Analysis of uranium-bearing dust in the vicinity of Jackpile Mine, Laguna Pueblo

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INTRODUCTION

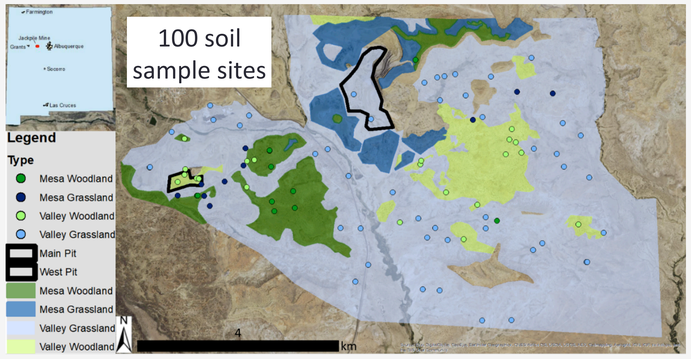
- Closed mines pose potential risks to the environment and human health. Uranium mine contamination of surface water, groundwater and soil have received moderate attention, but few studies have investigated dust transport of uranium.
- The presence of uranium-bearing dust, potentially initially distributed during active mining periods, has implications for remediation efforts and environmental and human health.
- Frequent dust storms increase the risk of aeolian transport of uranium in semiarid settings.

STUDY GOALS

- What are the trends in U concentration as distance from the pits increases?
  - Variations? Influences?
- How does U concentration vary with grain size?
  - Fractionation analysis
  - Potential inhalation risk?
- What is the U concentration in vertical soil profiles?
- Do large wind events correlate with greater U flux?
- Is local soil U content an indicator of dust-borne U risk?

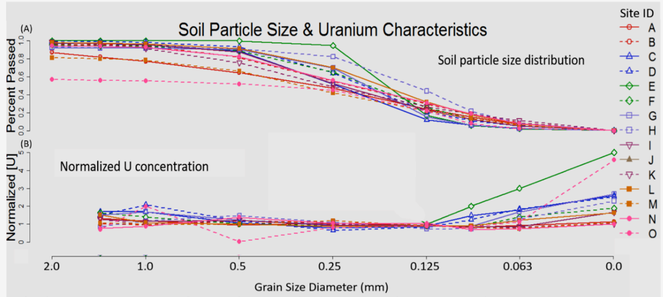
METHODS

- Dust traps at 15 locations collected samples at heights of 0.25, 0.5, 1.0, and 1.5 m above ground. Locations shown as sites A-O at right.
- Soil samples were collected at each trap installation, and at 100 sites selected in a stratified random way.
- Soil samples were sieved into eight size classes, and dust into two or three size classes (depending on mass of sample)
- Soil and dust samples were digested in acid and analyzed for trace metals on an ICP-MS, with a focus on U

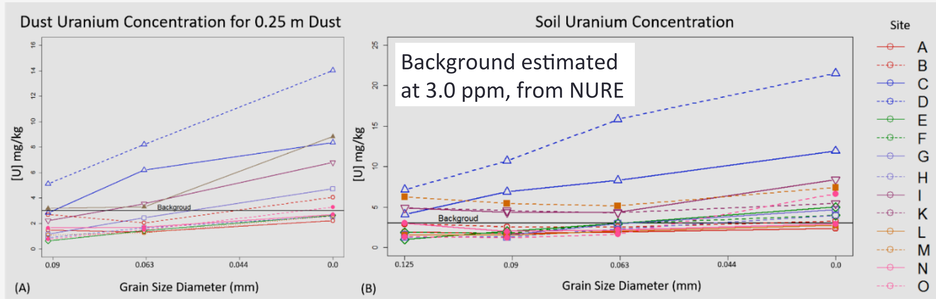


RESULTS: SIZE FRACTIONATION

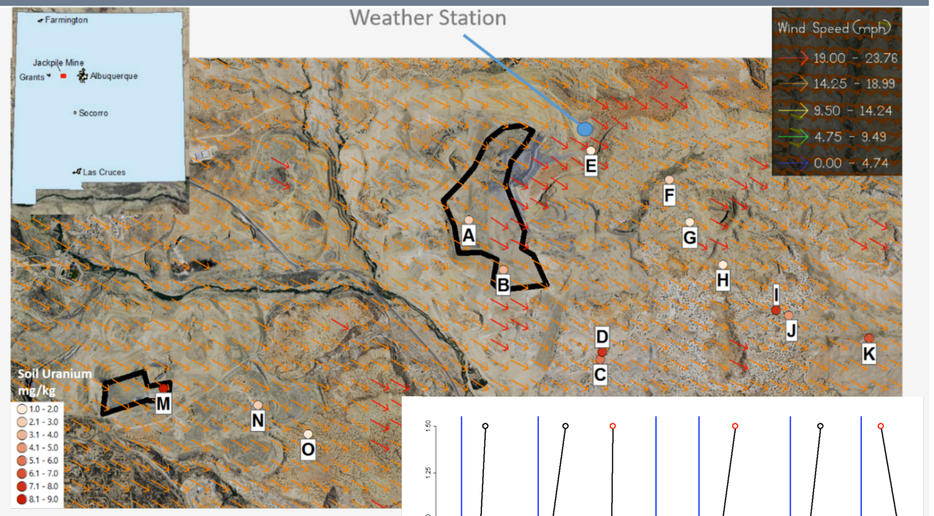
- Soil and dust U conc. Increased with decreasing particle size.
- Local soil concentration was a good predictor of dust U concentration at the 0.25 m dust trap height, but diverged with height.
- Mass flux was highest at lowest trap elevations, decreasing with height according to a power law relationship.



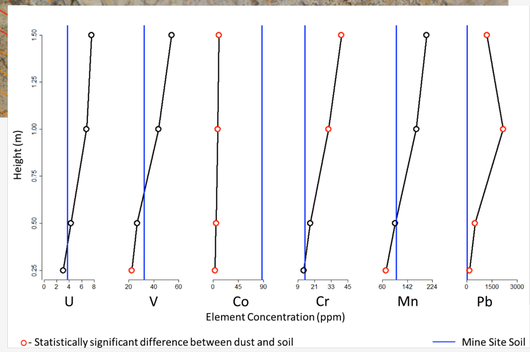
A) The percent pass for soil at each dust trap location. The x axis is grain size in mm with spacing on a negative log base 2 scale (phi scale). Classes are plotted at their lower limit, e.g., the points at 0 mm represent 0 - 0.063 mm. B) Normalized soil uranium concentrations for each of the 15 sites. Normalized soil U concentration (y axis) was calculated by dividing the size class concentration by the composite soil U concentration



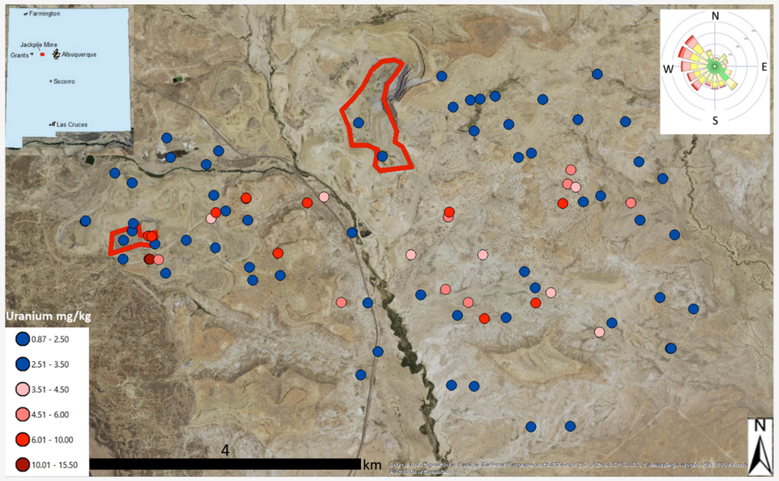
RESULTS: DUST TRAPS



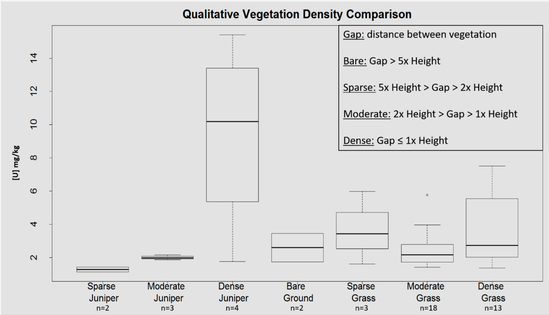
- Distance from the mine sites was not a predictor of soil or dust uranium content.
- On average U concentration increased with dust trap height, as did other metals of concern, most likely due to size fractionation.



RESULTS: SOIL SURVEY



- A more extensive soil survey revealed localized areas of high U concentration.
- These correlate with dense juniper stands.
- Alternative hypotheses, such as soil development into localized U-bearing bedrock outcrops, are being investigated.
- Mesa tops had high dust flux, but low U.



Woodland density appears to be a strong control on dust capture. Sparse woodlands increase scour in the bare ground between trees (relative to grasslands) but a density thrshold exists that leads to enhanced dust (and U) retention.

CONCLUSIONS

- Distance from the pit shows no correlation with uranium in the upper 5 cm of soil. Other factors appear to control accumulation, such as vegetation height and density and topographic relief, which are known to have a significant impact on wind speeds, soil erosion and dust deposition.
- The soil uranium content determined at 15 sites was compared to site elevation and vegetation height. Correlations suggest that elevation and vegetation height influence the erosion and deposition of U-bearing grains.
- Dust mass was measured at each dust trap and converted into a flux (g/d/m2). The relationship between mass flux and height above ground followed a power law relationship as supported by previous aeolian research.
- In general, higher uranium concentrations were associated with smaller particle size classes. Concentrations for 4 of 6 metals of concern were higher in the dust compared to the local soil, a trend we attribute to particle size fractionation during aeolian transport.

ACKNOWLEDGMENTS

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