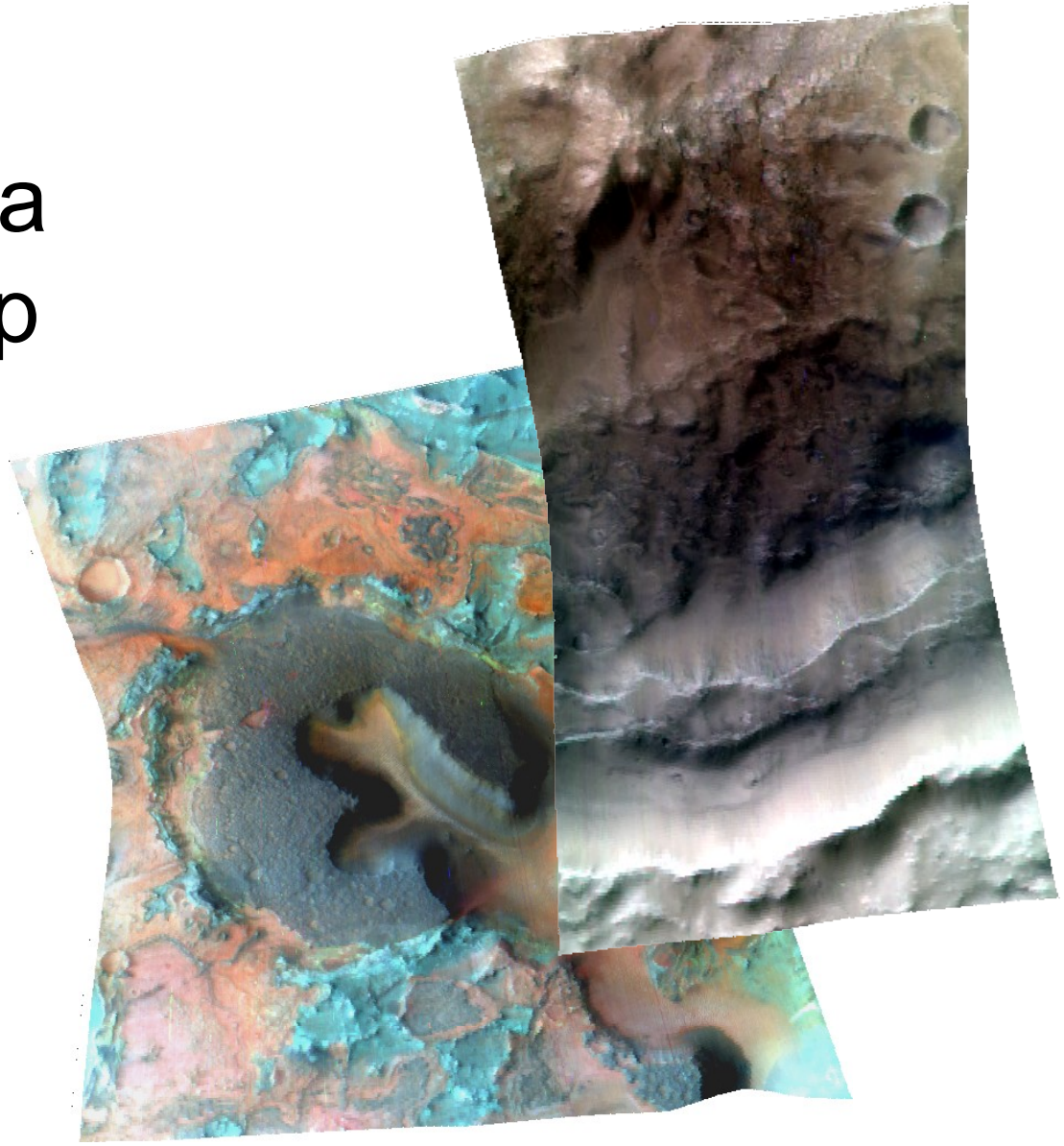
Finding your data with CRISM-map

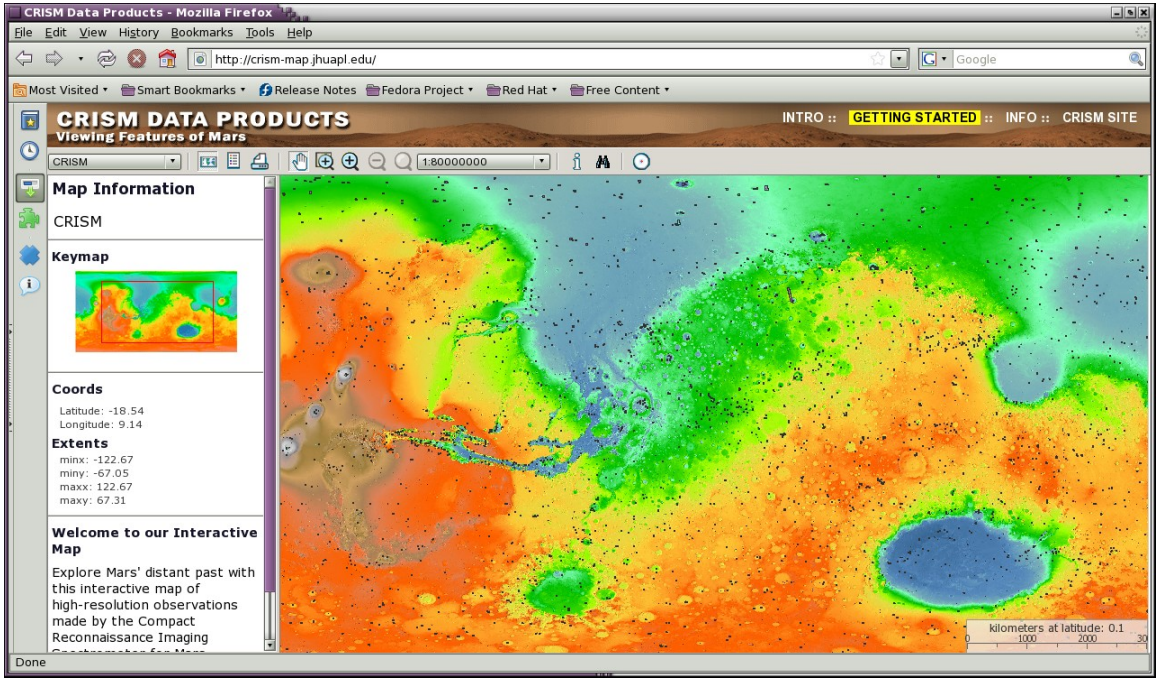


CRISM workshop

March 22, 2009

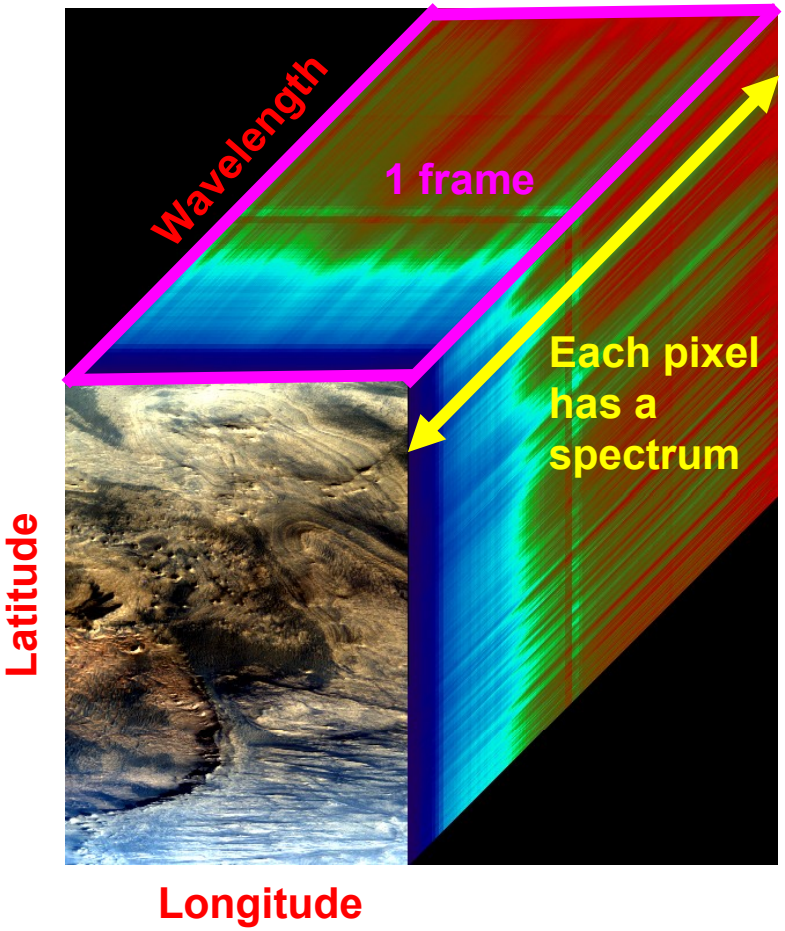
CRISM-map web site

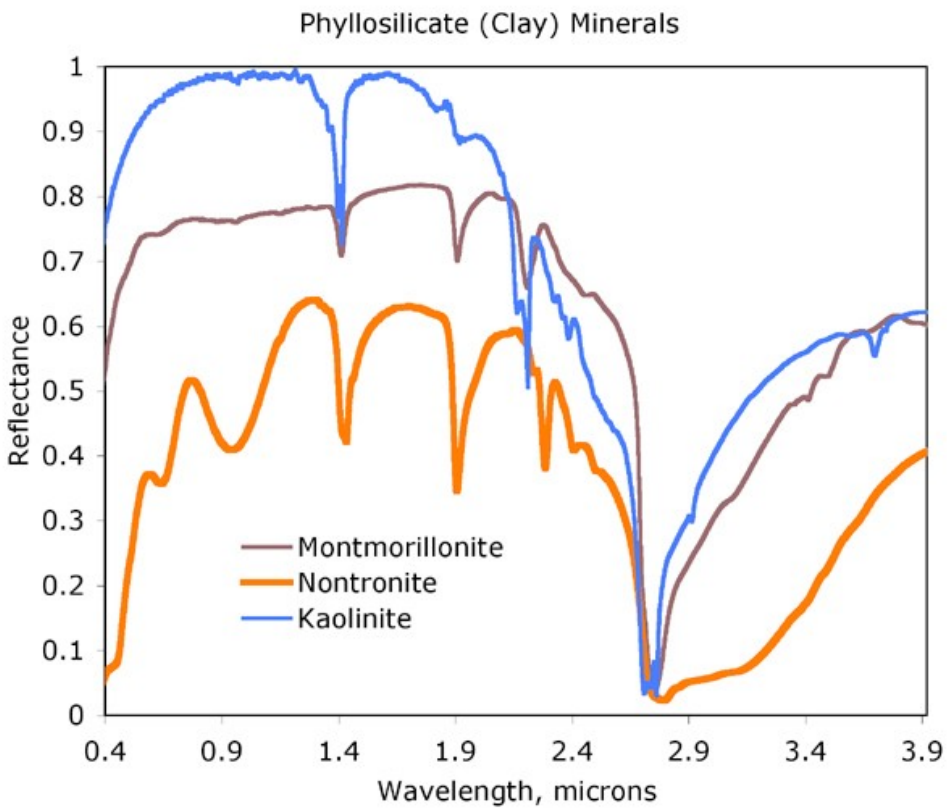
- Great tool to find exciting CRISM observations
  - Possesses all targeted CRISM data delivered to PDS
    - Uses browse products for rapidly identifying and briefly assessing an observation
      - **But not sufficient for mineral identification**
        - » Typical requires more detailed spectral analyses
    - Links to processed CRISM data and HIRISE and CTX images in coordinated observations



Url: http://crism-map.jhuapl.edu

CRISM – What the data looks like





A single image is taken in 544 colors

Each pixel has a spectrum that can be compared with "fingerprints" of different minerals.

CRISM – Raw Data

S Detector - VNIR

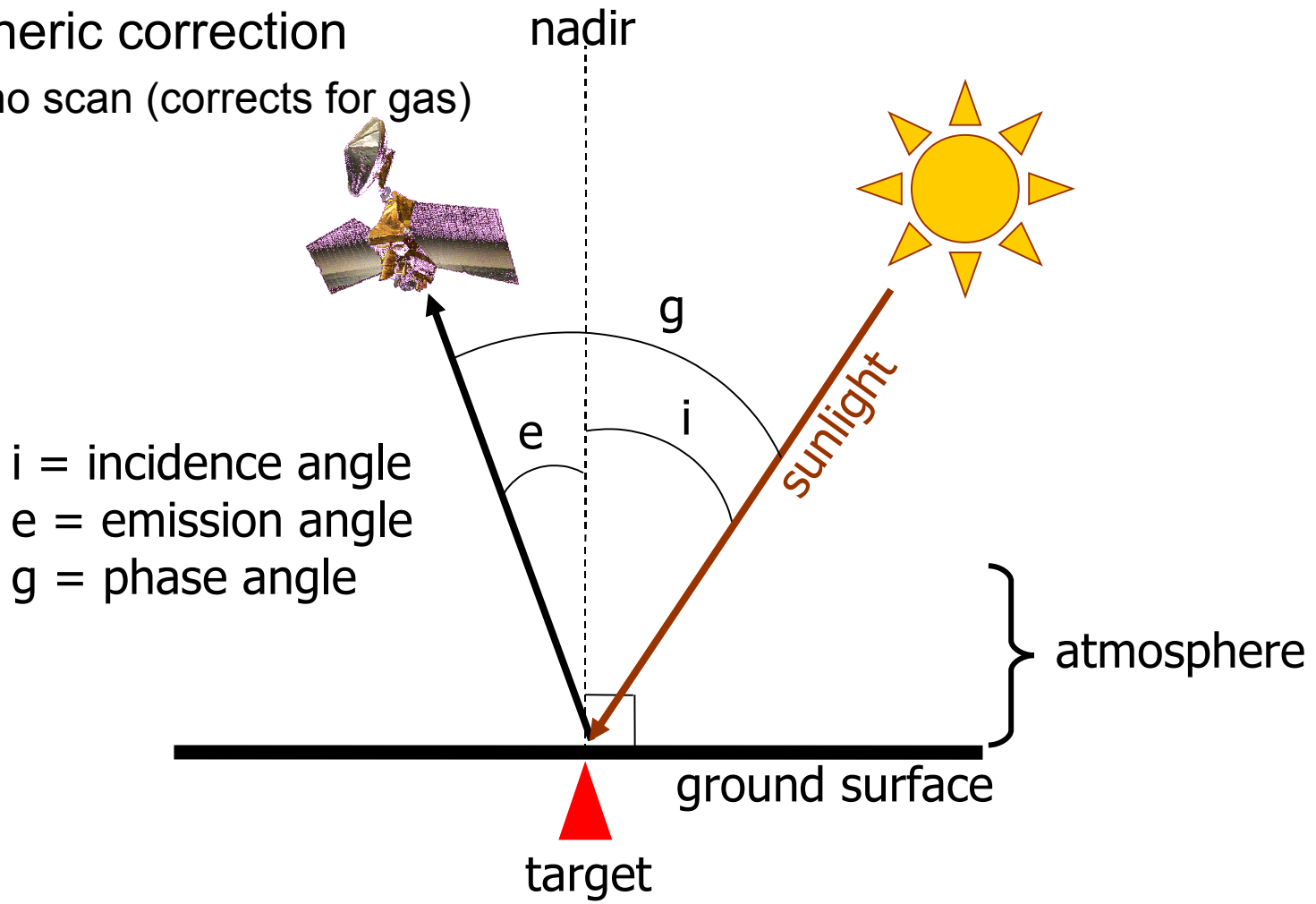
L Detector - IR

R=0.71 µm
G=0.60 µm
B=0.53 µm

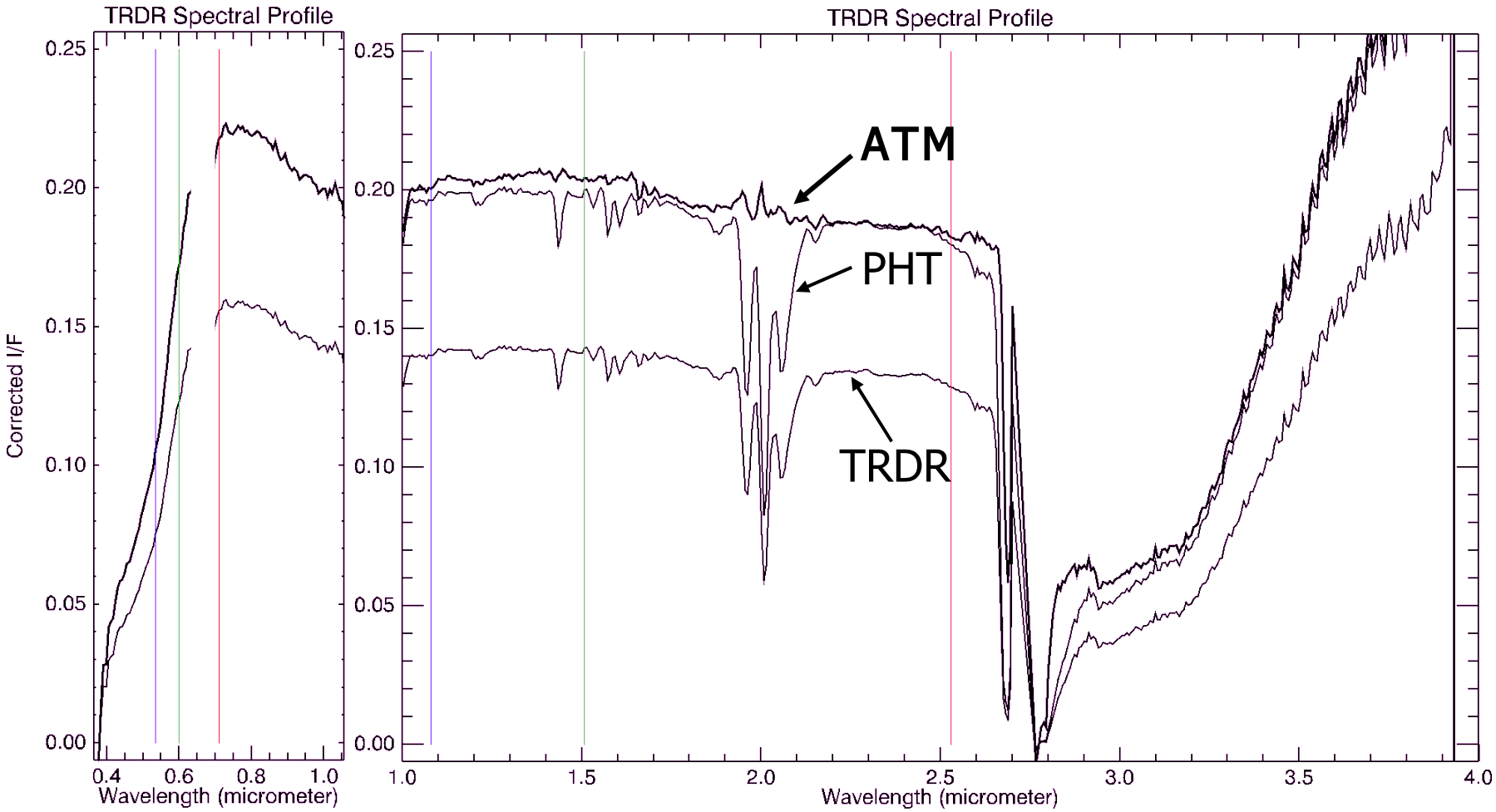
R=2.53 µm
G=1.51 µm
B=1.08 µm

How do we turn the raw data into browse products and what do they tell us?

- Instrument calibration
- Standardize observation geometry
  - Photometric correction (1/cos [i])
- Atmospheric correction
  - Volcano scan (corrects for gas)



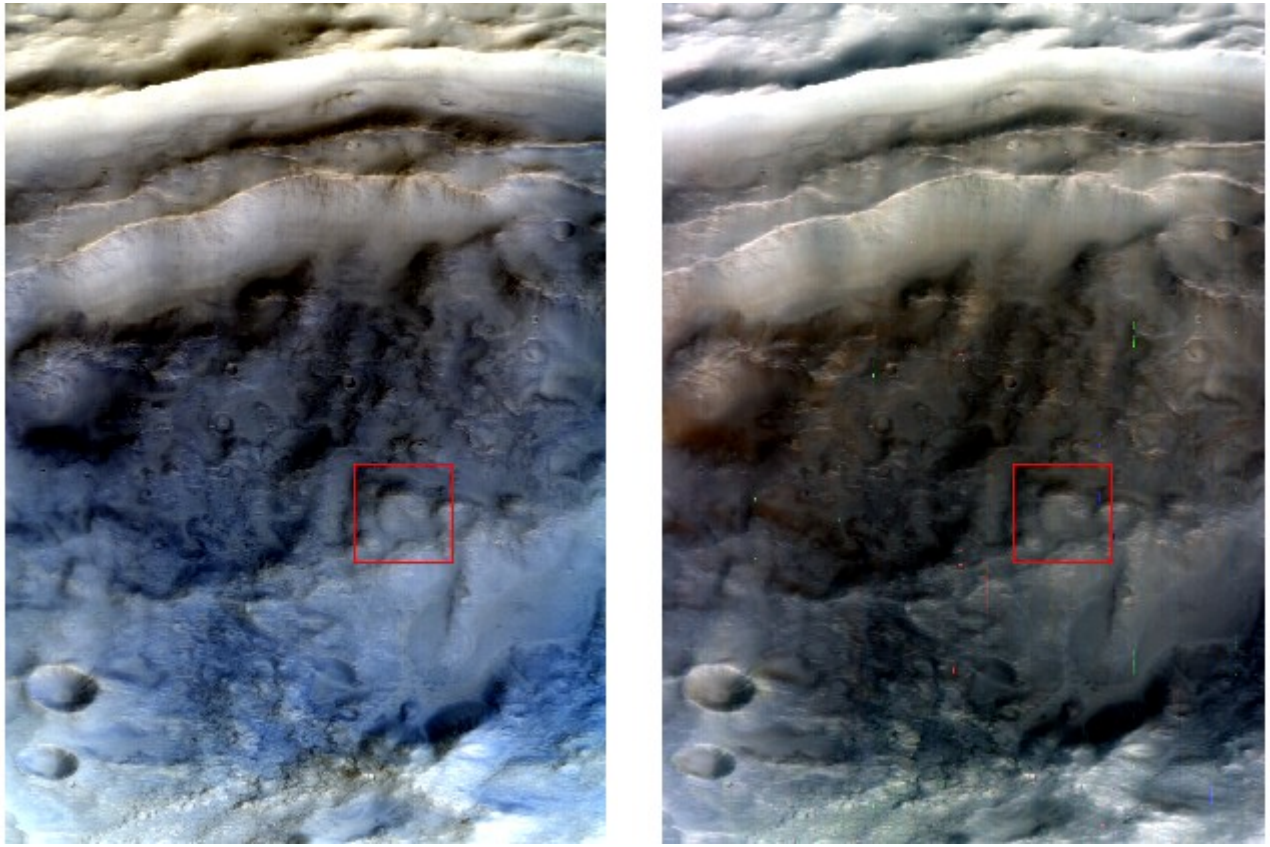
The influence on spectra - from Raw to Atm corrected



CRISM – Resulting image

S Detector - VNIR

L Detector - IR

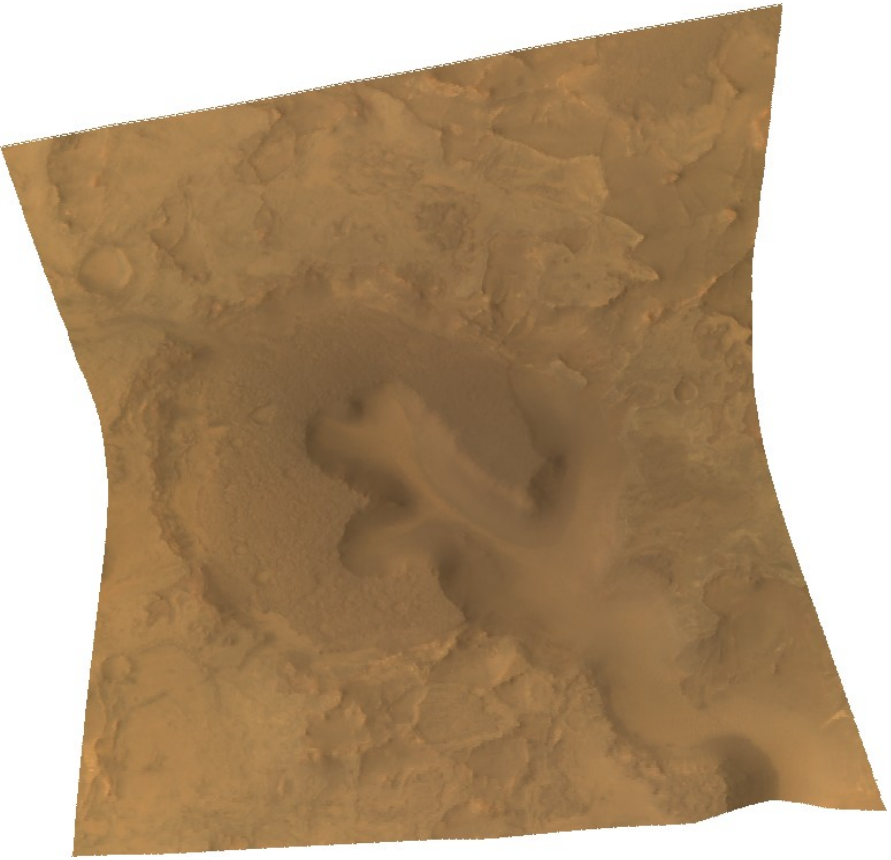


R=0.71 μm
G=0.60 μm
B=0.53 μm

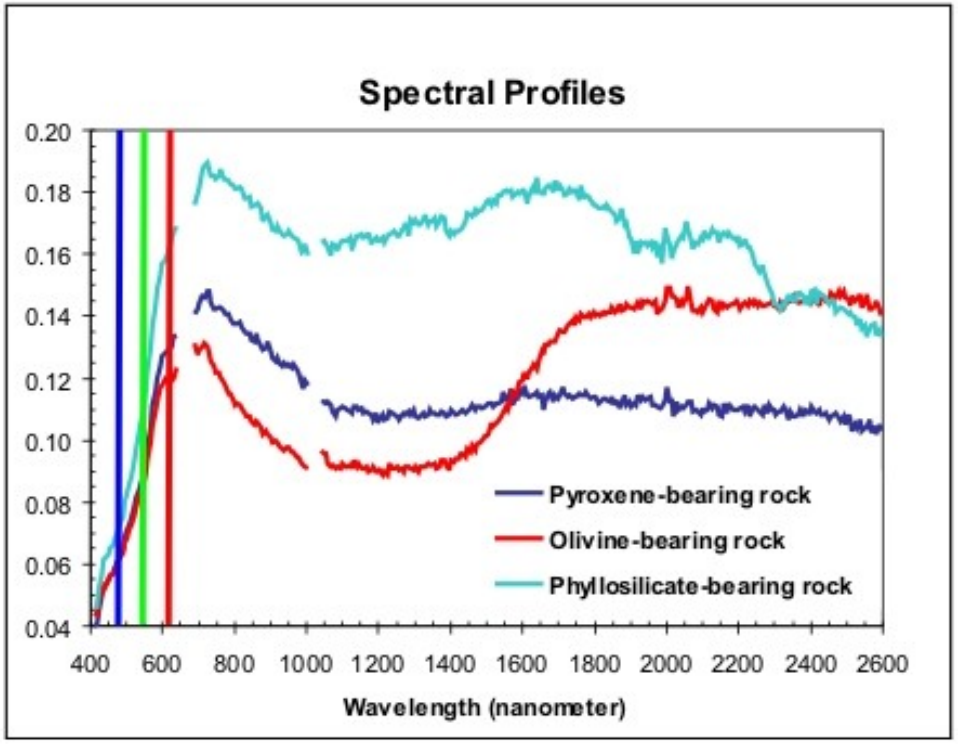
R=2.53 μm
G=1.51 μm
B=1.08 μm

NOTE: Browse products are crudely destriped only

CRISM - Analysis

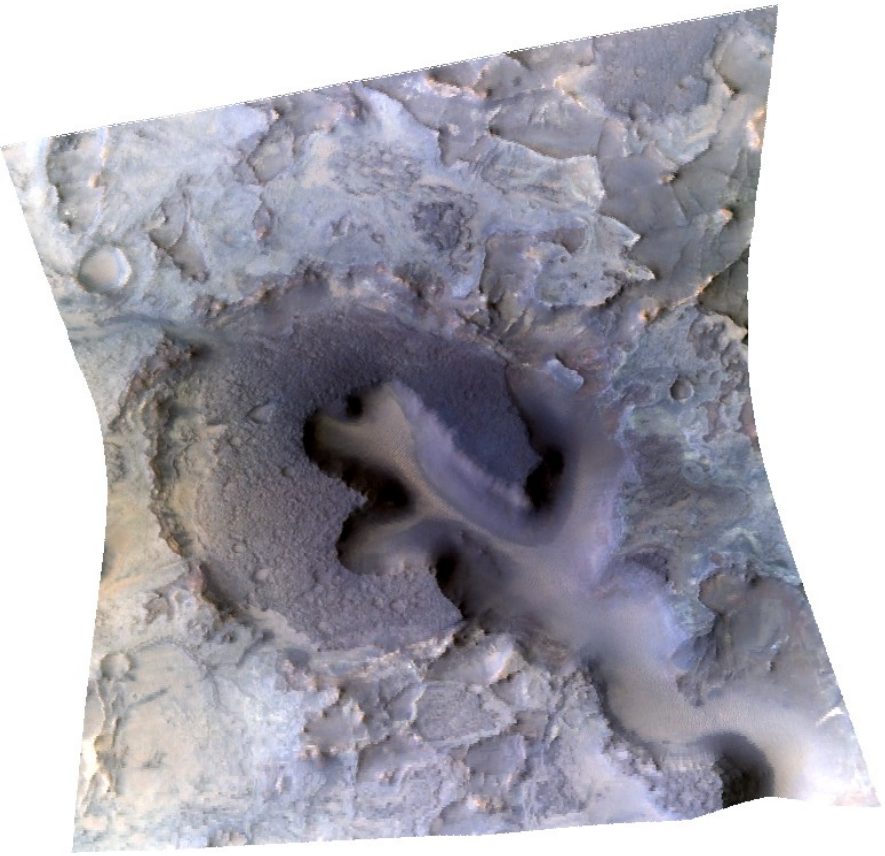


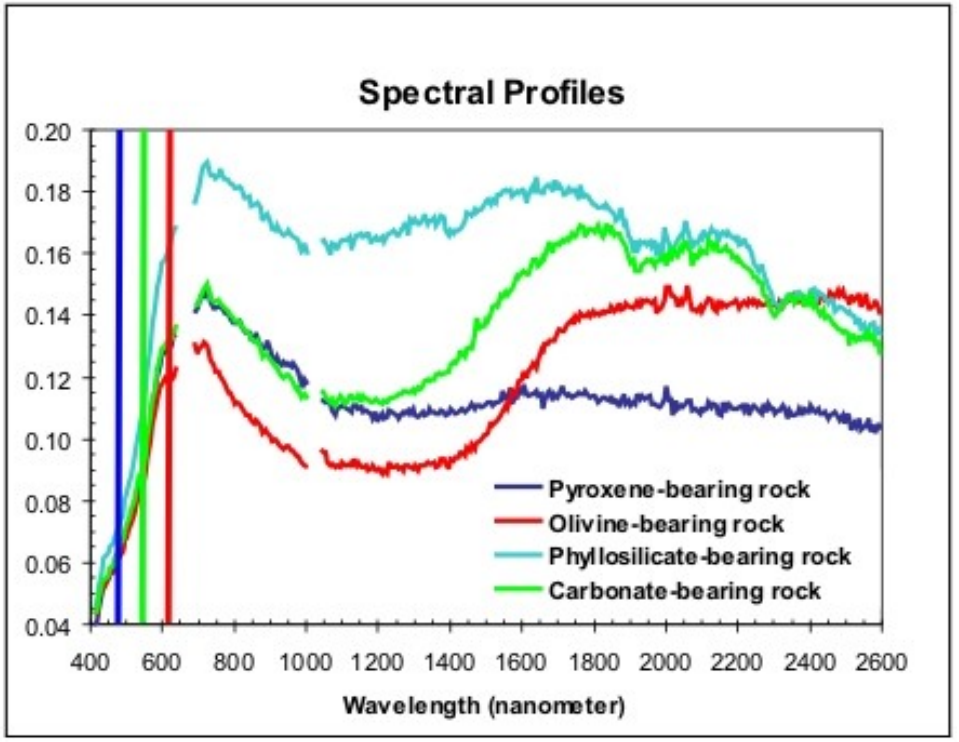
This is how part of the Martian highlands looks to the human eye. The image was taken Jan. 12, 2007.



The spectrum shows that olivine, pyroxene, and clay are present, but at visible wavelengths everything is dominated by red iron oxides.

CRISM - Analysis

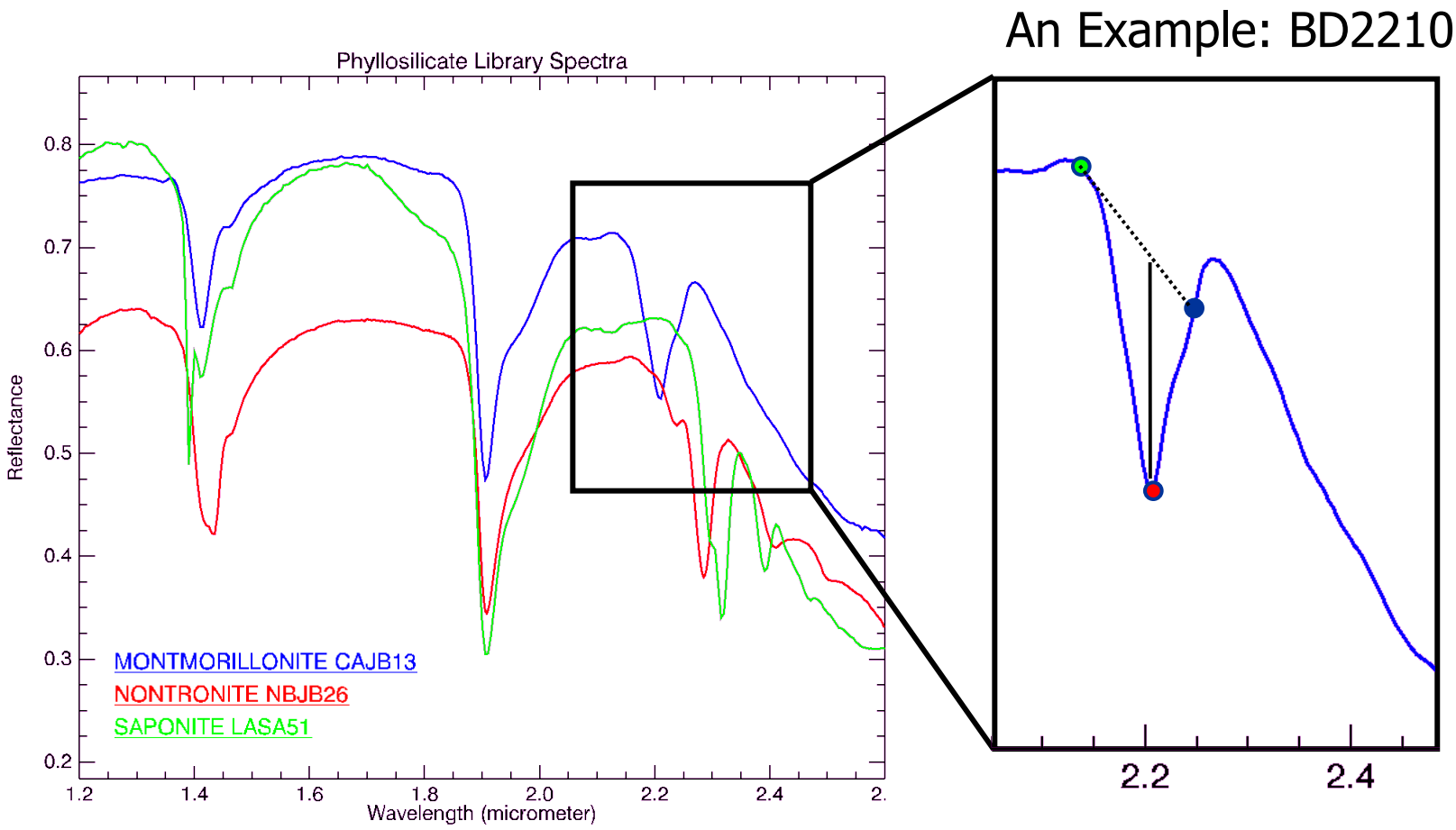




Computer enhancement can bring out subtle color differences, but still the scene is blanketed by red iron oxides that hide the underlying rocks.

CRISM – Use of summary parameters

Facilitates finding certain mineral absorptions



Summary Parameter Composites (Browse Products)

OLINDEX

0 - 0.03

1µm spectral shape and band position keyed to fayalite

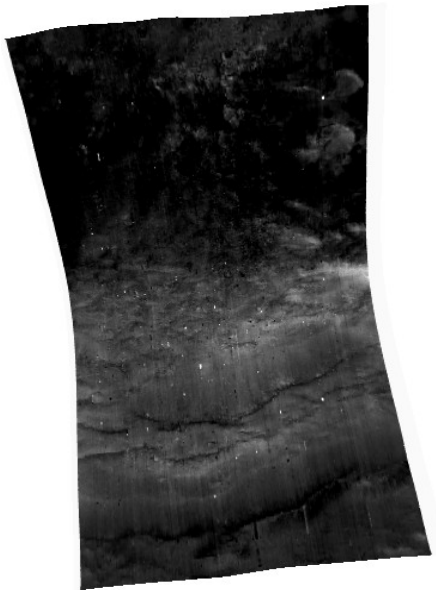
+

LCPINDEX

0 - 0.1

1 and 2µm spectral shape and band position keyed low-calcium pyroxene

+

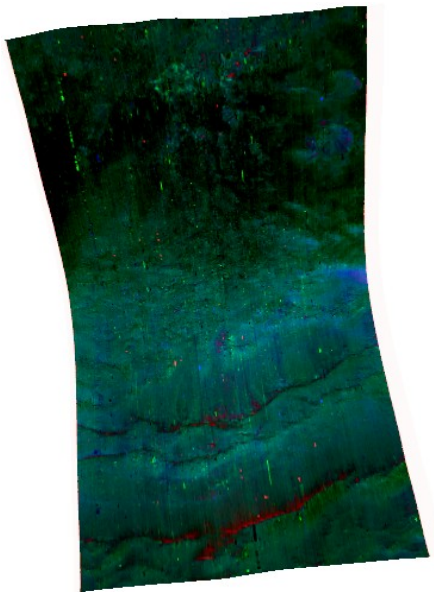


HCPINDEX

0 - 0.15

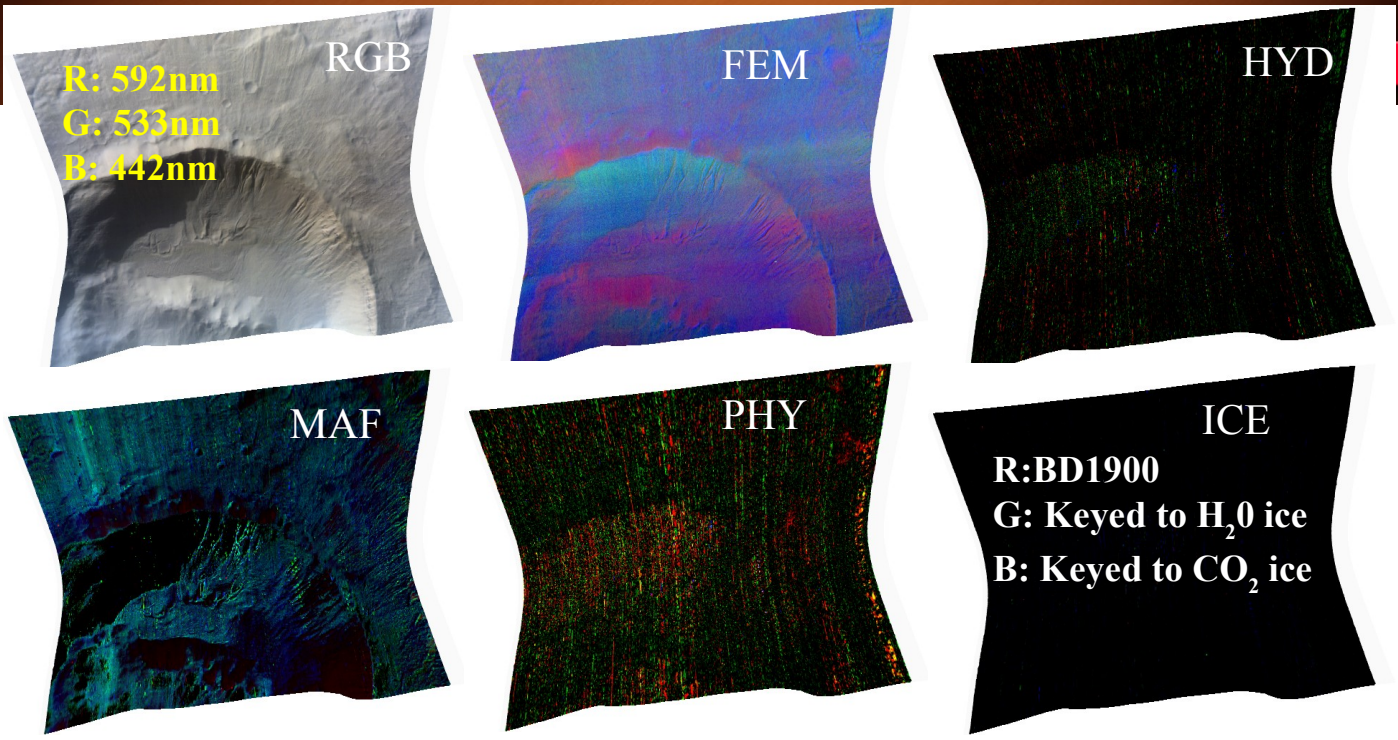
1 and 2µm spectral shape and band position keyed to high calcium pyroxene

=



MAF

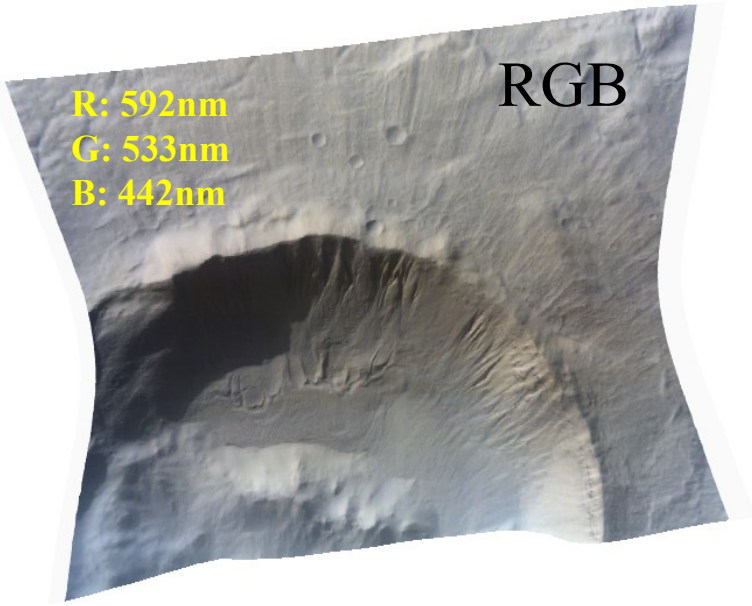
Browse products on crism-map

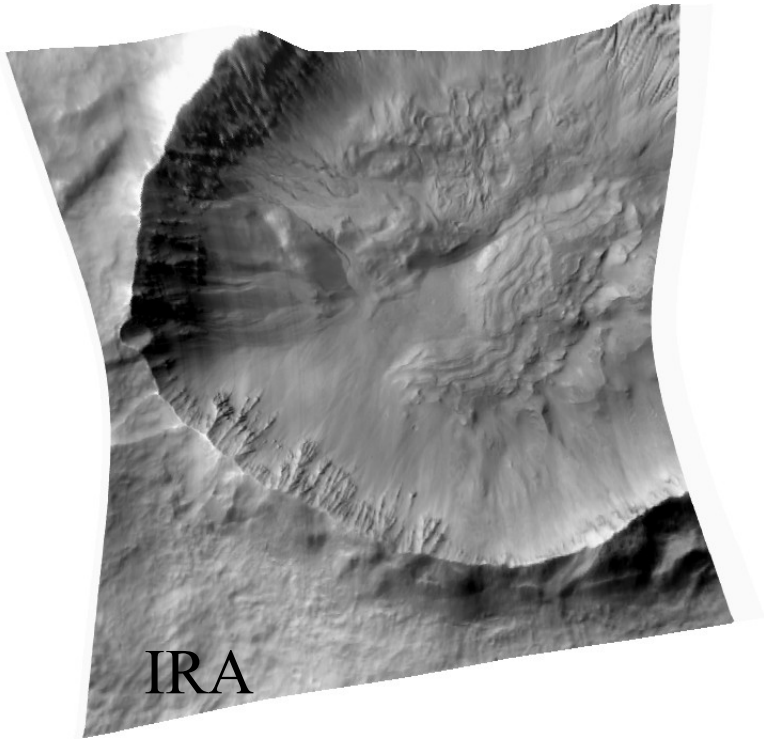


- Surface brigthness provided by VNIR RGB and IR IRA
  - Visible RGB and Infrared albedo
- Compositional information is concentrated in VNIR FEM, and IR MAF, PHY and HYD
- Water of CO2 ice is concentrated in IR ICE
- Beware – all are susceptible to detector, incidence angle, surface slopes, shade and atmospheric lighting condition

Browse products on crism-map

- Surface brightness and geological context
  - Visible RGB image
    - R = 592nm G = 533 nm B = 442 nm
    - Stretched over full dynamic range of data
  - Infrared albedo
    - 1300nm albedo – takes advantage of hyperspectral character of data to reduce noise
    - Stretched over full dynamic range of data

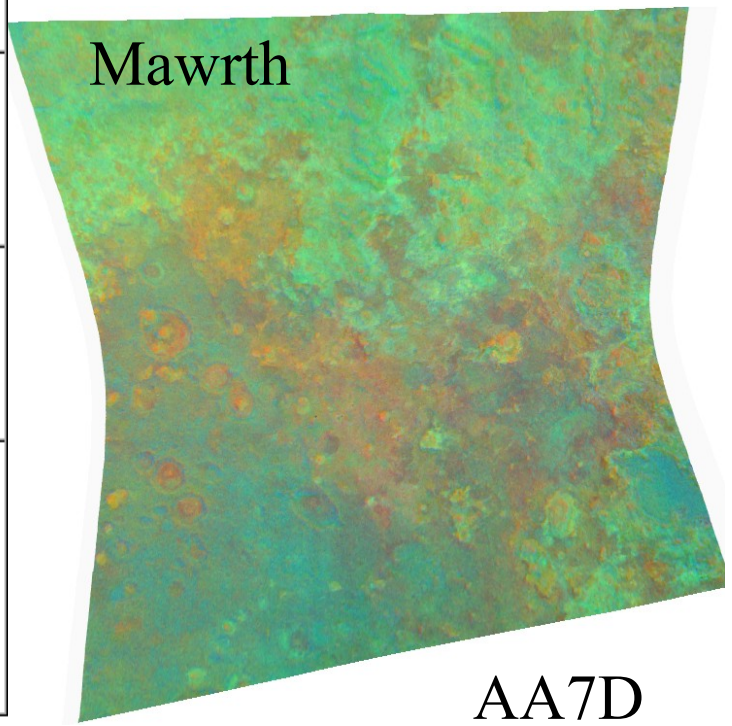




FEM – browse product

- VNIR FEM provides information related to iron minerals
- Good for finding significant dust coverage
  - High red content throughout the scene – indicates significant dust coverage
  - More green and bluer the cleaner the scene.

Channel	Parameter	Scaling	Significance	Cautions
Red	Depth of 530-nm band; relative to a continuum between 440 and 709 nm (BD530*)	0.00-0.17 to 0-250	Higher values indicate greater content or larger particle size of some fine-grained oxidized iron minerals	Higher values also occur where the atmosphere is dusty, or where dusty atmosphere overlies shadowed slopes
Green	Height of inflection at 600 nm; relative to a continuum between 440 and 709 nm (SH600*)	0.10-0.17 to 0-250	Higher values correlated with coatings or rinds present on rocks, and with some crystalline ferric oxides	Higher values also occur in hazy atmosphere, over shaded slopes, where there is a high solar incidence angle, and over ice
Blue	Integrated area in 1-micron band; from 830-1023 nm, relative to a flat continuum tangent to the reflectance peak near 750 nm (BDI1000VIS*)	0.000-0.025 to 0-250	Higher values indicate greater content or larger particle size of iron minerals, especially olivine and pyroxene	Weakly sensitive to crystalline ferric oxides

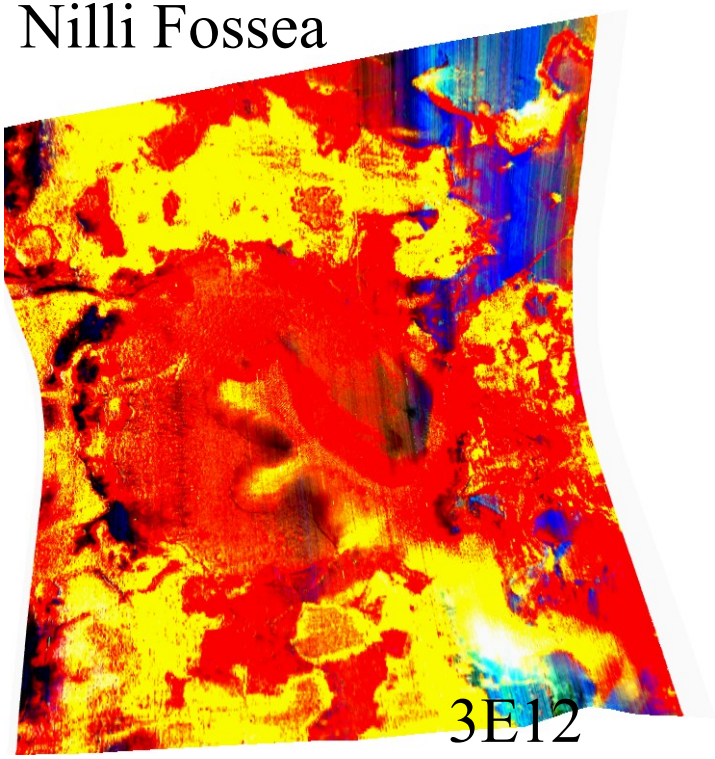


MAF – browse product

- IR MAF provides information related to mineralogy of iron-containing minerals
  - Unaltered igneous minerals such as olivine and pyroxene
  - Altered minerals including iron-rich phyllosilicates

Channel	Parameter Description and Name	Scaling	Significance	Cautions
Red	Olivine index; measures brightness at 1695 nm relative to a weighted average at 1080-1470 nm (OLINDEX*)	0.00-0.13 to 0-250	Higher values indicate greater content or larger particle size of olivine or iron-containing phyllosilicates	Dusty regions or atmospheric dust (both of which can be recognized in vnir_fem) may cause elevated values. Higher values can also result from illumination effects on sunward slopes
Green	Low-calcium pyroxene index; measures brightness contrast at 1080 and 2067 nm relative to 1330 nm (LCPINDEX*)	0.0-0.1 to 0-250	Higher values indicate greater content or larger particle size of pyroxene; favors low-Ca pyroxene	Higher values can also result from illumination effects on shaded slopes
Blue	High-calcium pyroxene index; measures brightness contrast at 1080 and 2067 nm relative to 1470 nm Å (HCPINDEX*)	0.0-0.2 to 0-250	Higher values indicate greater content or larger particle size of pyroxene; favors high-Ca pyroxene	Weakly sensitive to ice

Nilli Fossea



PHY – browse product

- IR PHY provides information related to hydroxylated minerals including phyllosilicates

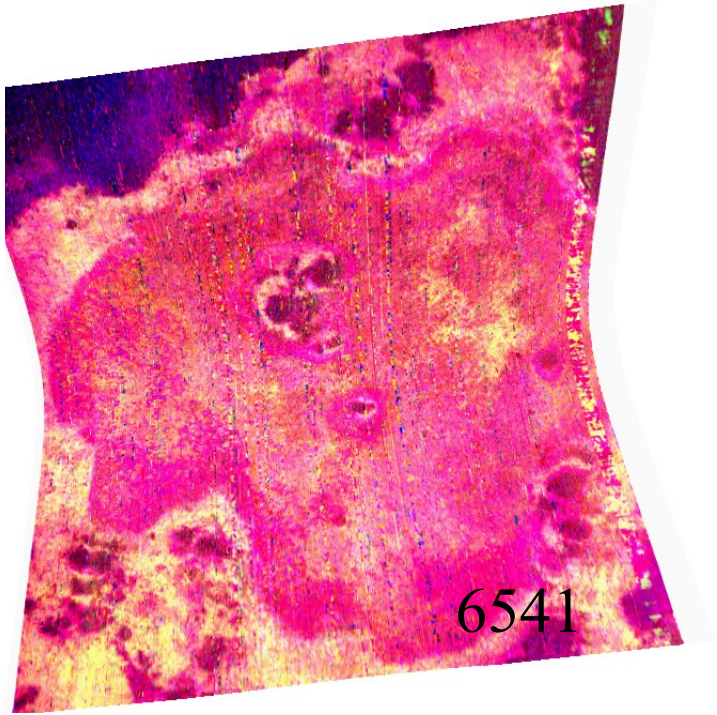
Channel	Parameter Description and Name	Scaling	Significance	Cautions
Red	Index for presence of Fe-OH and Mg-OH containing minerals; measures brightness around 2320 nm relative to 2170 nm (D2300*)	0.005-0.020 to 0-250	Higher values indicate greater content or larger particle size of iron/magnesium phyllosilicates	Weakly sensitive to shaded slopes and strong brightness boundaries. Intermittent detector artifacts at edges of images
Green	Depth of 2210-nm band due to Al-OH or Si-OH in minerals; relative to a continuum between Â 2140 and 2250 nm (BD2210*)	0.005-0.020 to 0-250	Higher values indicate greater content or larger particle size of aluminum phyllosilicates or hydrated silica	Weakly sensitive to shaded slopes and strong brightness boundaries. Intermittent detector artifacts at edges of images
Blue	Depth of 1900-nm band due to bound water; relative to a continuum between 1874 and 2006 nm (BD1900*)	0.01-0.04 to 0-250	Higher values indicate greater content or larger particle size of hydrated minerals	Also sensitive to water ice surface frost or atmospheric hazes that are accentuated at low solar incidence angles

HYD – browse product

- IR HYD provides information related to bound water in minerals, usually sulfates but in some cases phyllosilicates, hydrated glass, or other minerals

Channel	Parameter Description and Name	Scaling	Significance	Cautions
Red	"Sulfate" index, a measure of bound water or ice; measures the drop in reflectance from near 2300 nm to near 2400 nm (SINDEX*)	0.00-0.03 to 0-250	Higher values indicate greater content or larger particle size of minerals or glasses with bound, dissolved, or adsorbed molecular water, especially sulfates	This parameter is sensitive to water ice and to dust and atmospheric ice hazes that are accentuated at low solar incidence angles
Green	Depth of 2100-nm band in monohydrated sulfates; relative to a continuum between 1930 and 2250 nm (BD2100*)	0.01-0.04 to 0-250	Higher values indicate greater content or larger particle size of monohydrated sulfates	Also sensitive to water ice surface frost or atmospheric hazes that are accentuated at low solar incidence angles
Blue	Depth of 1900-nm band due to bound water; relative to a continuum between 1874 and 2006 nm (BD1900*)	0.01-0.04 to 0-250	Higher values indicate greater content or larger particle size of hydrated minerals	Also sensitive to water ice surface frost or atmospheric hazes that are accentuated at low solar incidence angles

Meridiani

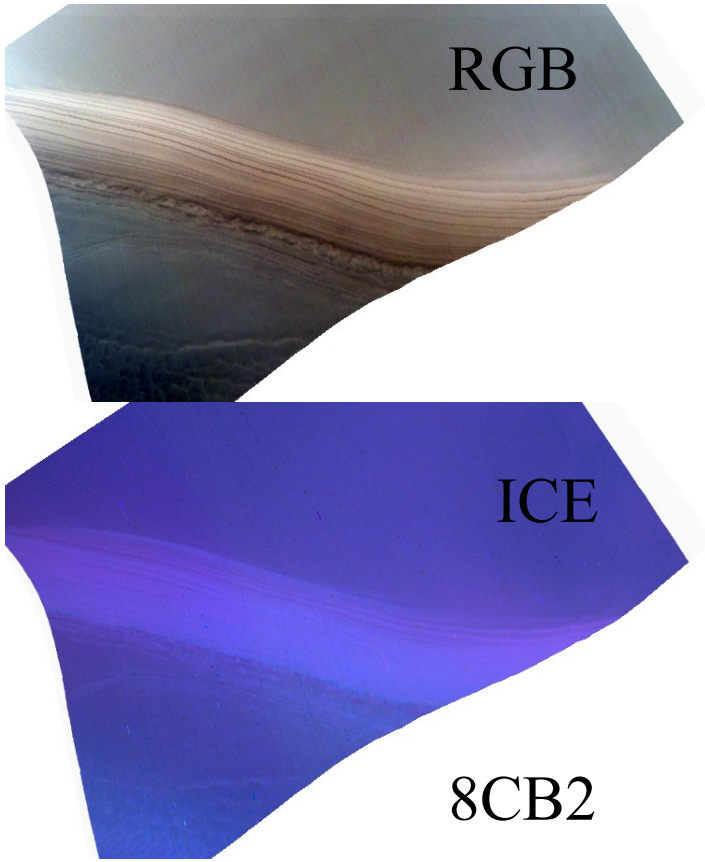


ICE – browse product

- IR ICE provides information related to water or carbon dioxide frost or ice.

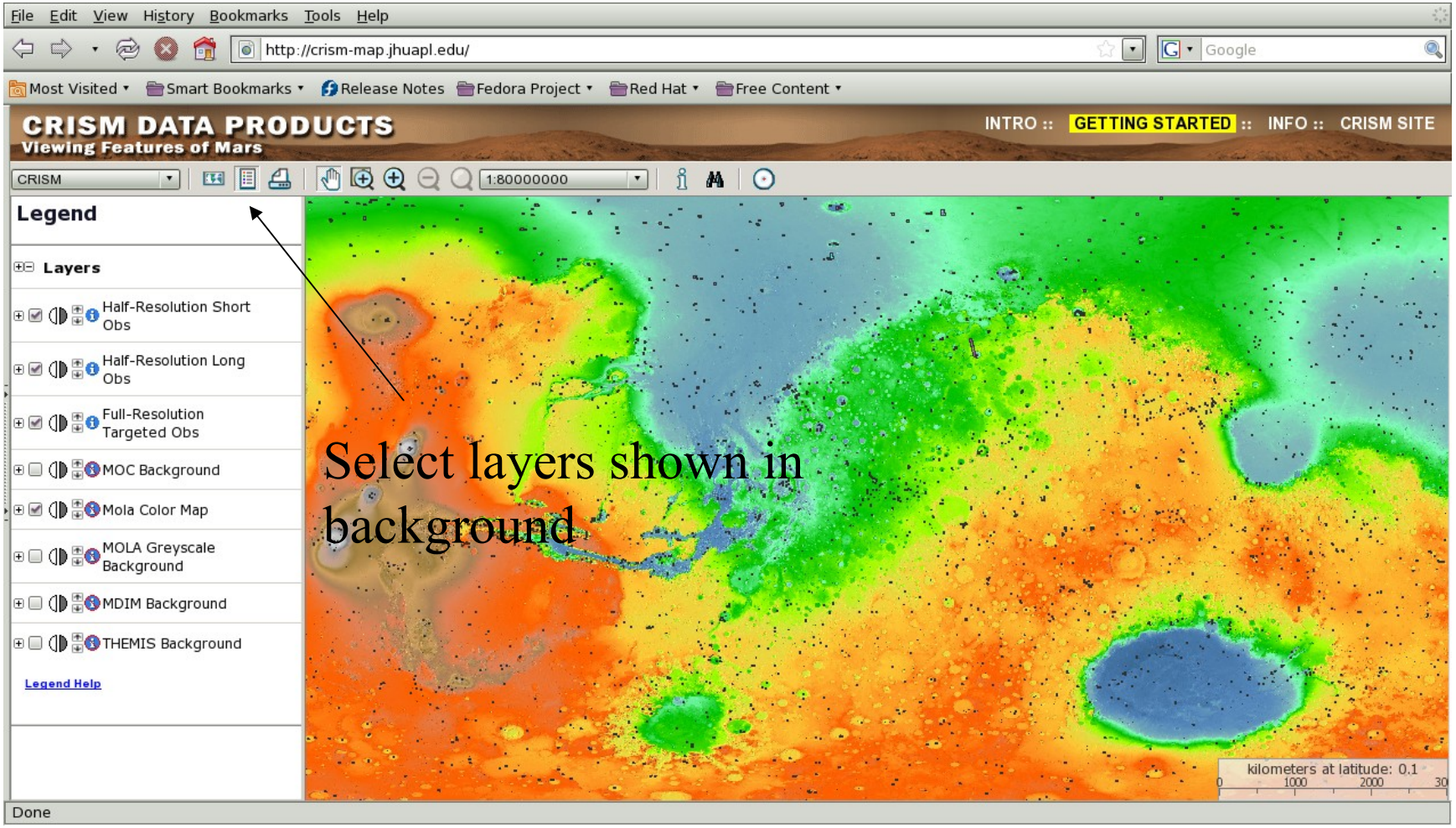
Channel	Parameter Description and Name	Scaling	Significance	Cautions
Red	1900-nm band depth, (BD1900*)	0.0-0.4 to 0-250	Leveraged for its sensitivity to water ice on the surface	Also sensitive to hydrated minerals and atmospheric water ice hazes
Green	Depth of 1500-nm band due to water ice; relative to a continuum between 1367 and 1808 nm (BD1500*)	0.00-0.65 to 0-250	Higher values indicate greater content or larger particle size of water ice frost	Also weakly sensitive to atmospheric water ice hazes that are accentuated at low solar incidence angles
Blue	Depth of 1435-nm band due to CO2 ice; relative to a continuum between 1370 and 1470 nm (BD1435*)	0.00-0.35 to 0.250	Higher values indicate greater content or larger particle size of carbon dioxide ice	Weakly sensitive to hydroxylated minerals including phyllosilicates

North Polar cap



Navigating CRISM-map to find useful observations

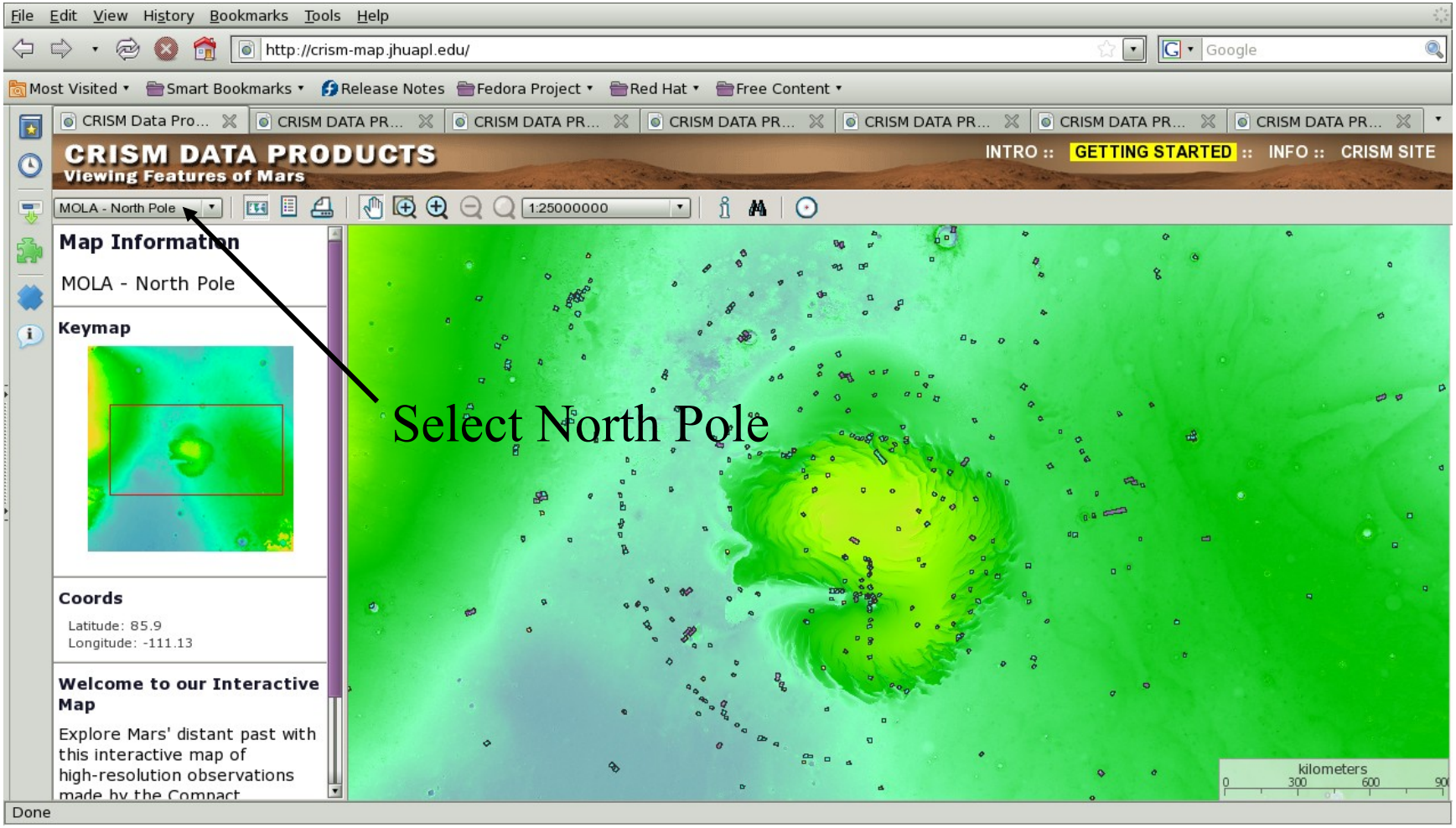
Each black spot is a CRISM targeted observation



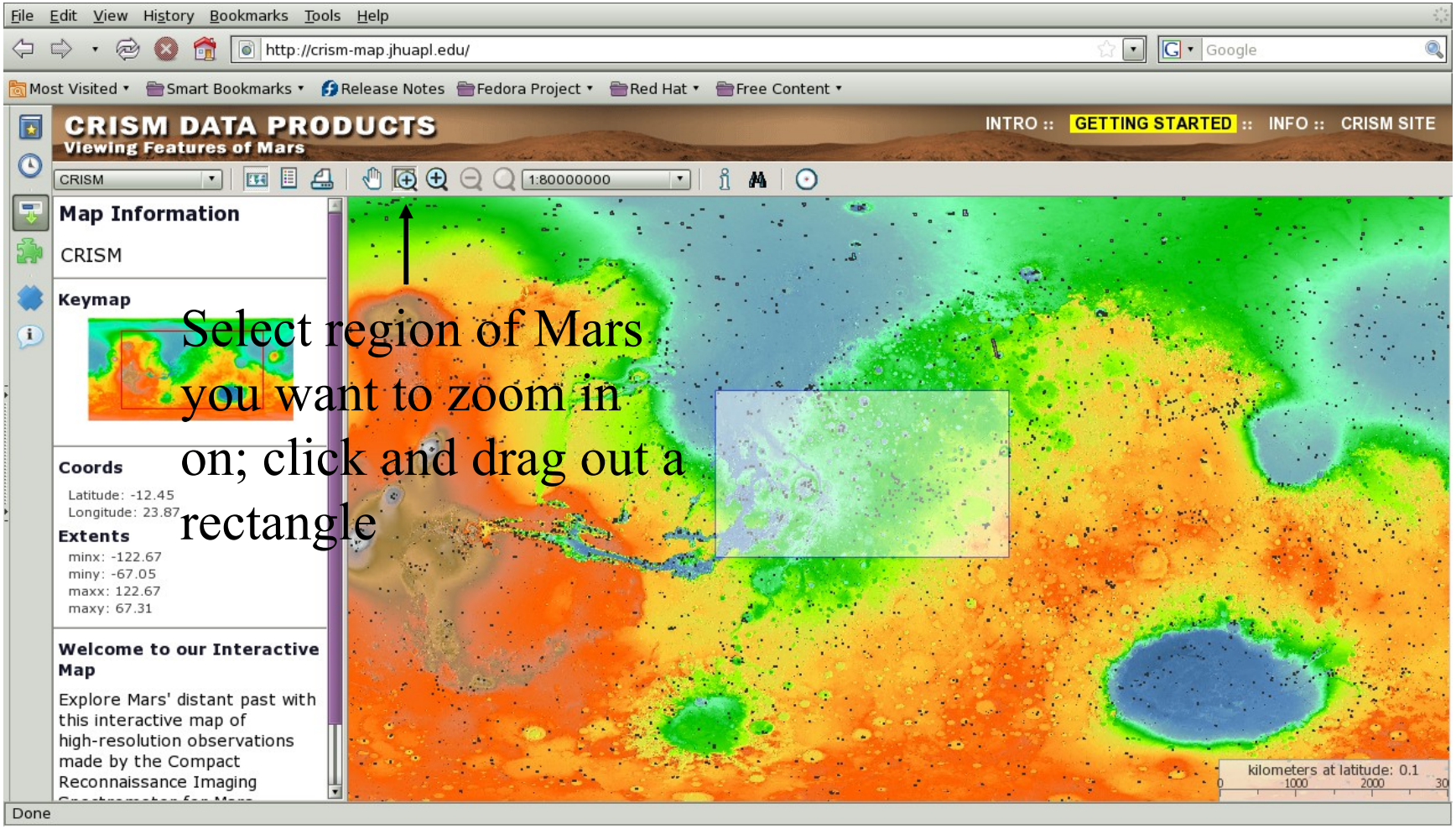
Three types of targeted observations - FRT, HRS and HRL

Navigating CRISM - Interested in the pole?

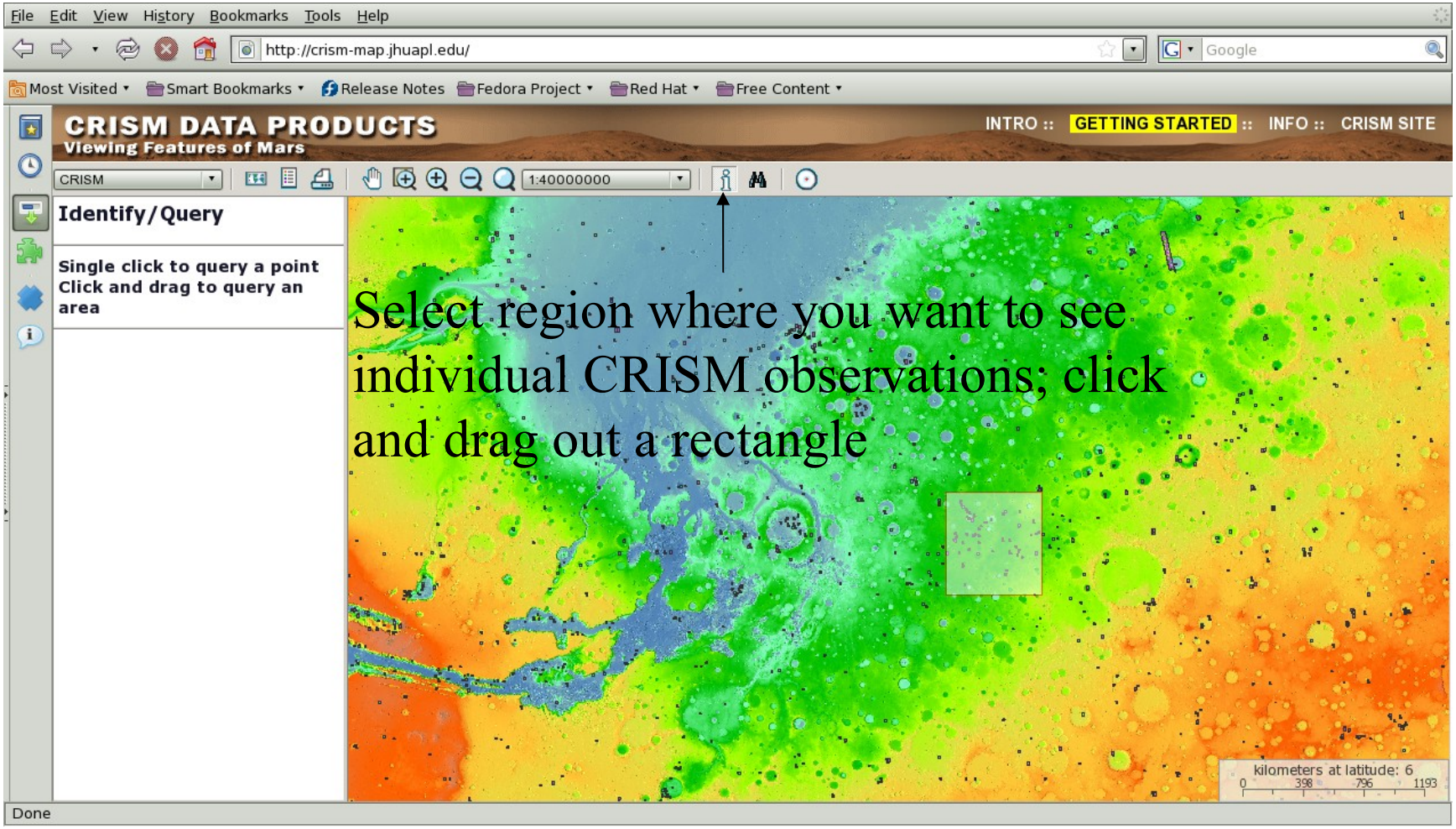
Each black spot is a CRISM targeted observation



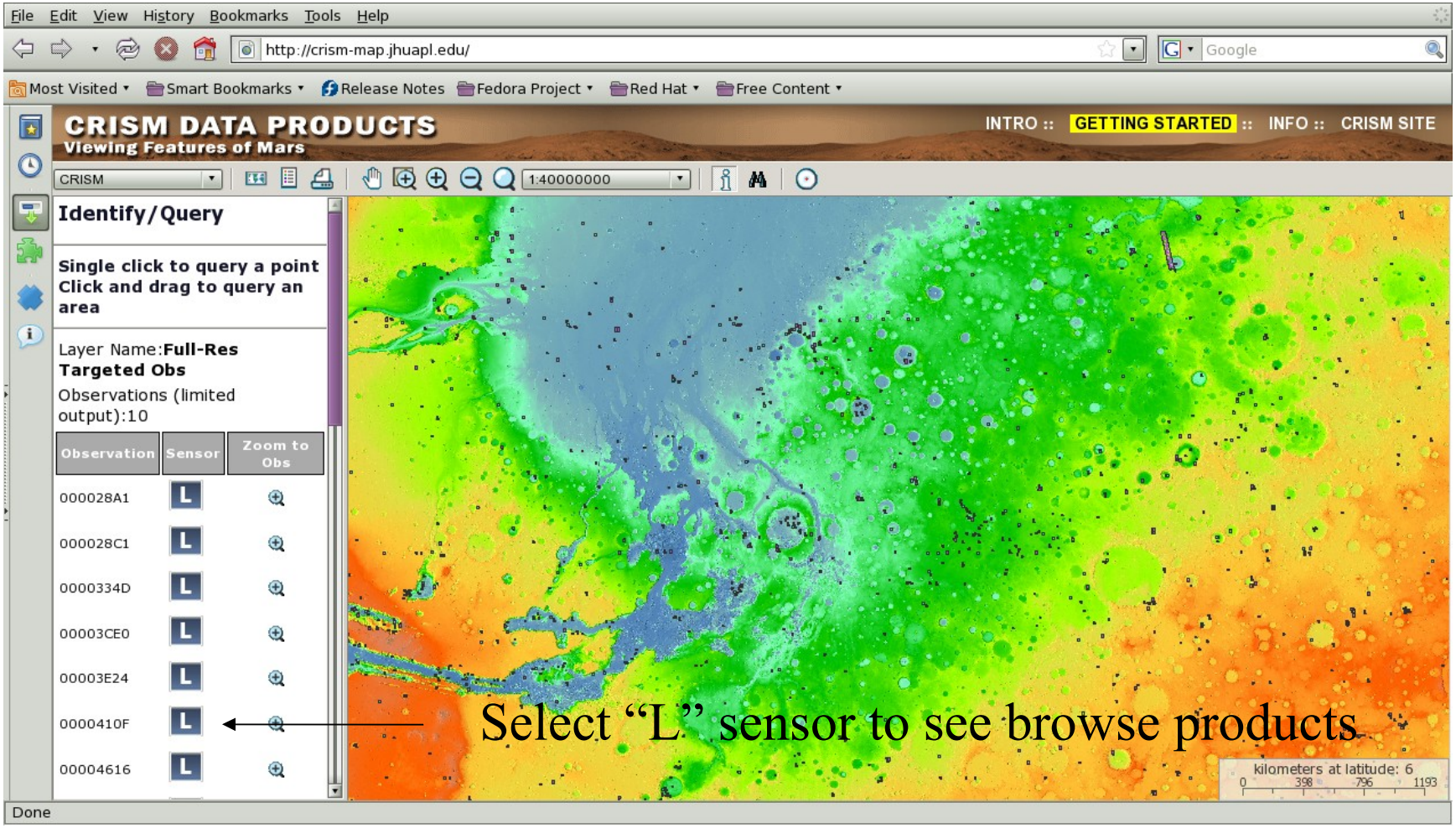
Zooming in onto a region of interest



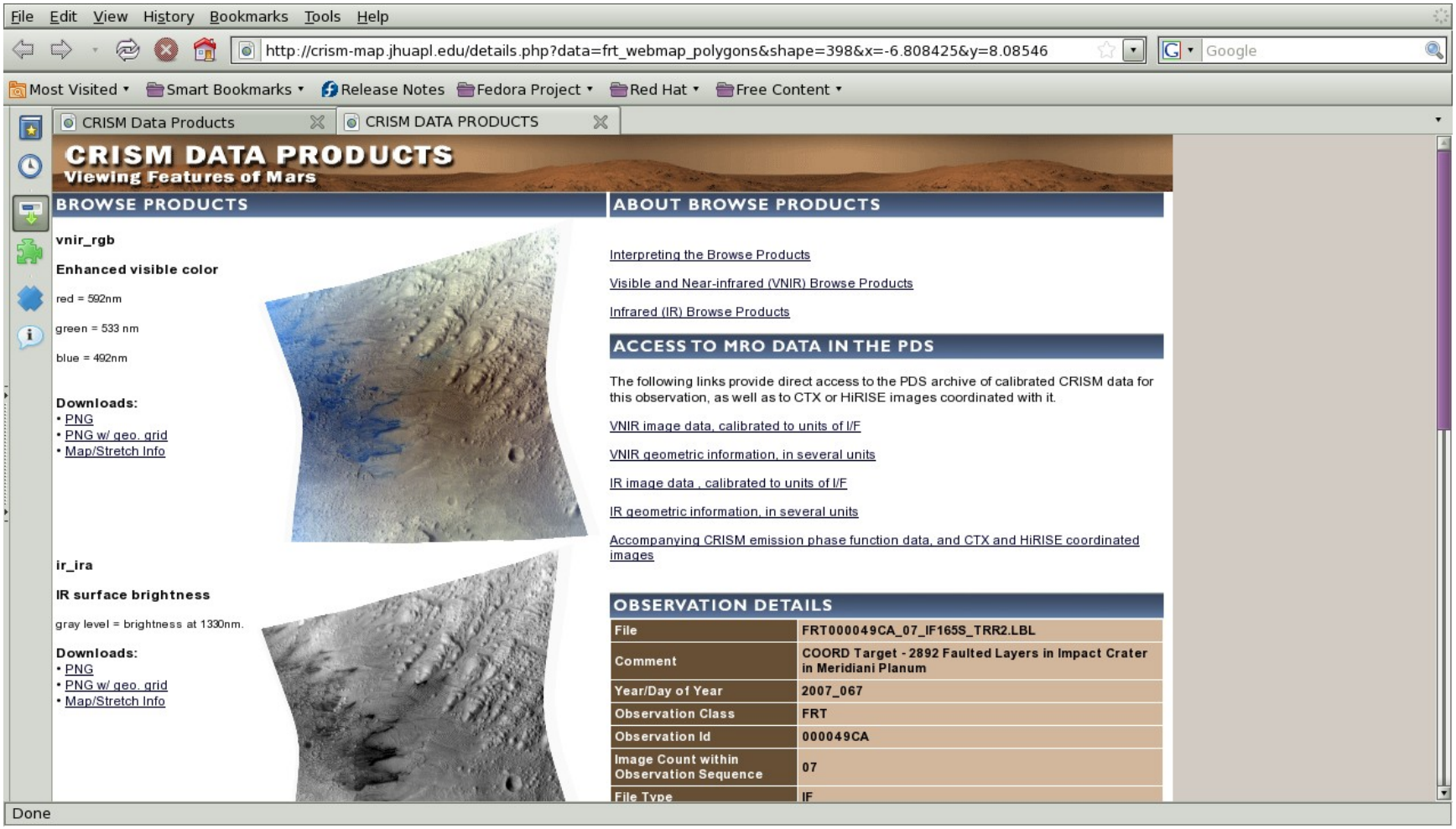
Finding images in an area



List of images in area



CRISM Each individual observation web page



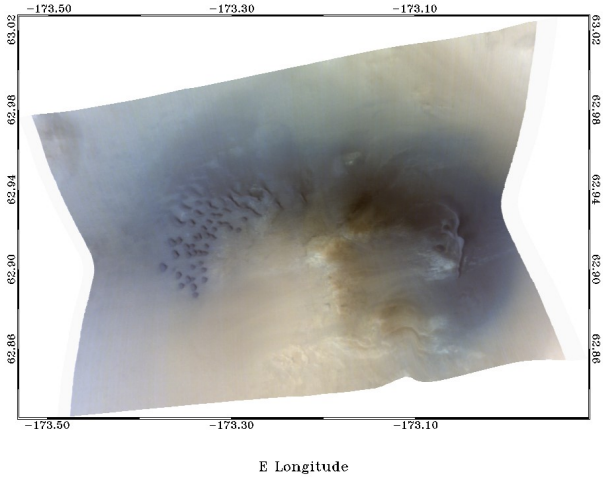
Observation 49CA

Web page features

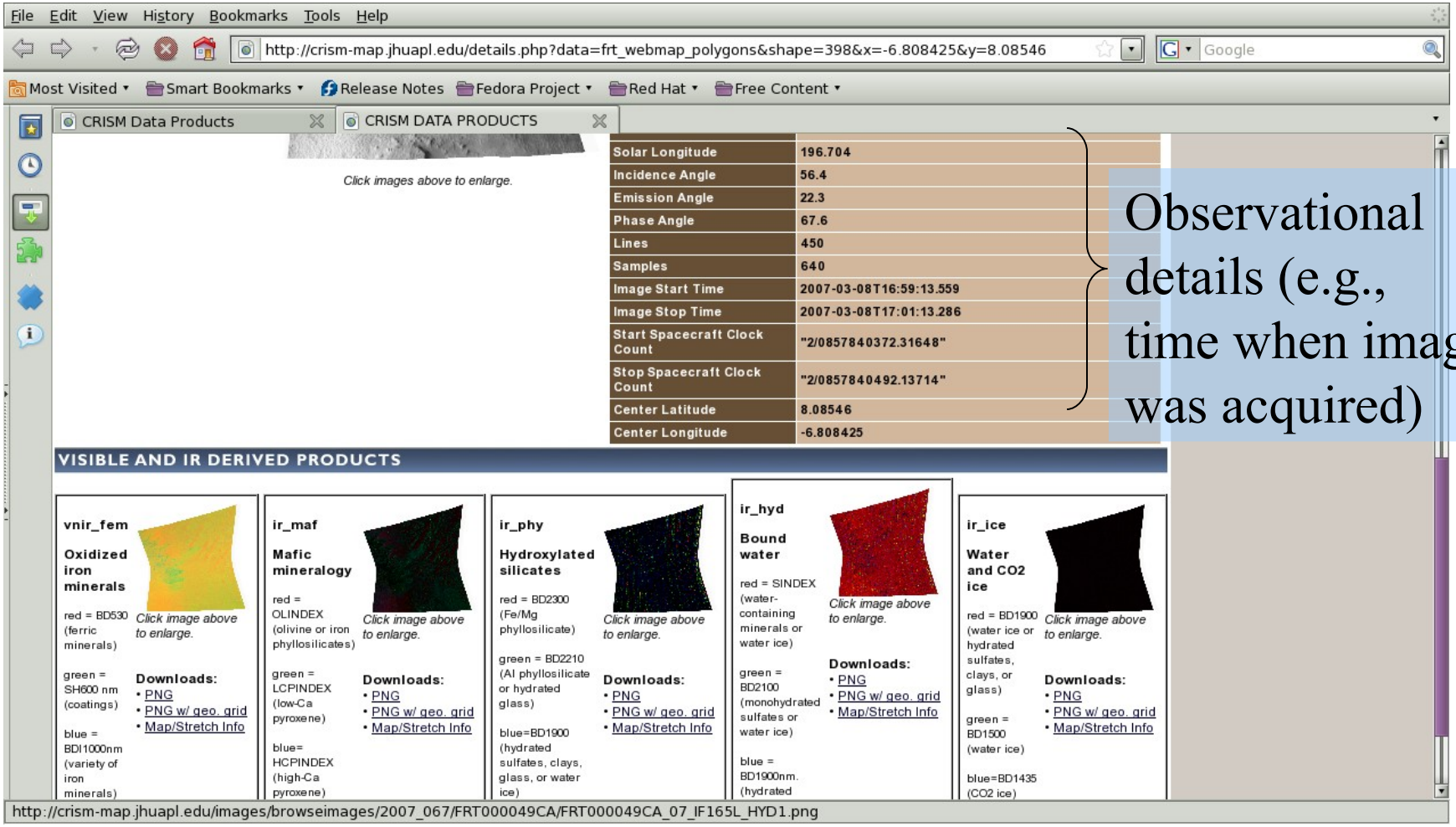
Click on image or PNG for full resolution image

Click on PNG with grid to get lat-long grid; on Map Stretch Info to link to text file with projection and stretch information for each RGB channel.

Links to the PDS

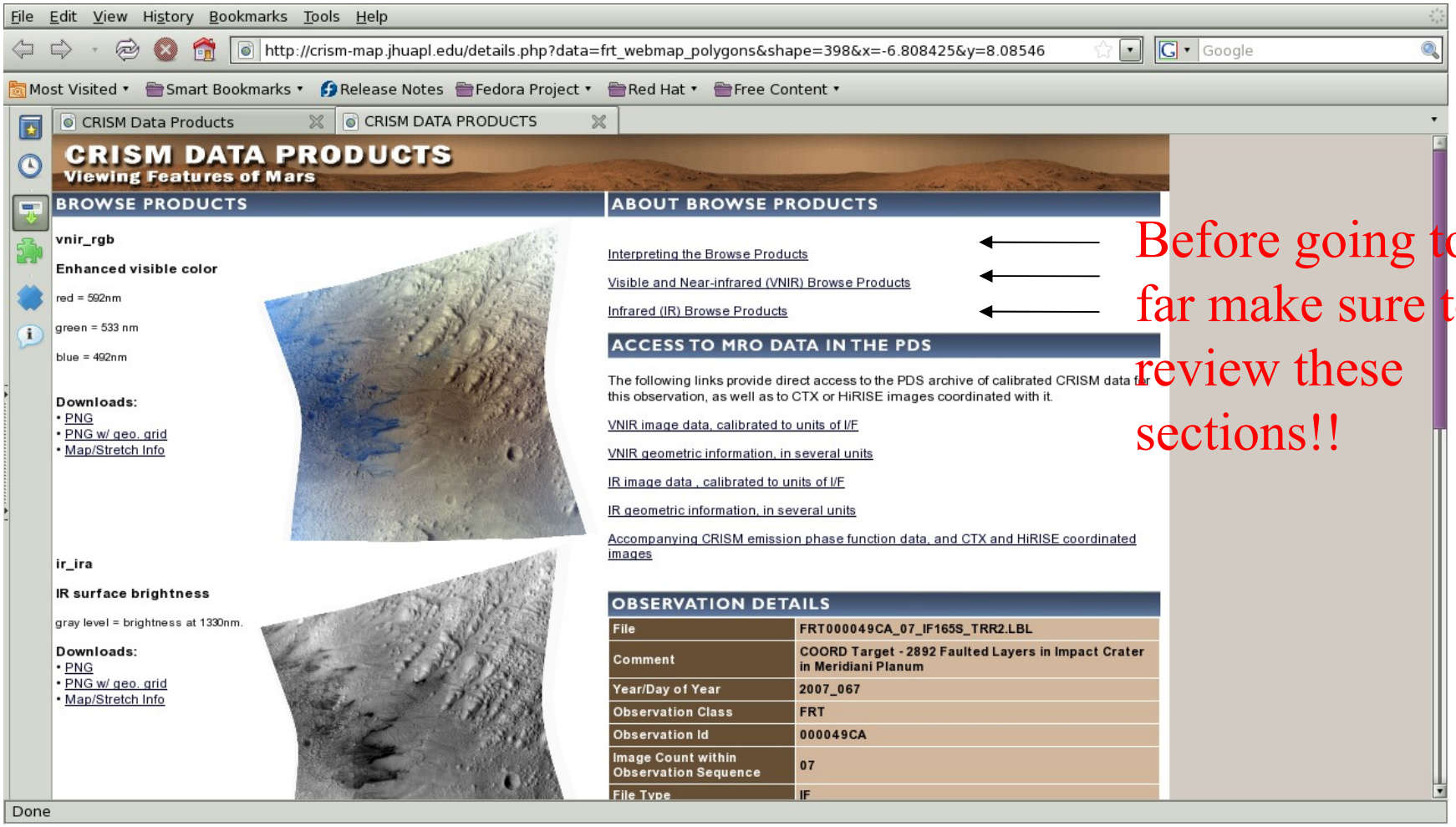


Individual observation



Observational details (e.g., time when image was acquired)

Individual observation 000049CA



Before going to far make sure to review these sections!!

Also use your common sense – you're just seeing spectral indices and they don't just respond to minerals!

About the browse products

http://crism-map.jhuapl.edu/popinterpret.php

CRISM DATA PRODUCTS
Viewing Features of Mars

Interpreting the Browse Products

CRISM browse products are intended to provide a high-level overview of the contents of calibrated image data, and are not meant for quantitative analysis or to be interpreted with an awareness of possible false detections due to illumination or instrumental effects. However, every effort was made in the construction of the browse products to preserve useful information and the dynamic range of the original calibrated data. In addition, the mapping information specified with the map/stretch information for each product is sufficient to register the browse images with other data sets. Typically registration errors are about 200 m or less.

Two versions of the data provide an overview of surface brightness. **vnir_rgb** is enhanced color over the visible range, and **ir_ira** is brightness at a wavelength near 1330 nm.

Compositional information on the surface is concentrated in four of the browse products (**vnir_fem**, **ir_maf**, **ir_phy**, and **ir_hyd**). Not all of the sites exhibit spectral evidence for mineralogical diversity. If a location is covered in dust, it appears red in **vnir_fem** and bland in the other products. Sites with diversity in igneous mineralogy will appear interesting in **ir_maf.** Sites with minerals formed by interaction of crustal rocks with liquid water will appear interesting in **ir_phy** and **ir_hyd**.

Sites that have water ice on the surface or as clouds will appear pink, yellow or green in **ir_ice**, whereas those with carbon dioxide frost on the surface will appear bluish.

In addition to those caveats, many of the parameters in the latter four browse products have dependencies on solar incidence angle, surface slopes, atmospheric conditions, detector artifacts, and response to phases other than what the products were intended to show. For example, **ir_phy** and **ir_hyd** can have bluish colors due to spectral effects of water ice, either as surface frosts or atmospheric hazes. Illumination geometry or atmospheric dust and ice hazes can create artifacts in **vnir_fem**, **ir_maf**, **ir_phy**, and **ir_hyd**. **ir_phy** is particularly susceptible to detector artifacts.

An excellent reference describing the parameters used in constructing **vnir_fem**, **ir_maf**, **ir_phy**, **ir_hyd, and ir_ice is:**

Pelkey, S. M., J. F. Mustard, S. Murchie, R. T. Clancy, M. Wolff, M. Smith, R. Milliken, J.-P. Bibring, A. Gendrin, F. Poulet, Y. Langevin, and B. Gondet, CRISM multispectral summary products: Parameterizing mineral diversity on Mars from reflectance, J. Geophys. Res., 112, E08S14, doi:10.1029/2006JE002831, 2007.

CRISM Data Products Usage Policy

CLOSE WINDOW

Done

http://crism-map.jhuapl.edu/popvnir.php

CRISM DATA PRODUCTS
Viewing Features of Mars

Visible and Near-infrared (VNIR) Browse Products

Information in CRISM's 107 VNIR wavelengths (at 0.36-1.05 microns) is represented as two browse products.

The first is a false color red-green-blue (**vnir_rgb**) image constructed from 590, 530, and 440 nm wavelengths, that has been stretched to optimize the dynamic range at the site shown. Thus, the stretch varies from image to image. These data received an approximate correction for photometric effects, that is, differences in local solar time and the angle of sunlight to the surface. This correction was performed by dividing the brightness of Mars' surface at each wavelength ("I/F") by the cosine of the solar incidence angle (angle of sunlight to local vertical).

The second false color image (**vnir_fem**) provides information related to iron minerals. It is derived from spectral data that have been corrected for photometric effects. The parameter data have also been filtered to reduce the effect of detector noise.

Channel	Parameter	Scaling	Significance	Cautions
Red	Depth of 530-nm band; relative to a continuum between 440 and 709 nm (BD530*)	0.00-0.17 to 0-250	Higher values indicate greater content or larger particle size of some fine-grained oxidized iron minerals	Higher values also occur where the atmosphere is dusty, or where dusty atmosphere overlies shadowed slopes
Green	Height of inflection at 600 nm; relative to a continuum between 440 and 709 nm (SH600*)	0.10-0.17 to 0-250	Higher values correlated with coatings or rinds present on rocks, and with some crystalline ferric oxides	Higher values also occur in hazy atmosphere, over shaded slopes, where there is a high solar incidence angle, and over ice
Blue	Integrated area in 1-micron band; from 830-1023 nm, relative to a flat continuum tangent to the reflectance peak near 750 nm (BDI1000VIS*)	0.000-0.025 to 0-250	Higher values indicate greater content or larger particle size of iron minerals, especially olivine and pyroxene	Weakly sensitive to crystalline ferric oxides

About the browse products

http://crism-map.jhuapl.edu/popvnir.php

CRISM DATA PRODUCTS
Viewing Features of Mars

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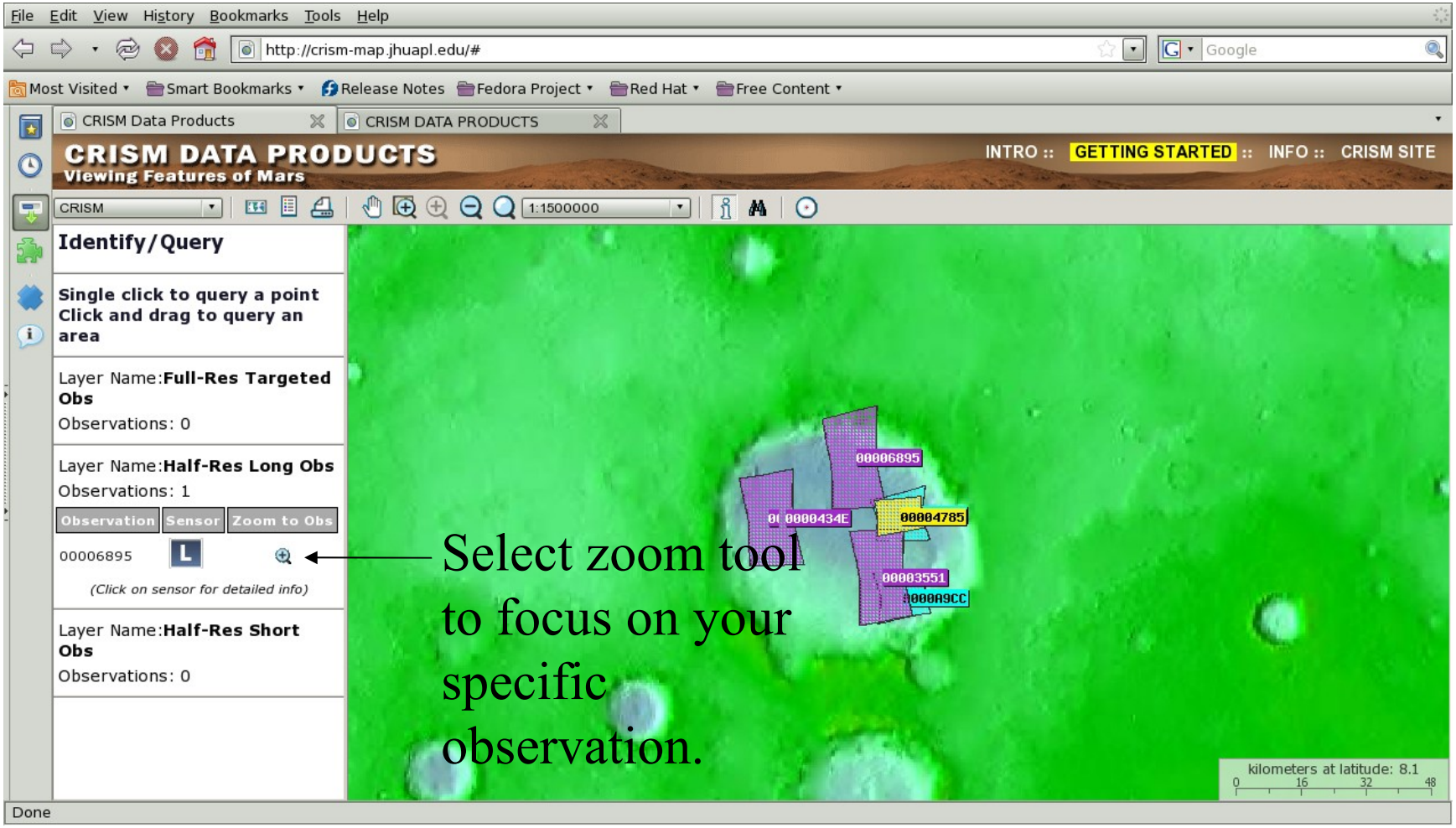
Channel	Parameter	Scaling	Significance	Cautions
Red	Depth of 530-nm band; relative to a continuum between 440 and 709 nm (BD530*)	0.00-0.17 to 0-250	Higher values indicate greater content or larger particle size of some fine-grained oxidized iron minerals	Higher values also occur where the atmosphere is dusty, or where dusty atmosphere overlies shadowed slopes
Green	Height of inflection at 600 nm; relative to a continuum between 440 and 709 nm (SH600*)	0.10-0.17 to 0-250	Higher values correlated with coatings or rinds present on rocks, and with some crystalline ferric oxides	Higher values also occur in hazy atmosphere, over shaded slopes, where there is a high solar incidence angle, and over ice
Blue	Integrated area in 1-micron band; from 830-1023 nm, relative to a flat continuum tangent to the reflectance peak near 750 nm (BDI1000VIS*)	0.000-0.025 to 0-250	Higher values indicate greater content or larger particle size of iron minerals, especially olivine and pyroxene	Weakly sensitive to crystalline ferric oxides

Other navigation tricks

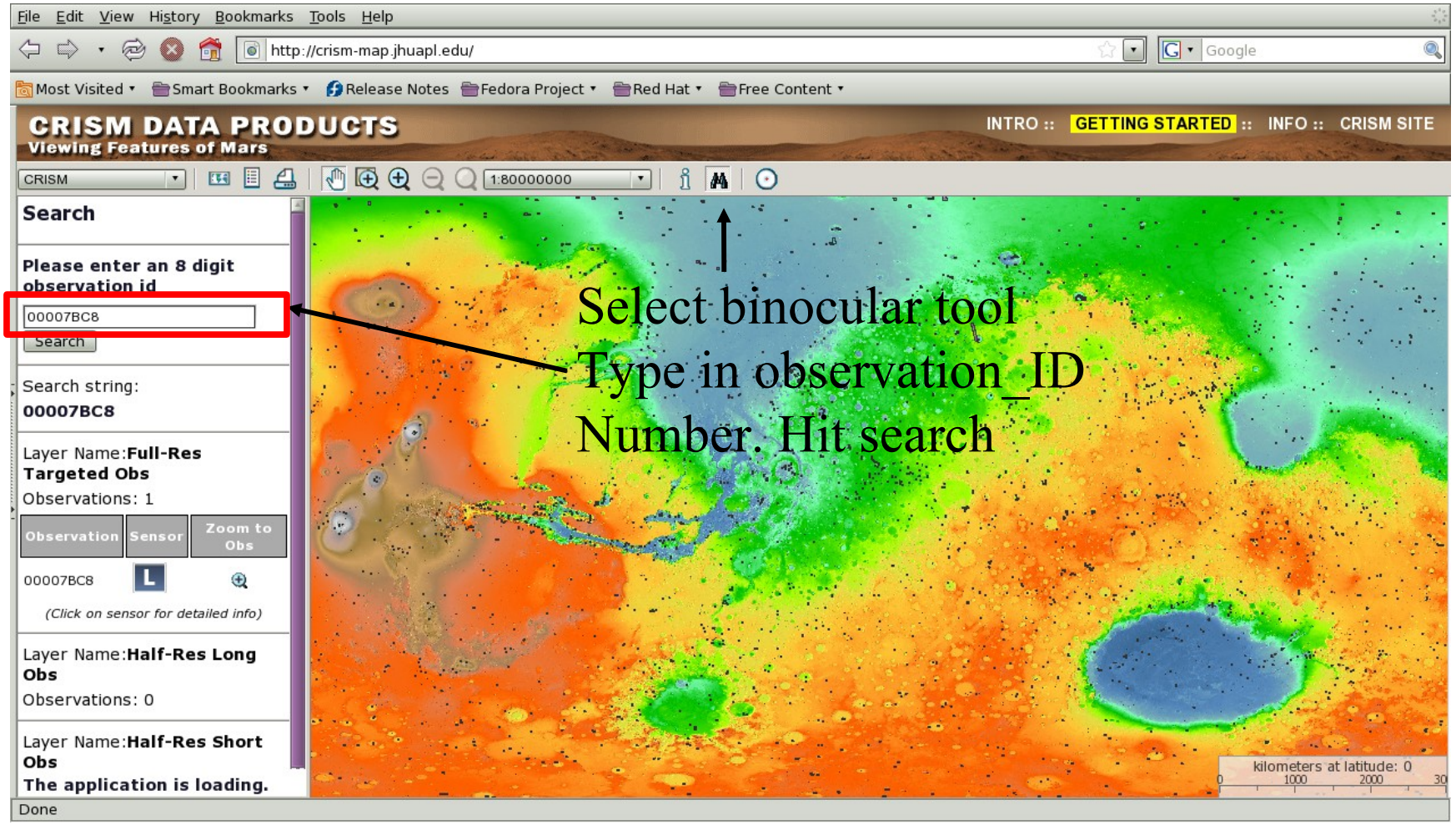
If you find a good observation, and want others in the area



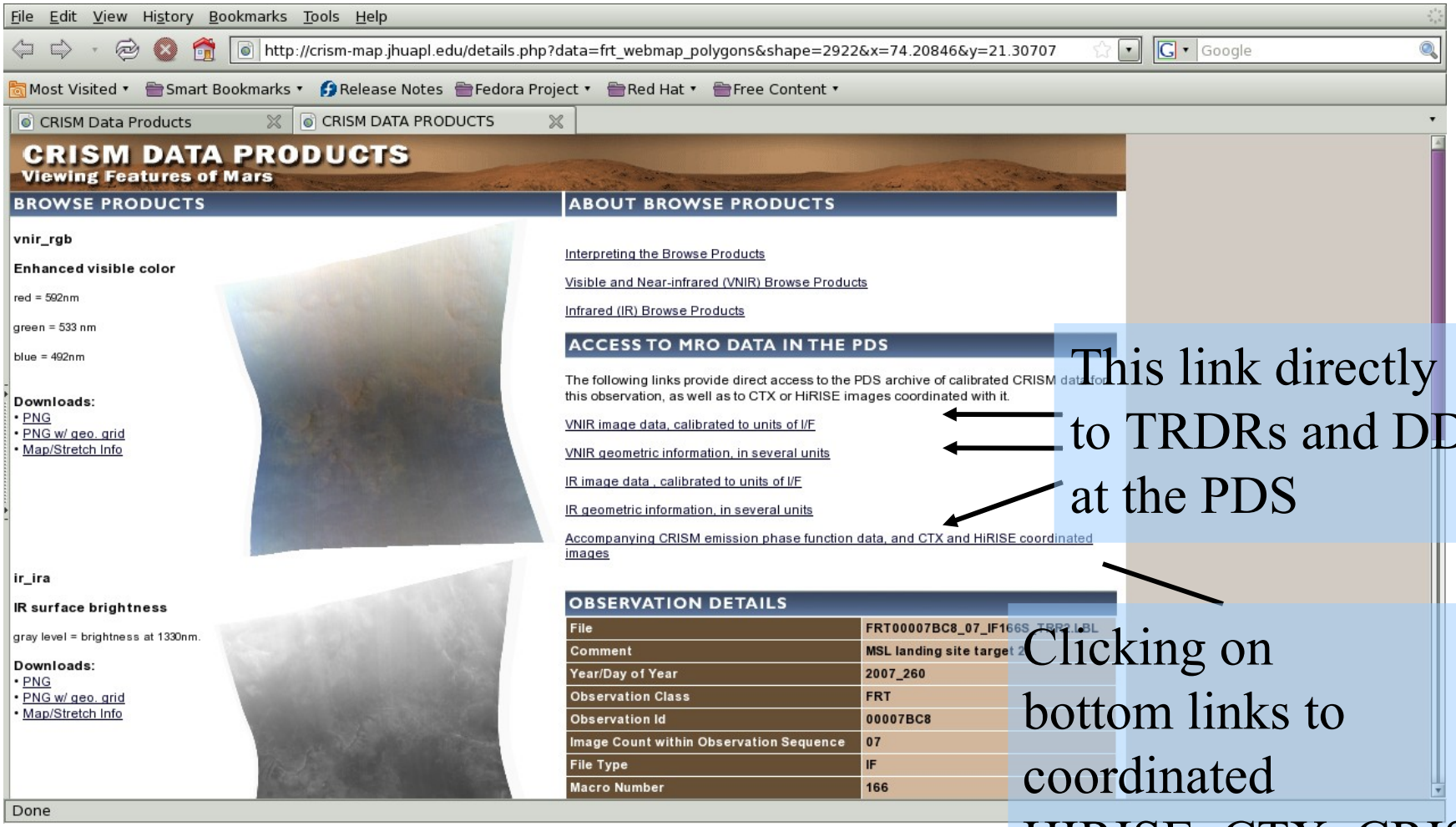
Select zoom tool to focus on your specific observation.

Other navigation tricks

If you find a good observation in the literature and you want more information on it.



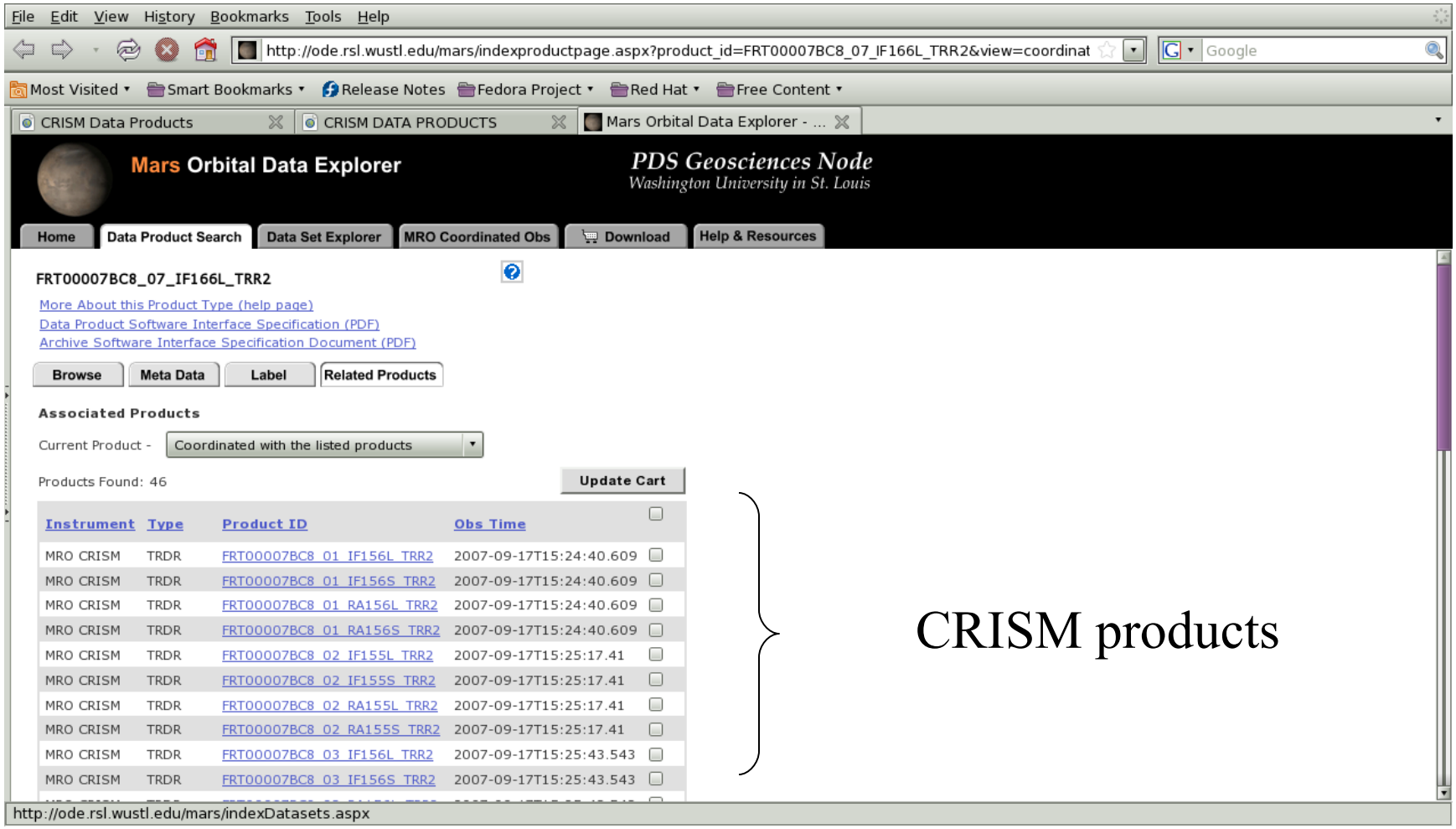
To confirm your observations go to the PDS to get the full CRISM cubes



This link directly to TRDRs and DDRs at the PDS

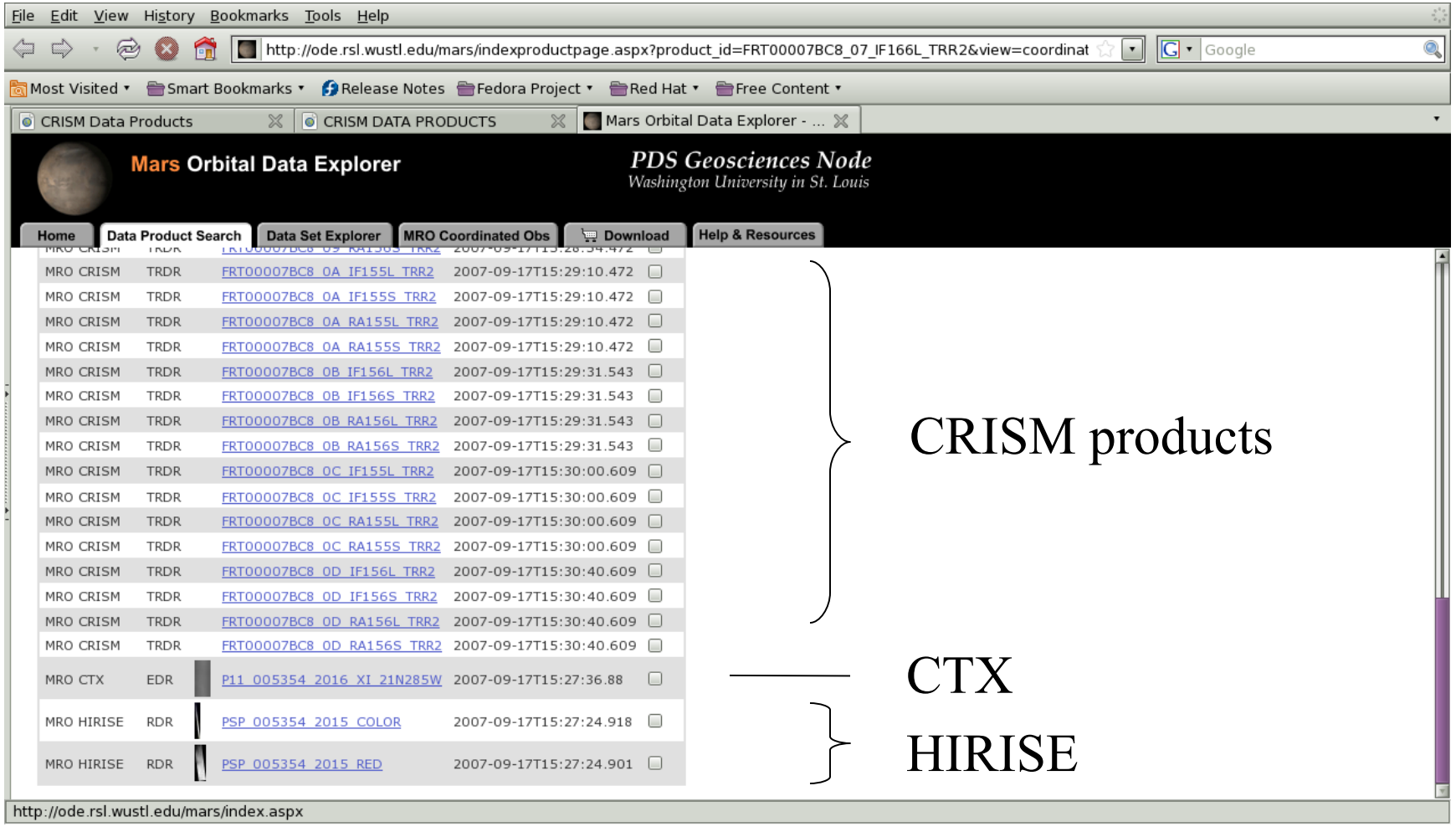
Clicking on bottom links to coordinated HIRISE, CTX, CRISM TRDRs and EPFs if available

CRISM and accompanying MRO data at the PDS



CRISM products

CRISM and accompanying MRO data at the PDS



See Scott and Frank's presentations for which CRISM files are required to work the ENVI CRISM CAT.