Fall 2022

Soil Contamination due to Nuclear Testing

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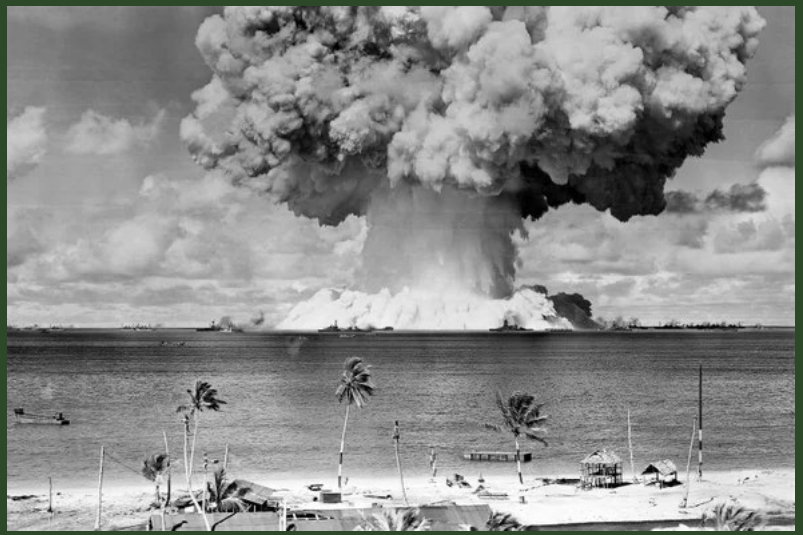
CHE- 141405H FALL 2022

Big picture

- Why this topic:
  - Nuclear contamination has long term effects (cdc.gov)
  - Australia and the U.S. took land from indigenous peoples to conduct nuclear tests (Rapaport, Hughes)
  - Give idea of whether indigenous peoples can return to their lands safely



Picture of nuclear testing in marshall islands (Hart et Hughes)

Terms

- Semipalatinsky Test Site Sary Uzen Site (STS) (Krivitskiy)
- Boreholes - deep narrow vertical holes (Krivitskiy)
- Explosion with the release of soil (ERS) - underground nuclear explosion resulting in ejection of radioactive contaminants outside the borehole(Krivitskiy)
- Ashing - heating element until it's only ash to do elemental composition analysis (inorganic ventures)

Primary Research Article

- Experimental question
  - Is there still any radioactive contamination in the sites, and if so how much? (Krivitskiy)
- Examining differences between types of detonations and nuclear contamination (Krivitskiy)
- STS one of the largest nuclear test sites in the world (Krivitskiy)
  - 340 underground tests (Krivitskiy)
- Secondary purpose: determine the specific types of radioactive contamination (Krivitskiy)

Literature Research

- Methodology
  - Gamma spectrometer, plastic containers used to pick 500-1000g (Krivitskiy)
  - Precipitation reactions, sampling and ashing to determine ions (Krivitskiy)
  - Use these methods to determine the amount of radioactive contamination (Krivitskiy)
  - Note the type of explosion: ERS or no ERS? (Krivitskiy)
    - See how this affects the amount of contamination

Summary of Findings

- Most of the test sites had contamination (Krivitskiy)
- 2 groups
  - Radioactive contamination of surface soil (Krivitskiy)
    - 2 Subgroups
      - ERS (Krivitskiy)
      - No deformation of ground soil (Krivitskiy)
      - ERS had more radioactive contamination of local area (Krivitskiy)
  - No radioactive contamination of surface soil (Krivitskiy)
    - Not explained why there is no contamination compared to other test sites

Follow up Questions

- Determine why some boreheads didn’t have any radioactive contamination?
  - Could possibly shed insight on processes that could be taken in the future to limit radiation from nuclear tests
- Radioactive contamination from explosions not in boreholes?
  - Not all nuclear testing happened in boreholes, some detonations occurred from boats (Hart et Hughes)
  - This would be more applicable to nuclear testing in the Farrow islands (Hart et Hughes)

Experimental Research

The soils project

Series of labs to analyze properties of soil, such as microbial activity, levels of potassium, phosphorous, and bioactivity

Introduction

- Two samples:
  - Prairie
  - Fallow
- Experimental question: see the effect biological activity would have on soil.
- Thus, chose soil with predicted very little biological activity (fallow) vs soil with a lot of biological activity (prairie)

Soil Sampling

- 2 samples
  - Prairie
  - Fallow
- Prairie had more noticeable plant life than fallow when taking soil samples (plants, bugs, leaves)

Fallow

Prairie

Sieving

- Sort soil into: > 6.4mm, 2mm to 6.4m, < 2mm
- Dirt in both samples was similar color
- Fallow made more <2mm fraction from similar volumes of samples
- With fractions, can do analysis on soil to measure potassium, phosphorous, microbial activity, etc in future labs

>6.4mm, 2mm to 6.4mm, <2mm (ground) prairie samples

Soil Texture/ pH + EC Lab

- Clay % overestimated as not enough time given to settle
- My prairie value for electrical conductivity much higher than class average, perhaps because more variation because of what plants are growing nearby
- Both soils are effectively very similar at supporting plant life
    - Surprising to me as previous labs show prairie supporting much more bioactivity compared to fallow

	Prairie	Fallow	Class Avg Prarie	Class Avg Fallow
pH (pH)	8.00	7.95	8.12	7.97
electrical conductivity (µS)	317	329	251	327
%clay (m/m)	32.3%	43.4%		
%silt (m/m)	23.8%	3.8%		
%sand (m/m)	39.9%	52.7%		
type	clay loam	silty clay	sandy clay loam	silty clay loam

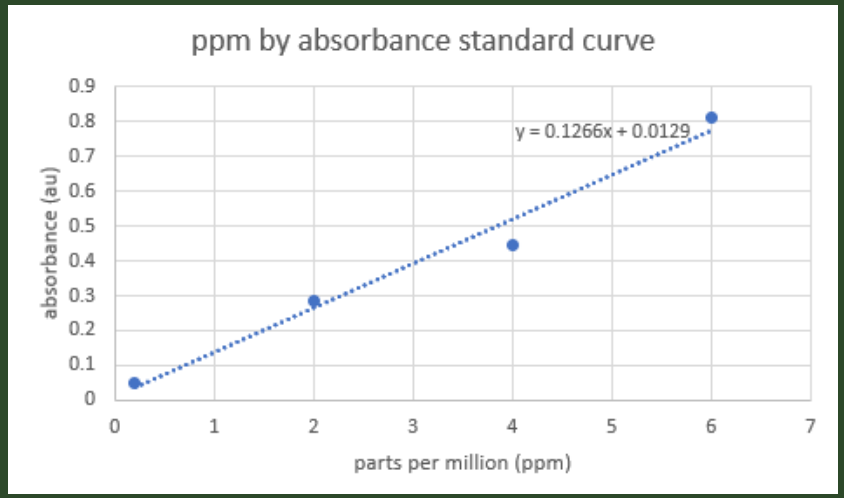
K Analysis

- Prairie
  - 832 $\frac{\text{lb K}}{\text{acre}}$, above optimum, class average 525 $\frac{\text{lb K}}{\text{acre}}$
- Fallow
  - 497 $\frac{\text{lb K}}{\text{acre}}$, above optimum, class average 466 $\frac{\text{lb K}}{\text{acre}}$
- Nutrients does not limit crop yield in either case (Heckman)
- Both soils are not managed so remedial action could be taken if the soils were to be used to farm crops (Heckman)
- The biological activity of prairie soil could have led to the increased potassium content
- Class values are reasonably close, prairie continues trend of having massive amount of variation throughout the class data

P Analysis Lab

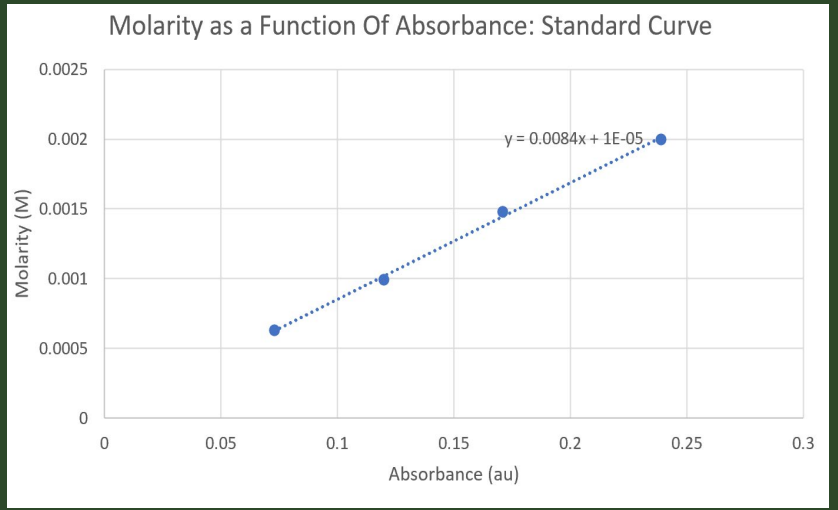
- Amount of phosphorous in samples
- Sample value for 4ppm standard is lower than standard curve; this may mean ppm for the sample should be higher
- Values close to class avg
- Biological activity on prairie lab could have led to higher phosphorus content

	amnt of P lb/acre
prairie	45.2
fallow	64.62
prairie class avg	43.96
fallow class avg	62.37



POXC Experimental + Calculations Lab

- Created standards that were used to relate the amount of $KMnO_4$, to amount of reactive carbon by spectroscopy
- Put too much water into STD4, leading to STD4 being overly diluted
  - Prairie: 934 mg RC/kg soil
  - Fallow: 478 mg RC/kg soil
- Reinforces findings from previous labs, prairie had more biological activity reflected by higher reactive carbon value



Slake Test

- Aggregate stability shows ability to withstand erosion (Che 141 lab manual)
- Fallow lower stability than prairie
- Fallow more cloudy, more flakes at bottom
- Shows prairie soil more suited to supporting plant life
- Biological activity can support ability to withstand erosion, reinforces previous results

Fallow Prairie

Cotton Test

- Measured biological activity in soil
- Found that prairie soil was more biologically active than fallow
  - Prairie sample was much more decomposed than fallow sample
- Agreed with prediction that prairie would be more bio active
- Prairie had earthworms!!

Prairie

Fallow

Microbial Activity Titration

- Prairie: 60.1 mg CO_2/(kg*soil(days)
- Fallow: 40.7 mg CO_2/(kg*soil(days)
- Follows trend that prairie has more bioactivity- sample consumed more CO_2 per day than fallow sample
    - This shows more micro-organisms
- Had lab errors leading to my final solution being extremely dilute, led to sample 1 being very easy to over titrate, but results were still reasonable.

Pictures of 1 set of analytes after titration

POXC Calculations lab

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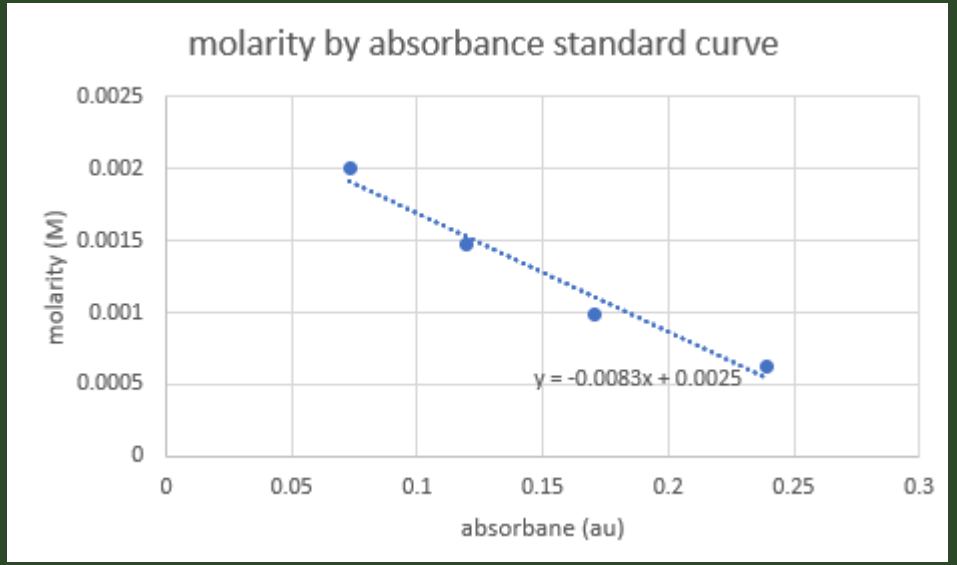

Experimental Research Conclusions

- Confirmed hypothesis that prairie soil had more biological activity than fallow soil
  - Shown through microbial activity titration, cotton test, slake test, poxc test
- Results of more biological activity
  - Prairie soil had more aggregate stability, more potassium, less phosphorus,
- Results from all labs were consistent and the difference in biological activity explained the differences observed between the soil samples throughout the semester

Works Cited

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Soil Fertility Test Interpretation Phosphorus, Potassium, Magnesium, and Calcium Joseph R. Heckman, Ph.D., Extension Specialist in Soil Fertility