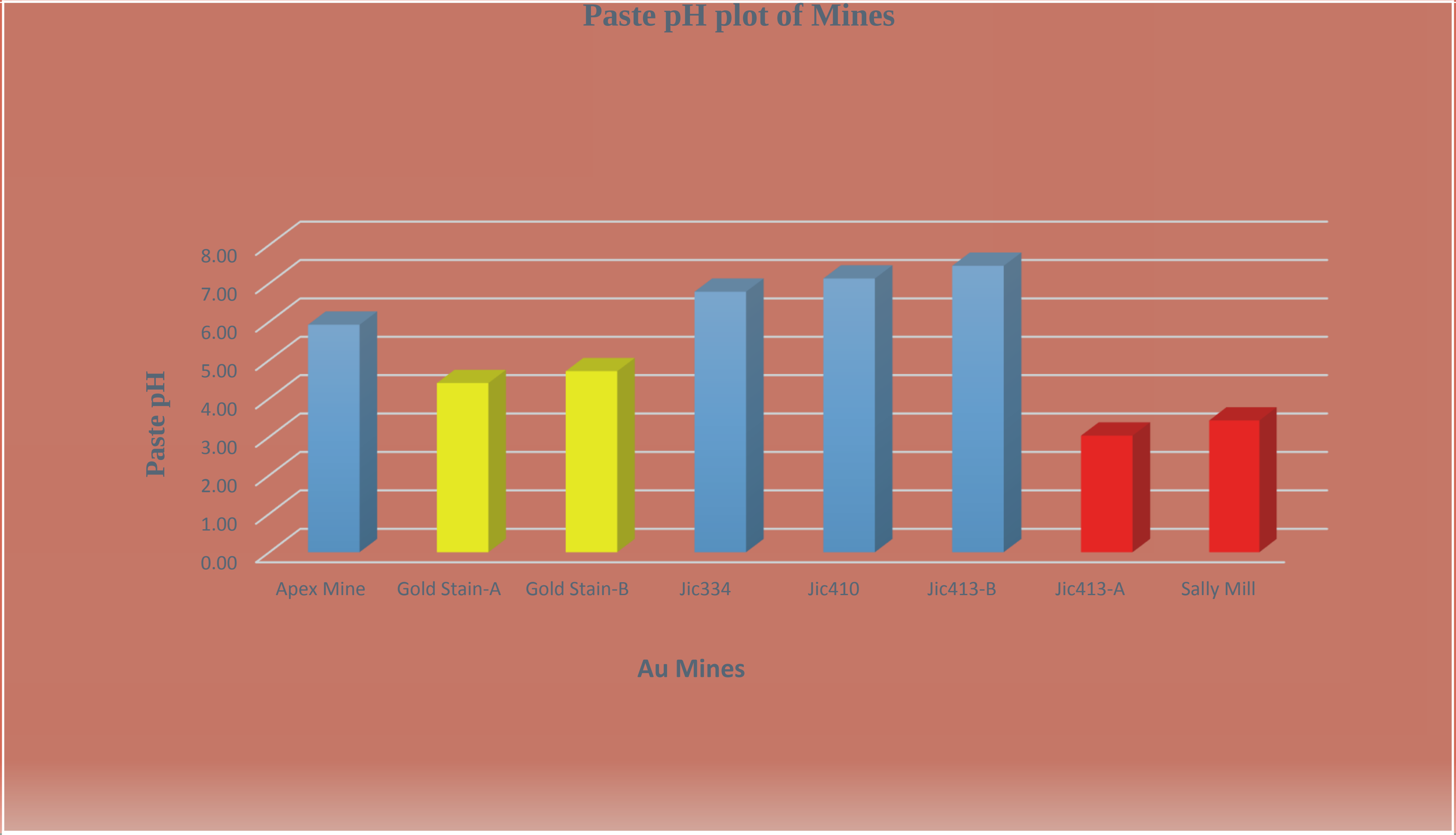
Au >1ppm

Represent pH 4-3

Represent pH 5-4

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

Paste pH graph – Au mines



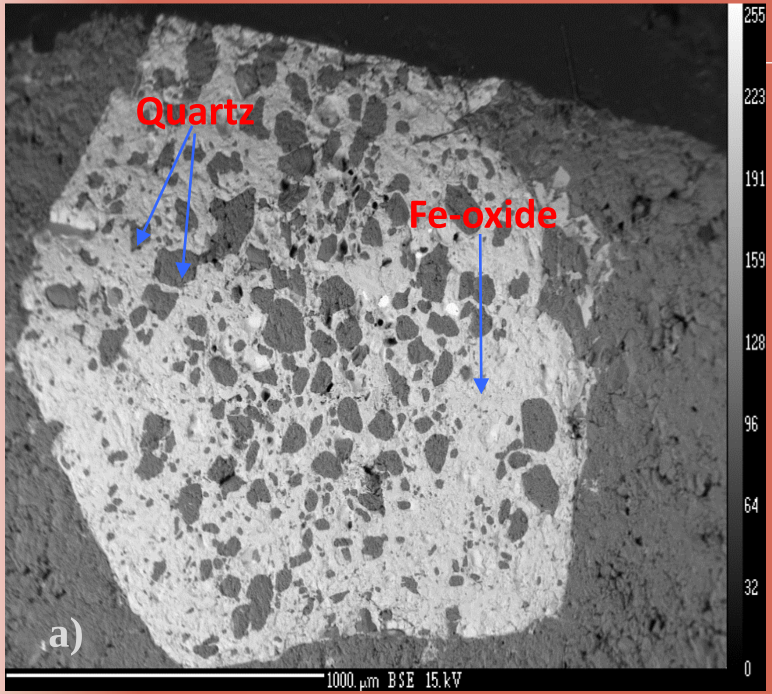
Paste pH, Fused bead, acid digestion and ICP-MS Analyses – U mines

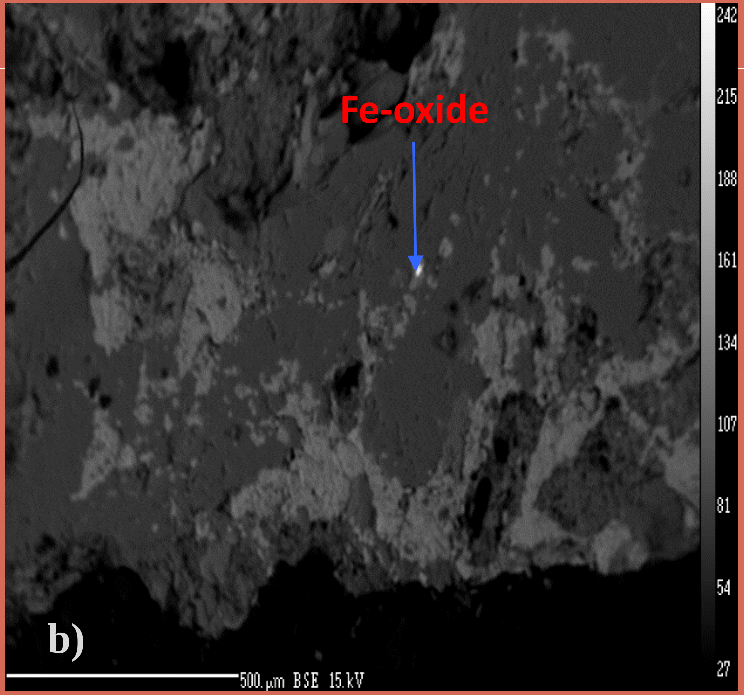
Waste Rock Pile	Average paste pH	Uranium (ppm)	Vanadium (ppm)	Thorium (ppm)
Jeter 1	8.16	23.7	93	14.1
Jeter 29	8.15	75.1	101	12.4
Jeter 31	8.16	138	74	13.8
Little Davie	8.24	160.5	457	1.32
Lucky Don	7.70	126.5	563	1.96

Represent U,V >100

Represent U, V >400

Microprobe Analysis (BSE) images of Au Samples





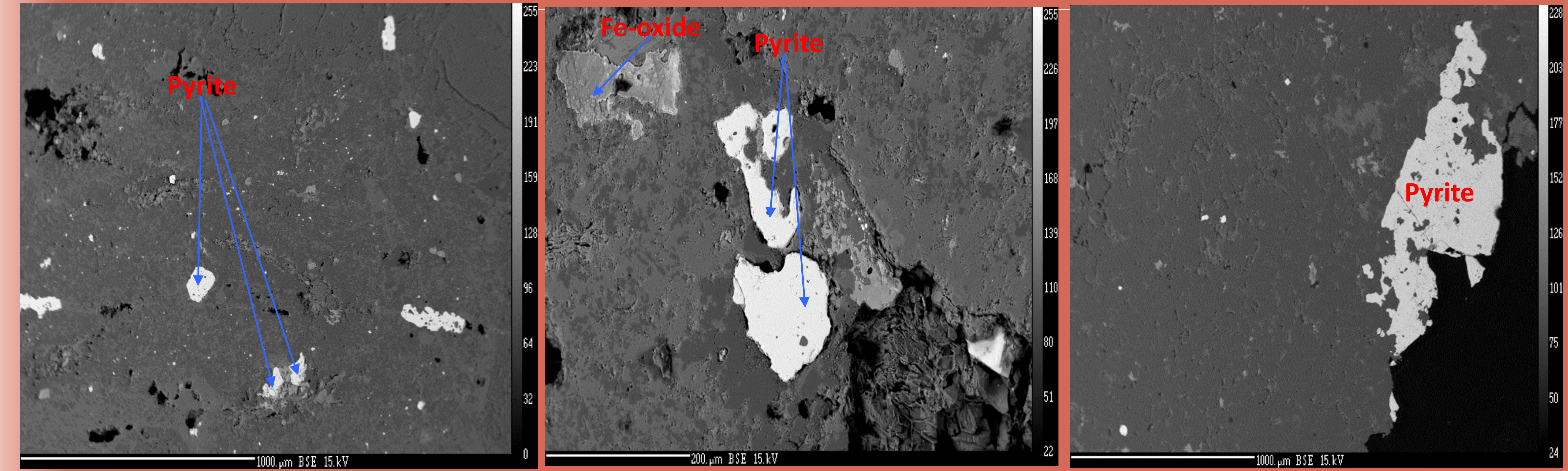
Figures a) Backscattered electron images of quartz grain replacing Fe-oxide in sample Jic410. This is likely supergene replacement.

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.

Pyrite is pristine hence no release of acid mine drainage into the environment

Microprobe Analysis (BSE) images of Au Samples



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.

Pyrite is pristine hence no release of acid mine drainage into the environment

Microprobe Analysis Quantitative Analyses - Au

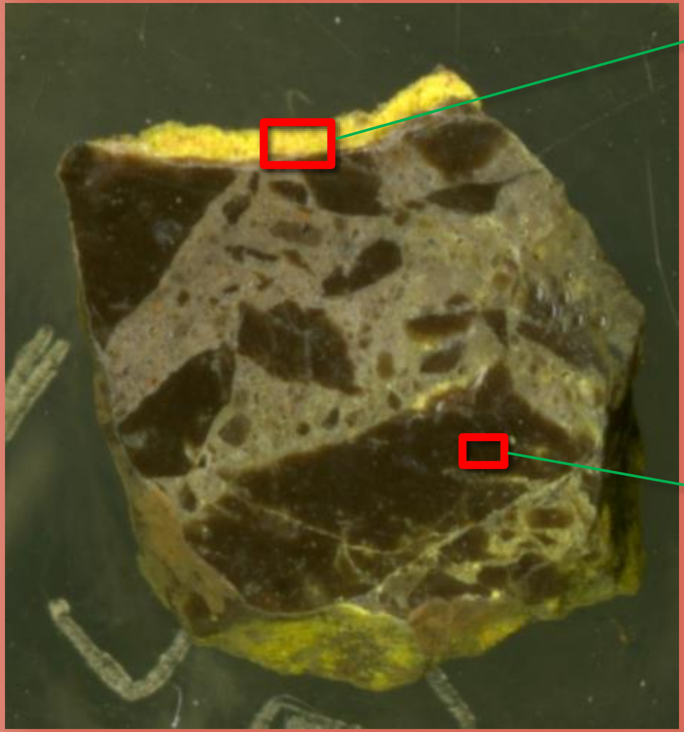
Quantitative scan for pyrite

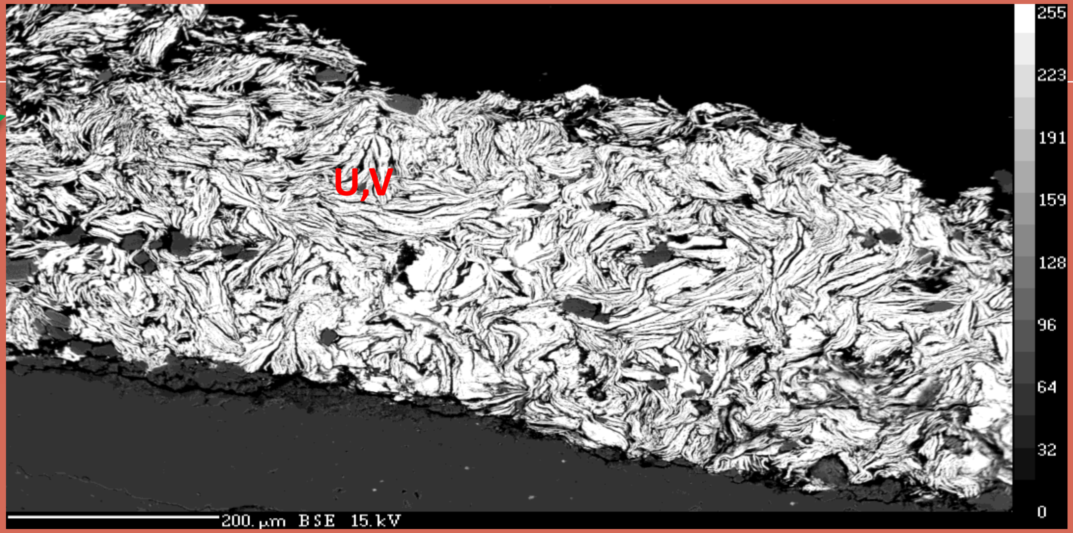
High S and F percentages

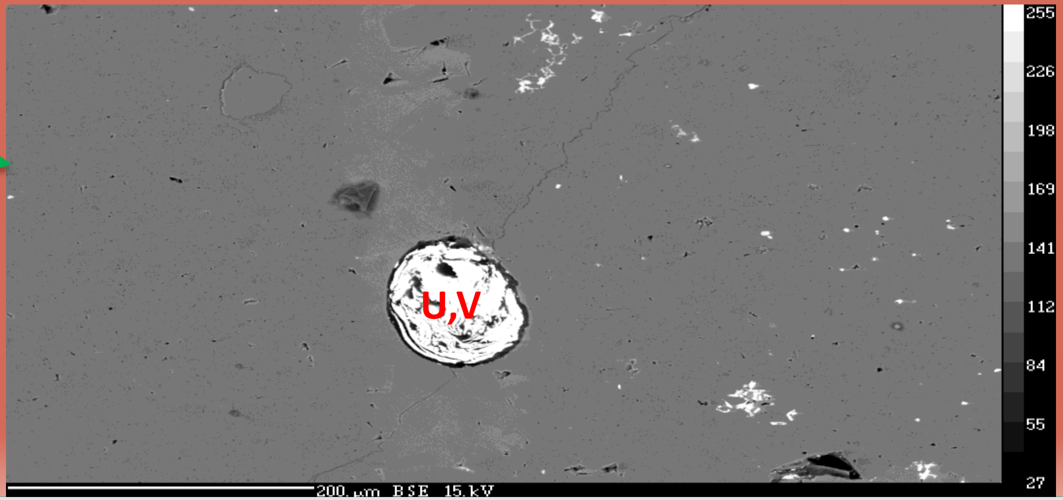
As percentage between 0.02-5%

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

Microprobe Analysis (BSE) images of U Samples

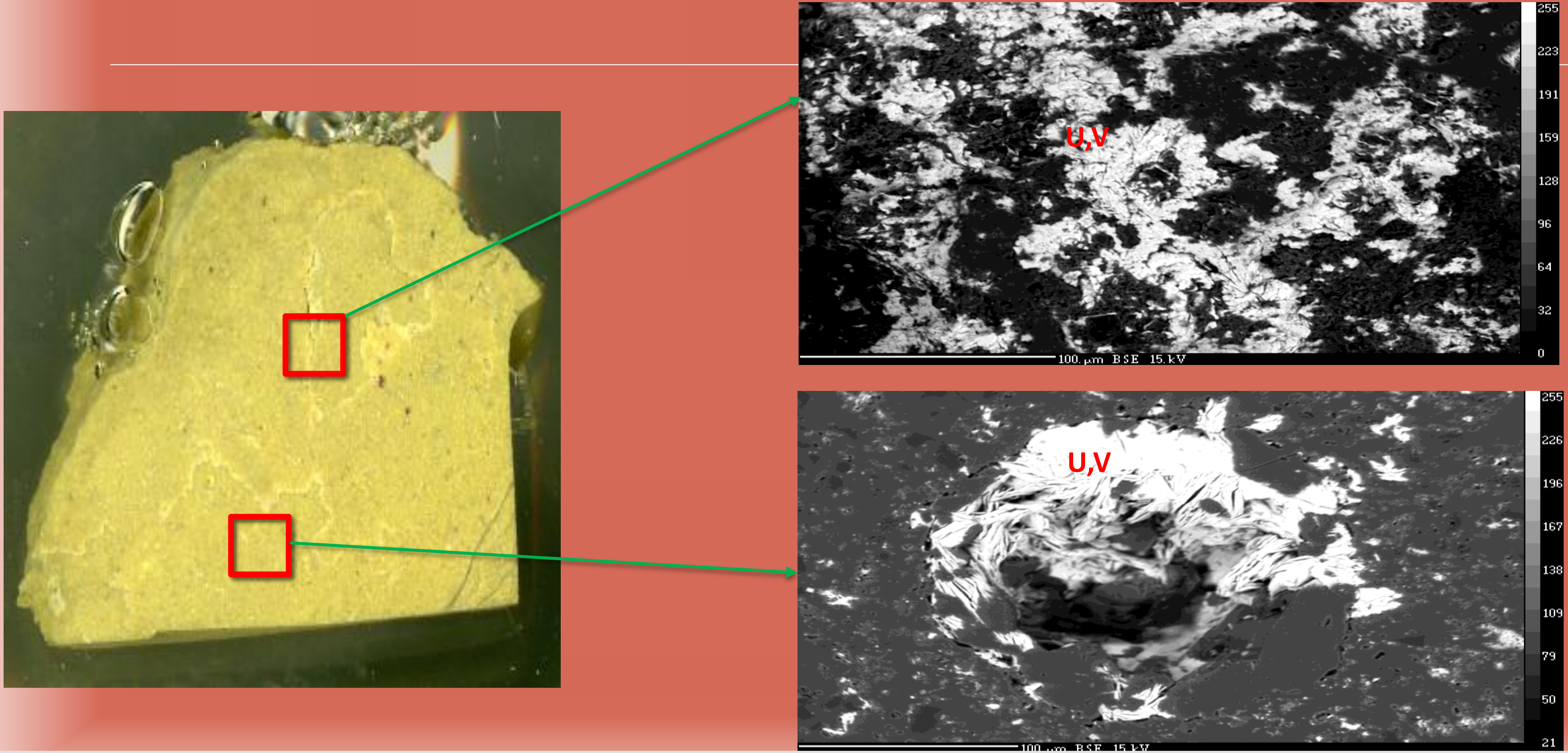






Uranium and Vanadium minerals observed

Microprobe Analysis (BSE) images of U Samples



Uranium and Vanadium minerals observed

Preliminary Conclusion – U Mines

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 with high radioactivity from scintillometer should be covered

Preliminary Conclusion – Au Mines

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 ICP in some waste rock piles suggest possible Au mineralization potential.

Future Work

Leaching tests are recommended to confirm if acid and/or metals could be leached into the environment from waste rock piles.

Further field studies needed to determine the mineral potential of rock piles with elevated Au and U values

Appreciation

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Thank you

Questions