GEOC5089 ME5089 Exploration Geochemistry Sampling part 1

INSTRUCTOR—Dr. Virginia T. McLemore

FALL 2023

Exploration Geochemistry

GEOC5089 ME5089

Safety Share

Hydration

Ernest Brakohiapa

August 22, 2023

Hydration in the Body

- Hydration is the replacement of fluids lost through sweating, exhaling and elimination of waste.
- The body loses about 2-3 quarts of water daily and need to be replaced.

Importance of Hydration

Our bodies need water for survival, drinking enough water everyday is essential for different functions

- To regulate body temperature
- To keep joints lubricated
- It prevents infections
- Carries nutrients and oxygen to cells
- Enable organs to function well
- It also improves sleep quality and brain function

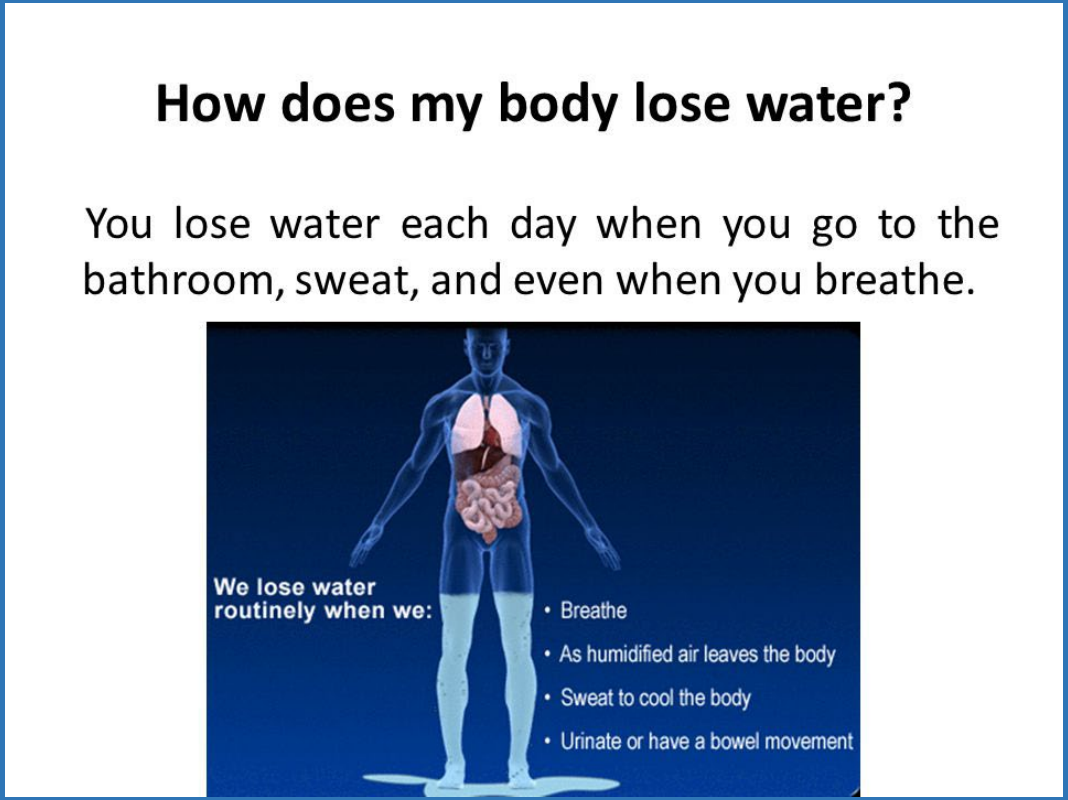
Dehydration Hazards

Workers can be dehydrated when

- Exposed to sunlight
- Working in heat environment
- Sweating excessively

Dehydration can cause a number of health and safety hazards and can be dangerous especially in hot weather.

- Headache
- Dizziness due to drop in blood pressure
- Kidney problems due to infrequent urination
- Seizures from low level of electrolytes
- Heat stroke



Symptoms of Dehydration

Include:

- Little or no urine,
- Urine that is darker than usual
- Dry mouth
- Fatigue
- Extreme thirst
- Confusion
- dizziness

Source: google images

Recommendations / Conclusion

- Ensure your colleagues stay hydrated while in the field
- Prompt or offer water to your colleague when you notice signs of dehydration
- Drink enough to prevent dehydration
- Other water sources include, fruits, juices soups and vegetables

Source: google images

THANK YOU

References

- https://www.hhs.texas.gov/sites/default/files/documents/services/health/texercise/importance-of-hydration.pdf
- https://legacyperformwell.com/water-is-life/
- https://www.hsph.harvard.edu/news/hsph-in-the-news/the-importance-of-hydration/#:~:text=Drinking%20enough%20water%20each%20day,quality%2C%20cognition%2C%20and%20mood
- https://slideplayer.com/slide/3958838/
- https://stvincents.org/about-us/news-press/news-detail?articleId=43565&publicid=745

“Stream Sediment Geochemistry in Today’s Exploration World”

Author: W.K. Fletcher

Presented by Kyle Stafford for ME/GEOC-5089

Introduction

- Well established technique used for over half a century
- Used to identify anomalous watershed targets
- Has also been used for environmental monitoring, especially since the 1970s
- Can be successful even when poorly executed

Basics of the Model

- Hawke's (1976) model used as an example
- Size fraction and method of analysis chosen during an orientation survey
- Fits best in first and second order streams
- Stream can become "decoupled" and become unreliable as catchment size increases
- Methodology is often "compromised" than "optimized" (ex. Near universal use of -80 mesh)

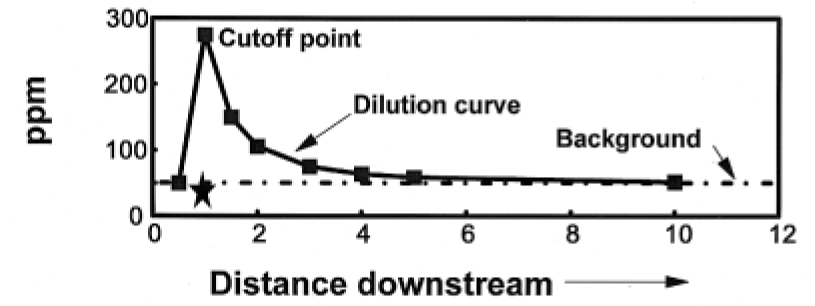
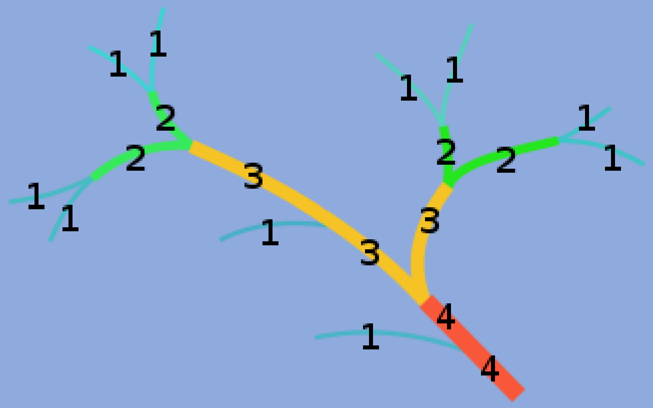


Figure 1: *Hypothetical anomaly dilution curve based on Hawke's model. The star marks the location of the source anomaly, the background concentration is 50 ppm and the cutoff point is the maximum extent of the anomaly upstream.*



Strahler Number (Wikimedia commons)

On the Stream Bed

- For routine surveys, material is usually silt to fine-medium sand
- Avoid bank material
- For routine surveys in high energy streams, adequate sample material locations may be on behind large boulders, in low-energy pools, and voids below gravel bars
- To better pick up Heavy Mineral Associated Elements (HMEs), good sites include silt-sand in lee of the boulders, pools, and cobble-gravel “pavement”.
  - Sampling in some of these localities can act as a pseudo heavy mineral sample
- Sediments are not soils and should be treated differently

Element Distribution

- Can vary depending on sample location, morphology, size fraction, and other factors

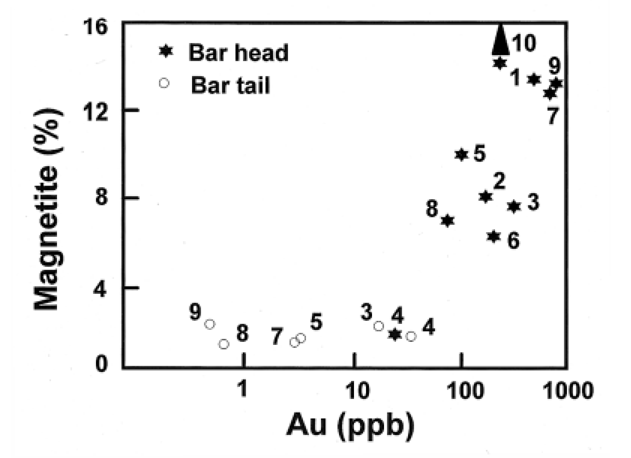


Figure 4: *Concentrations of magnetite (–212+150 µm) and gold (–106+75 µm) in bar head and bar tail sediments from Harris Creek, British Columbia. Numbers indicate increasing distance downstream. Note the very different trends: gold and magnetite are both concentrated at bar head, heavy mineral trap sites but not in sandy bar tail pools. In the pools magnetite concentrations are approximately constant whereas gold values increase upstream (towards an unknown source). Based on Day and Fletcher (1991).*

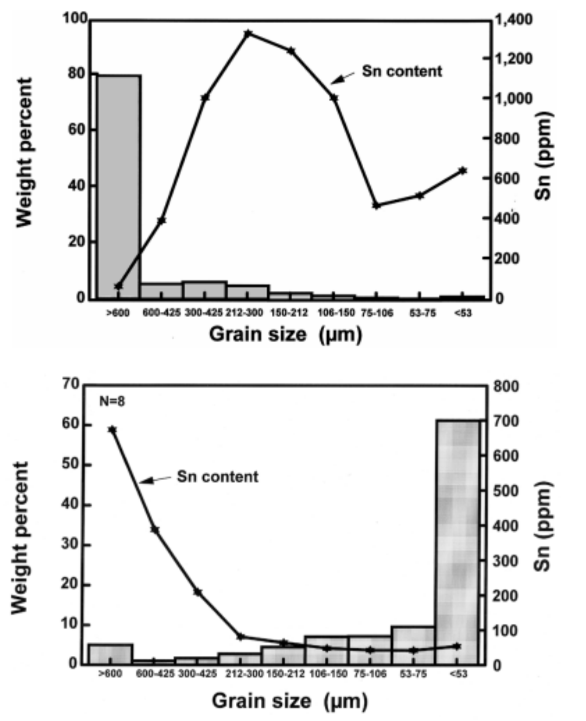


Figure 5: *Grain size distribution and concentrations of Sn in sediments (**a**) and soils (**b**), Tanjong Tualang, Malaysia. Based on Sirinawin et al. (1987).*

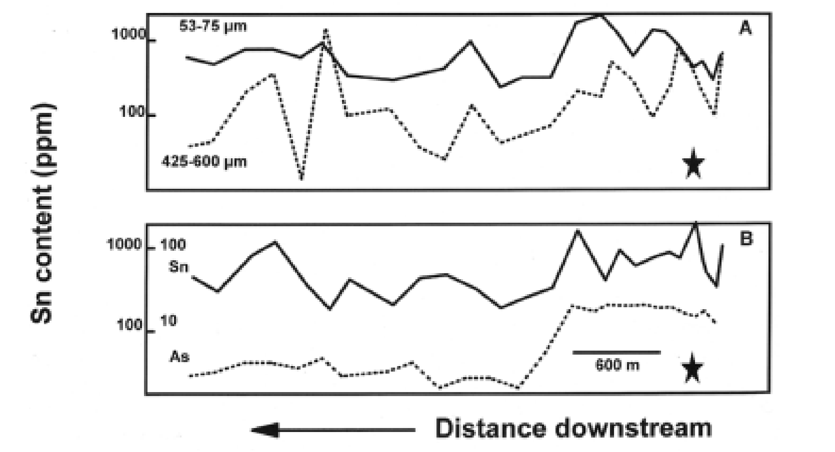


Figure 7: *(**a**) concentrations of Sn in the −75+53 µm and –600+425 µm stream sediments from the S. Petal, Malaysia; and (**b**) concentrations of Sn and As in –80 mesh sediments from the S. Petal. Soil anomalies at the source contain 1300–1800 ppm Sn and 1930–2600 ppm As. The down-stream dispersion pattern for W is similar to that for Sn whereas patterns for Cu, Pb, Zn, Li and F are similar to the As patterns. Location of the primary tin mineralization indicated by (*). Based on Fletcher et al. (1984, 1987).*

When to Sample

- Seasonal weather and localized events have a great effect on stream sediment sampling
- Trapping of heavy minerals in bars is best performed immediately after a flood peak
  - Can be logistically challenging
- Moss mats, if present, can provide a trap for sediments and heavy minerals

Size Fraction and Sample Size

- No universal recommendation is possible, but -80 mesh (-177 um) is widely used
  - Would obviously not be useful if anomalies are found in coarse fractions
- Other fractions, such as less than 100um, can be useful for gold exploration
- Sample size should be representative
  - The more, the better in most cases
  - Affects detection limit

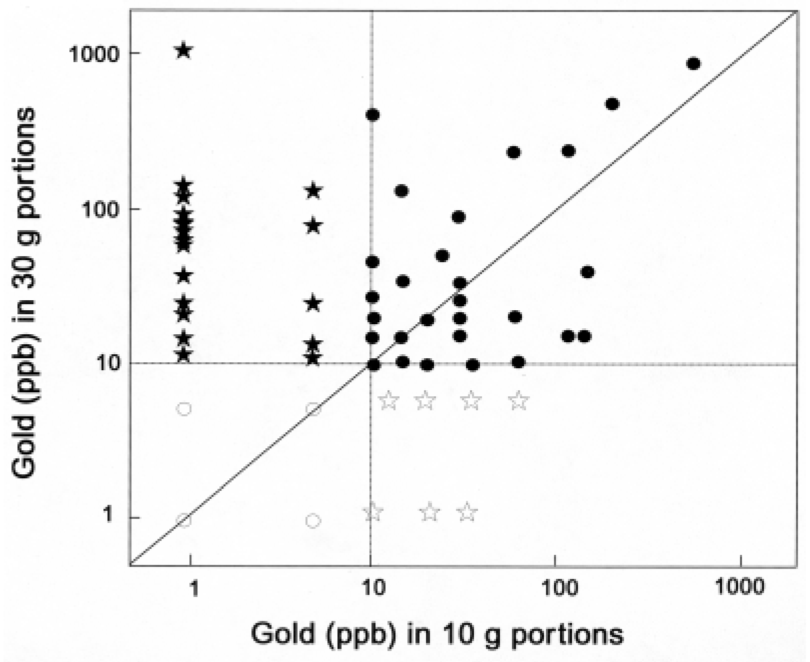


Figure 13: *Determination of gold content of 10 and 30 g splits of stream sediment samples from British Columbia. Note that with a threshold of 10 ppb thirteen anomalous samples went undetected in the 10 g splits versus only three using 30 g splits. The considerable scatter in the data probably results from there being too few gold particles in samples of these sizes. Data courtesy of Westmin Resources Ltd.*

Importance of Orientation Surveys

- First step in a serious stream sediment survey
- Will help establish optimum sample densities, sizes, sampling media, size fractions, etc
- Sample density and spacing is key, don’t want to sample an area too large or small.

Conclusions

- Stream sediment surveys are a robust, cost-effective method of exploration
- Results of surveys can be improved by attention to sample representativity at scales that range from catchment basin size, location of sample site, sample methods and time of year, and sample size

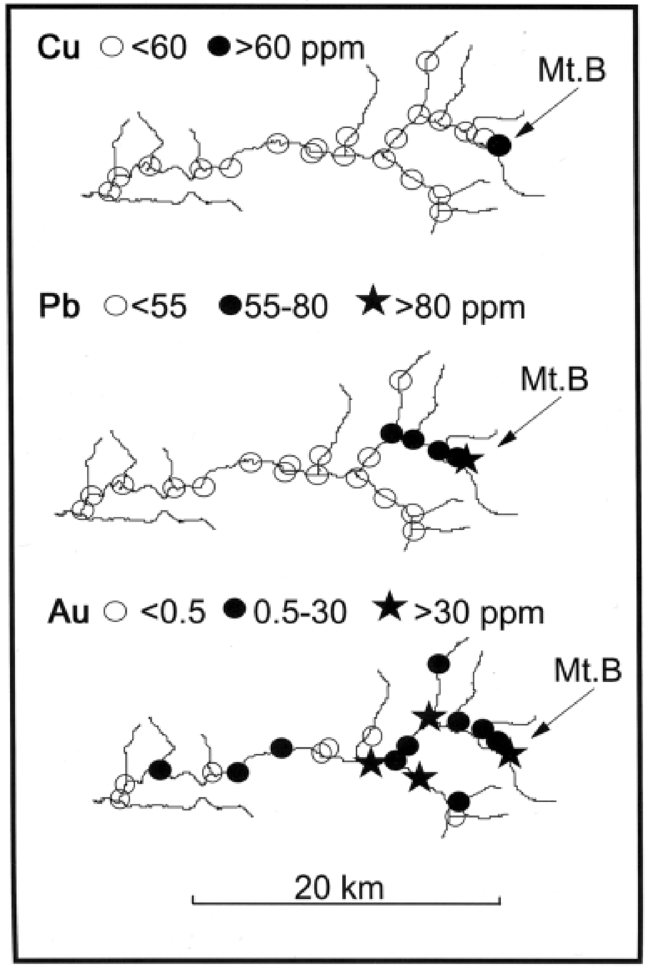


Figure 8: *Results obtained in a reconnaissance stream sediment survey downstream from the Mt. Bini copper-gold-molybdenum deposit in Papua New Guinea: gold content in heavy mineral pan concentrates; copper and lead in ground < 2 mm sediments. Bulk cyanide leach gold (not shown) did not display a distinct anomalous dispersion train at the reconnaissance level. Modified from Dugmore et al. (1996).*

Thoughts on Article

- Pros:
- Detailed and thorough article
- Lots of good information
- Good figures

- Cons:
- Layout could be improved (put orientiation survey near beginning)

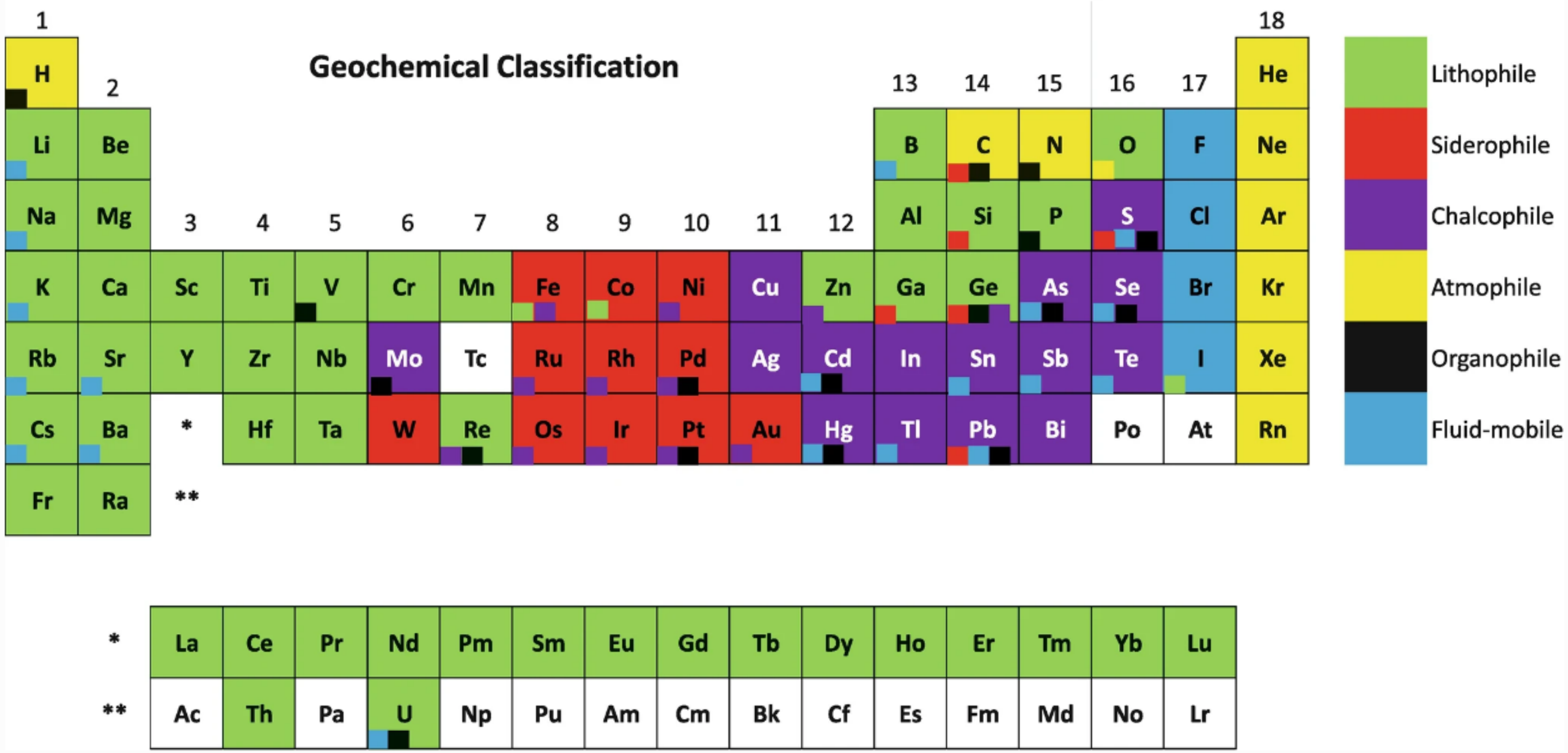
Questions?

References

- Fletcher, W.K., 1997, Stream Sediment Geochemistry in Today's Exploration World in Proceedings of Exploration 97: Fourth Decennial International Conference on Mineral Exploration edited by A.G. Gubins p. 249–260
- Hawkes, H.E., 1976, The downstream dilution of stream sediment anomalies: J. Geochem. Explor., 6, 345-358.

Geochemical Classification of Elements, Fig. 1

From: Geochemical Classification of Elements



Geochemical Classification of Elements, Fig. 1

Cosmochemical classification of elements: Cosmochemical classification of elements based on 50% condensation temperatures at 10^{-4} bar using data from Lodders and Fegley (1998)

SAMPLING

WHY SAMPLE?

WHY SAMPLE?

- Estimate contents of a population in an unbiased manner with an acceptable and affordable degree of precision—representative
  - Exploration stage to locate economic mineral deposits, drill targets
  - Determine physical and chemical characteristics
  - Development stage to determine reserves
  - Process amenability
  - Production stage to maintain grade control
  - Environmental monitoring, compliance

SAMPLING MEDIA

A variety of sampling media can be tested

- solid
- liquid
- air
- biological
- Other materials

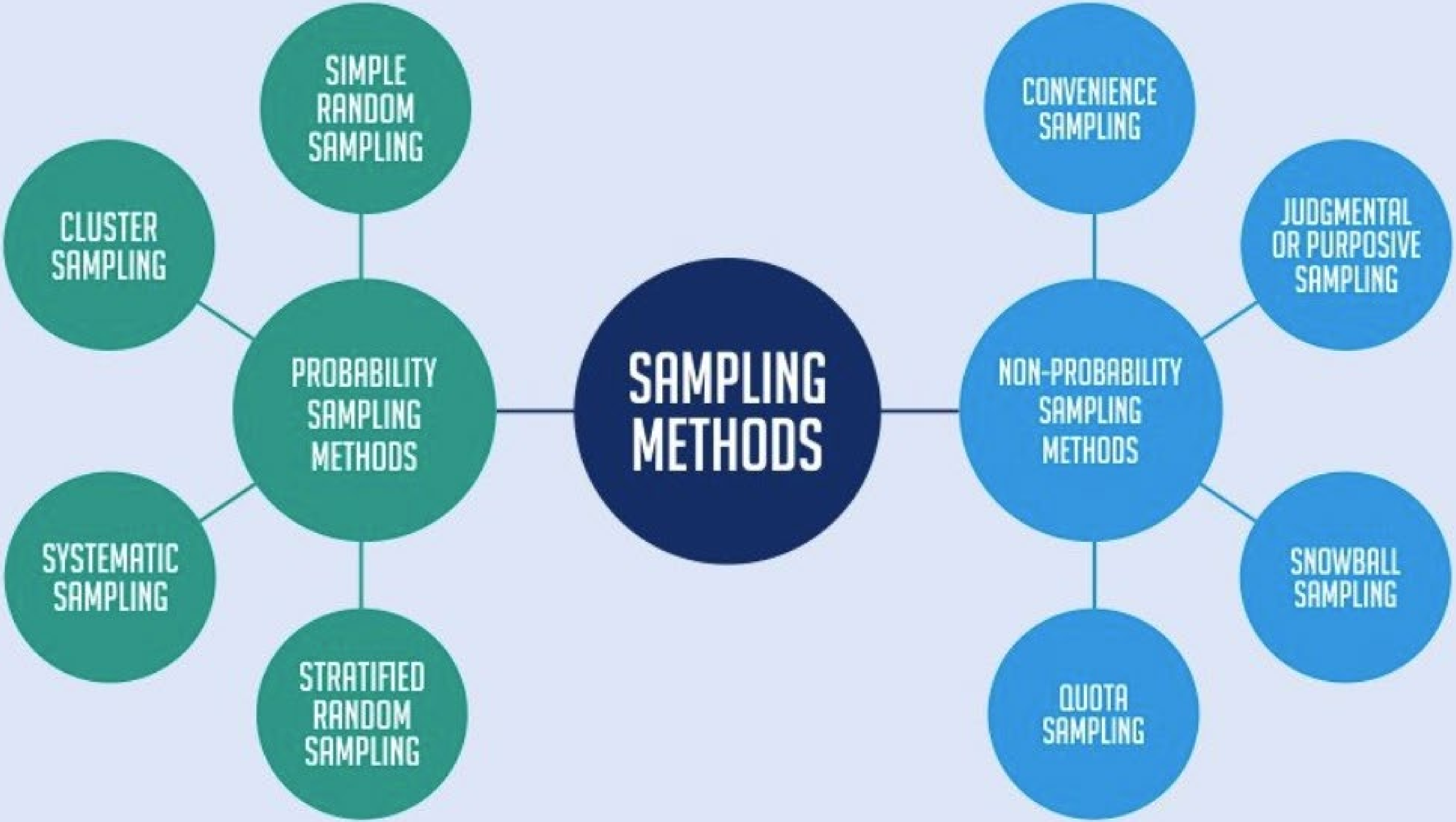
In fact, all types of sampling media should be sampled at some point during the life of the mine, preferably in the initial stages.

Definition of sample

- A representative portion, subset, or fraction of a body of material representing a defined population
- Portion of a population that is actually studied and used to characterize the entire population

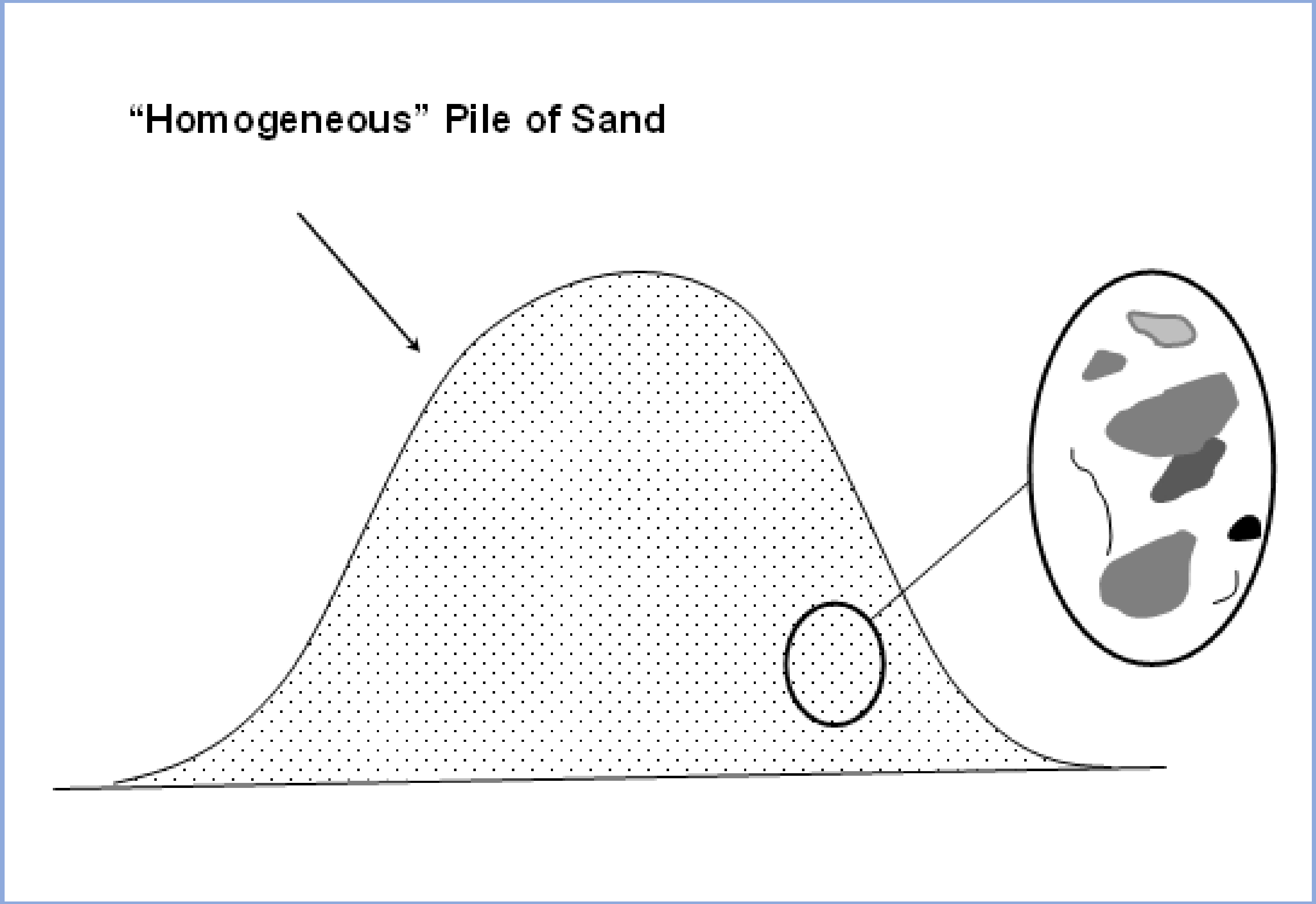
Collecting a representative sample can be difficult because of the compositional, spatial, and size heterogeneities

Sampling procedure, process, storage, preservation, pretreatment are important factors


SAMPLING METHODS
PROBABILITY SAMPLING METHODS
SIMPLE RANDOM SAMPLING
CLUSTER SAMPLING
SYSTEMATIC SAMPLING
STRATIFIED RANDOM SAMPLING
NON-PROBABILITY SAMPLING METHODS
CONVENIENCE SAMPLING
JUDGMENTAL OR PURPOSIVE SAMPLING
SNOWBALL SAMPLING
QUOTA SAMPLING

Types of samples

- Outcrop
- Core
- Drill cuttings (reverse circulation)
- Other drilling
- Grab samples
- Channel sampling (small chips over a specified interval)
- Pan sampling (heavy concentrates)
- Trench sampling
- Composite sampling
- High grade sampling (selected pieces of the most highly mineralized material)
- Run of mine ore feed
- Crusher product



Heterogeneity as a function of the scale of observation (from McLemore et al., 2014)

Gallinas Mountains Project

Sample Entry

Sample id	Gal1	Waypoint id	Gal1	Collected by	VTM
Media	solid	Type of sample	rock	Depth start	0
Method of sample collection	channel			Depth end	0

Sample Sourc: natural exposure/outcrop

☐ Is this legacy data?

☑ Is alteration present?

Reason for sampling: chemistry, thin section

☑ Is fluorite present?

☑ Is brecciation present?

☑ Is mineralization present?

☑ Is hemitization present

DESCRIPTIO

Rock Type	sedimentary	Rock Nam	sandstone		
Geologic Age	Permian	Rock Mineralization	vein		
Rock Alteration	altered	Structure Sample (igneous rock)			
Deposit Environment	continental	Source Rock (metamorphic)			
Metamorphism		Facies Grade		Quantity	1 bag
Sample Comments	chip of outcrop, thin fluorite veins				
Type of Analysis		Date analyzed			

Information needed on sample collected in the field

Take photo of sample location

Why do you need a sampling plan?

Why do you need a sampling plan?

- Document what is to be done
- Consistency
- Everyone following the same procedures
  - Today and in the future
  - But they are living documents
- Contract or regulatory obligations
- Reduce errors
- Reduce cost

The plan should be based upon the geology and regulatory requirements.

COMPONENTS OF A SAMPLING PLAN

- Define questions and objectives
- Develop site conceptual models
- Costs and potential consequences of not sampling
- Identify types of data and information needed
- Define confidence level and quantity of data required to answer questions
- Design the sampling plan

COMPONENTS—continued

- Develop protocols
- Conduct an orientation or pilot study before implementation
- Conduct sampling plan
- Analyze and manage data (interpretation)
- Make decisions (risk management)
- Educate and inform the parties involved

Example of a sampling plan

https://geoinfo.nmt.edu/staff/mclemore/documents/samplingplan_v5.pdf

1. DEFINE QUESTIONS AND OBJECTIVES

- Identify sources, transport, and effects of potential contamination of soil and drainage quality
- Validate predicative models
- Validate mitigation/remediation/reclamation efforts
- Preventative and remediation monitoring
- Establish background or existing conditions
- Identify impacted areas vs. pristine areas
- Potential use of water in operations
- Operational compliance monitoring
- Validate reclamation efforts

2. DEVELOP SITE CONCEPTUAL MODELS

Review existing data

- Climatic data
- Physical data
- Geology (mineralogy)
- Hydrogeology (Surface-ground water interaction)
- Mining history and impacts of mine workings
- Biology
- Other data available

3. COSTS AND POTENTIAL CONSEQUENCES OF NOT SAMPLING

- Avoid being data rich but information poor
- Public perceptions of risk
- Perceptions of chemicals associated with the mining industry, such as cyanide
- Some long-term and widespread environmental problems should be considered relatively high-risk even if the data on which the risk assessment is based are somewhat incomplete and uncertain

4. IDENTIFY TYPES OF DATA AND INFORMATION NEEDED

- What sampling media (solid, liquid, biological/wetlands, air)?
- What are sources, transport mechanisms, and receptors?
- What other parameters must be monitored?
- What type of sample is to be collected and is it representative of sampling?
- What field measurements are required?
- What is the feasibility of sampling?
- How much sample is needed?

5. DEFINE CONFIDENCE LEVEL AND QUANTITY OF DATA REQUIRED TO ANSWER QUESTIONS

- What is the confidence level needed?
- How many samples are required to get the needed results?
- What is the precision required?

6. DESIGN THE SAMPLING PLAN

- QA/QC
- Data format
- Safety issues (OSHA vs. MSHA vs. local, state vs. good neighbor/employer)
- Sample location, number of samples, and frequency of sampling, proper labeling of samples (site specific)
- What constituents or parameters are required for each media

7. DEVELOP PROTOCOLS

- Collection techniques
- Sample collection
- Observational field data
- Modify sampling plan and deviations
- Opportunistic sampling
- Contamination
- Handling/transport
- Preservation and storage (from field to laboratory)

7. DEVELOP PROTOCOLS—continued

- Sample pre-treatment in the laboratory
- Filtration
- Sample preparation
- Sample separation
- Archival/storage
- Analytical procedures and techniques

8. ORIENTATION OR PILOT STUDY

- Clear understanding of target type
- Understanding of surficial environments
- Nature of dispersion from mineralized areas
- Sample types available
- Sample collection procedures
- Sample size requirements

8. ORIENTATION OR PILOT STUDY—continued

- Sample interval, depth, orientation, and density
- Field observations required
- Sample preparation procedures
- Sample fraction for analyses
- Geochemical suite for analyses
- Data format for interpretation

9. CONDUCT SAMPLING PLAN (PROGRAM IMPLEMENTATION)

10. ANALYZE AND MANAGE DATA

- Reporting data
- Presentation of data
- Interpretation
- Data interpretation approaches
  - Statistical
  - Spatial
  - Geochemical
  - Geological

10. ANALYZE AND MANAGE DATA—continued

- Reporting and dissemination
- What becomes of data (storage)
- Common data formats
- Use the data
- Reliability and limitations of findings
- Evaluate the data (statistics)

11. MAKE DECISIONS (RISK MANAGEMENT)

12. Educate and inform the parties involved

REE in Coal Sampling Plan

CORE-CM PROJECT—SAN JUAN RIVER-RATON BASINS, NEW MEXICO FIELD SAMPLING PLAN

Prepared by the Characterization Team

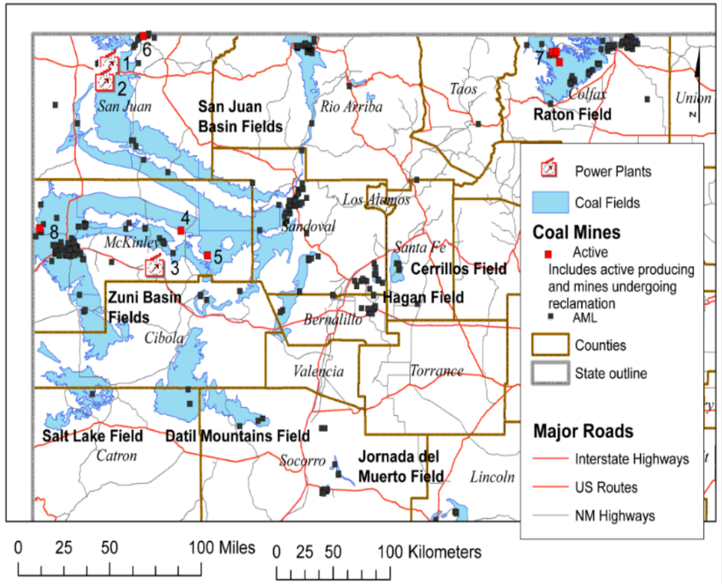
November 2021

1.0 INTRODUCTION

In order to evaluate REE in coal and associated stratigraphic units in the San Juan and Raton basins, a variety of field sampling methods of solid and water are required. This Field Sampling Plan describes the field sampling and analyses that will be conducted as part of studies for the CORE-CM Project. The field sampling program will be carefully planned to meet the Data Quality Objectives (DQOs), minimize cost, and minimize the potential conflicts between the numerous investigations. Appendix 1 is a list of SOPs. Appendix 2 includes forms used during the sampling program. All of this information is in the Project Database. The specific fields and data collected have been determined by various PIs to be important to characterize the samples. A SQS database will be designed to store, manage, and interpret data.

2.0 REE SAMPLING PROGRAM METHODOLOGY

Representative samples will be collected from each coal field. Clay, black shales, and other stratigraphic units above and below coal seams will be sampled as appropriate. Samples on Federal land do not require any permission for access and will be given higher priority for sampling. Coal waste and by-products will be sampled from active and inactive coal mines. The New Mexico State Land Office has granted permission to sample on state land and a permit is pending. Permission before sampling on private (including active coal mines and power plants) or Tribal lands will be obtained before sampling.



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)

District id	District	Year of Discovery	Year of Initial Production	Year of Last Production	Estimated Cumulative Production	Formation	Prefix used for sample id
DIS257	Barker Creek coal field	1882		1905		Menefee	BAR
DIS150	Bisti coal field	1961	1980	1988	$40,075,148.00	Fruitland	BIS
DIS259	Chaco Canyon Coal Field	1905	1905			Menefee	CHACO
DIS260	Chacra Mesa coal field	1922		1945		Menefee	CHACA
DIS174	La Ventana	1884	1904	1983		Menefee	LAV
DIS118	Crownpoint coal field	1905	1914	1951	$20,758.00	Crevasse Canyon	CRWN
DIS155	Fruitland coal field	1889	1889	2001	$3,137,957,050	Fruitland	FRUIT
DIS119	Gallup coal field	1881	1882	2001	$121,522,629,885	Crevasse Canyon	GALL
DIS156	Hogback coal field	1907	1907	1971	$301,237.00	Menefee	HOG
DIS146	Monero coal field	1882	1882	1970	$5,277,552.00	Menefee	MON
DIS016	Mount Taylor coal field	1936	1952	1953	$69,948.00	Crevasse Canyon	TAY
DIS157	Navajo coal field	1933	1963	9999	$4,714,689,147	Fruitland	NAV
DIS258	Newcomb coal field	1955				Menefee	NEW
DIS021	Raton coal field	1820	1898	2002	$954,470,032.00	Vermejo, Raton	RAT
DIS003	Rio Puerco coal field	1901	1937	1944	$139,555.00	Crevasse Canyon	RIO
DIS009	Salt Lake coal field	1980	1987	1987	$100,000.00	Moreno Hill	SALT
DIS121	San Mateo coal field	1905	1983	2001	$1,678,742,326	Menefee	MAT
DIS261	Standing Rock coal field	1934	1952	1958		Menefee	STND
DIS158	Star Lake coal field	1907			$0.00	Fruitland	STAR
DIS263	Tierra Amarilla coal field	1935	1955	1955		Menefee	AMAR
DIS159	Toadlena	1950			$0.00	Menefee	TOAD
DIS124	Zuni coal field	1916	1908	1926	$16,010.00	Crevasse Canyon	ZUNI

Metadata

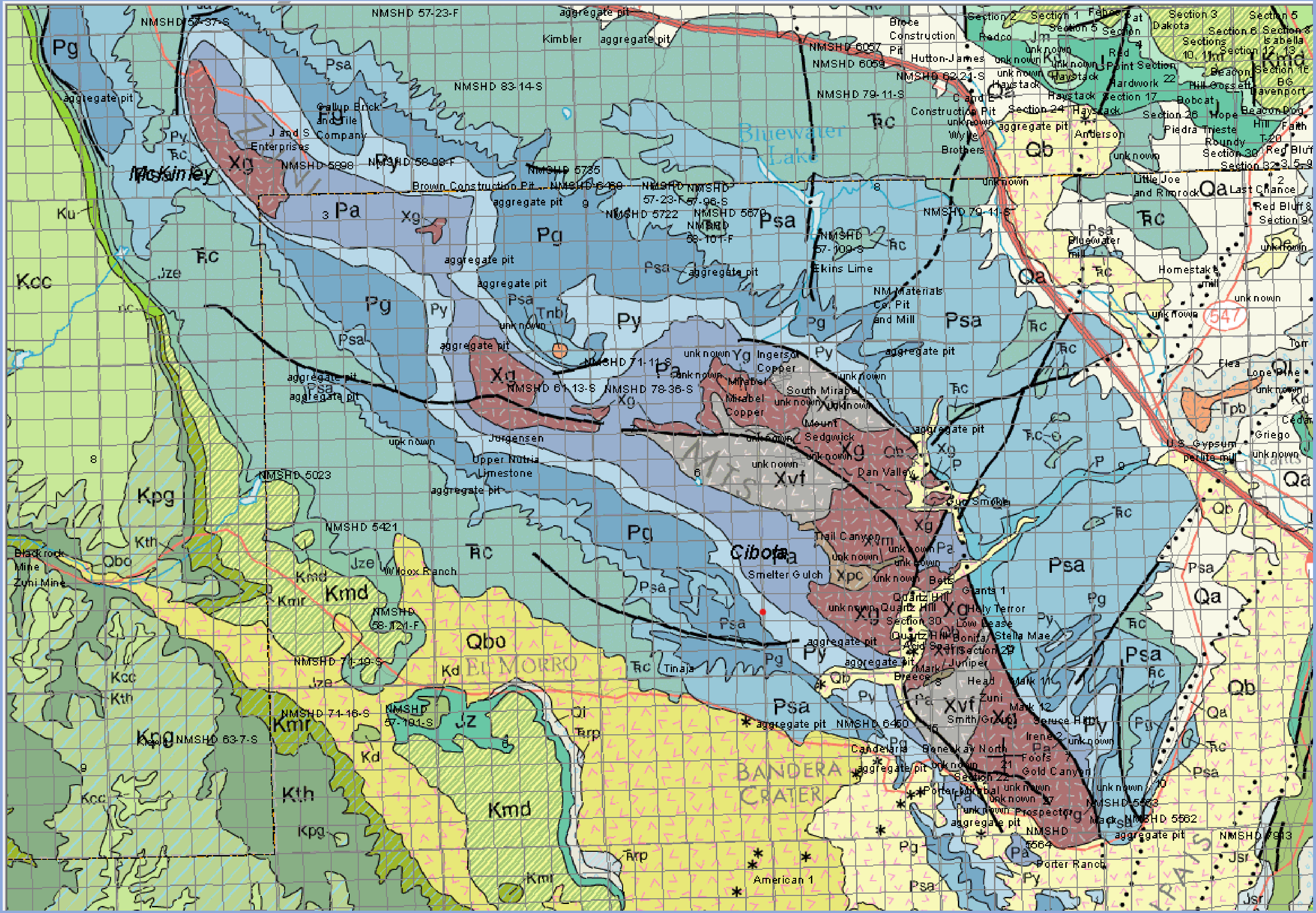
- USGS and DOE require information on the **sample—see spreadsheet**
- It can take 1-2 hrs to collect the sample properly and obtain all of the metadata required

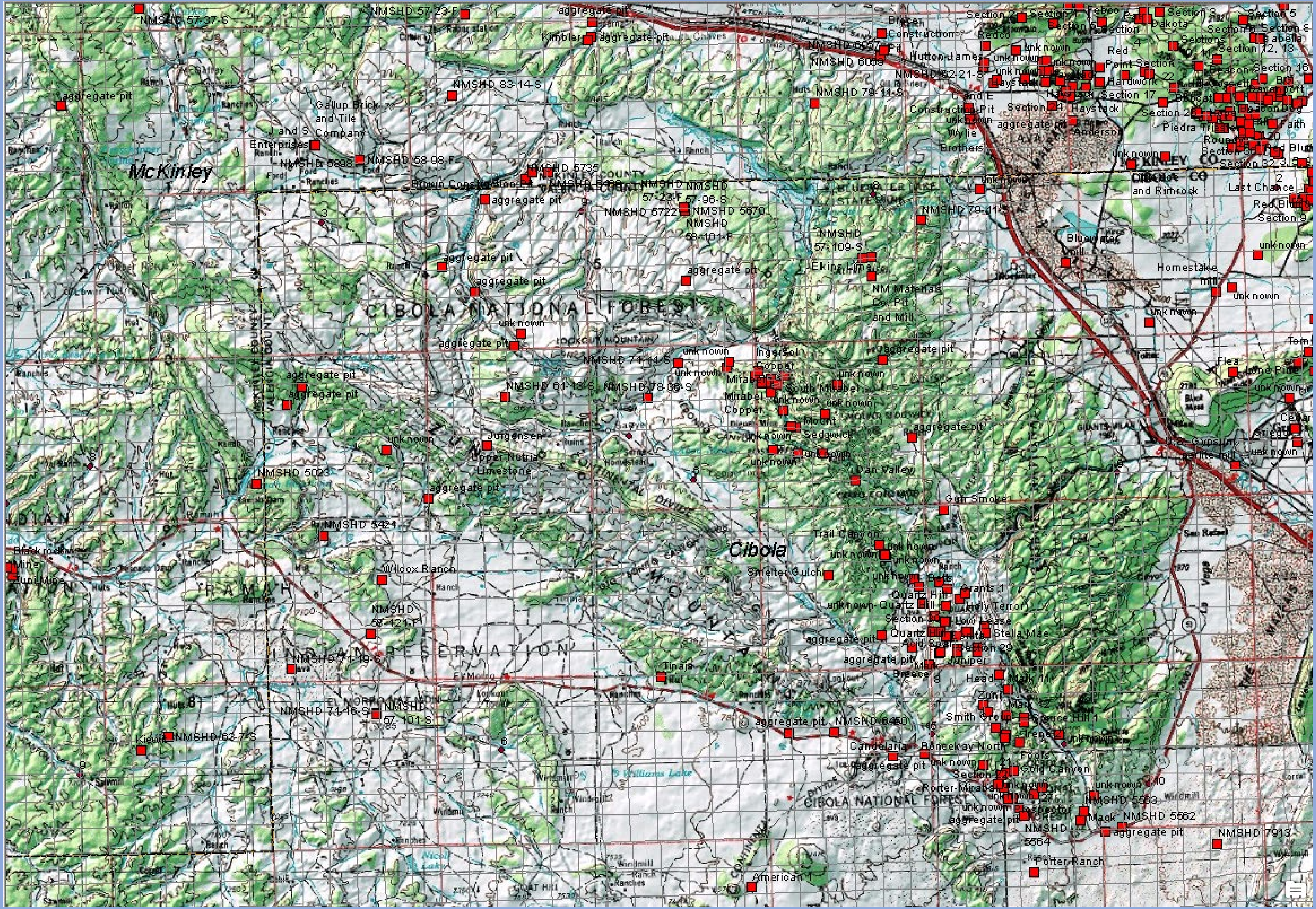
Tonight

- Select points on maps
  - I NEED THESE POINTS BY FRIDAY
- Prepare/collect field sampling gear
- Camping gear
  - What does you team need

TABLE 1.7 Goldschmidt's (1888–1947) classification of the elements (Goldschmidt, 1954)

Lithophile	Siderophiles	Chalcophile	Atmophile
Li, Na, K, Rb, Cs	Fe[a], Co[a], Ni[a]	(Cu), Ag[b]	(H), N, (O)
He, Ne, Ar, Kr, Xe	Ru, Rh, Pd, Zn, Cd, Hg[c],	Be, Mg, Ca, Sr, Ba	
B, Al, Sc, Y, REE	Os, Ir, Pt	Ga, In, Tl	
Si, Ti, Zr, Hf, Th	Au, Re[d], Mo[d]	(Ge), (Sn), Pb	
P, V, Nb, Ta	Ge[a], Sn[a], W[e]	(As), (Sb), Bi	
O, Cr, U	C[e], Cu[a], Ga[a]	S, Se, Te	
H, F, Cl, Br, I	Ge[a], As[c], Sb[d]	(Fe), Mo, (Os)	
(Fe), Mn, (Zn), (Ga)		(Ru), (Rh), (Pd)	


McKinley
Cibola
Bluewater Lake
ZUNI
MTS
EL MORRO
BANDERA CRATER
Gallup Brick and Tile Company
J and S Enterprises
Brown Construction Pit
Kimbler
aggregate pit
unknown
Upper Nutria Limestone
Jurgensen
Wilcox Ranch
Blackrock Mine
Zuni Mine
Ingersol Copper
South Mirabel
Mirabel Copper
Mount Sedgwick
Dan Valley
Trail Canyon
Smelter Gulch
Quartz Hill
Holy Terror
Low Lease
Bonita
Stella Mae
Tinaja
Candelaria
Porter Ranch
American 1
Gold Canyon
Bluewater mill
Homestake mill
U.S. Gypsum perlite mill
Ekins Lime
NM Materials Co. Pit and Mill
Hutton-James
Construction Pit
Wylie Brothers
Anderson
Little Joe and Rimrock
Last Chance
Red Bluff
Lone Pine
Griego
Section 17
Section 24
Section 30
Section 32
NMSHD 57-23-F
NMSHD 83-14-S
NMSHD 5898
NMSHD 5735
NMSHD 5722
NMSHD 5670
NMSHD 71-11-S
NMSHD 61-13-S
NMSHD 78-36-S
NMSHD 5023
NMSHD 5421
NMSHD 71-19-S
NMSHD 71-16-S
NMSHD 63-7-S
NMSHD 6450
NMSHD 5562
NMSHD 79-11-S
Pg
Pa
Psa
Py
Xg
Xvf
Xpc
Qb
Qa
Qbo
Kcc
Kpg
Kth
Kmd
Kmr
Kd
Jze
Jz
Ku
Tnb
Tpb


McKinley
Cibola
CIBOLA NATIONAL FOREST
INDIAN RESERVATION
RAMAH
aggregate pit
unknown
NMSHD 57-37-S
NMSHD 83-14-S
Gallup Brick and Tile
J and S Company
NMSHD 58-98-F
NMSHD 5735
NMSHD 6722
NMSHD 5670
NMSHD 57-109-S
NMSHD 71-44-S
NMSHD 61-48-S
NMSHD 78-66-S
Jurgensen
NMSHD 5023
NMSHD 5421
Wilcox Ranch
NMSHD 71-19-S
NMSHD 71-16-S
NMSHD 57-101-S
NMSHD 62-7-S
Kiewit
Blackrock Mine
Elkins Limes
NM Materials Co. Pit and Mill
Ingersol Copper
Mirabel Copper
South Mirabel
Mount Sedgwick
Oak Valley
Gun Smoke
Trail Canyon
Smelter Gulch
Quartz Hill
Stella Mae
Tinaja
NMSHD 6450
Candelaria
Smith
Potter Ranch
NMSHD 5563
NMSHD 5562
NMSHD 5564
NMSHD 7913
American 1
Bluewater mill
Homestake mill
Haystack
Red Point
Section 17
Last Chance
Red Bluff
Section 9
Hutton James
Brown Construction
Kimble
Dakota
Flea
Poison Canyon