CRISM data products for Gale Crater MSL landing site mapping effort

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MRO CRISM

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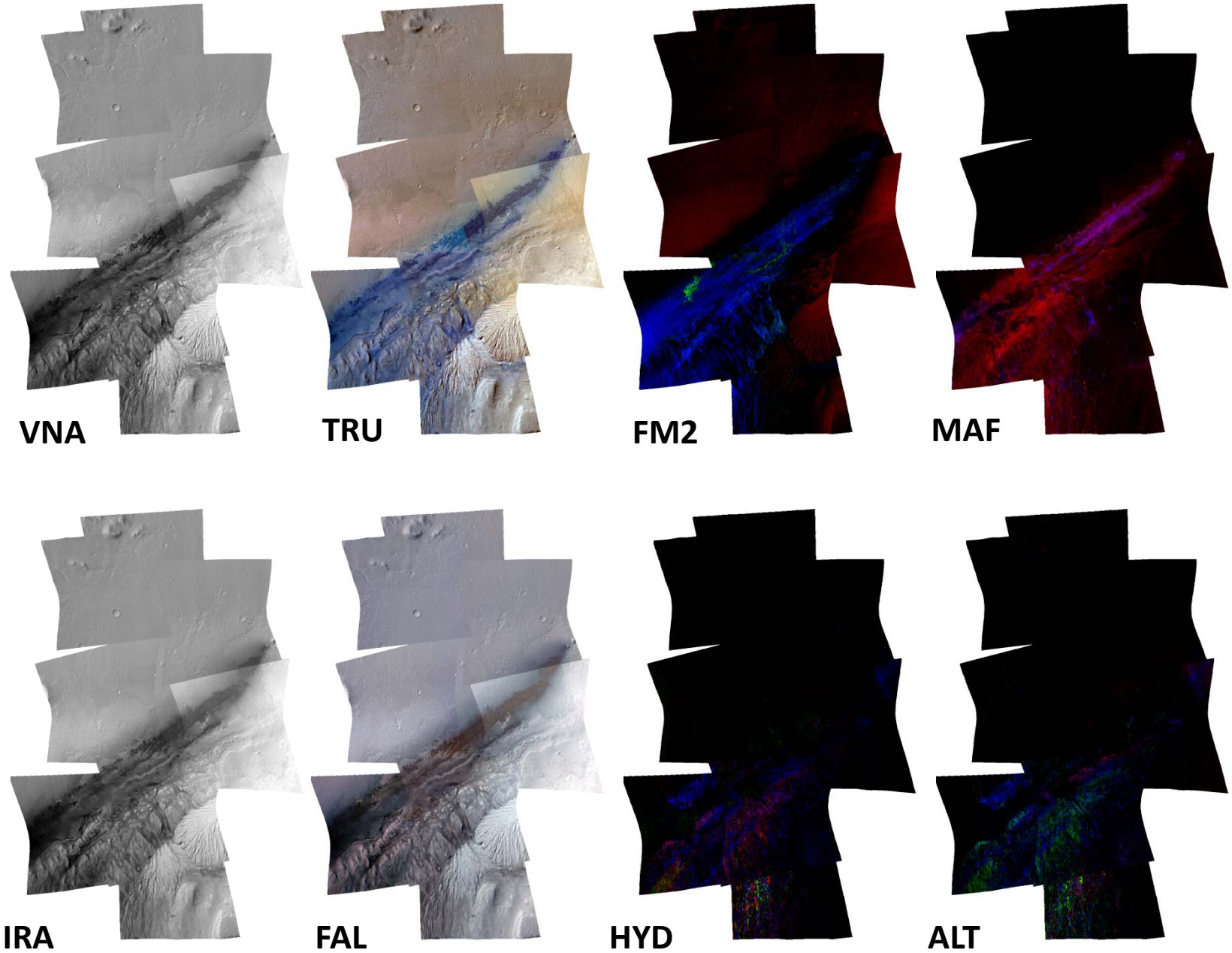
Outline

- Available products and how to access them
- CRISM data processing overview – what's been done to the data
- Showcase of products
- Usage tips
- References, links to more information

Available Products

A total of 8 CRISM VNIR- and IR-based mosaics:

	Product	Description	R Channel (Greyscale)	G Channel	B Channel
VNIR	**VNA**	Reflectance at 770nm	R770	--	--
VNIR	**TRU**	VNIR color	R600	R530	R440
VNIR	**FM2**	Iron-bearing minerals	BD530	BD920	BDI1000VIS
IR	**IRA**	Reflectance at 1330nm	R1330	--	--
IR	**FAL**	IR color	R2529	R1506	R1080
IR	**MAF**	Mafic minerals	OLINDEX3	LCPINDEX2	HCPINDEX2
IR	**HYD**	Hydrated minerals - sulfates	SINDEX2	BD2100_2	BD1900_2
IR	**ALT**	Alteration minerals - sulfates and phyllos.	D2300	SINDEX2	BD1900_2


VNA
TRU
FM2
MAF
IRA
FAL
HYD
ALT

Access and File Format

- Products and documentation are available on the CRISM website: http://crism.jhuapl.edu/msl_landing_sites/index_news.php

- File format:
  - GeoTIFF (.tif) and associated world files (.tfw)
  - PNG files also available
  - Byte-scaled (0-255 for FM2, MAF, HYD, ALT; 0-254 for VNA, TRU, IRA, FAL composites)
  - Background value is 255 in all channels (white)
- Map projection:
  - Equirectangular (simple cylindrical) with center latitude at 0°N, and using the Mars IAU 2000 equatorial radius of 3396190 m.
- Spatial resolution:
  - 3072 pixels/degree, or 19.295149 m/pixel
- File size:
  - Color composites are ~10Mb each, greyscale composites are ~3Mb

Data Processing 1/2

- Relies heavily on the prototype-MTRDR pipeline documented in detail here: http://crism.jhuapl.edu/CRISM_workshop_2012/

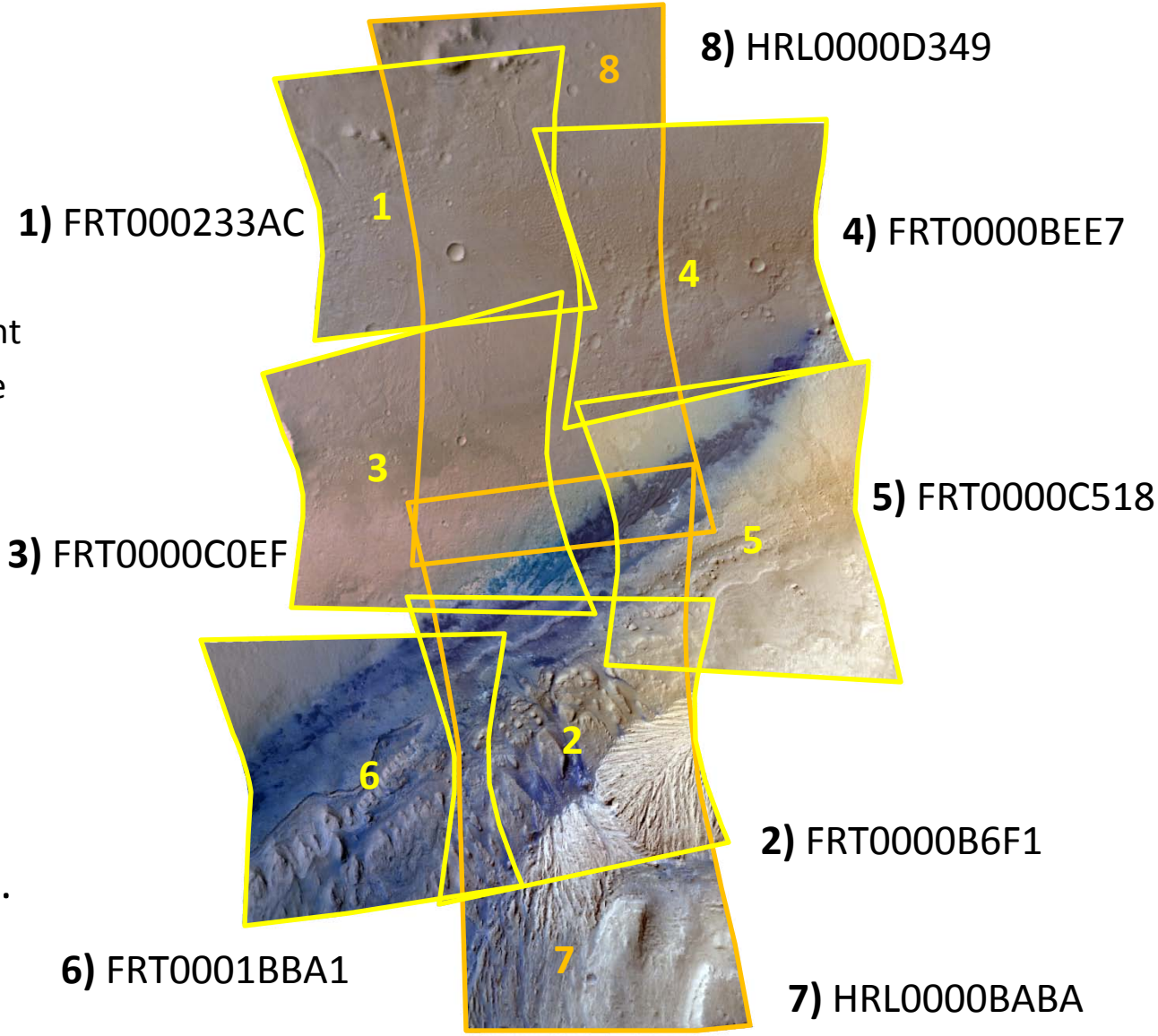
- VNIR and IR TRR3s are used as input
  - Includes an upgraded radiometric calibration and a custom hyperspectral data filtering procedure [Seelos et al. 2009] that remediates systematic and stochastic noise artifacts.
- Photometric and atmospheric corrections are applied
  - Atmospheric “volcano scan” correction has been upgraded; spectral and spatial correction residuals are minimized.
- 2 empirical corrections are applied
  - The EPF observations acquired with each targeted observation are used to normalize gimbal-induced atmospheric scattering and path length effects.
  - The effects of small cross-track variation in the instrument wavelength calibration ("spectral smile") are nearly removed through several steps of data reduction.
- VNIR and IR spectral cubes are joined together

Data Processing 2/2

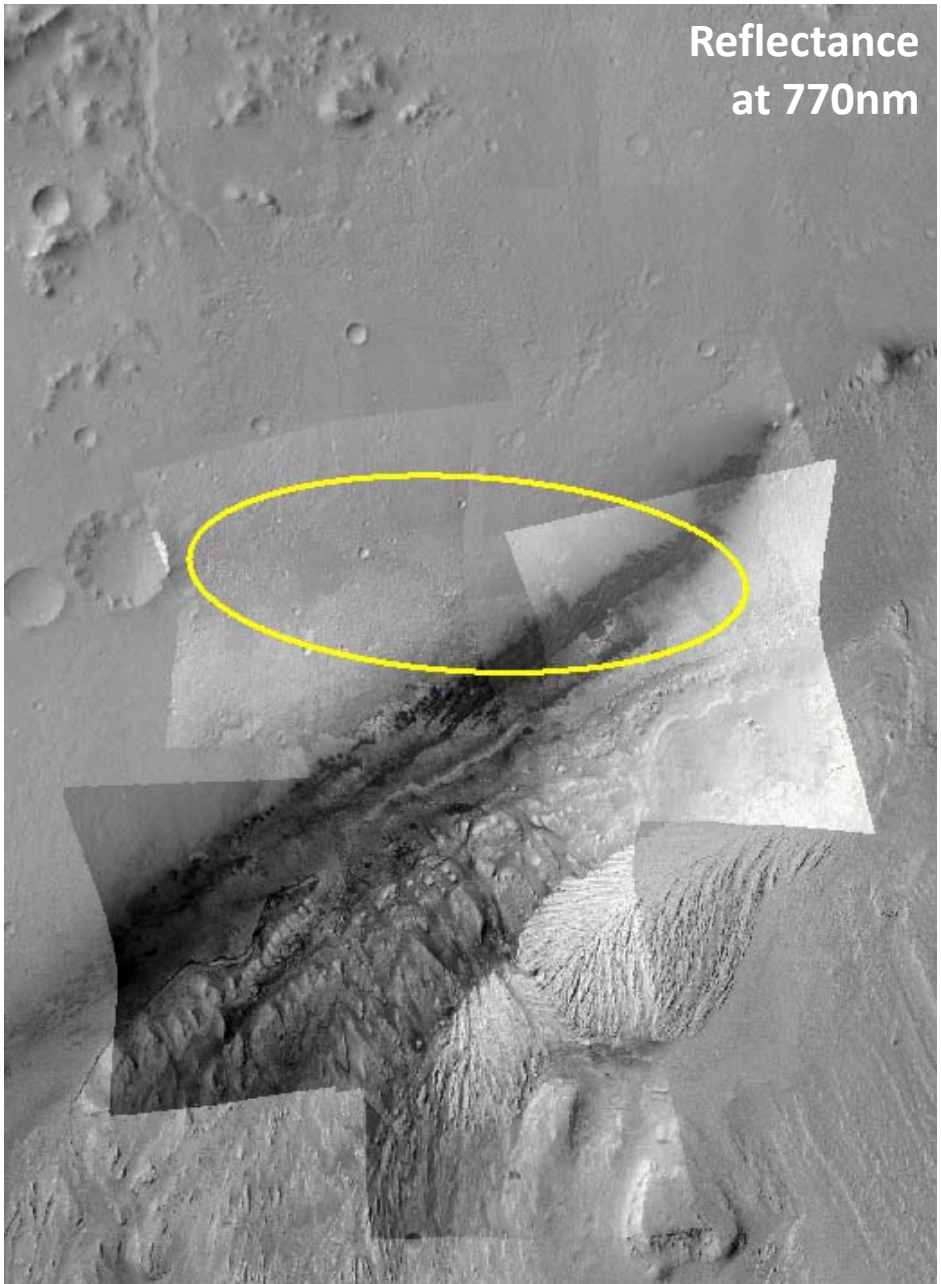
- Summary parameters are calculated
  - Formulations have been revised to take advantage of hyperspectral sampling and modified to better capture the target mineral spectral signature and to avoid ambiguity.
  - See online documentation for a detailed table of summary parameter formulations.
- Map projected
  - In this case, using an equirectangular projection with center latitude at 0°N, and the Mars IAU 2000 equatorial radius of 3396190 m.
- Spatial alignment
  - Each CRISM product was warped using the IDL/ENVI RST algorithm to better align with the CTX basemap, considered “truth” for the mapping effort.
- Browse products assembled
  - Single-band and 3-color composites of each browse product were generated.
- Mosaics rendered
  - Each browse composite (FM2, MAF, HYD, ALT) was iteratively adjusted to provide nearly seamless mosaicking.
  - The color composites (TRU, FAL) and individual band mosaic products (VNA, IRA) have been rendered using a developmental statistical balancing procedure.
  - Results are byte-scaled and exported as GeoTIFFs.

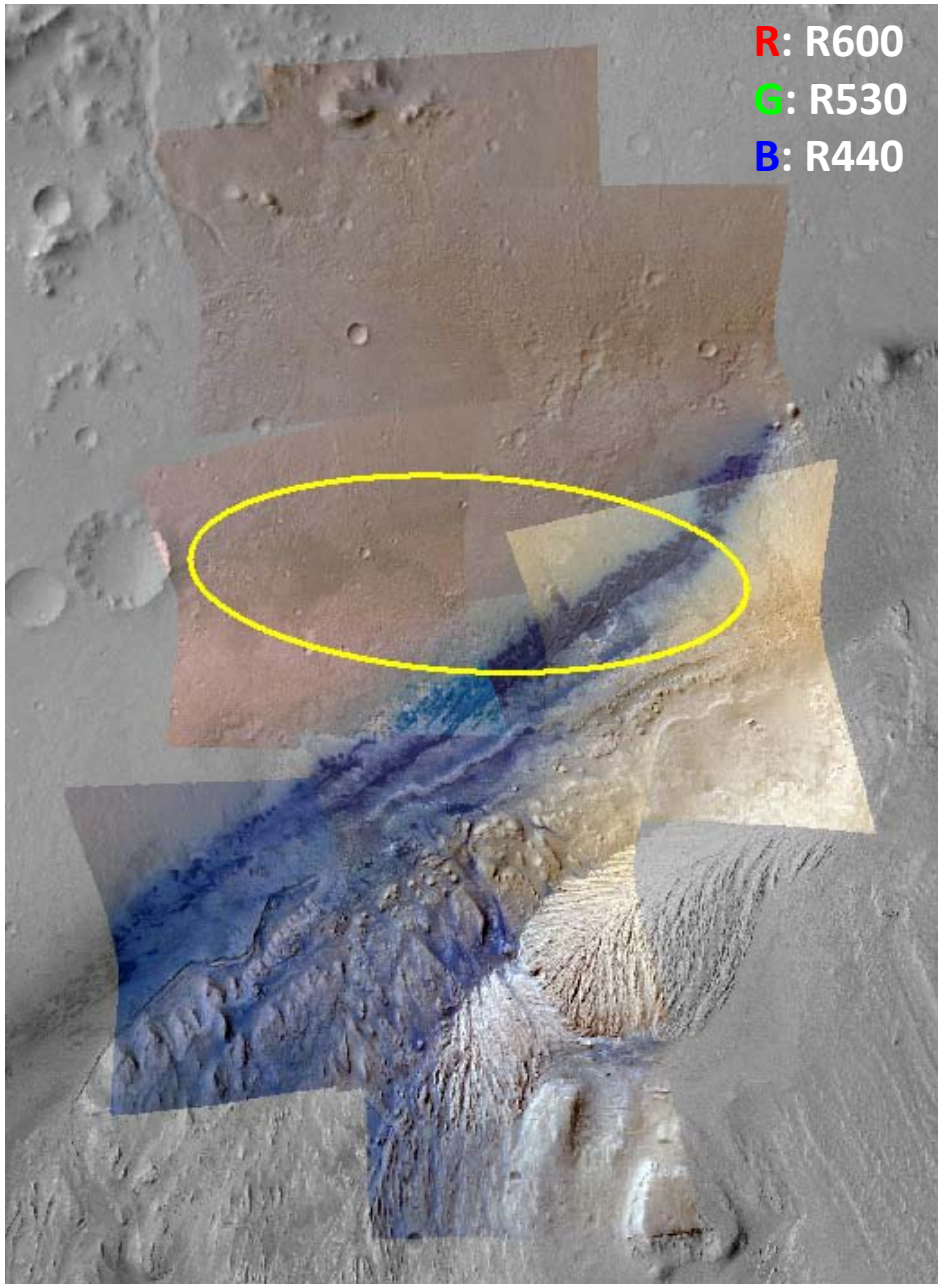
Mosaic Component Map and Stacking Order

- All available CRISM targeted observations were evaluated for inclusion, but only 8 met all qualifications:
  - both VNIR and IR present
  - IR detector temperature threshold ≤127.5K
  - 900 nm atmospheric dust opacity
- The mosaic stacking order favors FRTs over HRLs, and common mode observations are sorted by atmospheric opacity where relevant.



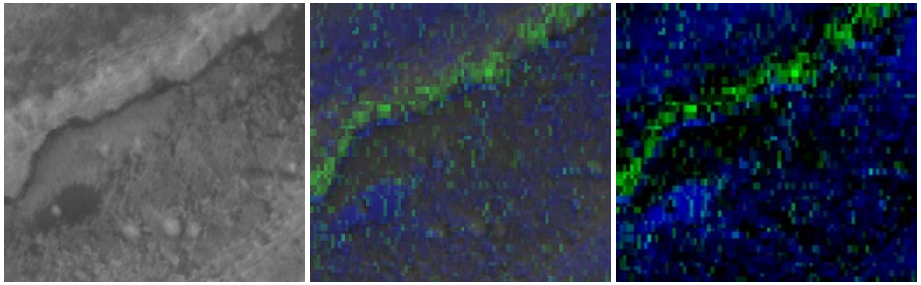
VNA and TRU Composites



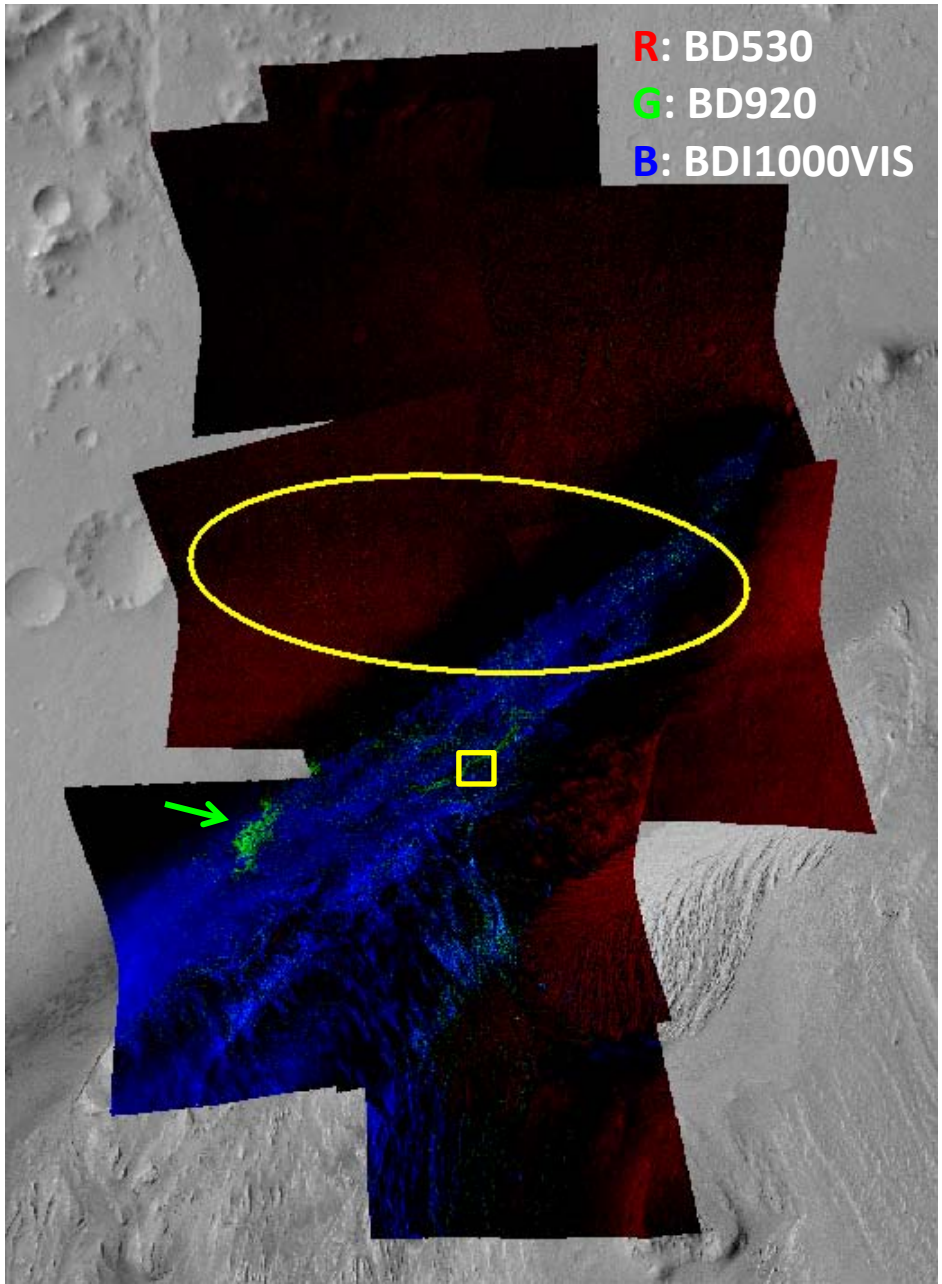


FM2 Composite

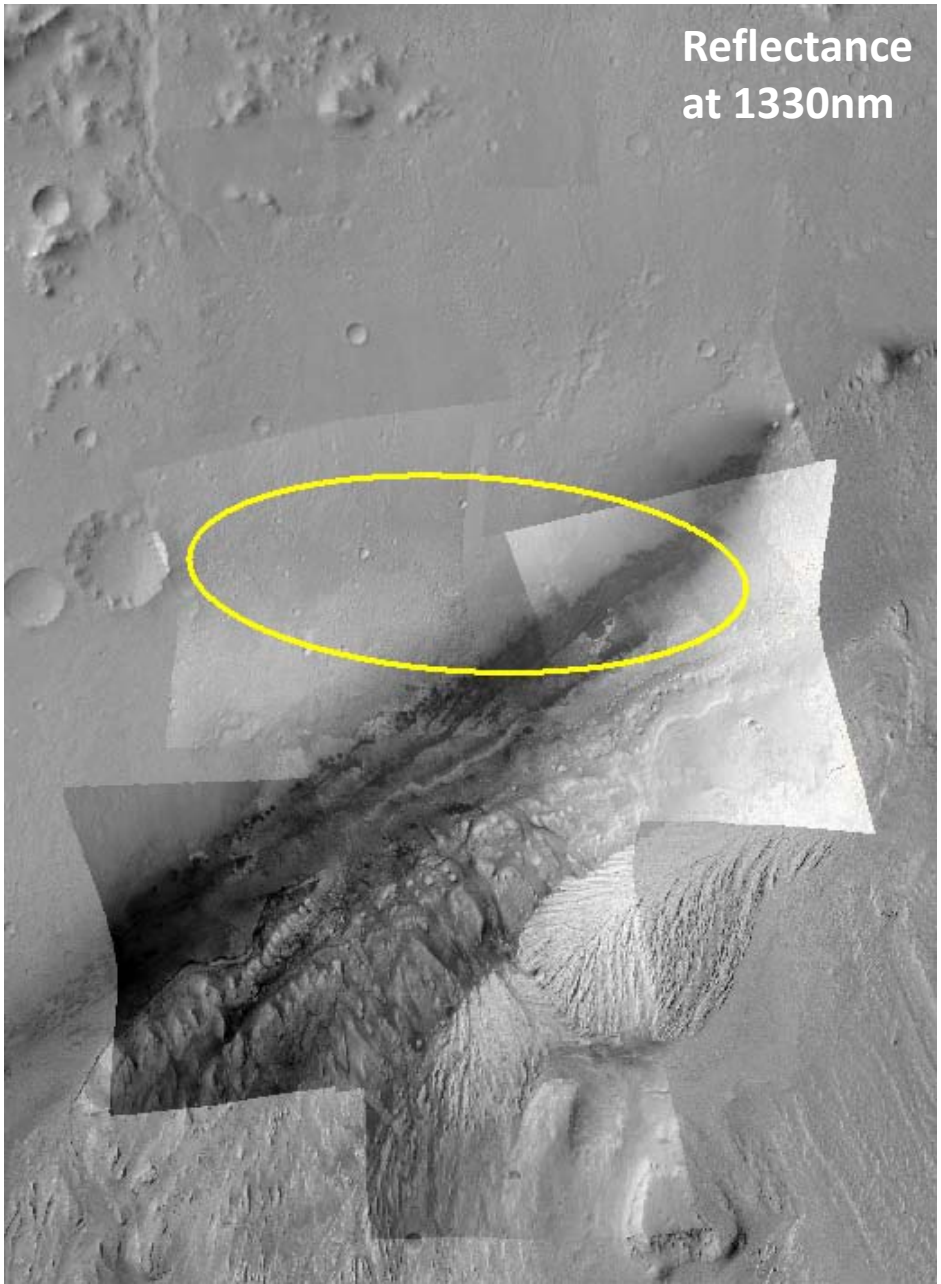
- This product shows key features in the visible wavelength range that commonly indicate which iron-containing minerals dominate.
- Red/orange areas are dominated by ferric iron-bearing dust or analogous material.
- Blue areas are dominated by mafics.
- Green or yellow colors indicate the presence of crystalline ferric minerals (principally hematite).

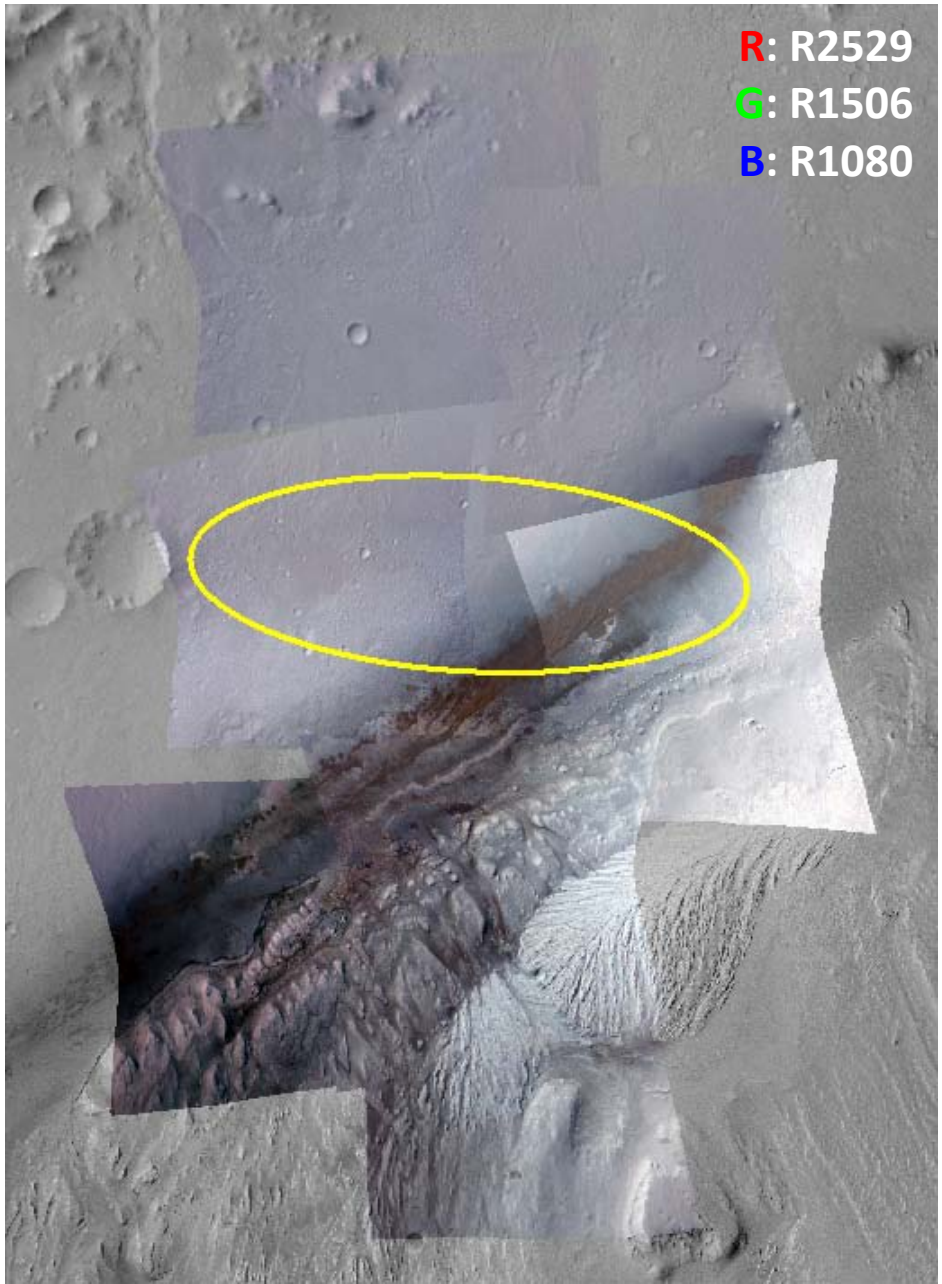


CTX 50% over CTX FM2



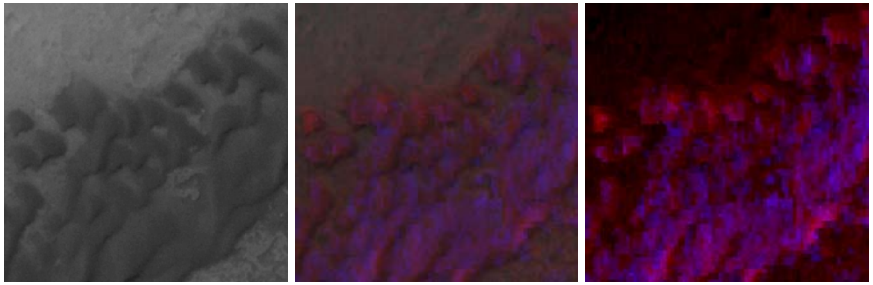
IRA and FAL Composites



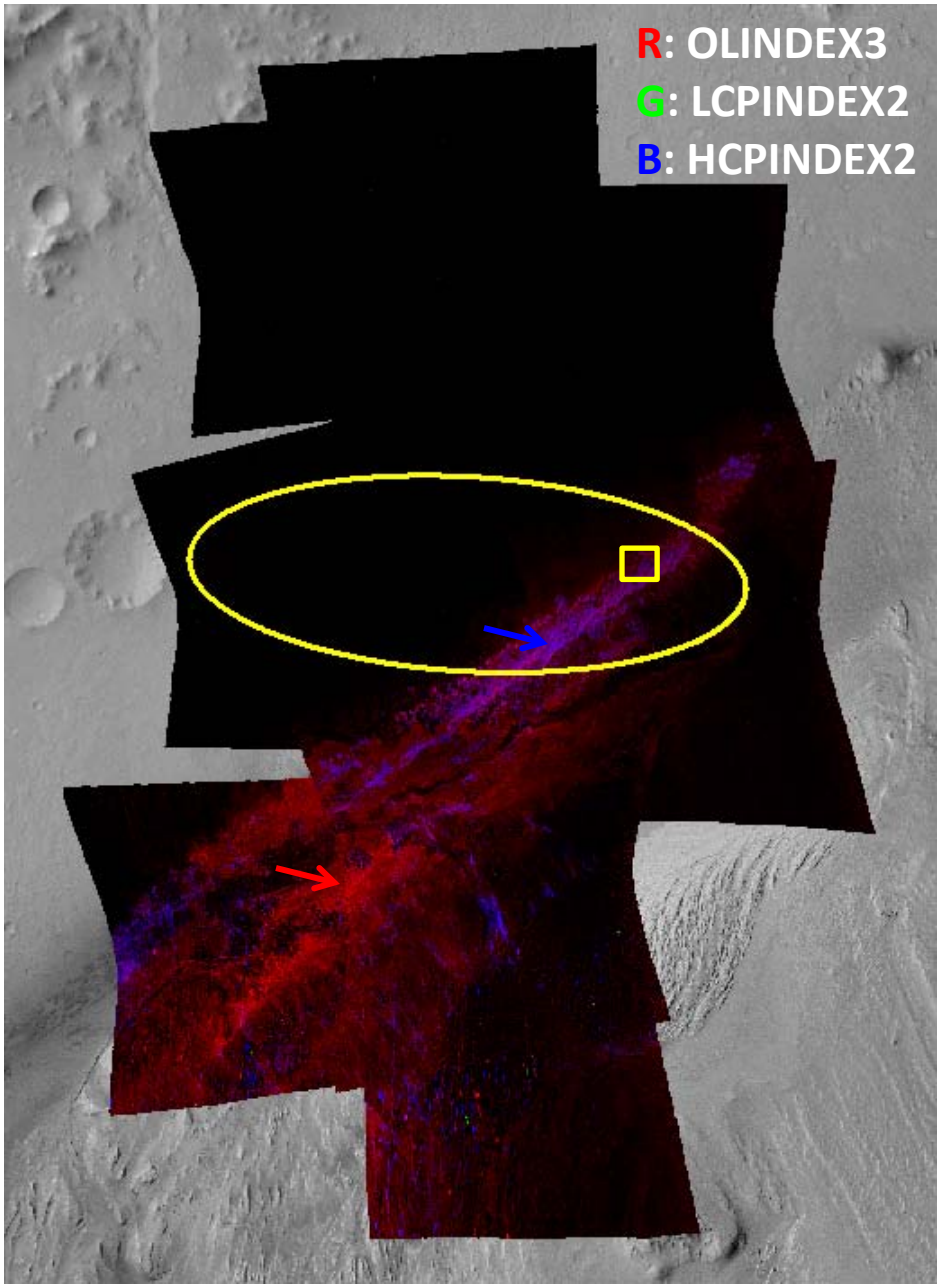


MAF Composite

- This product shows indices sensitive to iron- and magnesium-containing (usually primary) minerals.
- Occurrences can be bedrock but usually represent regolith or sand.
- Reds indicate olivine or Fe-containing phyllosilicate; these minerals in dust also causes it to appear a weak red.
- Materials with low-Ca pyroxene appear green.
- Materials with high-Ca pyroxene appears blue.

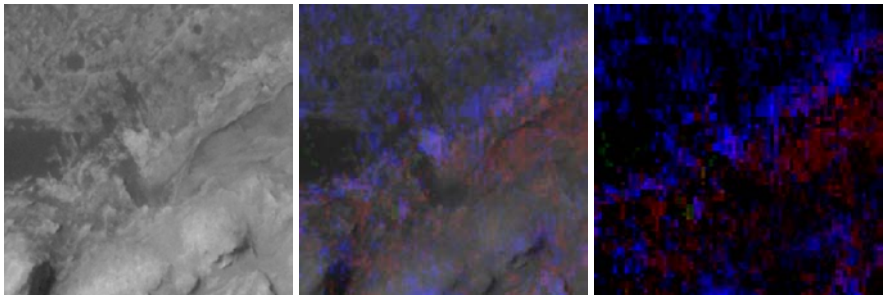


CTX 50% over CTX MAF

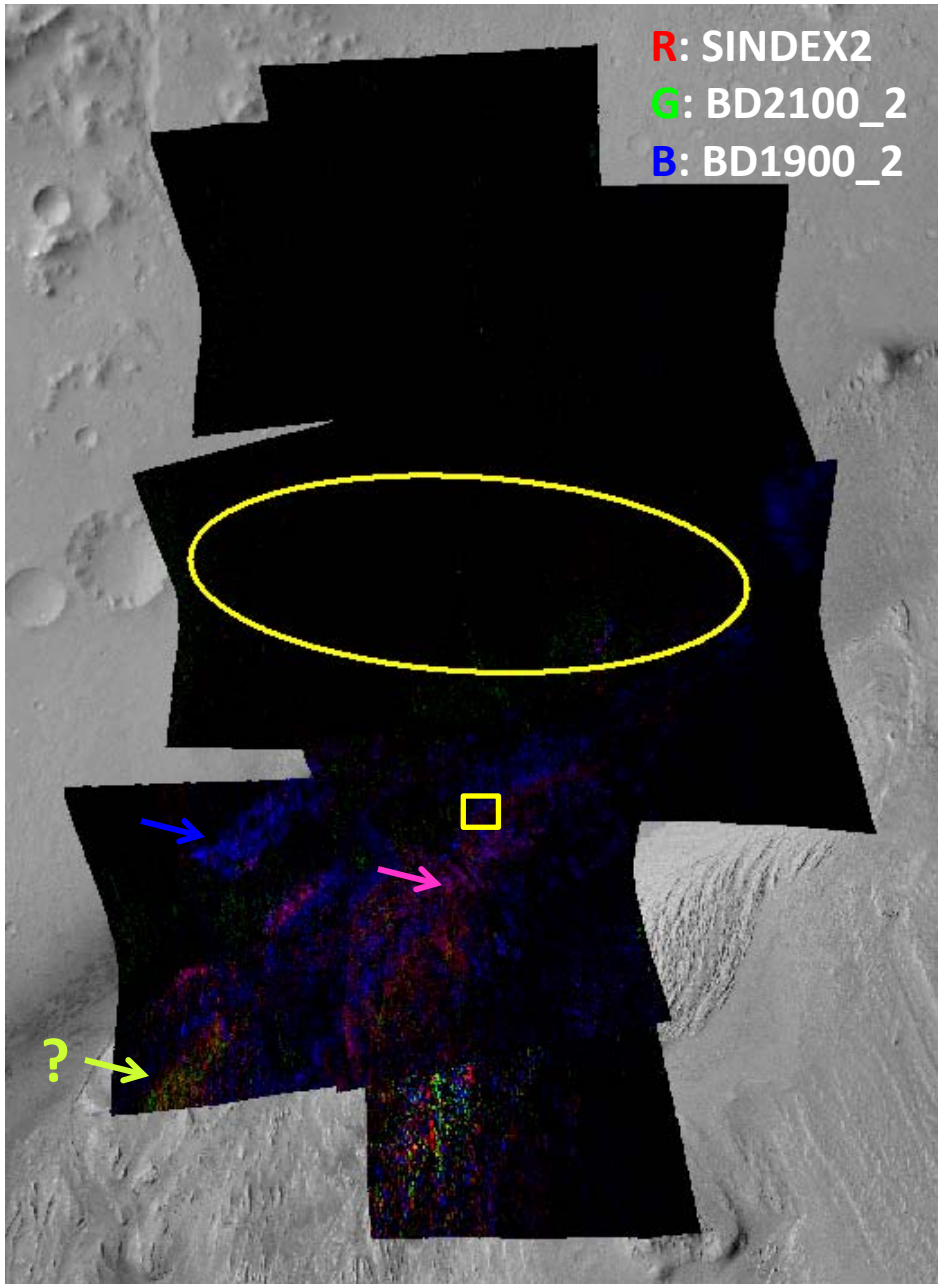


HYD Composite

- This product shows indicators of hydrated (water-containing) minerals, but is optimized to show different types of hydrated sulfates.
- Polyhydrated sulfates appear magenta and/or blue.
- Monohydrated sulfates appear green or usually yellow
- Other hydrated minerals appear blue.

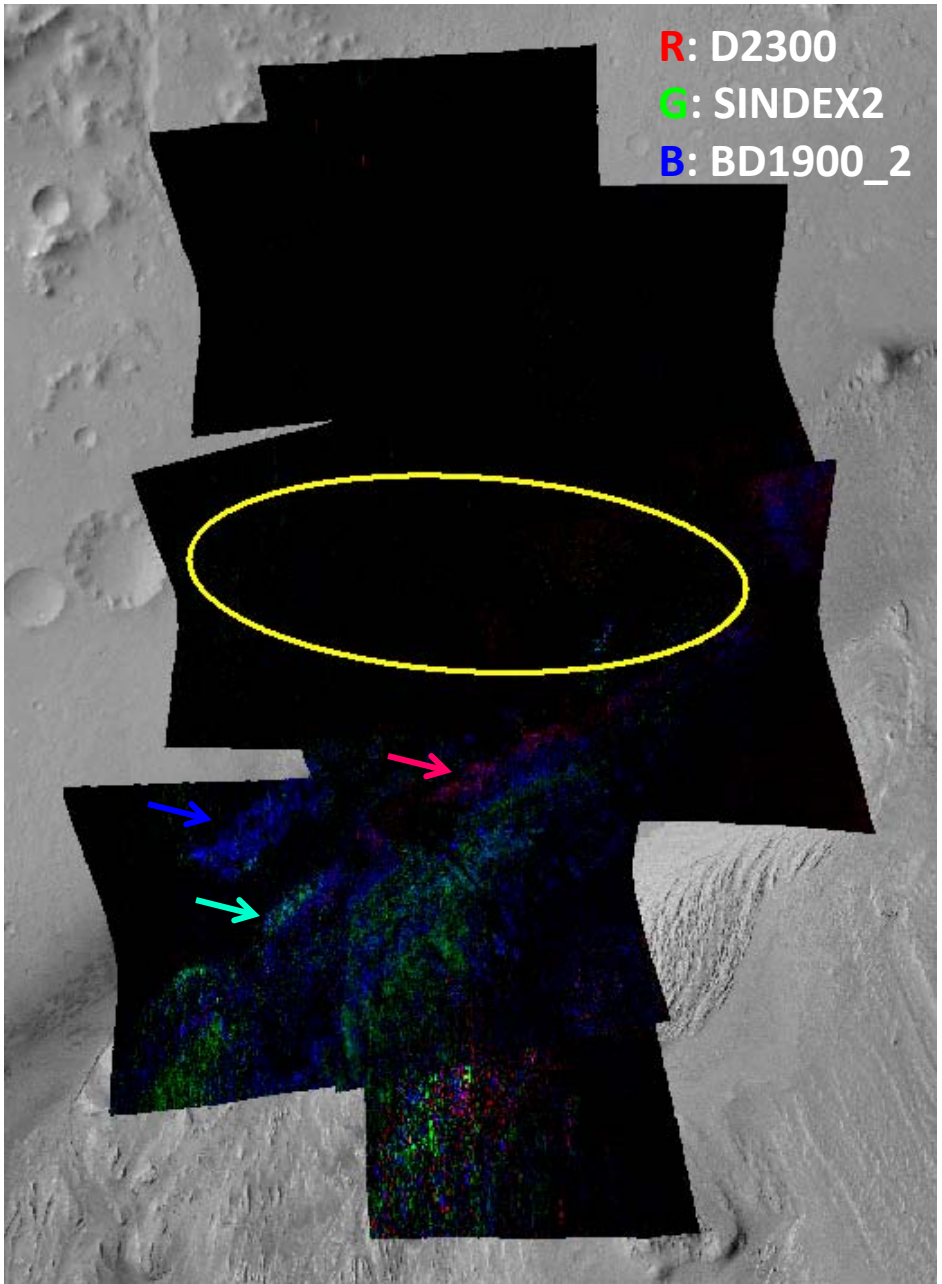


CTX 50% over CTX HYD



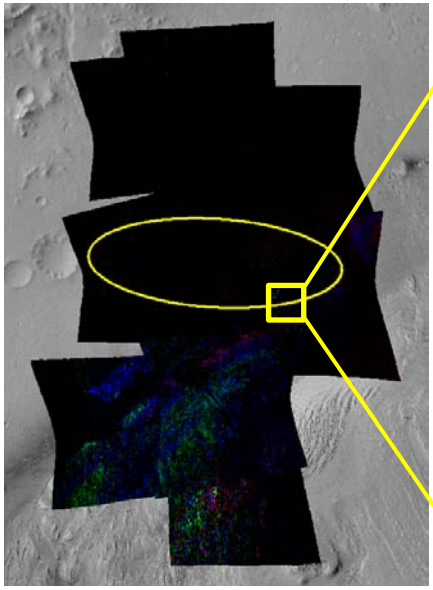
“ALT” Composite

- This product is a combination of parameters for hydrated and/or hydroxylated minerals believed to be present at Gale Crater. Together with FM2, we believe that this product depicts alteration products present and detectable by CRISM.
- Red/magenta areas have Fe/Mg phyllosilicates.
- Hydrated sulfates are green or blue-green.
- Blue areas either have more hydrated sulfates or one or more additional hydrated phases.

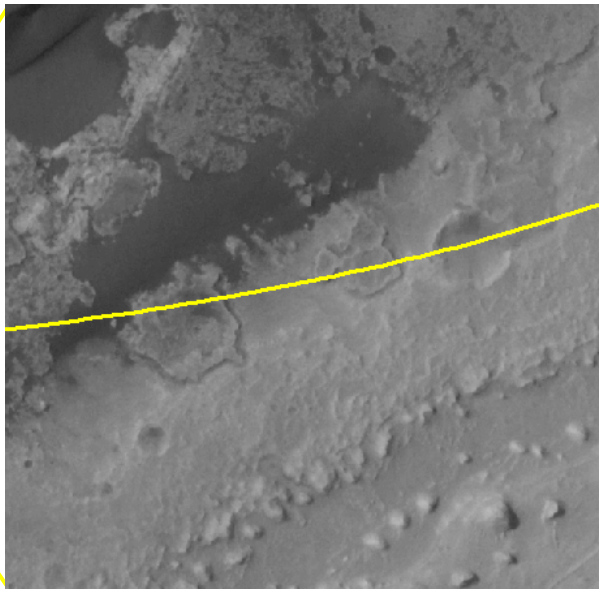


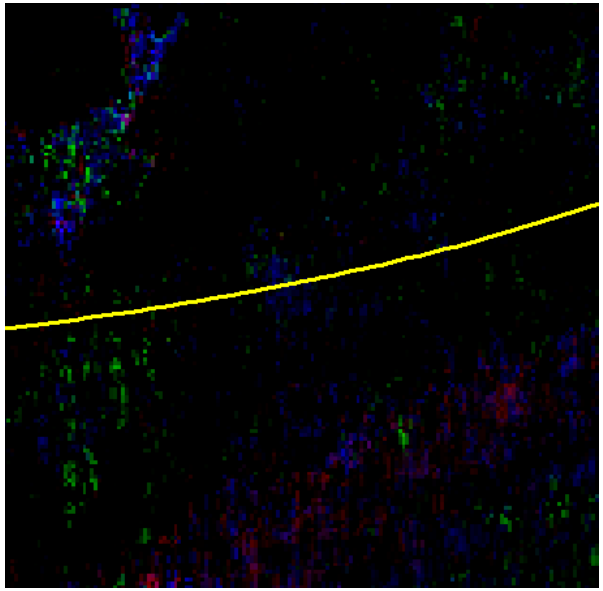
ALT Example

ALT over CTX

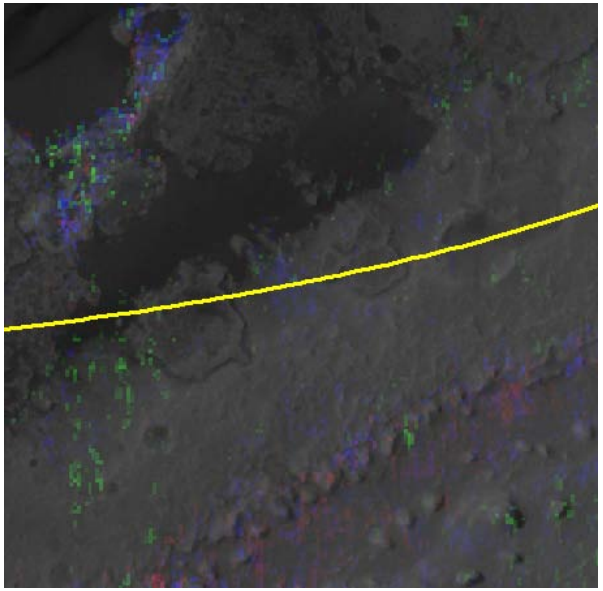


CTX

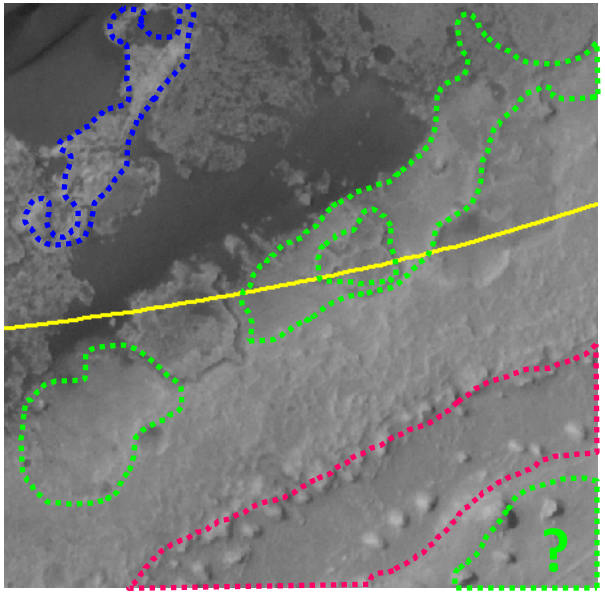




ALT



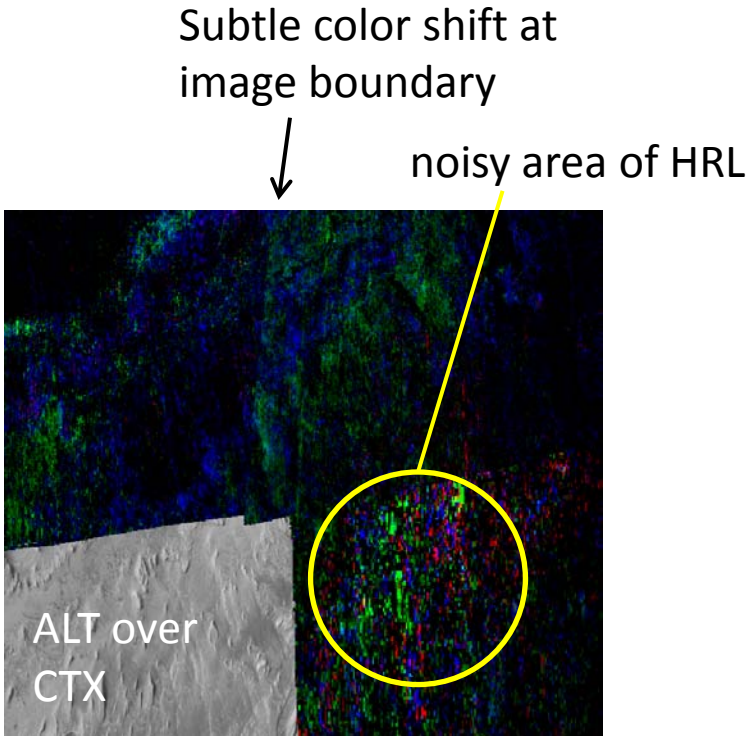
50% ALT over CTX

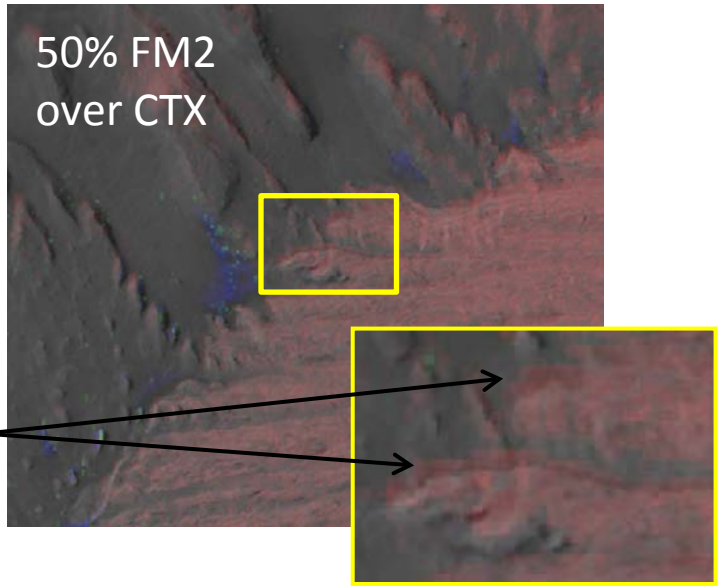


Sketch mineralogic map

Usage tips

- Interpretation pitfalls
  - Beware changes at mosaic seams or boundaries between images
  - Beware over-interpreting noise/speckles
    - Ask yourself, “Is it spatially coherent? Does it make sense with morphology?”
  - Beware spatially misregistered areas
- Remember that browse product mineral indicators are qualitative and relative.
- To determine a particular mineral species (nontronite, saponite, keiserite, etc), you will need to analyze the spectral data.





References/for more info:

LINKS

- CRISM MSL products and documentation:
  - General: http://crism.jhuapl.edu/msl_landing_sites/index.php
  - Special mosaic products: **http://crism.jhuapl.edu/msl_landing_sites/index_news.php**
- 2012 CRISM Data User's Workshop: http://crism.jhuapl.edu/CRISM_workshop_2012/

CITATIONS

- S. M. Pelkey, et al., "CRISM multispectral summary products: Parameterizing mineral diversity on Mars from reflectance," *JGR (Planets)*, vol. 112, Jul. 2007.
- F. P. Seelos, et al., "CRISM Map Projected Targeted Reduced Data Records (MTRDRs) – High Level Analysis and Visualization Data Products," presented at the *Planetary Data: A Workshop for Users and Software Developers*, 2012.
- F. P. Seelos, et al., "CRISM Data Processing and Analysis Products Update — Calibration, Correction, and Visualization," *LPSC*, 2011, vol. 42, p. 1438.
- F. P. Seelos, et al., "CRISM Hyperspectral Data Filtering with Application to MSL Landing Site Selection," *AGU Fall Meeting Abstracts*, vol. 23, p. 1234, Dec. 2009.
- M. J. Wolff, et al., "Wavelength dependence of dust aerosol single scattering albedo as observed by the Compact Reconnaissance Imaging Spectrometer," *JGR (Planets)*, vol. 114, Jun. 2009.