

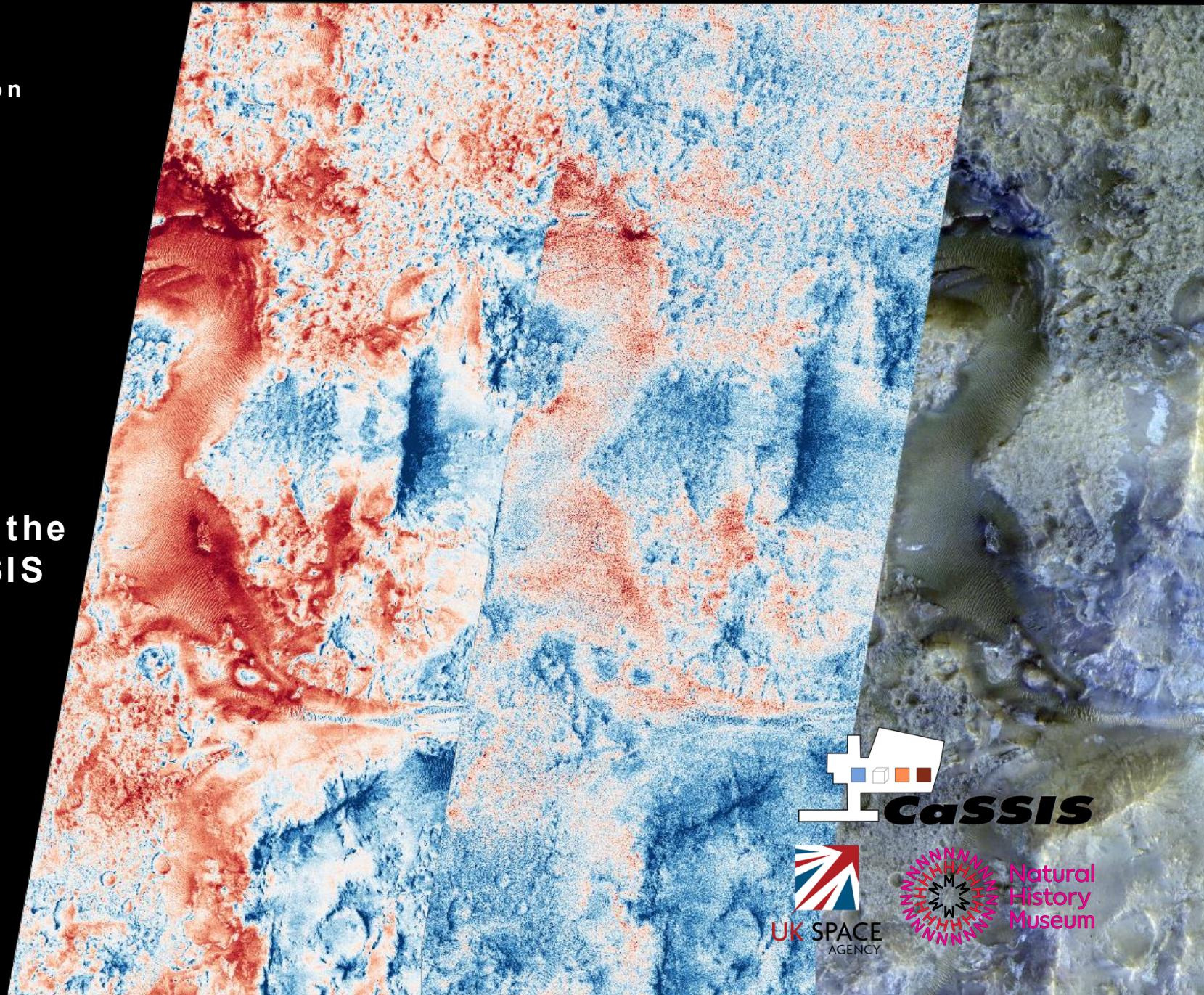
EGU 2025

PS 1.4 Mars Science & Exploration

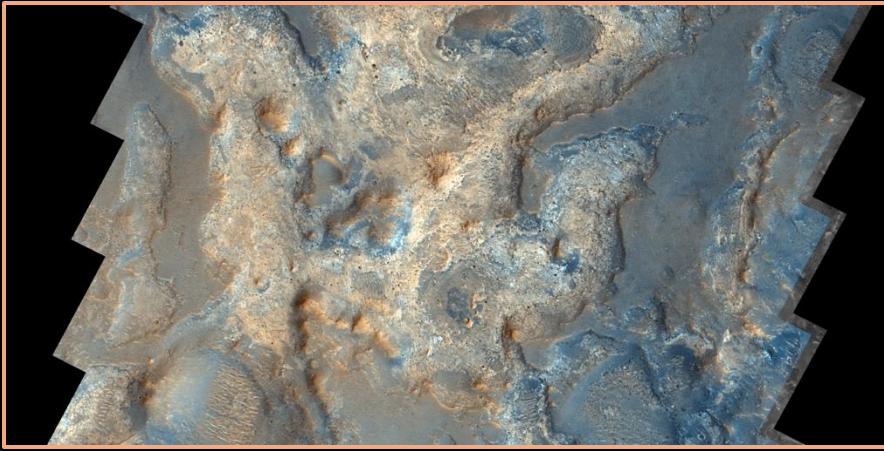
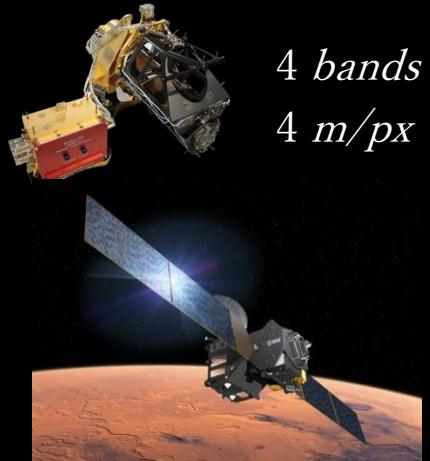
Supervised Spectral Parameter Learning

over Jezero Crater with the
ESA ExoMars TGO CaSSIS
Multiband Imager

Roger Stabbins
& Peter Grindrod
Natural History Museum, London, UK



CaSSIS

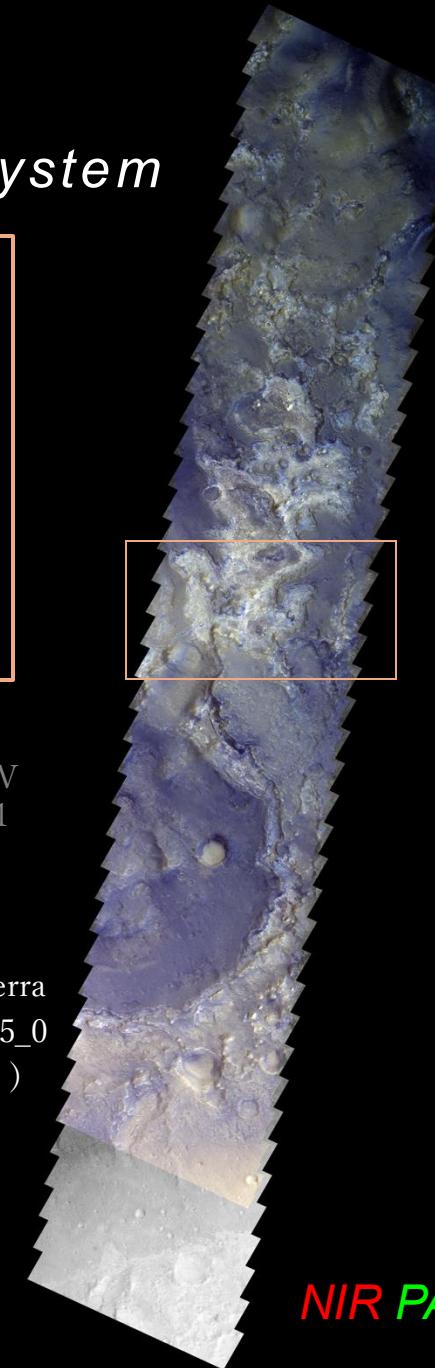
Colour & Stereo Surface Imaging System

PAN BLU

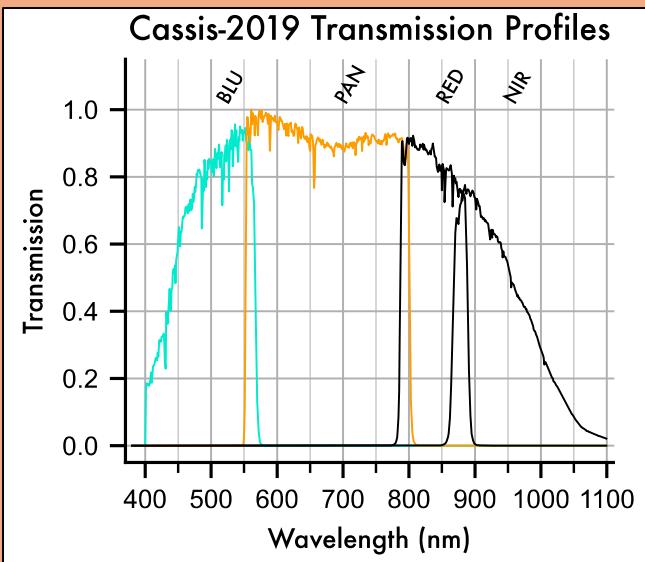
sBLU cBLU - 2PAN

Perry et al. 2022 doi:10.1016/j.pss.2022.105581

Western Arabia Terra
MY37_027423_015_0
(14.05° , 354.38°)
 ϕ 39.1°
3/2/2024



NIR PAN BLU



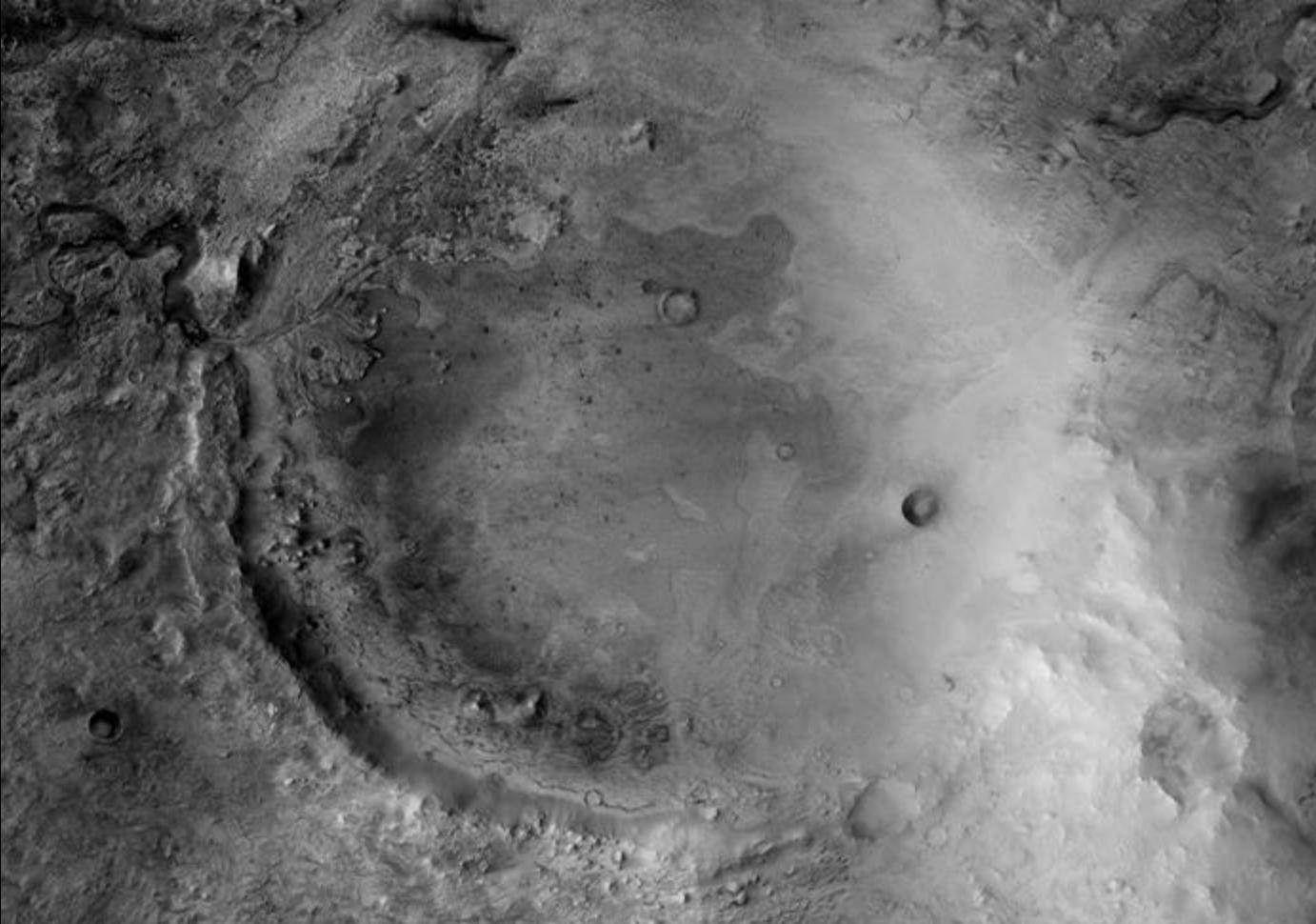
after Pommerol et al 2022
doi: 10.1016/j.pss.2022.105580

r.stabbins@nhm.ac.uk

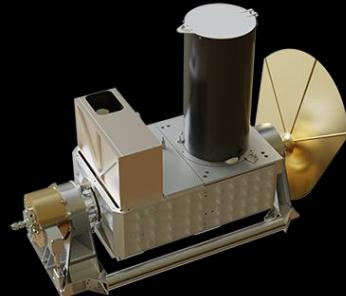
MY37_027423_015_0
POSITION: 14.051°N , 354.380°E
INCIDENCE ANGLE: 44.553
LOCAL TIME: 09:10:40
SOLAR LONGITUDE: 182.071
CREDIT: ESA/GO/CaSSIS CC-BY-SA 3.0 IGO



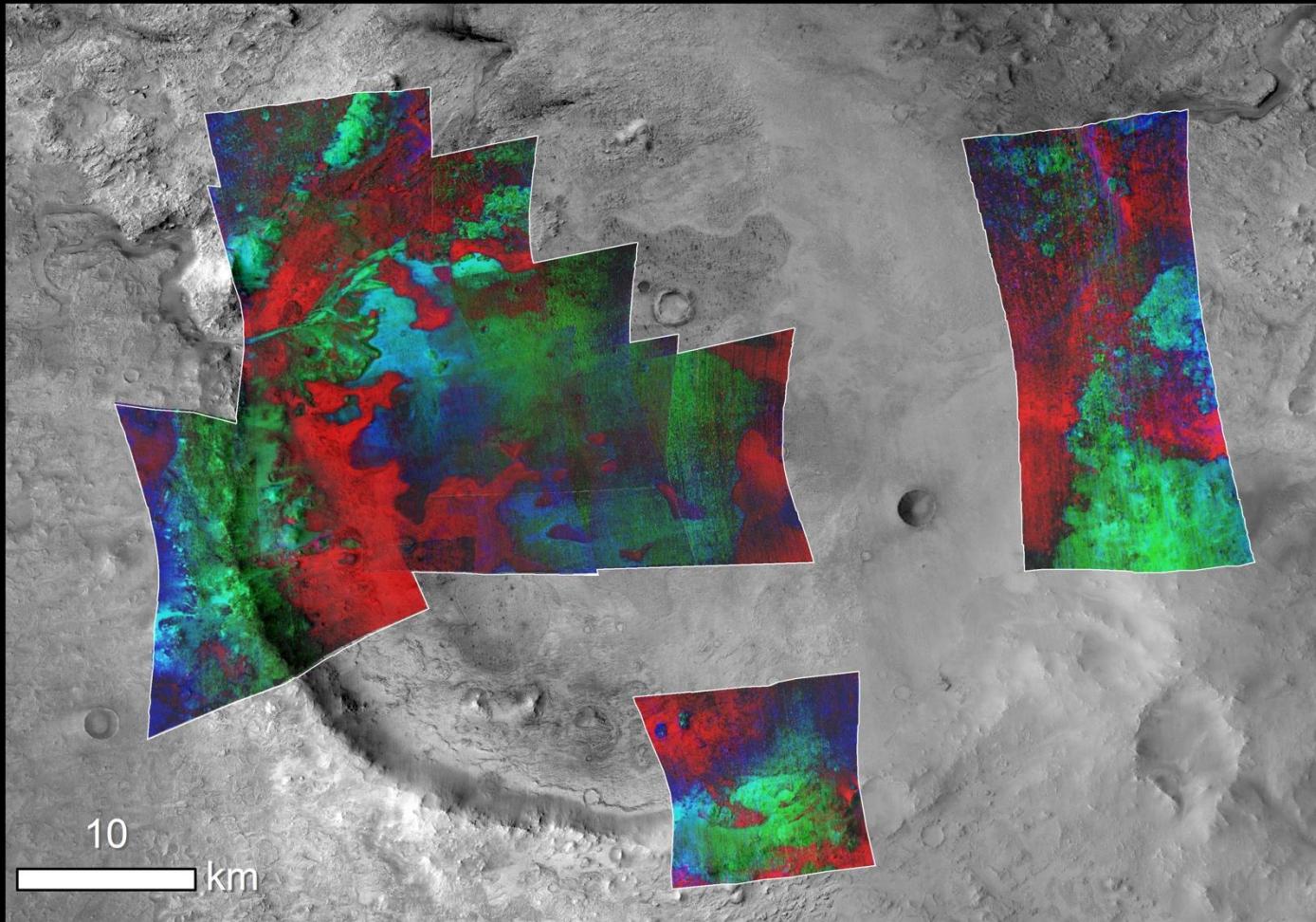
Jezero Crater *Mineralogical Diversity*



Jezero Crater *Mineralogical Diversity*



CRISM
544 bands
 $\geq 18 \text{ m}/\text{px}$



Mafic Minerals

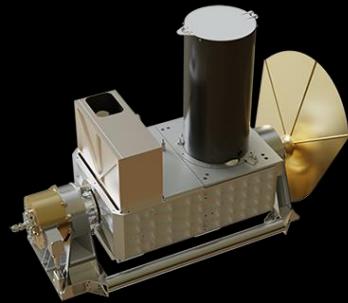
Red
Olivine & Fe-carbonates

Green
Low-Ca Pyroxene

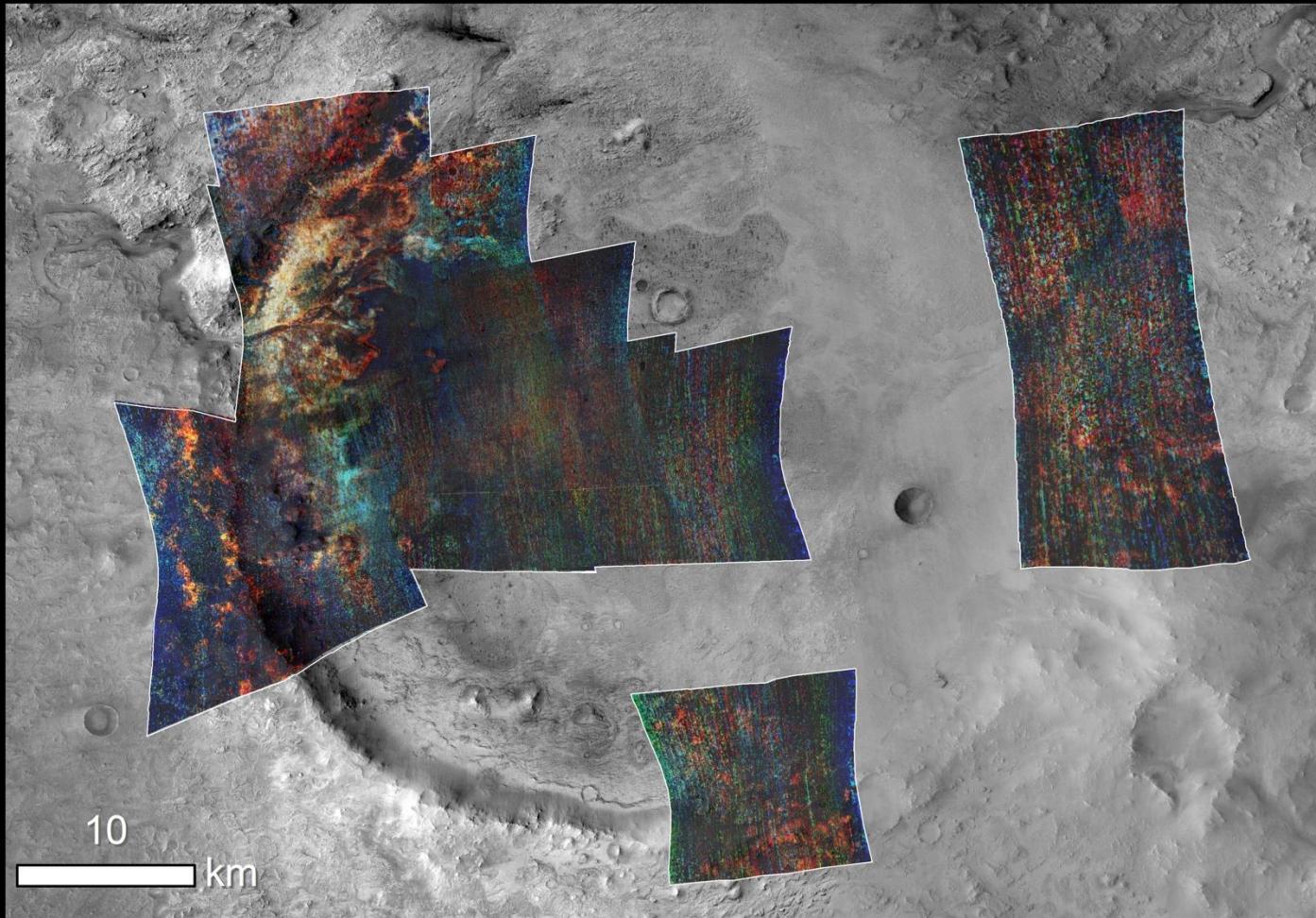
Blue
High-Ca Pyroxene

Horgan et al. 2020. *The mineral diversity of Jezero crater: Evidence for possible lacustrine carbonates on Mars*, Icarus, doi:10.1016/j.icarus.2019.113526

Jezero Crater *Mineralogical Diversity*



CRISM
544 bands
 $\geq 18 \text{ m}/\text{px}$



Phyllosilicates

Red/Yellow
Fe/Mg-clays or
carbonates

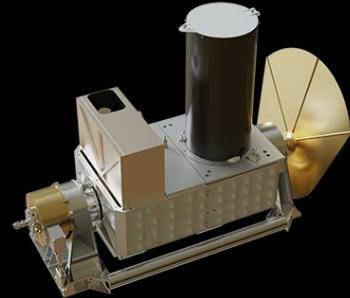
Green
Al-clays

Cyan
Opal or hydrated
silica

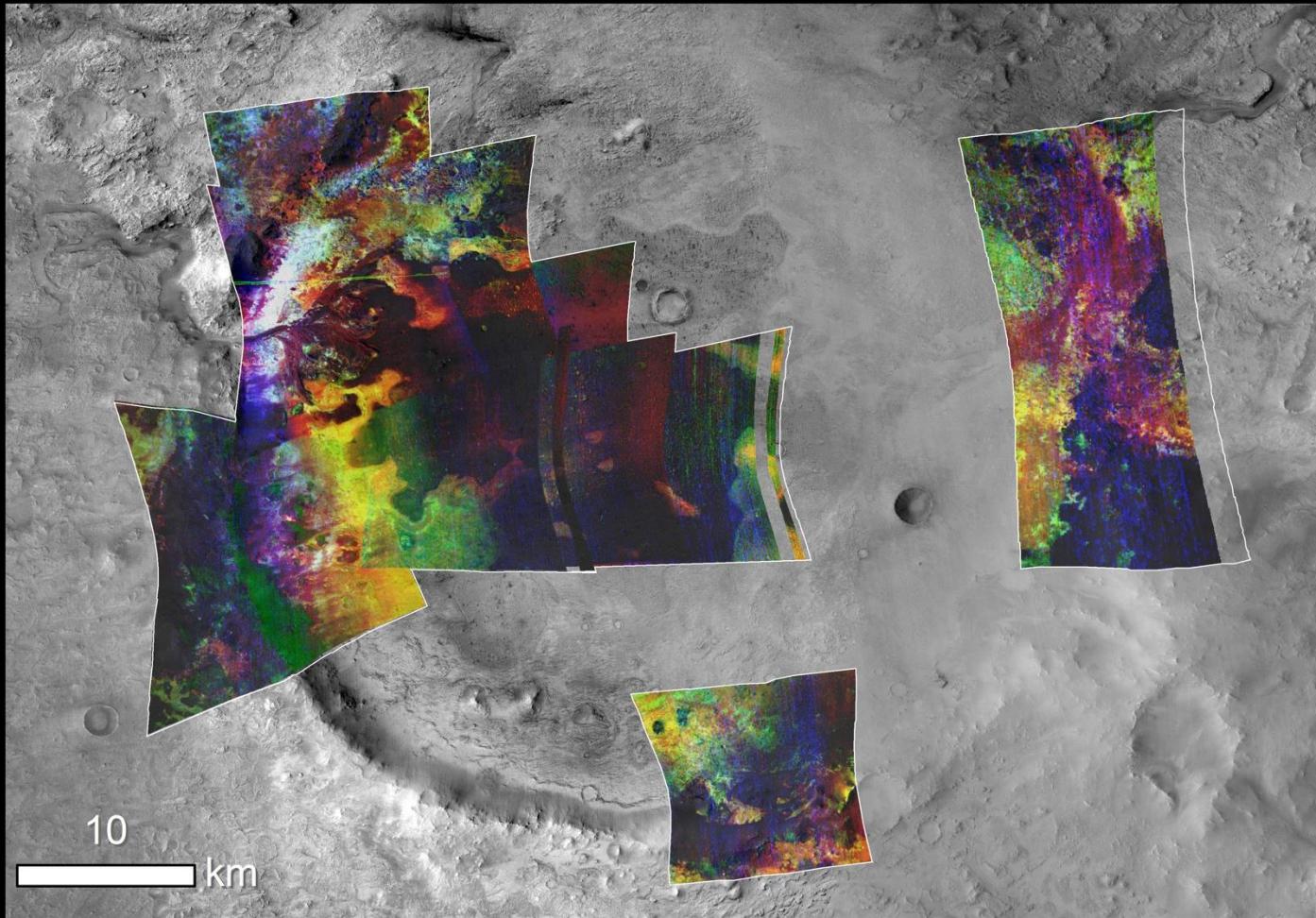
Blue
Opal or hydrated
silica

Horgan et al. 2020. *The mineral diversity of Jezero crater: Evidence for possible lacustrine carbonates on Mars*, Icarus, doi:10.1016/j.icarus.2019.113526

Jezero Crater *Mineralogical Diversity*



CRISM
544 bands
 $\geq 18 \text{ m}/\text{px}$

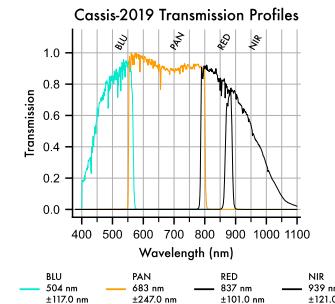
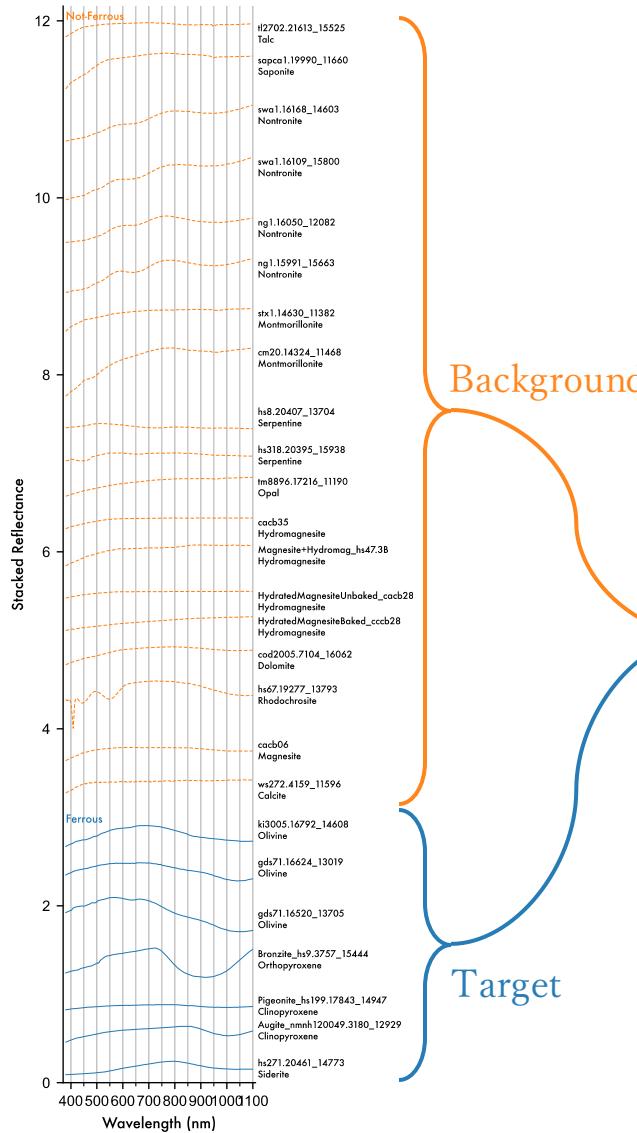


- Carbonates
 - Red*
Olivine-dominated
 - Cyan/Blue*
Strong carbonates/weak olivine
 - Yellow/White*
Strong carbonates/olivine
 - Green*
Weak olivine/clays/carbonates

Horgan et al. 2020. *The mineral diversity of Jezero crater: Evidence for possible lacustrine carbonates on Mars*, Icarus, doi:10.1016/j.icarus.2019.113526

SSPL Supervised Spectral Parameter Learning

Stabbins et al. 2024. Earth & Space Science,
doi:[10.1029/2023EA003398](https://doi.org/10.1029/2023EA003398)



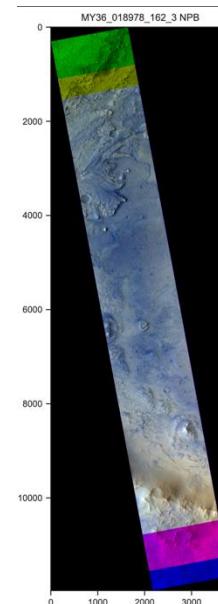
SSPL

CaSSIS I/F
cube

Spectral Parameter Pair Linear Combinations

spc_id	Rank	Fisher Ratio	sp_0	sp_1	lida_a_0_1	lida_a_1_1
83	1.0	3.324786	R_683_504	R_939_837	-0.057214	-0.998362
146	2.0	3.224047	R_837_504	R_939_837	-0.036606	-0.999330
233	3.0	3.195297	R_939_837	S_504_837	0.996207	0.087012

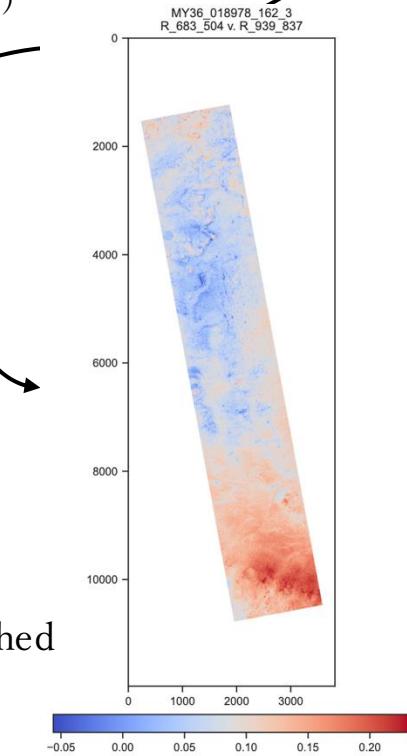
ranked by separation (Fisher Ratio)
of target from background



SP
C

...

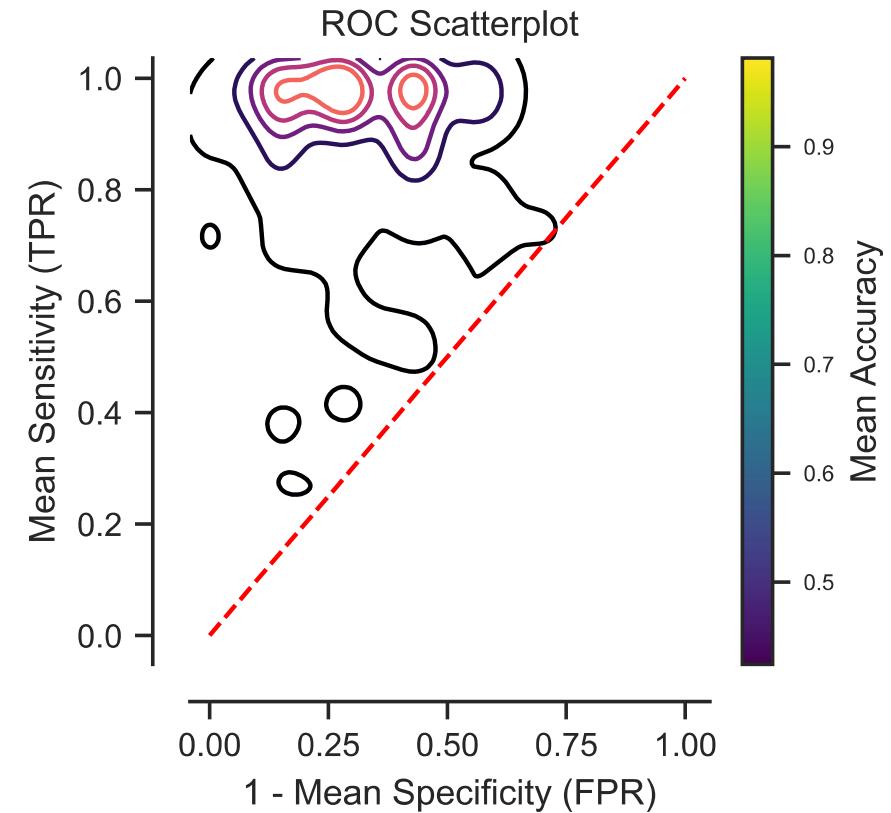
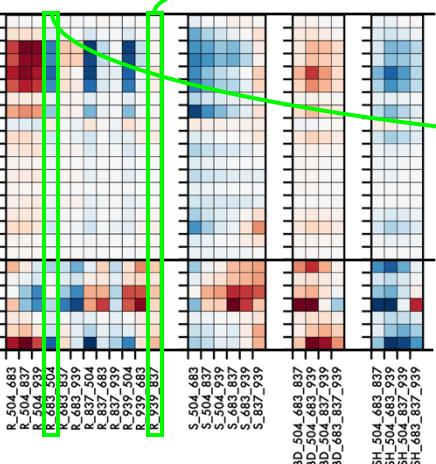
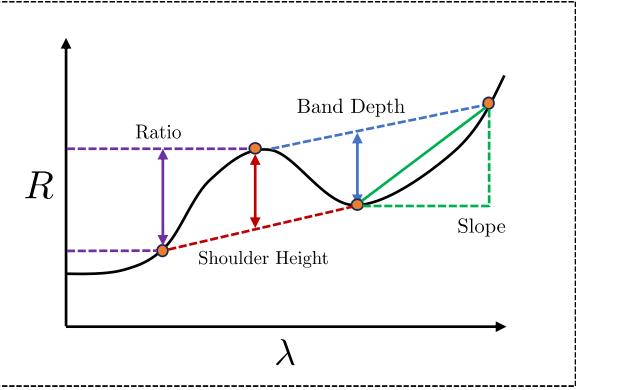
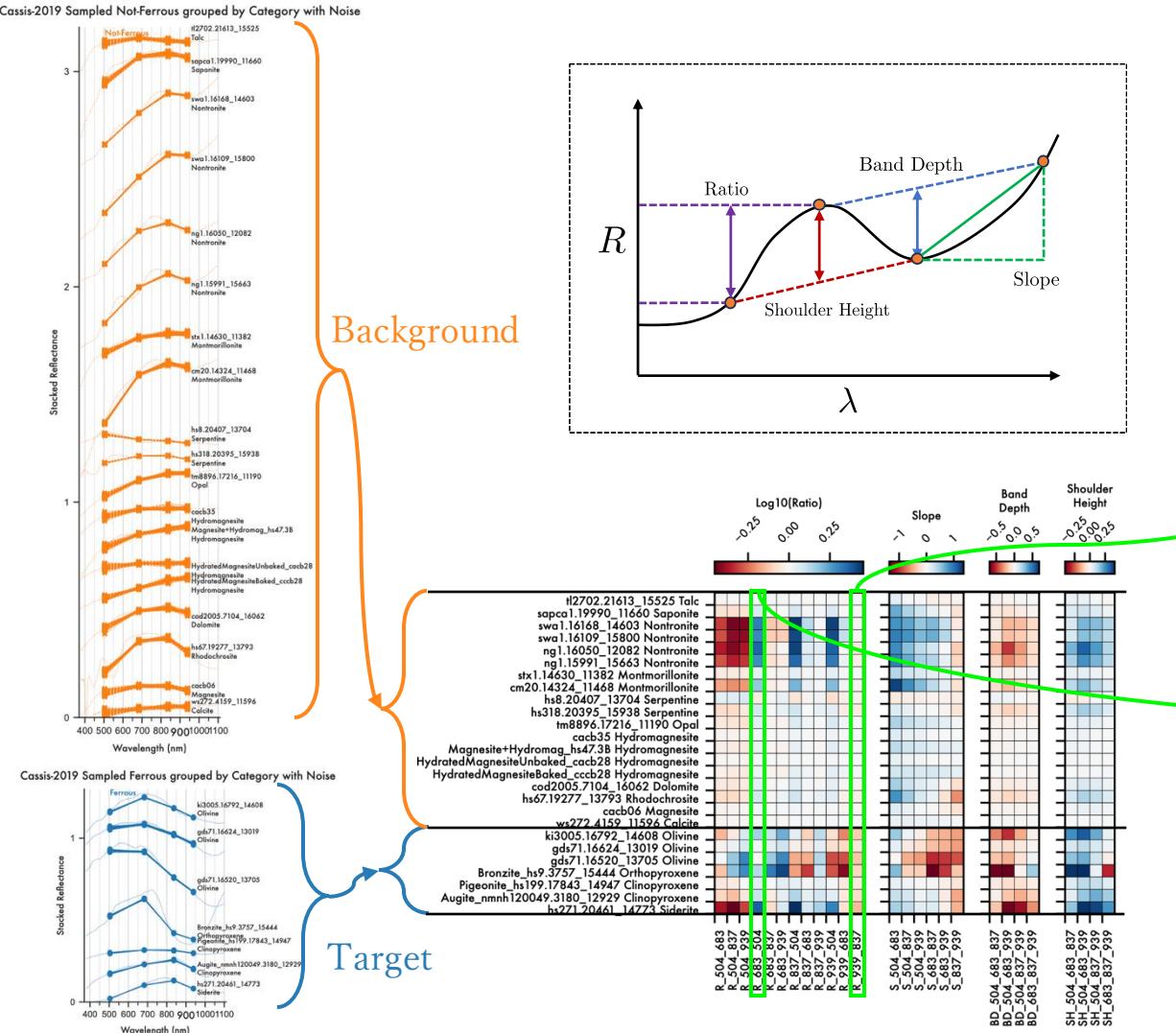
SPC Stretched Product



PLDA Parallel Linear Discriminant Analysis

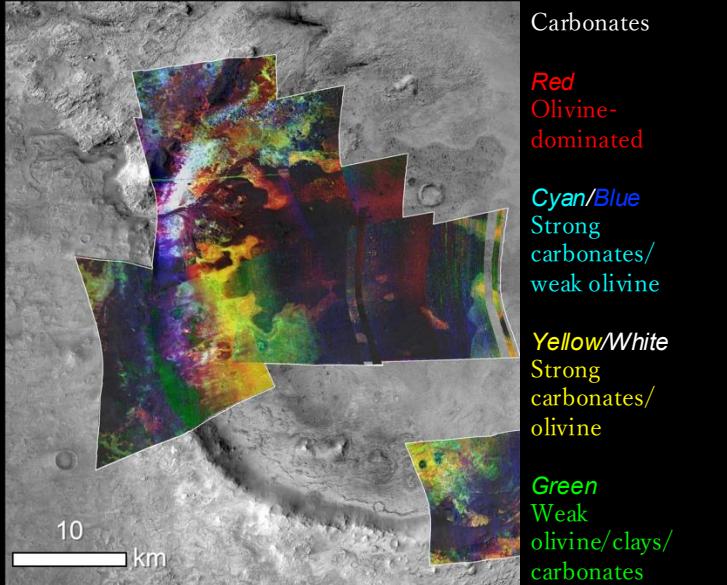
Inside Supervised Spectral Parameter Learning

Stabbins et al. 2024. Earth & Space Science,
doi:[10.1029/2023EA003398](https://doi.org/10.1029/2023EA003398)

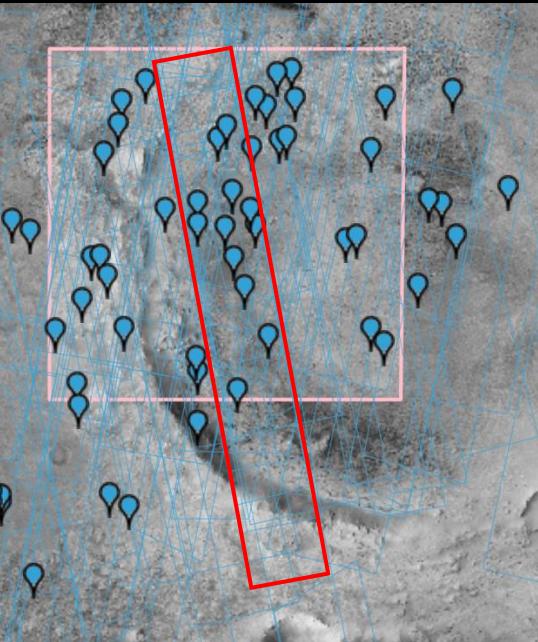
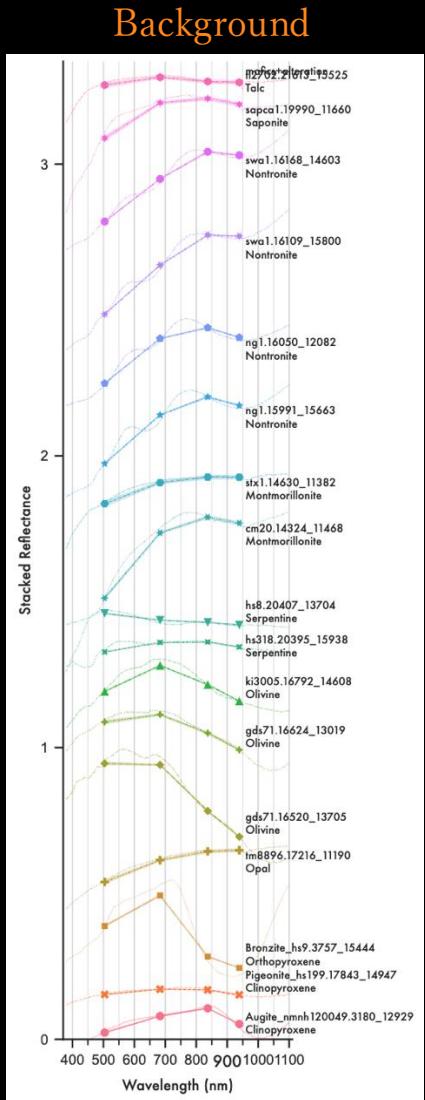
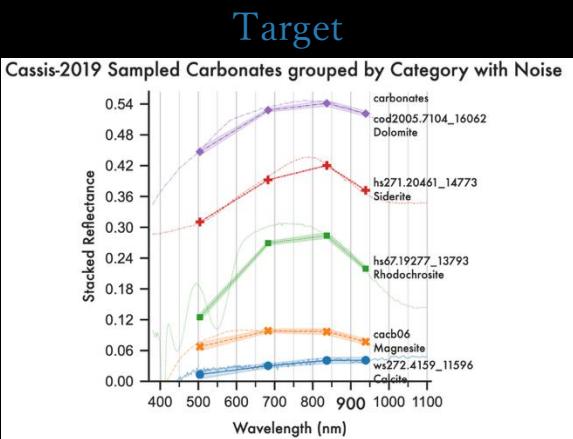


$$\text{Fisher Ratio} = \frac{\text{Between-Class Scatter}}{\text{Within-Class Scatter}}$$

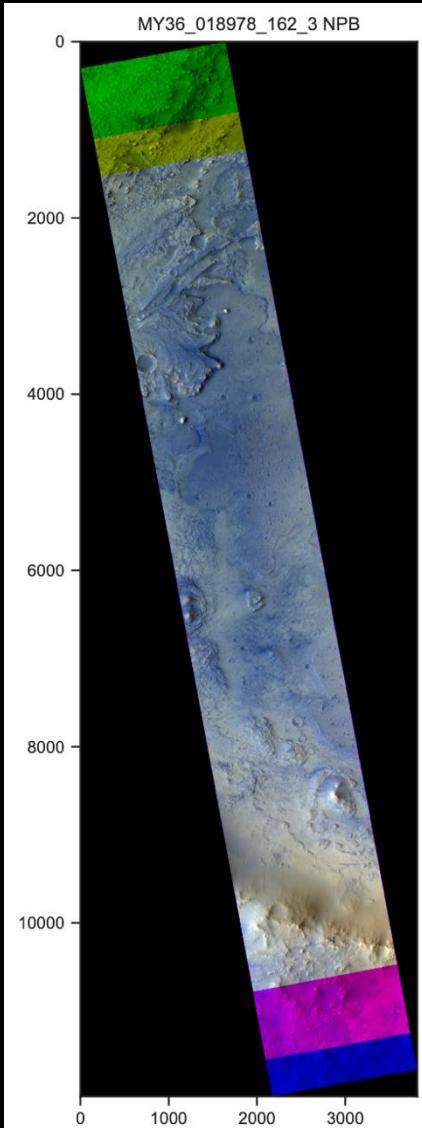
Jezero Crater *Training Spectral Library*



Horgan et al. 2020. doi:10.1016/j.icarus.2019.113526

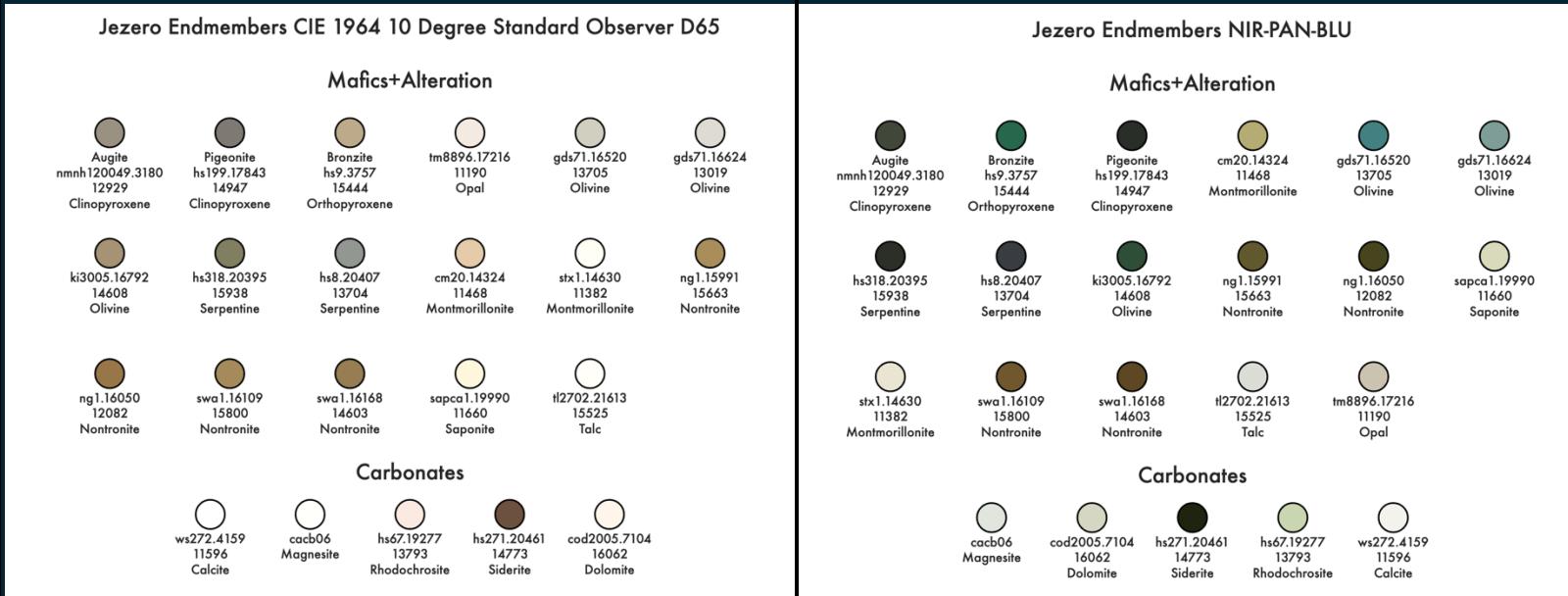
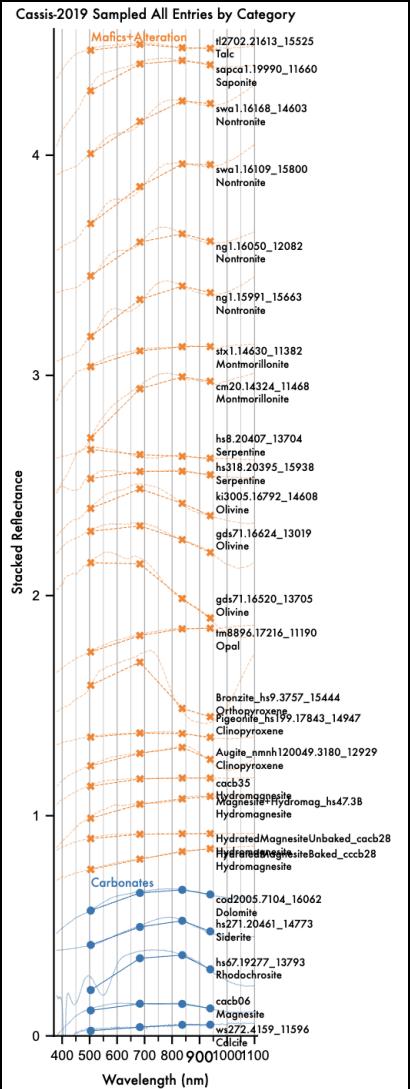


Jezero Crater
MY36_018978_162_3
77.470E, 18.349N
(18.35°, 77.47°)
 ϕ 63.0°
23/2/2022



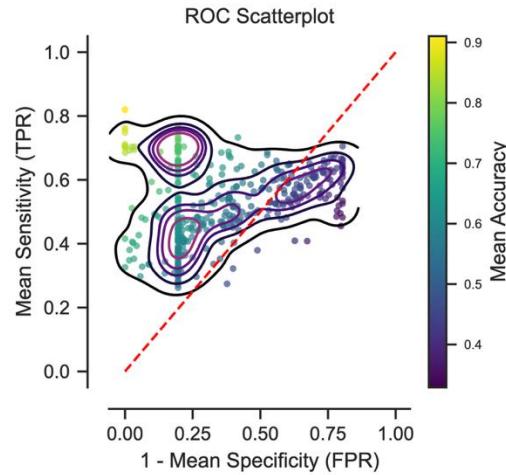
Results

Expected Natural & NPB Colours



Carbonates have low colour contrast in natural lighting simulations,
as well as expected NPB (**NIR PAN BLU**) CaSSIS Browse products

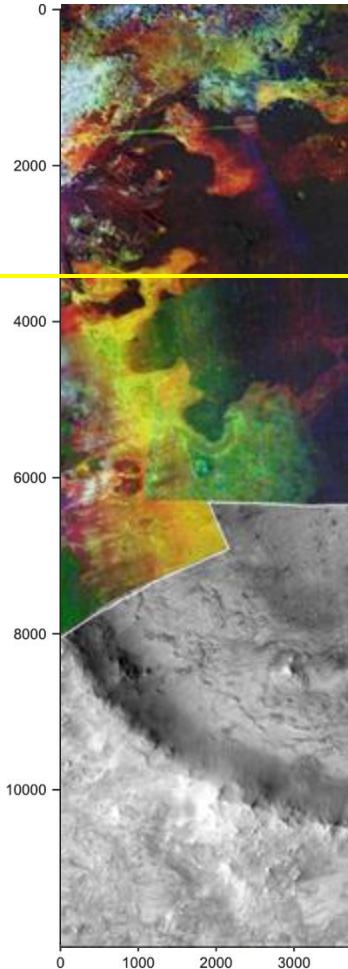
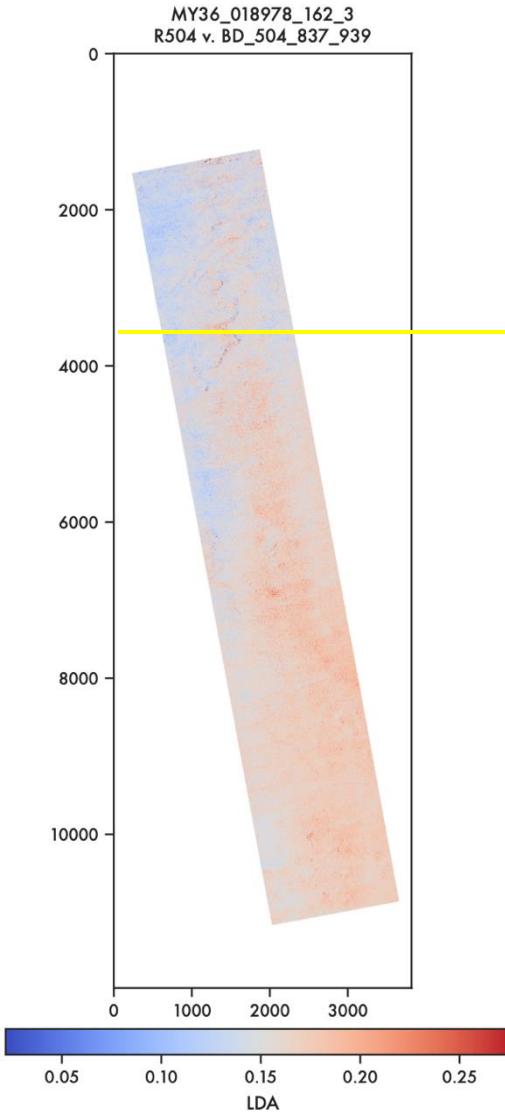
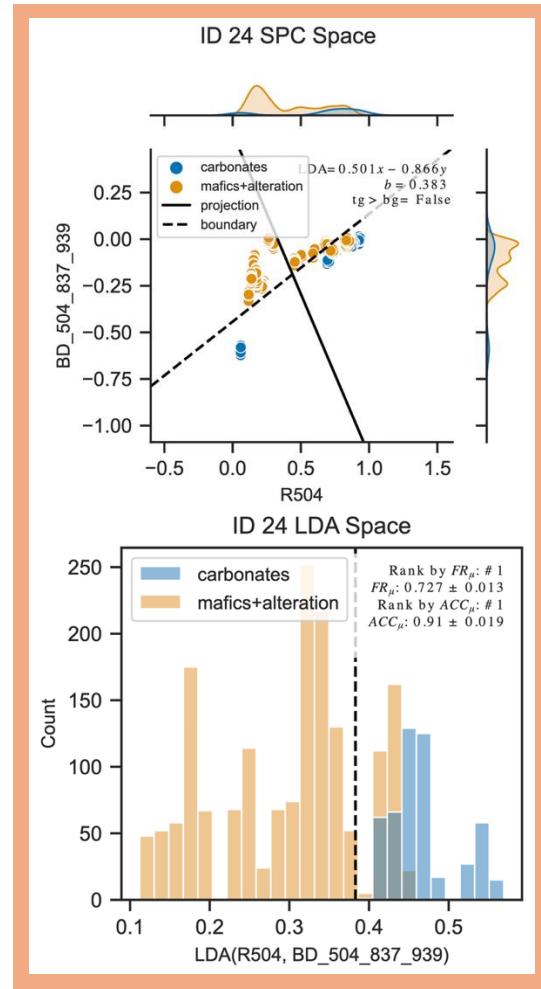
Results Learned Spectral Parameter Combinations



Low True Positive Rate

Individual Spectral Parameters have poor target separation, but Spectral Parameter Combination achieves separation with ~90% accuracy.

Image shows some noisy change in target signal.



sptk *the Spectral Parameters Toolkit*

sptk provides a simple Python interface for:

- instrument spectral response simulation
- instrument spectral library sampling
- instrument spectral reconstruction error evaluation
- instrument spectral parameter evaluation
- spectral parameter and spectral parameter combination material discrimination evaluation and ranking

Available via pip:

```
pip install sptk=0.1
```

DOI:10.5281/zenodo.10694286

Git: <https://github.com/rbstabbins/sptk>

'Main' branch for PanCam (v0.1 Release 2/2024)

'cassis_development' branch for CaSSIS, WIP



The screenshot shows the GitHub repository page for 'sptk'. The repository has 2 branches and 3 tags. The README file is visible, showing the project's purpose: investigating multispectral imaging systems to identify distinct materials. It also lists the Natural History Museum and UK Space Agency as partners. The repository was created by rbstabbins on Feb 22, 2024, and has 37 commits. The code is written in Python 100.0%.

About
sptk is a Python package for investigating the ability of a multispectral imaging system to identify distinct materials and material groups through differences in reflectance spectra.

Code

Commits

Files

Releases 3

Packages

No packages published
Publish your first package

Languages

Python 100.0%

README MIT license

NATURAL HISTORY MUSEUM

UK SPACE AGENCY

sptk
The Spectral Parameters Toolkit

R. B. Stabbins¹ (r.stabbins@nhm.ac.uk), P. M. Grindrod¹, S. Motaghian¹, E. J. Allender², C. R. Cousins² and the ExoMars PanCam Science Team

1. Department of Earth Science, Natural History Museum, London, UK
2. School of Earth and Environmental Sciences, University of St Andrews, UK

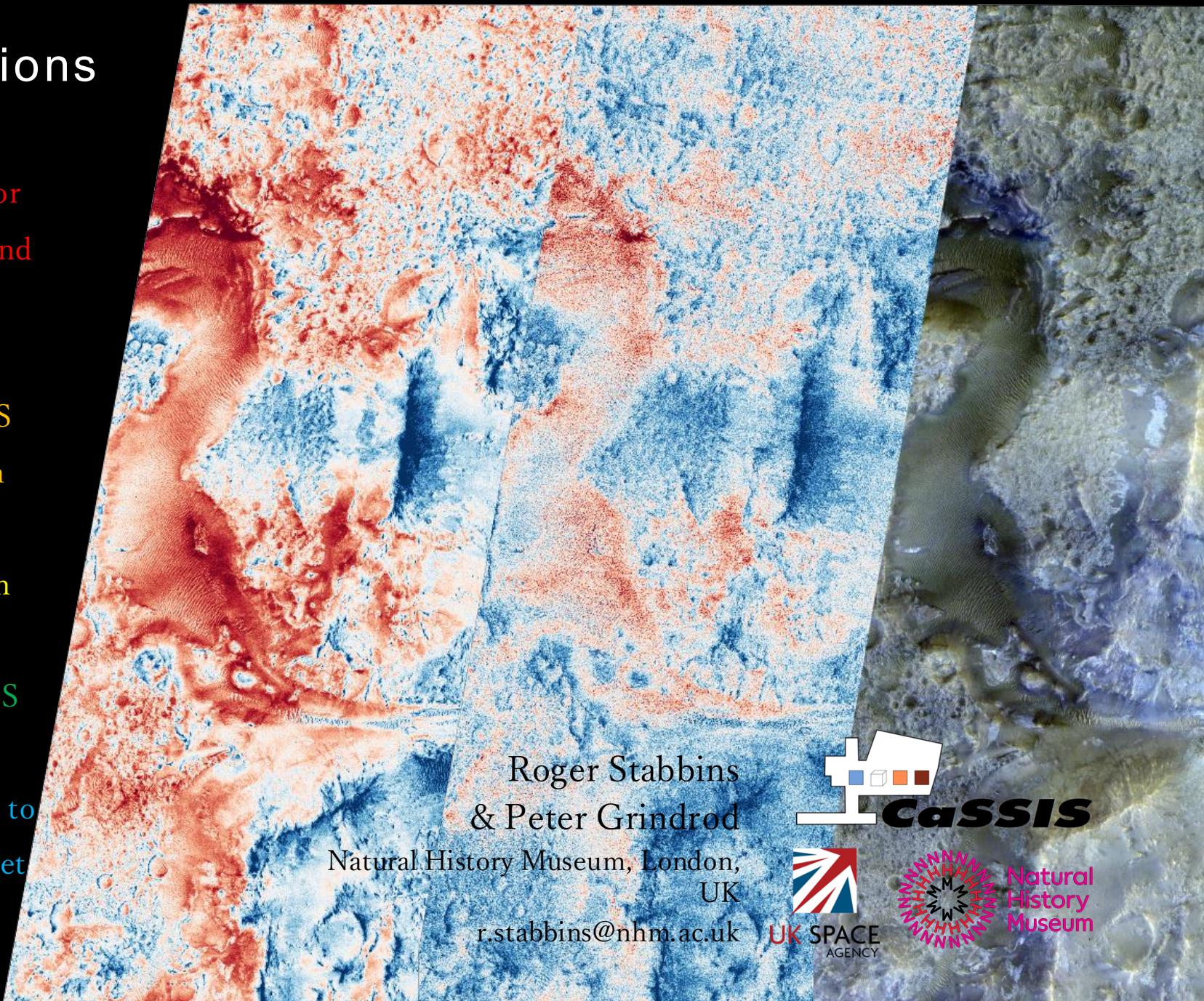
sptk: The Spectral Parameters Toolkit

DOI 10.5281/zenodo.10692531

sptk is a Python package for investigating the ability of a multispectral imaging system to identify distinct materials and material groups through differences in reflectance spectra.

Summary & Conclusions

- Supervised Spectral Parameter Learning gives a novel method for investigating target vs. background separation tasks for a given multiband imager
- SPTK can generate novel CaSSIS Spectral Parameter Combination Products
- Carbonates are still hard to see in VNIR...
- Photometric correction of CaSSIS I/F products will likely help
- Further CaSSIS Jezero Coverage to be explored, as well as other target vs. background tasks.



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