CORE-CM project—San Juan River-Raton Basins, New Mexico

New Mexico Bureau of Geology and Mineral Resources
New Mexico Tech
Earth Science for the 21st Century
San Juan College
Sandia National Laboratories
Los Alamos National Laboratory EST. 1943
New Mexico Tech
SonoAsh

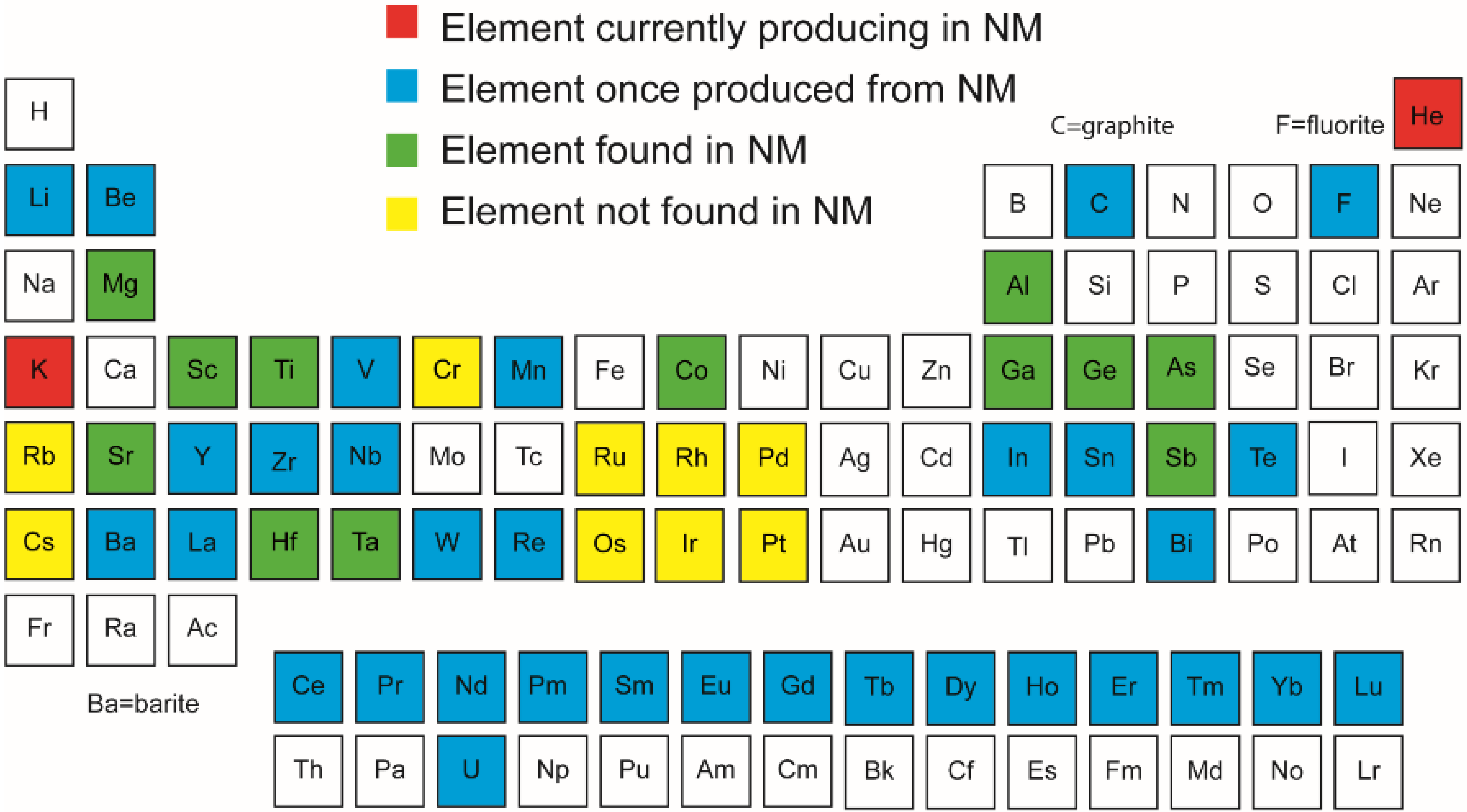
Definitions

Critical minerals

CORE-CM=Carbon Ore, Rare Earth and Critical Minerals

- Identified to be a nonfuel mineral or mineral material essential to the economic and national security of the United States
- From a supply chain that is vulnerable to disruption
  - Disruptions in supply chains may arise for any number of reasons, including natural disasters, labor strife, trade disputes, resource nationalism, conflict, and so on
- That serves an essential function in the manufacturing of a product, the absence of which would have substantial negative consequences for the U.S. economy or national security

Critical Minerals in New Mexico



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

Coal in general has potential for REE, Co, Ga, Ge, Ni, Zn, and other CM

Graphite is found adjacent to some Raton coals that have been intruded by Tertiary igneous dikes

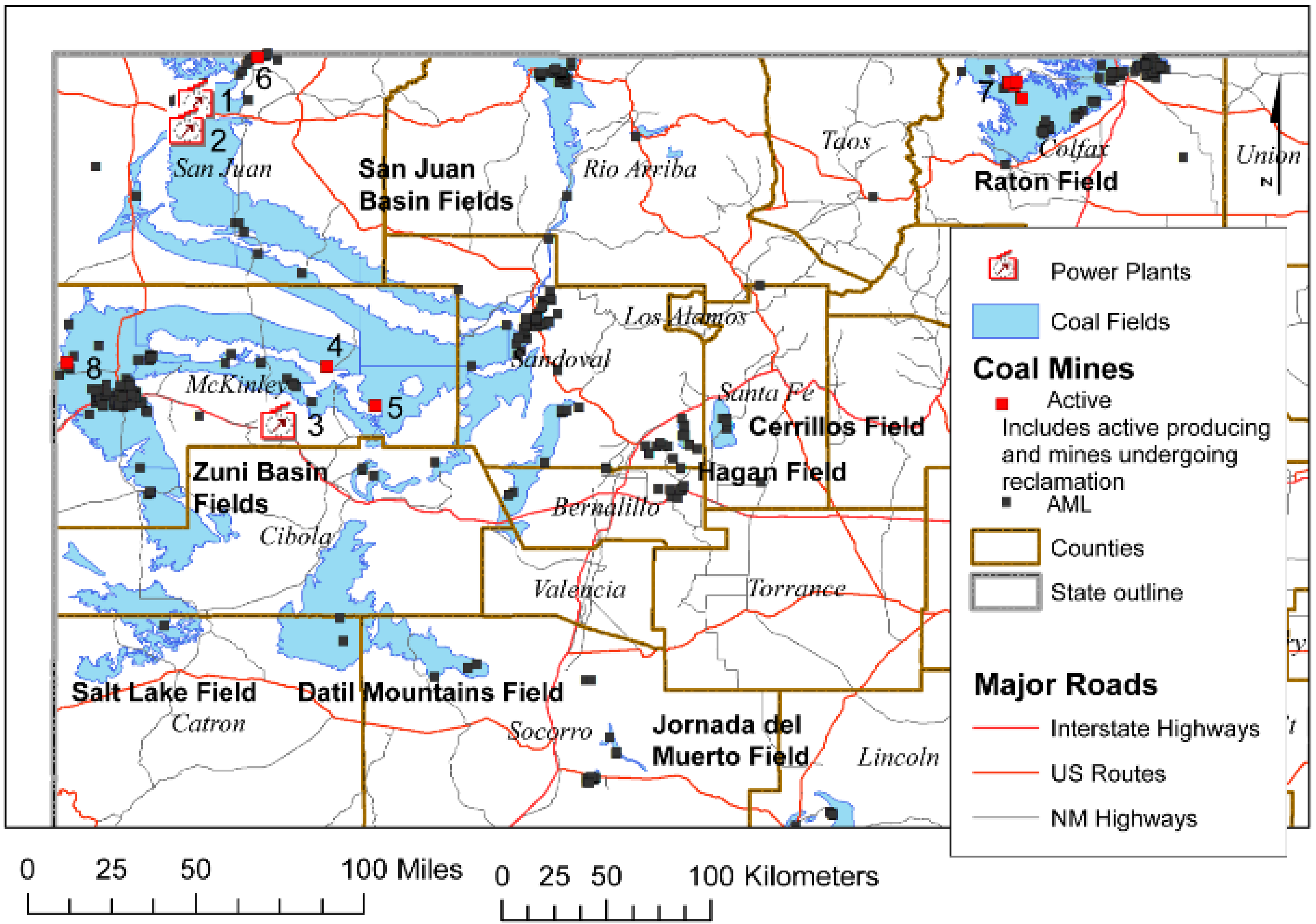
Definition of AML (Abandoned Mine Lands)

- Lands that were excavated and left unreclaimed where no individual or company has reclamation responsibility and there is no closure plan in effect
- Excavations, usually older than 10 yrs that have been deserted and where further mining is not intended in the near future
- Includes 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
- Also called inactive, legacy, and orphaned mines

Coal is important to New Mexico (DOE, 2020)

- Fuels electrical generating plants (3 in NM and fuels Arizona plants)
- 2 surface mines and 1 underground mine in San Juan Basin
  - El Segundo
  - Navajo
  - San Juan
- Resources at Raton, Sierra Blanca fields
- 12th coal in production in U.S. in 2020
  - 10,249,000 short tons
- 15th in estimated recoverable coal reserves in U.S.
  - 65 million short tons of recoverable reserves

CORE-CM Project area—San Juan and Raton coal fields



1 San Juan-Public Service Co. of NM plant and San Juan underground mine (Westmoreland)
2 Four Corners-Arizona Public Service Co. plant and Navajo mine (Bisti Fuels Co., LLC)
3 Escalante-TriState plant
4 El Segundo mine (Lee Ranch Coal)
5 Lee Ranch mine (Lee Ranch Coal)
6 La Plata (reclamation)
7 York Canyon and Ancho mines (reclamation)
8 McKinley mine (reclamation)

Blasting at the San Juan mine, New Mexico

Stratigraphy of the San Juan Basin, NM

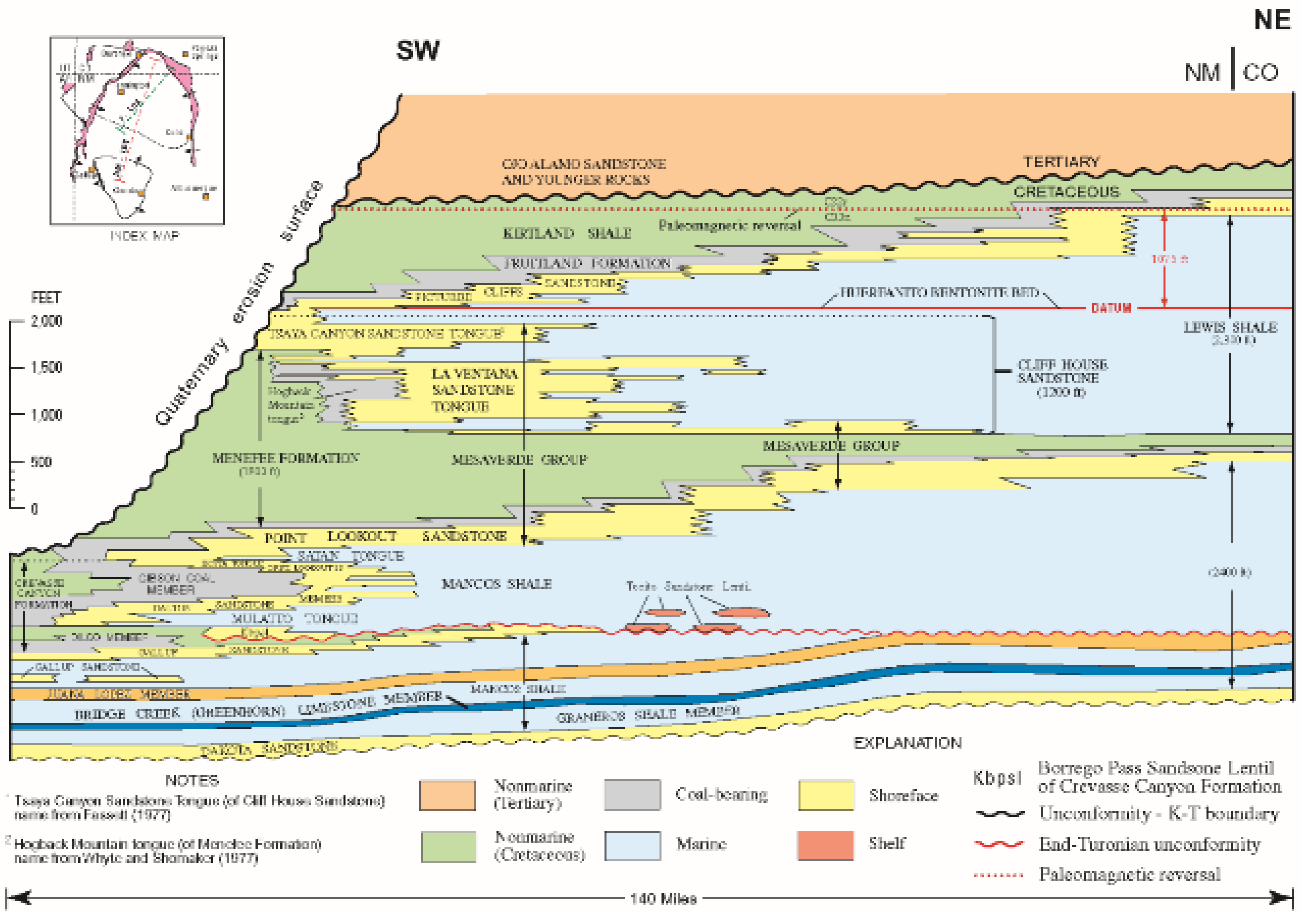
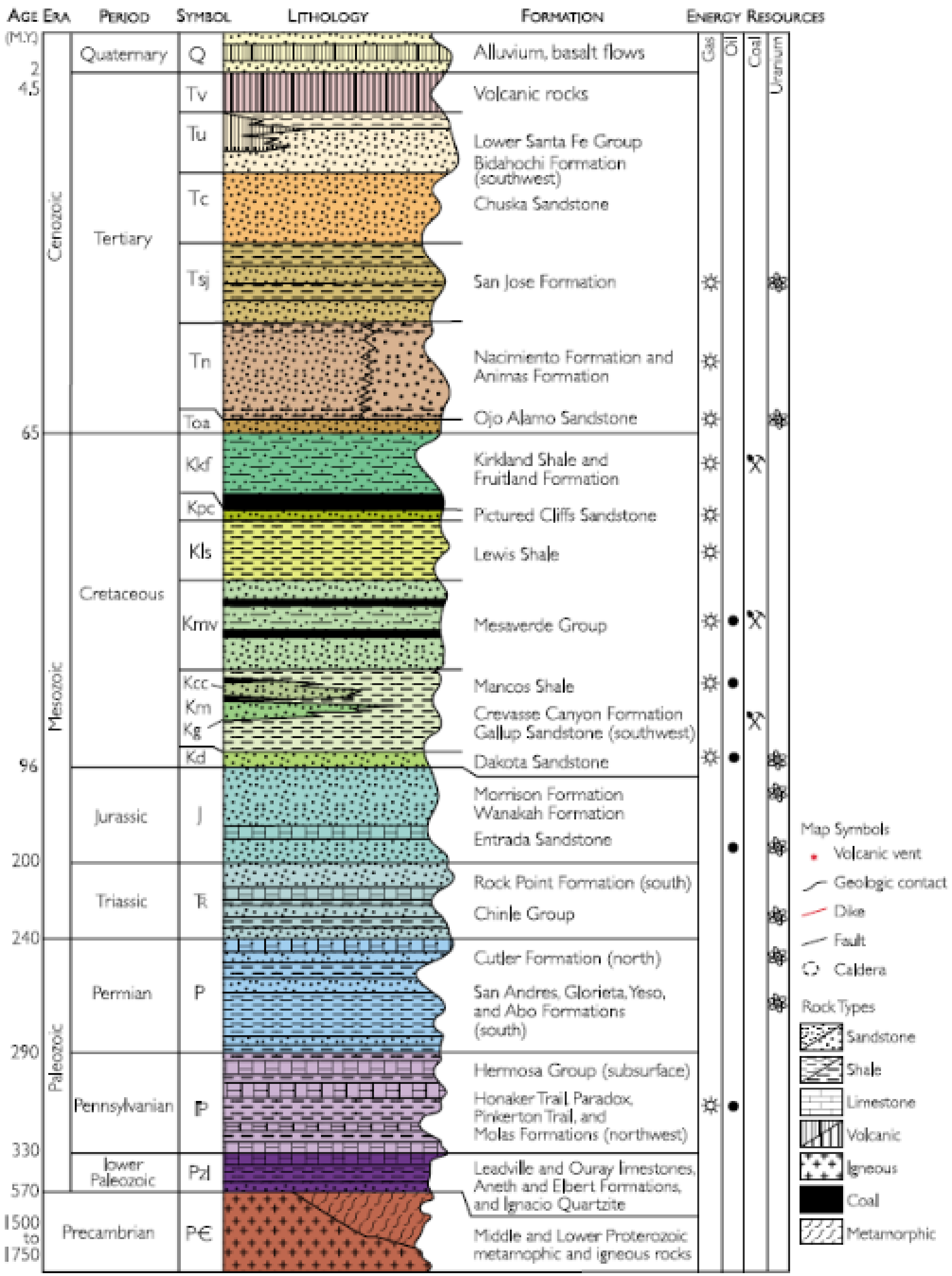


Figure 4. Stratigraphic section showing Upper Cretaceous rocks in the San Juan Basin, New Mexico and Colorado. Tocito Sandstone Lentil and coal-bearing zones are shown diagrammatically. Stratigraphy of rock units from the Point Lookout Sandstone upward is modified from Fassett (1977), stratigraphy for lower part of section is modified from Nummedal and Molenaar (1995). F - LOS on index map is Fassett (1977) line of cross section; NM - LOS is Nummedal and Molenaar (1995) line of cross section. Position of paleomagnetic reversal from chron C33n to C32r is from Fassett and Steiner (1997). Vertical exaggeration x 55.



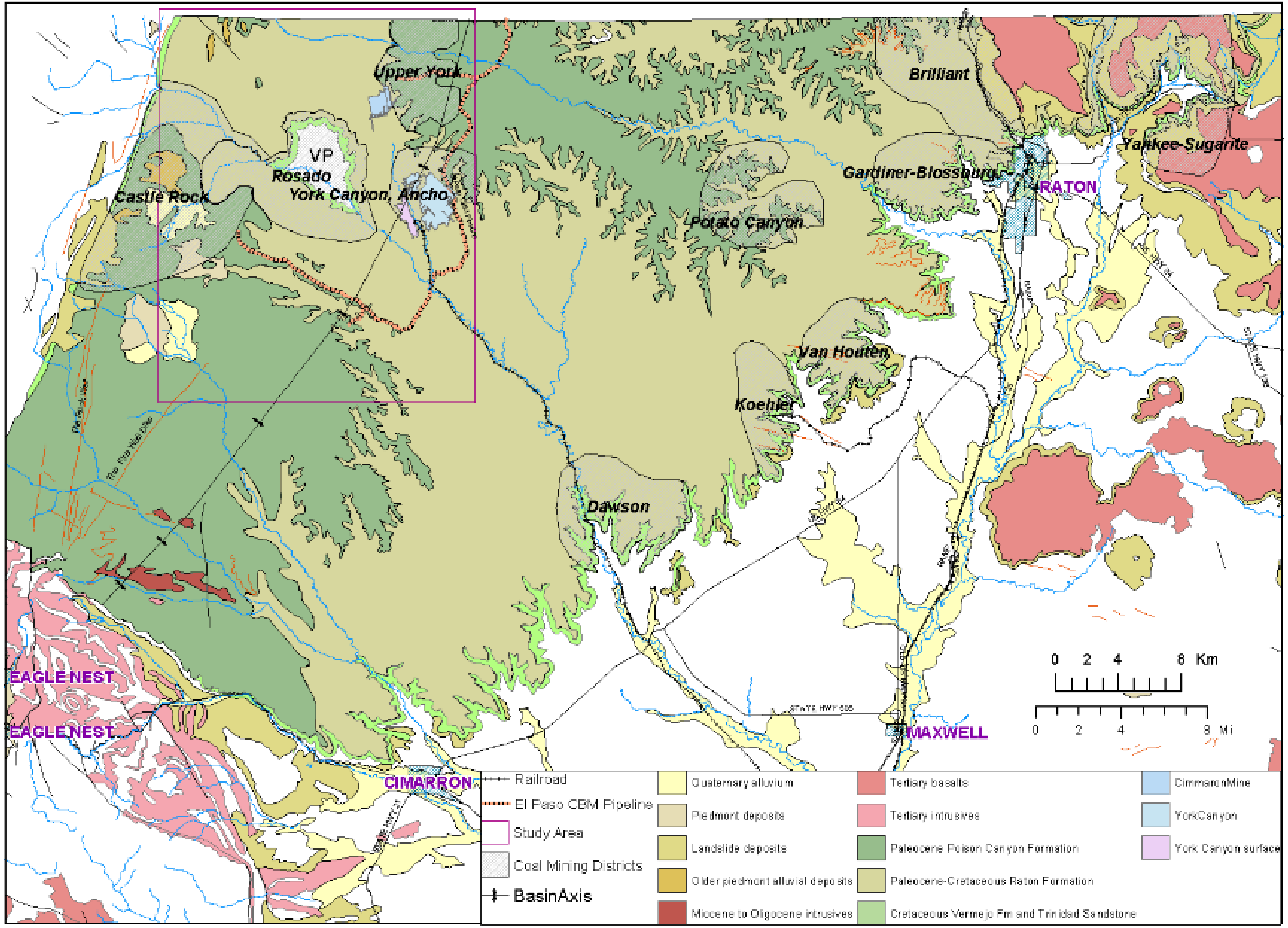


Figure 1.Generalized geologic map of Raton coalfield, New Mexico with mining districts (Pillmore, 1991) and outline of study area. Geology from New Mexico Bureau of Geology, 2003.

Objectives

- Basinal Assessment of CORE-CM Resources
  - identify and quantify the distribution of REE and CM in coal beds and related stratigraphic units in the San Juan and Raton basins
  - identify and characterize the sources of REE and CM
- Basinal Strategies for Reuse of Waste Streams
- Basinal Strategies for Infrastructure, Industries and Businesses
  - evaluate the basinal industry infrastructure and determine the economic viability of industrial upgrading
- Technology Assessment, Development, and Field Testing
- Technology Innovation Center
- Stakeholder Outreach and Education

Tasks

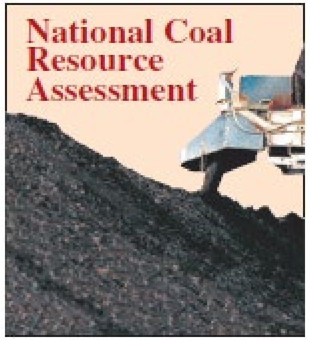
- A basinal assessment for CM and REE potential, using state-of-the-art technologies to estimate basin-wide CM and REE resources in coal and related stratigraphic units
- Identify, sample, and characterize coal waste stream products
- Conduct bench tests to develop a basinal reuse of waste strategy
- Illustrate the current status of the feedstock supply of REE and CM to understand the basinal REE industry's capital expenditures and obstacles to expanding REE-related business development
- Develop a life-cycle analysis to establish pathways, process engineering, and design requirements to upgrade REE processing industry
- Evaluate technology gaps
- Establish a Center Of Excellence And Training Center (COE) for coal ash beneficiation at San Juan County
- Create REE research-based activities that can be shared during the NMBGMR summer geology teacher workshop and assemble REE research-related articles for an REE-centered issue of Lite Geology

1. A basinal assessment for CM and REE potential, using state-of-the-art technologies (such as machine learning, other mineral resource assessment methods, etc.) to estimate basin-wide CM and REE resources in coal and related stratigraphic units

Develop safety plan, sampling plan, database, and SOPs

- Provide consistent safety protocols and what to do if there is an incident
- Identify areas to be sampled, how sampling is conducted, what data are obtained on collected samples, sample archive for future studies
- Collect, store, and output data for effective interpretation
- Be compatible with NMBGMR databases, USGS and DOE databases, and GIS
- Provide a consistence set of reliable data
- SOP—standard operating procedures (how to perform project activities)

Compile existing data



USGS PP1625B

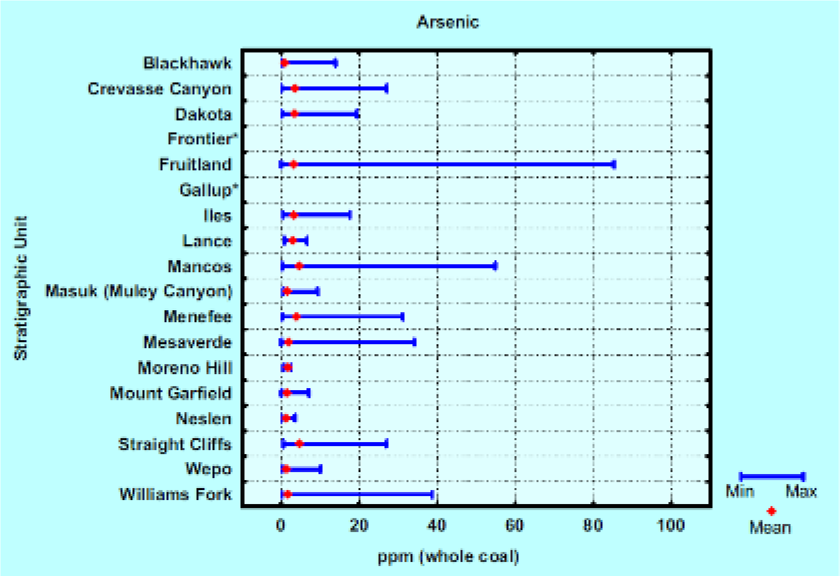


Figure A7-15. Minimum, maximum, and mean content of arsenic for coal from all stratigraphic units in the Colorado Plateau coal assessment area (* indicates insufficient data).

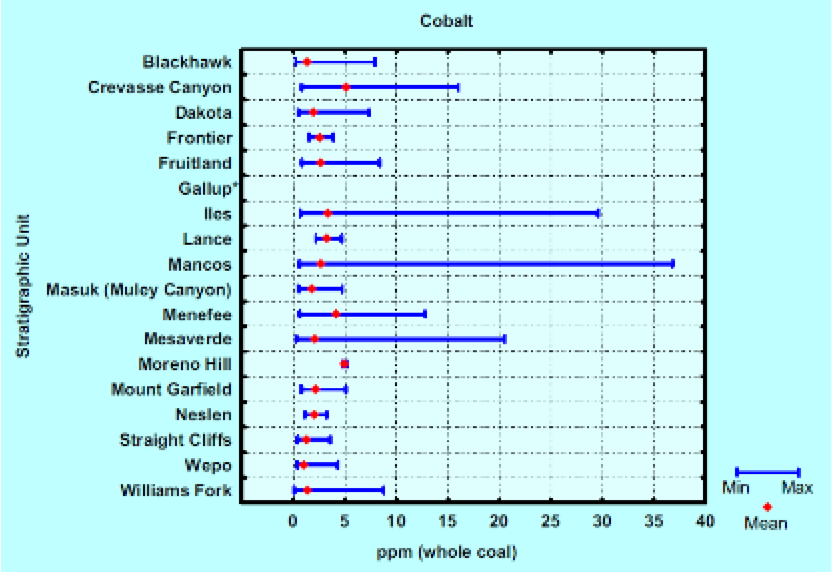


Figure A7-19. Minimum, maximum, and mean content of cobalt for coal from all stratigraphic units in the Colorado Plateau coal assessment area.

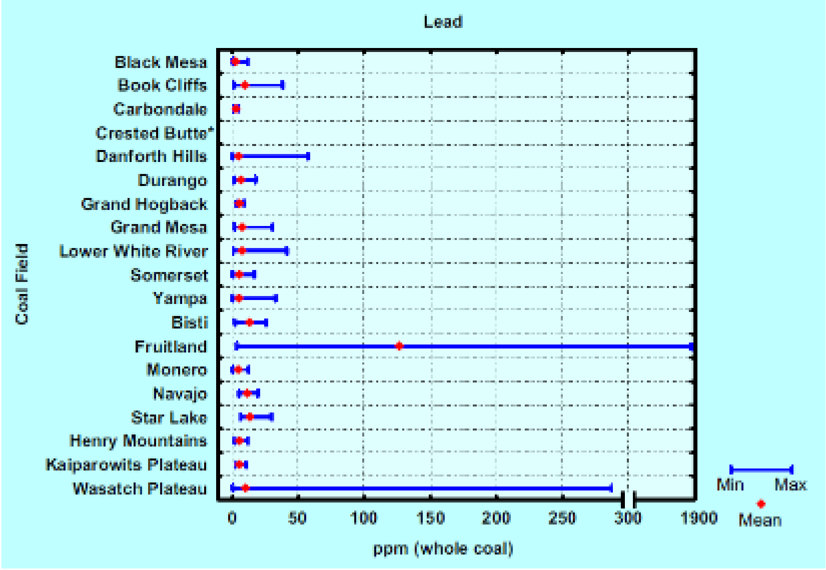


Figure A7-8. Minimum, maximum, and mean content of lead for coal from high-priority coal fields in the Colorado Plateau coal assessment area (* indicates insufficient data).

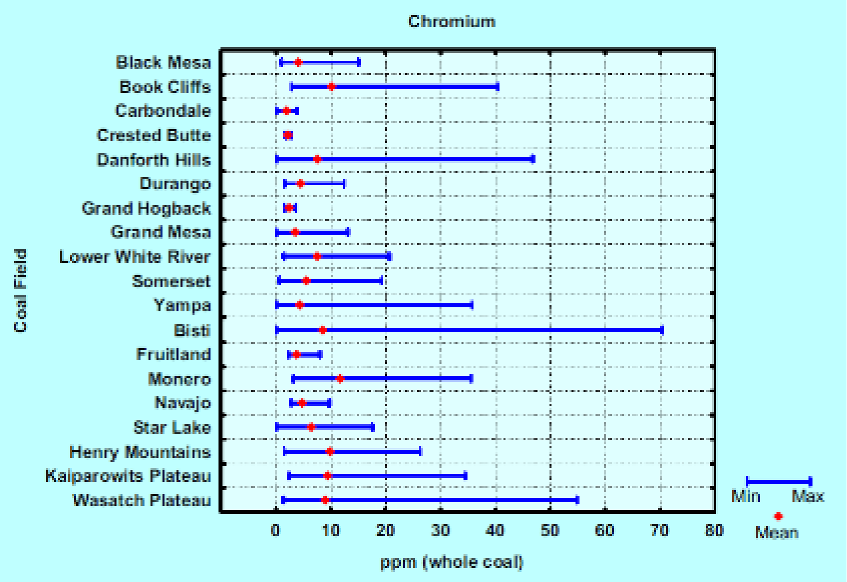


Figure A7-5. Minimum, maximum, and mean content of chromium for coal from high-priority coal fields in the Colorado Plateau coal assessment area.

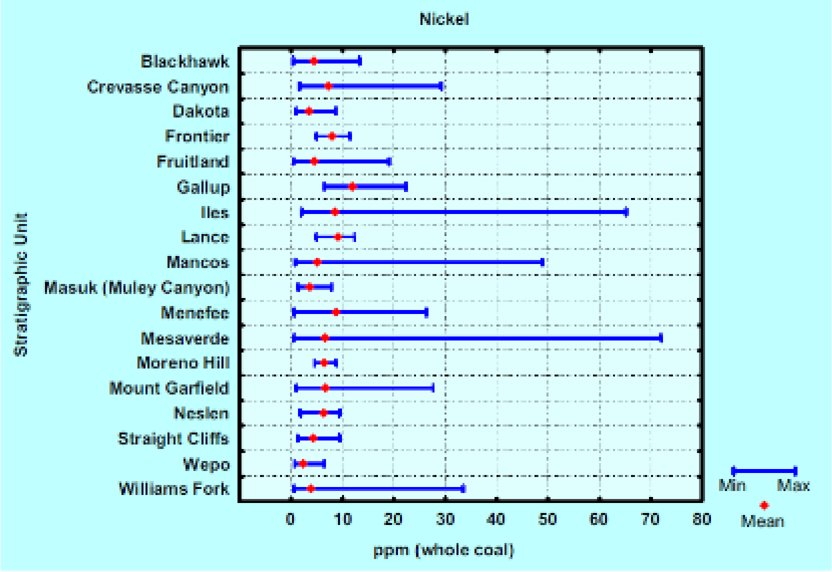


Figure A7-24. Minimum, maximum, and mean content of nickel for coal from all stratigraphic units in the Colorado Plateau coal assessment area.

Compare NM coals to other REE deposits

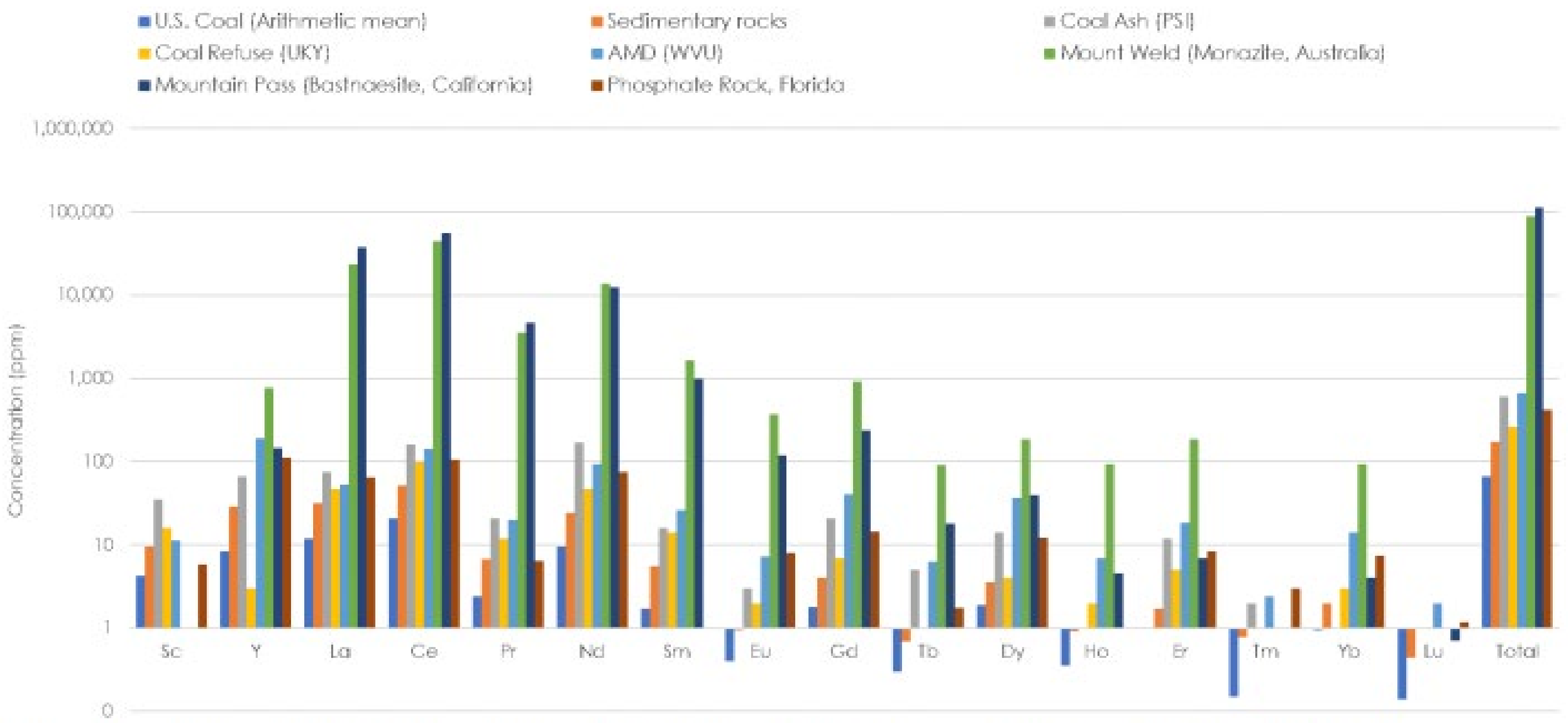


Figure 2 - Concentration of Rare Earth Elements in Conventional Ores and Unconventional Resources as Coal, Coal Refuse, Fly Ash, and Acid Mine Drainage; Sedimentary Rock and Phosphate Rock [3-10]

https://www.netl.doe.gov/coal/rare-earth-elements/program-overview/background#ref02

Collect samples

- Outcrops of coal seams
- Stratigraphic units above and below coals (tonsteins, clays, black shales, beach-placer sandstone deposits)

- Drill core of coal deposits (log, photograph, sample core for mineralogical and chemical characterization)

- Coal wastes from active, reclamation, and AML sites
  - Fly ash, bottom ash
  - Waste rock piles (dumps)
  - AMD (acid mine drainage)
  - Processing waters

Selection of field sample sites

We will have 2 phases of sampling

1st sampling phase

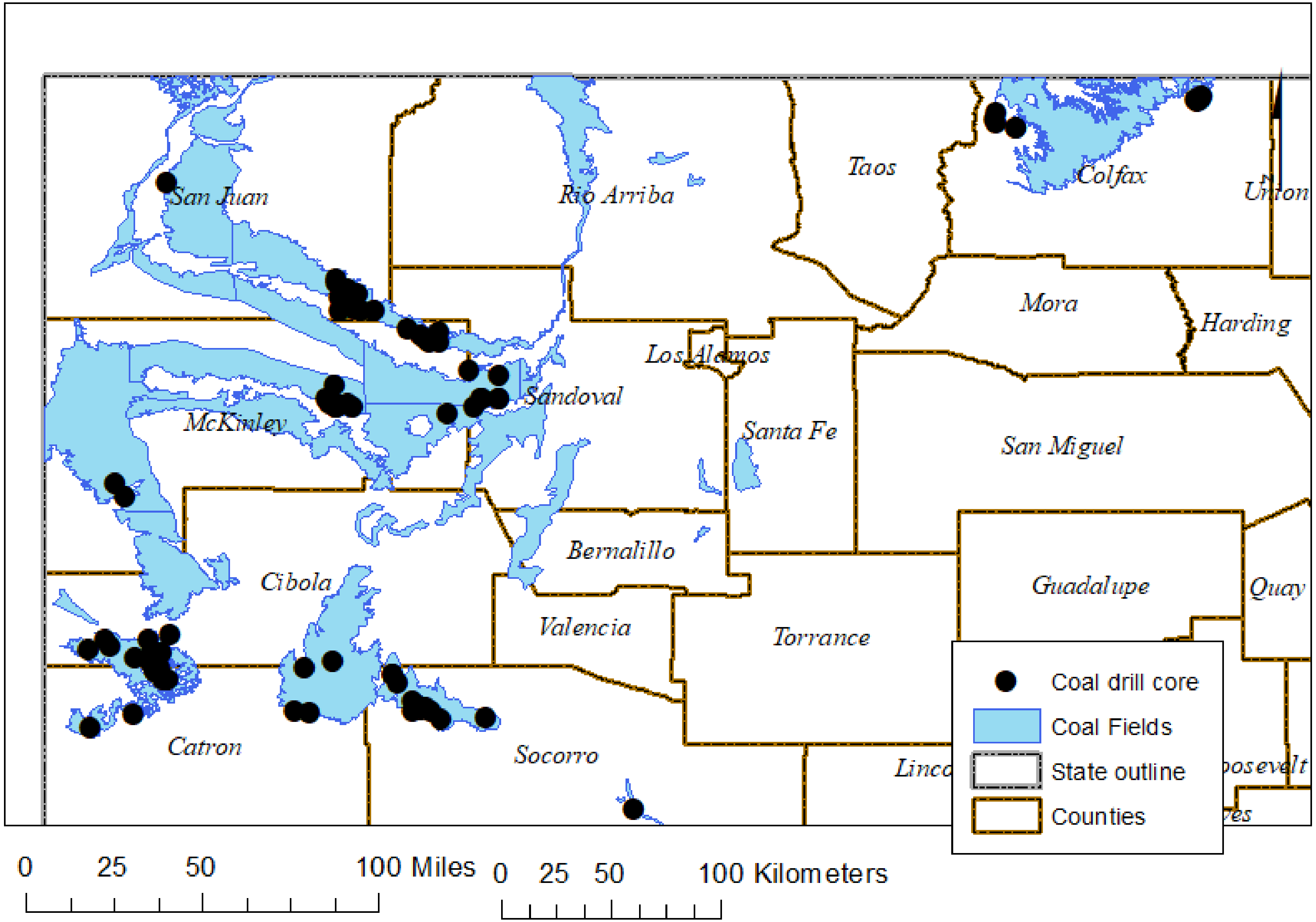
- Obtain representative samples from all coal fields (including drill core, outcrops)
    - Identify coal seams, clay, black shale, graphite (Raton Basin)
- Available field access (accessible roads, Federal land, sites we have permission from private owners, tribes, and State Land Office)
- Field descriptions
- Radioactivity (measure of elevated REE)
- Use of LANL LIBS/RAMAN instrument

2nd sampling phase

Sample sites will be selected using machine learning techniques (LANL) to select sites to “fill in the gaps” for a complete basin assessment

Sample drill core of coal deposits

- Log (describe the core)
- Photograph
- Sample core for mineralogical and chemical characterization



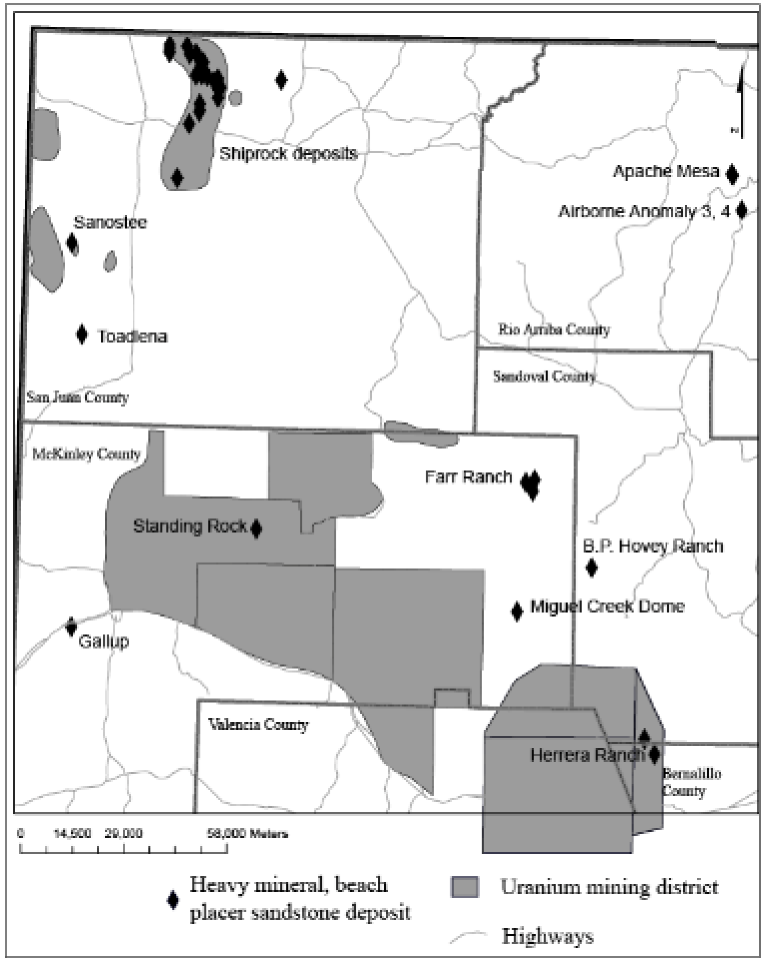
NMBGMR has drill core of coal deposits from 146 locations scattered throughout San Juan and Raton Basins

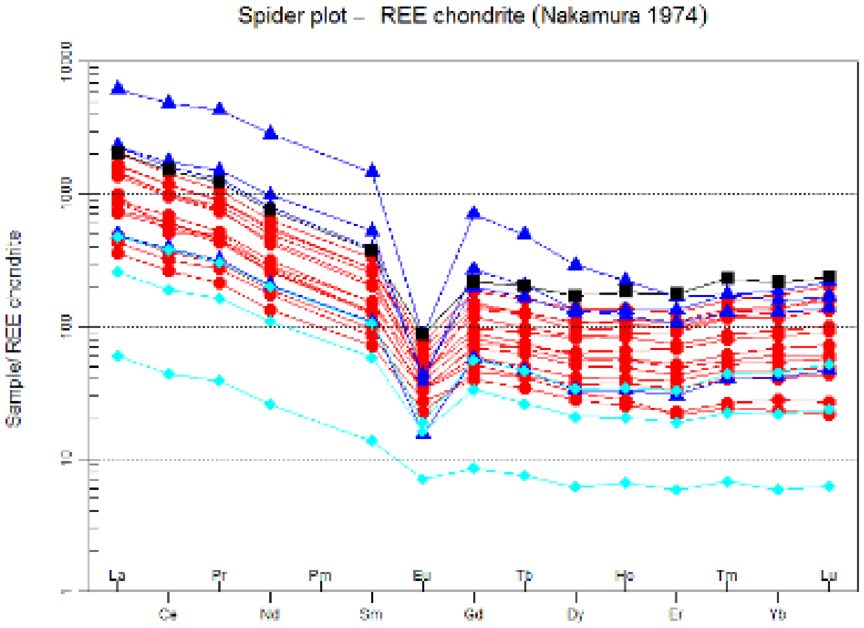
Holes will be selected on the basis of coal field, completeness of the core, core description, radioactivity (measure of elevated REE), and use of LANL LIBS/RAMAN instrument

We will sample the coal seams and layers above and below the coal seams

Beach-placer sandstone deposits

- Beach-placer sandstone deposits in the San Juan Basin are restricted to Late Cretaceous rocks and contain high REE
    - NM REE database
- Gallup, Dalton, Point Lookout, and Pictured Cliffs Sandstones
- Are in the vicinity of coal deposits

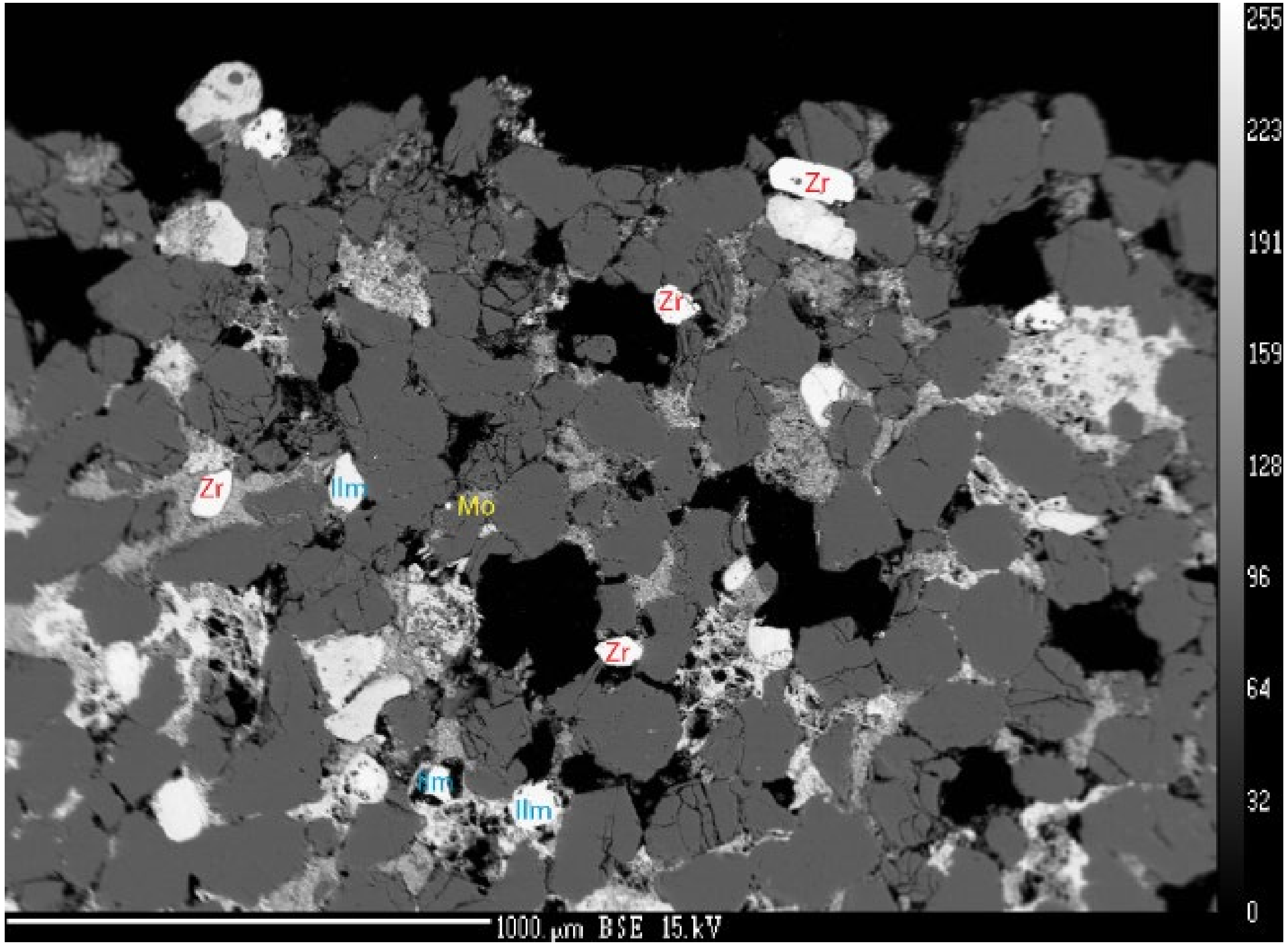


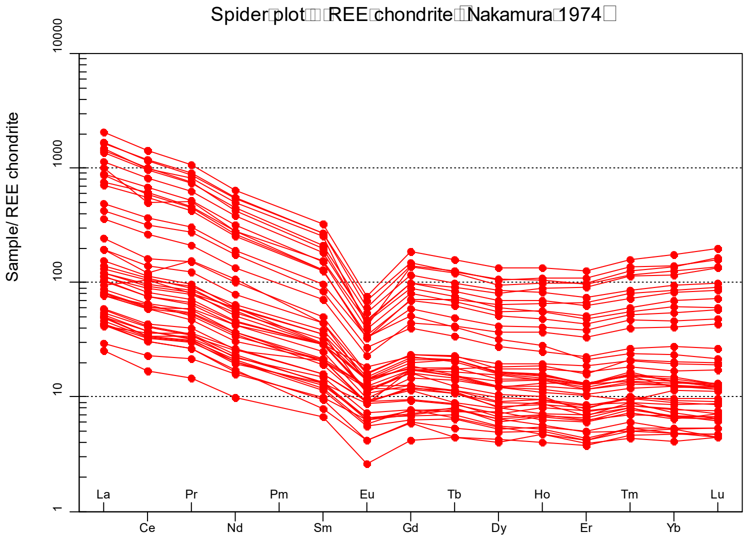


Chondrite-normalized REE plot of selected beach-placer deposits, Apache Mesa (red), Standing Rock (light blue), Sanostee (dark blue), and B.P. Hovey (black) in the San Juan Basin, New Mexico. Chondrite values are from Nakamura (1974)

Characterization methods

- Field characterization (location, lithology, description of units, radioactivity, thickness)
- Paste pH, S, C, acid base accounting of mine wastes (ARD diagram)
- Mineralogy (petrography, XRD)
- Whole-rock chemical analyses (ALS)
- Electron microscopy (mineral chemistry, texture, identification and location of REE and other CM)
- Particle size analyses of mine wastes
- Field-portable, in situ LIBS/RAMAN analysis
- Micro X-ray CT (μ-XRCT)
- Focused ion beam–scanning electron microscopy (FIB-SEM)

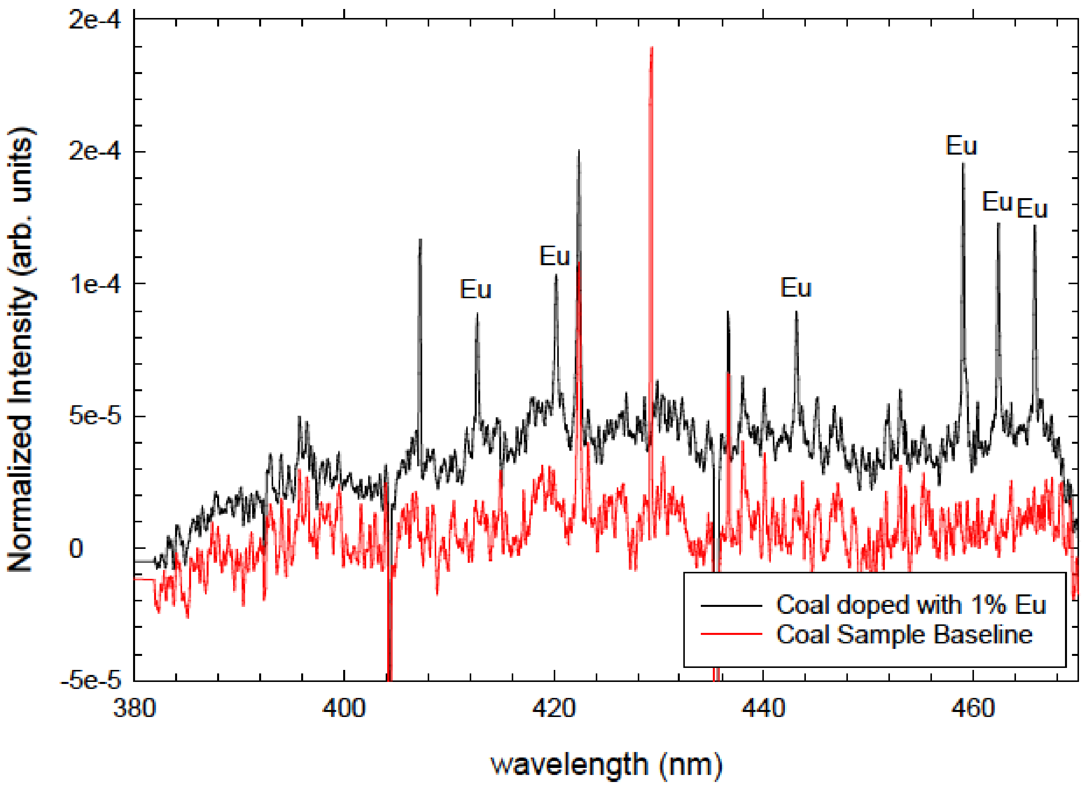




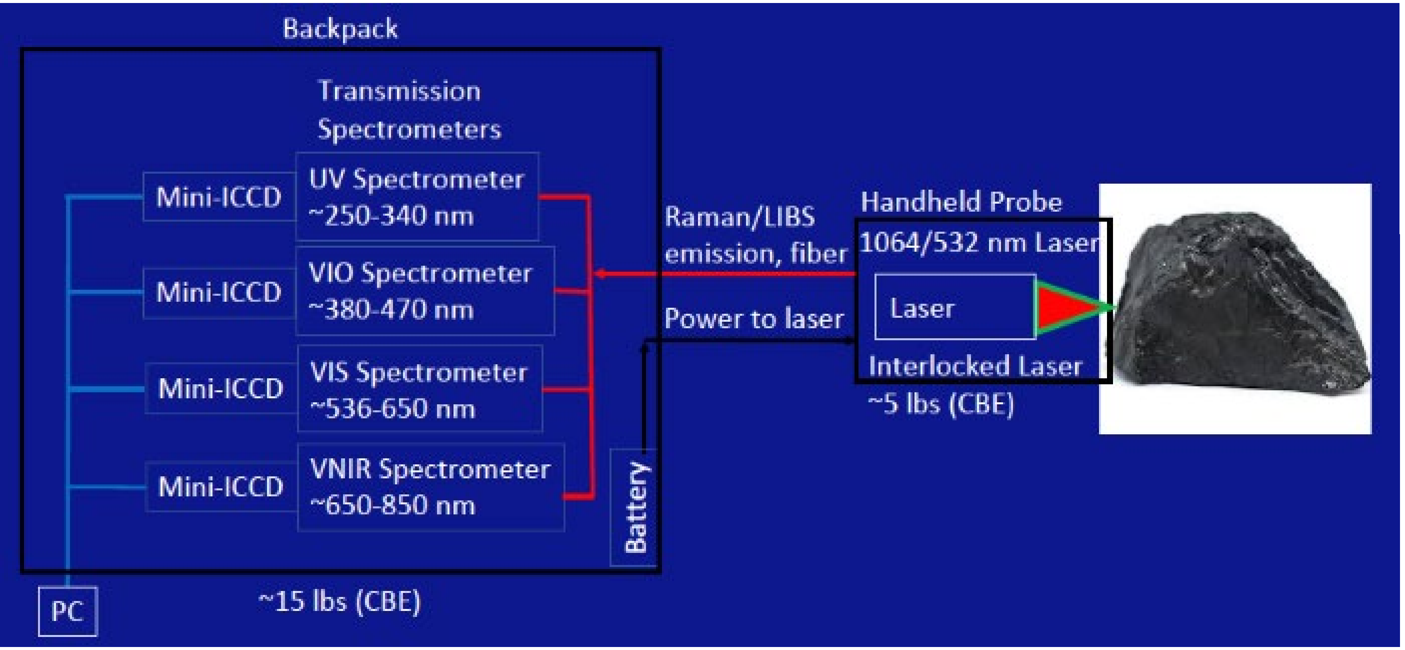
Electron microprobe photo of sample SAN 6 from Sanostee beach-placer deposit Zircon =red, ilmenite=blue, and monazite=yellow (REE mineral), mottled, lighter colored cement=iron oxide (hematite), dark grey grains=quartz, black areas=pore spaces

LANL: Field-portable, in situ LIBS/RAMAN analysis

- Field-portable Laser Induced Breakdown Spectroscopy (LIBS) and Raman spectroscopy instrument
- Collects geochemical and mineralogical data from the same sample volume
- Calibrated to detect all REE in coal and coal by-product samples



Above: example of LIBS data showing detection of Eu in a doped sample [Clegg et al. 2019]



Left: diagram of LIBS/RAMAN instrument [Clegg 2021]

Sandia: Task and Approach

Microscale characterization techniques to identify where REEs and critical metals are hosted

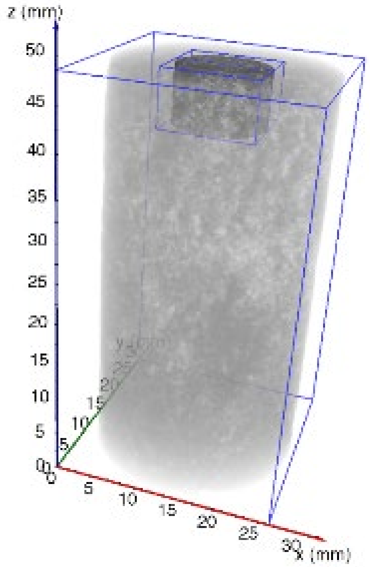
- 3D spatial petrography:
  - Micro X-Ray CT (µ-XRCT) to obtain nested 3D image volumes – use imaging and post-processing to quantify locations & geometry of specific mineral components
  - Focused ion beam–scanning electron microscopy (FIB-SEM) with energy dispersive spectroscopy or electron backscatter diffraction; can be registered with µ-XRCT – 3D micron to nano-scale quantification of geometry and composition
- Estimate/characterize the maturity of coal using infrared and Raman microscopy
- Conduct lab analysis (ICP-MS) to assist assessment of the potential reserve in acid drainage and abandoned mines as needed

Development of regionally optimized extraction technique

- Develop an optimized extraction technique from coal and various waste streams for the San Juan Basin using chelating agents, supercritical CO_2, and H_2O

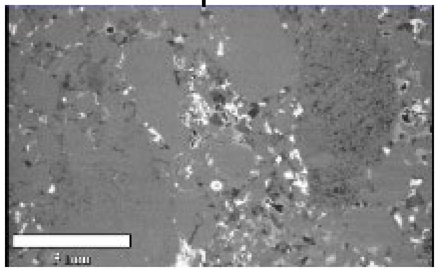
Micro X-Ray CT example on sandstone plug

- *Example of registered 11 µm and 27 µm datasets*

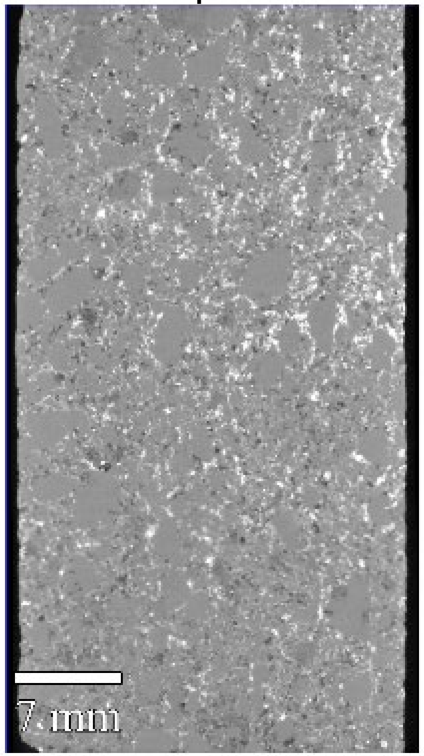


Vertical images from 3D datasets

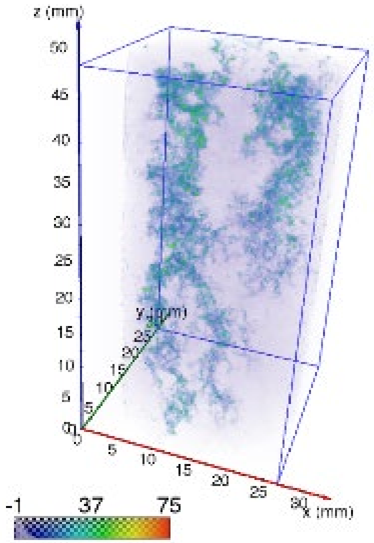
11 µm



27 µm



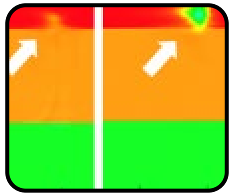
3D rendering of dissolved regions from pre-post reacted samples



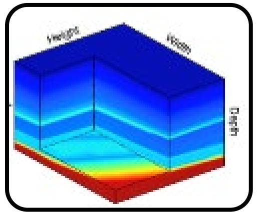
LANL: Geologic model development using physics-guided machine learning techniques

- Objective: Apply machine learning techniques to improve geologic models and fill in gaps in characterization data
- Train models by looking at direct or indirect signatures to help estimate abundances of REE and critical minerals in the resource assessment

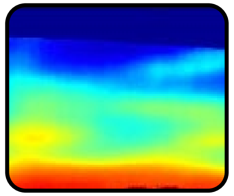
Examples of machine learning applications:



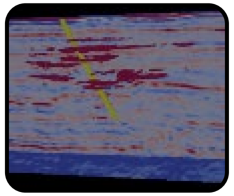
Resolution Enhancement
[Yang et al. (2021)]



3D Imaging
[Zeng et al. (2021)]

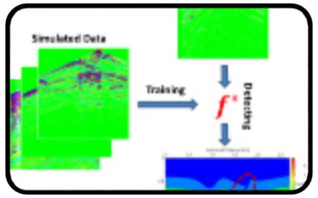


Field Data Imaging
[Feng & Lin (2021)]

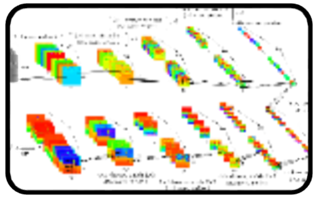


In-Situ Imaging
[Feng et al. (2021)]

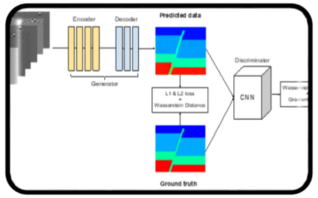
Machine learning model examples:



Ridge Regression Models
[Lin et al. (2017, 2018)]

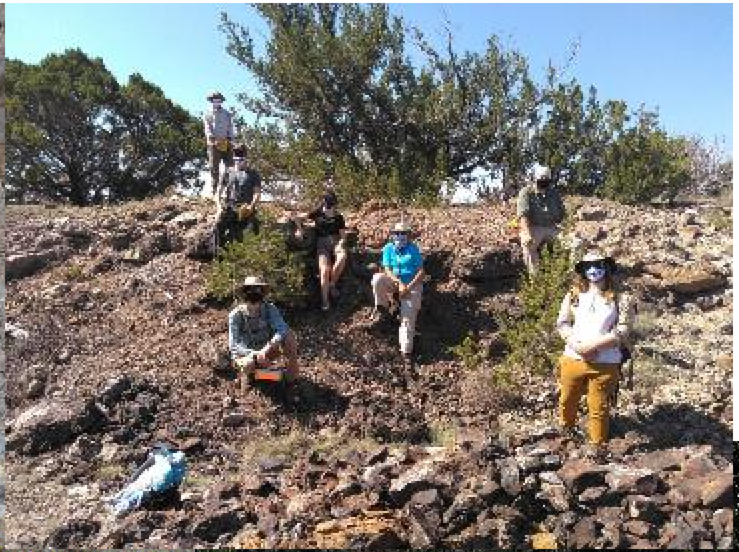


Deep Learning Models
[Wu & Lin (2019)]



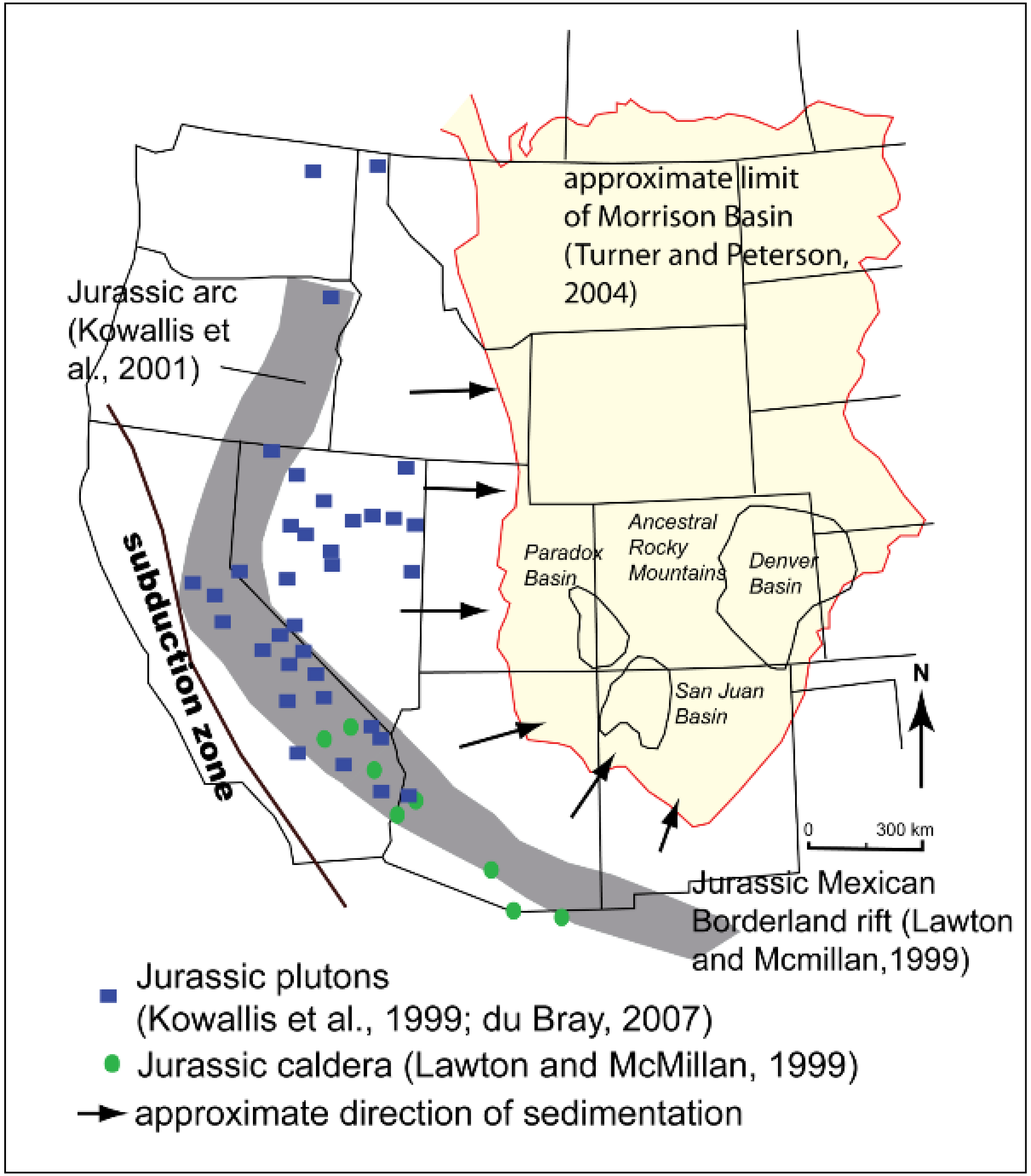
Deep Learning with Physics
[Zhang & Lin (2020)]

Students from New Mexico Tech and San Juan College will be hired and trained to perform field sampling and laboratory work

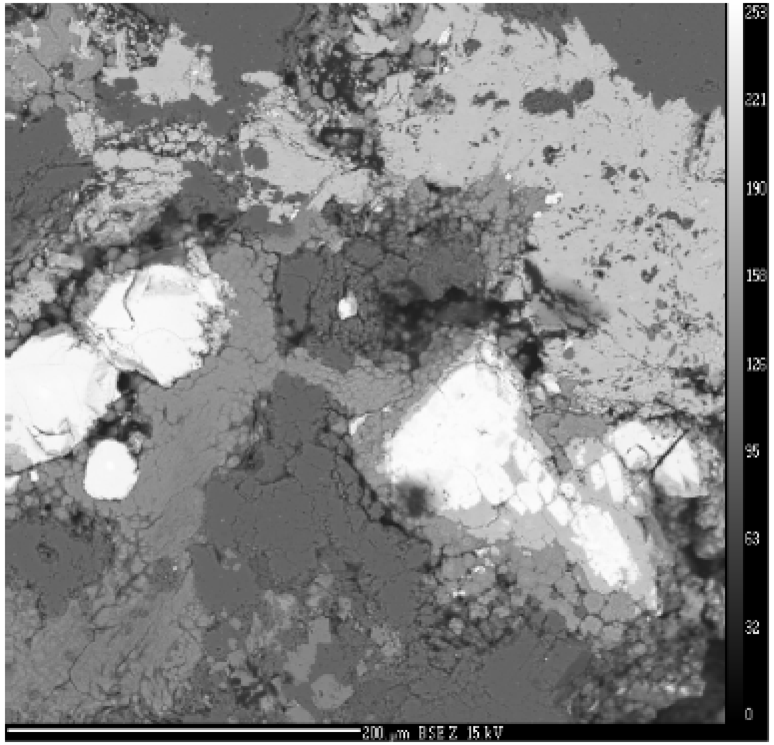


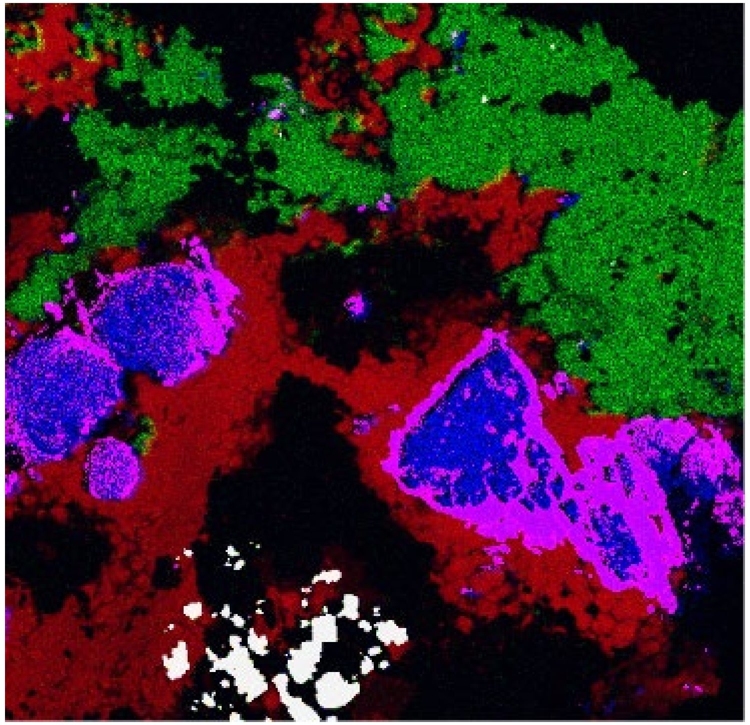
Identify and characterize the sources of REE and CM

Test a possible regional source of REE and CM in New Mexico coals from the volcanic ash (now tonsteins, clay deposits) erupted from the Jurassic arc in western U.S.



Electron microprobe characterization and other techniques of REE deposits illustrates how we identify the source of REE and CM on the microscopic scale

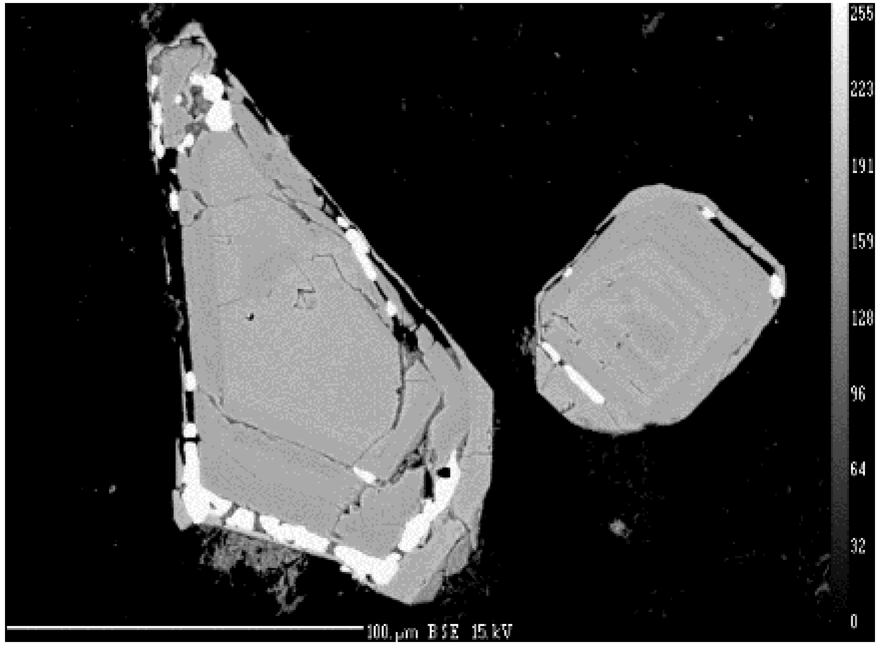


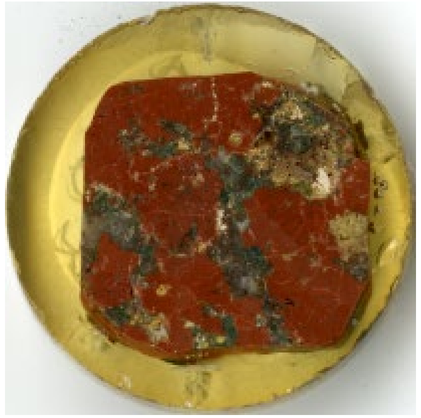


Synchysite Ca(LREE)$(CO_3)_2F$

Thorite $(Th,U)SiO_4$

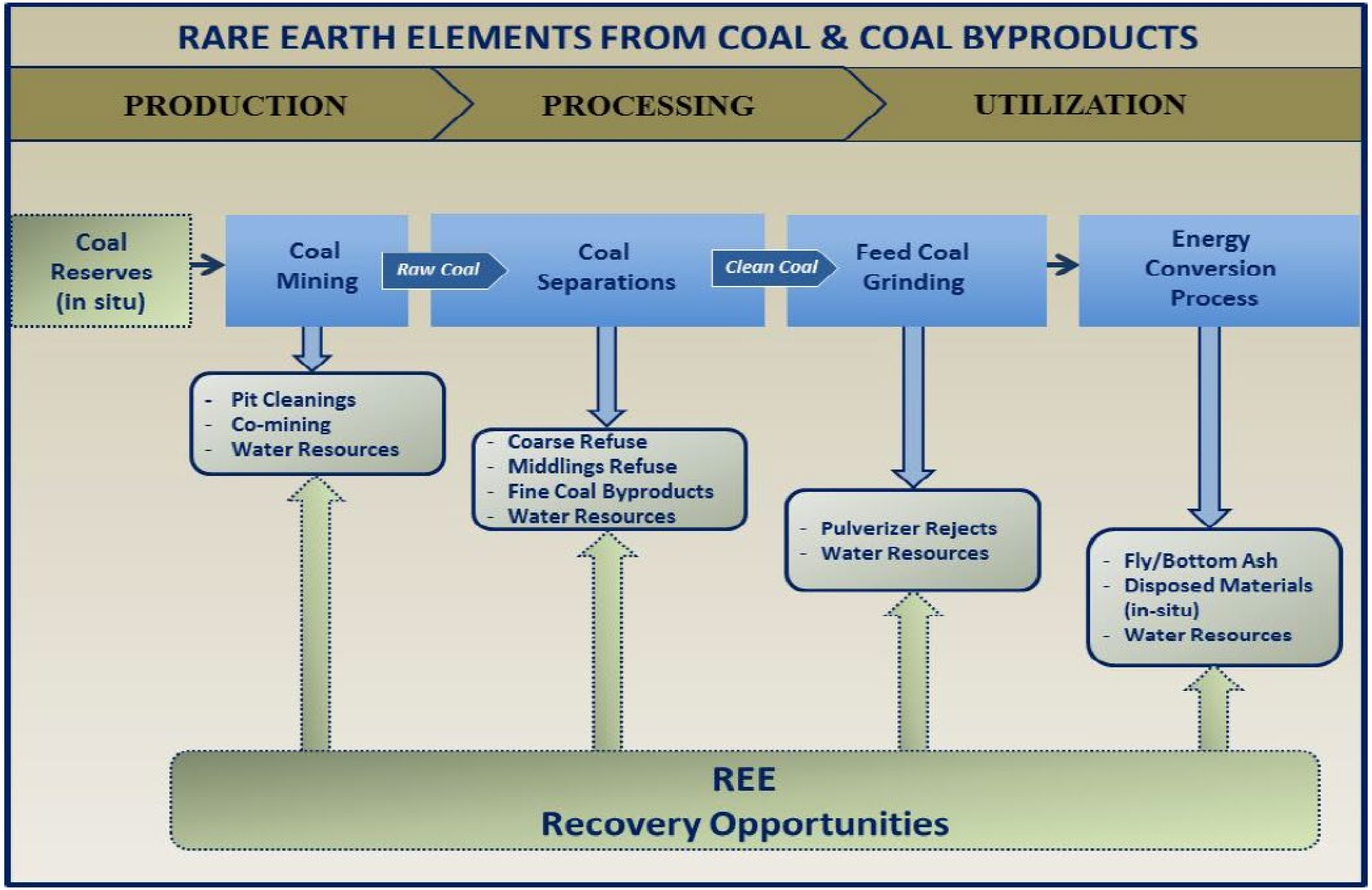
Xenotime YPO_4





The high-Z rim on zircon (episyenite, REE33) contains Ca, V, Fe, HREE, Th, P and Si

2. Identify, sample, and characterize coal waste stream products



We will sample for REE and CM in as many of these waste streams as possible from the active mines and electrical plants

Select samples based upon availability by each company

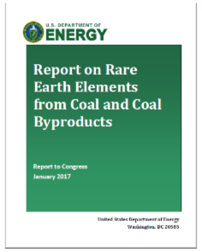


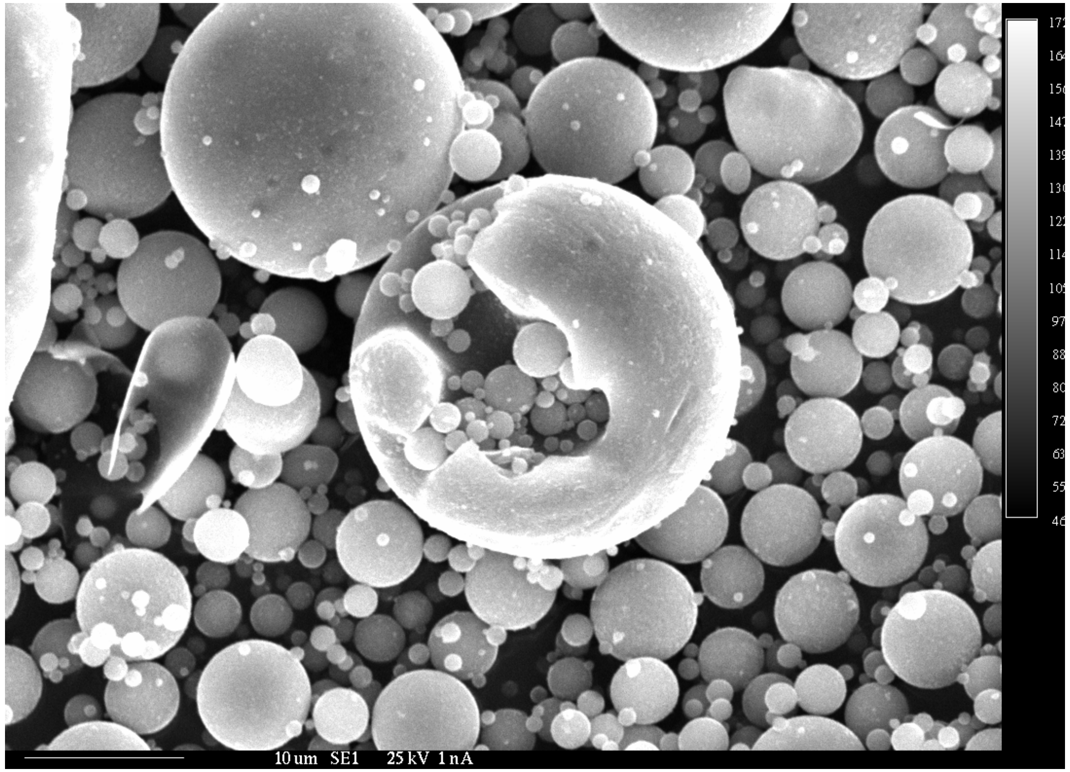
Figure 4. Many opportunities for REE recovery span the coal value chain

Active power plants and coal mines in NM

1. San Juan-Public Service Co. of NM plant and San Juan underground mine (Westmoreland)
2. Four Corners-Arizona Public Service Co. plant and Navajo mine (Bisti Fuels Co., LLC)
3. Escalante-TriState plant
4. El Segundo mine (Lee Ranch Coal)
5. Lee Ranch mine (Lee Ranch Coal)

Mine Waste from AML sites (>500 coal mines in NM)

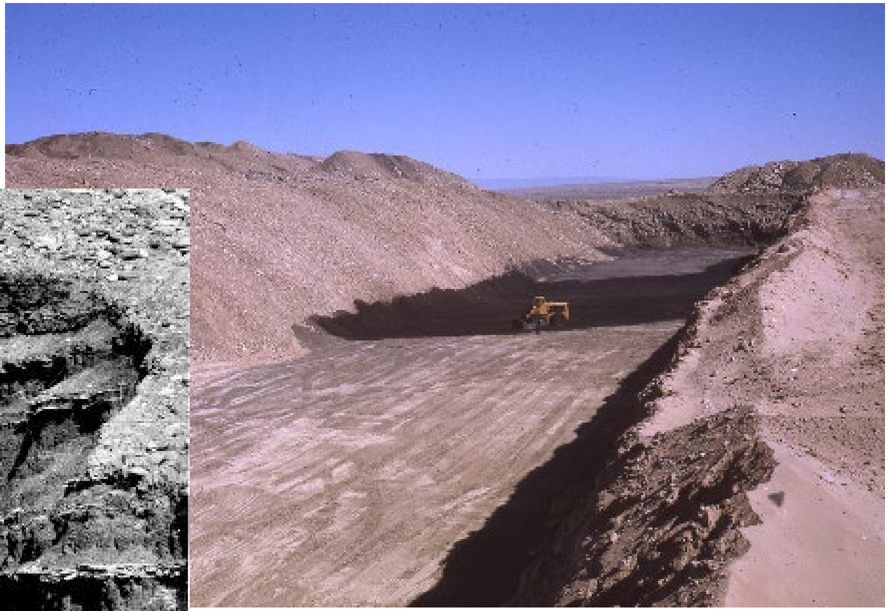
Another potential source for Critical Minerals, including REE, are mine wastes from AML sites (mine rock piles, coal ash, tailings, acid mine drainage, etc.) at inactive mines and abandoned mine lands (after obtaining permission from owners) that could be recovered at a profit and even pay for cleanup costs

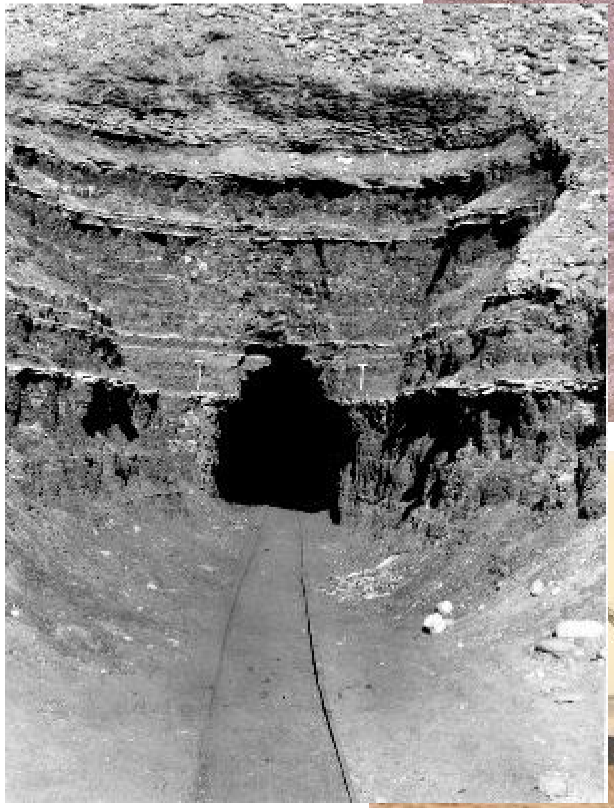


Probe image of fly ash

Mine Waste from AML sites—objectives

- Identify mine wastes that can be used to extract REE, CM, or other commodities essential to the U.S. economy and security
  - Active mine and reclamation sites
  - AML coal mines from NM Mines Database
- Identify other potential technologies that can be developed for reprocessing of mine wastes
- Identify hazards, especially those that can be removed or mitigated through profitable activities

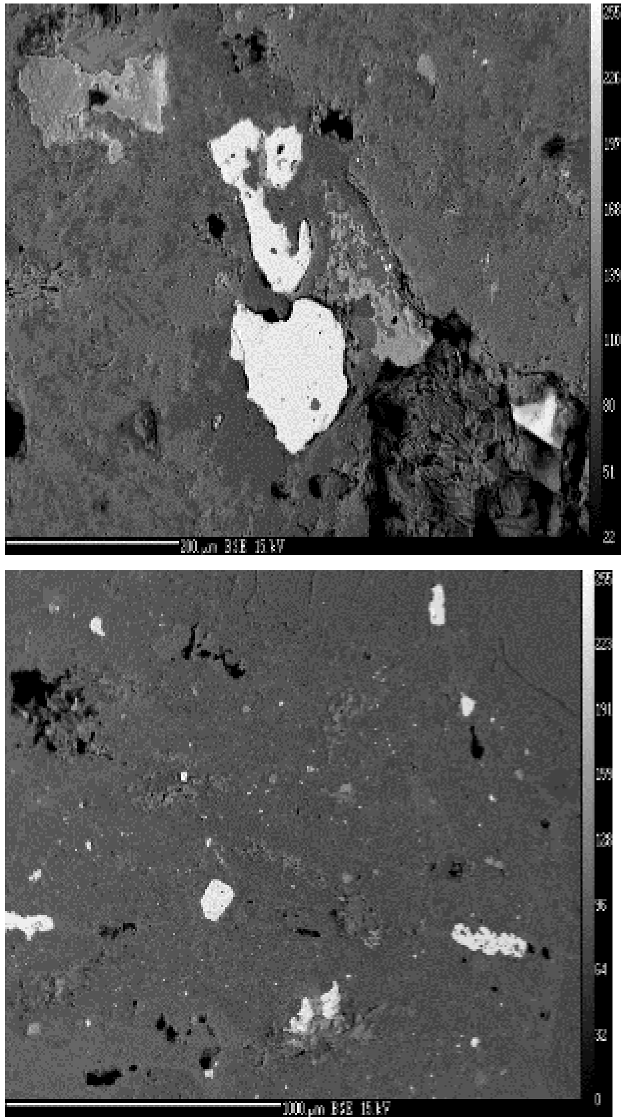




Sample mine wastes from active mines, repositories of coal ash, and AML sites

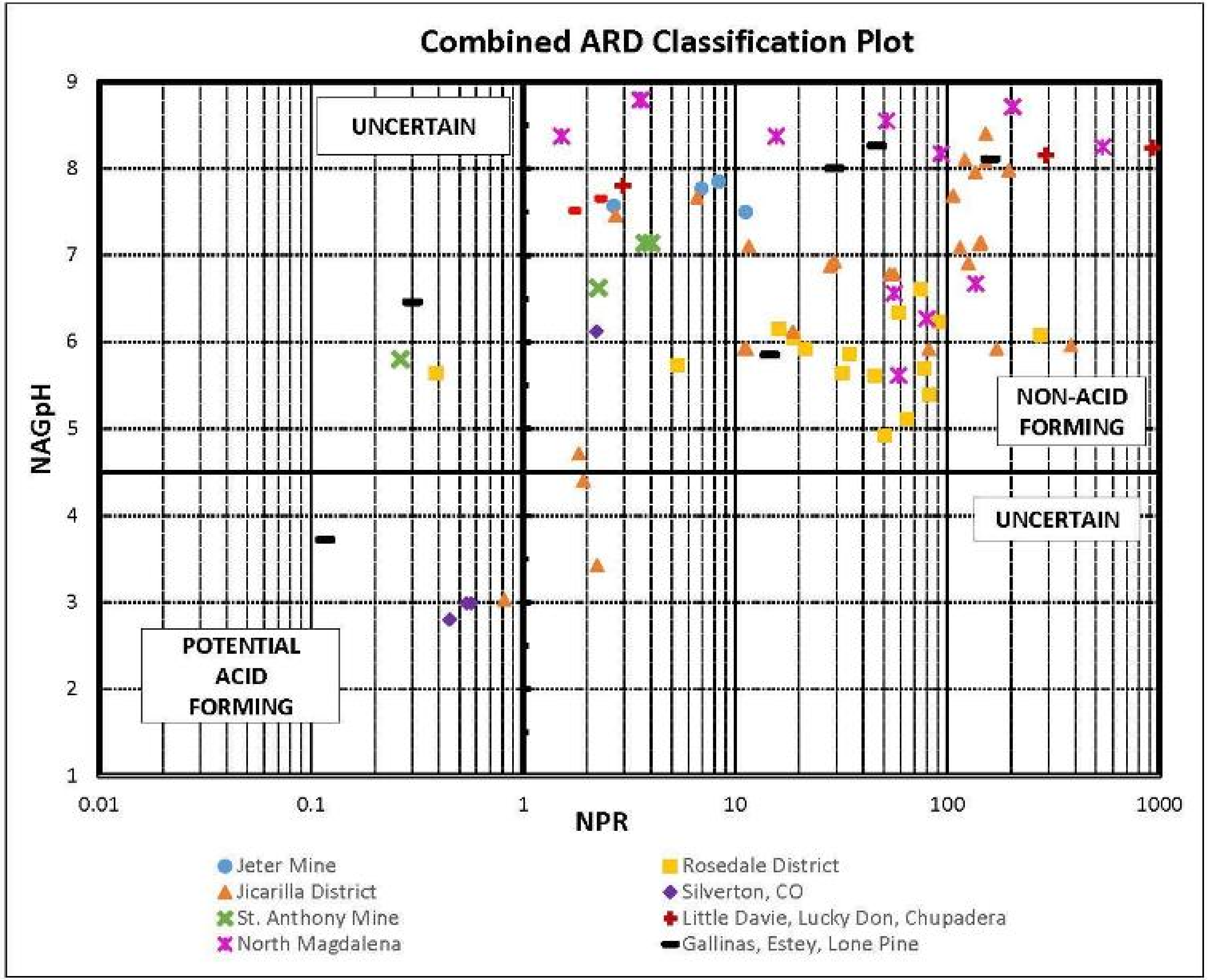
- Complete the New Mexico Mines Database with additional locations and information of missing inactive coal mines (AML)
- Select AML mines to sample (after obtaining permission from current owners, sample AML on Federal land)
- Soil Petrography–First step is determine mineralogy, including electron microprobe examination
- Characterize the samples
- Interpret data

2 mm



Backscattered electron images of pyrite

ARD Diagram



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

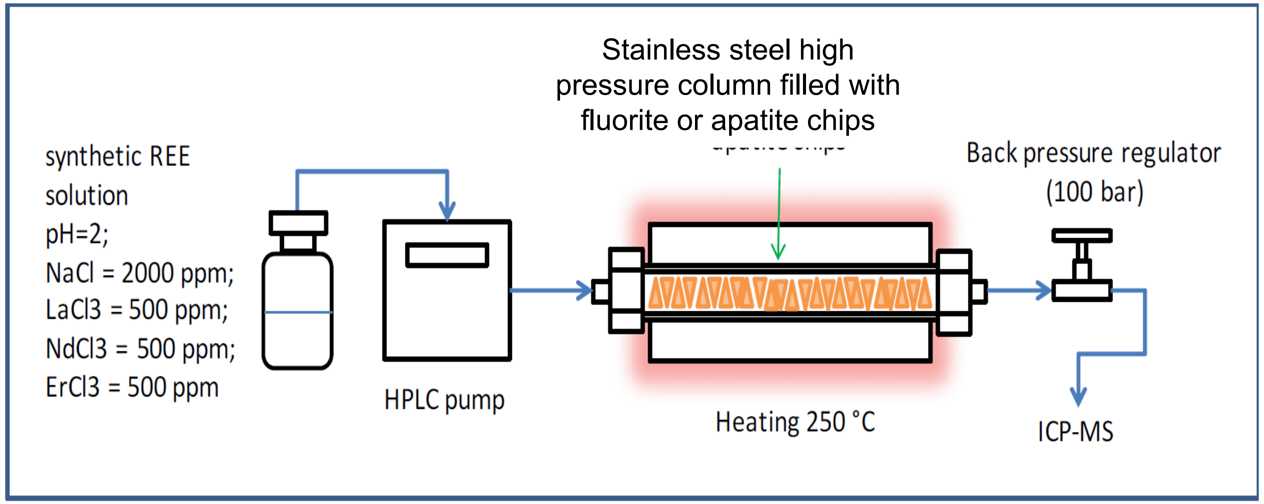
$$AP = S(\%) \times 31.25$$
$$NP = C(\%) \times 83.3$$
$$NNP = NP - AP$$
$$NPR = \frac{NP}{AP}$$

3. Conduct bench (i.e. laboratory-scale) tests to develop a basinal reuse of waste strategy

LANL: Hydrothermal REE separation technology

- Technology based on natural ore-forming processes that concentrate REE using hot water and ligands (phosphate, fluoride)
- Hydrothermal-based technology (with fluorite) extracts from aqueous feedstock M/HREE selectively
- Hydrothermal approach permits to avoid extracting and concentrating U and Th (radioactive contaminants)
- The technology is patented (U.S. provisional patent application No. 62/859,428)

Schematic of separation and extraction hydrothermal reactor proof-of-concept experiments

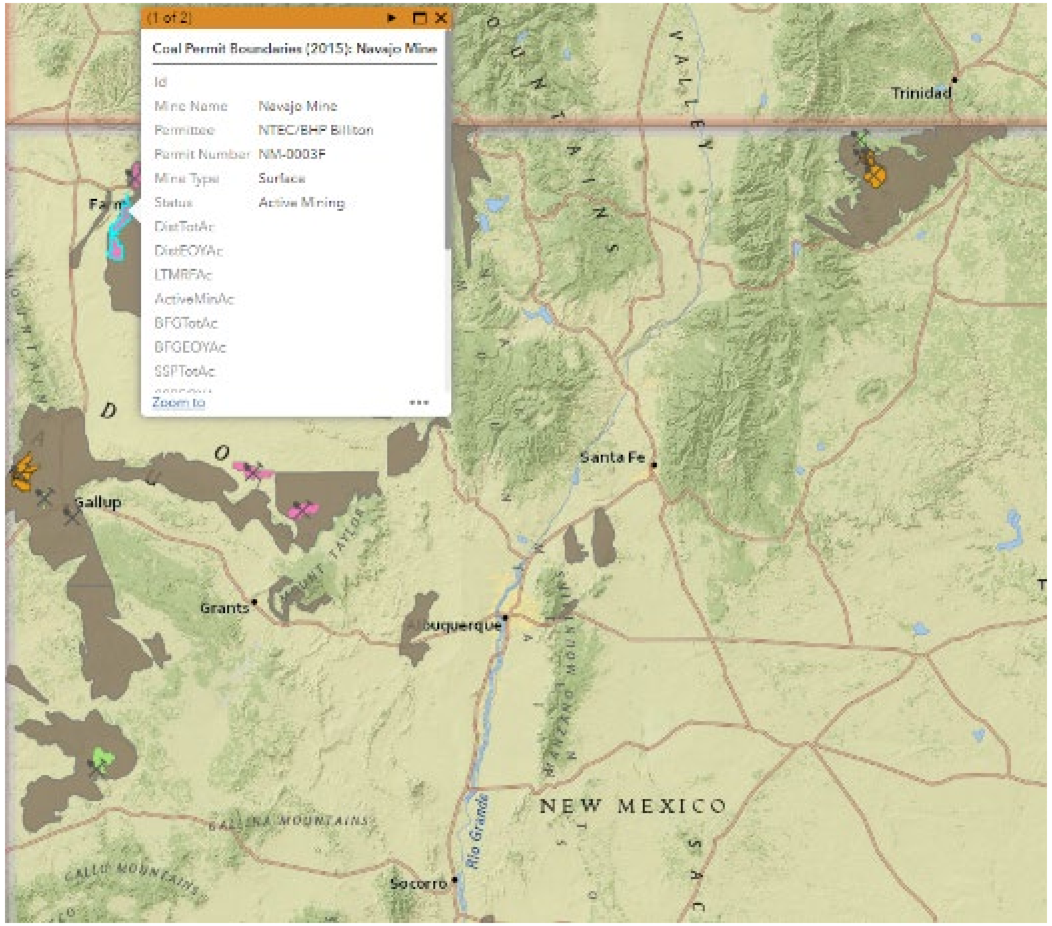


Migdissov et al., 2020

4. Illustrate the current status of the feedstock supply of REE and CM to understand the basinal REE industry's capital expenditures and obstacles to expanding REE-related business development

PRRC: Basinal Resource for REE, CM Industry

- Access the available infrastructure for coal mining and coal byproduct processing
- Investigate the current status of the feedstock supply for the basinal REE and CM industry and their potential development trend
- Analyze existing or potential technologies to mine or access coal, coal byproducts, waste streams, or alternate source materials current (or future) facilities that refine these raw resource materials into feedstock materials
- Understand the basinal capital expenditures of REE-related industry and perceived obstacles to expanding REE-related business lines
- Identify the main challenges as the concern for the business development

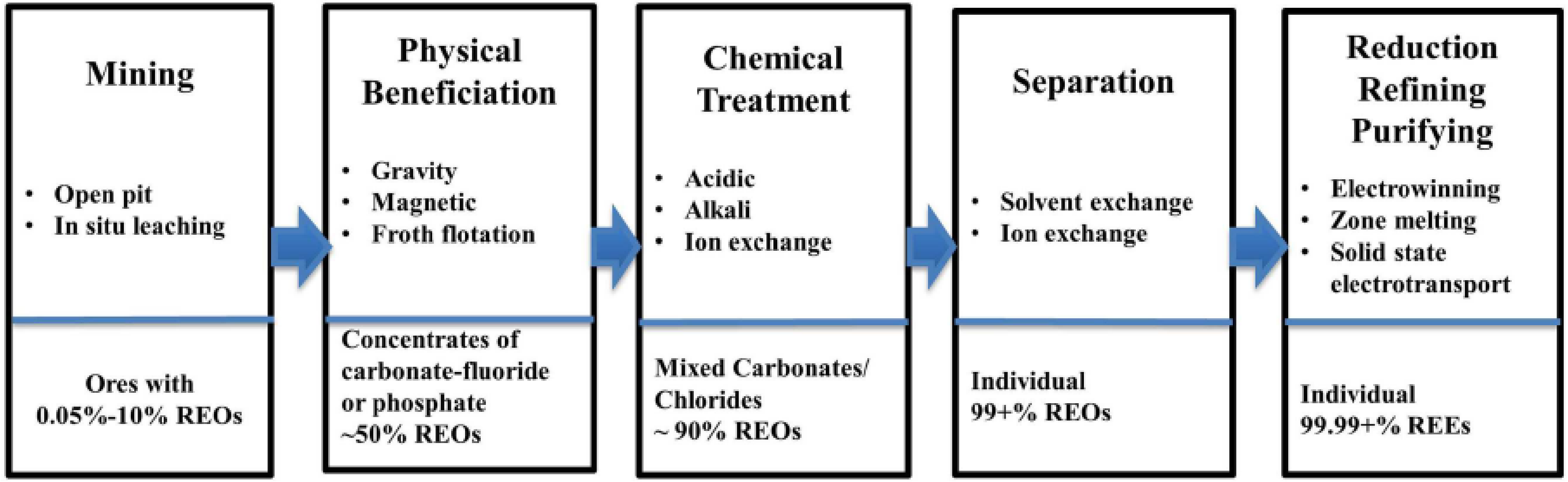


5. Develop a life-cycle analysis to establish pathways, process engineering, and design requirements to upgrade REE processing industry

PRRC: Life-cycle Analysis

- Conduct the life-cycle assessment to the current REE and CM supply chain, including the energy and material analysis, environmental impact assessment, scalability assessment and detailed economic analysis.
- Investigate the potential upgrading of the REE and CM process industry.
- A cradle-to-grave concept would be adopted to set the boundary of energy and material flows for all the processes involved in the REE industry

General processing routes for REE



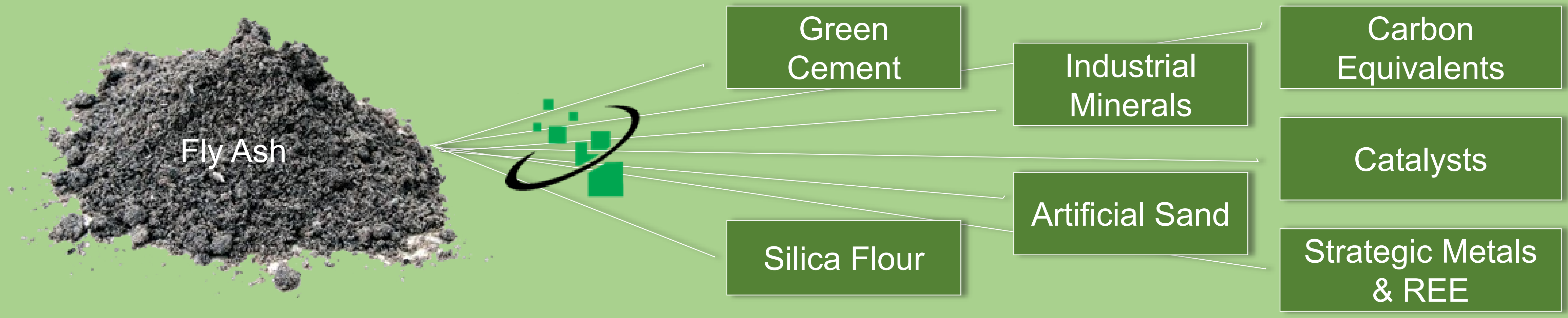
6. Evaluate technology gaps

7. Establish a Center of Excellence and Training Center (COE) for coal ash beneficiation at San Juan County

SonoAsh: Cement Decarbonization & Impounded Fly Ash Valorization Technology Pathway for New Mexico

Upcycling fly ash into engineered High Performance Green Cement, artificial sands and pathways to extract industrial minerals, CM, and REE. The patented technology is the only wet-ash beneficiation process, mitigating ash impacts accumulated over decades

<u>Waste to Value & Net Zero Carbon High Performance Cement</u>



SonoAsh Approach in Supporting New Mexico economy

Commercialization coordination of DOE phase 1 efforts to valorize coal ash using outcomes from project partners

Integrate and collaborate around SonoAsh project development efforts

There is an increased demand of REE

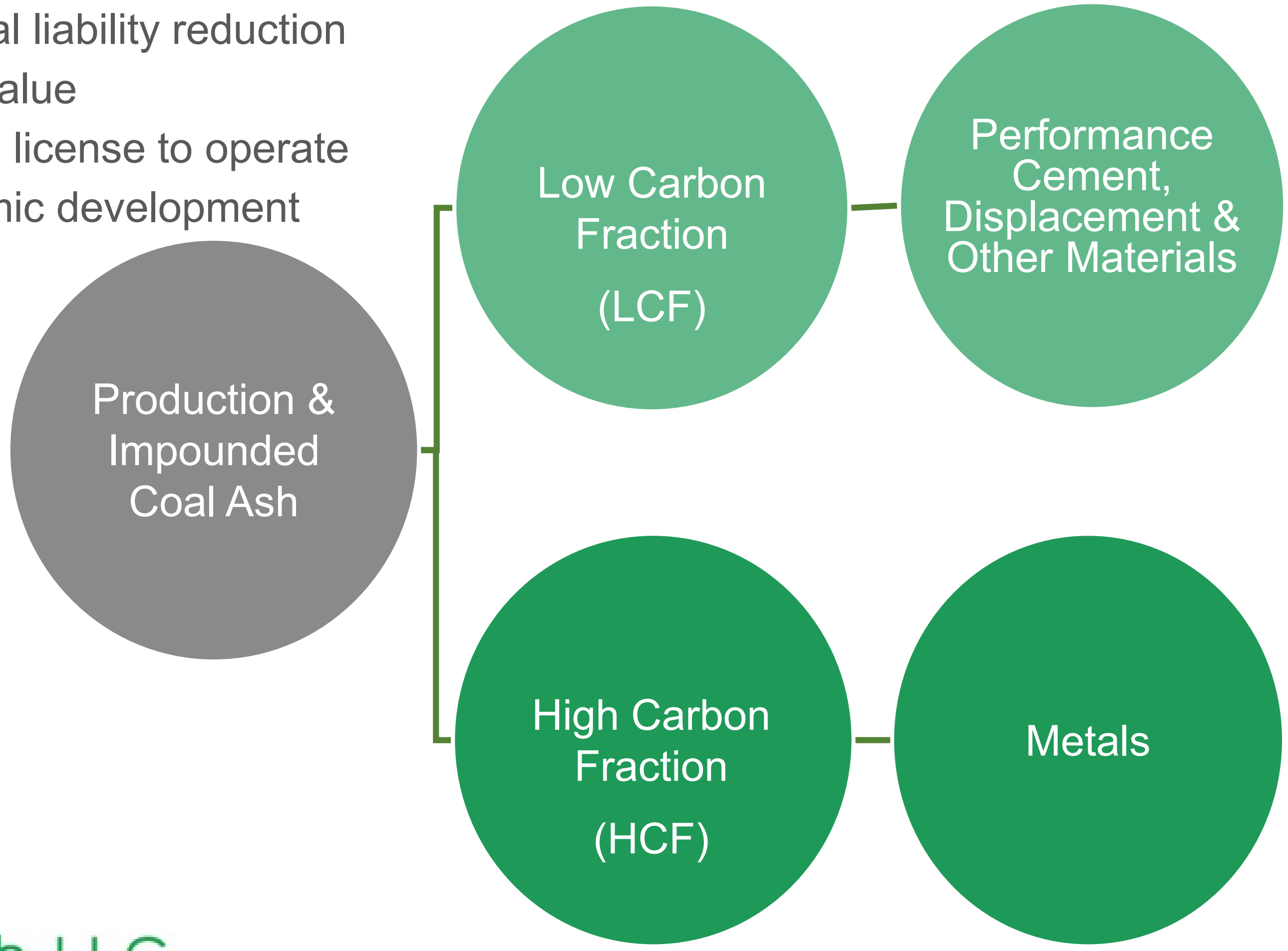
Above Ground Mining of REE is more cost efficient and environmentally friendly than traditional mining

The SonoAsh Process Will Work to Separate New Mexico Coal Ash into Low and High Carbon Fractions and Support Phase 1 Objectives

Coal Power Utility

- Environmental liability reduction
- Generating Value
- Renew social license to operate
- Rural economic development

SonoAsh



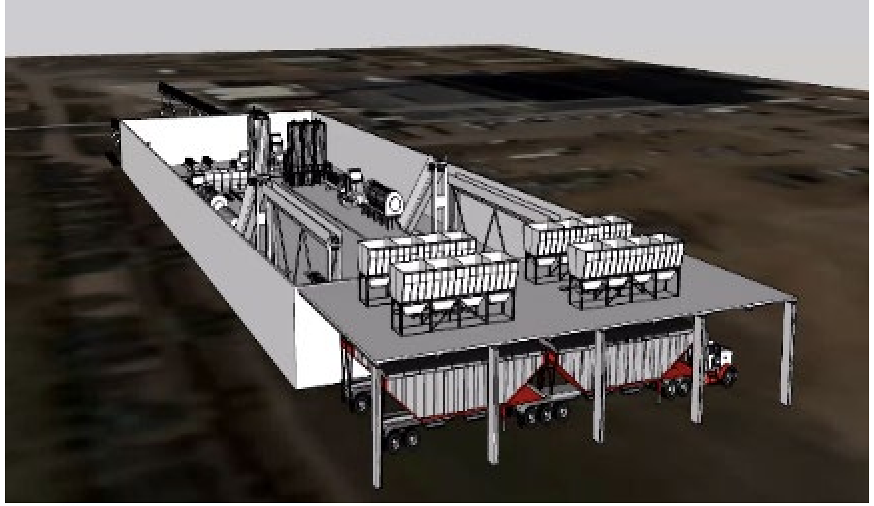
Cement Market Place

- Alternative low carbon cement cementitious material benefits
- Green cement for high performance applications (e.g. marine)
- Silica flour for enhancing properties of all Portland cement
- Cenospheres for lightweight concrete and foam fillers
- Environmental impact liability reduction

Other Markets

- Proppants – oil and gas applications
- Carbon abrasives - multiple industrial applications
- Technology metals, including rare earths – environmental, national defense, high technology & motor applications

SonoAsh Center of Excellence Proposal



8. Create REE and CM research-based activities that can be shared during the NMBGMR summer geology teacher workshop and assemble REE and CM research-related articles for an REE-CM-centered issue of Lite Geology

Education Outreach

Rockin' Around New Mexico

Rockin' Around New Mexico (RANM) is an NMT Master's of Science teaching/NMBGMR Professional Development training program that provides K-12 teachers with geology-themed field and classroom experience, as well as lesson plans, teaching materials and other resources

For the last 2 years we have offered this workshop virtually due to COVID concerns

2019 Rockin' Around New Mexico in Socorro, NM

Top Photo: Dr. Matt Zimmerer describes spreading of the Rio Grande Rift

Bottom photo: Dr. Nels Iverson introduces teachers to the electron microprobe

Rockin' Around New Mexico

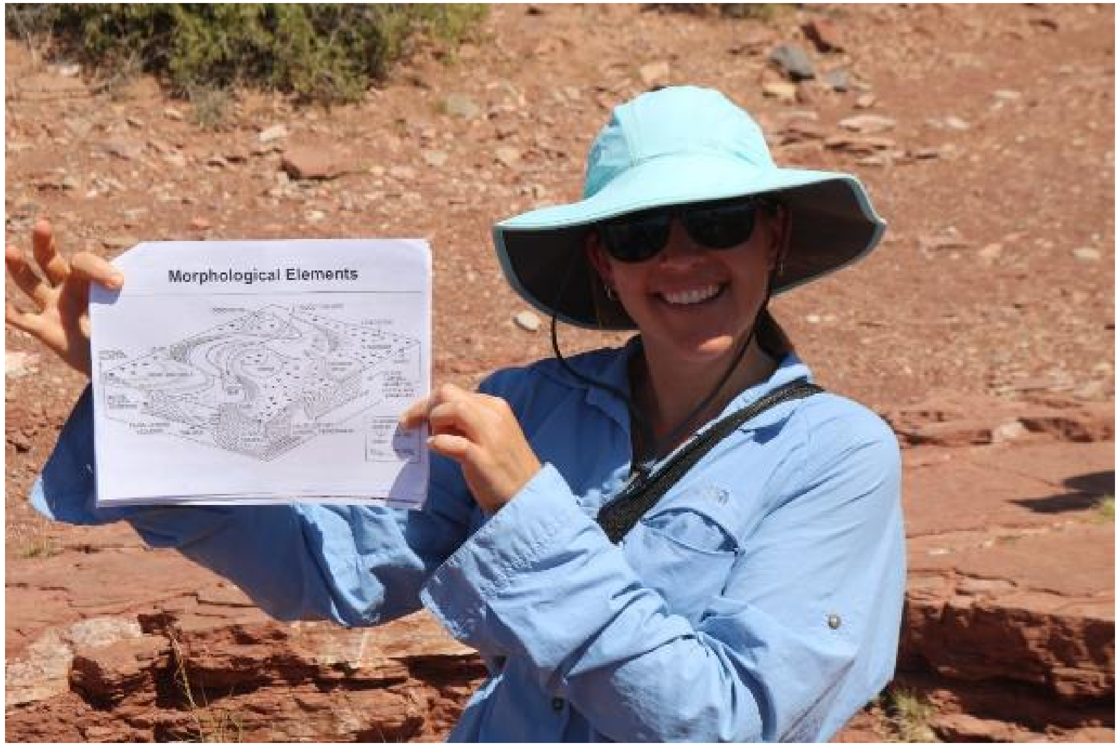
This program has served teachers for **25** years!

The location of RANM changes annually

Each year up to 30 K-12 teachers attend

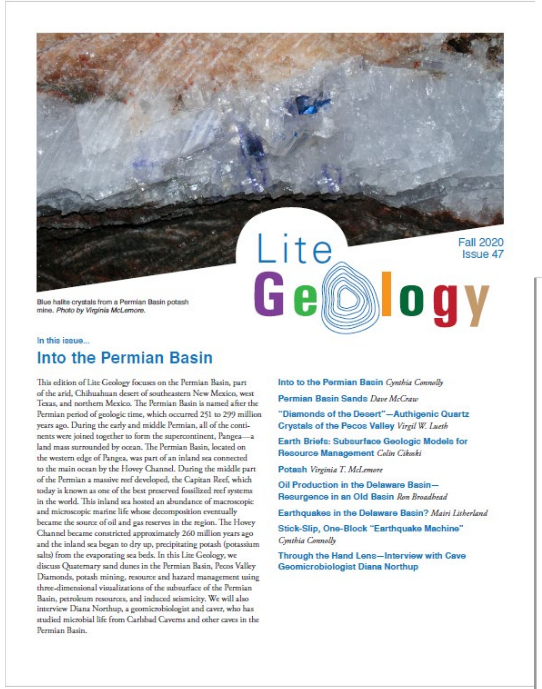
All costs for workshop materials and fees for K-12 teacher professional development are covered by our Rockin' DHSEM (Division of Homeland Security and Emergency Management) grant

The theme of RANM must focus on **hazard and hazard mitigation** to qualify for DHSEM funding



NMBGMR Mineral Museum Curator Kelsey McNamara teaches educators about morphological elements during Rockin'2018.

Education Outreach
Lite Geology



Fall 2020
Issue 47

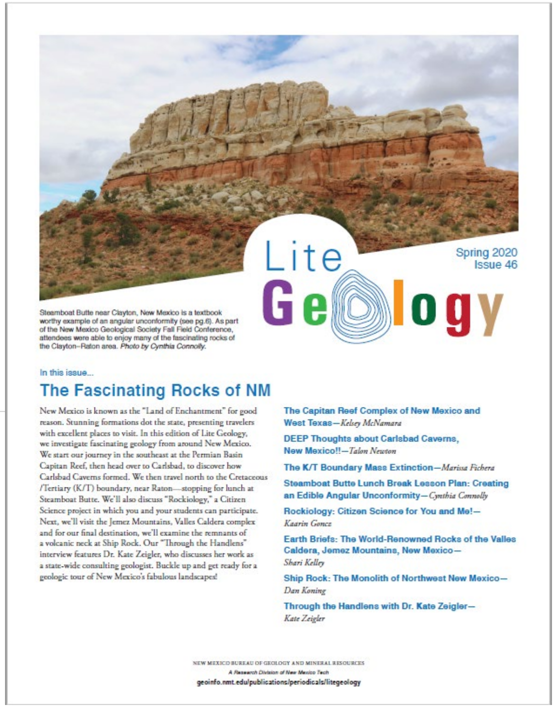
Lite Geology

Blue halite crystals from a Permian Basin potash mine. *Photo by Virginia McLemore.*

In this issue...

Into the Permian Basin

This edition of Lite Geology focuses on the Permian Basin, part of the arid, Chihuahuan desert of southeastern New Mexico, west Texas, and northern Mexico. The Permian Basin is named after the Permian period of geologic time, which occurred 251 to 299 million years ago. During the early and middle Permian, all of the continents were joined together to form the supercontinent, Pangea—a land mass surrounded by ocean. The Permian Basin, located on the western edge of Pangea, was part of an inland sea connected to the main ocean by the Hovey Channel. During the middle part of the Permian a massive reef developed, the Capitan Reef, which today is known as one of the best preserved fossilized reef systems in the world. This inland sea hosted an abundance of macroscopic and microscopic marine life whose decomposition eventually became the source of oil and gas reserves in the region. The Hovey Channel became constricted approximately 260 million years ago and the inland sea began to dry up, precipitating potash (potassium salts) from the evaporating sea beds. In this Lite Geology, we discuss Quaternary sand dunes in the Permian Basin, Pecos Valley Diamonds, potash mining, resource and hazard management using three-dimensional visualizations of the subsurface of the Permian Basin, petroleum resources, and induced seismicity. We will also interview Diana Northup, a geomicrobiologist and caver, who has studied microbial life from Carlsbad Caverns and other caves in the Permian Basin.



Spring 2020
Issue 46

Lite Geology

Steamboat Butte near Clayton, New Mexico is a textbook worthy example of an angular unconformity (see pg.6). As part of the New Mexico Geological Society Fall Field Conference, attendees were able to enjoy many of the fascinating rocks of the Clayton–Raton area. *Photo by Cynthia Connolly.*

In this issue...

The Fascinating Rocks of NM

New Mexico is known as the "Land of Enchantment" for good reason. Stunning formations dot the state, presenting travelers with excellent places to visit. In this edition of Lite Geology, we investigate fascinating geology from around New Mexico. We start our journey in the southeast at the Permian Basin Capitan Reef, then head over to Carlsbad, to discover how Carlsbad Caverns formed. We then travel north to the Cretaceous /Tertiary (K/T) boundary, near Raton—stopping for lunch at Steamboat Butte. We'll also discuss "Rockiology," a Citizen Science project in which you and your students can participate. Next, we'll visit the Jemez Mountains, Valles Caldera complex and for our final destination, we'll examine the remnants of a volcanic neck at Ship Rock. Our "Through the Handlens" interview features Dr. Kate Zeigler, who discusses her work as a state-wide consulting geologist. Buckle up and get ready for a geologic tour of New Mexico's fabulous landscapes!

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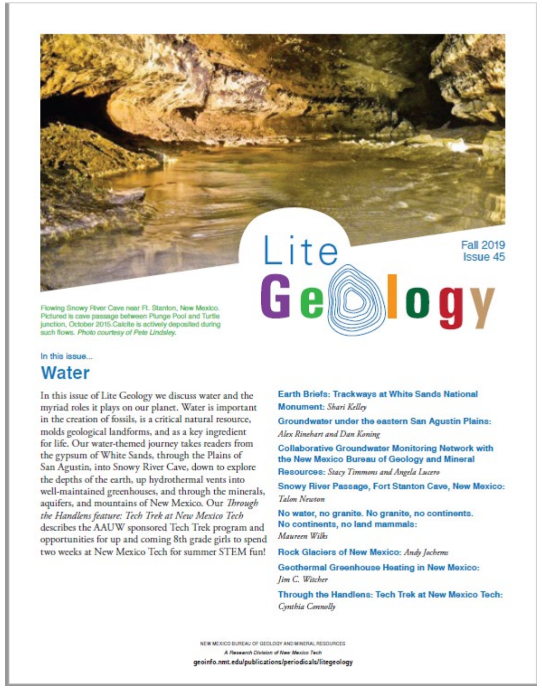

Fall 2019
Issue 45

Lite Geology

Flowing Snowy River Cave near Ft. Stanton, New Mexico. Pictured is cave passage between Plunge Pool and Turtle junction, October 2015.Calcite is actively deposited during such flows. *Photo courtesy of Pete Lindsley.*

In this issue...

Water

In this issue of Lite Geology we discuss water and the myriad roles it plays on our planet. Water is important in the creation of fossils, is a critical natural resource, molds geological landforms, and as a key ingredient for life. Our water-themed journey takes readers from the gypsum of White Sands, through the Plains of San Agustin, into Snowy River Cave, down to explore the depths of the earth, up hydrothermal vents into well-maintained greenhouses, and through the minerals, aquifers, and mountains of New Mexico. Our *Through the Handlens feature: Tech Trek at New Mexico Tech* describes the AAUW sponsored Tech Trek program and opportunities for up and coming 8th grade girls to spend two weeks at New Mexico Tech for summer STEM fun!

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Lite Geology is an online education outreach publication produced biannually by the New Mexico Bureau of Geology and Mineral Resources for K-12 teachers

An edition of Lite Geology will be dedicated to the collaborative research and results from the REE Project

Pictured are the covers of some of our latest editions of Lite Geology. These editions discussed the Permian Basin, Rocks of New Mexico and Water. You can read this online publication at https://geoinfo.nmt.edu/publications/periodicals/litegeology/home.cfml

Further Education Outreach

AAUW Tech Trek

For four years the NMBGMR has partnered with the American Association of University Women (AAUW) to provide a geology component to Tech Trek—a week-long immersive science camp for 60 8th grade girls

The NMBGMR usually provides a field trip and Mineral Museum tour, but in the future could offer another REE-CM-related class

Last year we provided materials that were shipped to participants for a virtual geology workshop

NMBGMR Geologist Shari Kelly passes around Atrasado limestone during a 2018 Tech Trek field trip to the Quebradas

SUMMARY

Objectives

- Basinal Assessment of CORE-CM Resources
  - identify and quantify the distribution of REE and CM in coal beds and related stratigraphic units in the San Juan and Raton basins
  - identify and characterize the sources of REE and CM
- Basinal Strategies for Reuse of Waste Streams
- Basinal Strategies for Infrastructure, Industries and Businesses
  - evaluate the basinal industry infrastructure and determine the economic viability of industrial upgrading
- Technology Assessment, Development, and Field Testing
- Technology Innovation Center
- Stakeholder Outreach and Education

Importance of the CORE-CM project—San Juan River-Raton Basins, New Mexico

- Select and archive samples to achieve project objectives, esp in the future
- Will delineate favorable geologic terranes and priority areas containing potential REE and CM deposits
- REE and CM resources must be identified before land use decisions are made by government officials
- Future mining of REE and CM will directly benefit the economy of NM
- Crucial to re-establish a domestic source of REE and CM minerals in the U.S. to help secure the nation’s clean energy future, reducing the vulnerability of the U.S. to material shortages related to national defense, and to maintain our global technical and economic competitiveness
- Training of the future workforce because students at New Mexico Tech and San Juan College will be hired to work on this project and outreach activities train high and middle school students as well as their teachers

Thank you!
Any questions?