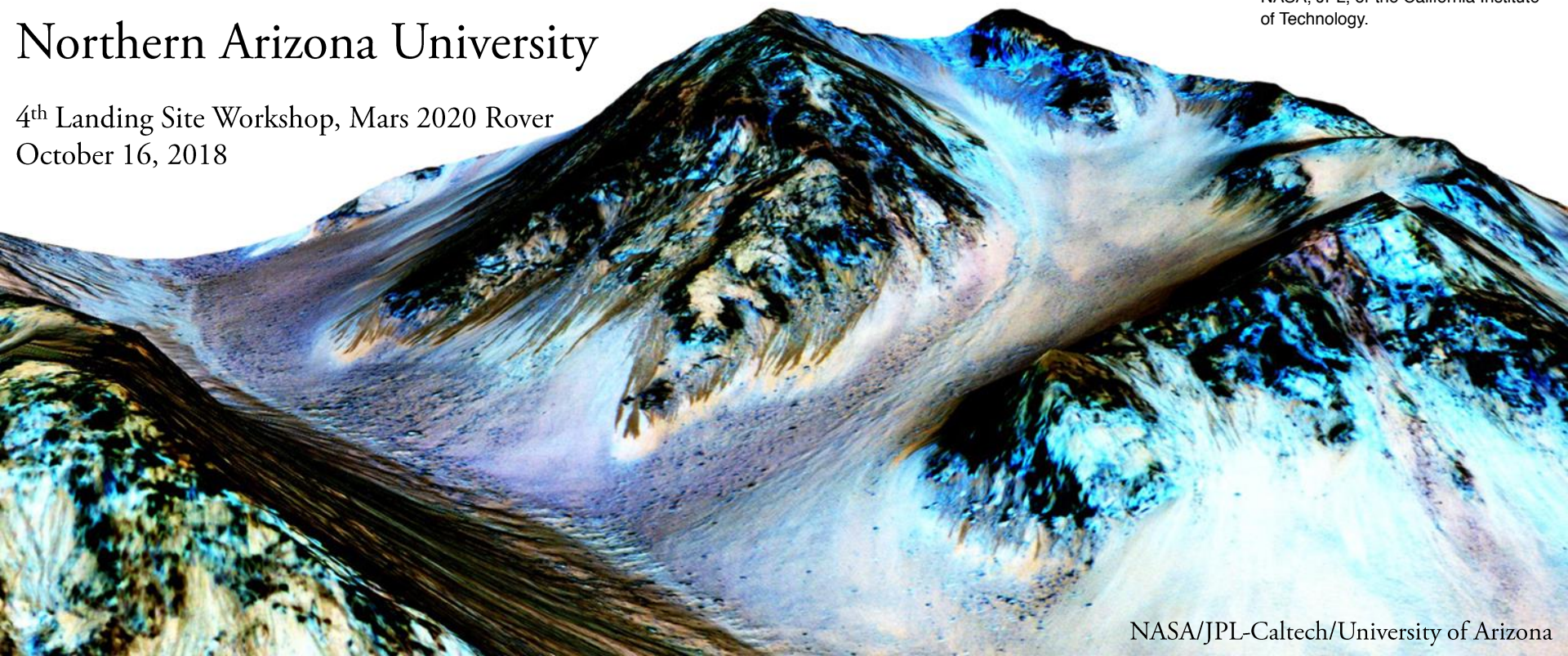
Squeezing More Science Out of Our Orbiters:
Using the Mars 2020 Rover and Returned Samples to Ground Truth Spectral Datasets

Mark Salvatore
Northern Arizona University

4th Landing Site Workshop, Mars 2020 Rover
October 16, 2018



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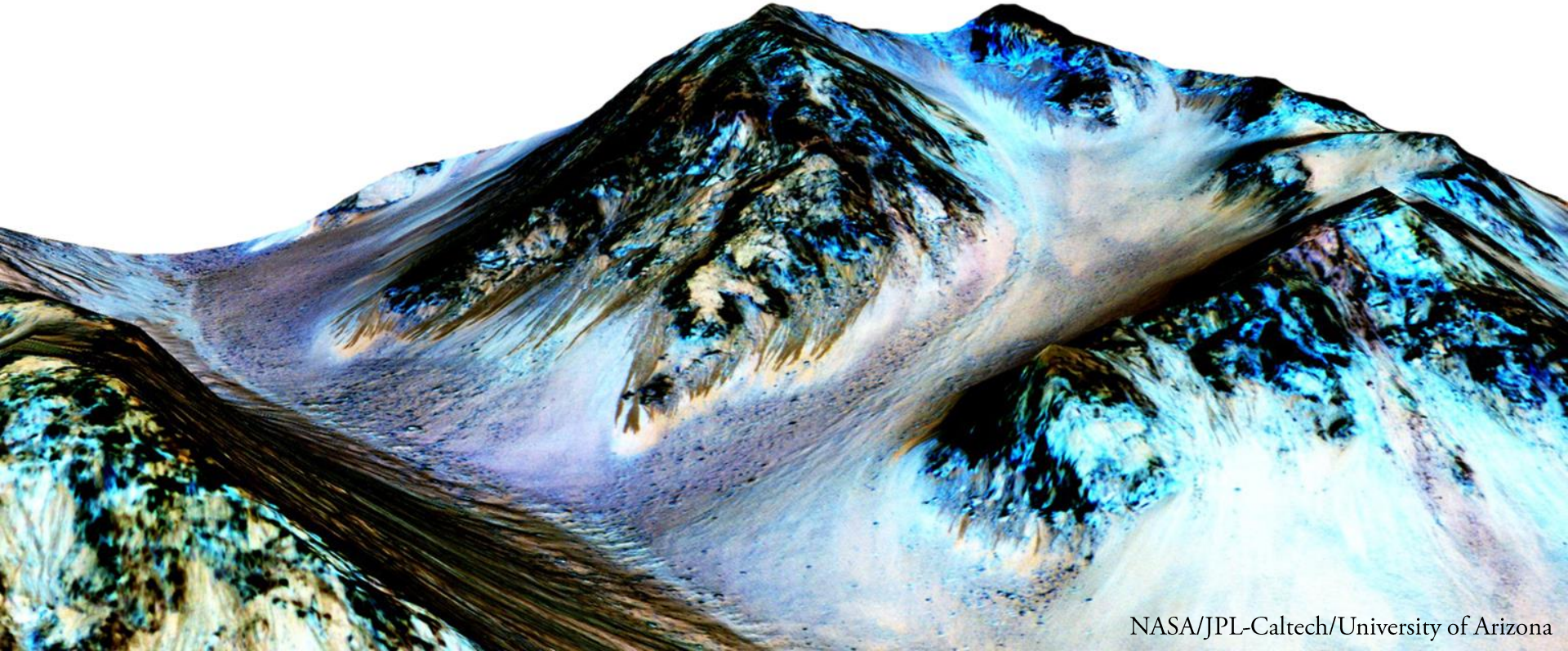
Take-Home Message

"The Mars 2020 rover provides us with a **unique opportunity** to validate past, current, and future remote sensing datasets through contemporaneous and synergistic surface characterization, well-planned spectral observations, and the selection of appropriate samples for caching and eventual return to Earth."



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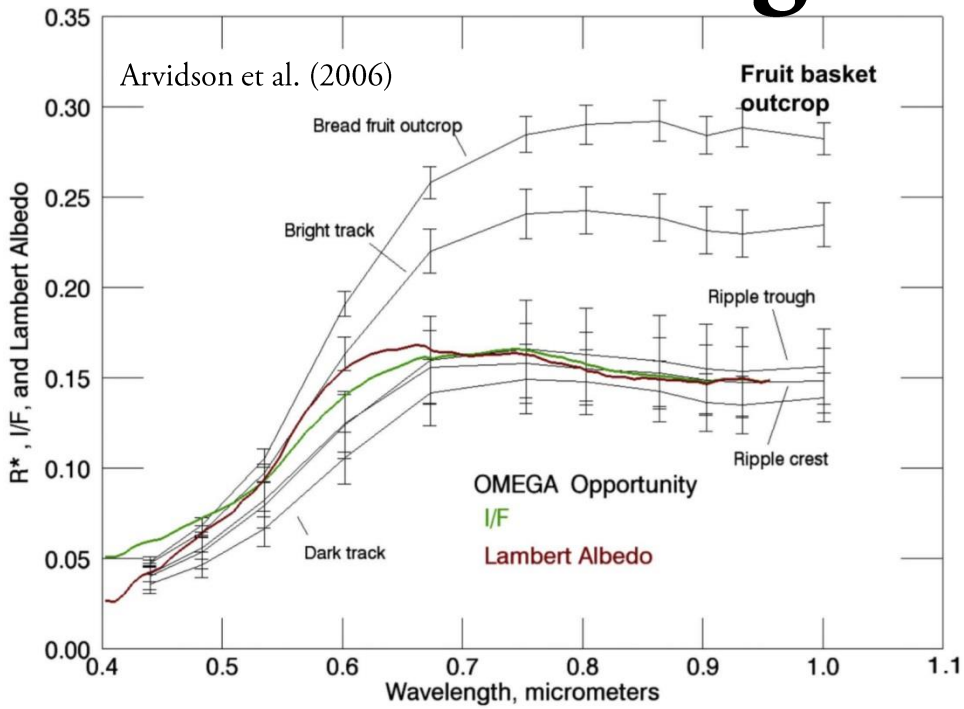
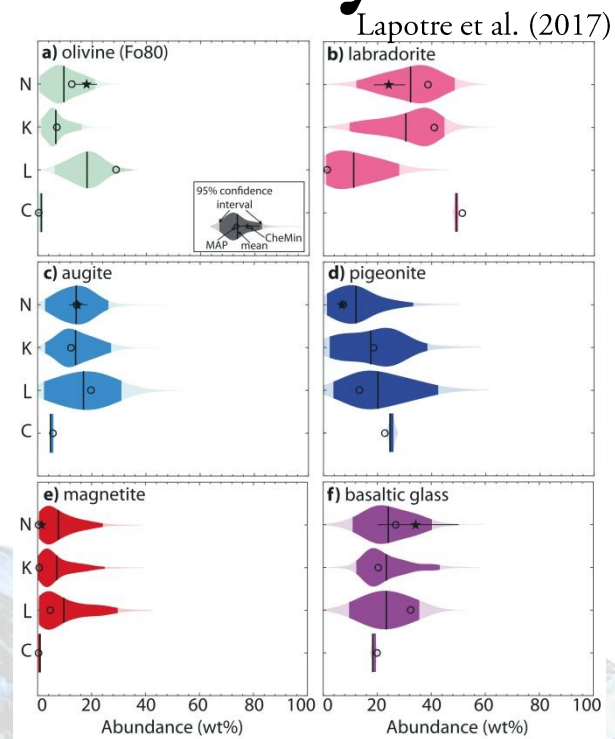
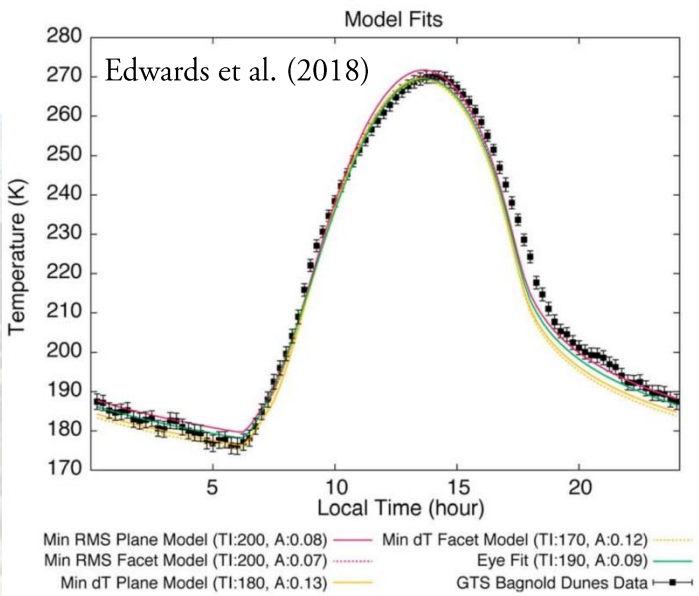
Outline

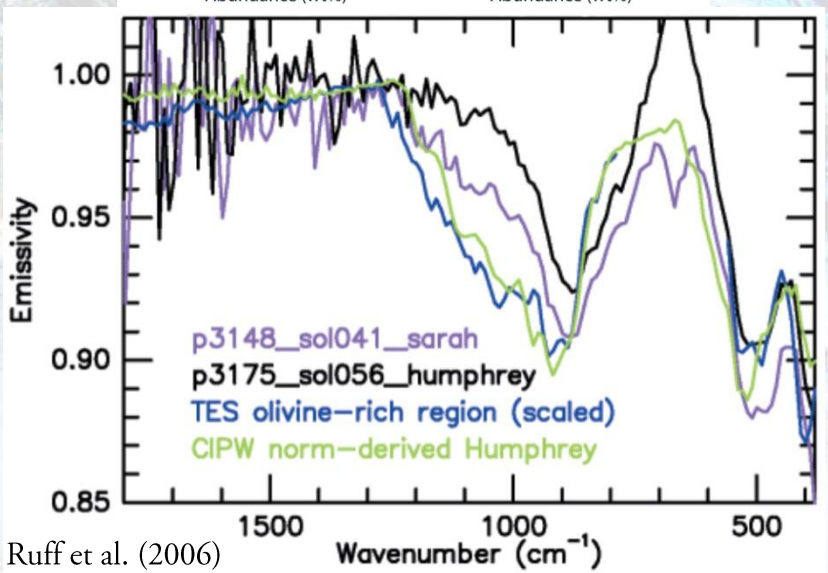
- Why make ground truthing a priority?
- Ground truthing success stories
- How to ground truth with the Mars 2020 rover
- Potential ground truthing targets
  - Columbia Hills
  - Jezero crater
  - NE Syrtis and Midway

Ground Truthing as a Priority



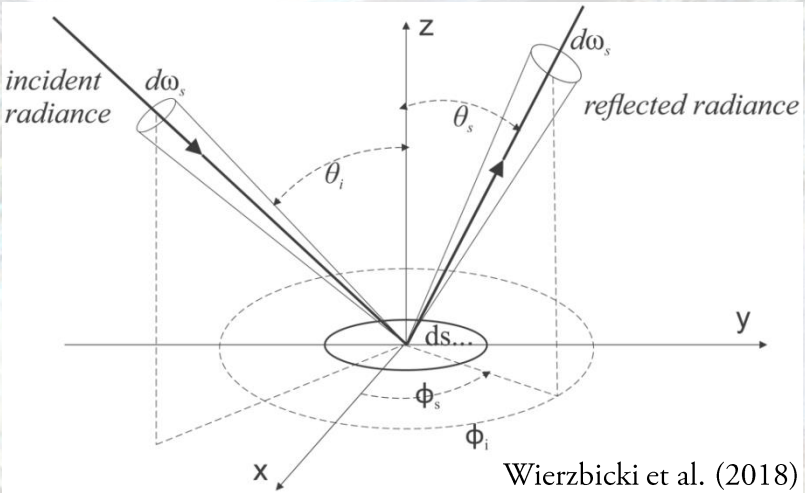




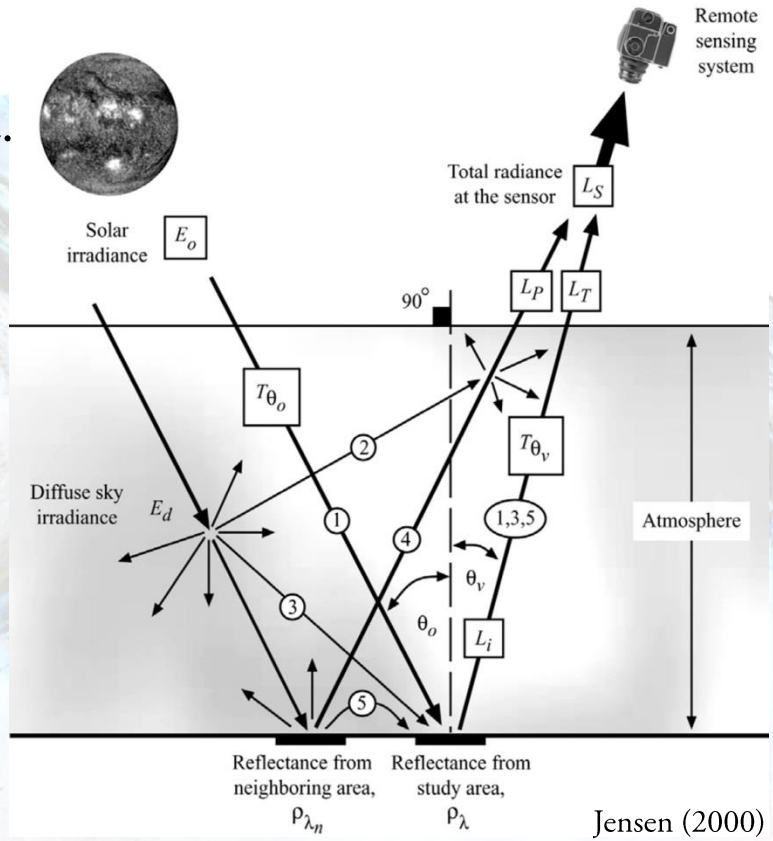


Ground Truthing as a Priority

- Goal of remote spectroscopy: Derive surface properties
  - Composition, thermophysical properties, etc.
- Many unknowns exist, including:
  - (Ever changing) atmospheric contributions
  - Bidirectional reflectance distribution
  - Surface (and subsurface) properties, including packing, grain size distribution, etc.
- Assumptions must be made to address these unknowns



Wierzbicki et al. (2018)

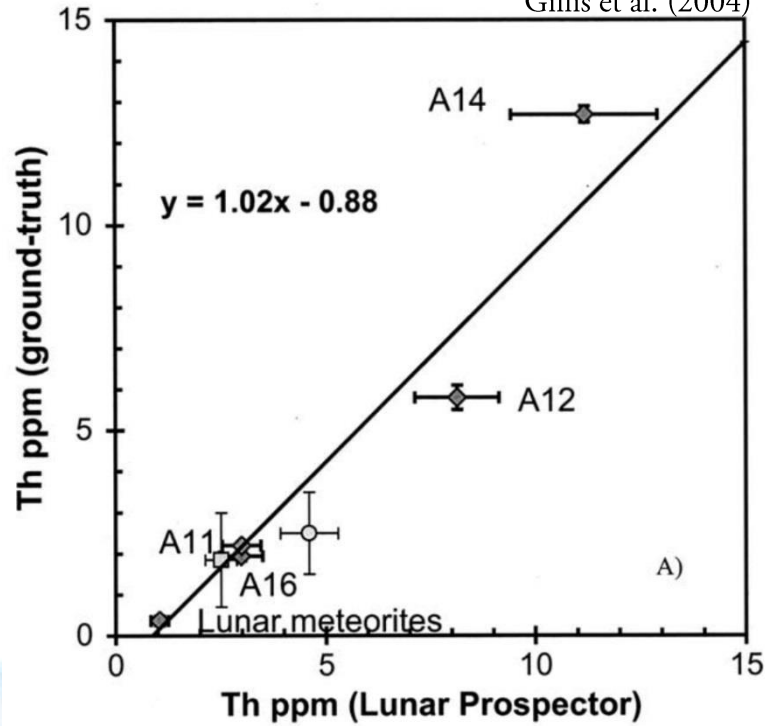


Jensen (2000)

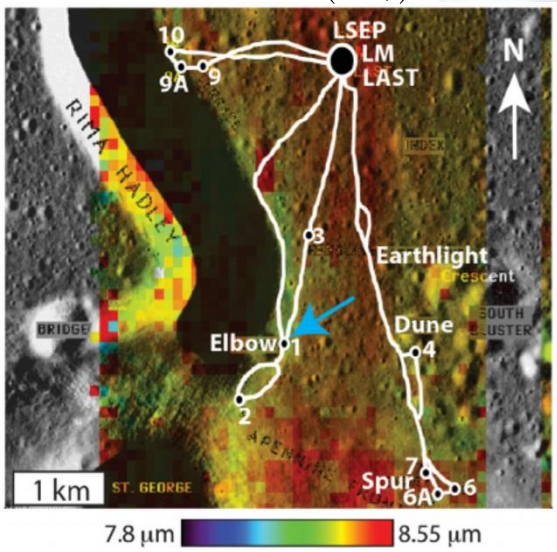
Success Stories

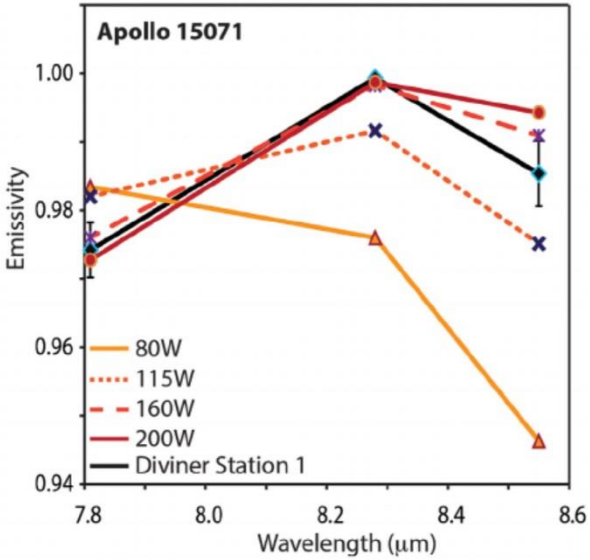
- Lunar samples have long been used to validate remote sensing datasets
  - Gamma ray spectroscopy (right)
  - Reflectance spectra (e.g., Pieters et al., 2009)
  - Emission data (below)
- Have provided insight into the **source** of many major spectral features
  - E.g., space weathering (Pieters et al., 2000; Noble et al., 2001)

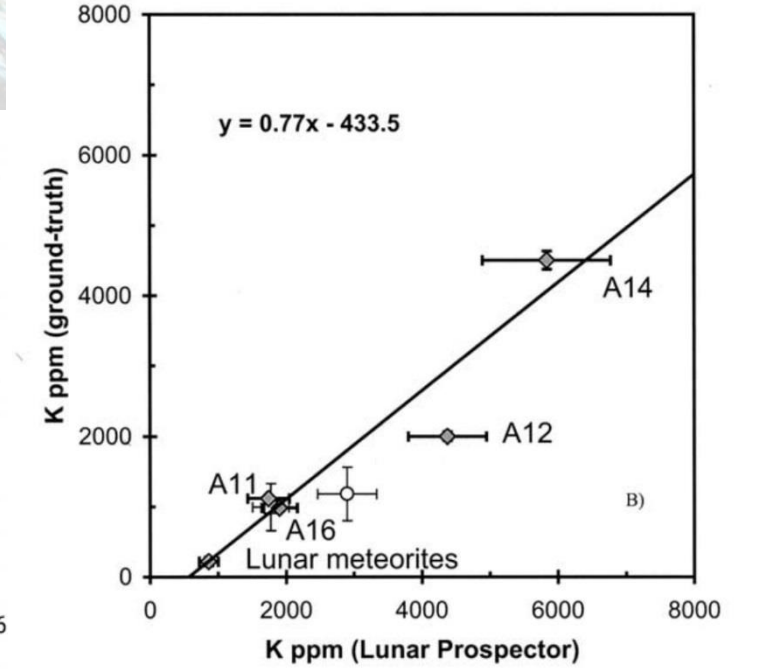
Gillis et al. (2004)



Donaldson Hanna et al. (2017)







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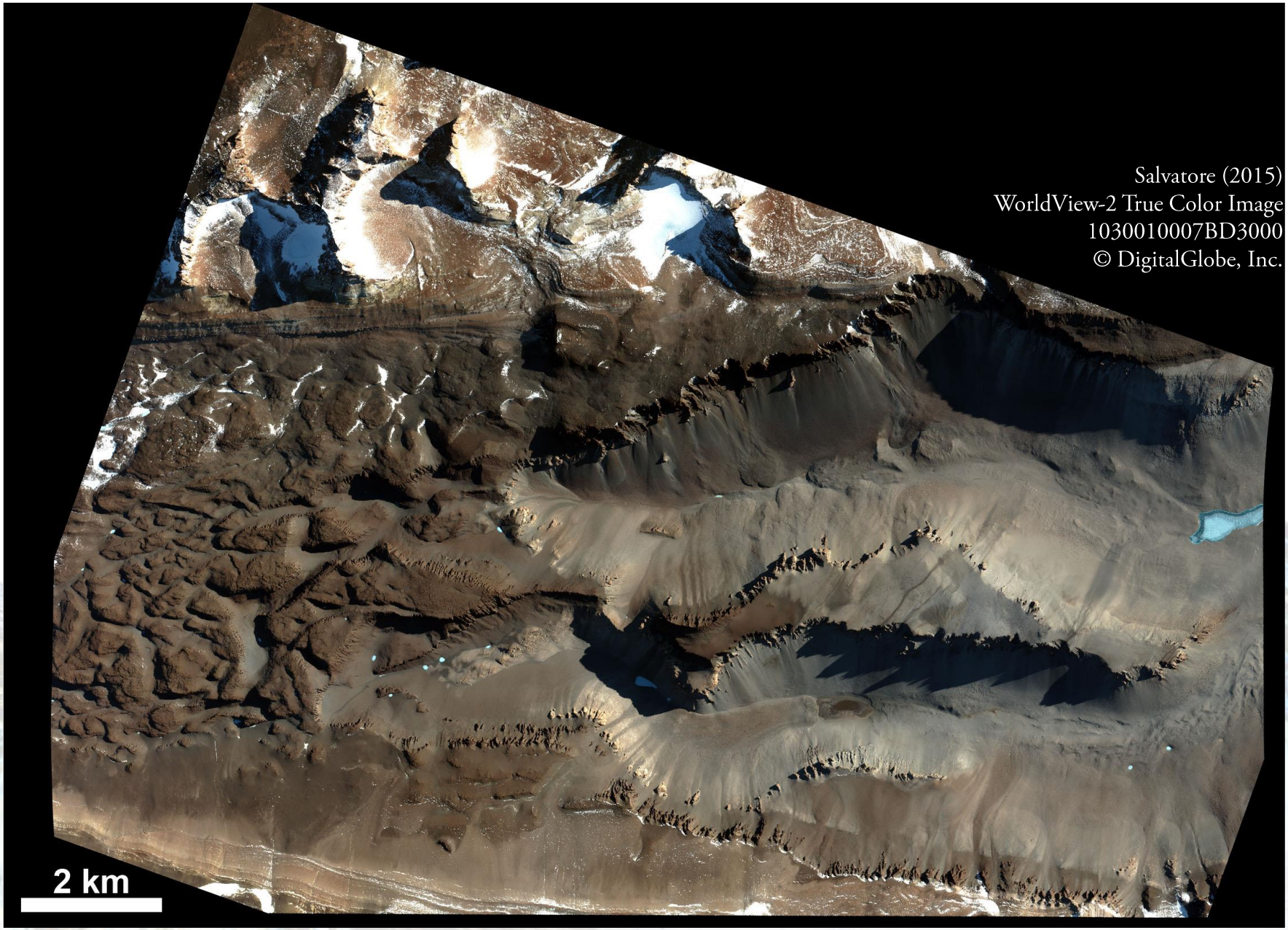

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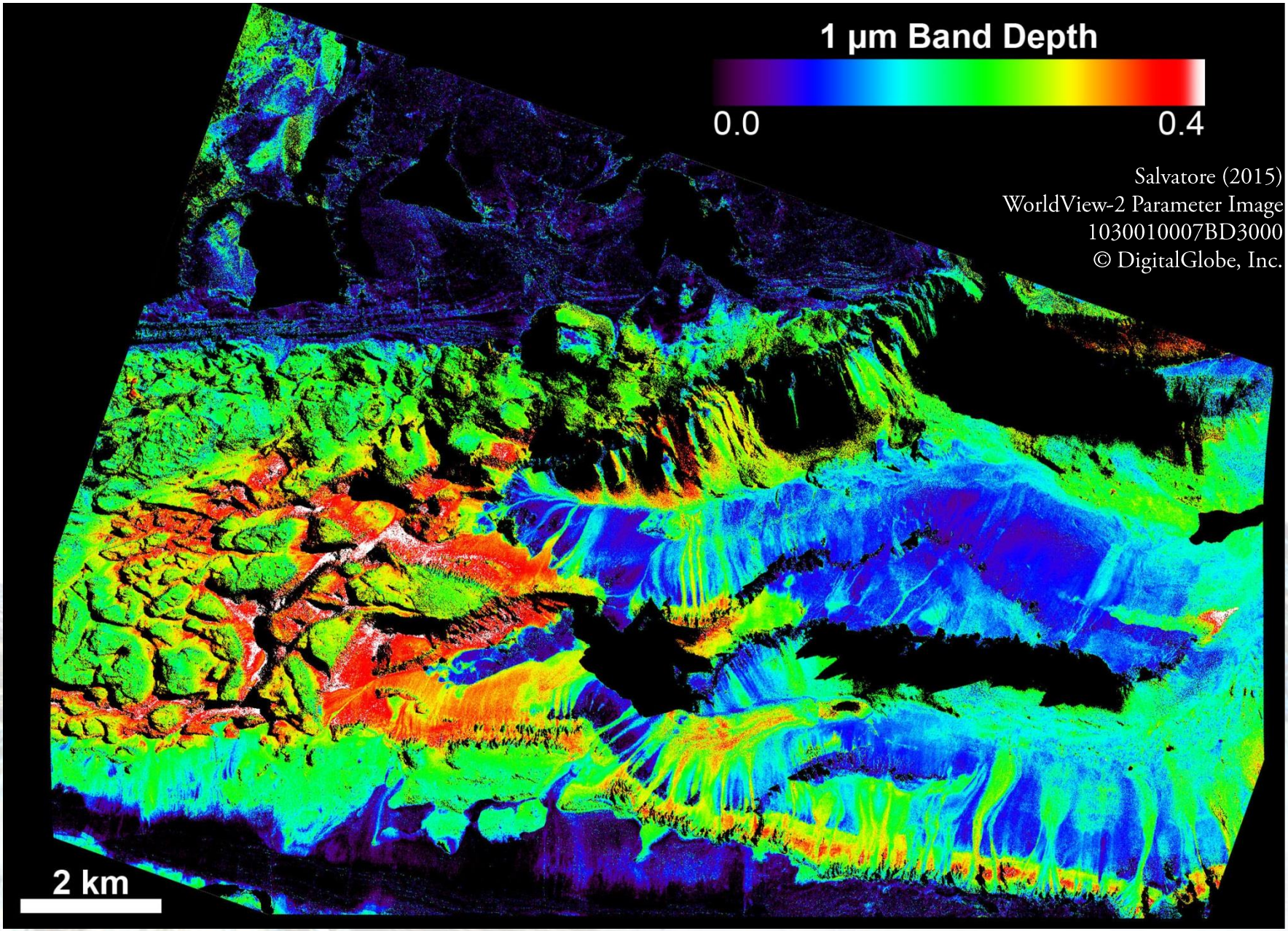

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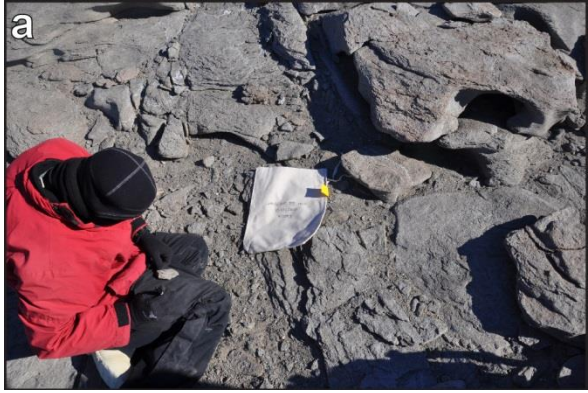

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  - Pre-field determination of ground truthing locations

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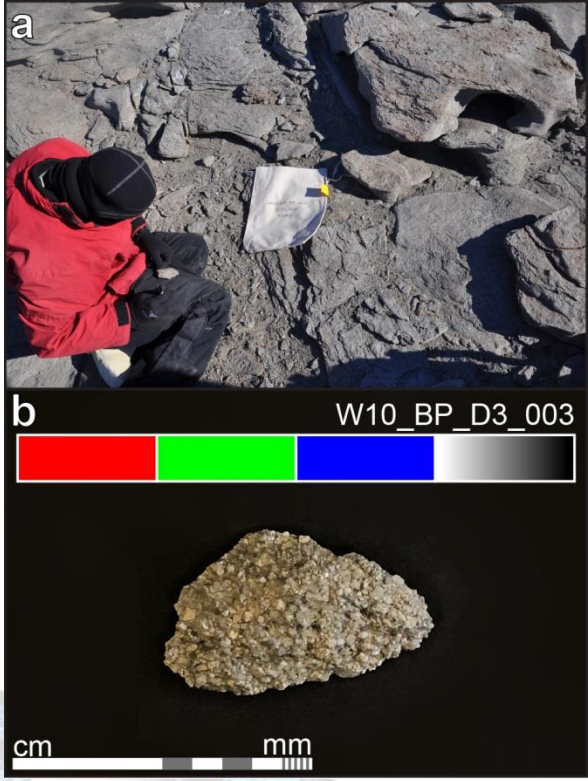

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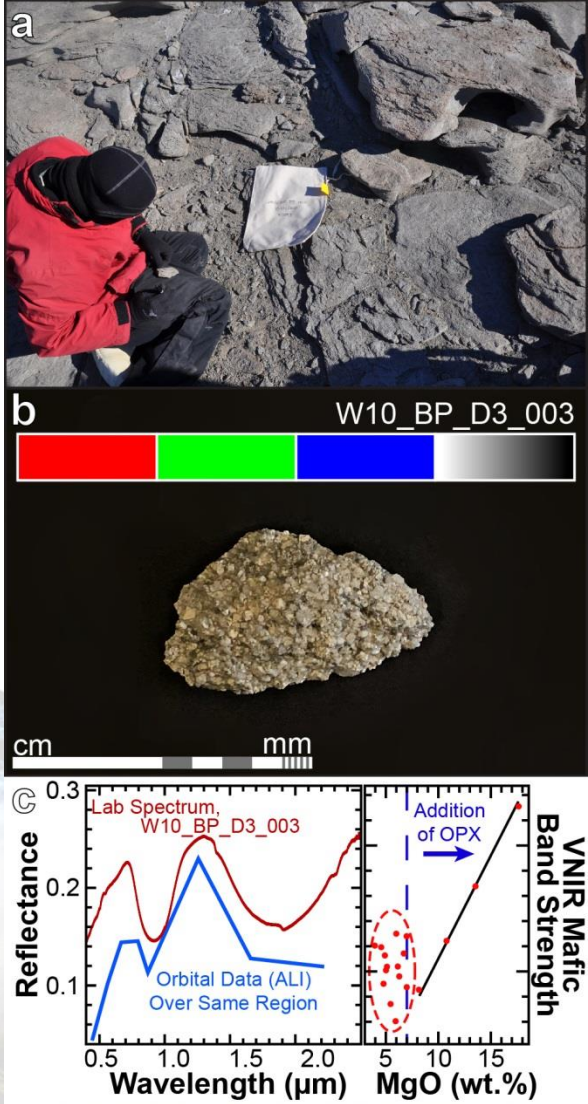

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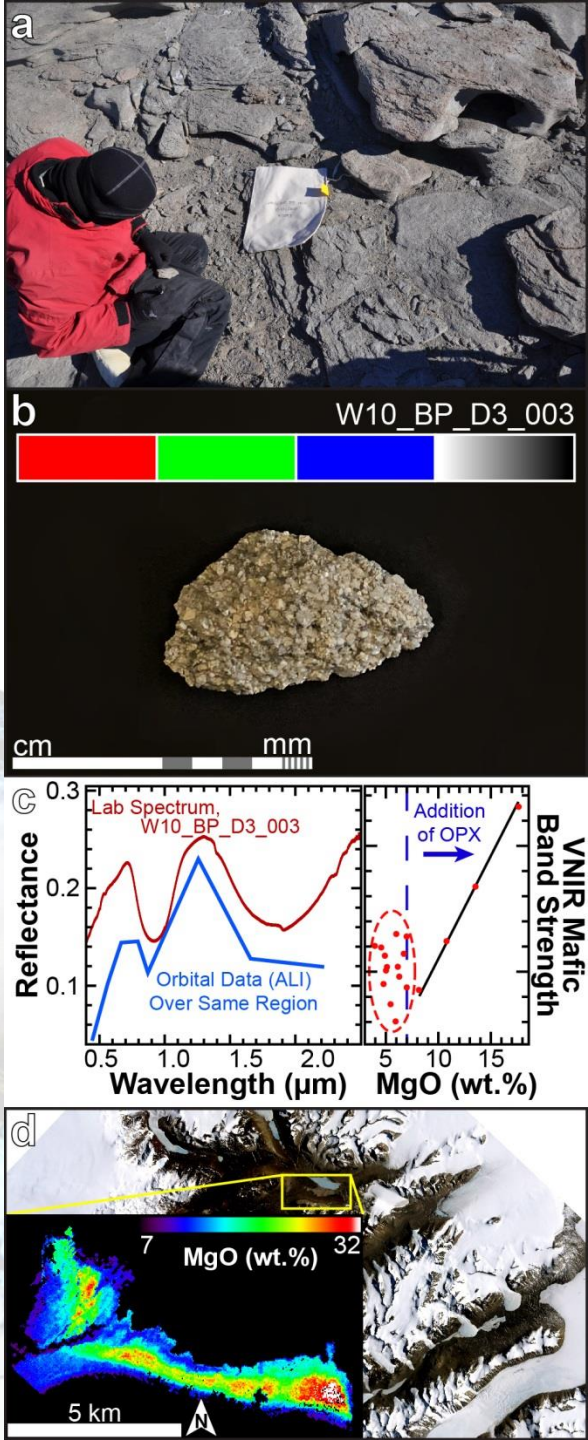
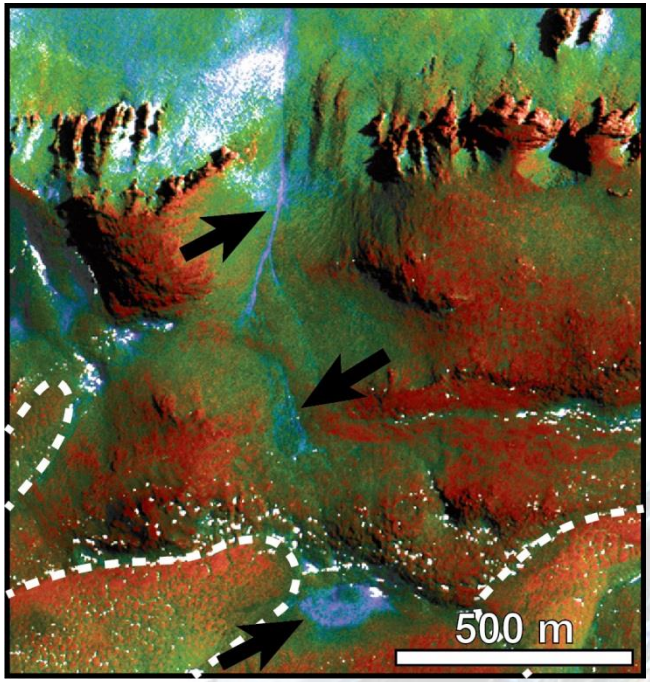
  - Association with other analyses and identification of key relationships
  - Translate back to remote sensing data for broader application to non-validated locations

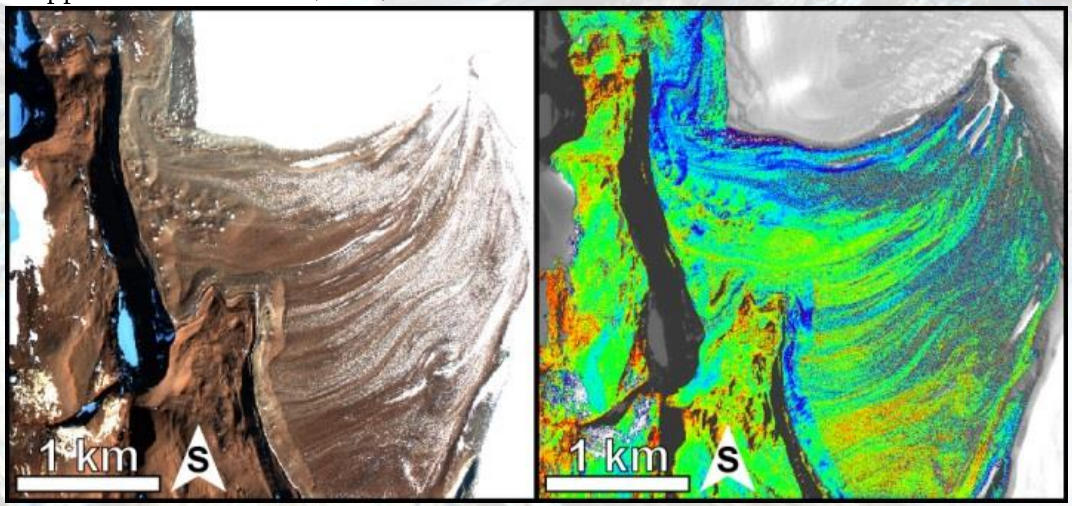


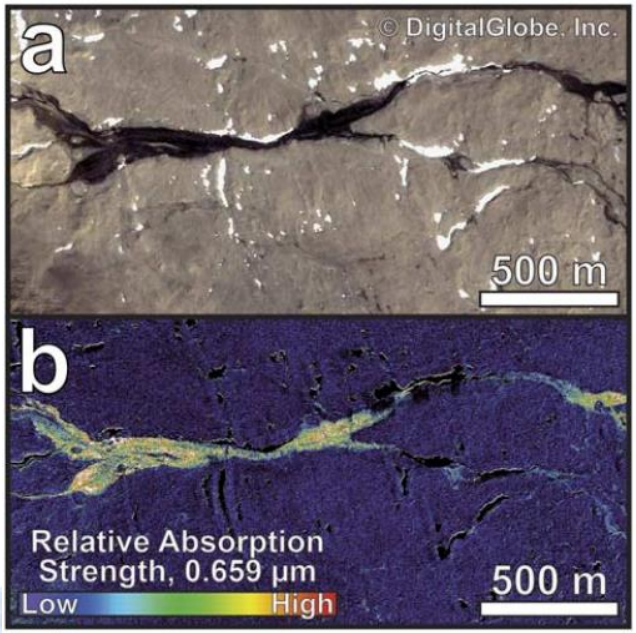
Modified from Salvatore et al. (2014)

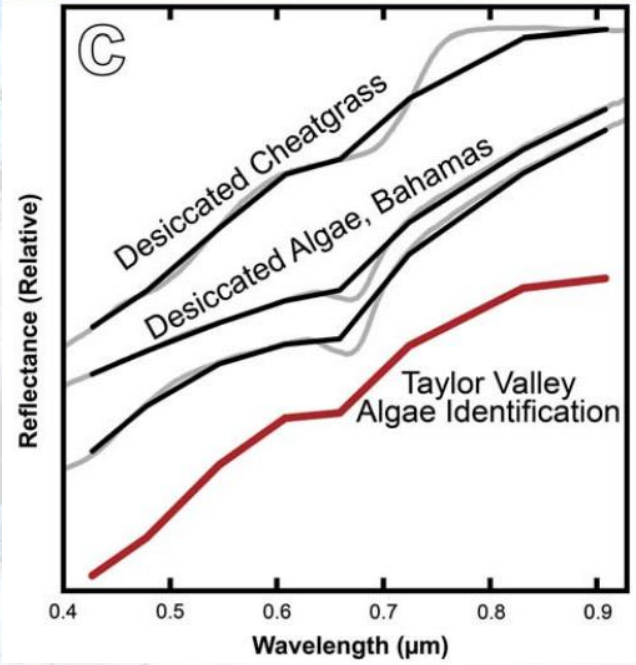
Success Stories



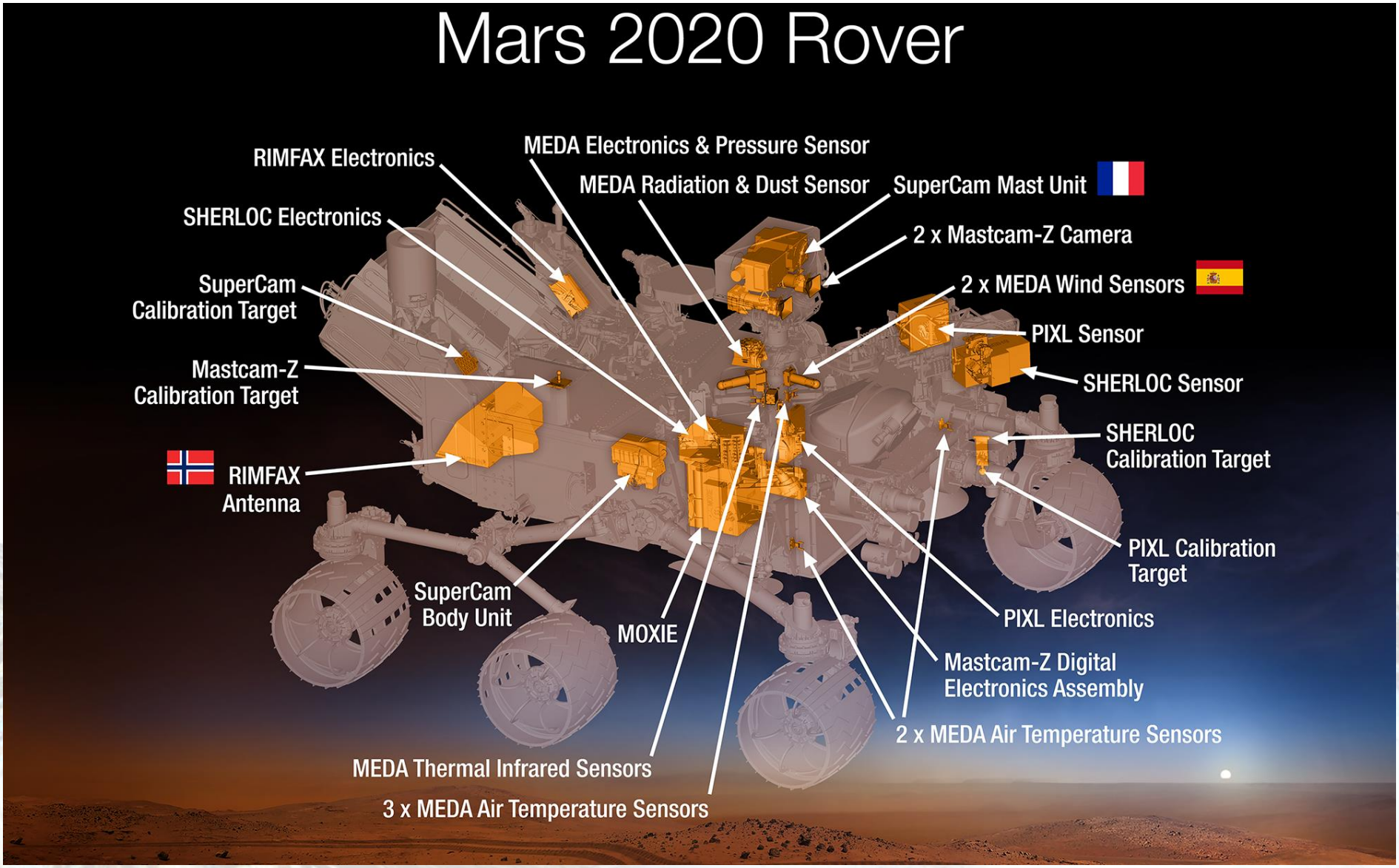
Snippets from Salvatore (2015)







Ground Truthing with Mars 2020



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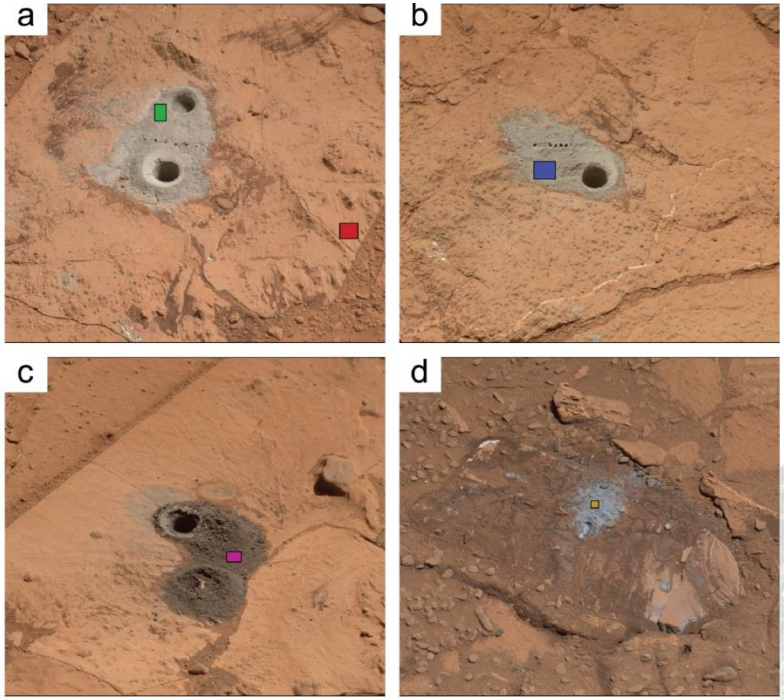

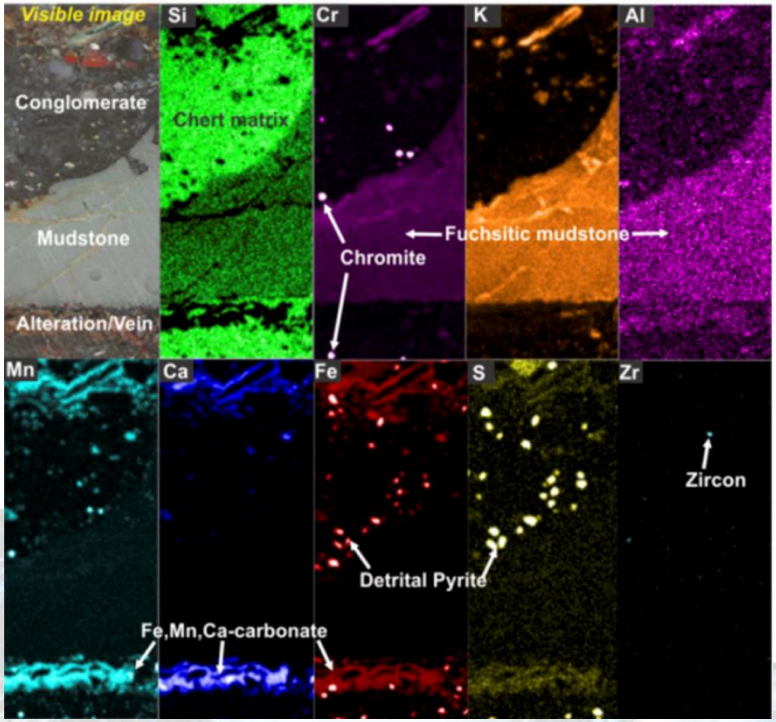

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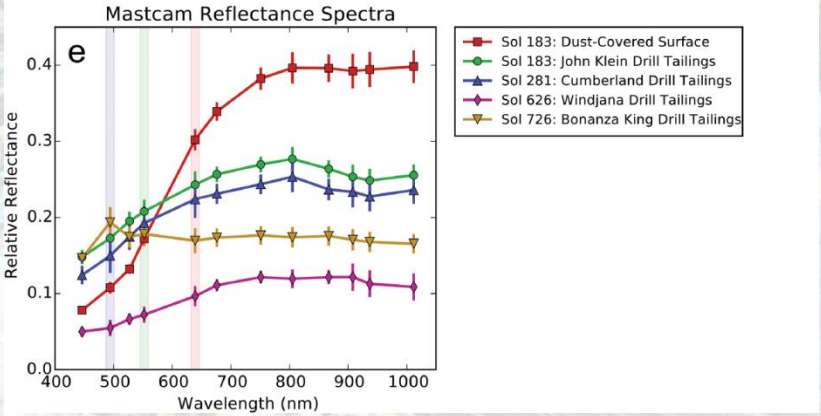
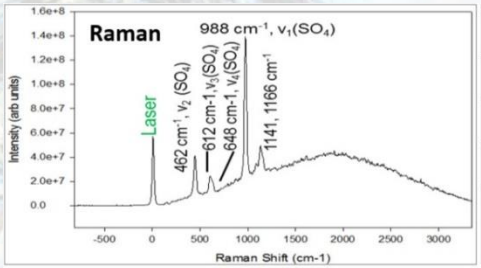
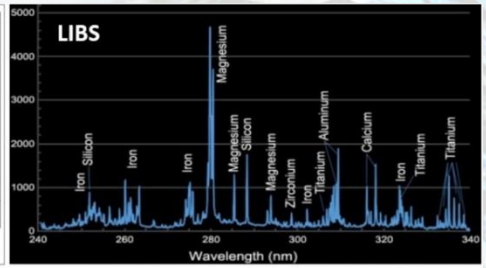
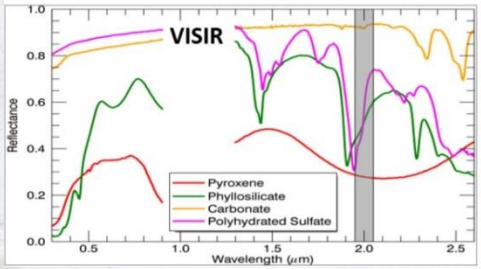
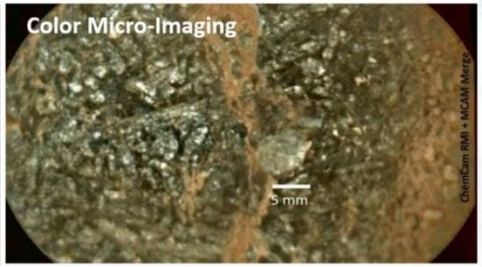


Wellington et al. (2017)









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Ground Truthing with Mars 2020

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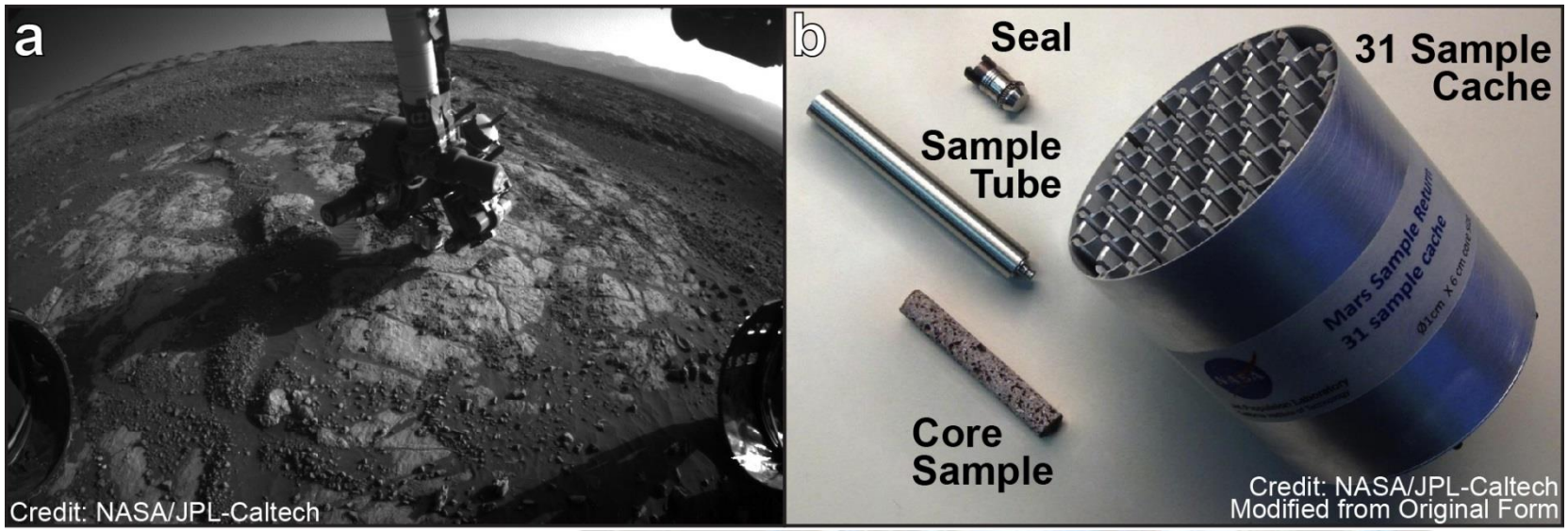

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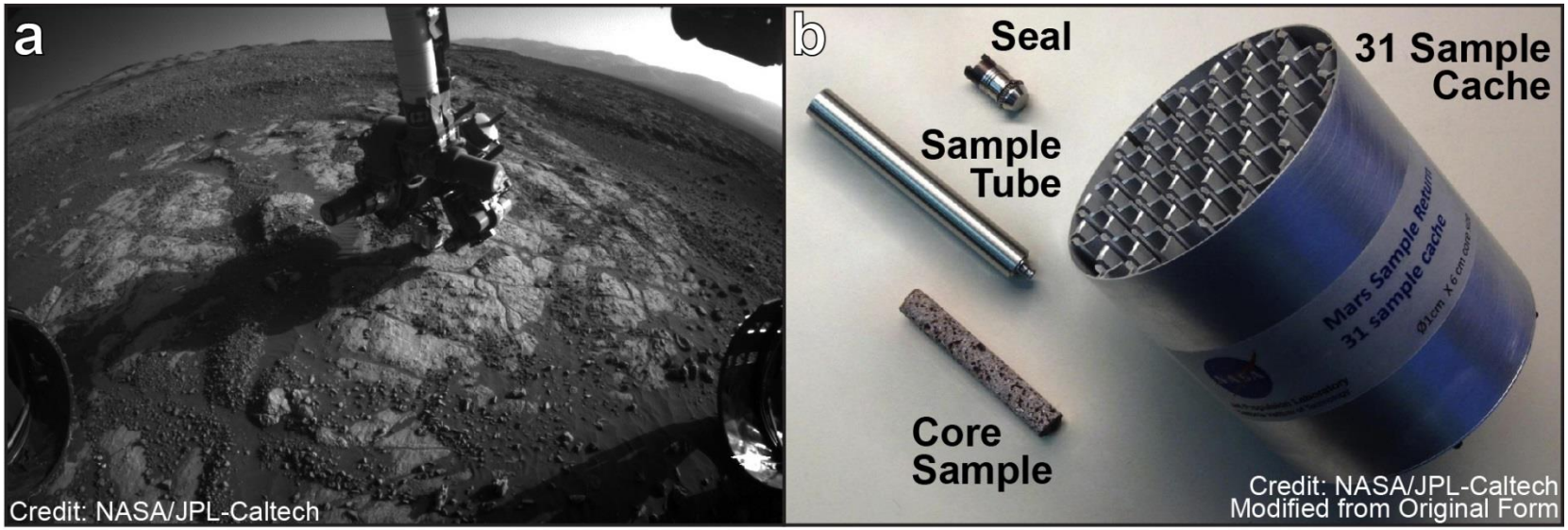

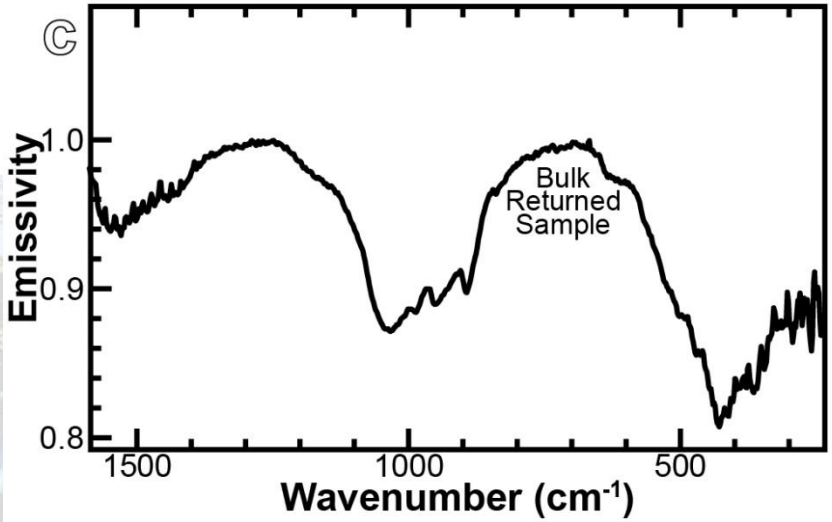

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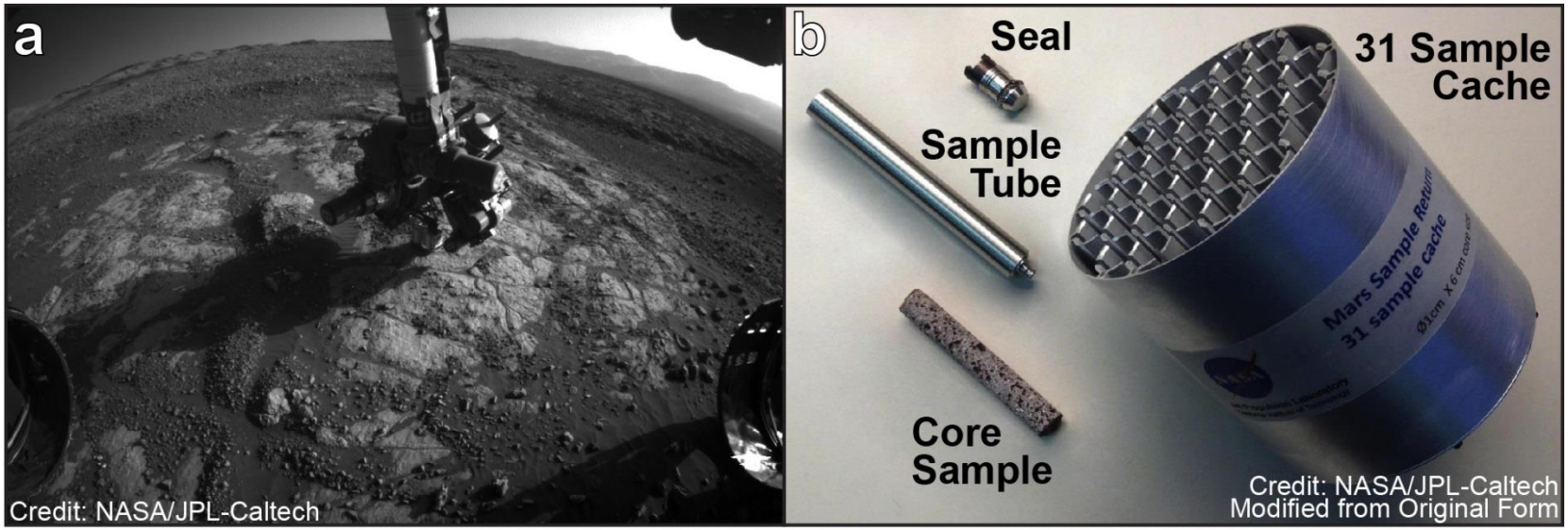

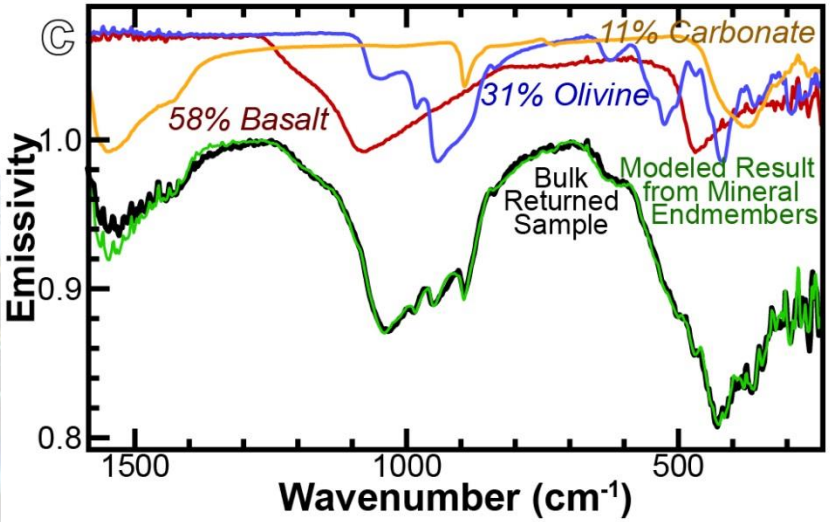

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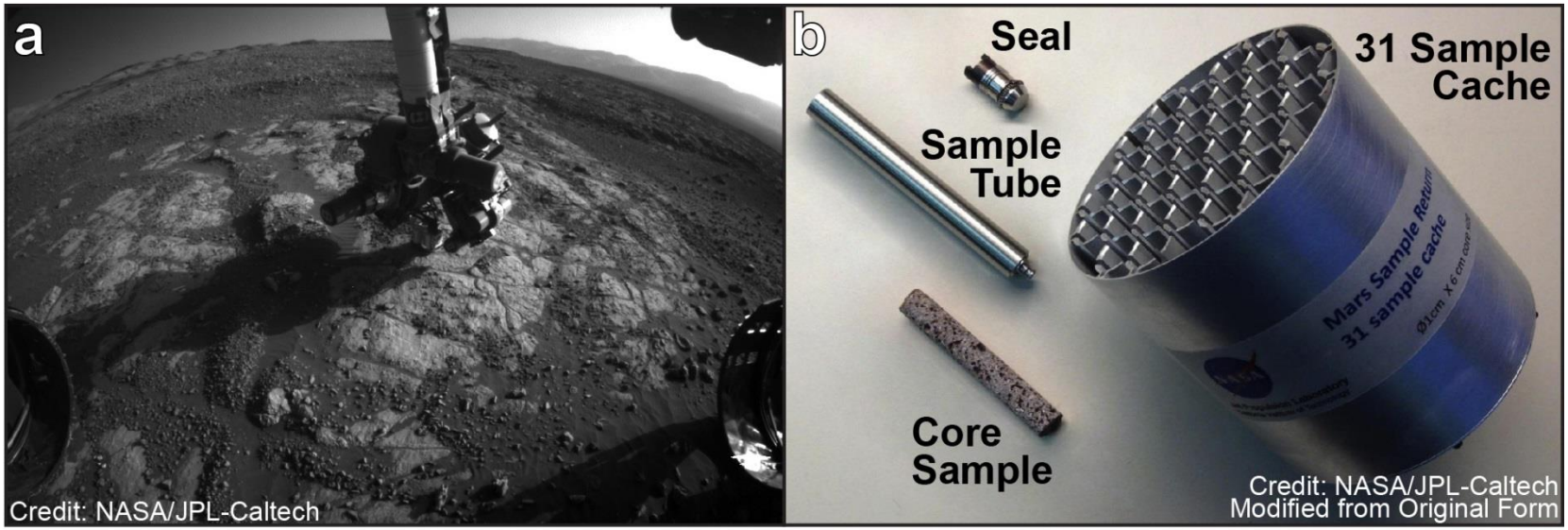

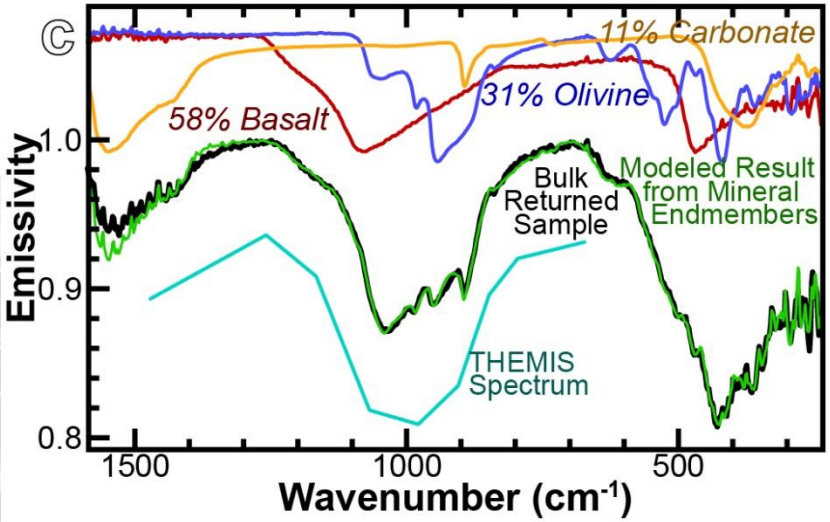

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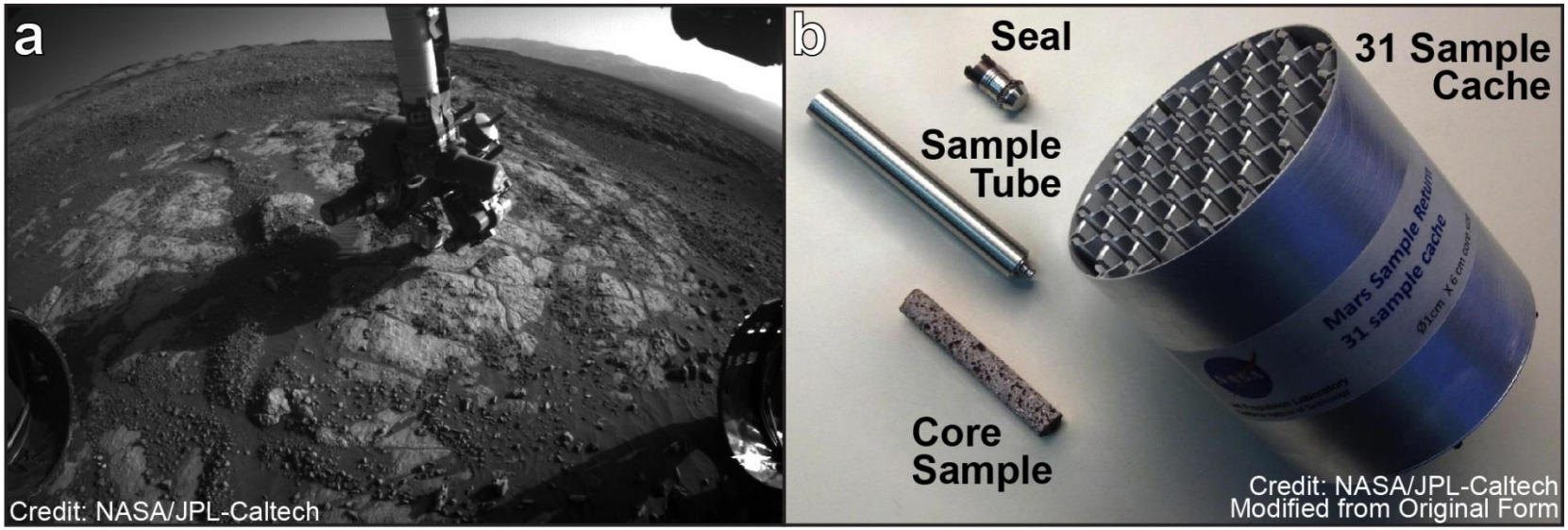

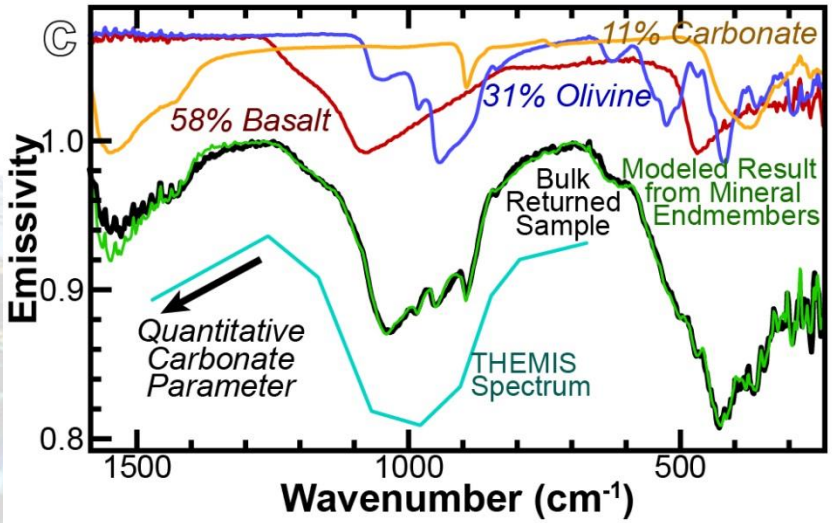

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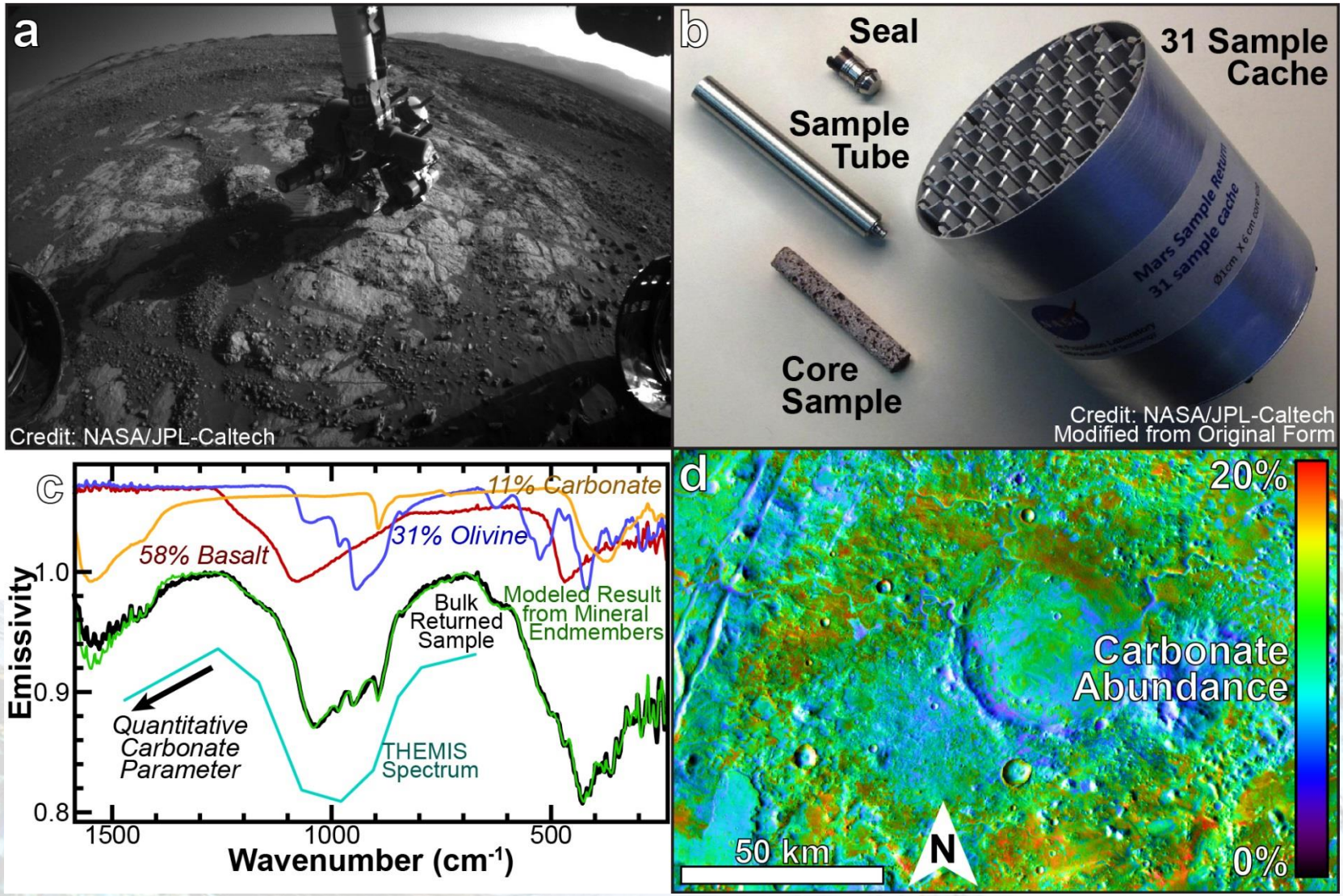
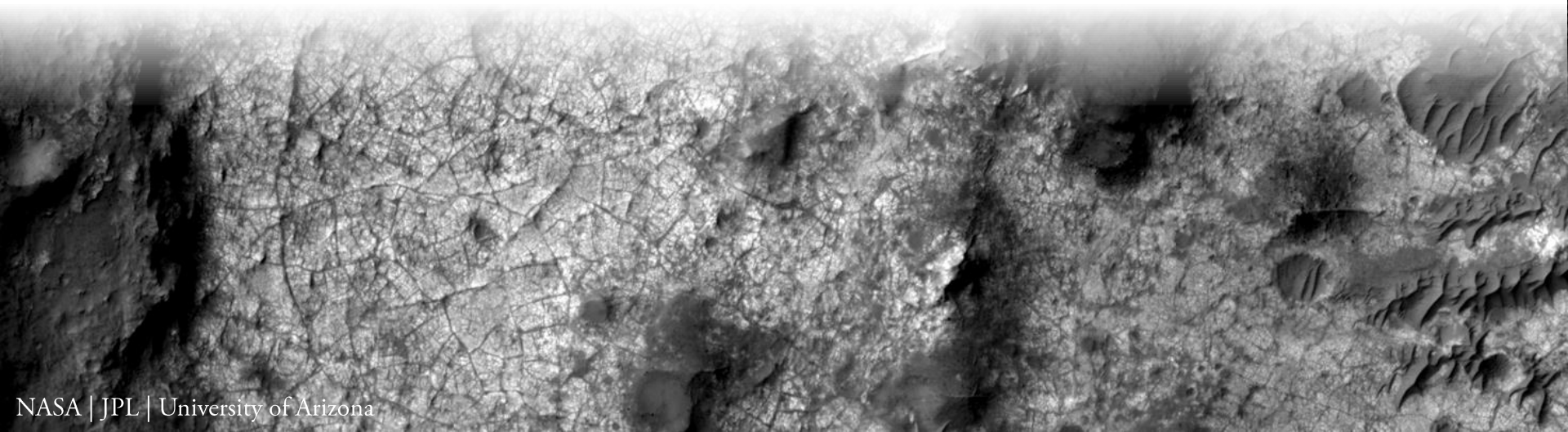


What Makes a Good Ground Truthing Candidate?

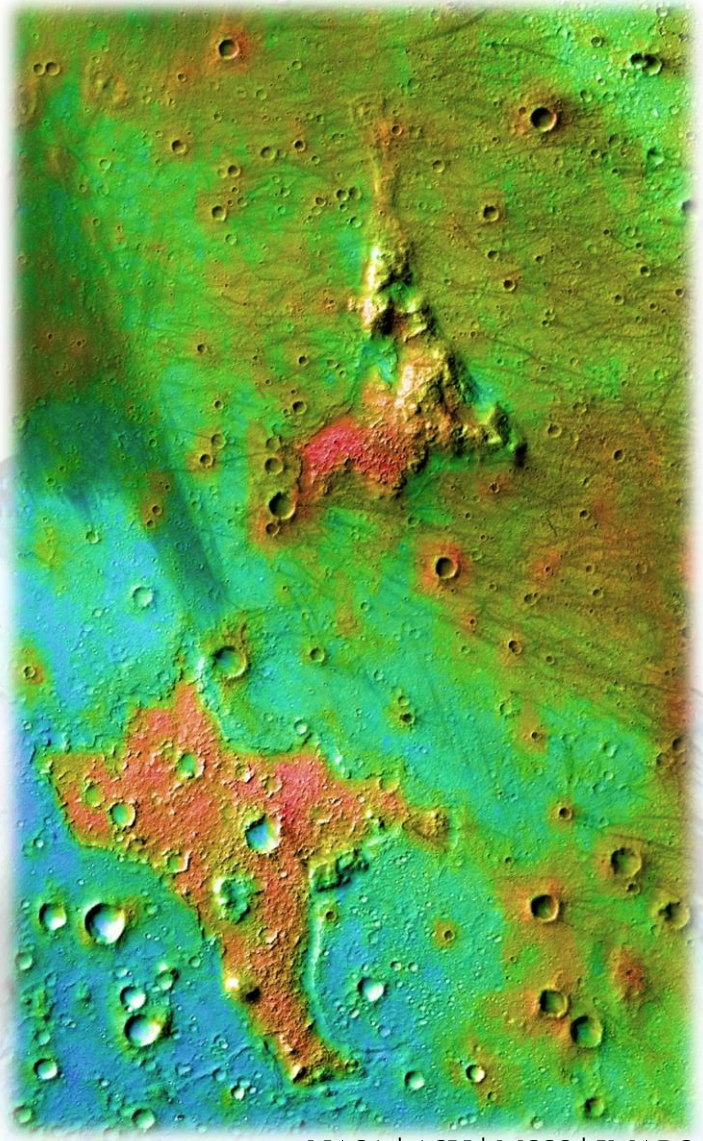
- Unique spectral/morphological signatures
  - Indicative of formation and/or modification processes
- Spatially extensive
  - Can be identified and characterized from orbit
- Geologically relevant
  - Informative and applicable to broader geologic questions

Sounds like our current strategy for sampling and surface analyses!



Ground Truthing @ Columbia Hills

- Spatially extensive geologic units:
  - Basaltic plains, surface dust, Comanche/Algonquin unit (Ruff et al., 2014)?
- Basaltic plains:
  - "Typical" Hesperian-aged volcanics
  - Datable surface – correlation to weathering (e.g., Mazatzal?)
- Surface dust:
  - Globally pervasive and physically/compositionally homogeneous
  - Valuable for spectral mixing models, understanding the effects of thin layers, human exploration implications, etc.
- Comanche/Algonquin unit:
  - Volcaniclastic unit, ~40 wt% olivine, ~25 wt% carbonate
  - Relationship to carbonate-bearing units in NE Syrtis region?



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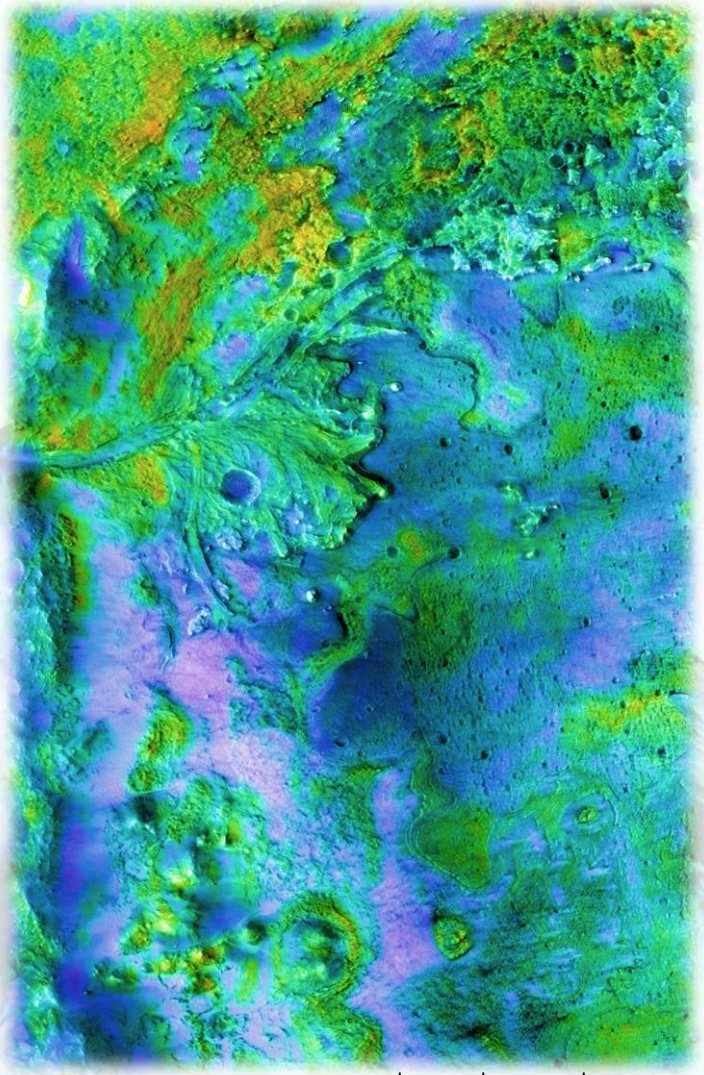
Ground Truthing @ Jezero Crater

- Spatially extensive geologic units:
  - Volcanically resurfaced floor, carbonate-bearing floor material, fan deposits
- Volcanically resurfaced floor:
  - "Typical" Hesperian-aged volcanics?
  - Relationship to underlying olv/carb-bearing unit?
- Carbonate-bearing floor material:
  - Relationship to regional carbonate unit, Comanche/Algonquin unit in Gusev crater, etc.?
- Fan deposits:
  - Aggregate of units present within the Jezero watershed
  - Smectite signatures and relationship to mode of formation (authigenic or detrital?)



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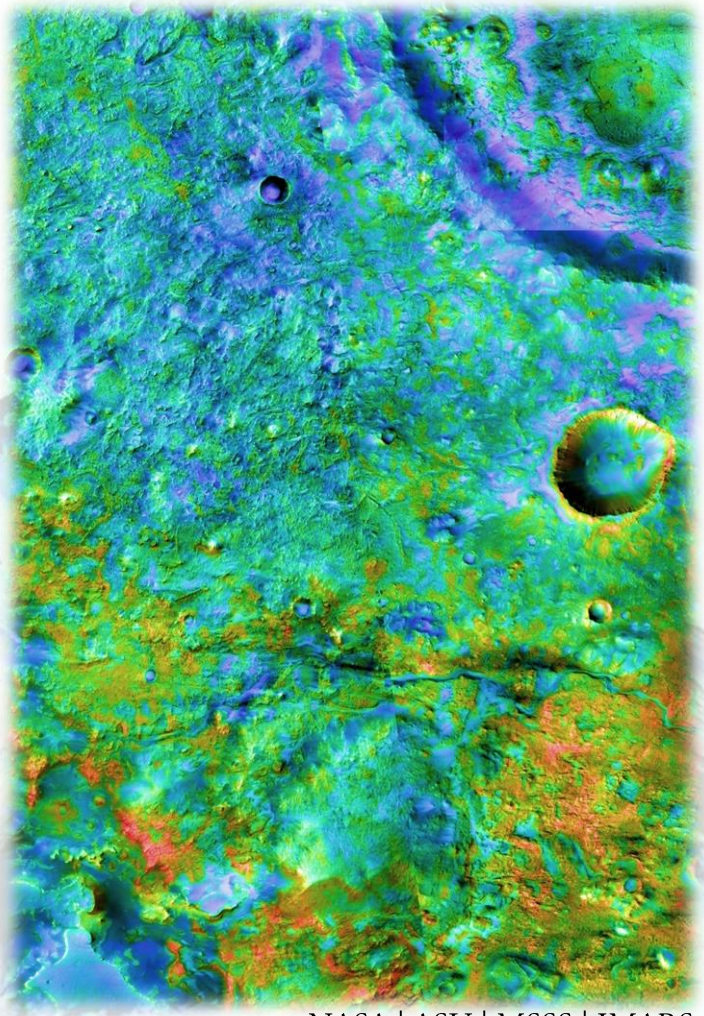
Ground Truthing @ NE Syrtis & Midway

- Spatially extensive geologic units:
  - Smectite-bearing basement, olivine-carbonate units, megabreccia blocks
- Smectite-bearing basement:
  - Correlate spectral and compositional diversity
  - Inform complex spectral unmixing models and compositional estimates
- Olivine-carbonate unit:
  - Relationship to Comanche/Algonquin unit in Gusev crater and other regionally extensive olv-carb-bearing units?
- Megabreccia blocks:
  - Ancient remnants of ancient Noachian crustal materials?
  - Diverse suite of samples could serve to validate remote sensing efforts of the ancient Noachian crust



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Summary & Take-Home Message

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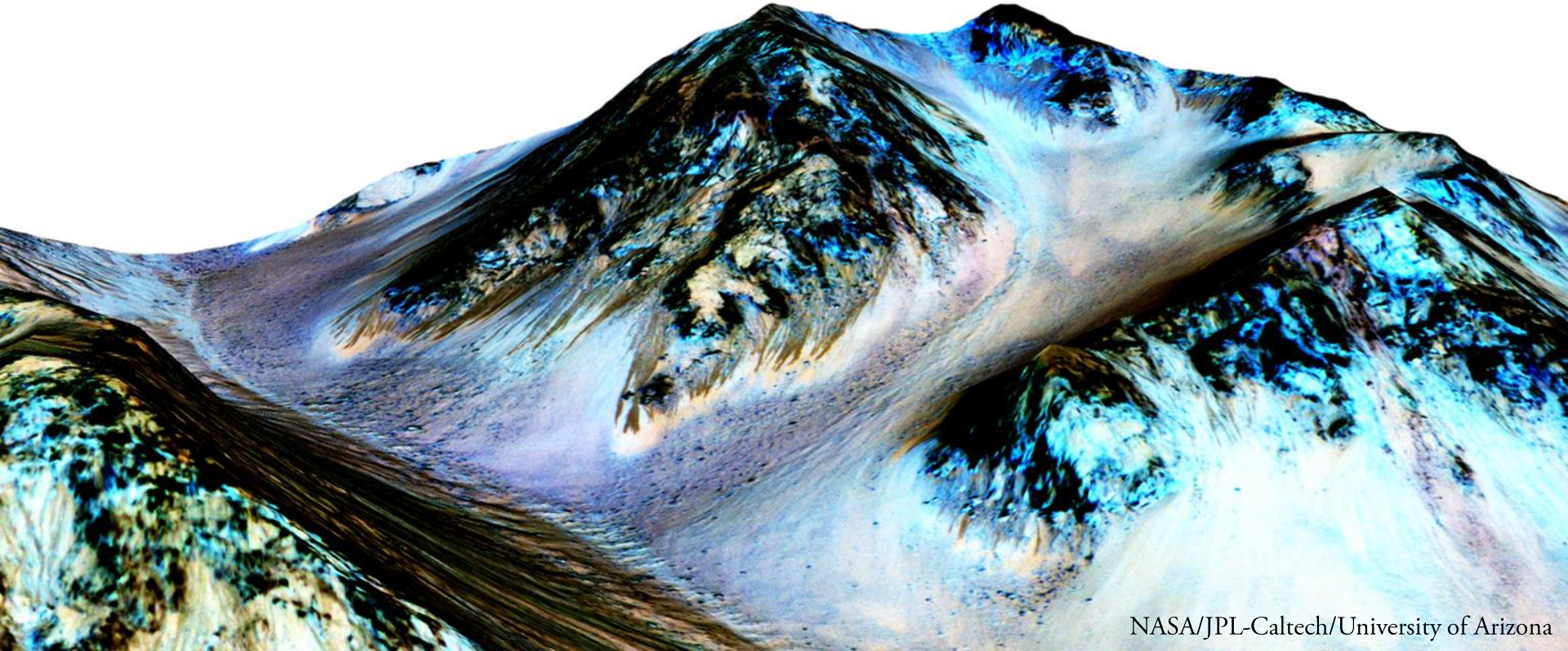

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