National Aeronautics and Space Administration

FY23 Strategic University Research Partnership (SURP)

Detecting toxic metal contamination through imaging spectroscopy

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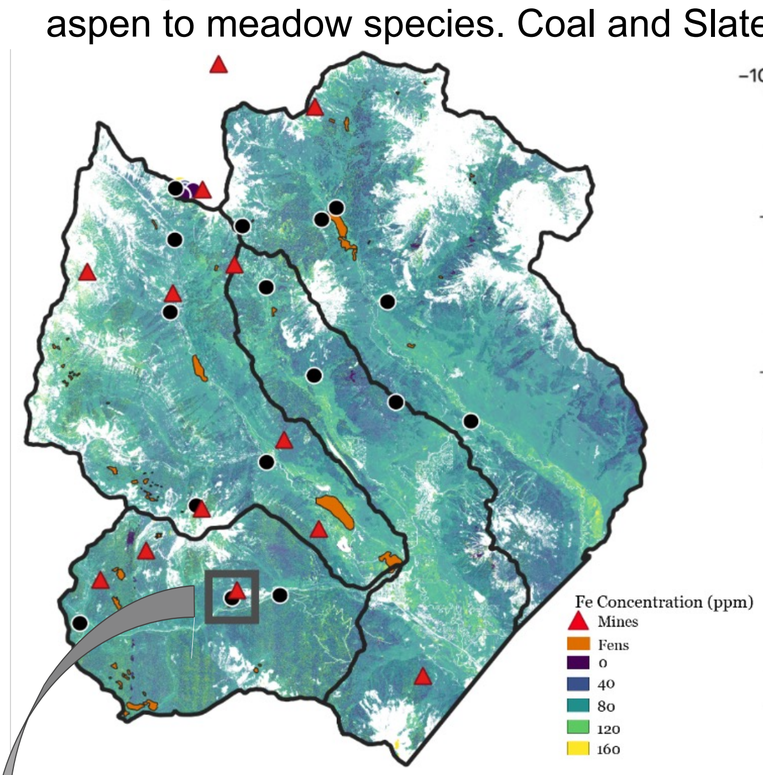
Objective: To identify areas of subsurface metal contamination through remotely sensed expressions of contamination in leaf chemistry by:

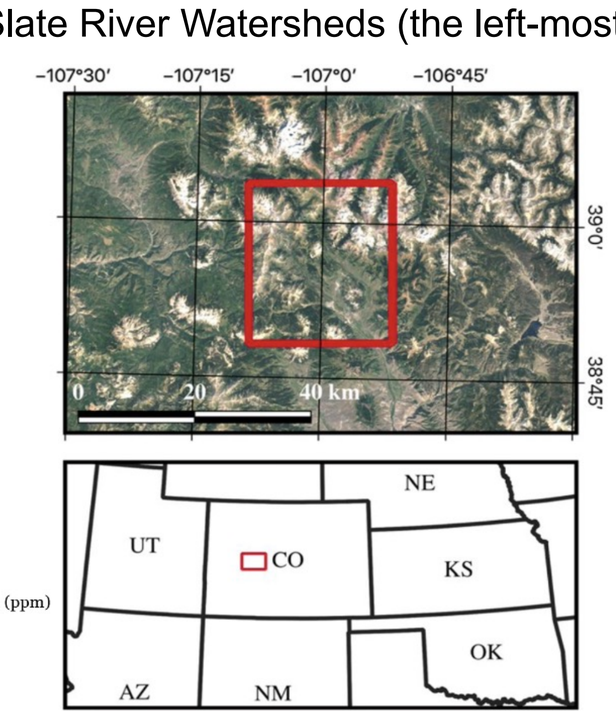
(a) Utilizing an existing foliar metal concentration dataset from field samples and paired VSWIR spectra to calibrate, evaluate, and quantify error of algorithms for mapping foliar metal concentrations [the focus of Year 1 activities, with results described more below].

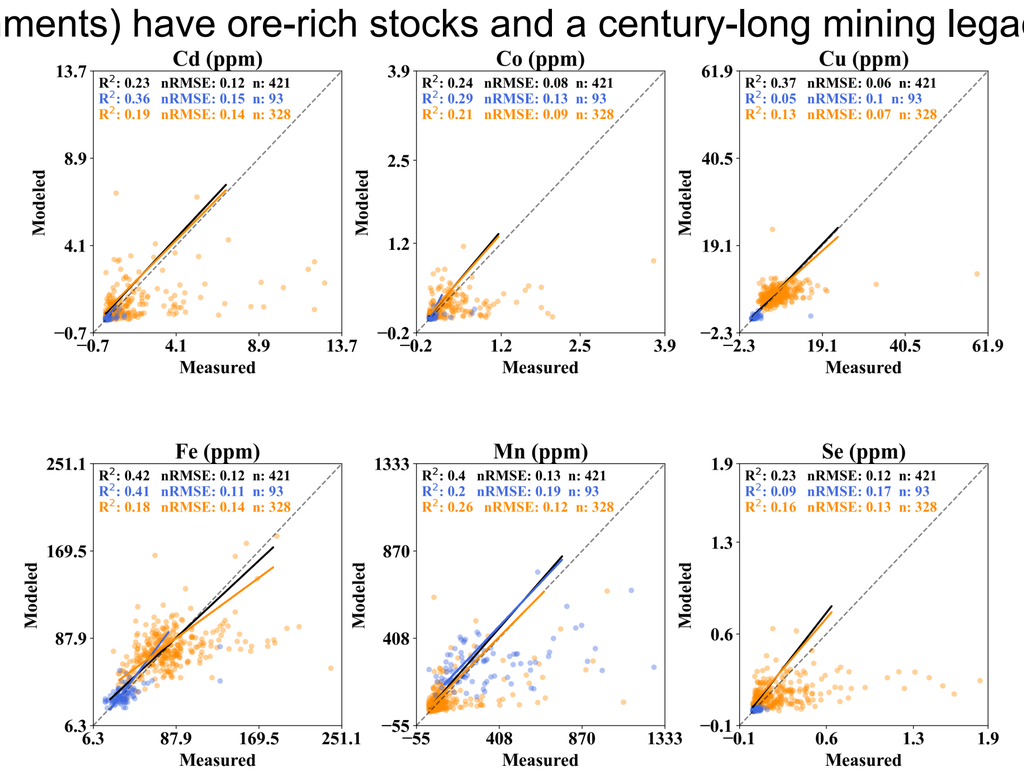
(b) Describing the relationship between foliar metal accumulation and the various levels of chemical association with the soil matrix.

(c) Assessing geochemical conditions at field sites to determine factors influencing metal mobilization through pre-existing samples and new sampling under fluctuating oxic/anoxic conditions.

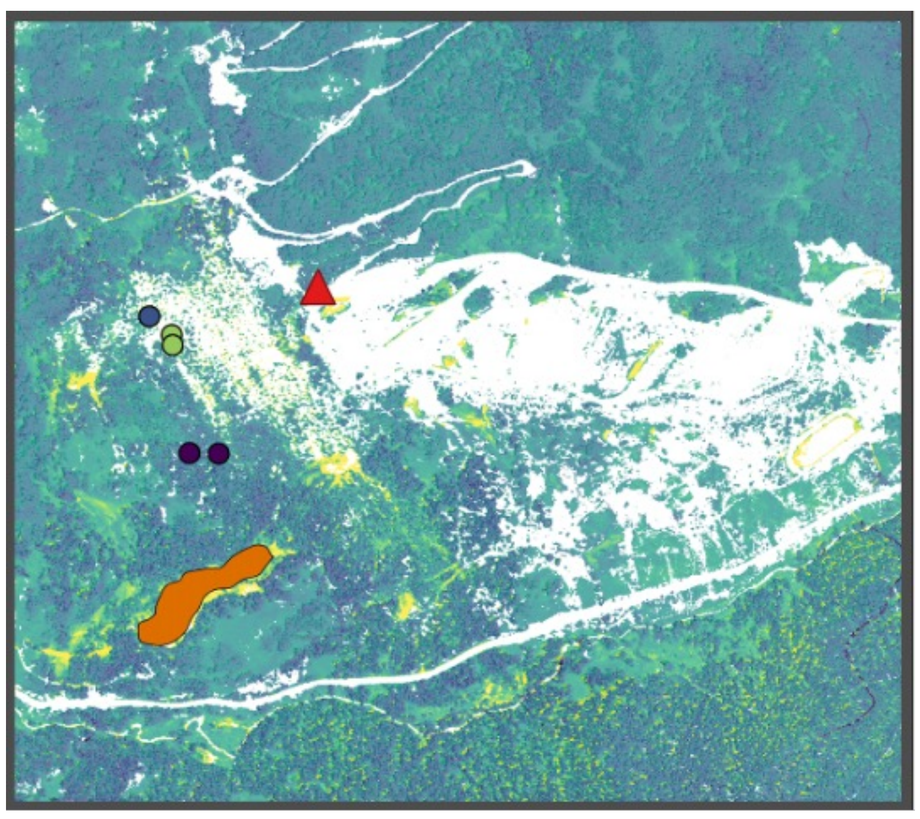
Background: The Upper East River Basin of Colorado is a 330 km^2 area comprised of four watersheds. Vegetation ranges from conifer and aspen to meadow species. Coal and Slate River Watersheds (the left-most catchments) have ore-rich stocks and a century-long mining legacy.

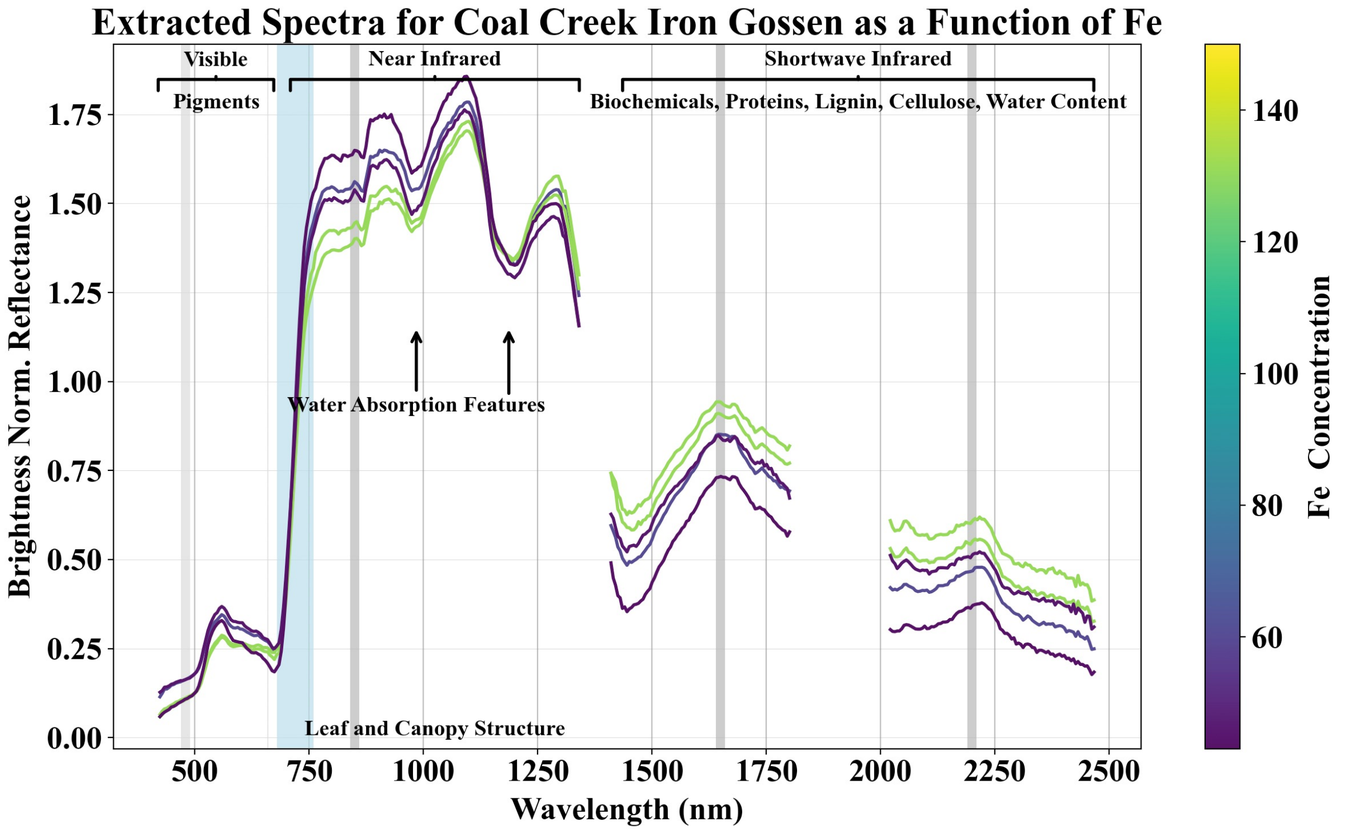






Approach and Results: **(a)** We found that a partial least squares regression (PLSR) algorithm which included all spectral and elemental information best predicted foliar metal concentrations. The extracted spectra paired with ground-truthed metal concentrations demonstrated our sensitivity to key broadband and narrowband spectral features that are indicative foliar metal toxicity (see extracted spectra below).





(b) Pending analyses will inform the relationship between foliar metal accumulation and their association to various levels of the soil matrix.

(c) Products generated in (a) and existing datasets from the literature informed sampling locations for field validation of metal hotspots in the summer of 2023. Foliar samples (n=122), leaf and mineral-level spectral samples (n=1044), soil porewater samples (n=24) and pH data (n=24) were collected and recorded at each sample location. The pending analyses will enable characterization of metal co-mobilization under fluctuating oxic/anoxic conditions and enable a deeper understanding of contaminant transport through the critical zone.

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

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Clearance Number: CL#00-0000
Poster Number: RPC#

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.*

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