CRISM Data Users' Workshop
Nili Fossae Data Processing Walkthrough

March 22, 2009

Frank Seelos and the CRISM Team
The intermediate data processing products, derived data products, and ancillary files presented here are available online:

PDS Geosciences Node: http://pds-geosciences.wustl.edu/workshops/
CRISM SOC: http://crism.jhuapl.edu/CRISM_workshop_2009/

Participants in the CRISM Data Users' Workshop are encouraged to replicate the data processing and analysis presented here as a hands-on exercise.
Example CRISM Observation: FRT000064D9

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<th>FRT000064D9_07_IF166S_TRR2.LBL</th>
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**VNIR RGB**
R: 0.71 μm  
G: 0.60 μm  
B: 0.53 μm

**IR RGB**
R: 2.53 μm  
G: 1.51 μm  
B: 1.08 μm
CRISM Data Processing Work Flow

• Typical CRISM data processing work flow (CAT functionality):
  – CAT: PDS to CAT conversion
  – PHT: Photometric correction [COS(i)]
  – ATM: Volcano Scan atmospheric correction (IR)
  – CLN: CIRRUS (CRISM Clean)
    • Destripe (VNIR and IR)
    • Despike (IR)
  – SUM: Summary parameter calculation
ENVI → CAT → Convert Format: PDS to CAT

FRT000064D9_07_IF166L_TRR2.IMG

Reverses Spectral Dimension
Applies Default Bad Bands

FRT000064D9_07_IF166L_TRR2_CAT.IMG
ENVI → CAT → ATP Corrections → [Select File] → Photometric correction: Division by cos(i):

FRT000064D9_07_IF166L_TRR2_CAT.IMG

FRT000064D9_07_IF166L_TRR2_CAT_PHT.IMG

CRISM Spectral Profile

Input Histogram

Input Histogram

CRISM Spectral Profile
Atmospheric Correction [Volcano Scan]

ENVI → CAT → ATP Corrections → [Select File] → Division by scaled volcano observation

FRT00064D9_07_IF166L_TRR2_CAT_PHT.IMG

FRT00064D9_07_IF166L_TRR2_CAT_PHT_ATM.IMG
ENVI → CAT → Data Filtering → CIRRUS → Clean Spectral Cube
Select both destripe and despike for IR data

FRT000064D9_07_IF166L_TRR2..._CAT_PHT_ATM.IMG

FRT000064D9_07_IF166L_TRR2..._CAT_PHT_ATM_DST_DSP.IMG
IR Spectral Summary Parameters

ENVI → CAT → Spectral Analysis Utilities → Spectral Summary Products → IR Data

IRA (Infrared Albedo Proxy)

D2300 (2300 nm Drop-Off)

ISLOPE1 (1800 nm to 2500 nm Inverse Spectral Slope)

LCPINDEX (Low-Calcium Pyroxene Index)
VNIR Progression: PDS to CAT

ENVI → CAT → Convert Format: PDS to CAT

FRT000064D9_07_IF166S_TRR2.IMG

Applies Default Bad Bands

FRT000064D9_07_IF166S_TRR2_CAT.IMG
Photometric Correction [COS(i)]

ENVI → CAT → ATP Corrections → [Select File] → Photometric correction: Division by cos(i):

FRT00064D9_07_IF166S_TRR2_CAT.IMG

FRT00064D9_07_IF166S_TRR2_CAT_PHT.IMG
ENVI → CAT → Data Filtering → CIRRUS → Clean Spectral Cube

Select destripe for VNIR data

FRT000064D9_07_IF166S_TRR2_CAT_PHT.JPG

\[\text{FRT000064D9_07_IF166S_TRR2_CAT_PHT.DST.JPG}\]
**VNIR Spectral Summary Parameters**

ENVI → CAT → Spectral Analysis Utilities → Spectral Summary Products → VNIR Data

FRT000064D9_07_IF166S_TRR2_CAT_PHT_DST.IMG

R770 (I/F @ 770 nm)

RBR (Red/Blue Ratio)

RPEAK (Wavelength of VNIR Reflectance Maximum)

BD530 (Band Depth @ 530 nm)
CRISM Data Analysis Work Flow

- Typical CRISM data analysis work flow (ENVI functionality):
  - Spectral unit identification
    - Guided spectral investigation
    - Link spectral data and selected spectral summary parameter(s)
  - Spectral extraction
    - Create ROIs based on linked information sources
  - Spectral ratios
  - Spectral library comparison
Spectral Unit Identification: D2300

- Select displays for pixel coordinate link
- Pixel coordinate link must be done with common-detector data
- VNIR/IR geographic link available after map projection
ROIs and Mean Spectra: D2300

Image → Overlay → Region of Interest...
Construct ROIs from spectral parameter thresholds; manual specification; ROI intersection

ROI Tool → Select target ROI → Stats
Compute spectral stats for spatial pixels in ROI

Selecting target and reference ROIs from common columns will mitigate spectral smile effects in the ratio

ROI file: FRT000064D9_D2300.roi
Ratio Spectrum and Library Comparison: D2300

SLI file: FRT000064D9_D2300.sli

**ENVI → Spectral → Spectral Math**
- Enter spectral math expression e.g. s1/s2
- Map variables to spectra in ENVI session

**ENVI → Spectral → Spectral Libraries → Spectral Library Viewer**
- CRISM phyllosilicate spectral library
Spectral Unit Identification: LCPINDEX

Image → Tools → Link → Link Displays...
Select displays for pixel coordinate link
ROIs and Mean Spectra: LCPINDEX

Image → Overlay → Region of Interest...
Construct ROIs from spectral parameter thresholds; manual specification; ROI intersection

ROI Tool → Select target ROI → Stats
Compute spectral stats for spatial pixels in ROI

ROI file: FRT000064D9_LCPINDEX.roi
Ratio Spectrum and Library Comparison: LCPINDEX

SLI file: FRT000064D9_LCPINDEX.sli

ENVI → Spectral → Spectral Math
Enter spectral math expression e.g. s1/s2
Map variables to spectra in ENVI session

ENVI → Spectral → Spectral Libraries → Spectral Library Viewer
CRISM phyllosilicate spectral library

Orthopyroxene CASB51  [Link to Spectral Library]
Typical CRISM georeferencing procedure (CAT/ENVI functionality):

- Project single cube (CAT)
  - MRO standard projection at native observation nadir resolution
- Project multiple cubes to a common reference (ENVI GLT)
  - CAT or user supplied projection information
  - VNIR/IR data from common observation for layer stacking
  - Data from different observations for mosaicking
- Layer stacking and/or mosaicking (ENVI)
ENVI → CAT → Map Utilities → Project Single Cube Data

Projects CRISM data to MRO standard using native nadir resolution

IR: 18.6 m/pxl

VNIR: 18.9 m/pxl

FRT000064D9_07_IF166L_TRR2_CAT_PHT_ATM_DST_DSP_PRJ.IMG

FRT000064D9_07_IF166S_TRR2_CAT_PHT_DST_PRJ.IMG
**Custom Map Projection: Build GLT**

ENVI → Map → Georeference from Input Geometry → Build GLT

- **Input X Geometry Band:** CRISM DDR Band 5 (Longitude, areocentric, deg E)
- **Input Y Geometry Band:** CRISM DDR Band 4 (Latitude, areocentric, deg N)
- **Input Projection:** Geographic Lat/Lon
- **Output Projection:** User Defined or Mars Default (MRO)
- **Output Pixel Size:** User Defined – Default is native image resolution
  - Set to consistent value for mosaicking or layer stacking
- **Output Rotation:** User Defined – 0 recommended in most cases

GLT: Geographic Lookup Table – A map of pixel locations relating one frame of reference to another

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**GLT Sample Lookup**

- 20.0 m/pxl

**GLT Line Lookup**

- 20.0 m/pxl

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FRT00064D9_07_DE166L_DDR1_GLT.IMG
Custom Map Projection: Apply GLT

ENVI → Map → Georeference from Input Geometry → Georeference from GLT
Input Geometry Lookup File: Select GLT file
Input Data File: Select data file to project
Background Value: 65535 is CRISM NULL value

ENVI → Map → Georeference from IGM
Cascades construction and application of GLT from DDR lat/lon information

IR: 20.0 m/pxl
VNIR: 20.0 m/pxl

FRT000064D9_07_IF166L_TRR2_CAT_PHT_ATM_DST_DSP_REF.IMG
FRT000064D9_07_IF166S_TRR2_CAT_PHT_DST_REF.IMG
CRISM VNIR/IR Layer Stacking

ENVI → Basic Tools → Layer Stacking
Select input layers (files) and output projection

FRT000064D9_07_IF166SL_TRR2_LST.IMG
1330 nm I/F

IR/VNIR Ratio

FRT000064D9_07_IF166SL_TRR2_LST_RAT.IMG
770 nm I/F

BD530 Type Location

D2300 Type Location

LCPINDEX Type Location
Walkthrough File List (1/2)

**VNIR IMG files:**
- FRT000064D9_07_IF166S_TRR2.IMG
- FRT000064D9_07_DE166S_DDR1.IMG
- FRT000064D9_07_IF166S_TRR2_CAT.IMG
- FRT000064D9_07_IF166S_TRR2_CAT_PHT.IMG
- FRT000064D9_07_IF166S_TRR2_CAT_PHT_DST.IMG
- FRT000064D9_07_IF166S_TRR2_CAT_PHT_DST_SUM.IMG
- FRT000064D9_07_IF166S_TRR2_CAT_PHT_DST_PRJ.IMG
- FRT000064D9_07_DE166S_DDR1_GLT.IMG
- FRT000064D9_07_IF166S_TRR2_CAT_PHT_DST_REF.IMG

**CRISM TRR2 PDS IMG file**
- CRISM DDR1 PDS IMG file
- CAT (ENVI) format CRISM IMG data file
- Photometrically corrected version of the above
- Destriped version of the above
- Spectral summary parameter cube calculated from the above
- Map projected version of the processed spectral data
- Custom geographic lookup table derived from the CRISM DDR
- Custom map projected version of the processed spectral data

**IR IMG files:**
- FRT000064D9_07_IF166L_TRR2.IMG
- FRT000064D9_07_DE166L_DDR1.IMG
- FRT000064D9_07_IF166L_TRR2_CAT.IMG
- FRT000064D9_07_IF166L_TRR2_CAT_PHT.IMG
- FRT000064D9_07_IF166L_TRR2_CAT_PHT_ATM.IMG
- FRT000064D9_07_IF166L_TRR2_CAT_PHT_ATM_DST.IMG
- FRT000064D9_07_IF166L_TRR2_CAT_PHT_ATM_DST_DSP.IMG
- FRT000064D9_07_IF166L_TRR2_CAT_PHT_ATM_DST_DSP_SUM.IMG
- FRT000064D9_07_IF166L_TRR2_CAT_PHT_ATM_DST_DSP_PRJ.IMG
- FRT000064D9_07_DE166L_DDR1_GLT.IMG
- FRT000064D9_07_IF166L_TRR2_CAT_PHT_ATM_DST_DSP_REF.IMG

**CRISM TRR2 PDS IMG file**
- CRISM DDR1 PDS IMG file
- CAT (ENVI) format CRISM IMG data file
- Photometrically corrected version of the above
- Atmospherically corrected version of the above
- Destriped version of the above
- Despiked version of the above
- Spectral summary parameter cube calculated from the above
- Map projected version of the processed spectral data
- Custom geographic lookup table derived from the CRISM DDR
- Custom map projected version of the processed spectral data

CRISM PDS IMG files have accompanying label (LBL) files
CAT/ENVI IMG files have accompanying header (HDR) files
Walkthrough File List (2/2)

VNIR + IR IMG files:
FRT000064D9_07_IF166SL_TRR2_LST.IMG
Merged CRISM VNIR and IR processed spectral data
FRT000064D9_07_IF166SL_TRR2_LST_RAT.IMG
IR/VNIR merged ratio parameter

Ancillary files:
FRT000064D9_D2300.roi
Region of interest file for D2300 spectral investigation
FRT000064D9_LCPINDEX.roi
Region of interest file for LCPINDEX spectral investigation
FRT000064D9_D2300.sli
Spectral library file for D2300 spectral investigation
FRT000064D9_LCPINDEX.sli
Spectral library file for LCPINDEX spectral investigation
FRT000064D9_D2300.sta
Spectral statistics for D2300 target ROI
FRT000064D9_D2300_reference.sta
Spectral statistics for D2300 reference ROI
FRT000064D9_LCPINDEX.sta
Spectral statistics for LCPINDEX target ROI
FRT000064D9_LCPINDEX_reference.sta
Spectral statistics for LCPINDEX reference ROI
FRT000064D9_07_IF166L_TRR2.ann
Annotation file for map projected images
FRT000064D9_07_IF166L_TRR2.grd
Grid definition file for map projected images

ENVI spectral library files have accompanying header (HDR) files
CRISM TRR3 Data Filtering Preview

FRT000064D9_07_IF166L_TRR2.IMG

FRT000064D9_07_IF166L_TRR2_IKF.IMG