National Aeronautics and Space Administration

FY25 Strategic University Research Partnership (SURP)

Detecting toxic metal contamination through imaging spectroscopy

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Objectives

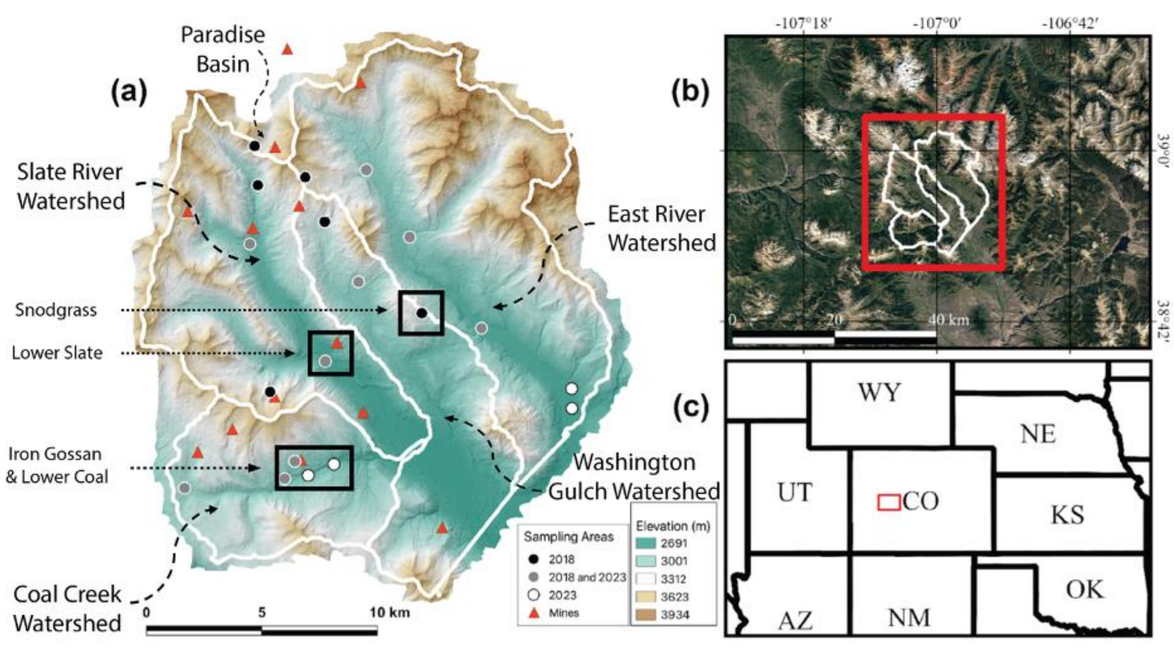
To identify areas of subsurface metal contamination through remotely sensed expressions of contamination in leaf chemistry by:

(a) Utilizing an existing foliar metal concentration dataset from field samples and paired VSWIR spectra to calibrate, evaluate, and quantify error of algorithms for mapping foliar metal concentrations.

(b) Evaluating the relationship between spectral predictors of foliar metal accumulation and the concentrations of these metals across various lithologies and metal hotspots.

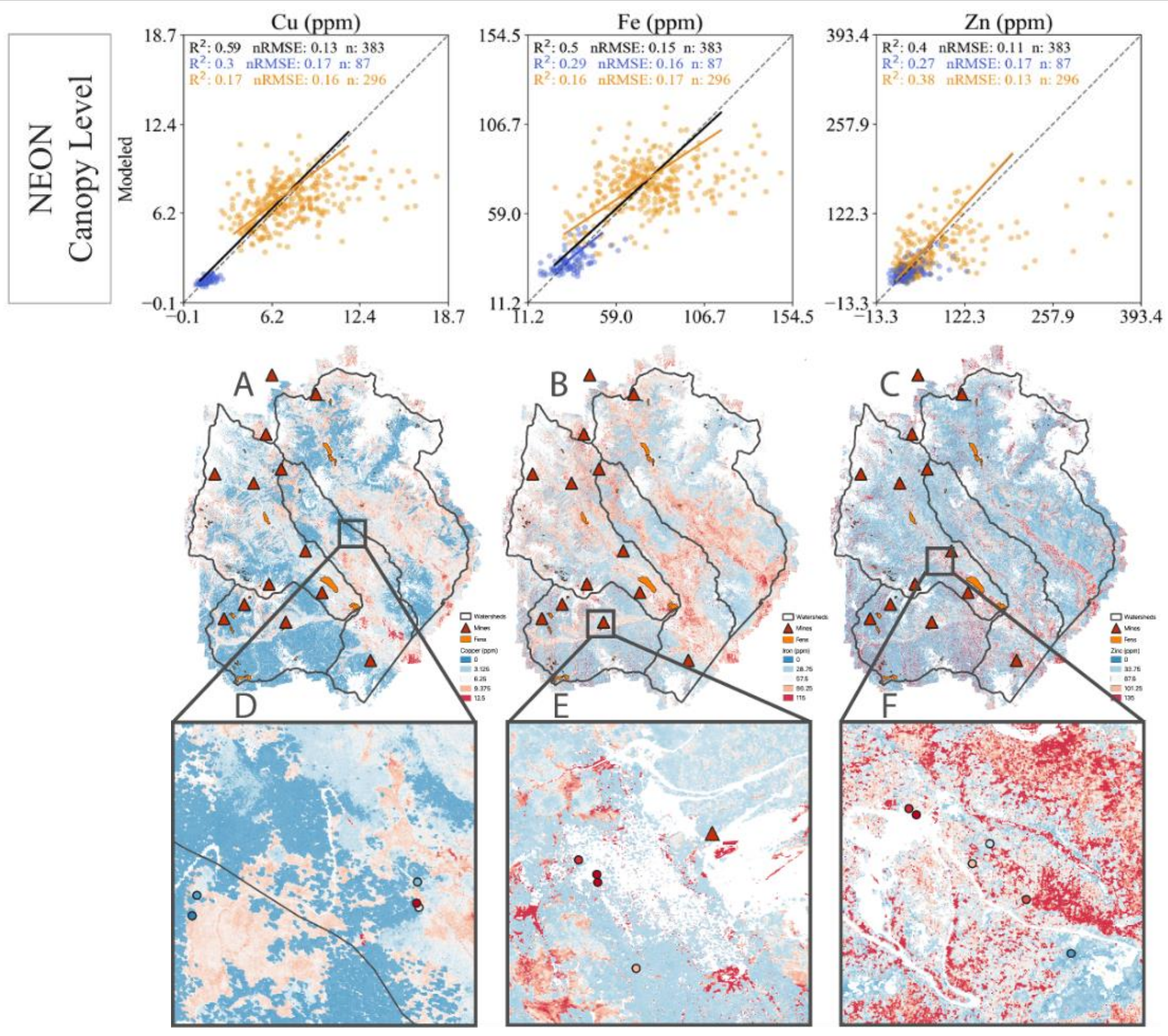
(c) Field validating metal mobilization occurrence through pre-existing samples and subsequent sampling.

Background



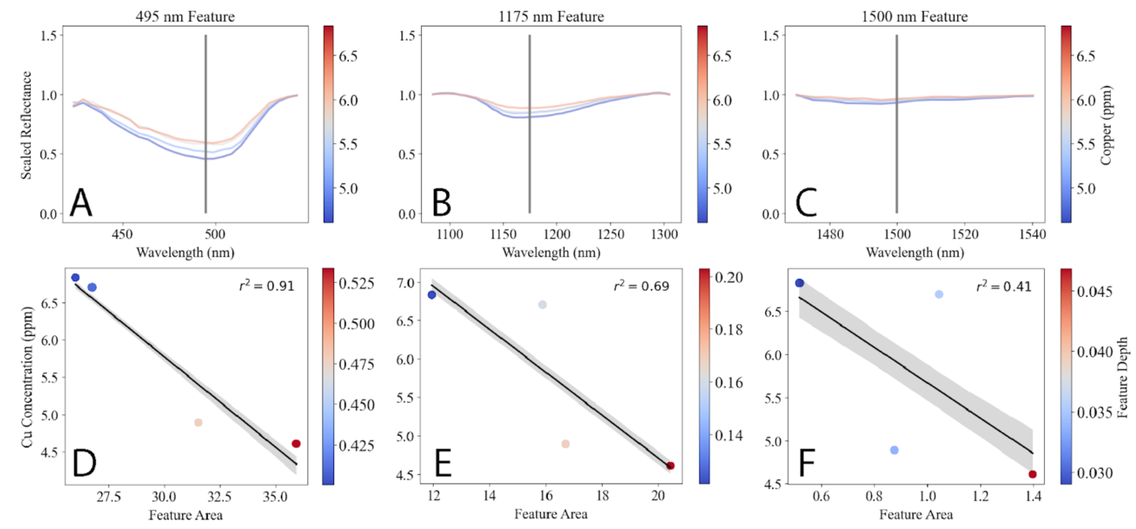
- The Upper East River Basin of Colorado is a ~330km^2 area comprised of four watersheds (Coal, Slate, Washington Gulch and the East River)
- Vegetation ranges from conifer and aspen to meadow species
- Coal and Slate River Watersheds (left-most catchments) have ore-rich stocks and an over century-long mining legacy

Approach

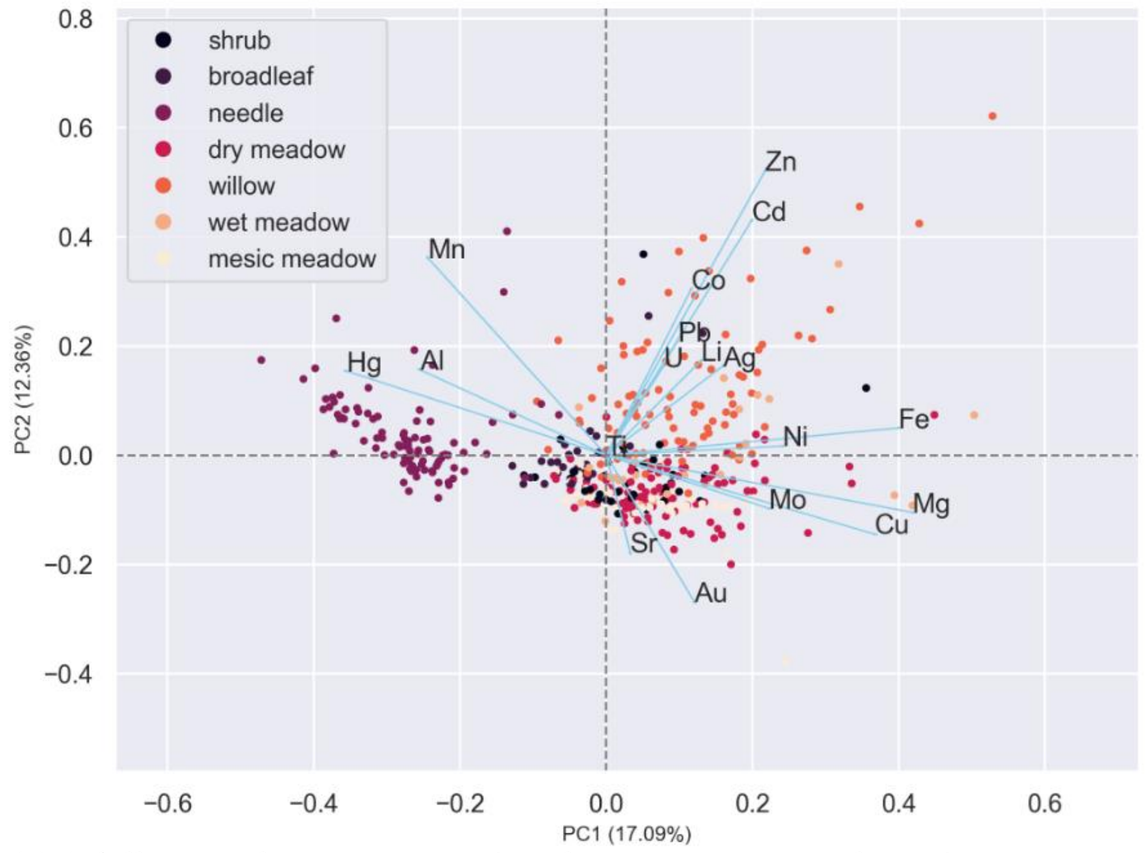


(a) Partial least squares regression (PLSR) algorithm best predicts foliar metal concentrations with all spectral and elemental information

Results



(b) Spectra paired with in situ metal concentrations show sensitivity to key spectral features linked to foliar metal toxicity. Cu shows the strongest spectral relationships to foliar metal concentrations in a continuum removal analysis. All species displaying clear relationships are located near known metal hotspots or directly above metal-rich rock.



(c) A follow-up hotspot campaign demonstrates metal persistence across years and PCA reveals multi-metal variance drivers, with an orthogonal relationship between Cu/Fe and Zn/Cd also supported by resampled data

Significance/Benefits to JPL and NASA

Characterizing foliar traits and their relationship to active geologic processes is of key strategic interest to JPL, and a cornerstone component of the SBG mission. Expanding the capacity of VSWIR retrievals to capture bioaccumulation of metal contaminants could open new avenues of research based on the data collected as part of SBG/ EMIT missions.

Publications:

[A] Grant, Kathleen, et al., "Linking remotely sensed foliar expressions of metal toxicity to various levels of chemical association with the soil matrix", submitted to *AGU Fall Meeting, San Francisco 2023.*

[B] Grant K., Chadwick K. D., Henderson A., Scott A., McCormick M., Pierce S., Hastings Porro M., & Maher K. (2025): Foliar element determination from field survey in association with the National Ecological Observatory Network Airborne Observation Platform survey, East River, Colorado 2018, ESS-DIVE repository. Dataset. doi:10.15485/2574425 accessed via https://data.ess-dive.lbl.gov/datasets/doi:10.15485/2574425 on 2025-08-11

[C] Grant K., Hechinger L., Vasquez A., Chadwick K. D., West A. J. (in prep): Foliar element determination from a field survey in association with an ASD Fieldspec3 survey, East River, CO 2023

[D] Grant K., Hechinger L., Vasquez A., Chadwick K. D., West A. J. (in prep): Foliar and soil visible to shortwave infrared imaging spectroscopy data from an ASD Fieldspec3 survey, East River, CO 2023

[E] Grant K., et al. (in prep): Remote detection of plant physiological responses to metal toxicity across a complex mountainous landscape. Remote Sensing of Environment.

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RPD-000 Clearance Number: CL#00-0000