Mineral Identification using Tetracorder during the TREX Field Campaign

A. V. Steckel, R. N. Clark, T. H. Prettyman, N. Kumari, M. L. Meier, N. C. Pearson, C. J. Ahrens, A. C. Martin, R. V. Patterson, M. Lane, F. Vilas, P. Knightly, D. Wettergreen, M. E. Banks, E. Bell, S. P. Wright, E. Z. Noe Dobrea, A. Hendrix

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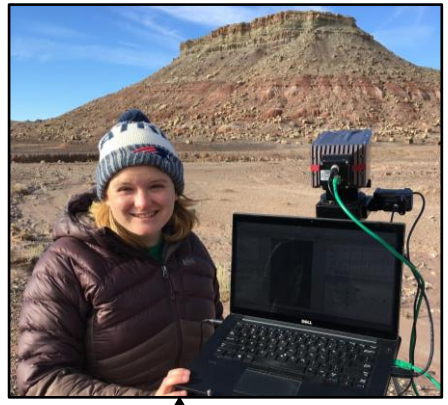
Amanda.Steckel@colorado.edu

Local hyperspectral surveys bridge the gap from orbital to *in situ* data

AVIRIS

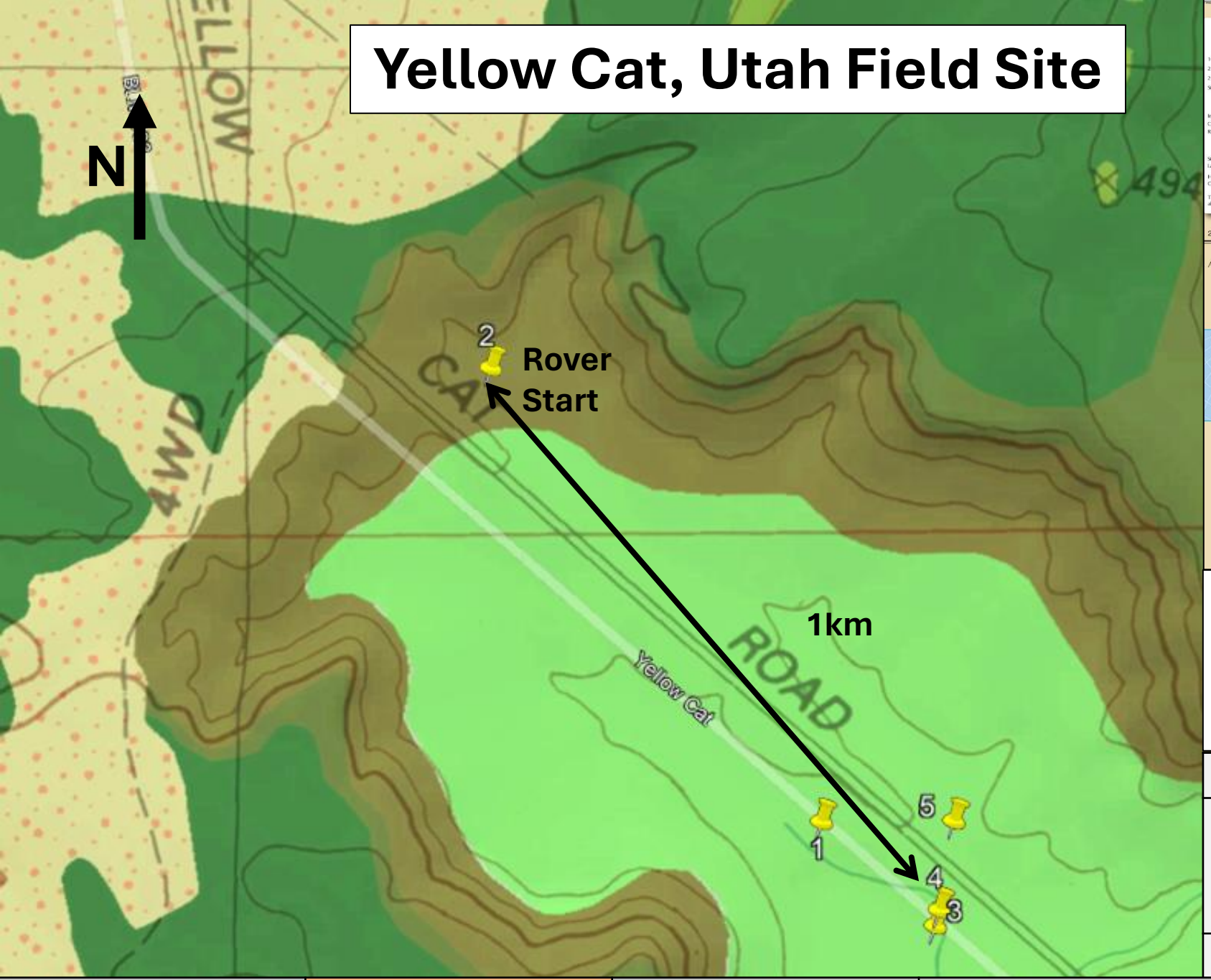
10^{1} m

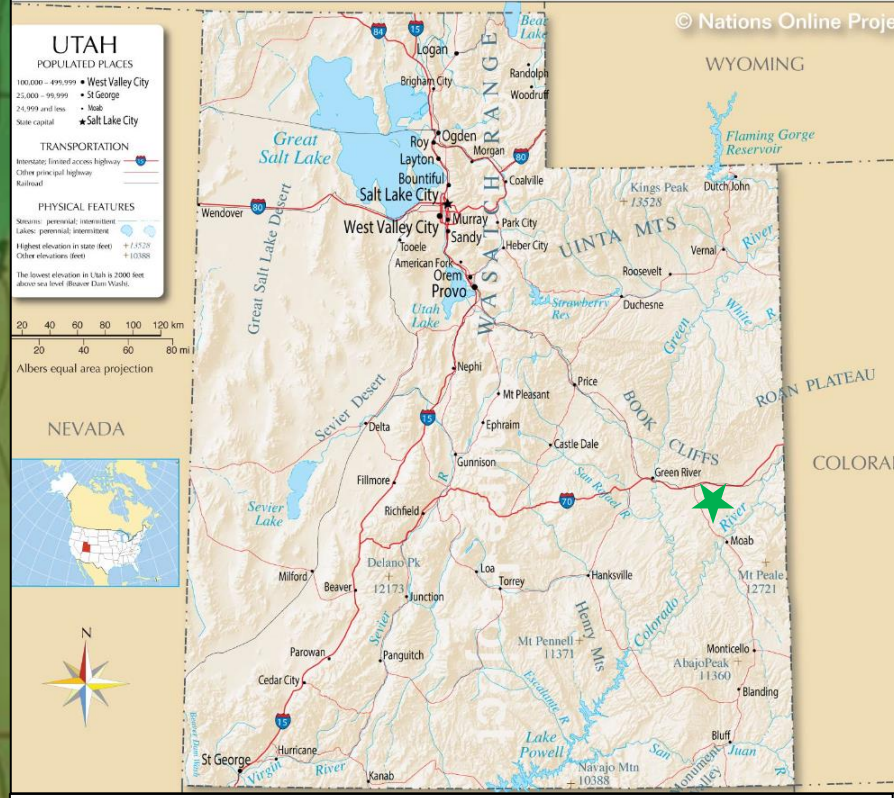


10^{-1} m

10^{-2} m

Yellow Cat, Utah Field Site





- Yellow Pins: Hyperspectral Scan
- Contour Interval = 40ft (12.2m)
- Map: Utah Geologic Survey, Mollie Hogans Quad

Formation	Member	Map Symbol
Cedar Mountain	Ruby Ranch	Kcmr
	Poison Strip	Kcmp
	Yellow Cat	Kcmy
Morrison	Brushy Basin	Jmb

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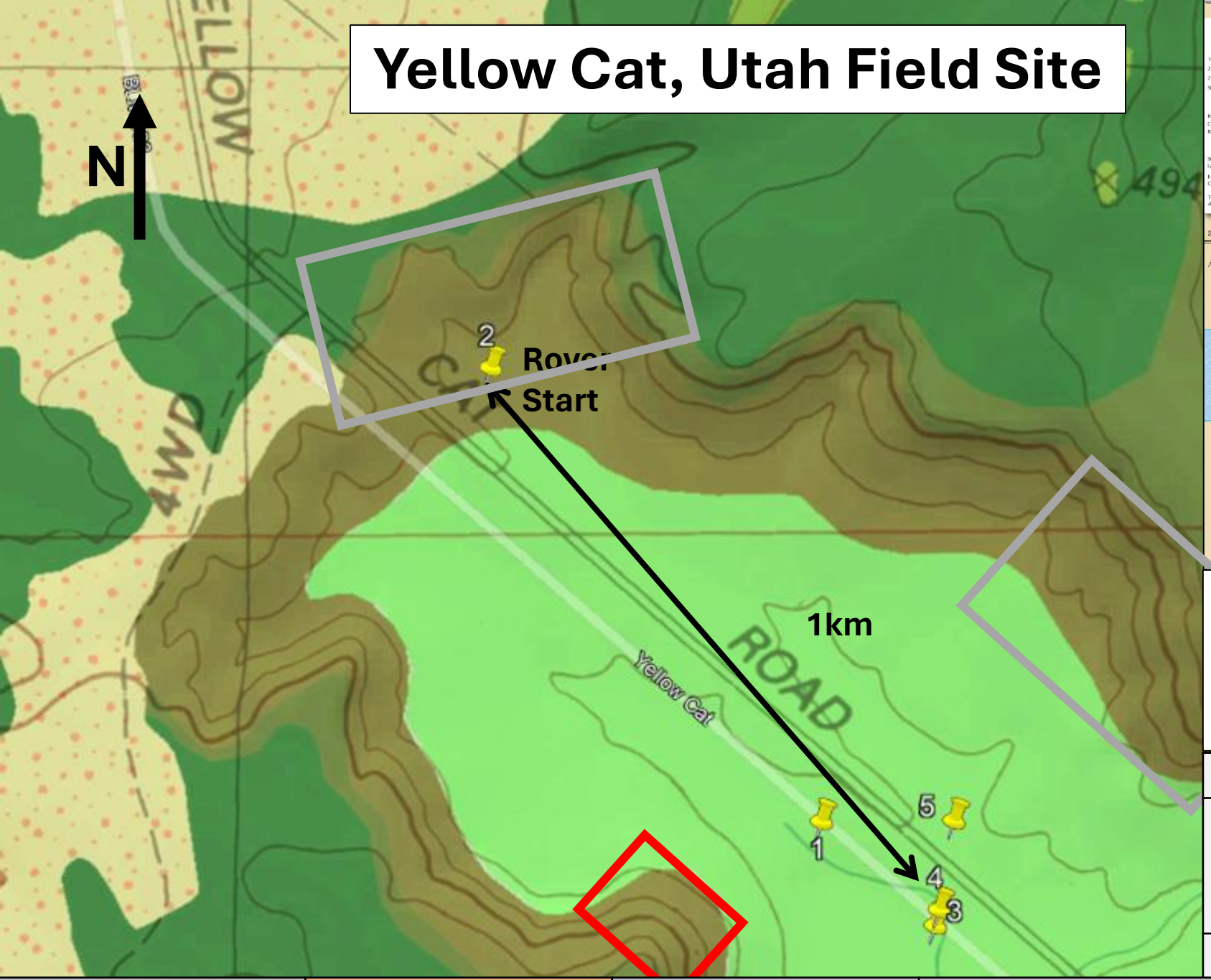

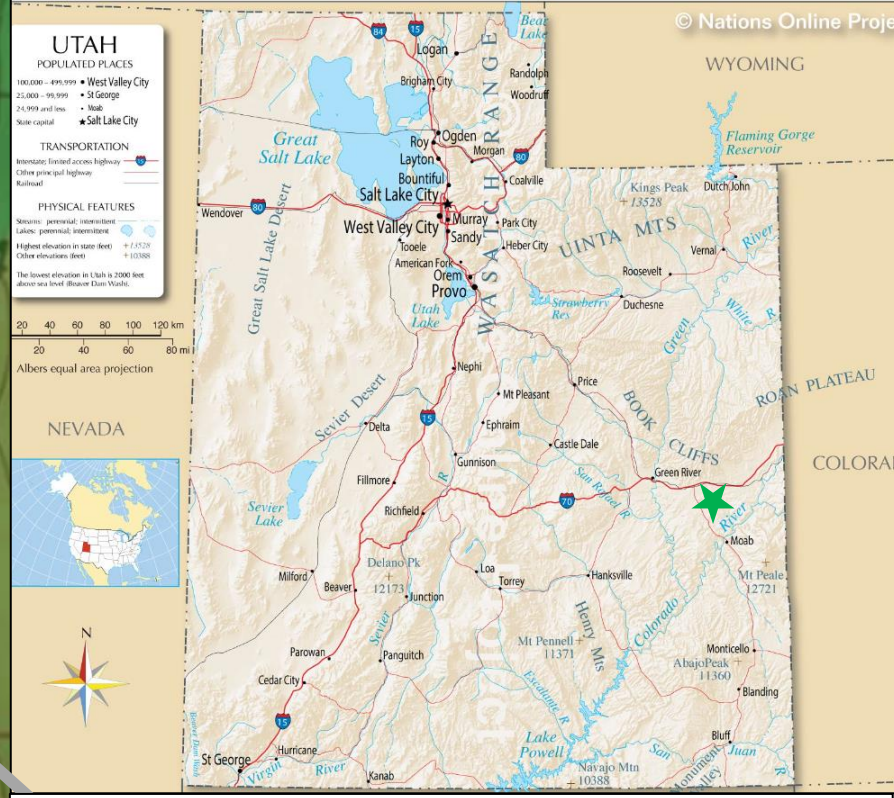

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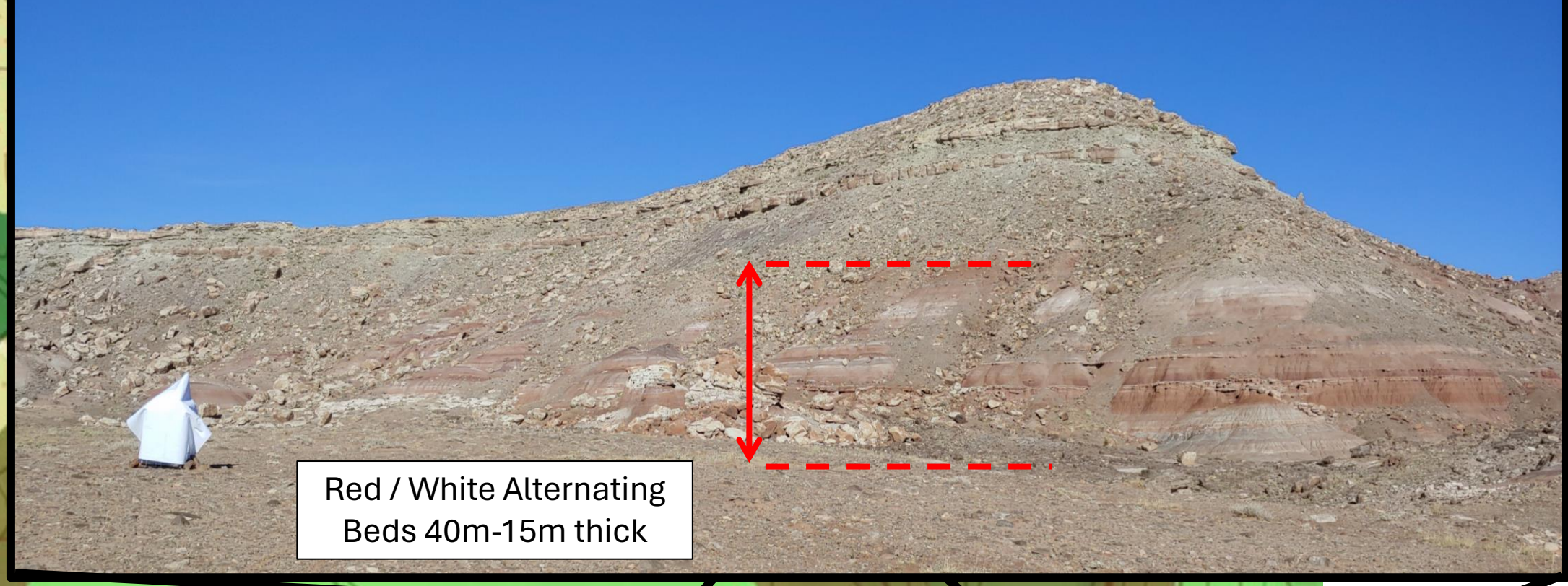

Cliffs provide important geologic context to material found in float during rover / astronaut traverse

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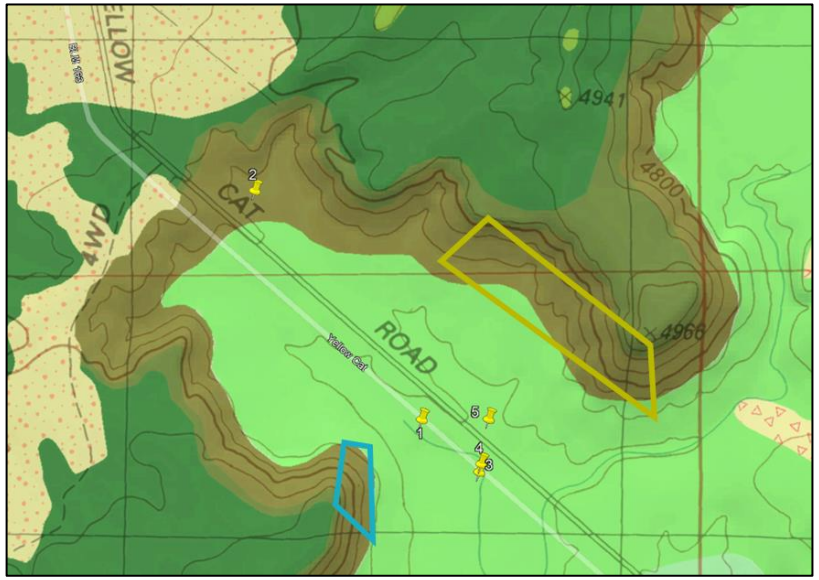
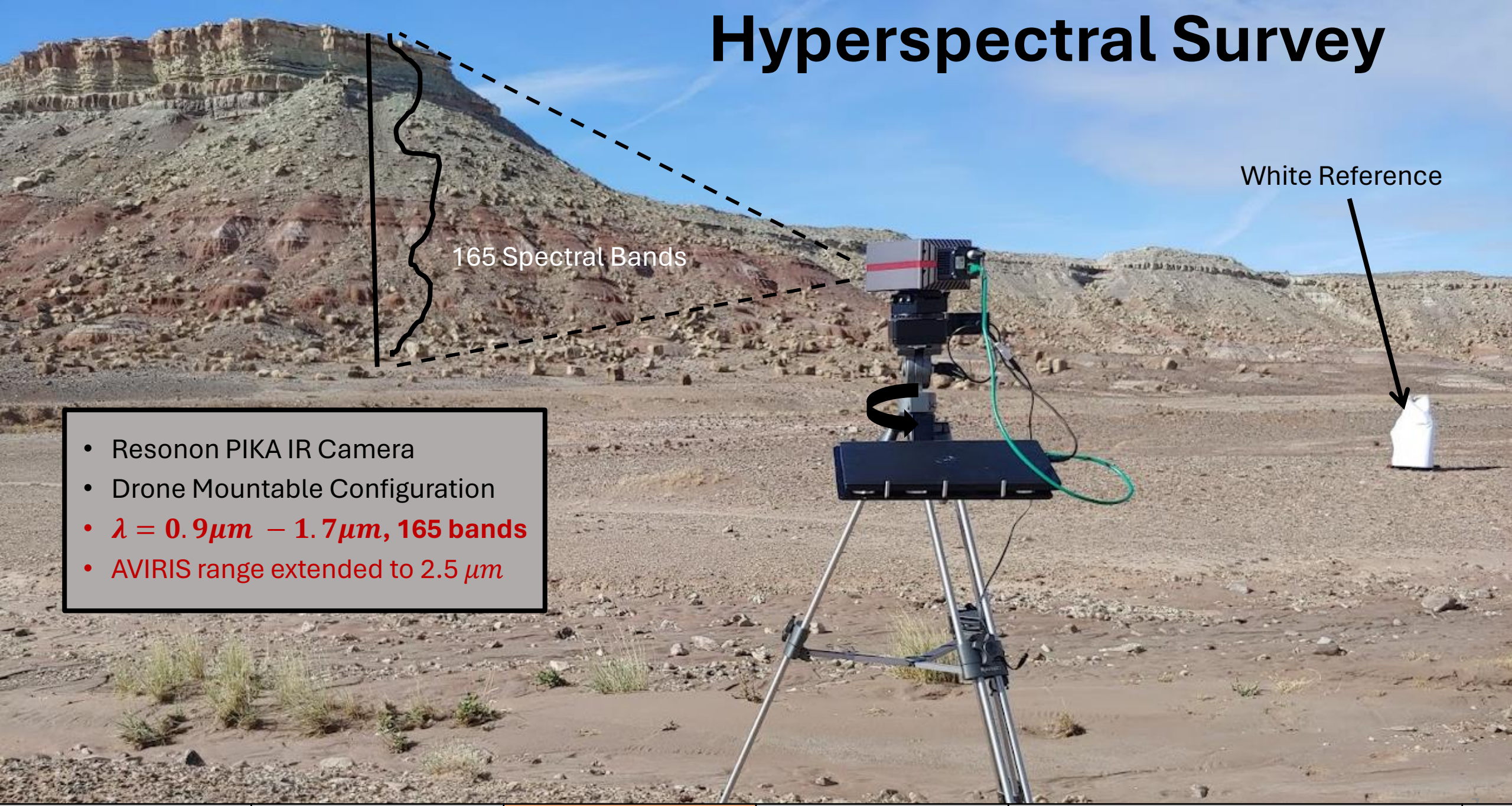
Tetracorder Results from AVIRIS (18m/pixel)



Kaolinite, Illite/Muscovite mixtures identified in Cliff 1 and Cliff 2

Sulfates	Other Minerals	Carbonates	Clays	
Gypsum	Chlorites, Serpentines, other	Calcite	Montmorillonite group	Mixtures with Kaolinite
Mixtures with Gypsum	Zeolites	Mixtures with Calcite	Mixtures with Mont. Group	Illite / Muscovite
Other Sulfates		Other Carbonates	Kaolinite Group	Illite / Muscovite Mixtures

Hyperspectral Survey



- Resonon PIKA IR Camera
- Drone Mountable Configuration
- $\lambda = 0.9\mu m - 1.7\mu m$, **165 bands**
- AVIRIS range extended to 2.5 μm

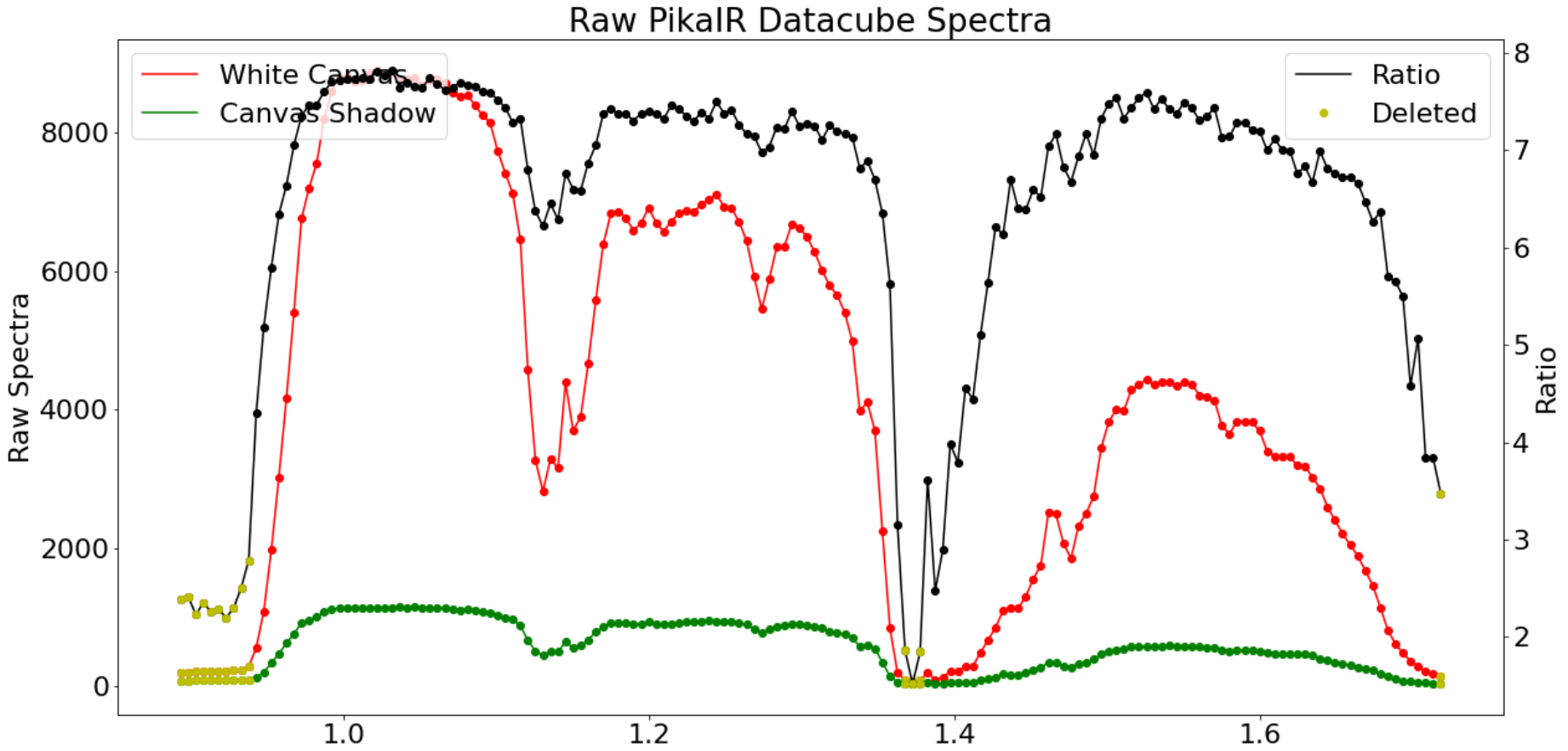
PikaIR Data Yields Signal near the Water Absorption Band

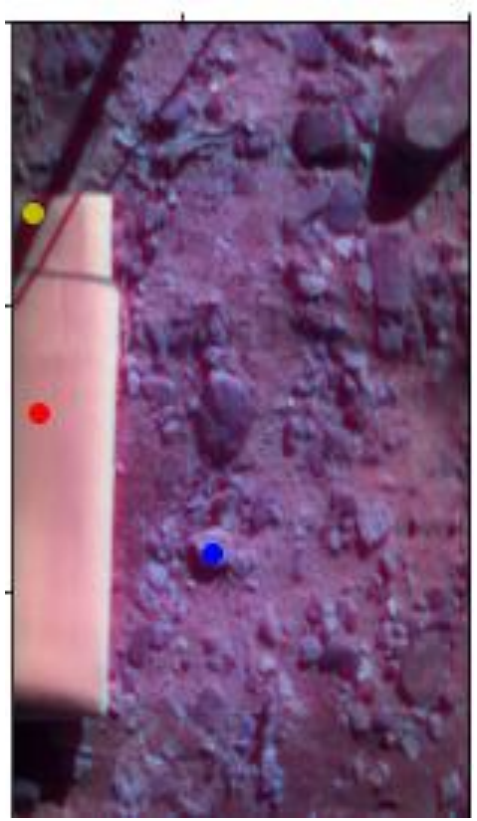
Raw Datacube
- Dark Current correction

Radiance
- Add Imager Calibration

Reflectance
- Add Measured Spectra of Canvas

Delete Bad Channels
- Using 154/168 Channels

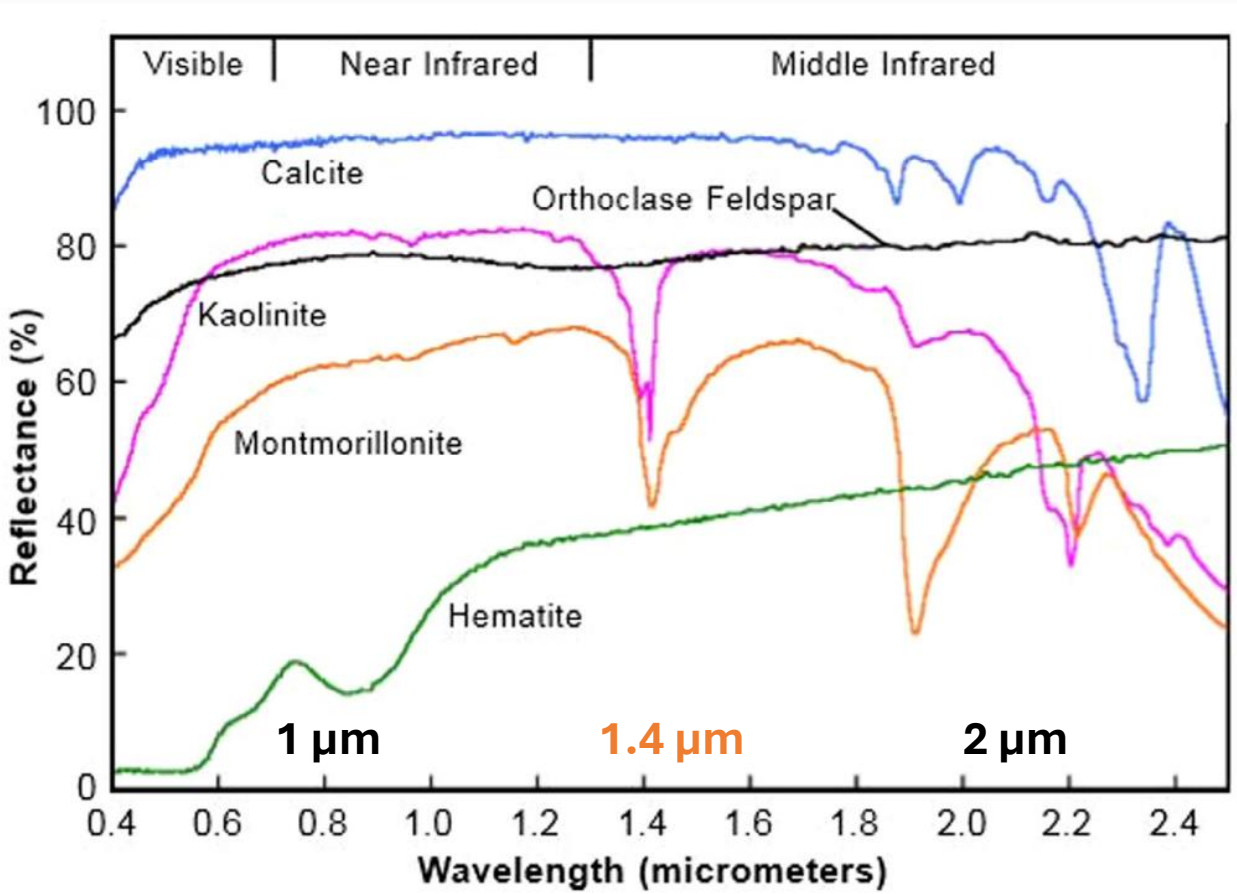




Tetracorder Expert System

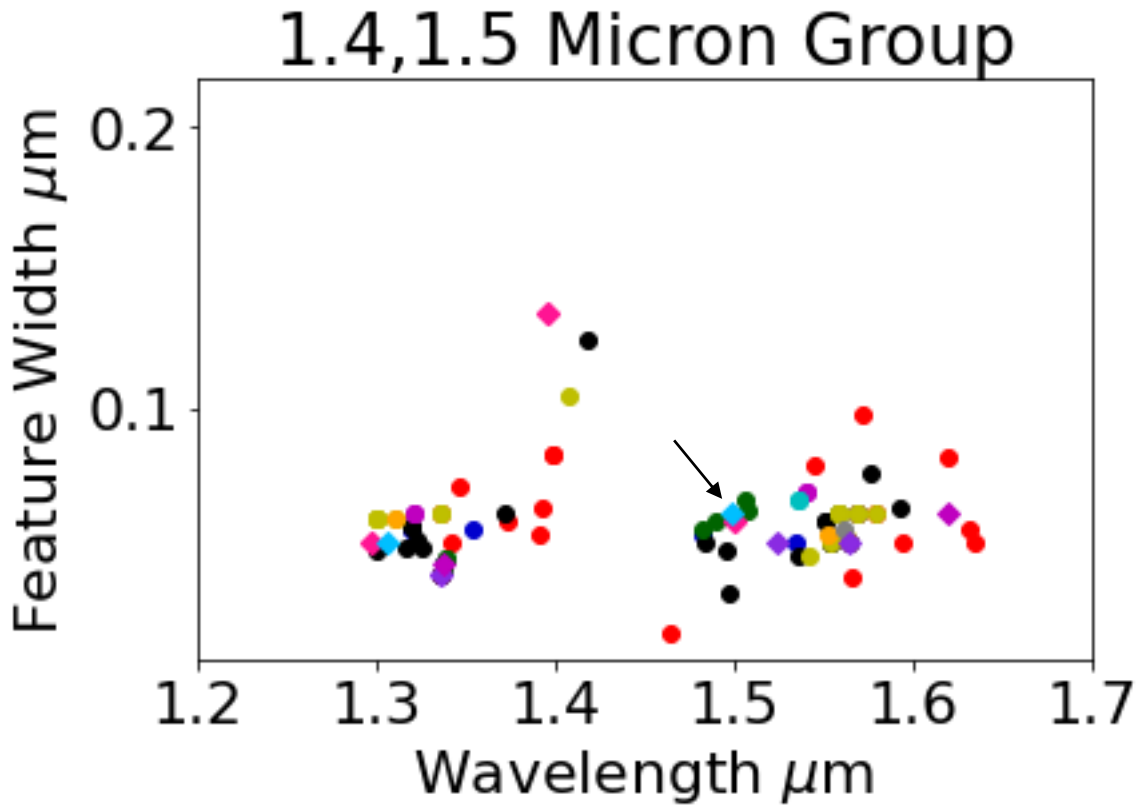
- Input: Calibrated PikaIR Datacube
- USGS Mineral Library convolved to match PikaIR channels
- Tetracorder Output:
  - **Fit:** Weighted correlation coefficient calculation
  - **Depth:** Weighted band depth calculation
  - **F*D:** Weighted fit times band depth calculation
- Developed for use with AVIRIS (0.35-2.5 µm)
- Python script to group spectra for mineral ID
  - Use Tetracorder results as inputs
  - Set a threshold for mineral ID
  - Compute average spectra of a group
- Manual mineral ID by comparing library spectra

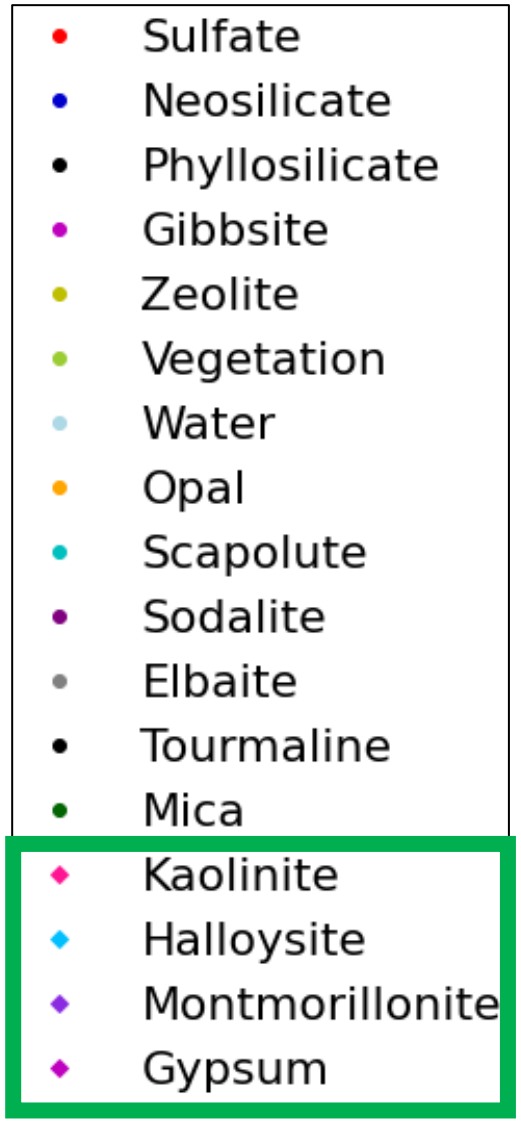
Tetracorder Mineral Groups (Clark+ 1999)



Width and Position of 1.4 µm Features

- Many positions overlap with similar shapes- are they unique enough for ID?
- Do more minerals need to be added to the library?
- Example: Kaolinite, Halloysite, Montmorillonite, and Gypsum

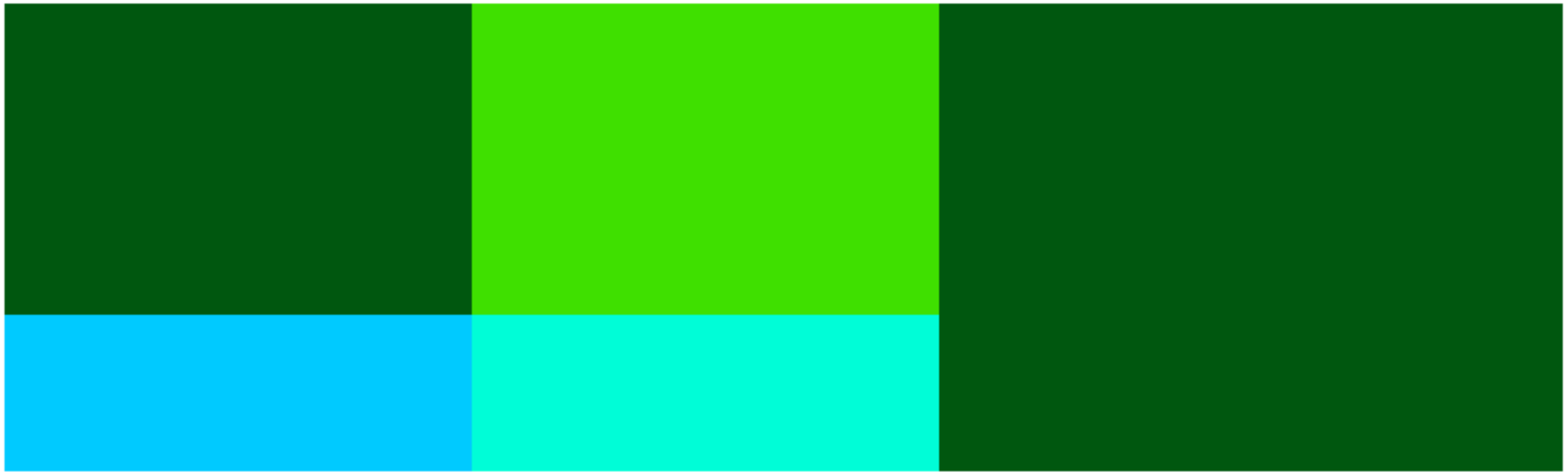




AVIRIS Results editing Tetracorder processing to use the PikaIR Spectral Range for Cliff 1

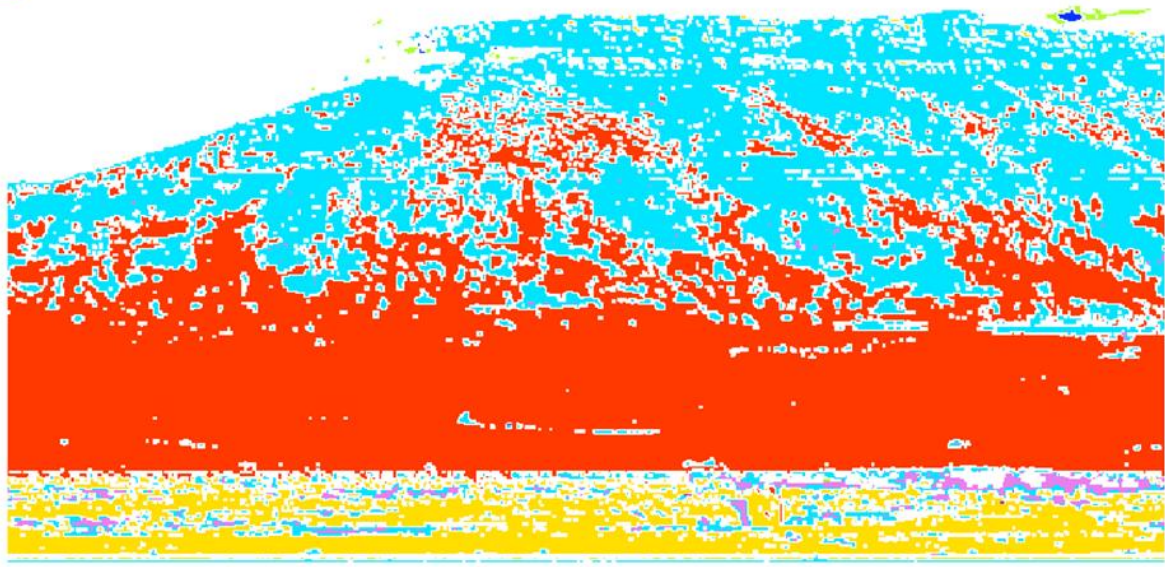
- Zeolite_natrolite
- sulfate_na82alun100c
- ulexite
- sulfate_kalun150c

This mineral ID for cliff 1 is **not reliable**:
1. AVIRIS is averaging over too broad a range (18m/pixel) at a poor angle (imaging steep cliff from overhead).
2. Tetracorder isn't designed to work in reduced spectral range 0.9-1.7μm.

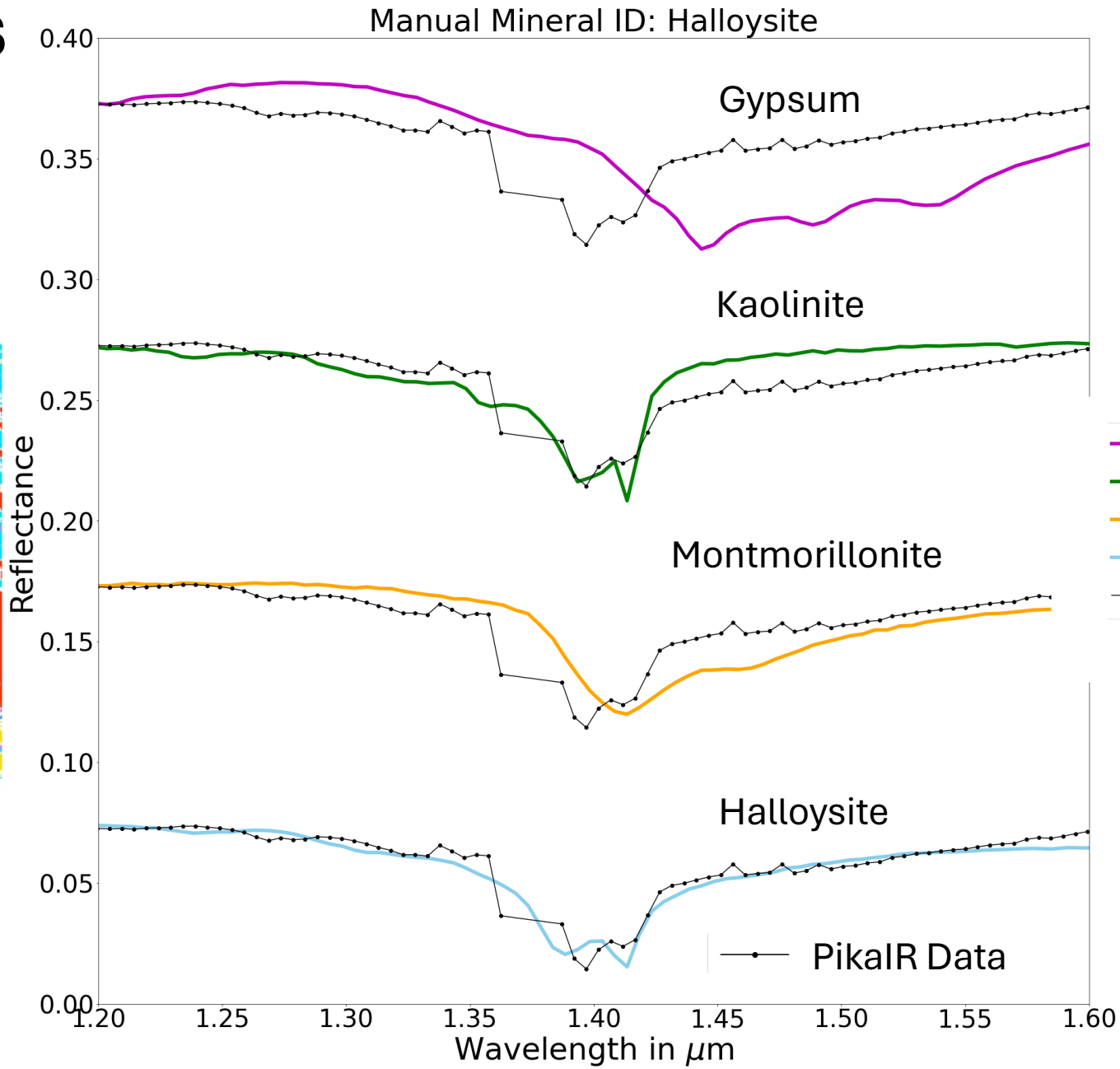


Cliff 1 Mineral ID Results

ohb_1.438_sulfate-alunite-na
ohb_1.410_kaolgrp-halloysite
ohb_1.425_sulfate-alunite



Halloysite is the best fit in the top of the cliff. Identification of the other minerals is in process.



Conclusion: Hyperspectral surveys provide valuable context for geologic origins

- Commercial drone-mountable instruments (e.g. PikaIR) have a limited spectral range, but close distance to target (50m vs. 10,000m) enables some signal through atmospheric water band
- Developing semi-autonomous mineral ID could enable surface exploration in the outer solar system

Next Steps:

- Complete processing cliffs 2 and 3 from Yellow Cat, compare with TREX team VNIR and FTIR data
- More minerals may need to be added to the library
- Contact me about a postdoc!