Generation and Evaluation of Systematic CRISM Mineral Indicator Maps

4th MSL Landing Site Selection Workshop
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Frank Seelos, Olivier Barnouin
David Humm, Howard Taylor, Chris Hash, Frank Morgan,
Kim Seelos, Debra Buczkowski, Scott Murchie, and Anne Sola
• CRISM data processing and product description
  – Updated radiometric calibration (TRR2 → TRR3)
  – Systematic spectral processing
  – Revised summary parameters and browse products

• MSL candidate landing sites – CRISM web site
  – Active online community resource
  – 170 targeted observations of the MSL candidate landing sites presented
    • CRISM prototype TRR3 I/F image cubes
    • Systematic browse products, false color composites, etc.

• Representative observations and derived analysis products
  – Mawrth Vallis
  – Holden Crater
  – Ebserswalde Crater
  – Gale Crater
A major upgrade of the CRISM data processing pipeline is nearing completion

- Non-map projected hyperspectral data, calibration version 3 (TRR3s)
  - Radiance (‘RA’) cubes – output from radiometric calibration version 3
  - I/F cubes – TRR3’s processed through custom filtering procedures
    - IR: kernel filter to remove stochastic noise
    - VNIR+IR: mitigation of systematic column-oriented noise

- Map-projected filtered hyperspectral data
  - Upgraded atmospheric correction
  - Correction for observation geometric/photometric effects
  - Correction for spectral smile effect

- Browse versions of the data with the above corrections
  - Reformulated to show more phases, reduce artifacts

- 1st release for MSL candidate landing sites - via CRISM web site
- Redelivery of other data will begin with next PDS delivery
Next Steps for Post TRR3 Processing

- Calibration upgrade and noise filtering
- Revised summary products
- PNG versions of summary product composites (browse products)
- Upgraded atmospheric correction
- Empirical correction of systematic calibration residual
- Map projection using MRO conventions
- Empirical normalization of geometric dependencies
- Revised summary products
- Combine VNIR+IR remove bad channels
- PNG versions of summary product composites (browse products)
The TRR3 data still exhibit two effects

- **Along-track brightness variations**
  - Due to continuously varying gimbal angle
  - Processing fits variation as a function of observing geometry in the central scan and accompanying EPF segments
  - Data is normalized to minimum emission angle
- **Cross-track brightness variations (optical artifact)**
  - Fits cross-track variations using a function constrained in form to follow spectral smile
  - Data is normalized to center of the FOV
Current I/F PDS deliverable

False color IR RGB composite; 0.5% linear stretch on each displayed band; spectral median plot with interquartile envelope and RGB wavelengths indicated; boxplots show data distribution of RGB bands

Note IR spectral slope and noise components
CRISM Data Processing Progression: Heimdal

TRR3 – Unfiltered

Spectral artifact at < 1.7 µm corrected

Improved flat-field

Minor change to systematic noise component; stochastic component effectively unchanged
CRISM Data Processing Progression: Heimdal

TRR3 – Filtered

Systematic and stochastic noise removed - spectral shape intact

TRR3 I/F PDS deliverable

Prototype TRR3 data for MSL candidate landing sites available as an early release

Note photometric effects at the top and bottom of the scene
CRISM Data Processing Progression: Heimdal

TRR3 – Filtered & Corrected

Simple photometric (cos(i)) and atmospheric (“volcano scan”) corrections

Empirical normalization of the data to the minimum sampled emission angle observing geometry

Empirical spectral smile residual correction

Corrected data used in the calculation of spectral summary parameters and browse products
FRT00007D87 - TRR2

Previous:
Use only 72 channels present in both multispectral and hyperspectral data for spectral parameter calculation
Spectral noise propagated into parameter

MAF -
Red: OLINDEX
Green: LCPINDEX
Blue: HCPINDEX

Current:
Evaluate spectral data in channels near wavelengths used in parameter calculations
Mitigates propagation of spectral artifacts
False positive strong olivine detection

MAF (previous) -
Red: OLINDEX
Green: LCPINDEX
Blue: HCPINDEX

Bright dust

IRA - Corrected brightness at 1.3 µm

MAF (current) -
Red: OLINDEX2
Green: LCPINDEX
Blue: HCPINDEX

OLINDEX2 – Mitigates spectral continuum effects in parameter calculation

New MSL candidate landing site CRISM browse products

Brief explanation of systematic data processing

Product overview
Detailed information on the browse products, parameter stretches, products interpretation, and caveats.

Click on the site name to access product the library.
Observations organized into tabs by type and time order
1 column = 1 observation
1 row = 1 product type
Data quality metrics –
IR detector temperature
Atmospheric opacity

http://crism.jhuapl.edu/msl_landing_sites/
Each product type emphasizes one way to visualize the observation information content: context image showing footprint, Fe minerals, mafic minerals, phyllosilicates, etc.

Click on a thumbnail to access full-resolution version.
Separate ‘global’ and regional stretches for site-to-site comparison and to highlight local heterogeneity.

Links to version of data already in the PDS (TRR2).

Links to early release of TRR3s.

Links to full resolution versions of the browse products with and without geographic grid.

Detailed breakdown of observation and data set characteristics: lat/lon/Lₖ, i/e/g, lines/samples/bands, etc.
Mawrth Vallis – FRT0000B141

VNIR RGB

VNIR spectral variability – Fe mineralogy

VNIR FM2

R: BD530
G: BD920
B: BDI1000
Western portion of the ellipse dominated by Al-phyllosilicate signatures

IR RGB

IR PHY

R: D2300
G: BD2210
B: BD1900
Holden Crater – FRT0000C1D1
Light toned deposits in IR RGB image correspond to enhanced D2300 and BD1900 spectral indices (magenta pixels – Fe/Mg phyllosilicate) in IR PHY browse product.
Eberswalde Crater – FRT0000AADE
Fe/Mg-Phyllosilicate detection - magenta pixels in IR PHY brose product – restricted to small knobs/outcrops
Gale Crater – FRT0000B6F1
Gale Crater – FRT0000B6F1

Distribution of ferric/ferrous iron phases
Hydrated sulfate signature correlated with pyroxene signature

R: SINDEX
G: BD2100
B: BD1900
CRISM support for MSL landing site selection:
http://crism.jhuapl.edu/msl_landing_sites/

• The systematic set of derived CRISM analysis products provides an objective framework for the evaluation and comparison of the spectral signatures at each candidate site

• CRISM prototype TRR3 I/F data available for MSL candidate landing sites via the website
Future Attractions – Systematic Product Mosaics
CRISM TRR3 Calibration - Additional Material
2 of 6 intermediate versions that were rejected (too-large spectral slopes, organized artifacts, etc.)

TRR3 – new
- spectral artifacts fixed
- less high-frequency spectral noise

TRR2 – old version has issues:
- time-drift of calibration at 1-1.7 μm
- artifacts at 1.9, 2.5, 3.2 μm
- systematic spectral noise
Unfiltered vs. Filtered Spectral Comparison

Polynomial form of the interpolation through noisy pixels preserves high spectral-frequency information.

Random noise from elevated detector operating temp. greatly reduced.
TRR2 vs. TRR3
2.3-µm Phyllosilicate Band TRR2 vs. TRR3 (1% stretch)
2.3-μm Phyllosilicate Band TRR2 vs. TRR3
(1% stretch)
MSL Systematic CRISM Browse Products Gallery