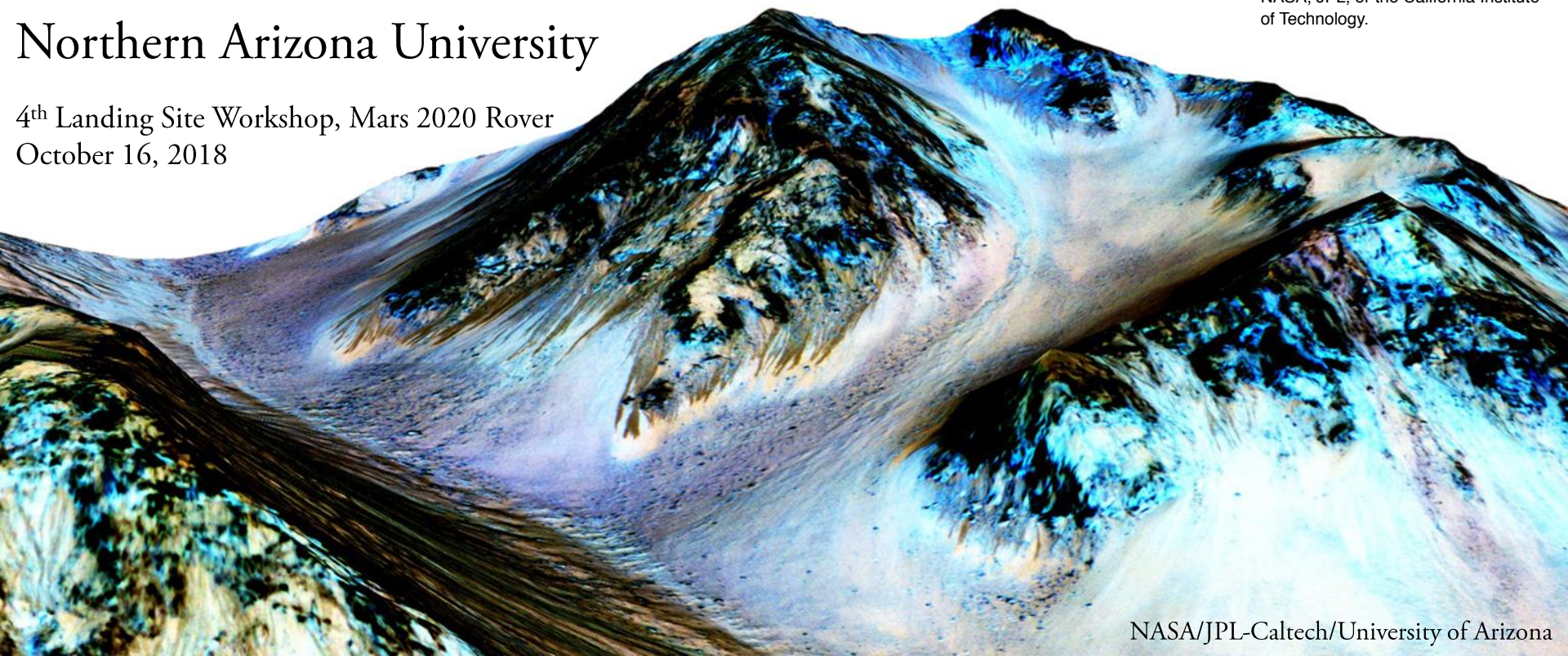
Squeezing More Science Out of Our Orbiters:
Using the Mars 2020 Rover and Returned Samples to Ground Truth Spectral Datasets

NOTE ADDED BY JPL WEBMASTER: This content has not been approved or adopted by NASA, JPL, or the California Institute of Technology. This document is being made available for information purposes only, and any views and opinions expressed herein do not necessarily state or reflect those of NASA, JPL, or the California Institute of Technology.

Mark Salvatore
Northern Arizona University

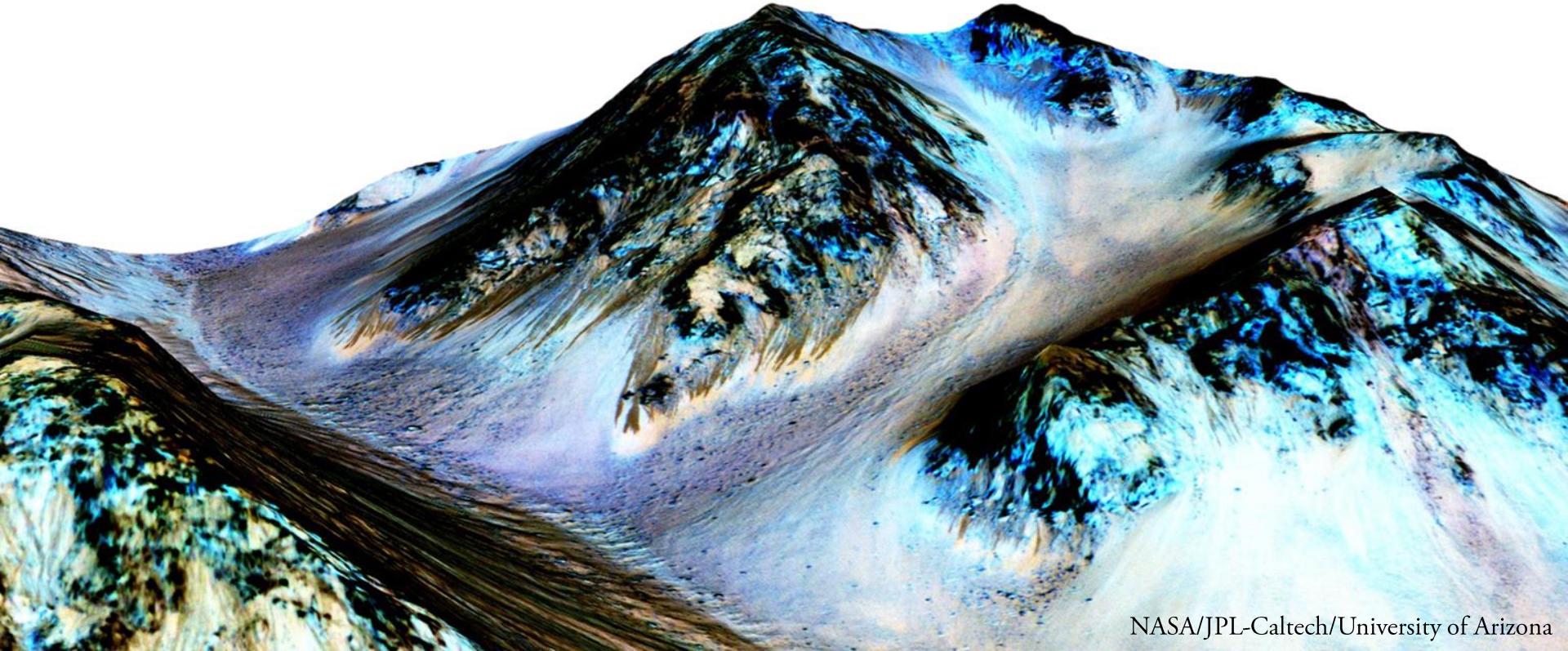
4th Landing Site Workshop, Mars 2020 Rover
October 16, 2018



NASA/JPL-Caltech/University of Arizona

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."

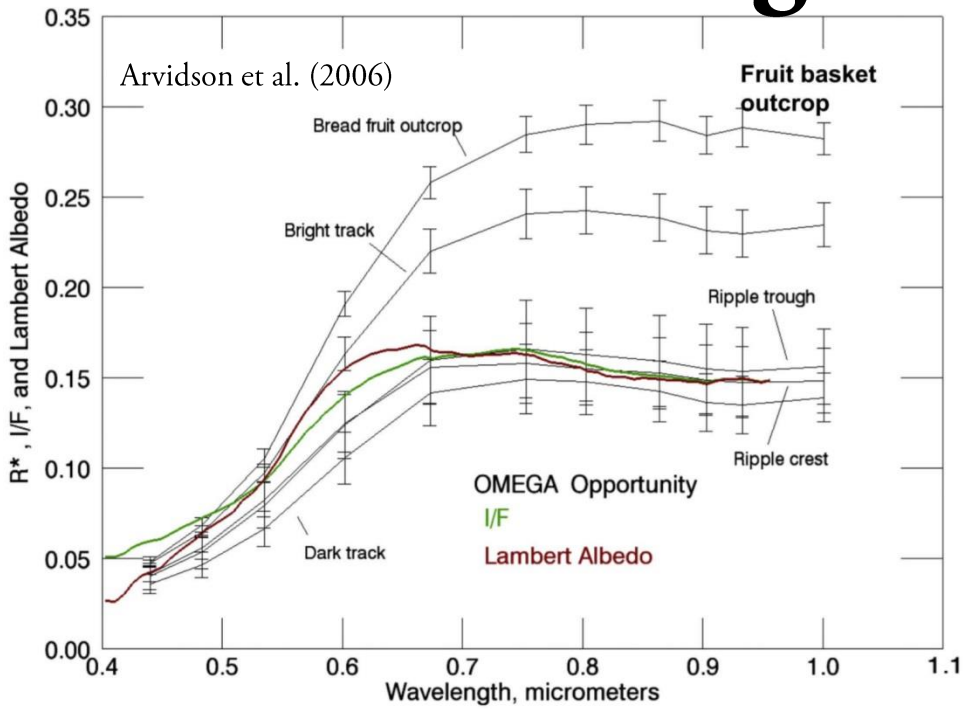


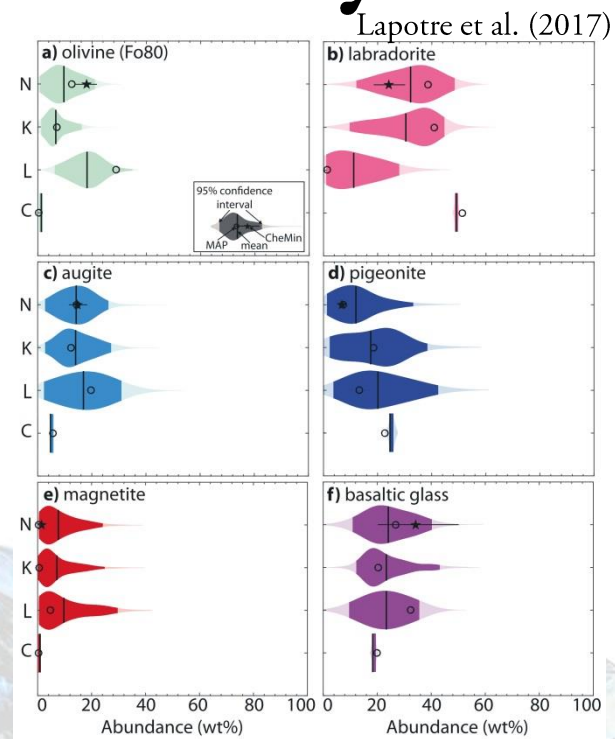
NASA/JPL-Caltech/University of Arizona

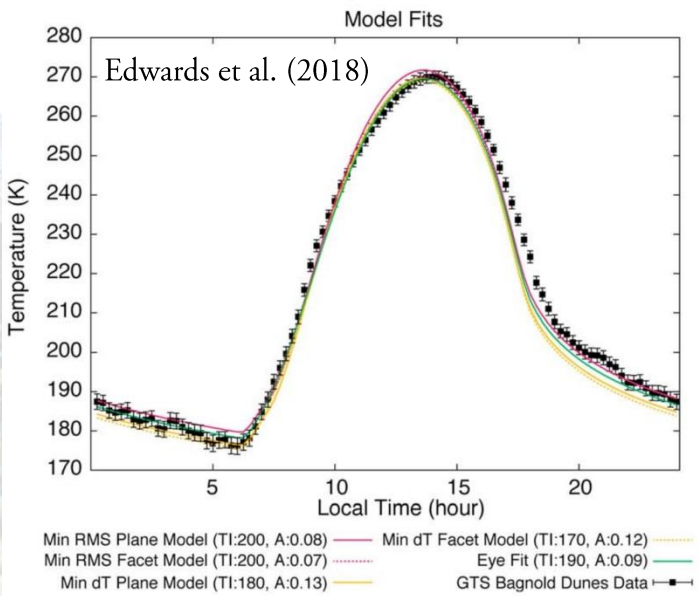
Outline

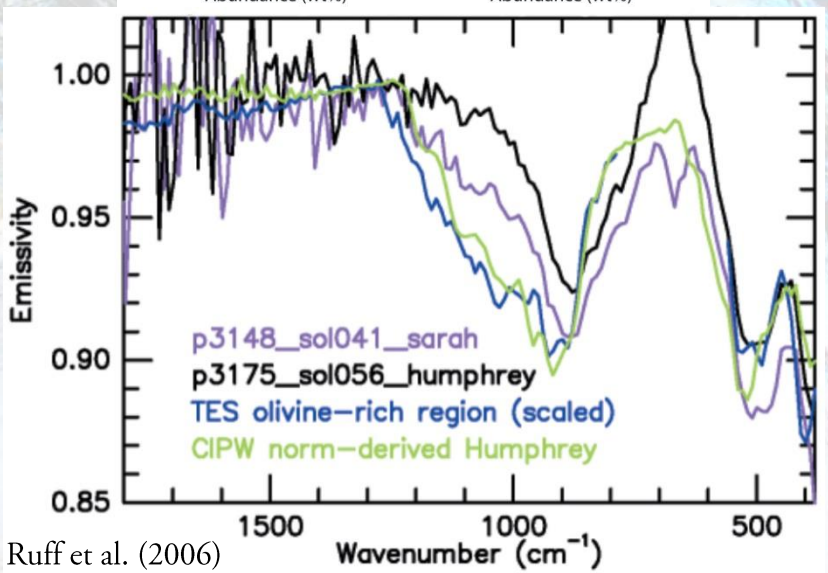
- Why make ground truthing a priority?
- Ground truthing success stories
- How to ground truth with the Mars 2020 rover
- Potential ground truthing targets
  - Columbia Hills
  - Jezero crater
  - NE Syrtis and Midway

Ground Truthing as a Priority



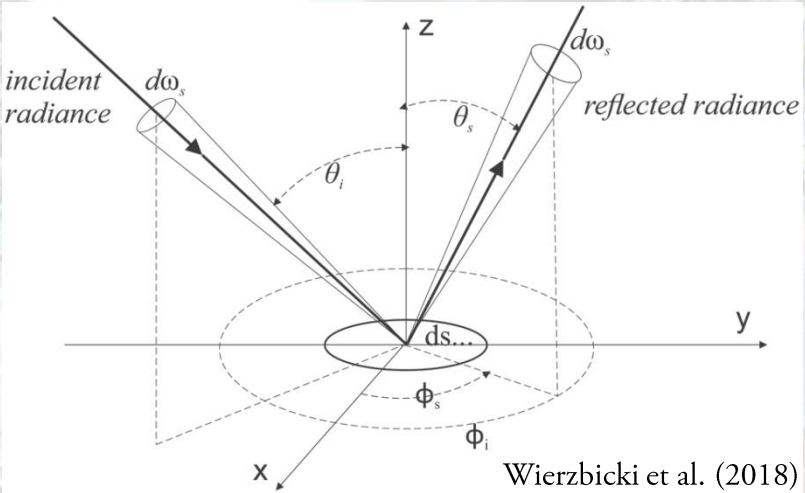




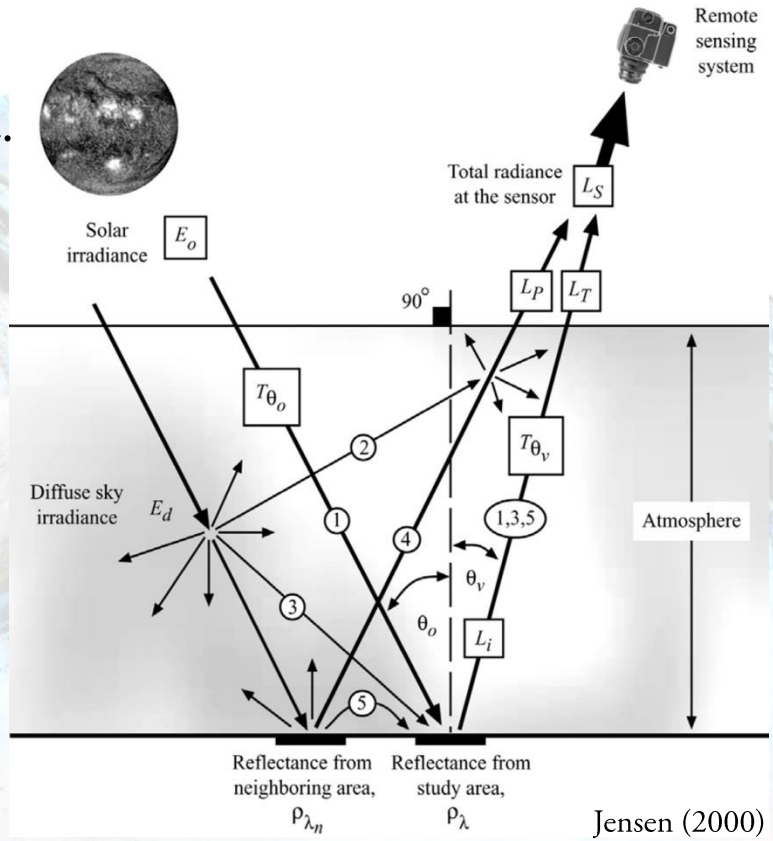


Ground Truthing as a Priority

- 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)

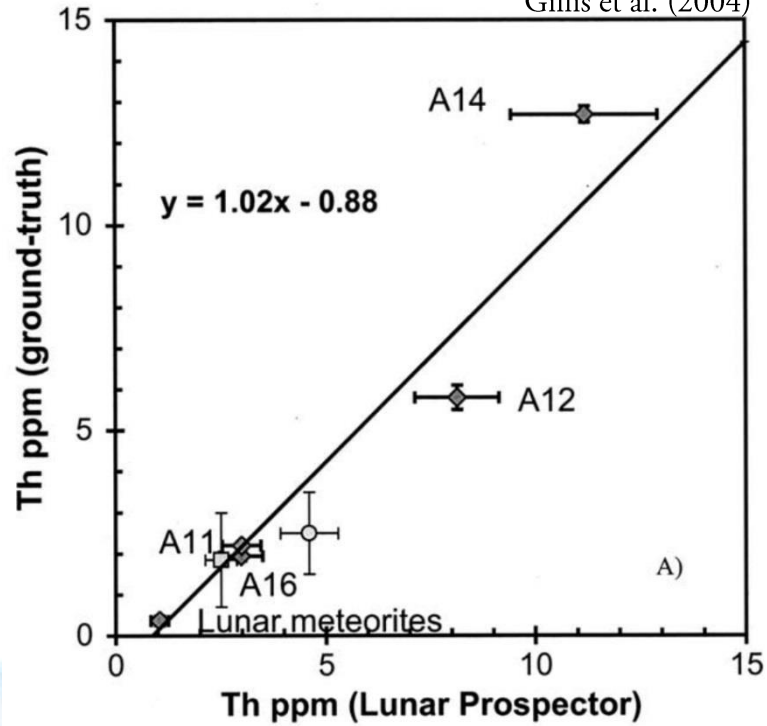


Jensen (2000)

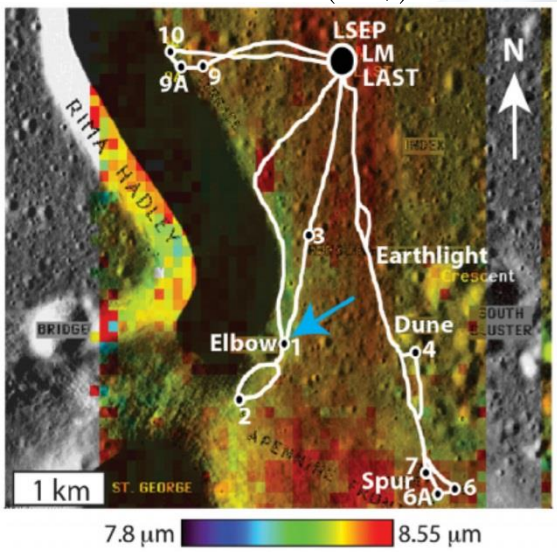
Success Stories

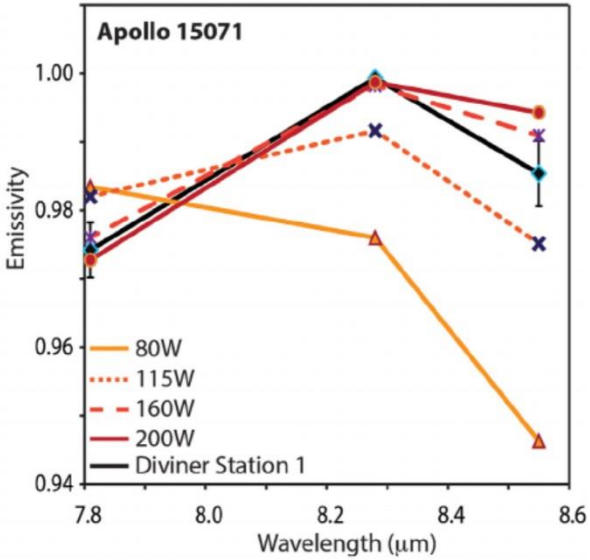
- Lunar samples have long been used to validate remote sensing datasets
  - Gamma ray spectroscopy (right)
  - Reflectance spectra (e.g., Pieters et al., 2009)
  - Emission data (below)
- Have provided insight into the **source** of many major spectral features
  - E.g., space weathering (Pieters et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

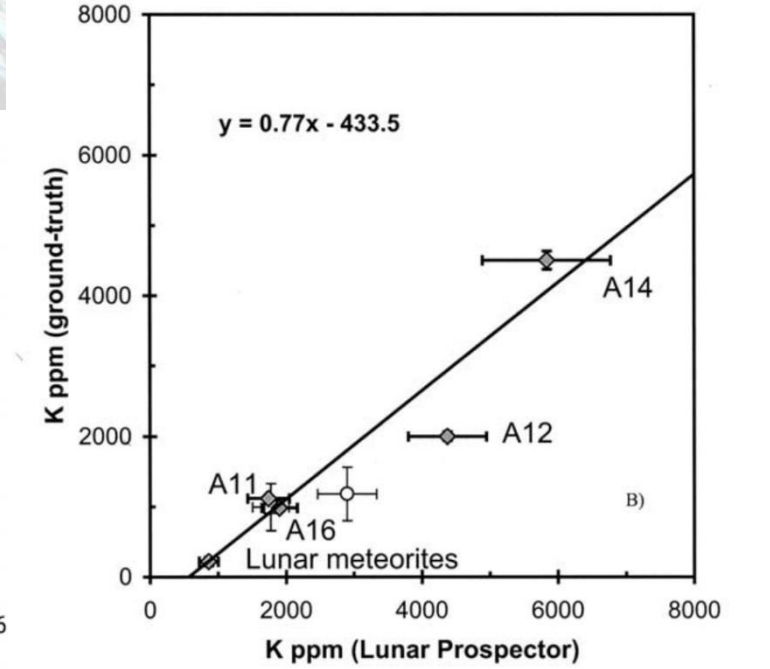
Gillis et al. (2004)



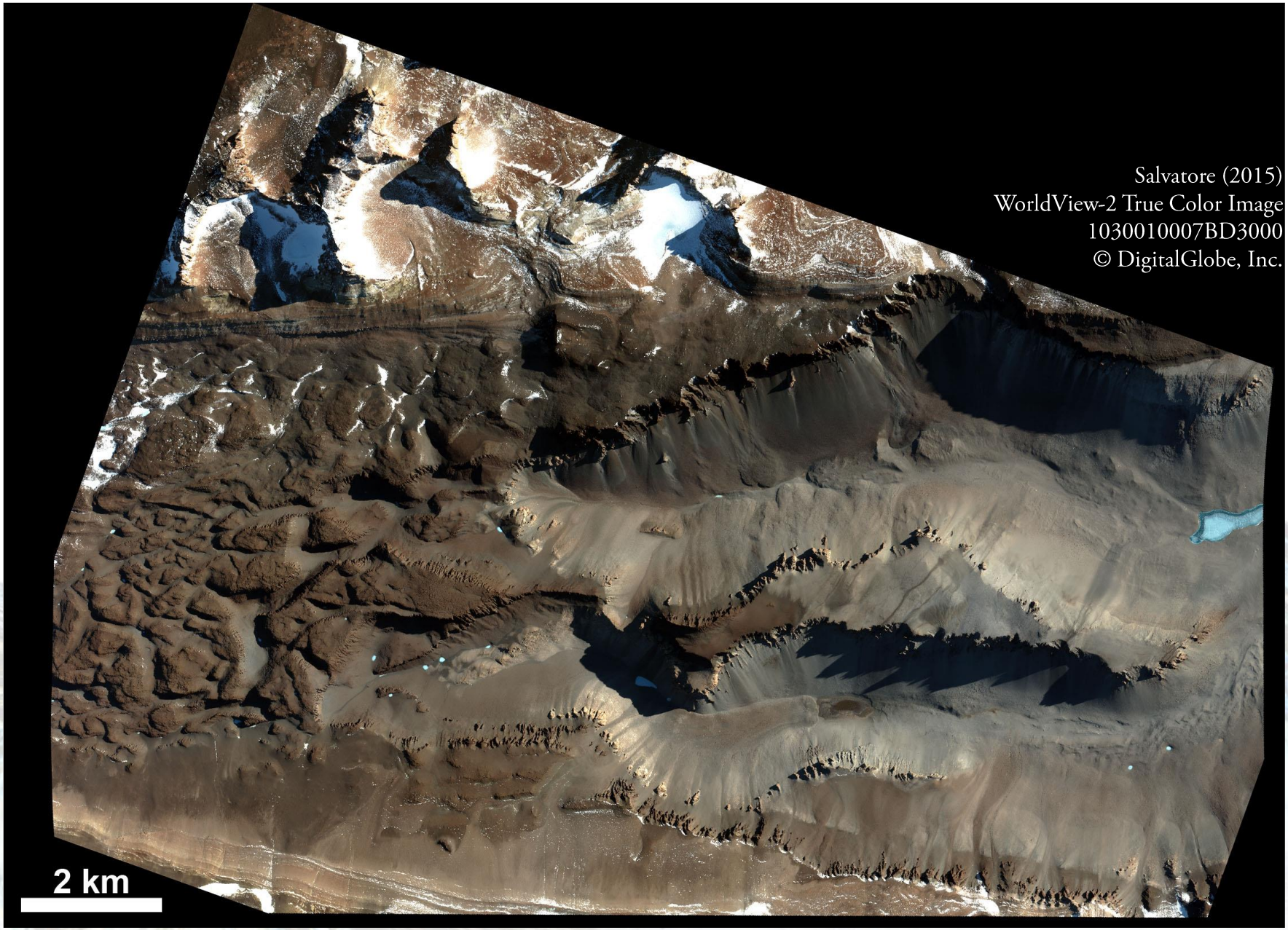
Donaldson Hanna et al. (2017)



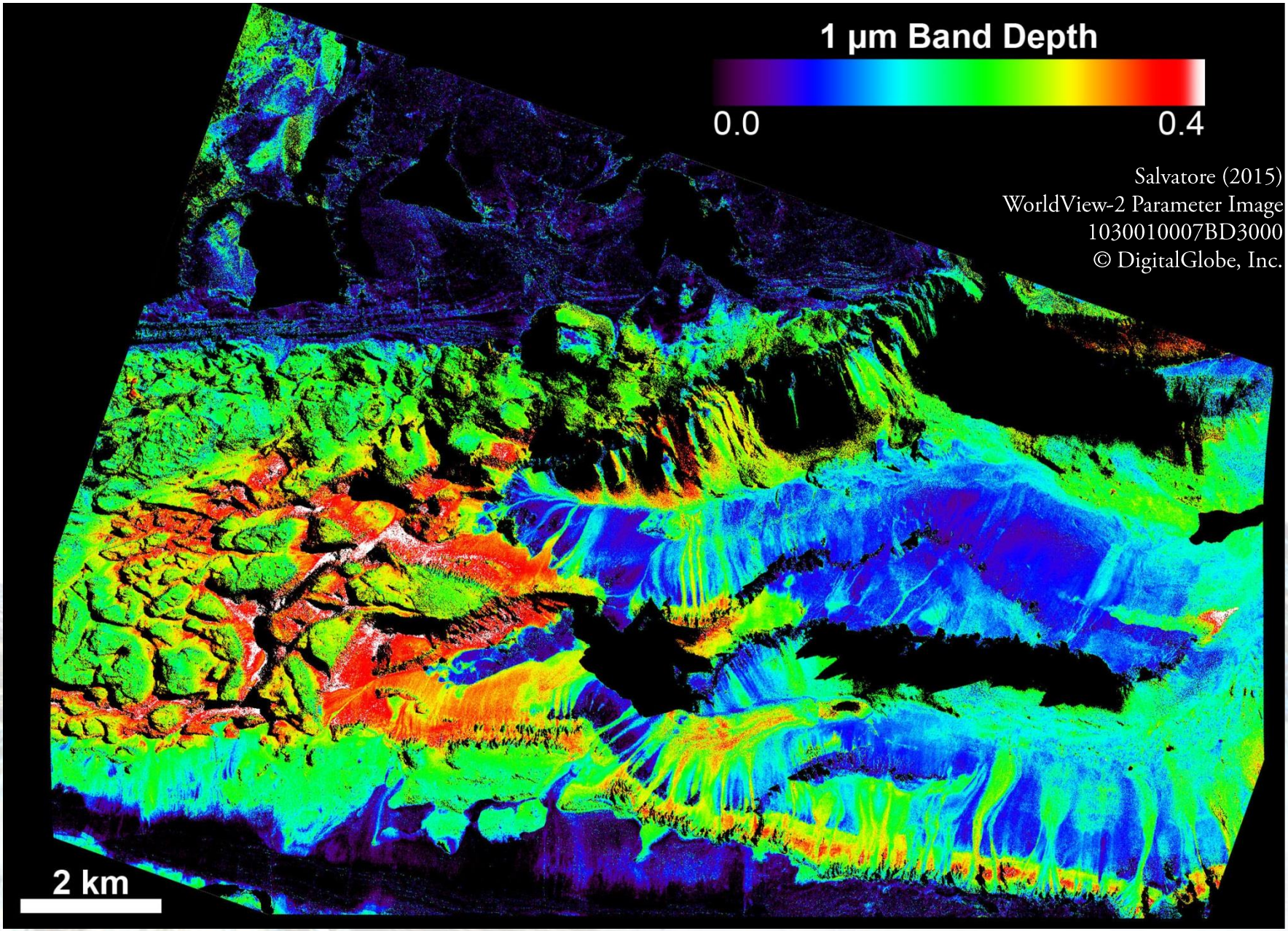




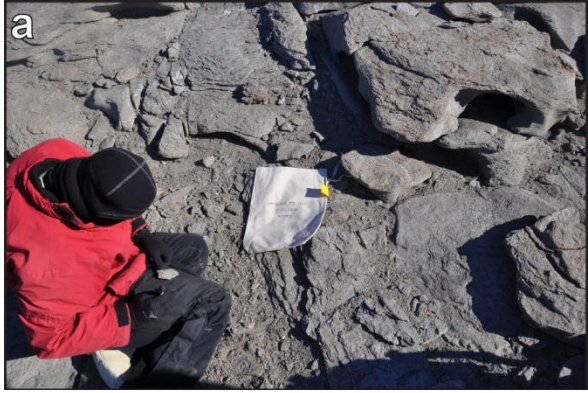
Success Stories



Success Stories



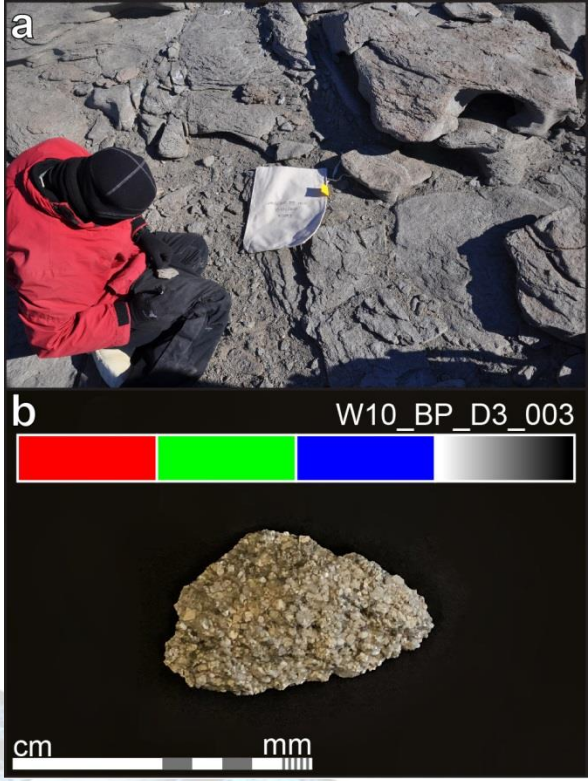
Success Stories



- Ground truthing of orbital datasets in the McMurdo Dry Valleys (MDV) of Antarctica
  - Pre-field determination of ground truthing locations

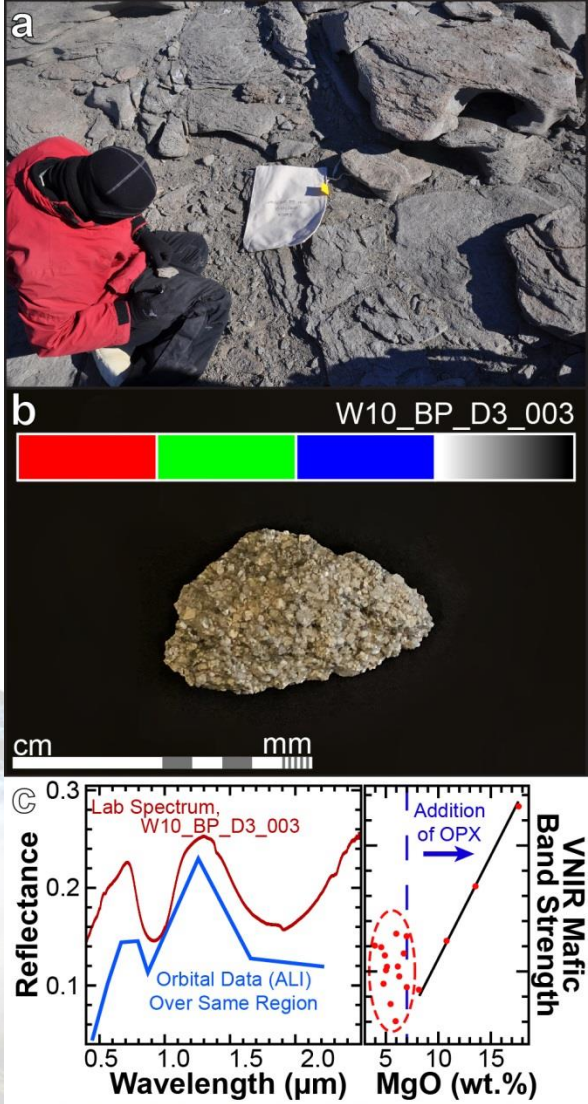
Success Stories

- Ground truthing of orbital datasets in the McMurdo Dry Valleys (MDV) of Antarctica
  - Pre-field determination of ground truthing locations
  - Documentation and laboratory investigations



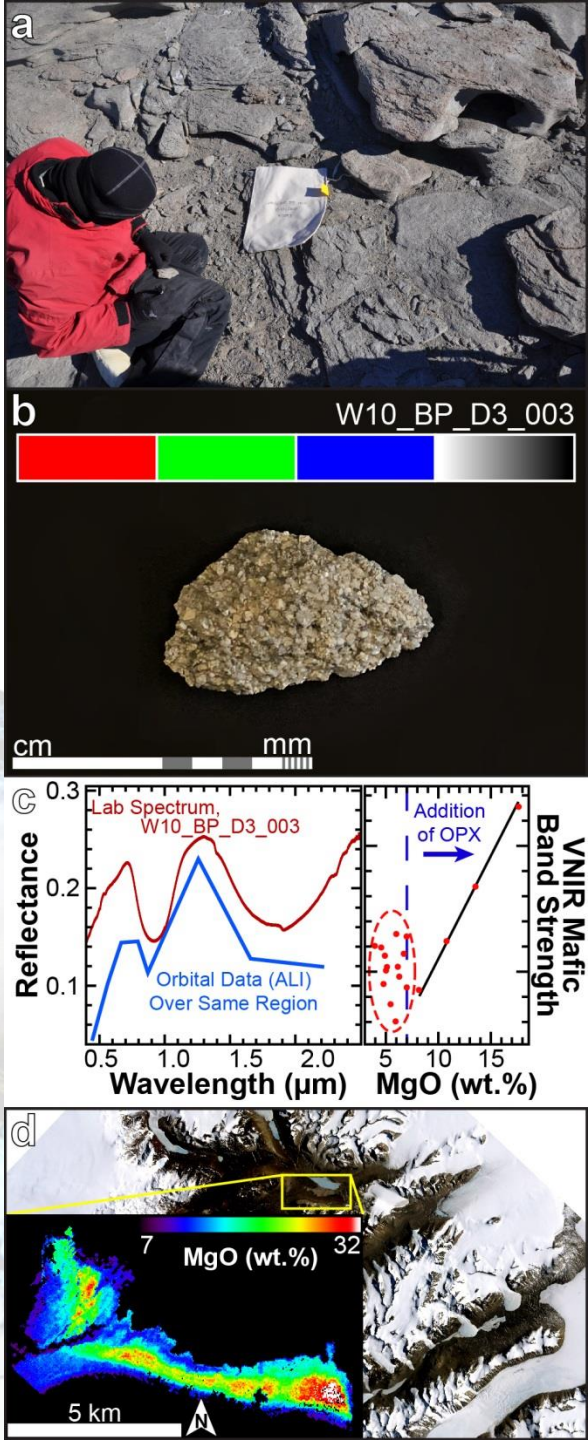
Success Stories

- Ground truthing of orbital datasets in the McMurdo Dry Valleys (MDV) of Antarctica
  - Pre-field determination of ground truthing locations
  - Documentation and laboratory investigations
  - Association with other analyses and identification of key relationships



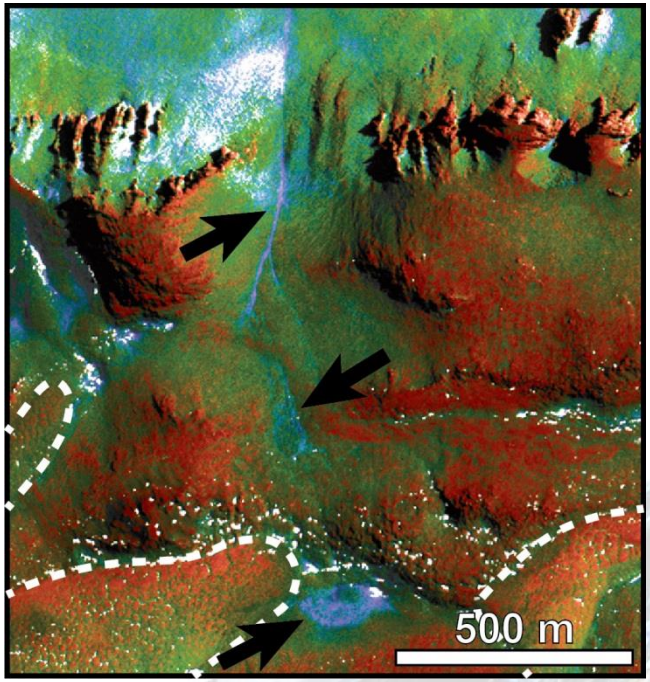
Success Stories

- Ground truthing of orbital datasets in the McMurdo Dry Valleys (MDV) of Antarctica
  - Pre-field determination of ground truthing locations
  - Documentation and laboratory investigations
  - Association with other analyses and identification of key relationships
  - Translate back to remote sensing data for broader application to non-validated locations

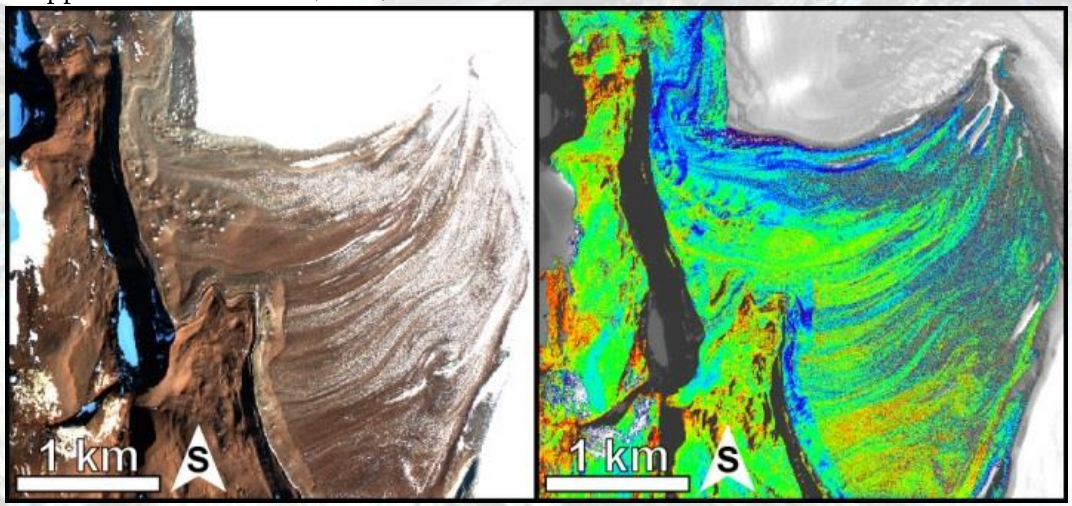


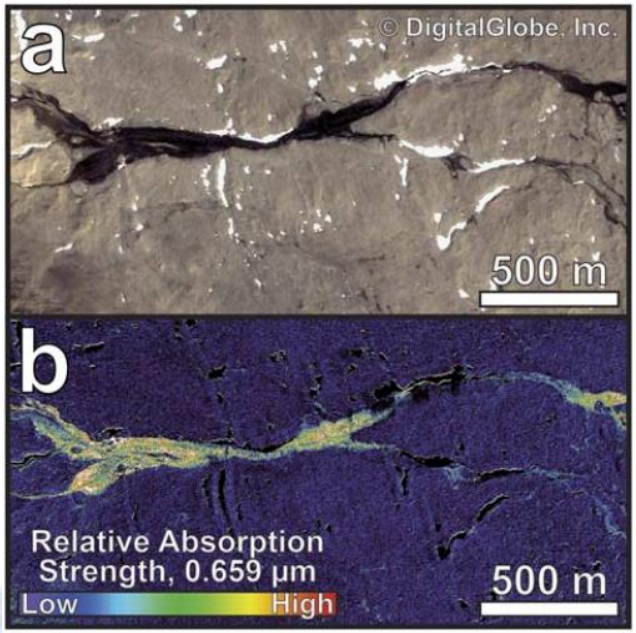
Modified from Salvatore et al. (2014)

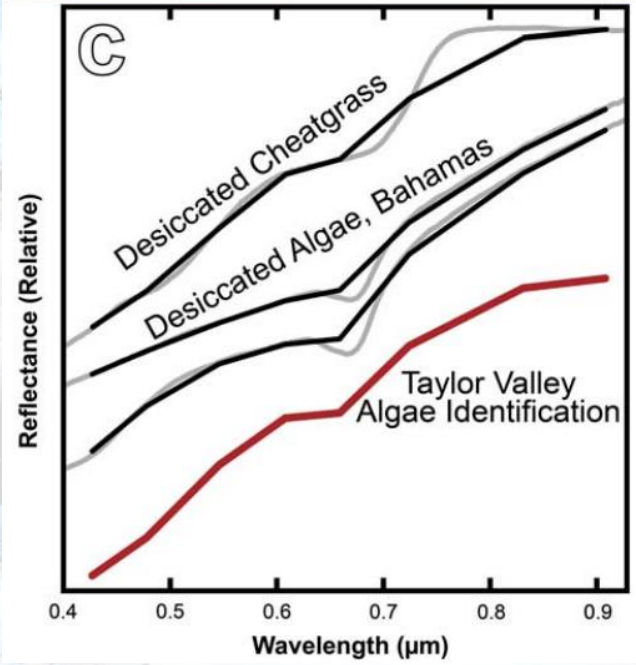
Success Stories



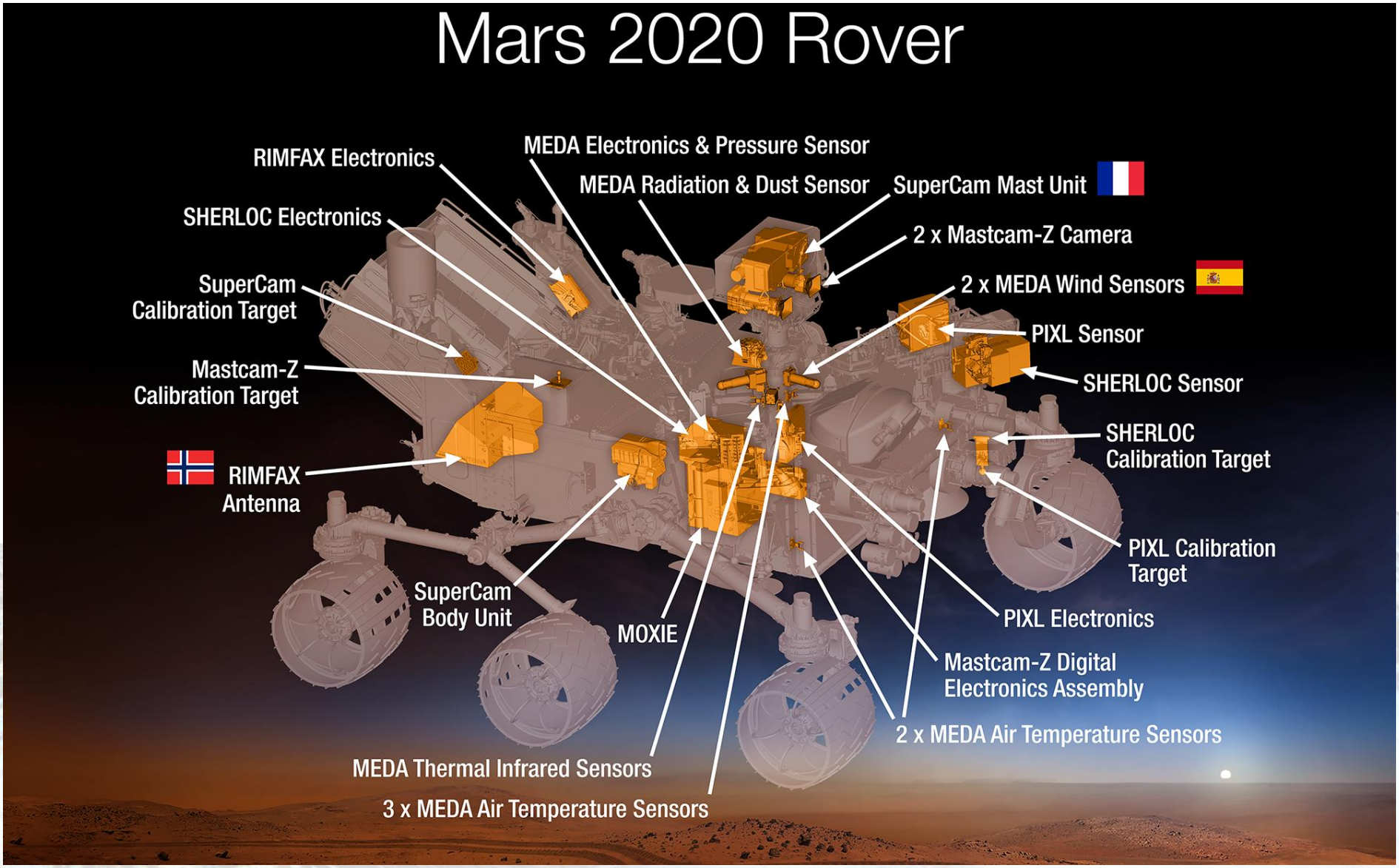
Snippets from Salvatore (2015)





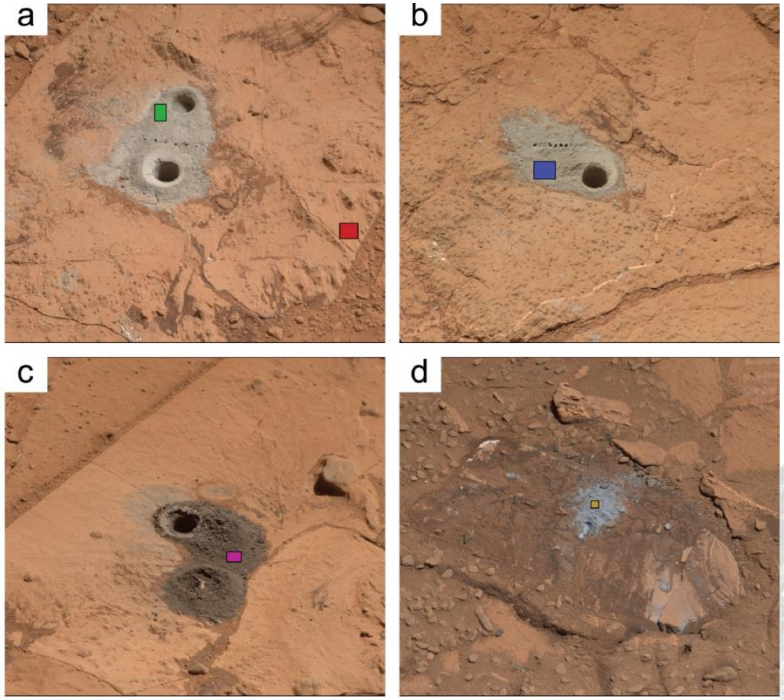


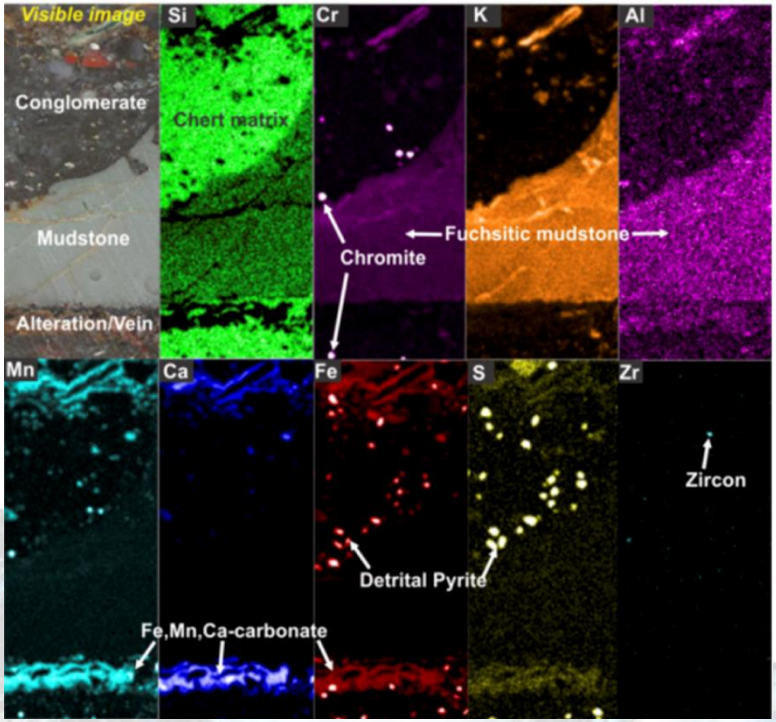
Ground Truthing with Mars 2020



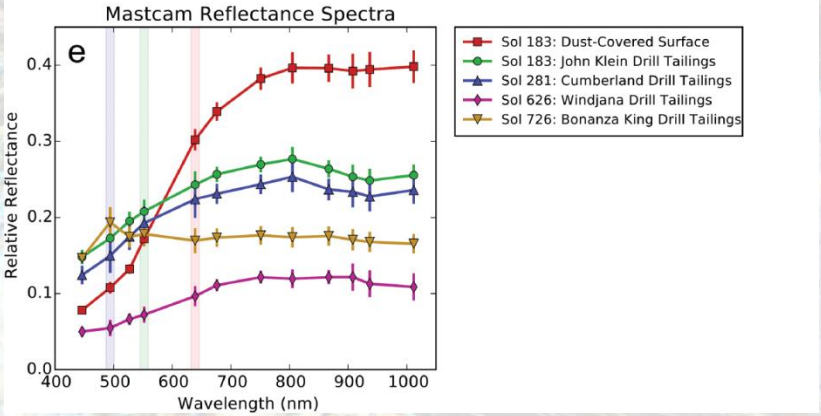
NASA

Ground Truthing with Mars 2020

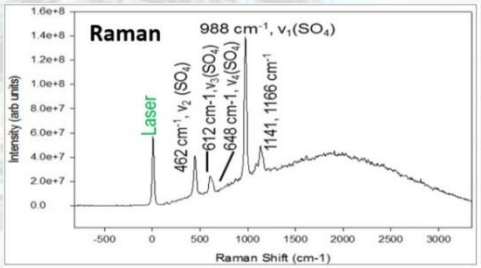


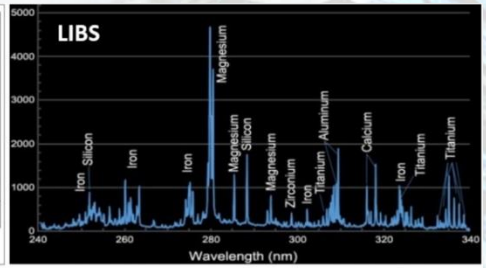


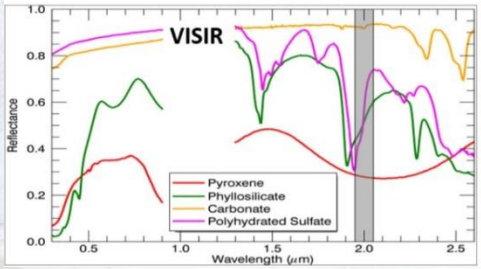
NASA | A. Al

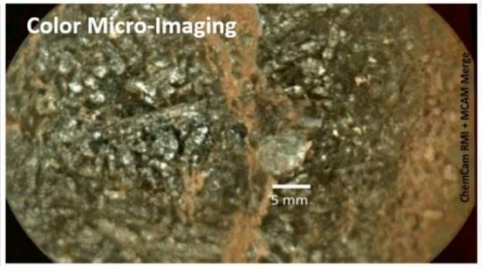


Wellington et al. (2017)





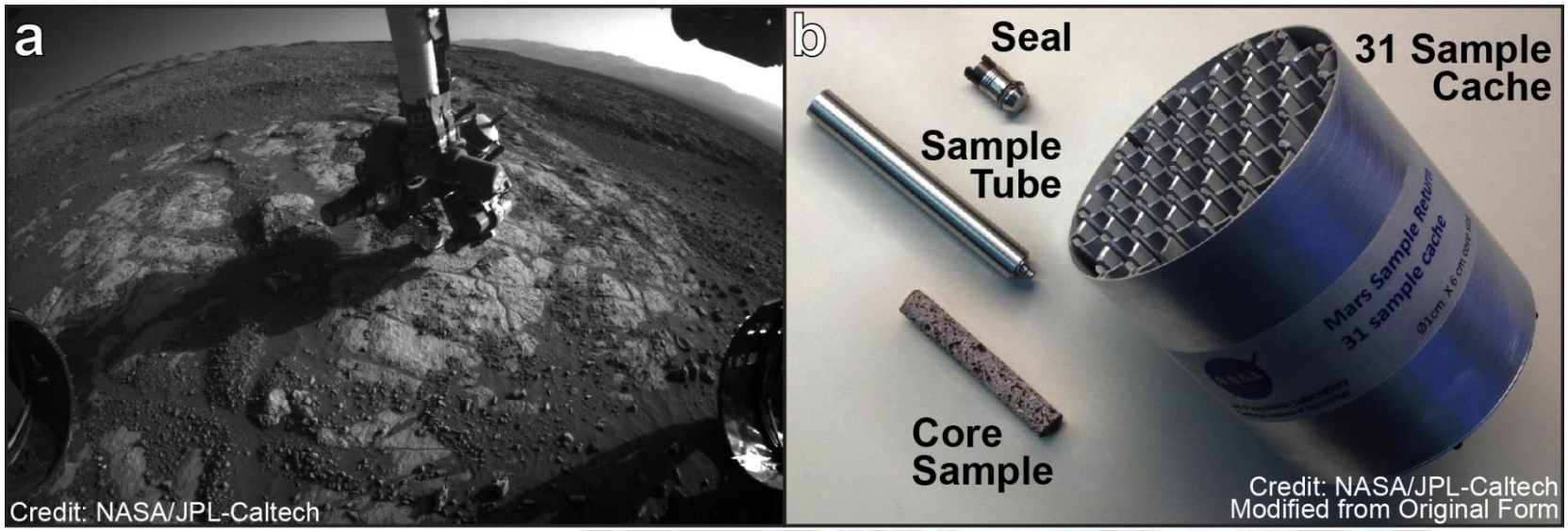




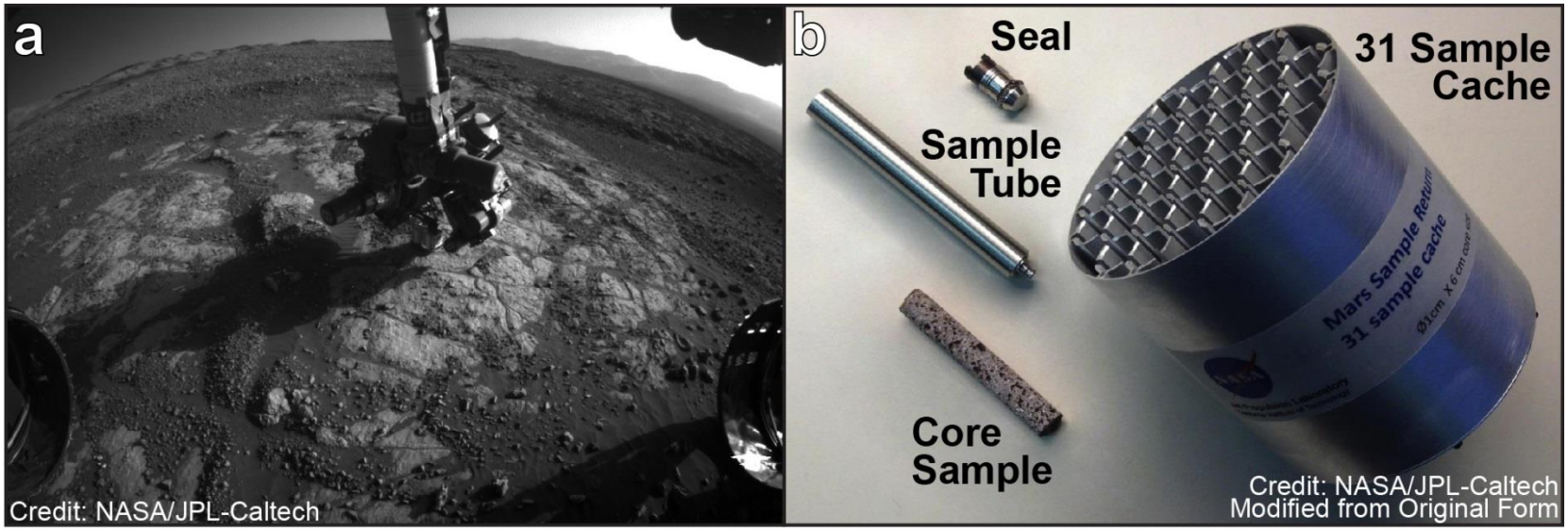
LANL

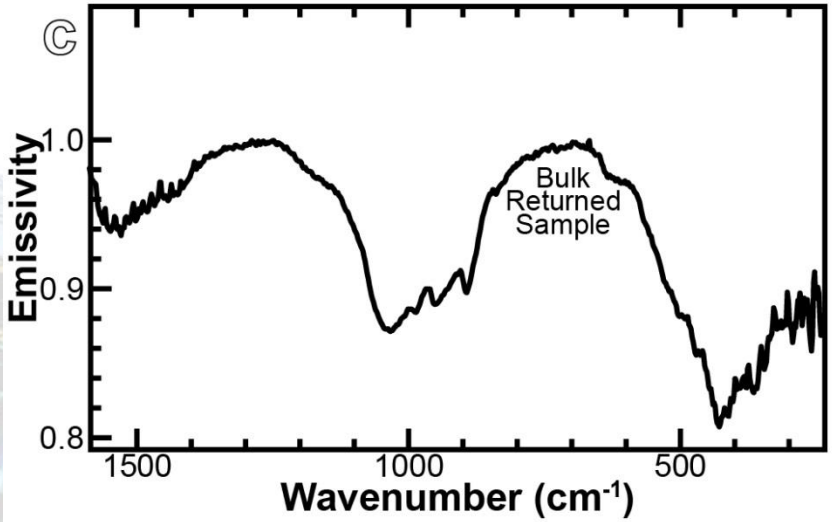
Ground Truthing with Mars 2020

Ground Truthing with Mars 2020

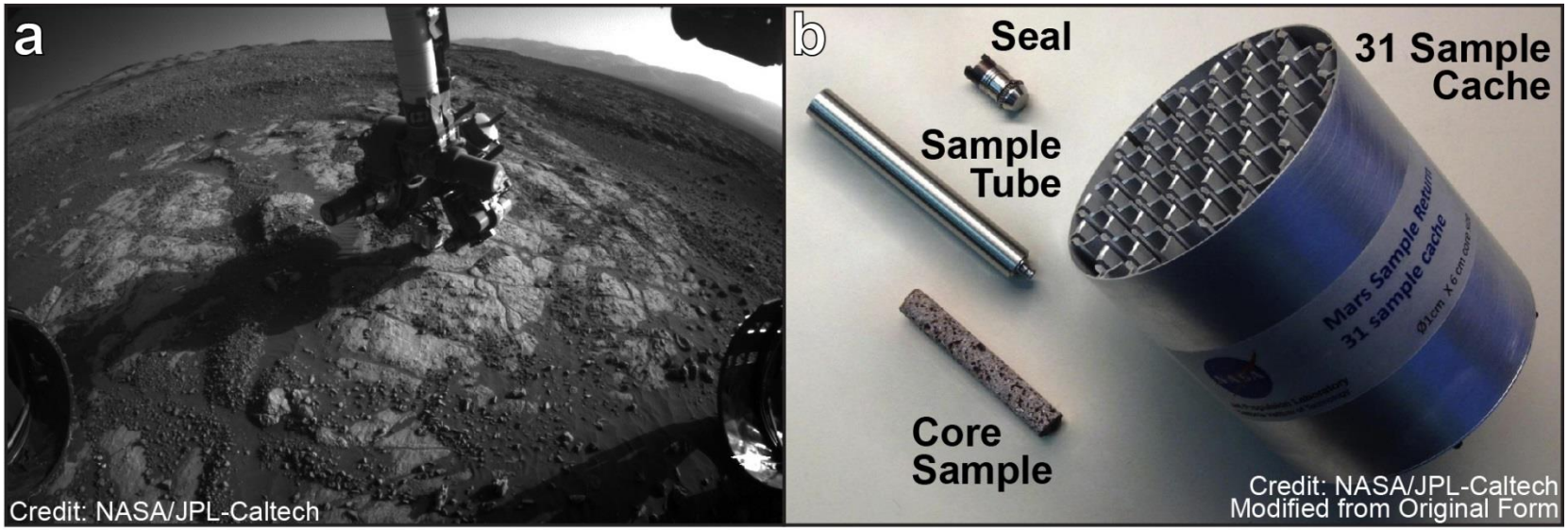


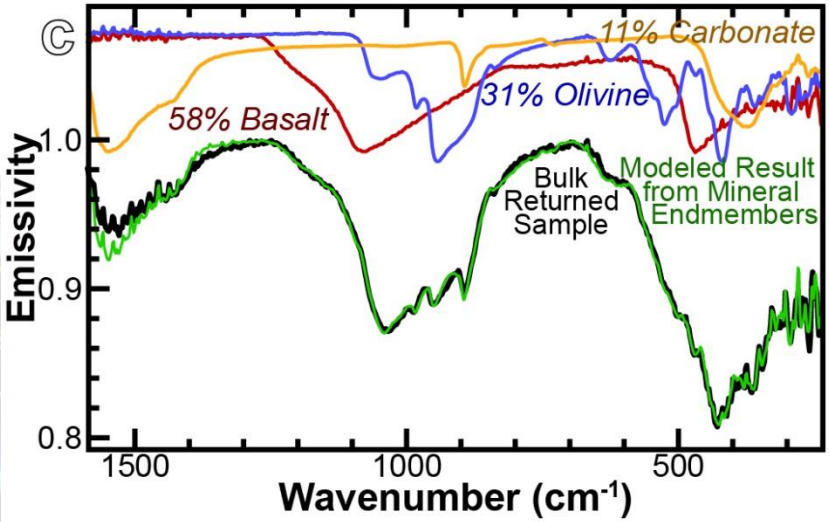
Ground Truthing with Mars 2020



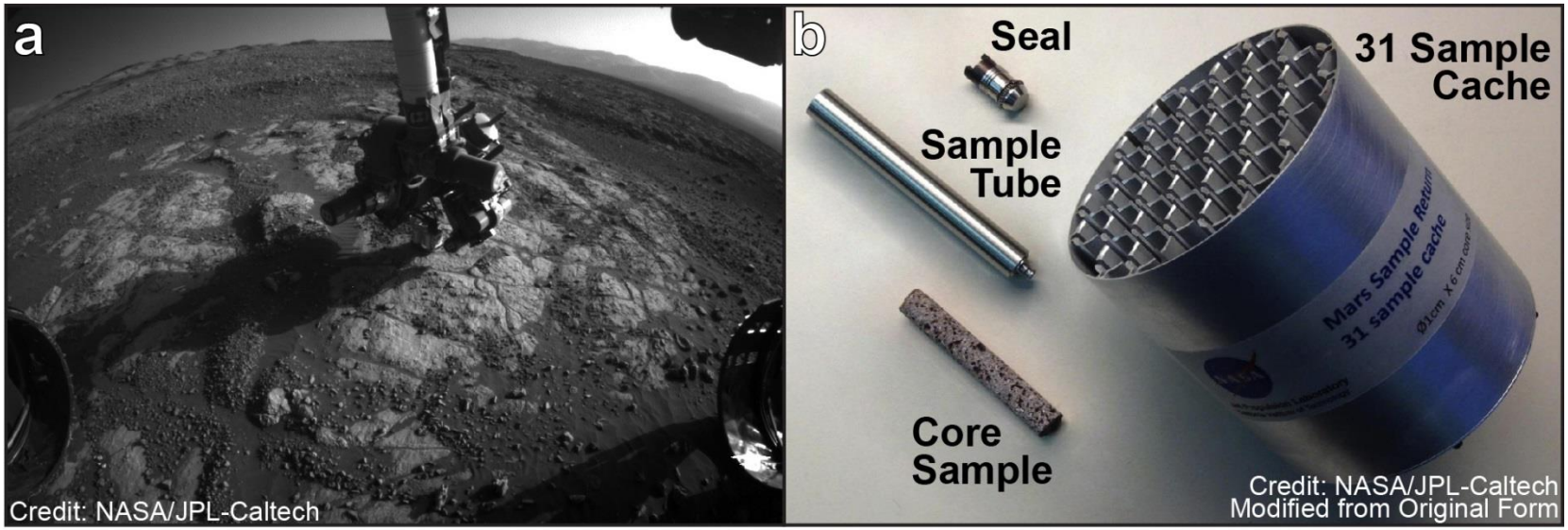


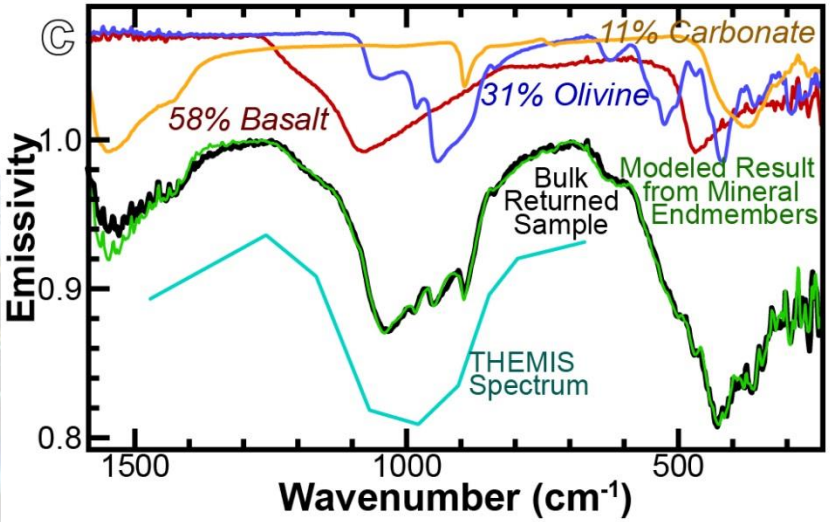
Ground Truthing with Mars 2020



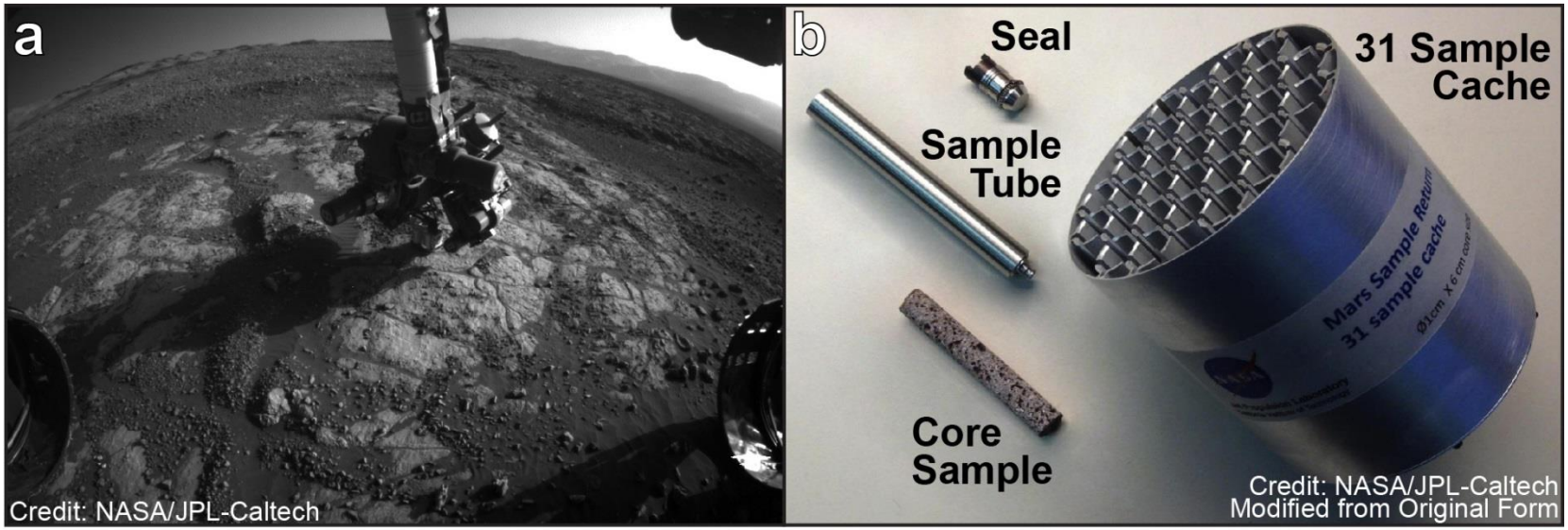


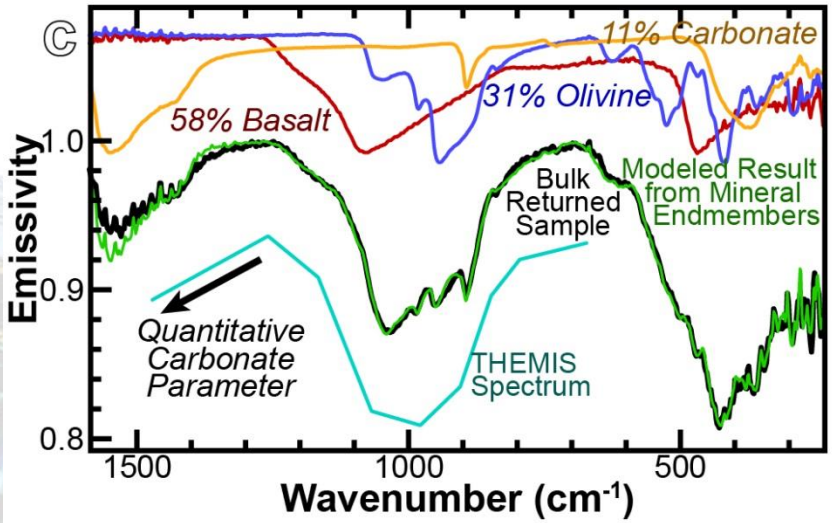
Ground Truthing with Mars 2020



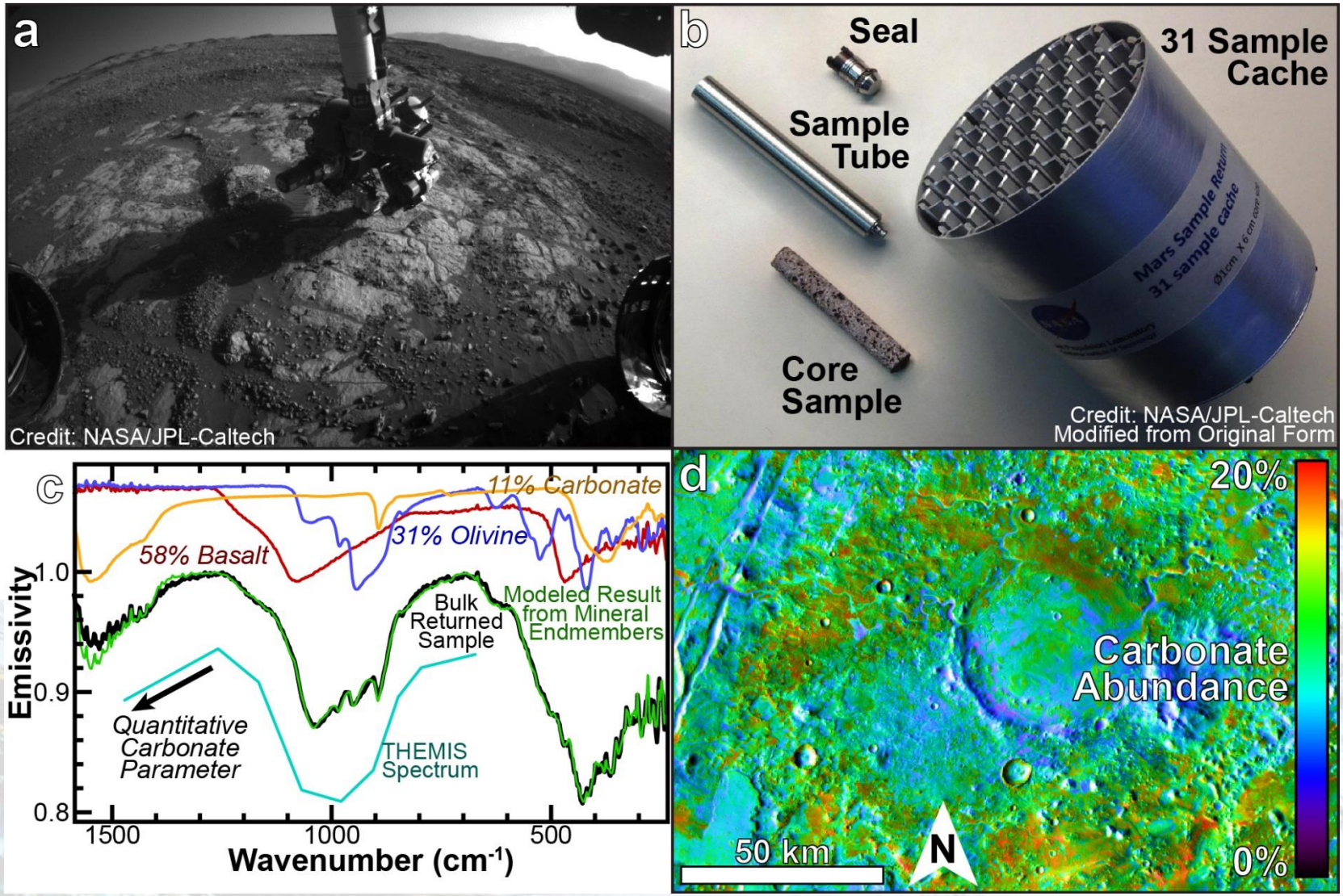


Ground Truthing with Mars 2020





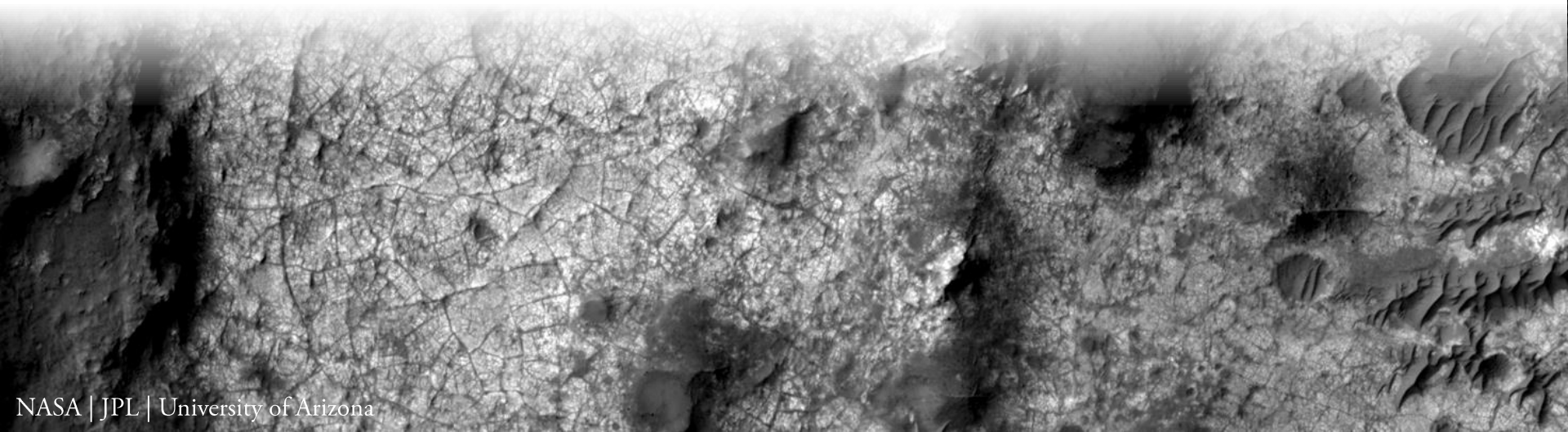
Ground Truthing with Mars 2020



What Makes a Good Ground Truthing Candidate?

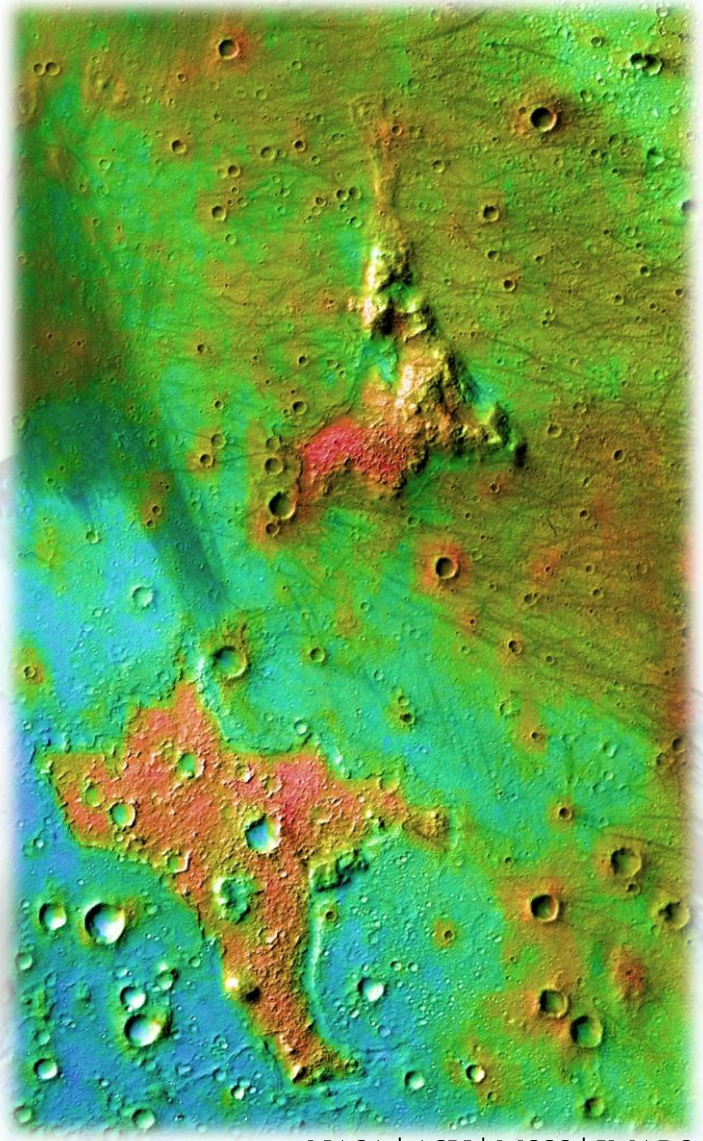
- Unique spectral/morphological signatures
  - Indicative of formation and/or modification processes
- Spatially extensive
  - Can be identified and characterized from orbit
- Geologically relevant
  - Informative and applicable to broader geologic questions

Sounds like our current strategy for sampling and surface analyses!



Ground Truthing @ Columbia Hills

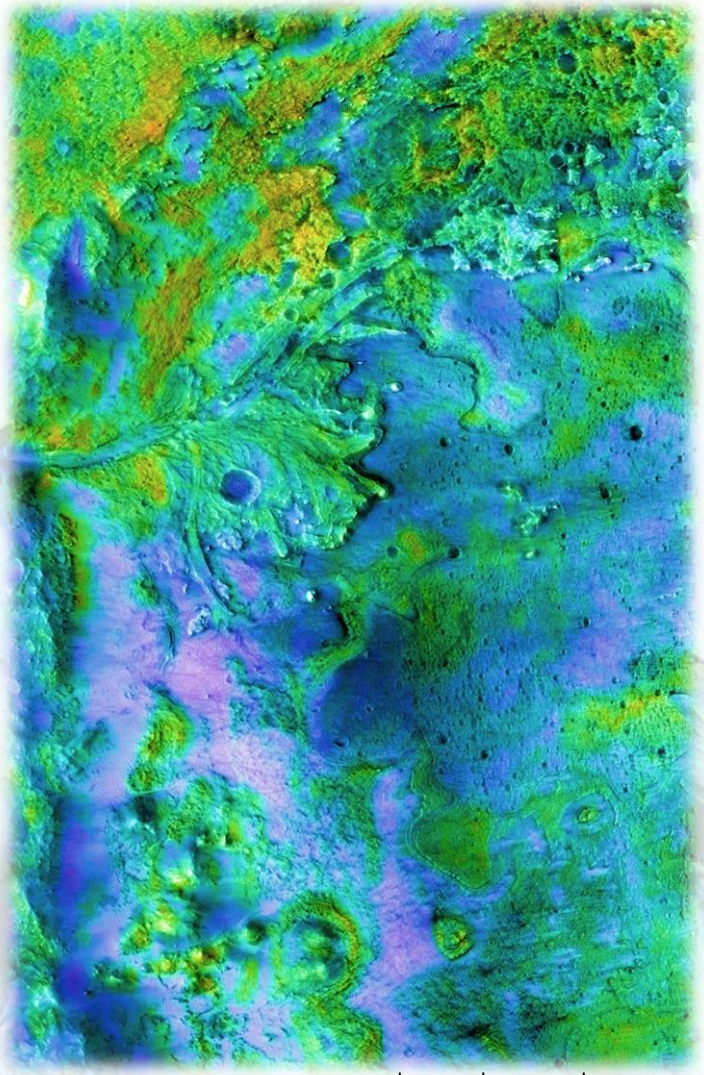
- Spatially extensive geologic units:
  - Basaltic plains, surface dust, Comanche/Algonquin unit (Ruff et al., 2014)?
- Basaltic plains:
  - "Typical" Hesperian-aged volcanics
  - Datable surface – correlation to weathering (e.g., Mazatzal?)
- Surface dust:
  - Globally pervasive and physically/compositionally 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?



NASA | ASU | MSSS | JMARS

Ground Truthing @ Jezero Crater

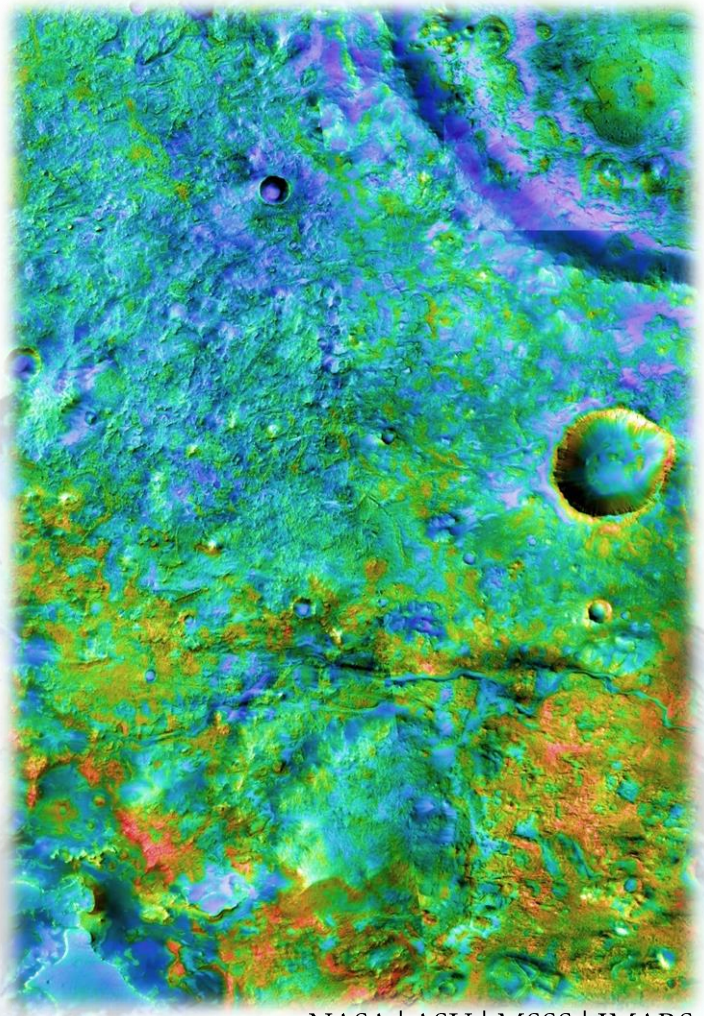
- Spatially extensive geologic units:
  - Volcanically resurfaced floor, carbonate-bearing floor material, fan deposits
- Volcanically resurfaced floor:
  - "Typical" Hesperian-aged volcanics?
  - Relationship to underlying olv/carb-bearing unit?
- Carbonate-bearing floor material:
  - Relationship to 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?)



NASA | ASU | MSSS | JMARS

Ground Truthing @ NE Syrtis & Midway

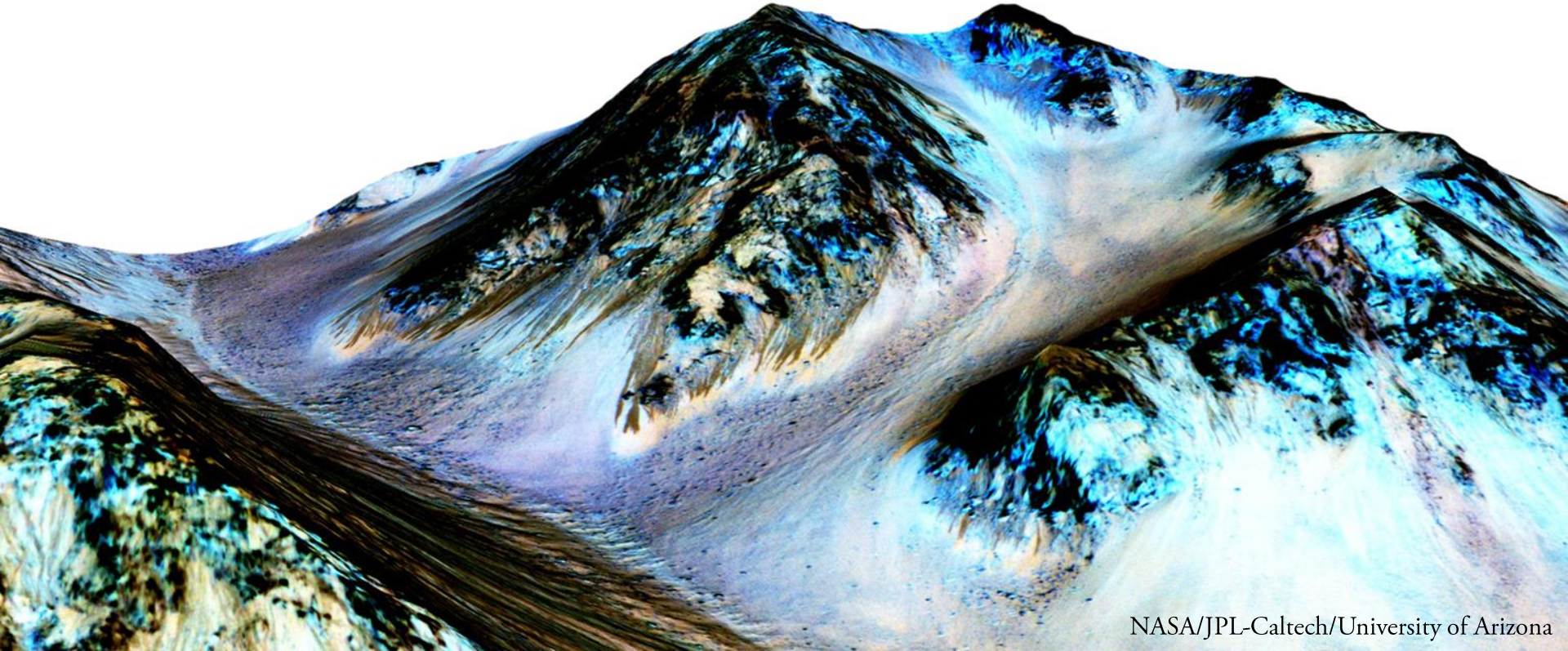
- Spatially extensive geologic units:
  - Smectite-bearing basement, olivine-carbonate units, megabreccia blocks
- Smectite-bearing basement:
  - Correlate spectral and compositional diversity
  - Inform complex spectral unmixing models and compositional estimates
- Olivine-carbonate unit:
  - Relationship 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



NASA | ASU | MSSS | JMARS

Summary & 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."



NASA/JPL-Caltech/University of Arizona