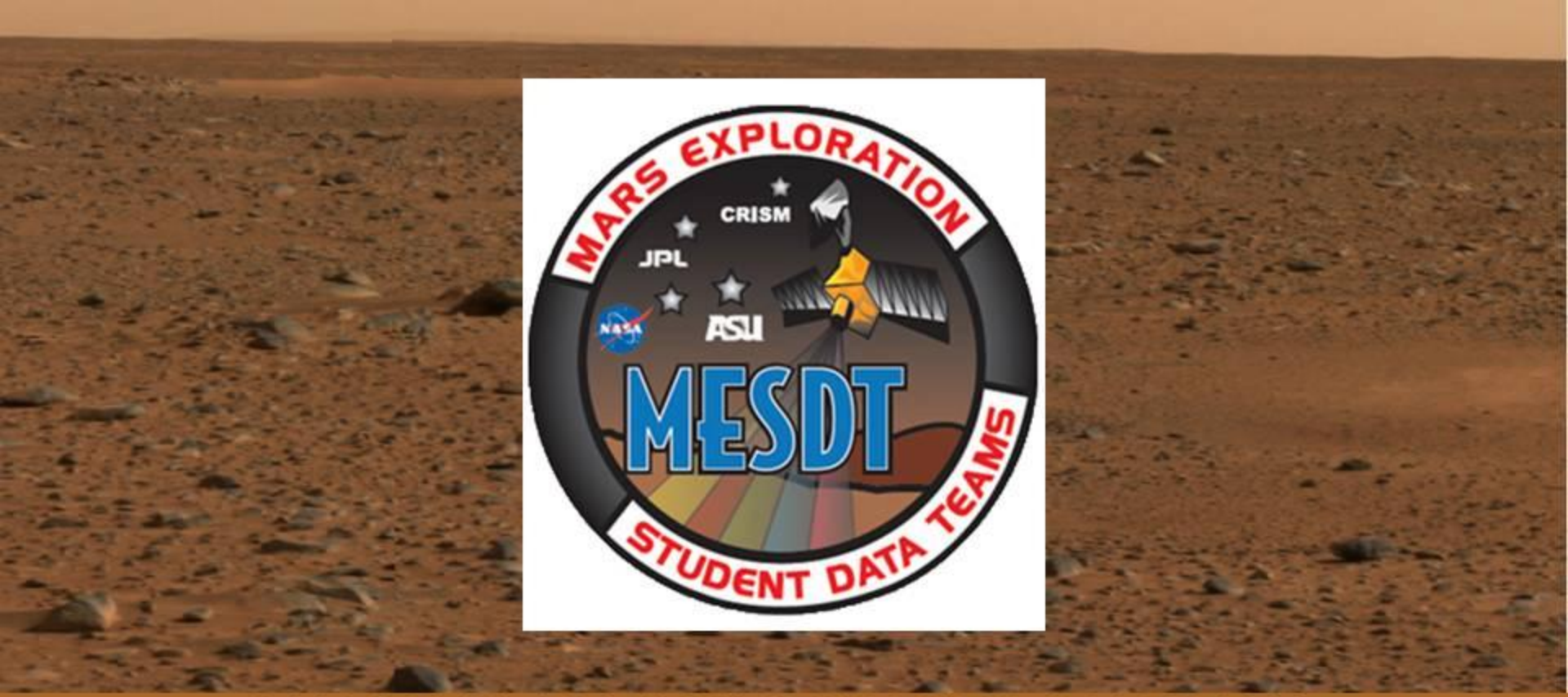


MARS EXPLORATION STUDENT DATA TEAMS

MESDT

MESDT Final Presentations

April 26th, 2012

CRISM

Today's Agenda

- Rick Snyder—Kickapoo High School
- Denise Thompson—Orting High School

- Time after each presentation for Q & A
- Final Decisions for the scholarship funding to be made by May 4th, 2012
  - 2012 Annual Meeting of Planetary Geologic Mappers
  - June 18-22, 2012
  - USGS Astrogeology Science Center in Flagstaff, AZ

Chasma Boreale: Cryptic Terrain as Indications of Sub-Surface Water and Stages of Geyser Formation

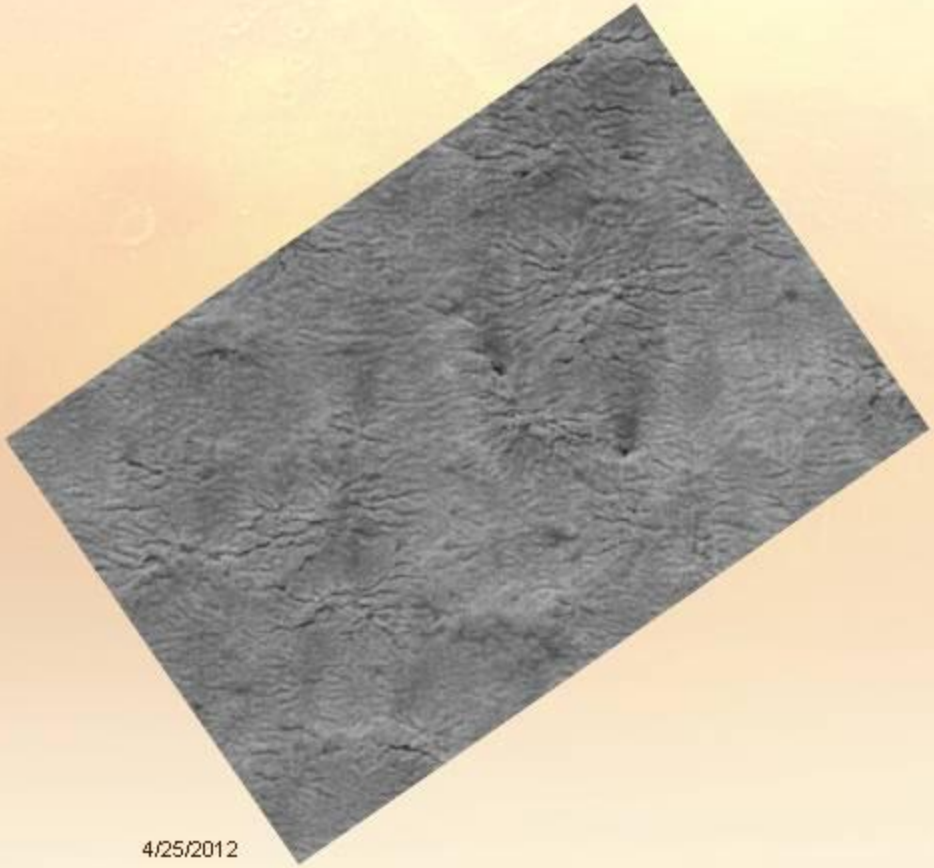
Jordyn Cloud, Sara Hickle, and Ravyn Vialpando
Kickapoo High School, Springfield, Missouri

May 28th, 2012

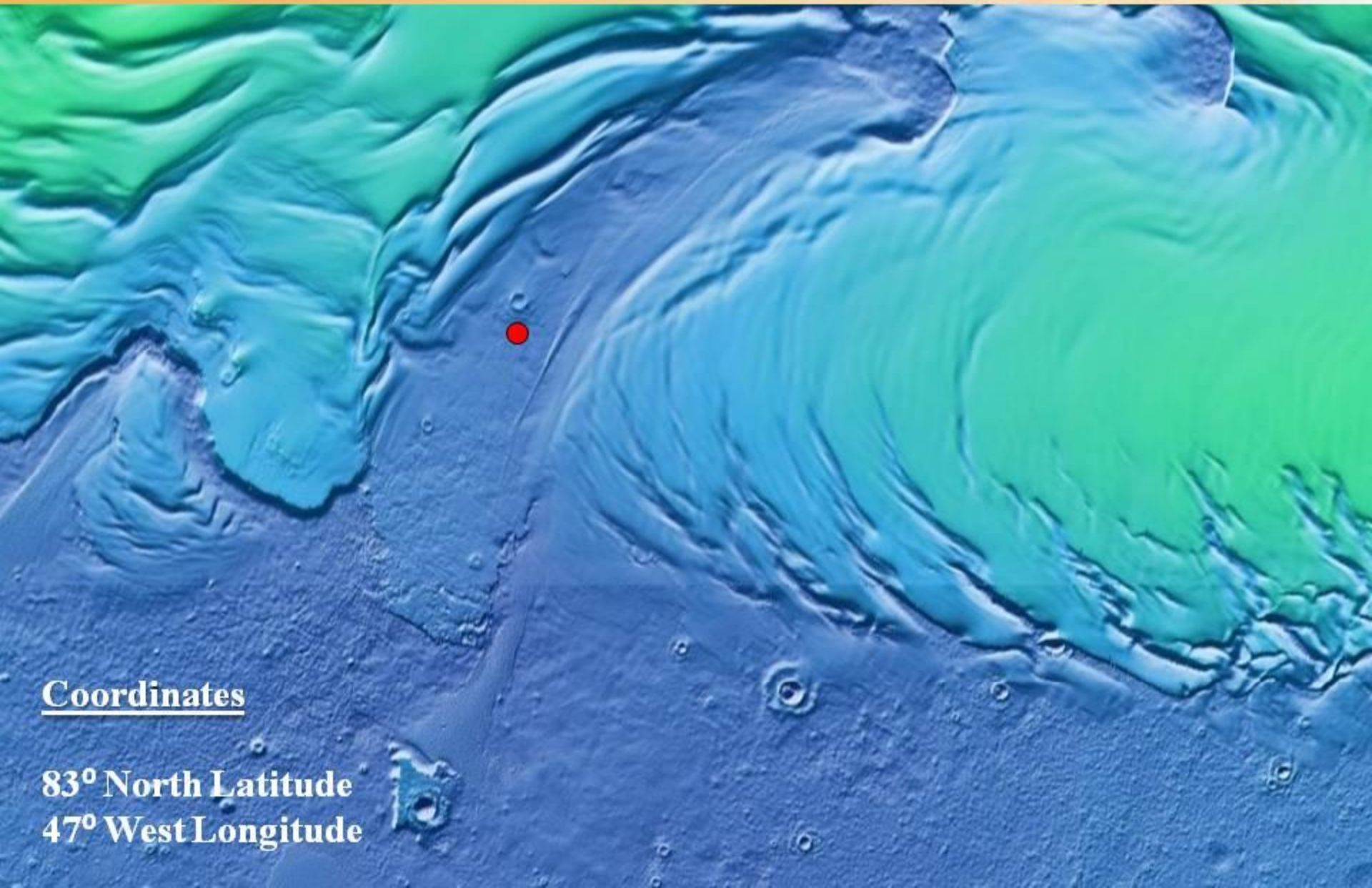
"We choose to go to the 'Poo not because it is easy…. but because it is hard"

Purpose of Research

Our approach was to provide morphological and spectroscopic evidence of geysers and cryptic terrain demonstrating that these formations go through a progression of stages and that these stages can be used to indicate the location and level of subsurface water



Area of Study: Chasma Boreale

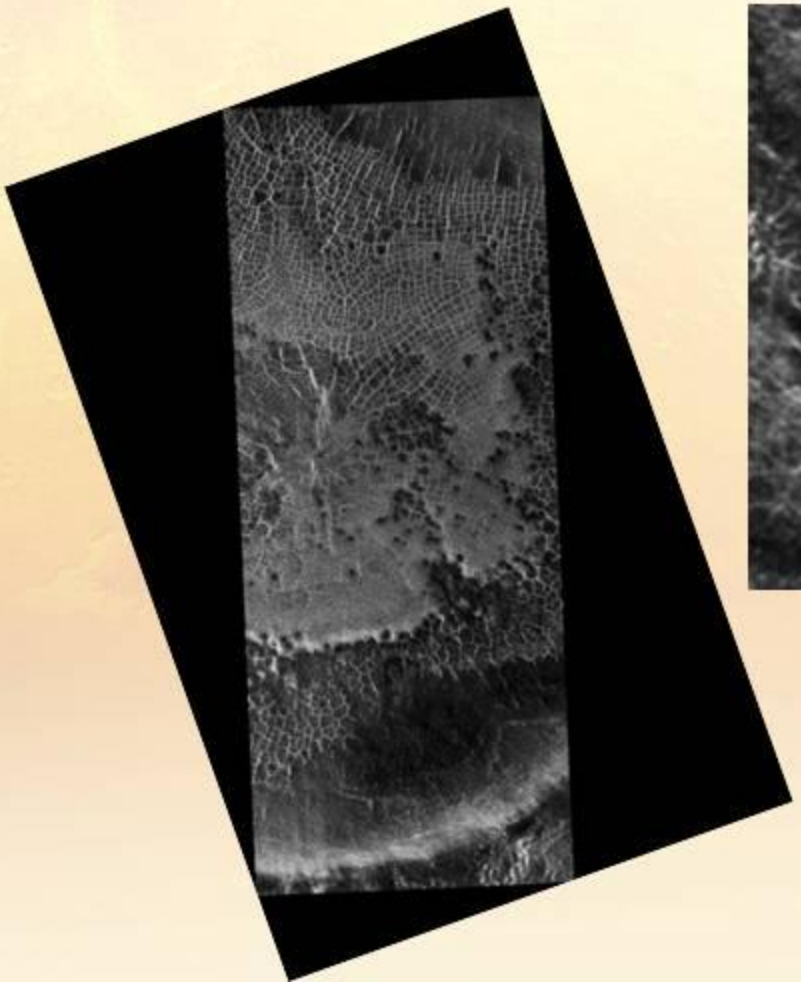


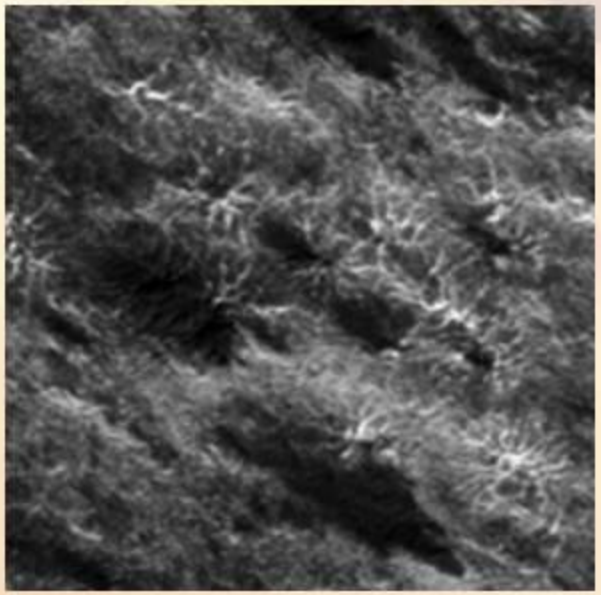
Target Area: 84th Parallel of Chasma Boreale

An image of Chasma Boreale as captured by THEMIS

Significance of Our Research

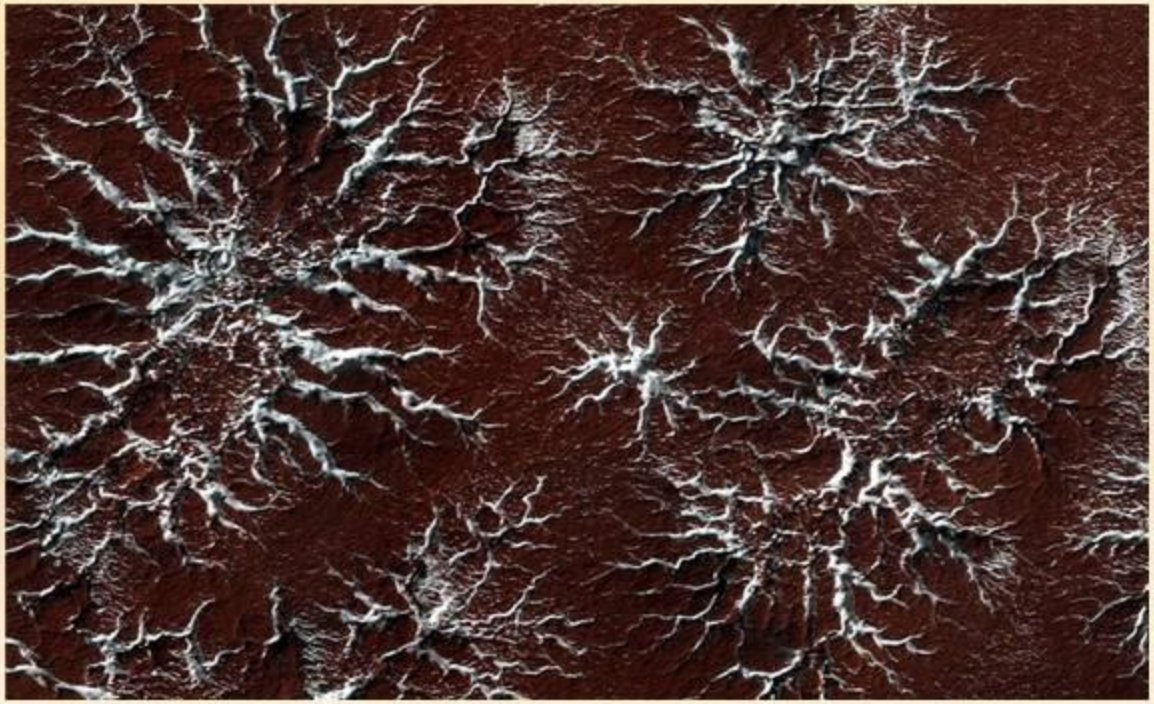
- *Distinguishing the stage of geyser/cryptic terrain development can be used as a morphological indication of the location/ levels of subsurface water deposits*



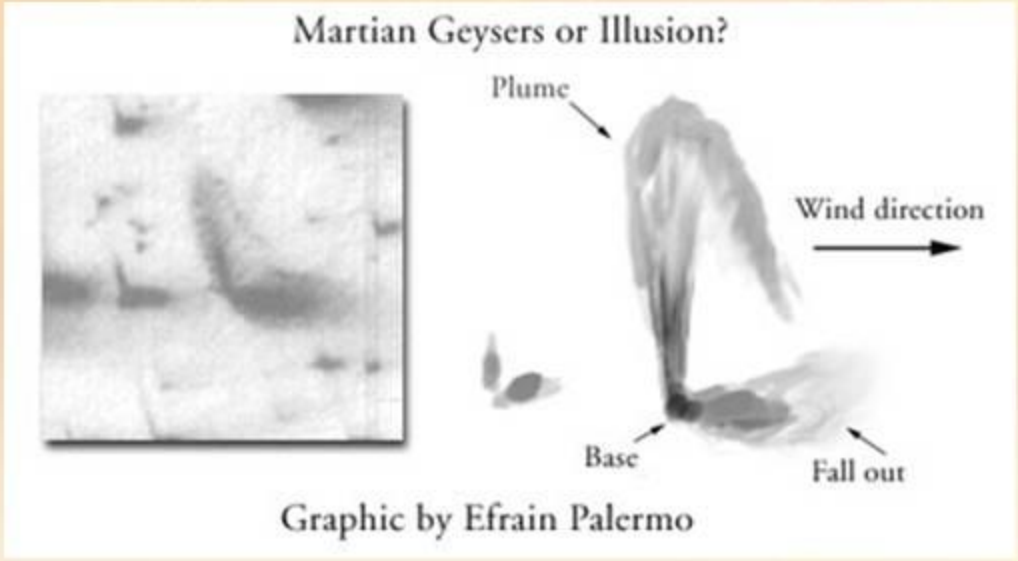


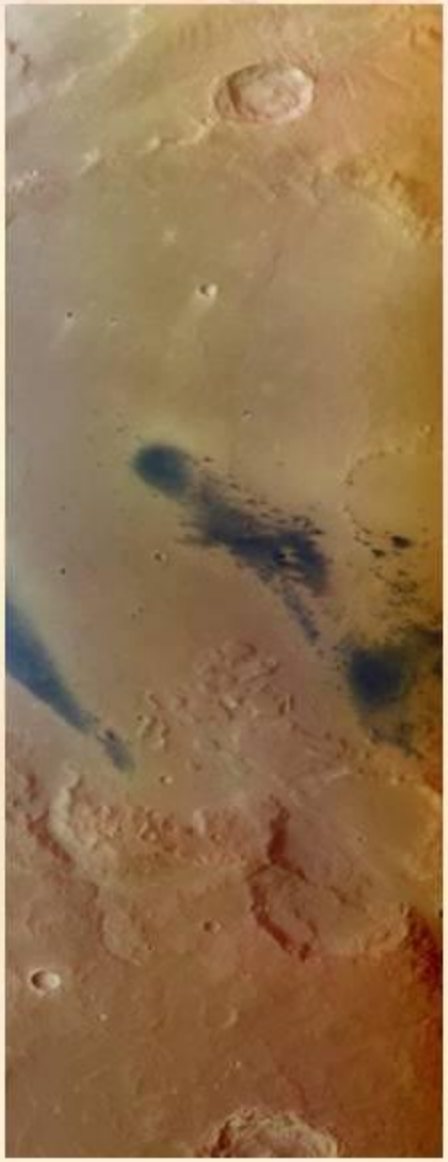
Definitions

- ***Martian geysers***: *Putative sites of jet-like eruptions that occur on Mars*
- ***Spiders***: *Web like features formed through Martian geysers*
- ***Cryptic Terrain***: *Unidentified types of landscape within a certain region of Mars*
- ***Albedo***: *The diffuse reflectivity of a surface*



Background of Geyser Formation





Methods - Targeting

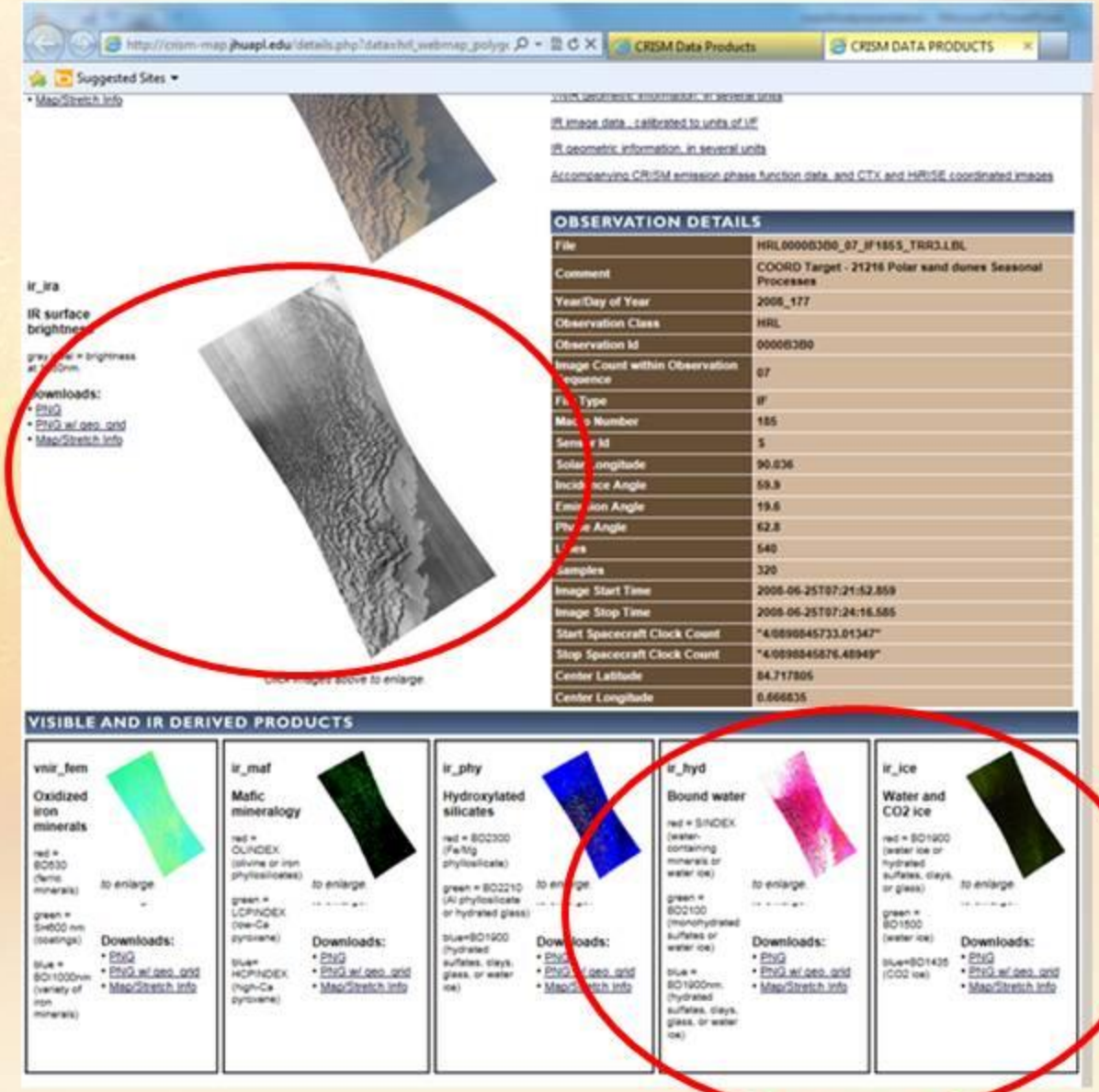
- *Analyzed 36 high resolution images of geysers and cryptic terrain in the northern and southern hemisphere using CRISM, HiRISE, THEMIS, MOC, and MSSS to compare morphologies and mineralogies of northern and southern geysers.*

- *Priority was finding high concentrations of geyser activity in the northern hemisphere to optimize thorough analysis*

- *Compared Albedo measurements of geyser deposits in the northern and southern hemisphere using Adobe Photoshop and a formula approved by Scott Murchie (see next slide)*

- *Compared Martian seasons with Earth seasons using the following website* http://planetary.org/explore/topics/mars/calendar.html

Crism Bound Water Method



Albedo Measurement Method

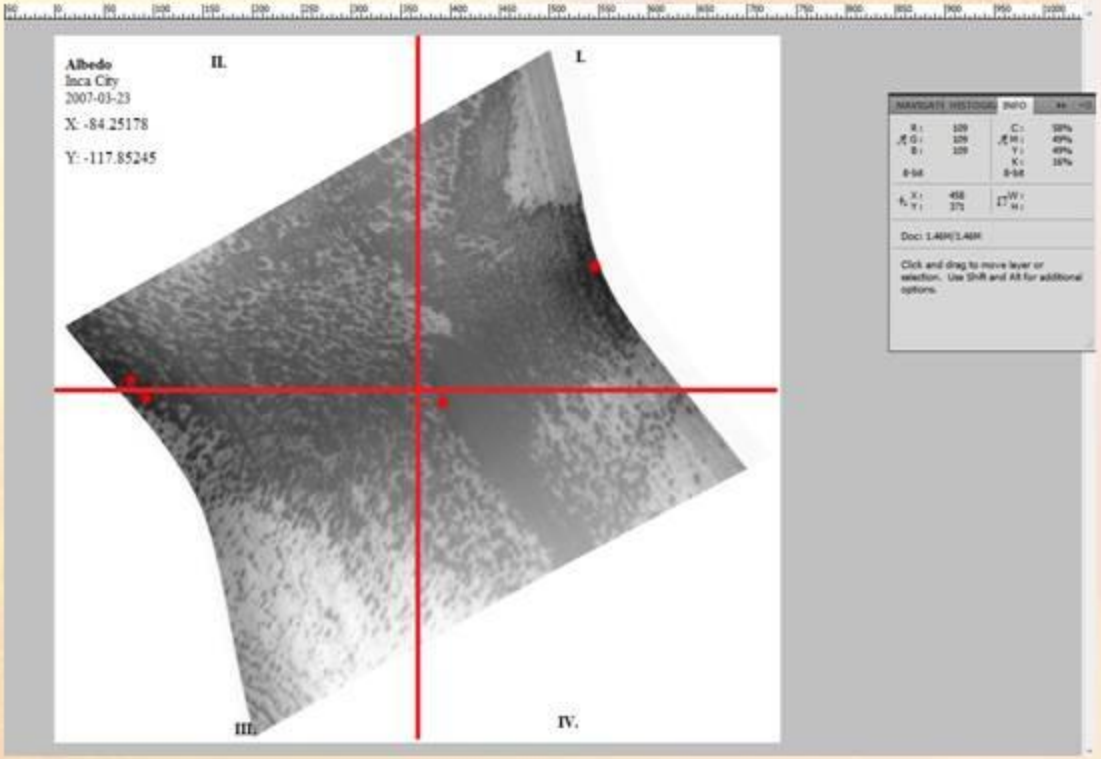
$$y = mx + b$$

$m = \frac{\text{max.} - \text{min.}}{250}$

$b = \text{min.}$

Photoshop value
0-250

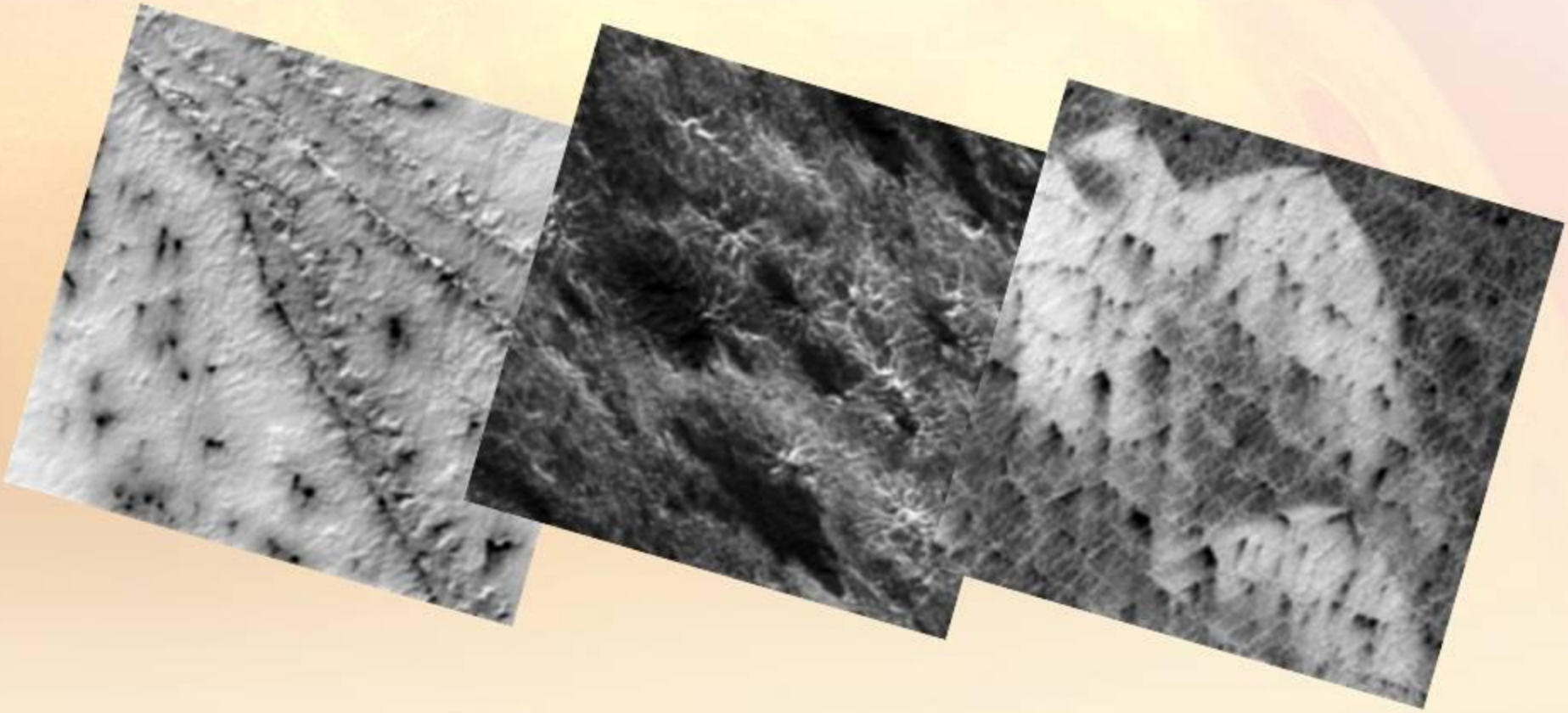
```
Min_Longitude=73.8280 Max_Longitude=74.0818
Min_Latitude=19.3078 Max_Latitude=19.5375
X resolution= 19.0701
Y resolution= 19.2798
Projection: Cylindrical
Projection center:
Longitude =  0.00000, Latitude = 17.5000
Stretch:
Grey channel:
Min pixel value:  0.1104 = 0 DN
Max pixel value:  0.2414 = 250 DN
```



Example: $\left(\frac{0.2414-0.1104}{250}\right) * 109 + 0.1104$

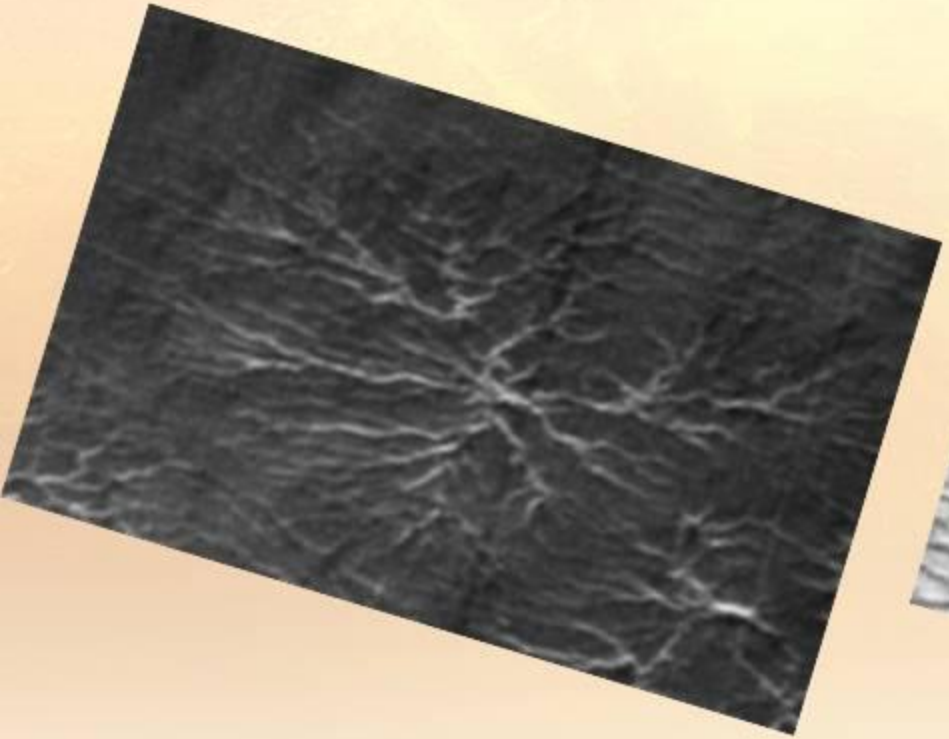
Hypothesis One

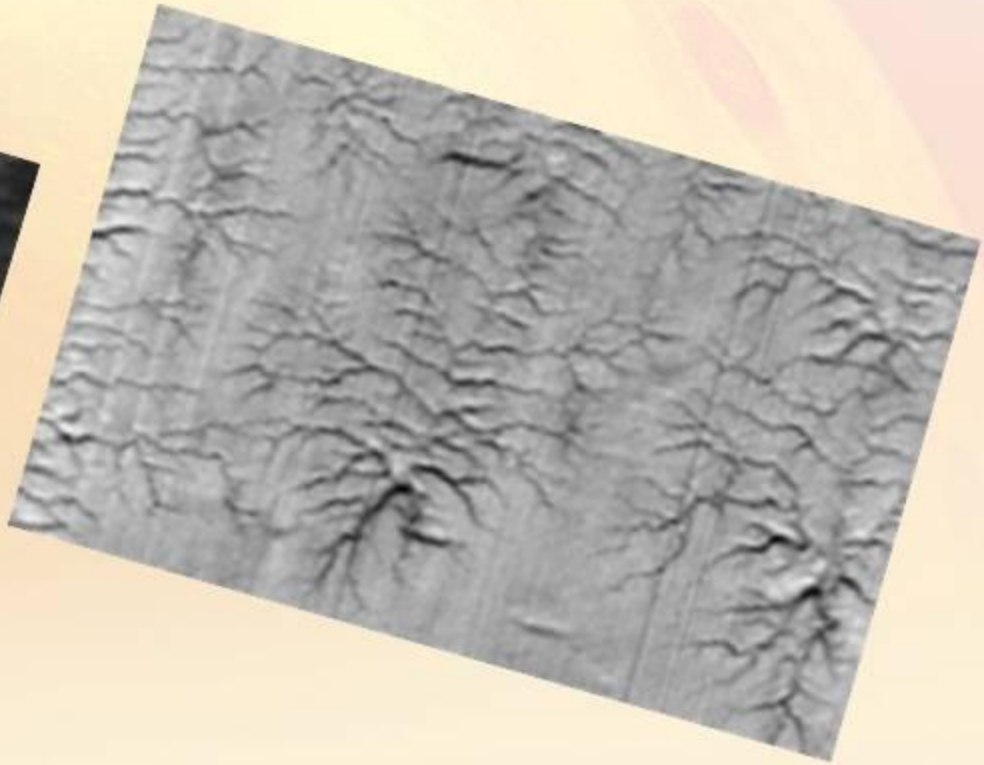
- *Geysers can be used to determine the location of sub-surface water deposits based upon their current stage of development*



Hypothesis Two

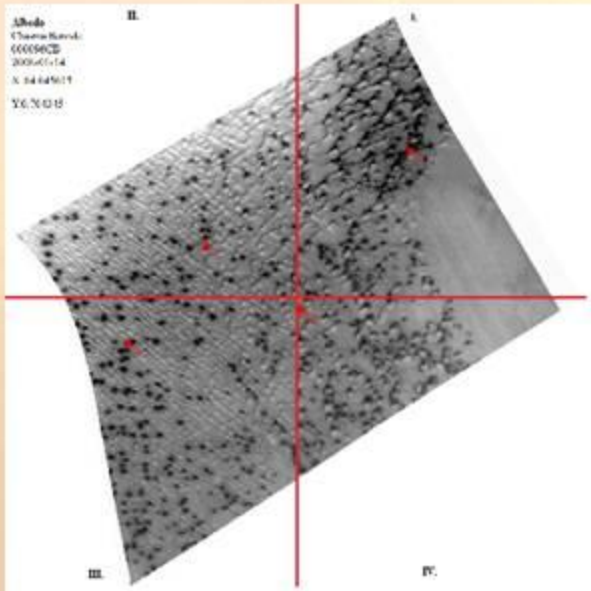
- *Once geysers have reached the third stage (Ness and Orme) of development they should indicate extensive "spider" networks indicating a deeper plumbing system and the possibility of accessing sub-surface water*



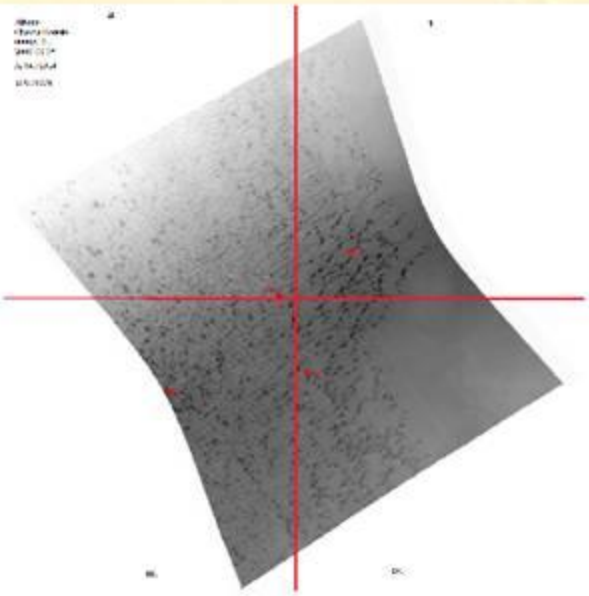


Hypothesis Three

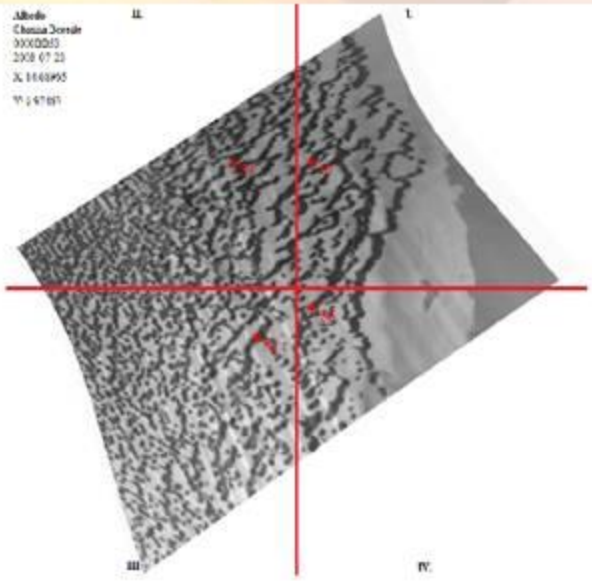
- *Geysers in a later stage of formation (Stage 3) will have a lower albedo and therefore have a higher bound water content*



Jan. 2008



March 2008

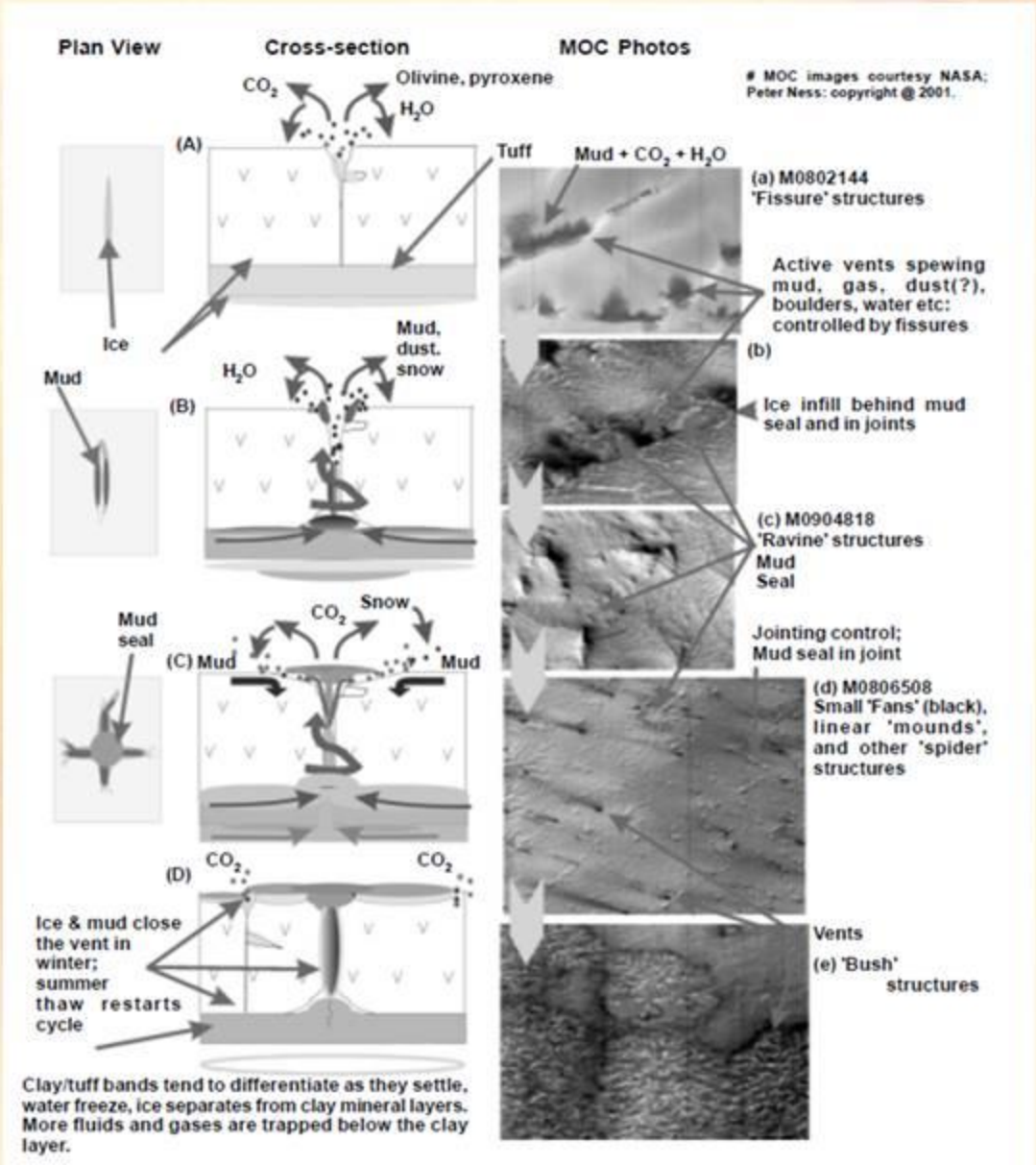


July 2008

Postulates and Observations

Postulates: Ness and Orme	Observations
There are different types of geysers, forming independently, and not in stages.	There are different types of geysers as a result of geysers being in different stages of formation.
Martian geysers are a seasonal occurrence, resulting in a short life span.	Geysers demonstrate seasonal activity, but are not seasonally created, resulting in a prolonged life span.
Geyser activity is limited to the Southern Hemisphere.	Chasma Boreale (northern hemisphere) demonstrates distinct features associated with geysers and geyser development.

Background of Geyser Formation (Ness and Orme)

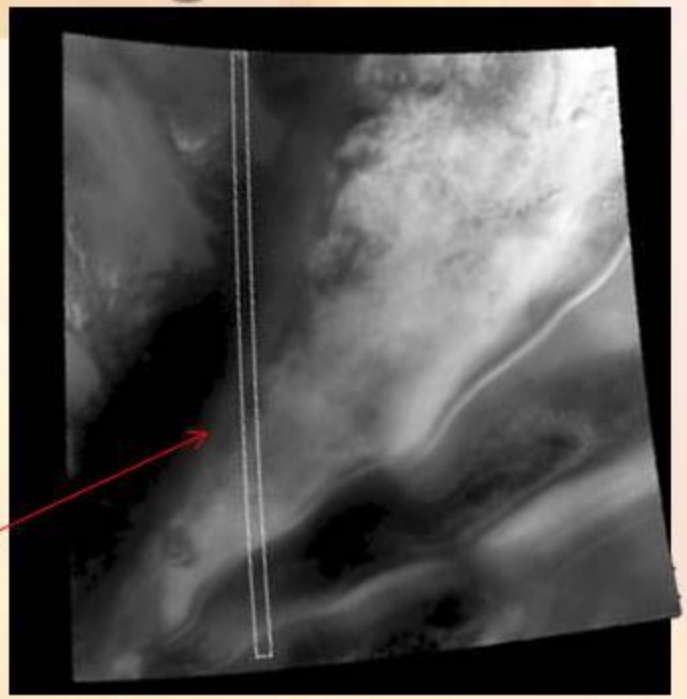


Geyser Stage Model

- *Established based on comparisons to southern hemisphere and the research of Ness and Orme*
- *Stage One – Dry venting, fans with clear direction.*
  - *"Spewing"*
- *Stage Two – Similar fan features, lacking direction because more material has gathered around central vent*
  - *"Collecting"*
- *Stage Three – Mud caps, or mounds, form over central vent, fluids find other routes to the surface, tributary venting*
  - *"Network formation"*

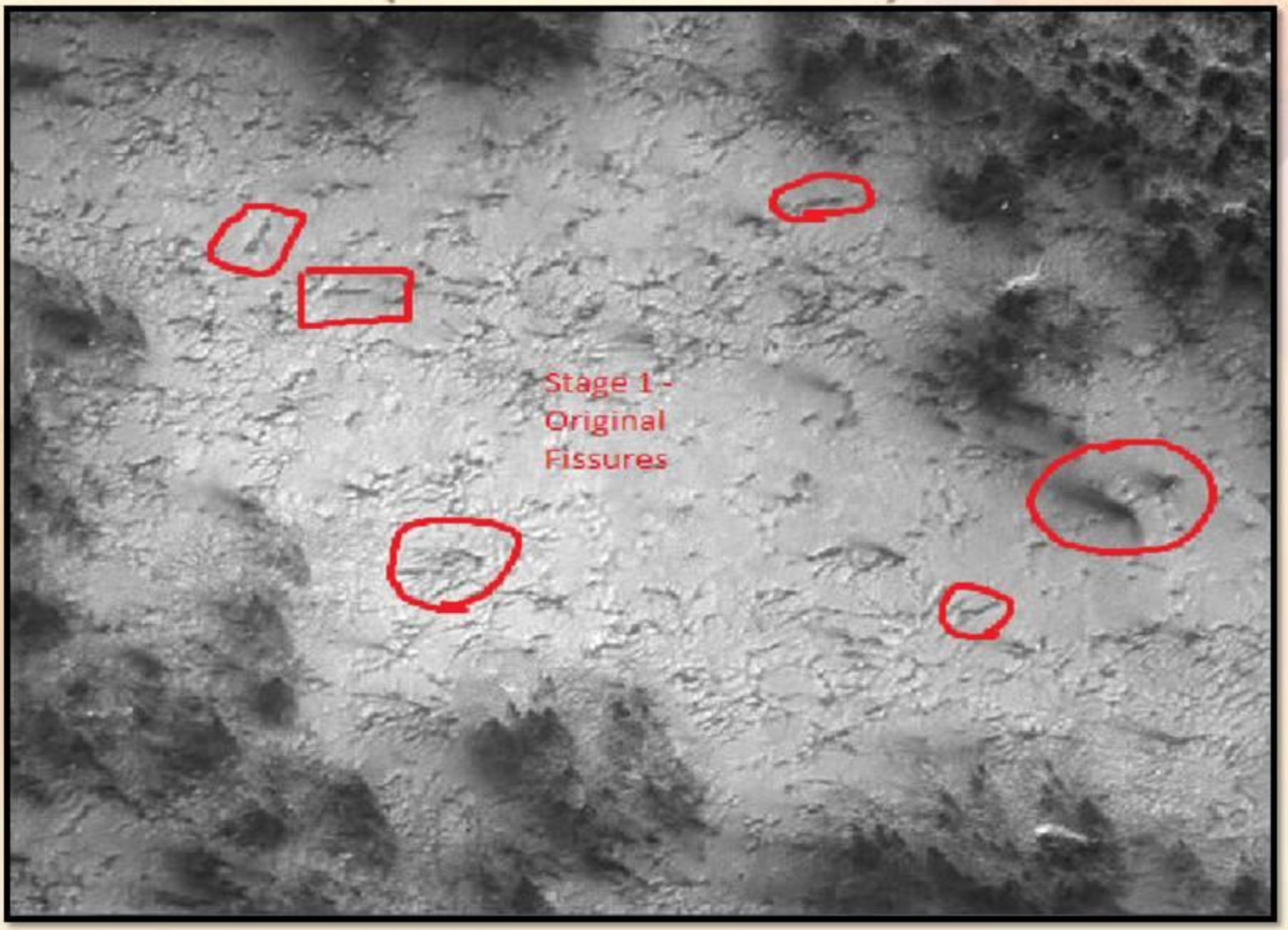
Chasma Australe Stages

Mars Orbiter Camera (MOC) M0900452 at -84.64, -95.52 – image from Malin Space Science Systems

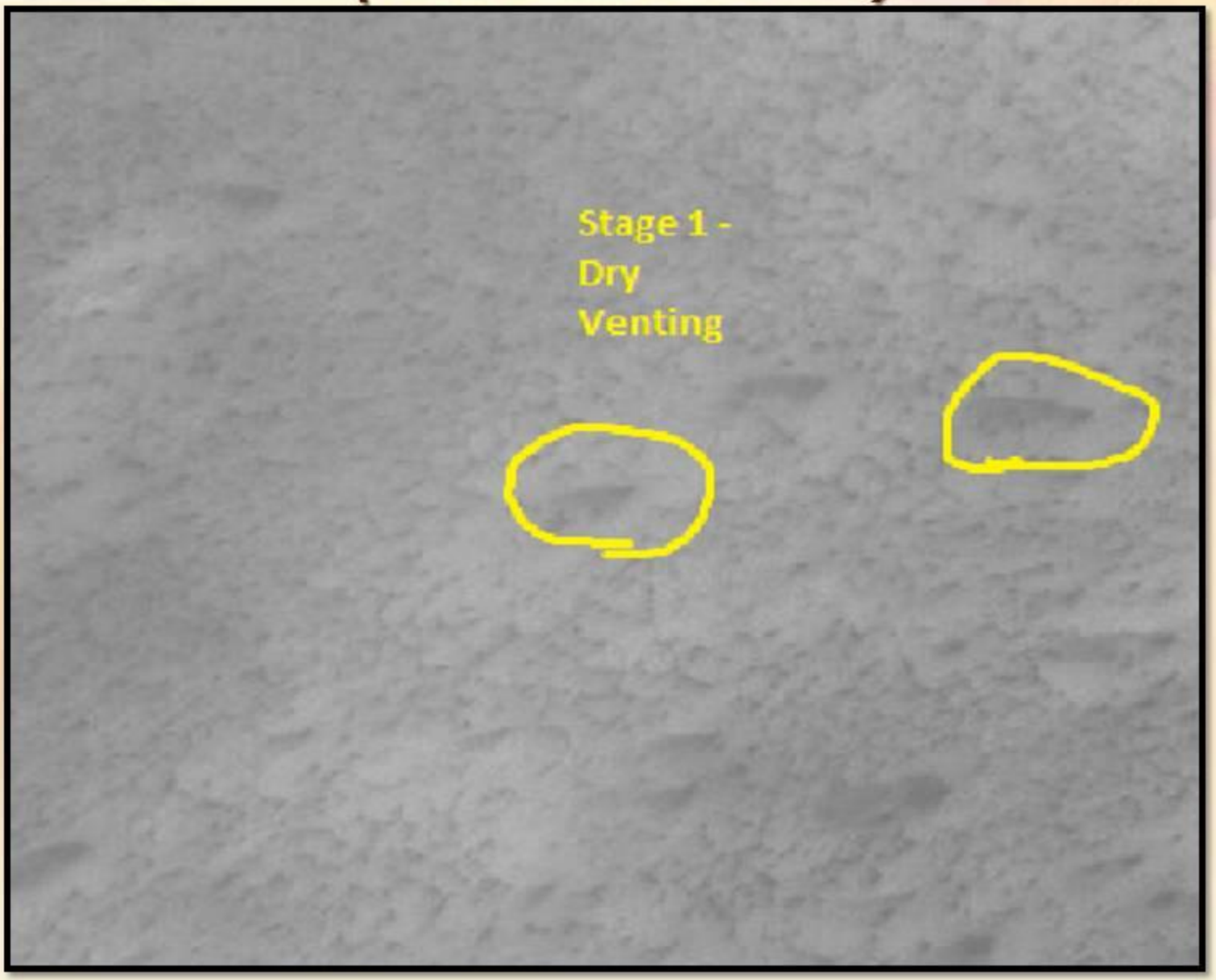


M0900453

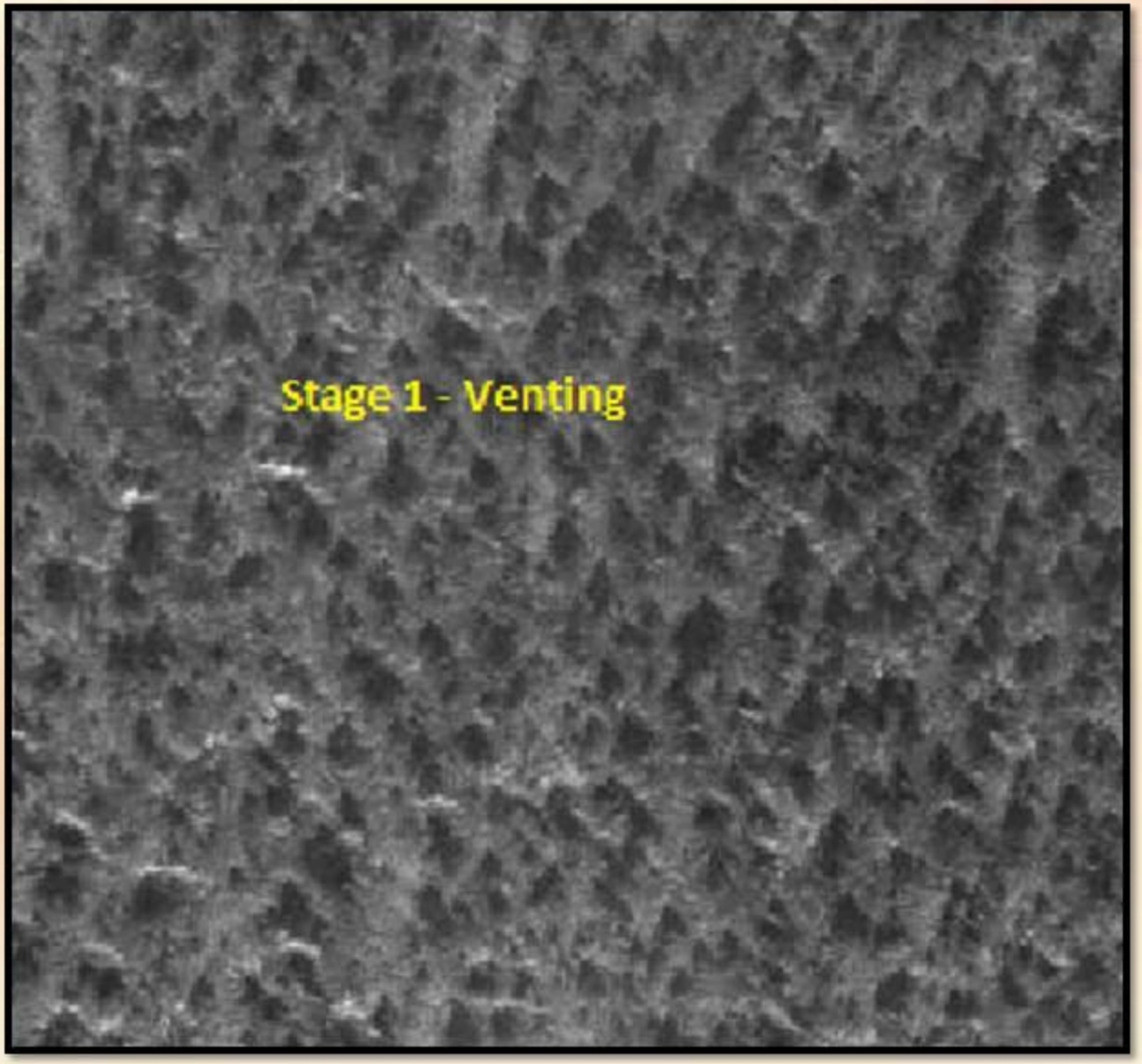
Stage1a- Original Fissures (Ness and Orme)



Stage1b- Dry Venting (Ness and Orme)

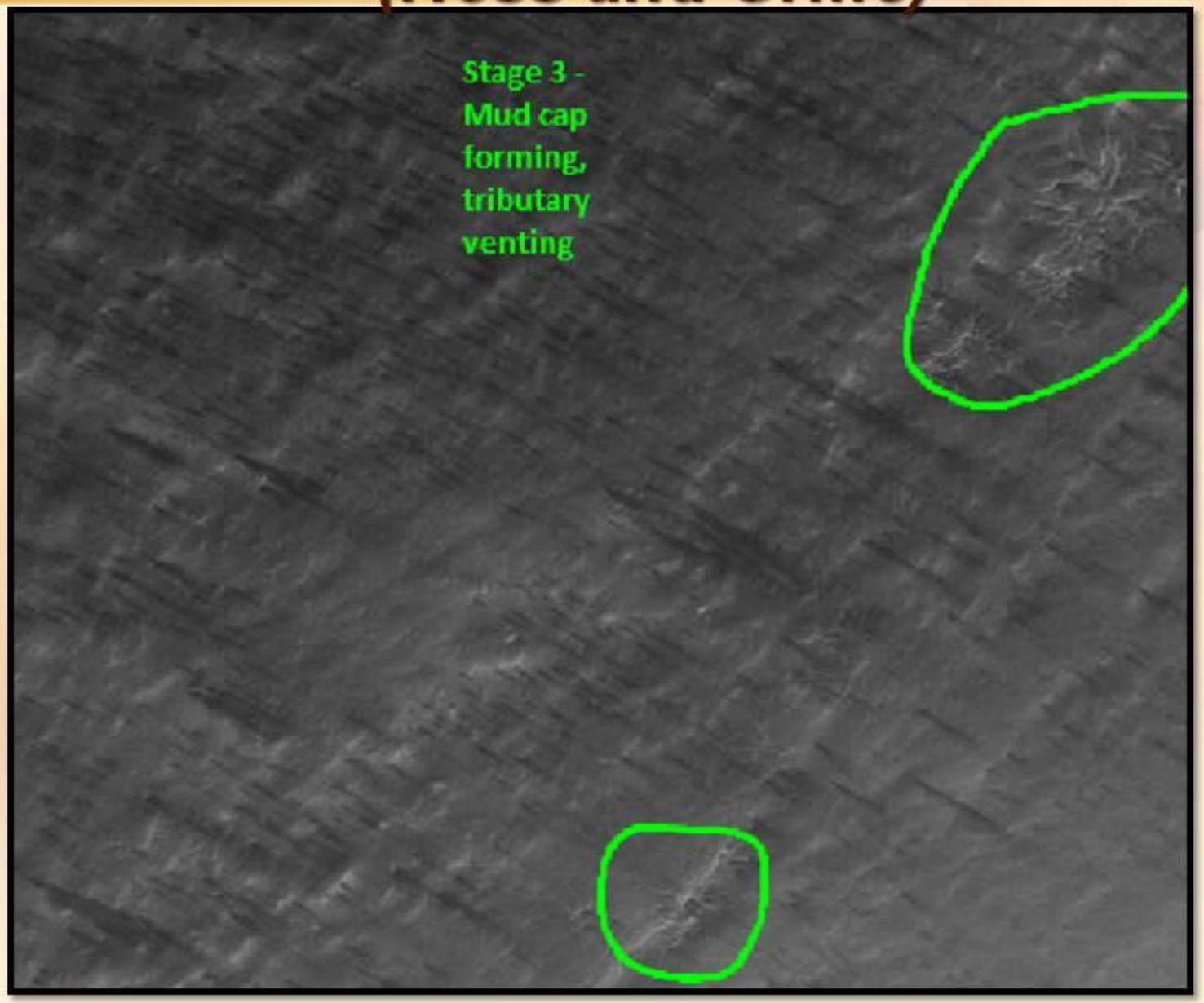


Stage 1c- Venting (Ness and Orme)



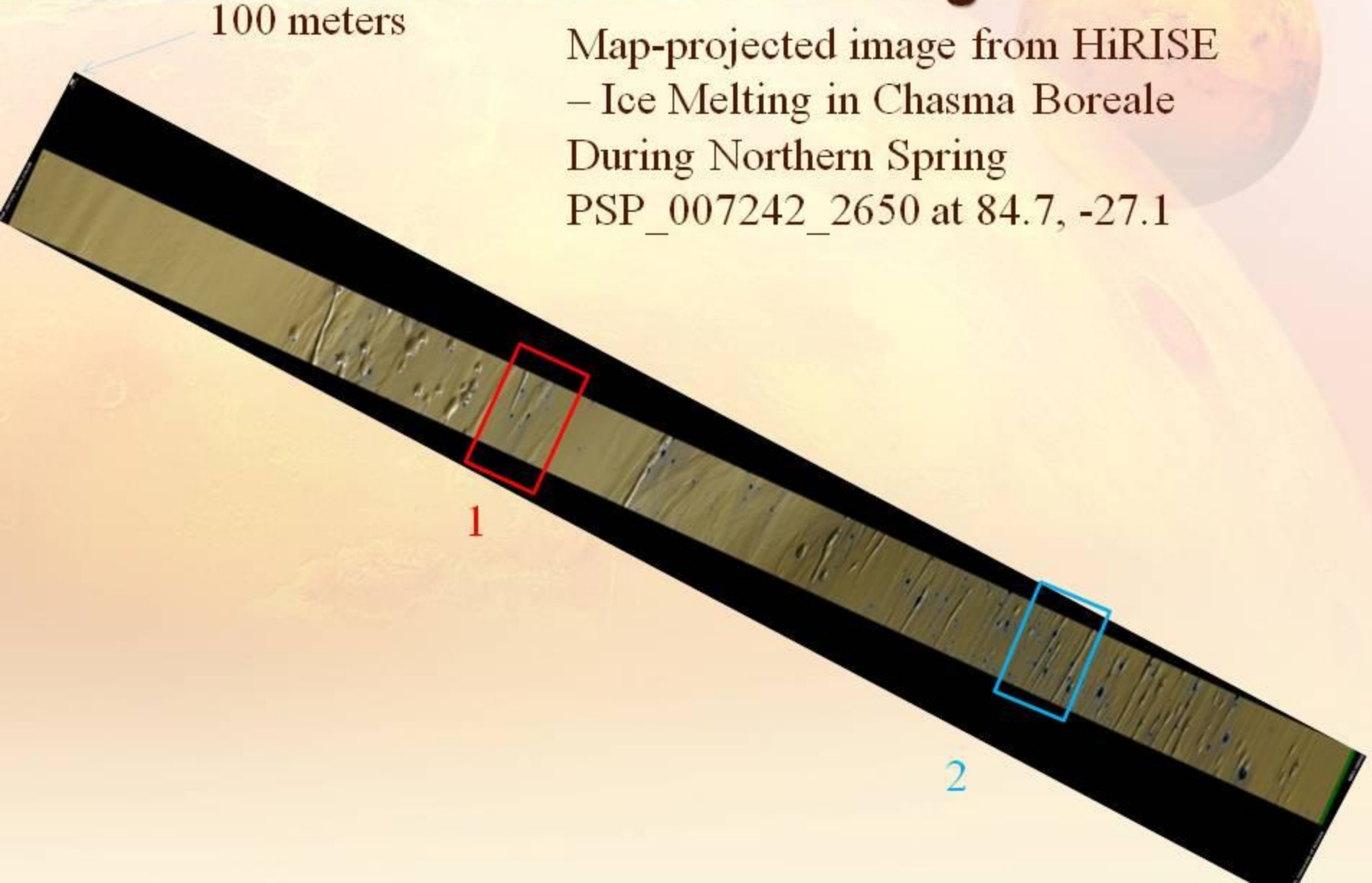
Stage 2- Ice Infill (Ness and Orme)

Stage 3- Mud Capping/Tibutary Venting (Ness and Orme)



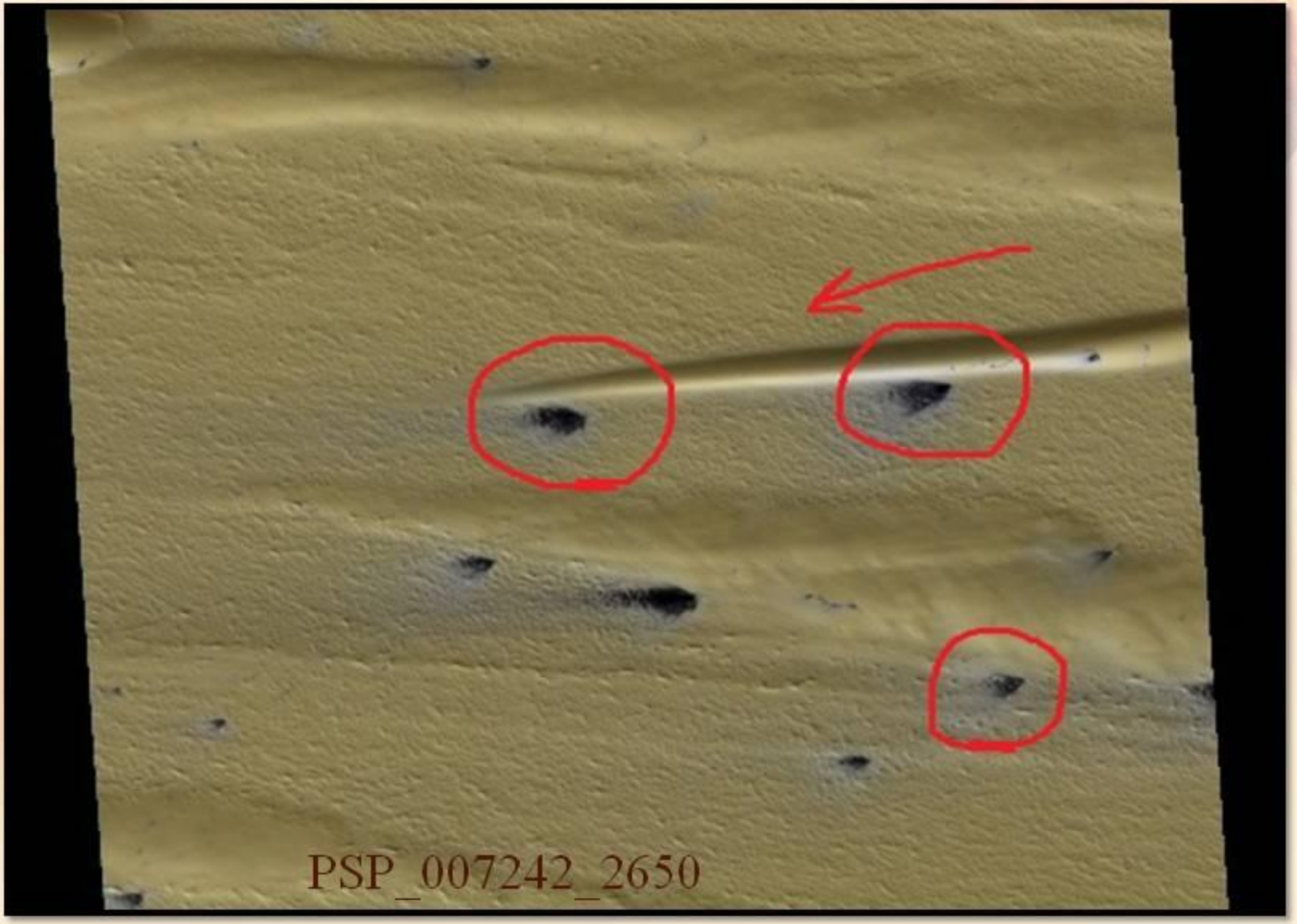
Stage 3- Mud Capping/Tibutary Venting (Ness and Orme)

Applications to Chasma Boreale Stages

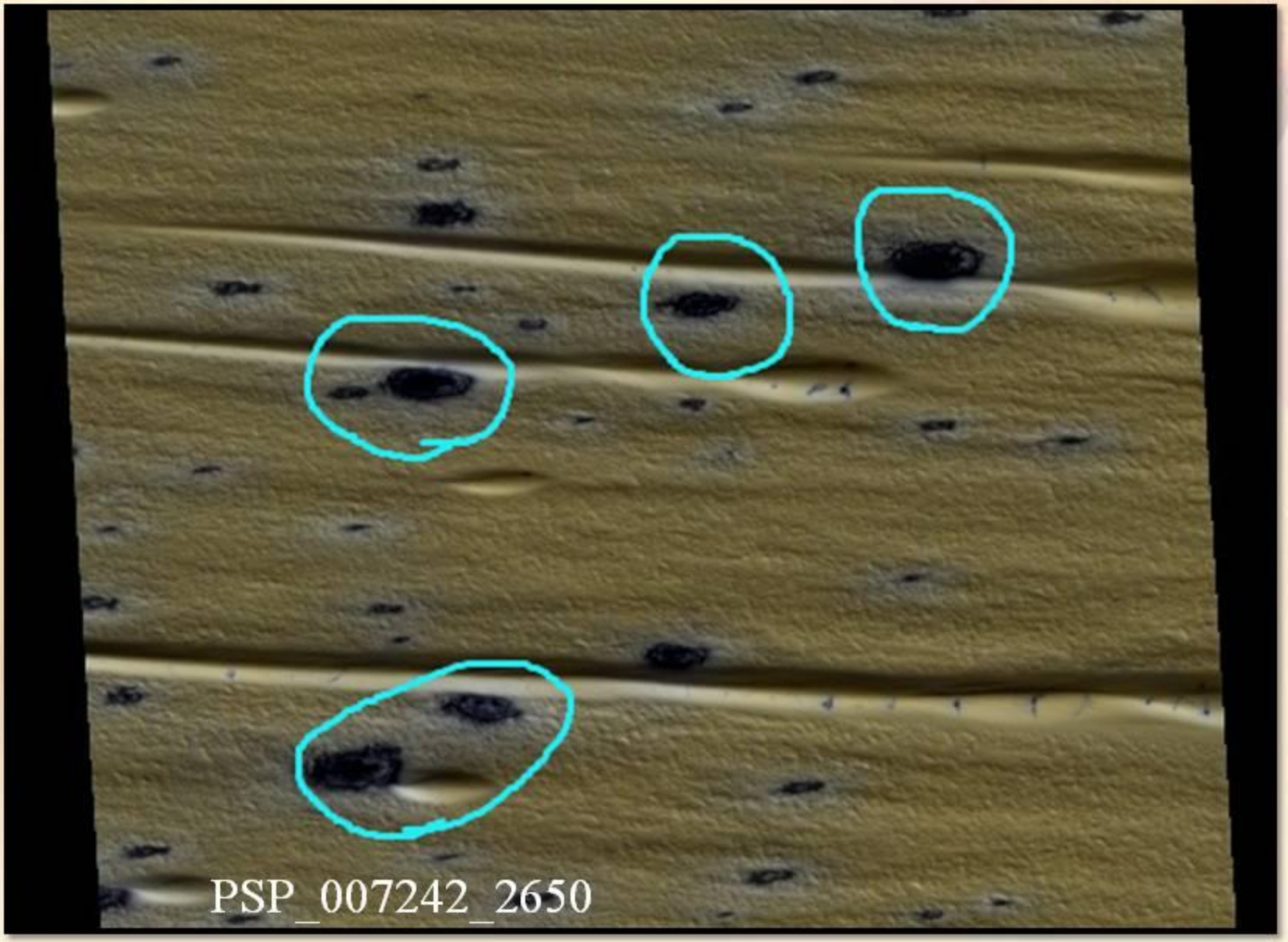


Applications to Chasma Boreale

1

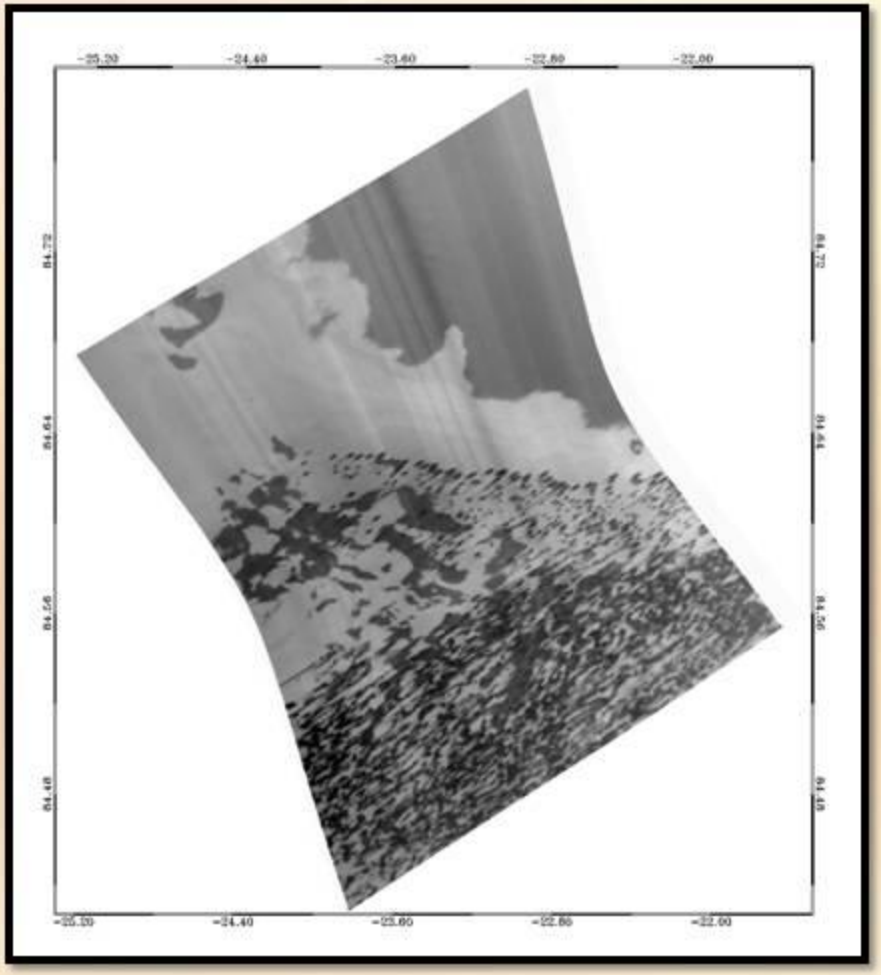


Applications to Chasma Boreale

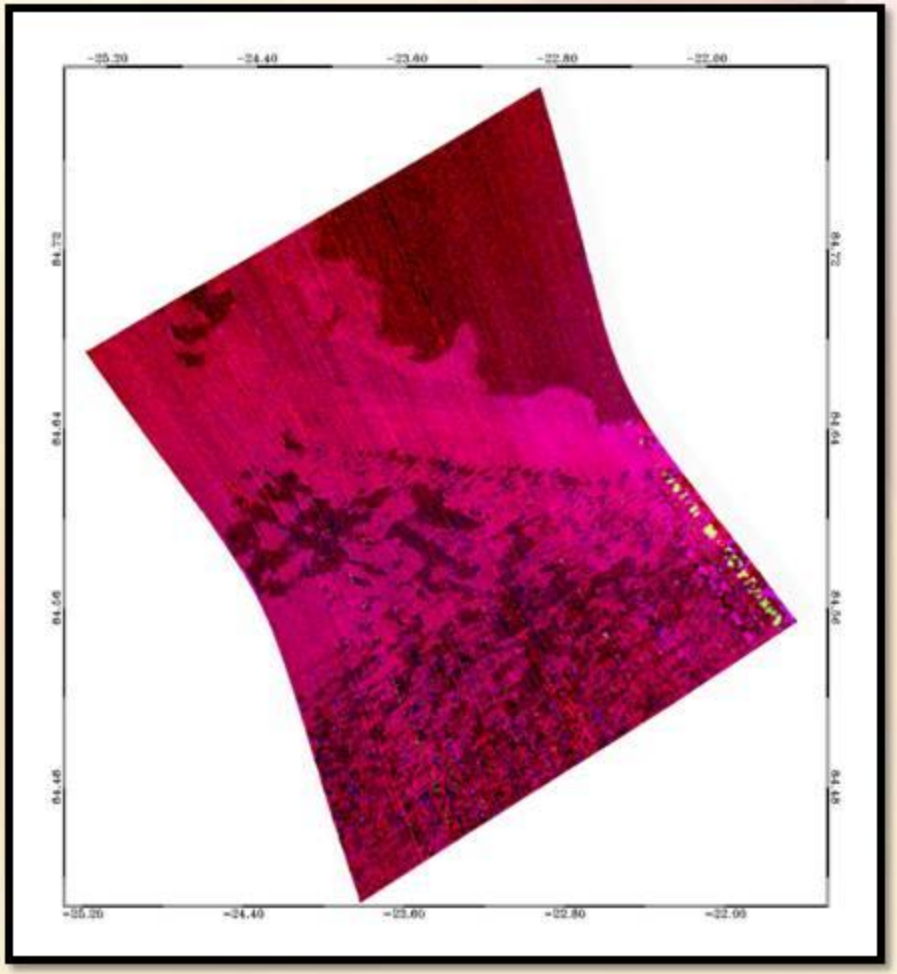


Ice Melting in Chasma Boreale –CRISM – Beginning of Northern Spring

0000BE5A Day:16 (2008)



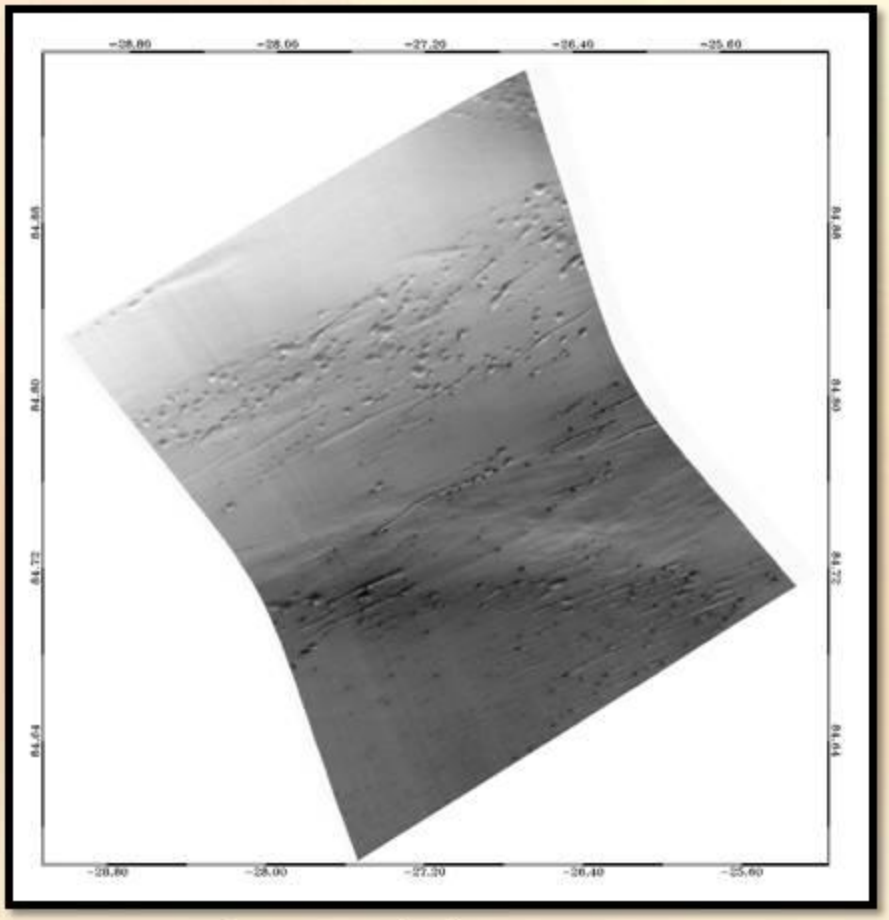
Surface Brightness



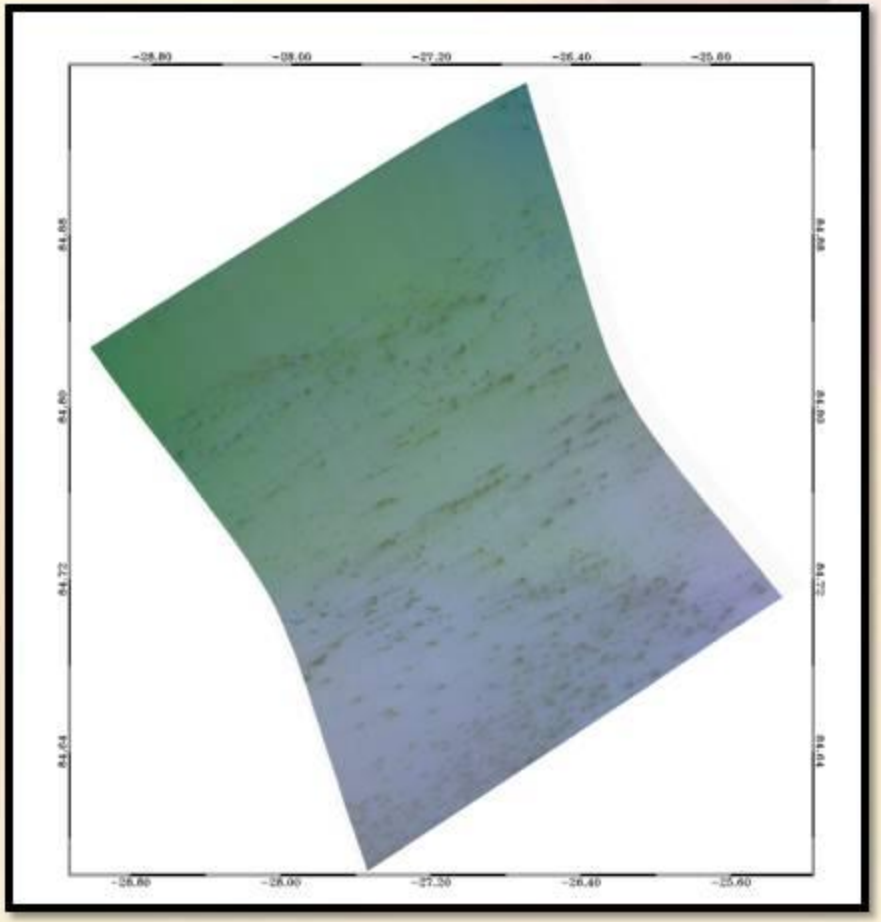
Bound Water (Ir_hyd)

Mud Runoff Chasma Boreale – CRISM– Beginning of Northern Spring

00009E31 Day:42 (2008)



Surface Brightness



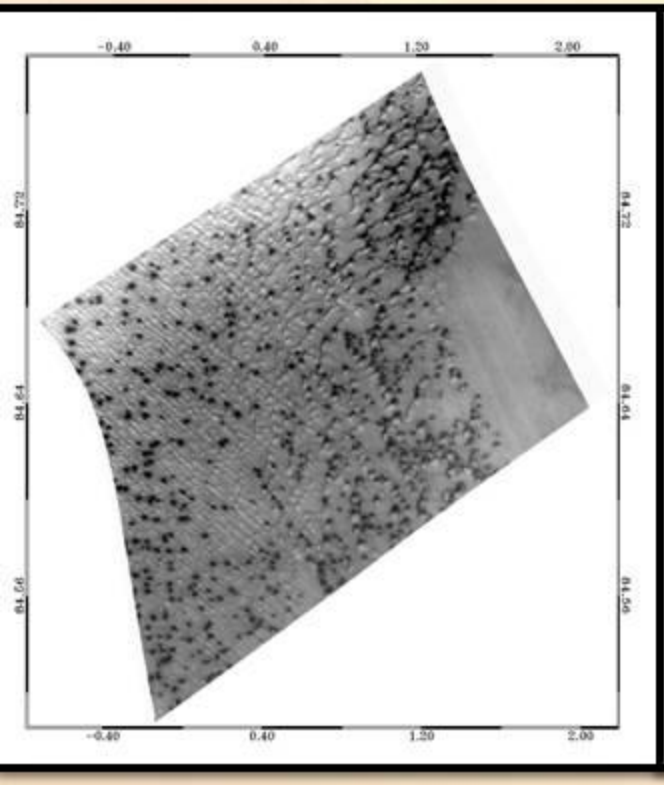
Water Ice (Ir_ice)

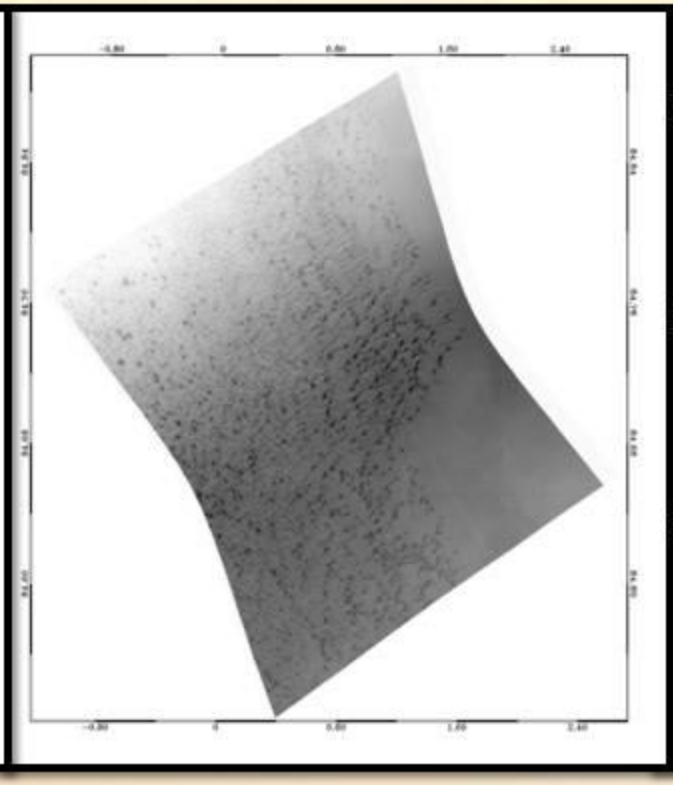
Progression from CRISM

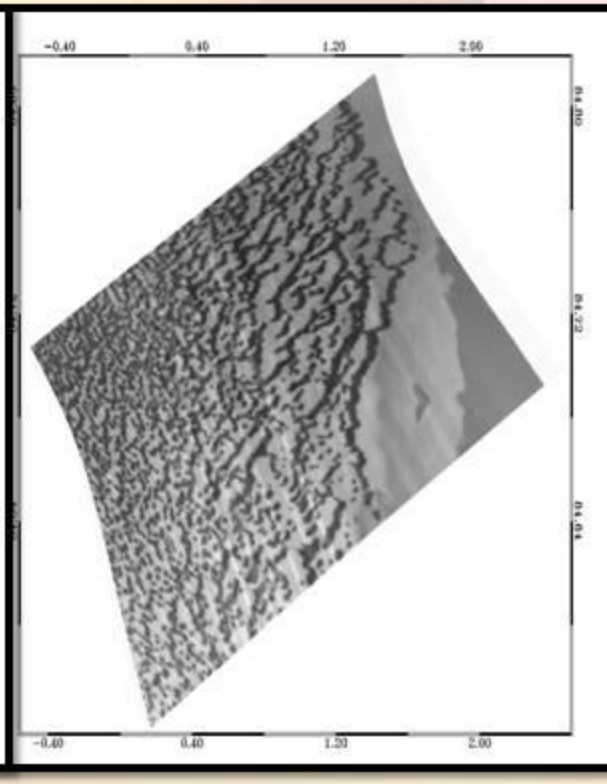
Beginning of Northern Spring

Middle of Northern Spring

Beginning of Northern Summer







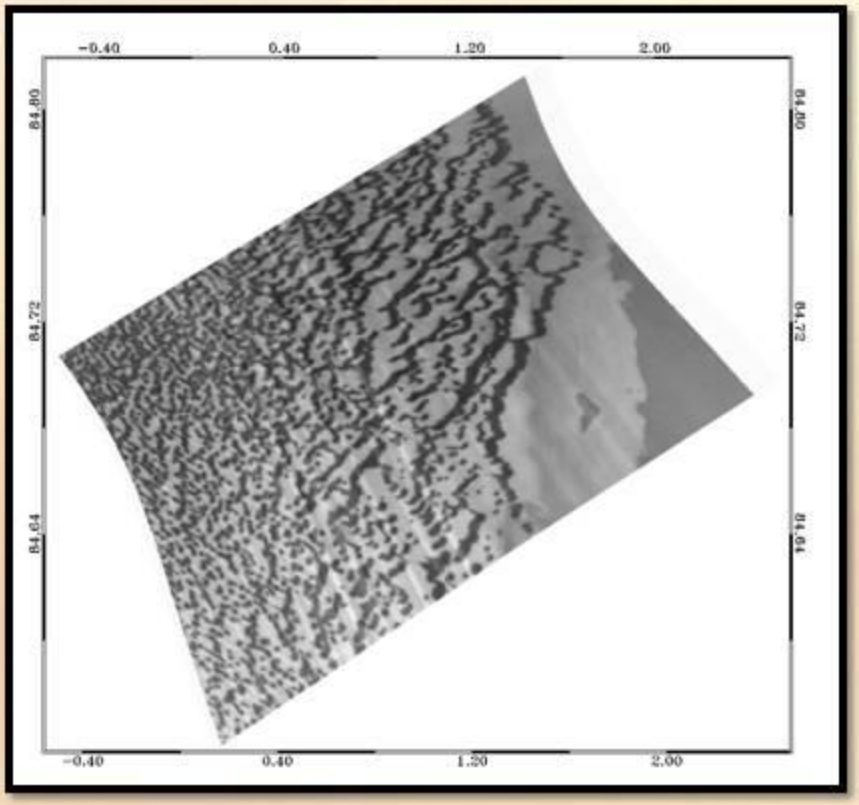
000096CB Day 14 (2008)

0000A41E Day 65 (2008)

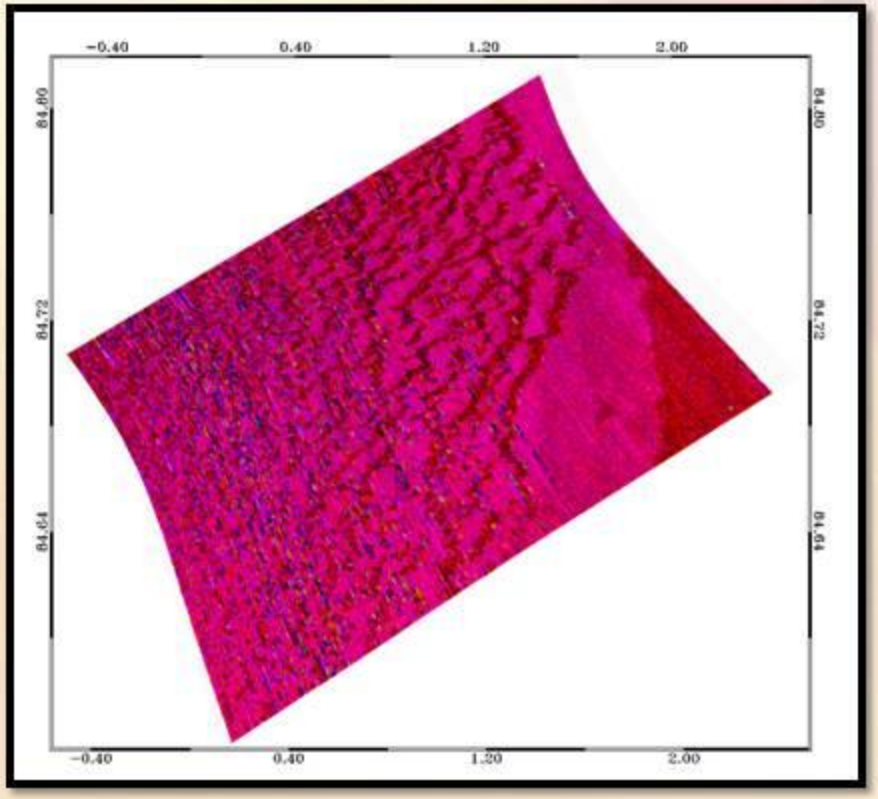
0000BB53 Day 205 (2008)

Tiles from CRISM
Beginning of Northern summer

0000BB53 Day:205 2008



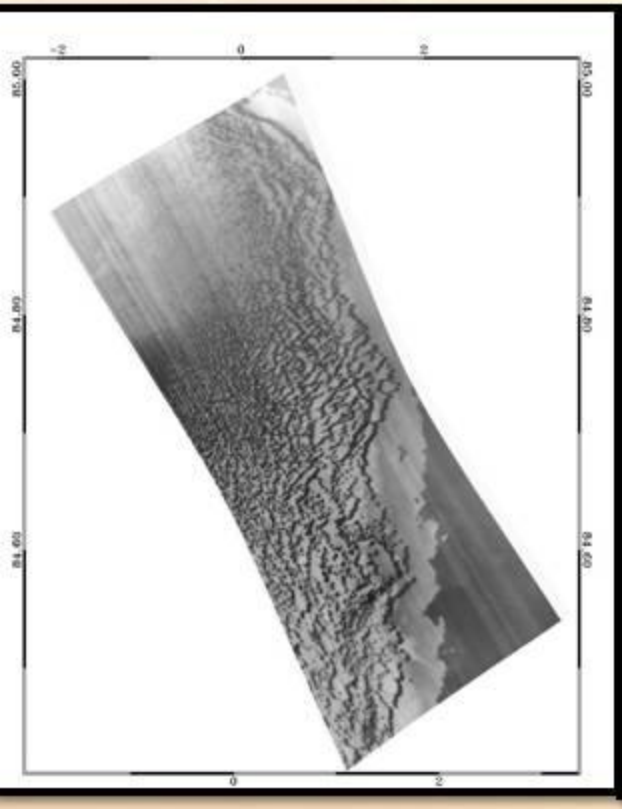
Surface Brightness



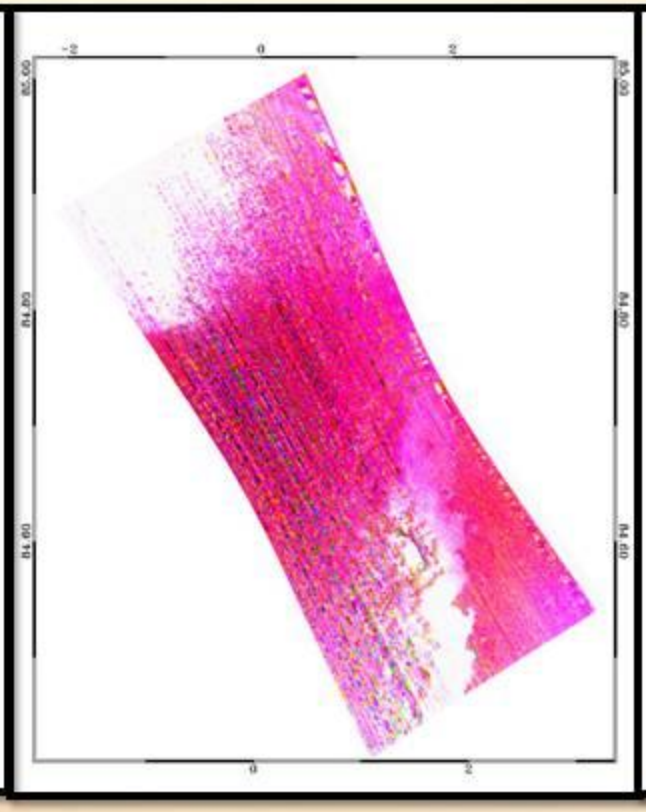
Bound Water
(Ir_hyd)

Chasma Boreale
Beginning of Northern Summer

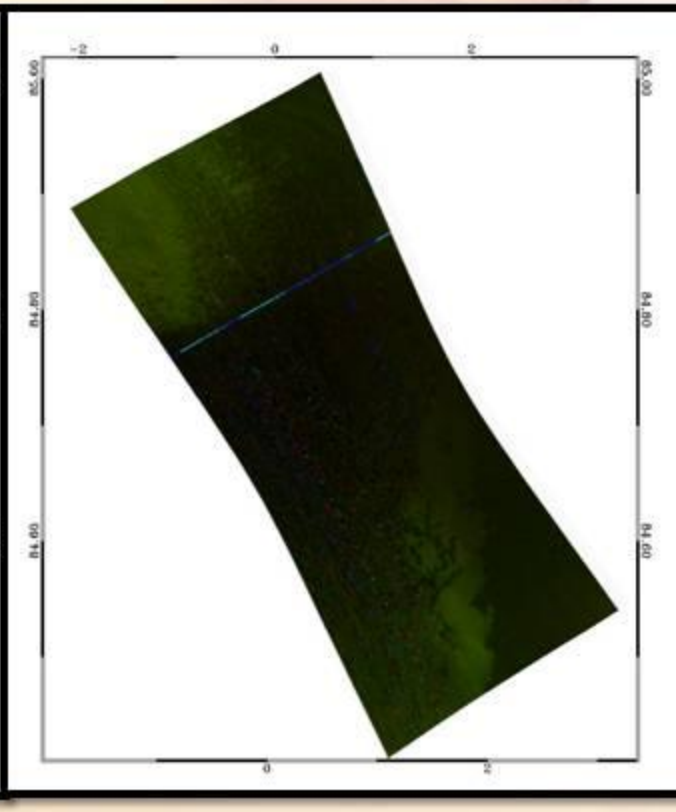
0000B3B0 Day:177 2008



Surface Brightness



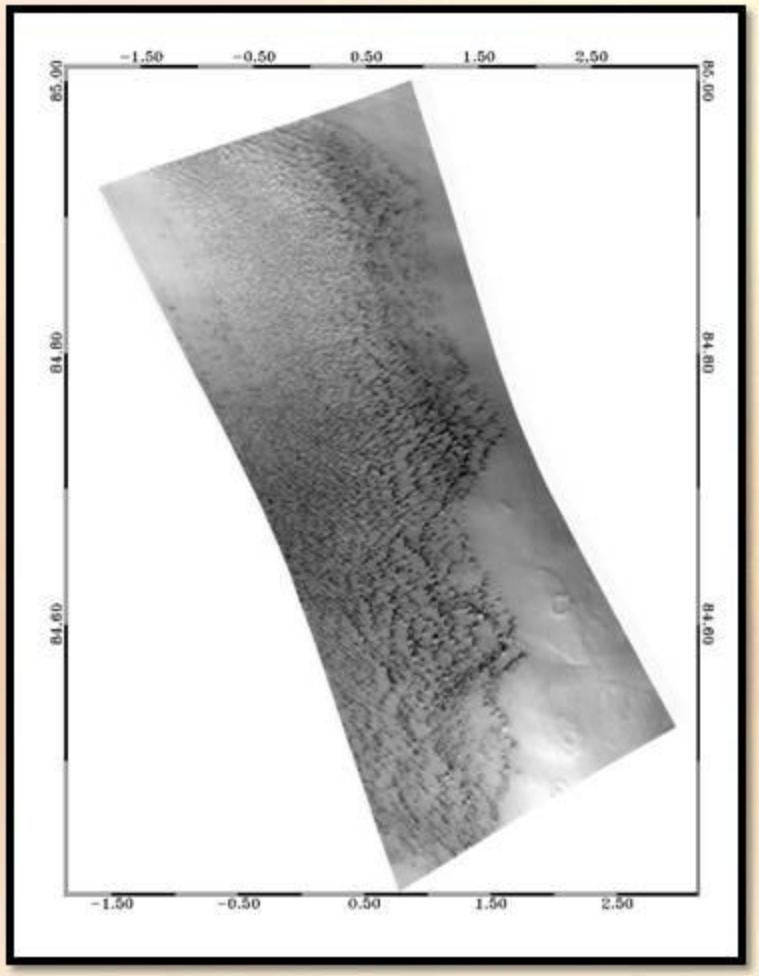
Bound Water
(Ir_hyd)



Water Ice
(Ir_ice)

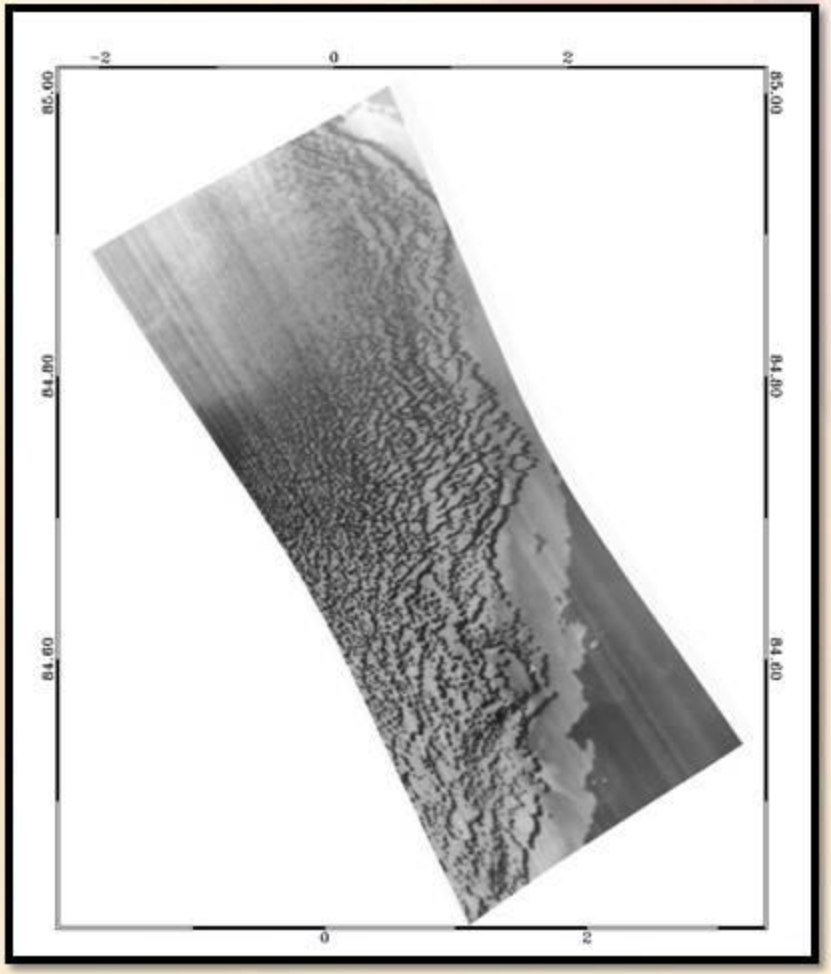
Progression – Tiles from CRISM

Middle of Northern Spring



0000AA3F Day:119 (2008)

Beginning of Northern Summer



0000B3B0 Day:177 (2008)

ESP_016994_2750_RED

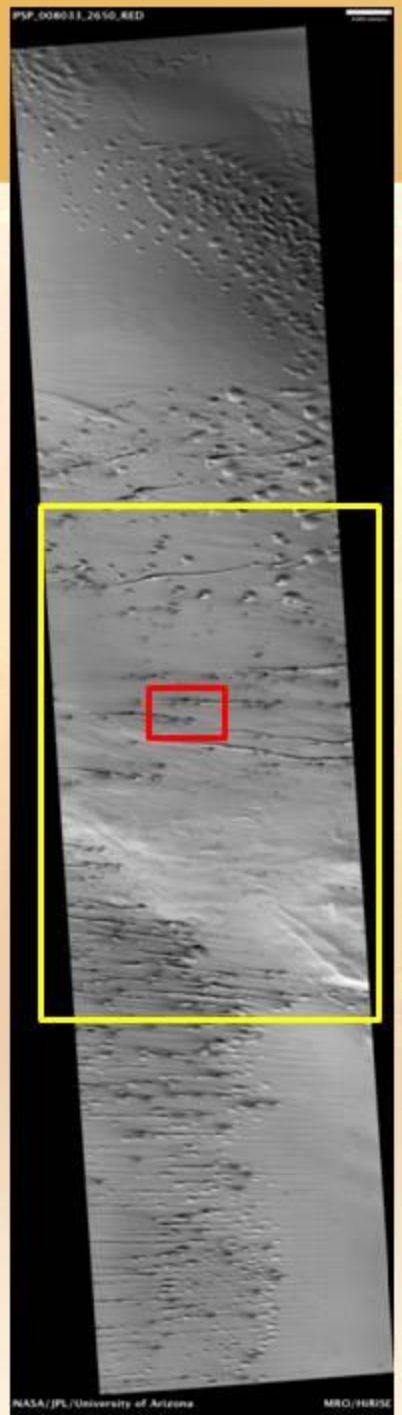
1000 meters

Frosted Chasma Boreale Dunes (HiRISE) 84.7, 1.1

March 2010 – Middle of Northern Spring

NASA/JPL/University of Arizona

MRO/HiRISE

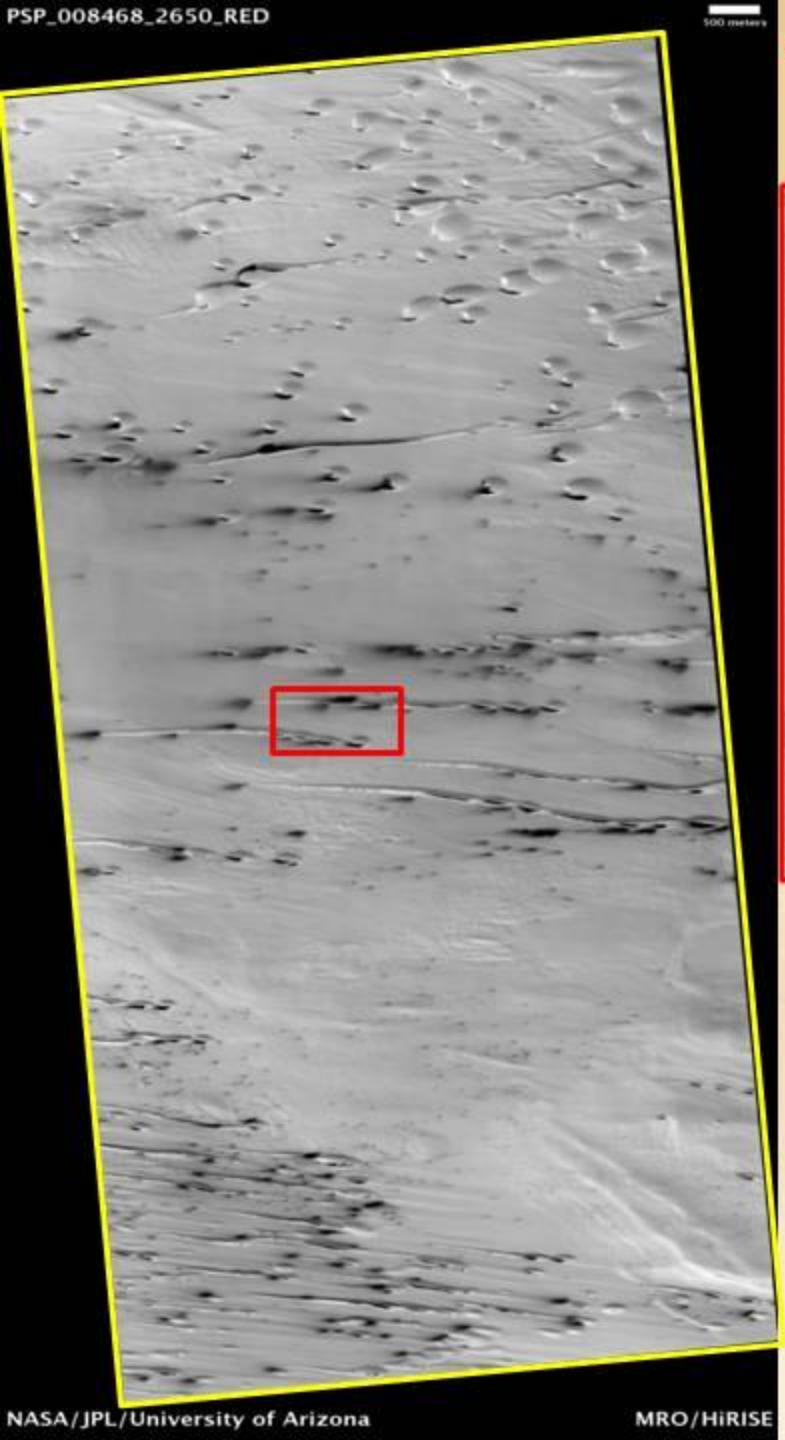


1000 meters

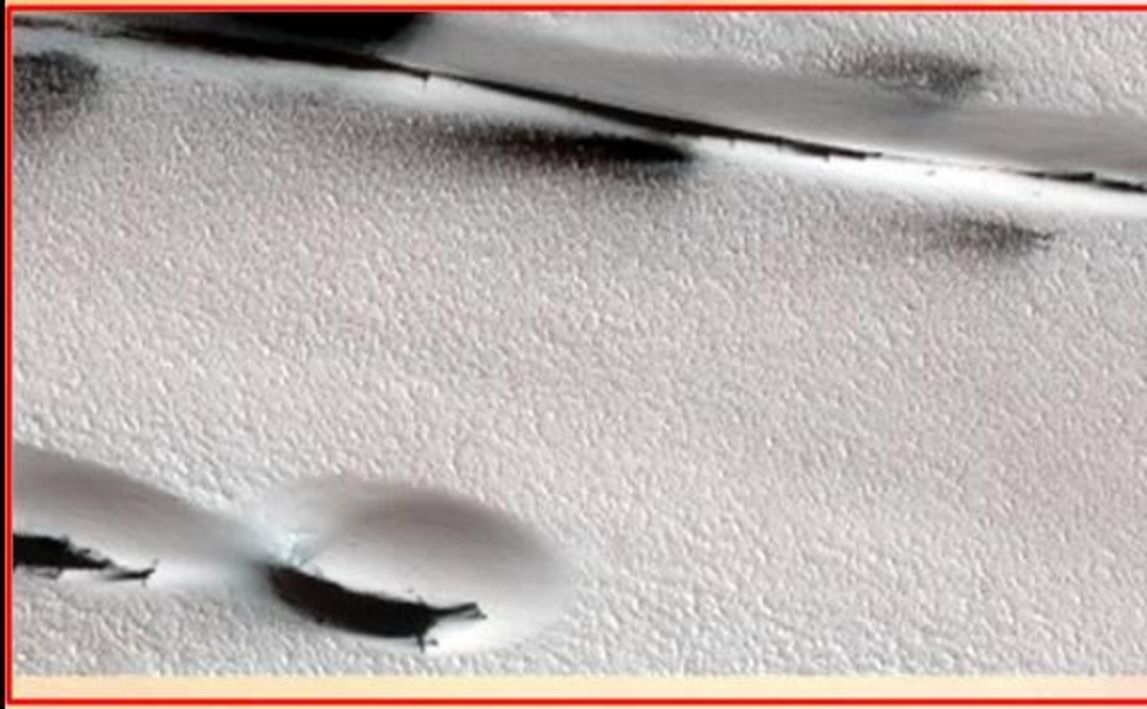
Defrosting Spots on Dunes in Chasma Boreale

*– **April** 2008 – Middle of Northern spring*

PSP_008033_2650_RED at 84.8, -26.2



500 meters

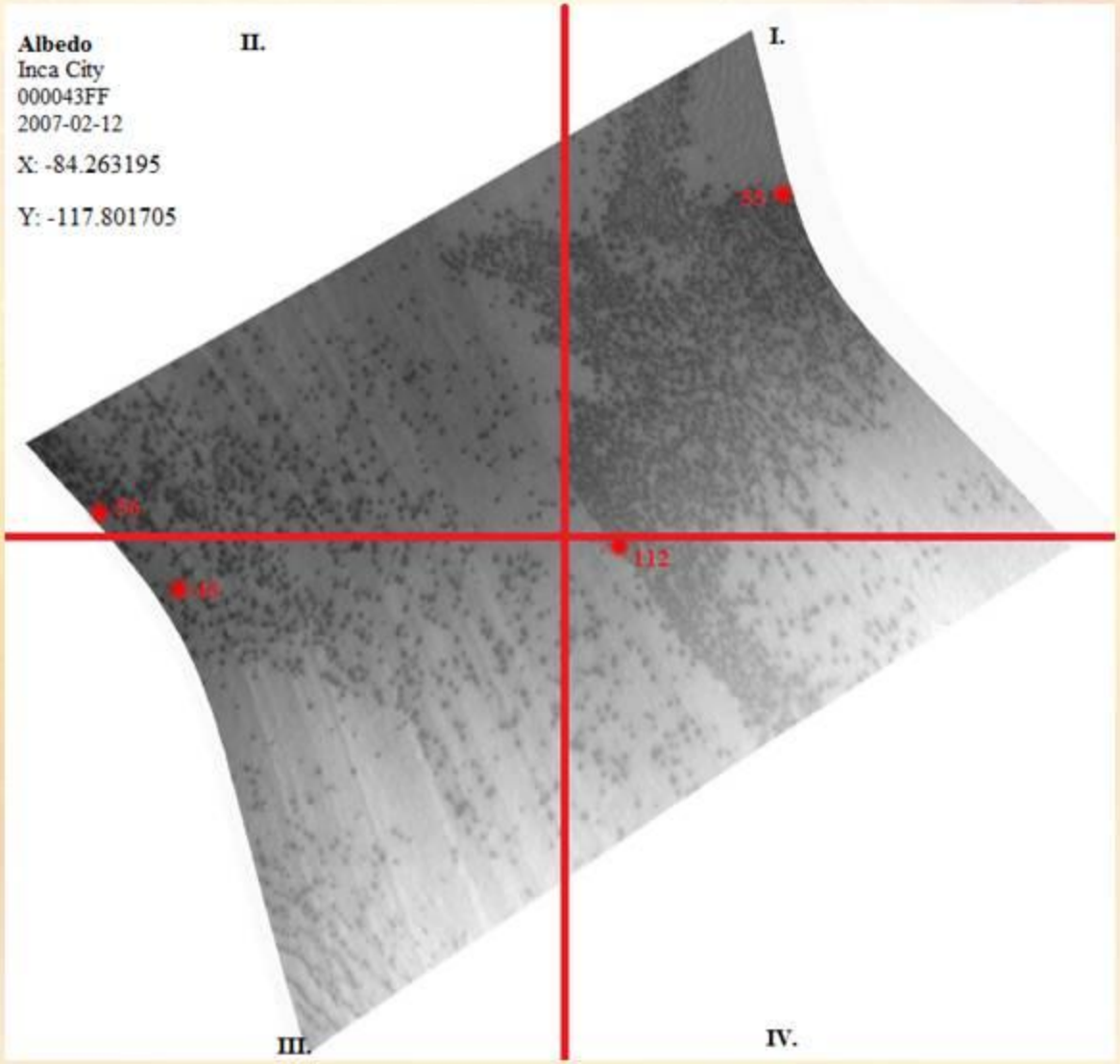


Defrosting Spots on Dunes in Chasma Boreale

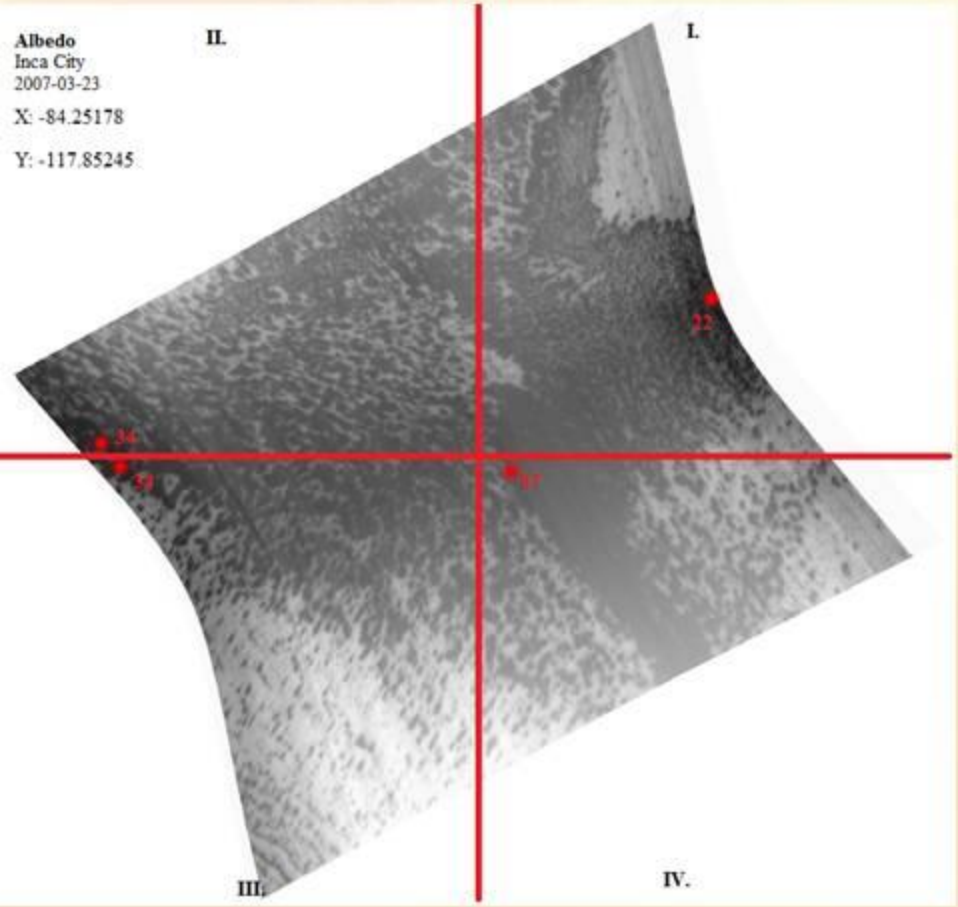
May 2008 – Middle of Northern spring

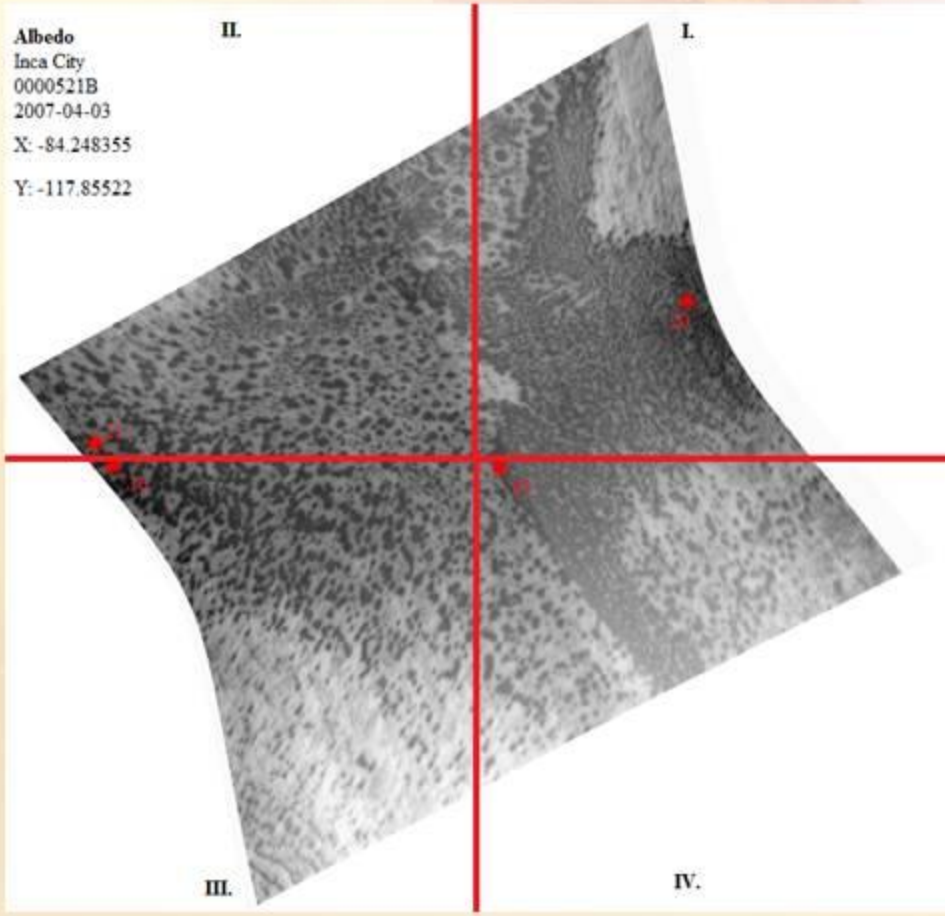
84.8, -26.2

Albedo Measurements of Inca City (Feb)

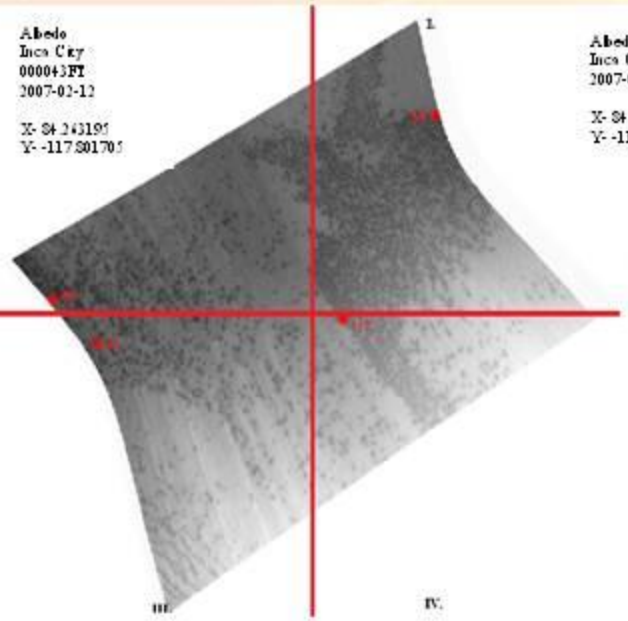


Albedo Measurements of Inca City (Mar-Apr)



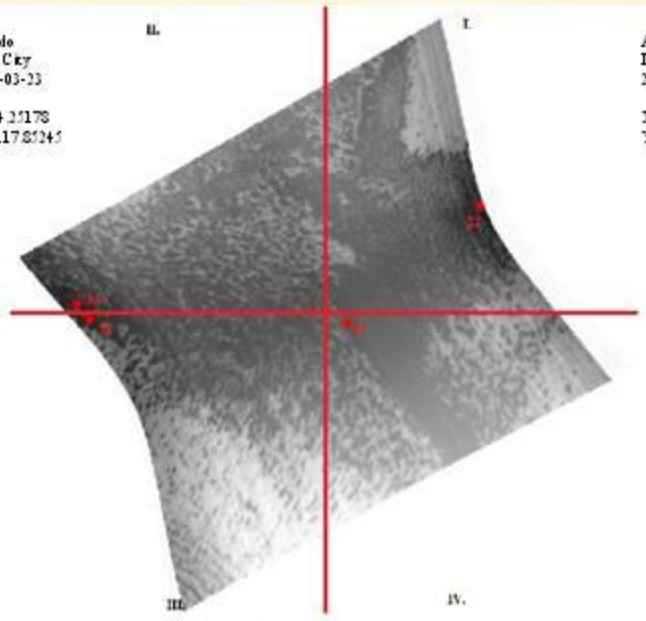


Albedo Measurements of Inca City (Feb-Apr)



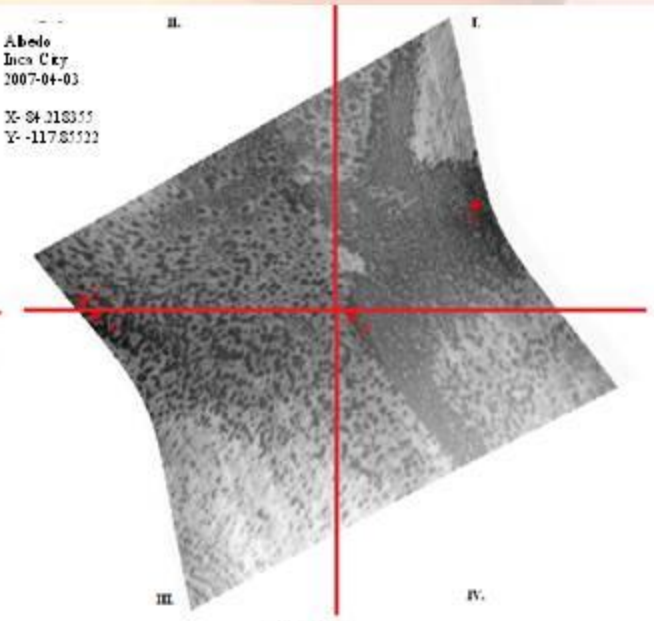
Feb. 2007

February	.337



March 2007

March	.267



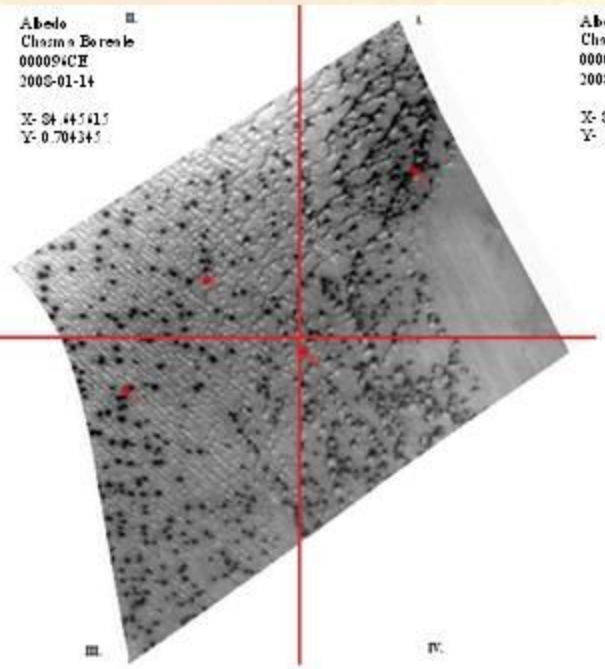
April 2007

April	.216

Inca City Albedo Values

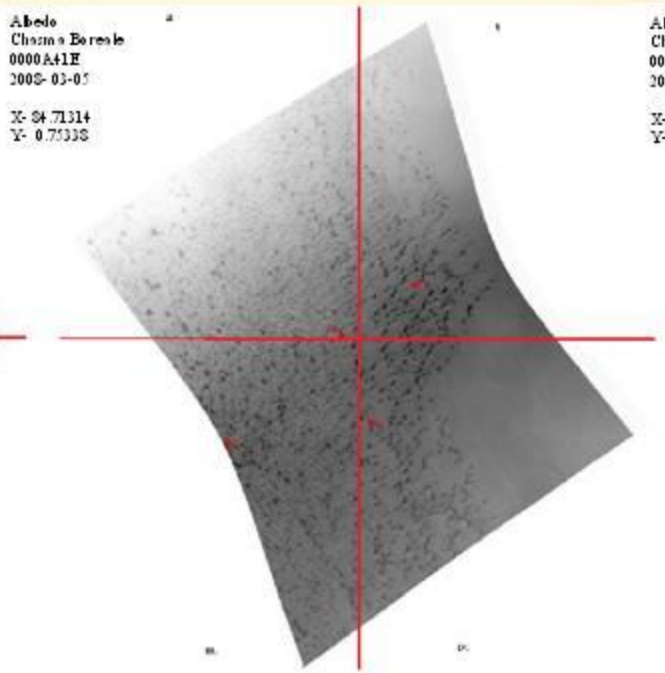
Month:	Average:
February	.337
March	.267
April	.216

Albedo Measurements of Chasma Boreale (Jan-July)



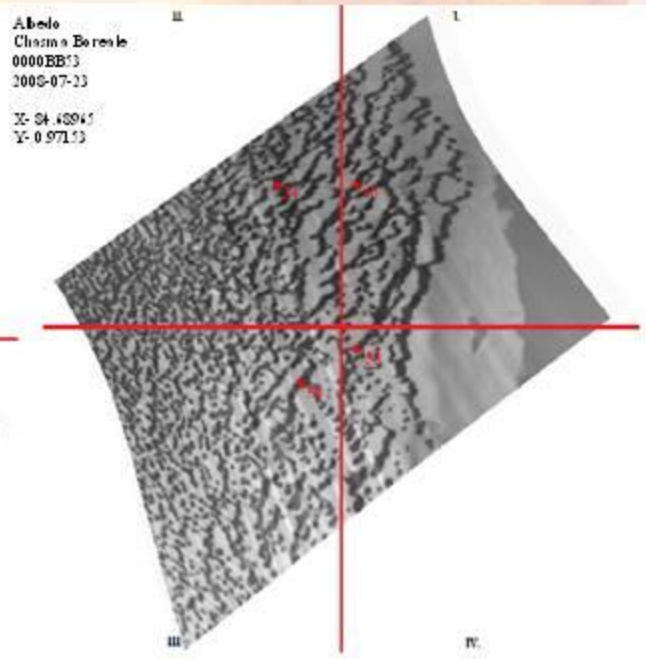
Jan. 2008

January	.333



March 2008

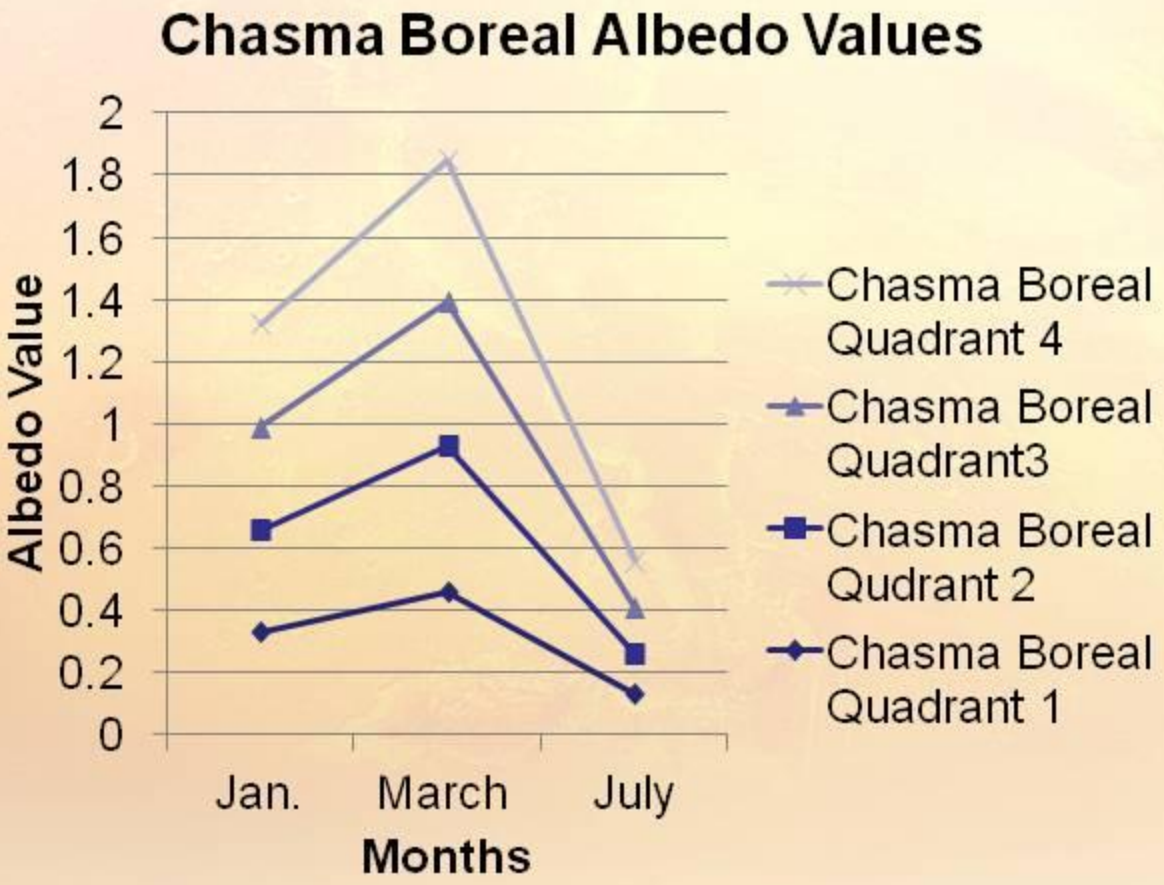
March	.467



July 2008

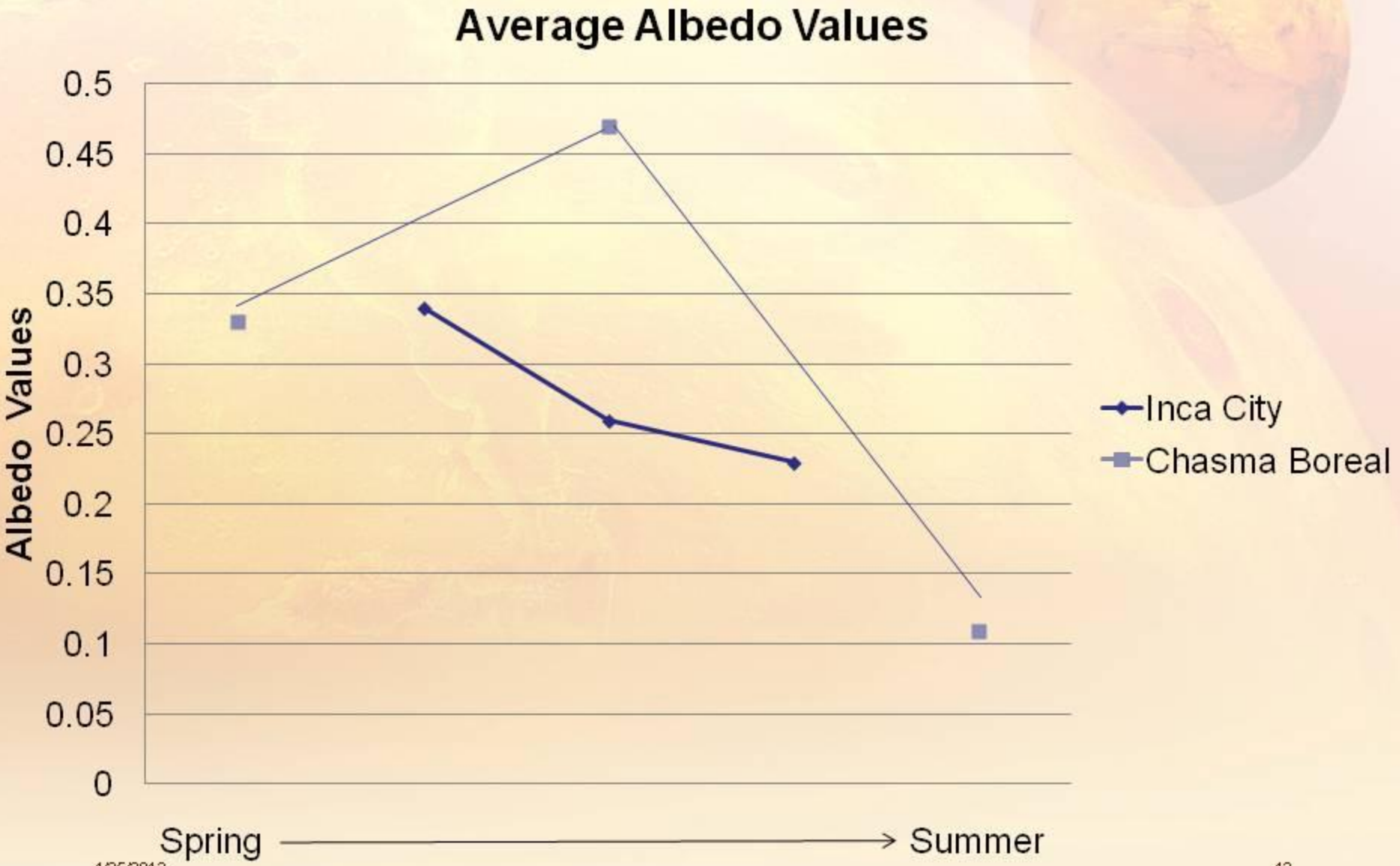
July	.143

Chasma Boreal Albedo Values



Month:	Average:
January	.333
March	.467
July	.143

Comparisons of Average Albedo Values



Analysis

- *Lower albedo near Chasma Boreale geysers support that there is a higher water content.*
- *Spectral images from CRISM reveal high concentrations of bound water and water ice in Chasma Boreale.*
- *High resolution images from HiRISE and MOC indicate that Chasma Boreale geysers are following the progression of formation described in the geyser stage model.*

Conclusions

- *Northern geysers are younger versions of the geysers found in the south because they lack spider networks, which also indicate that the northern geysers are shallower.*
- *Northern geysers will progress into stage three (network formation); therefore, delving down into the currently untapped reserves of deep, subsurface water.*
- *Chasma Boreale is an ideal area to investigate because of the abundance of geyser activity.*
- *Spring and early summer is the best time to capture geyser activity.*

References

Ness, P. K., & Orme, G.M. (2002). Spider Ravine and Plant Like Features on Mars- Possible Geophysical and Biogeophysical Modes of Origin. *Journal of the British and Planetary Science, 55, xxxx*

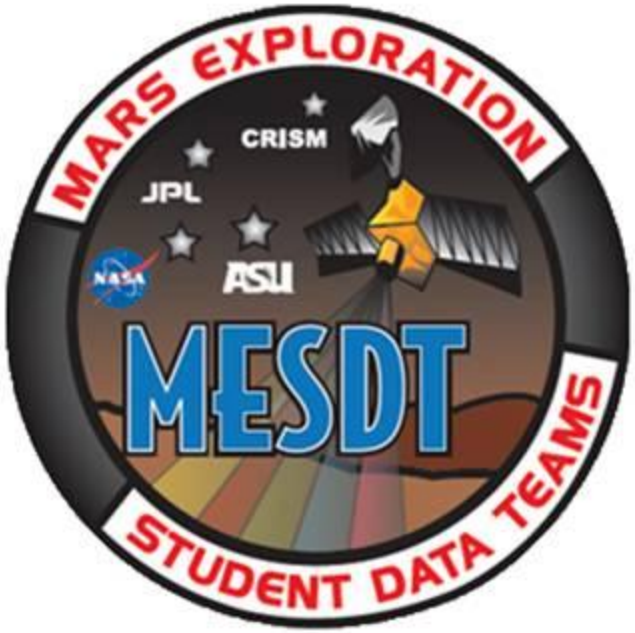
Hansen, C.J., Okubo, C. and many others (2007). HiRISE Views of the Sublimation of Mars' Southern Seasonal CO2 Cap. *Seventh International Conference on Mars*

Millikan, R.E., Mustard, J.F. (2007). Estimating the water content of hydrated minerals using reflectance spectroscopy I. Effects of darkening agents and low-albedo materials. Retrieved from http://www.sciencedirect.com

Piqueux, S. & Christensen P.R. (2007). Basal Sublimation of the Seasonal Caps and Sub-Ice Gas Flow: A Major Geomorphological Agent In the Martian Polar Regions. *Seventh International Conference on Mars.*

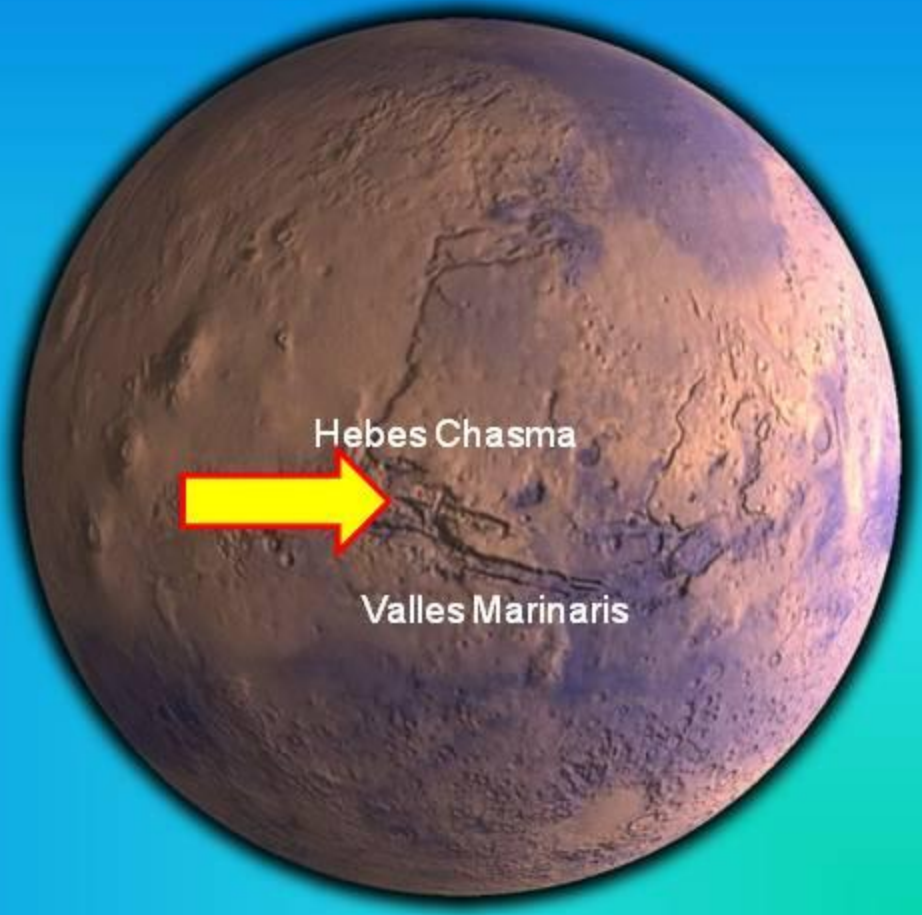
Piqueux, S., Byrne S., and Richardson, M.I. (2003). Sublimation of Mars's southern seasonal CO2 ice cap and the formation of spiders. *Journal of Geophysical Research*, 108, NO. E8, 5084

Questions/Comments?



Candor Chasma as a Proposed Mars Mission Landing Site

Taylor Biggs
&
Bradley Renner
Orting High School



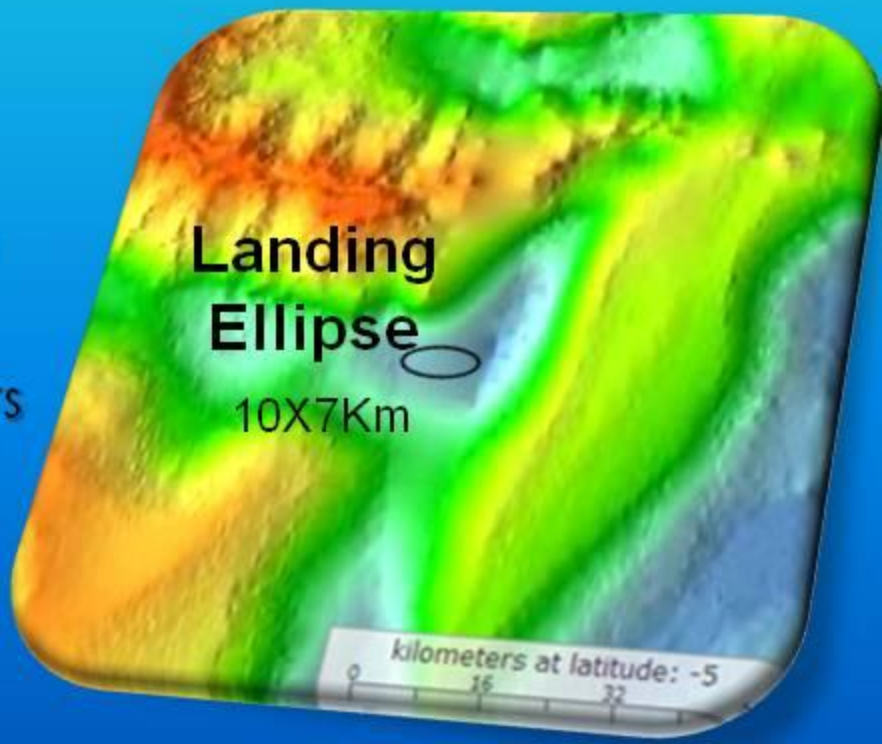
Introduction to the Mission

- Area of study: Candor Chasma:
  - south of Hebes Chasma and north of Valles Marinaris.

- Our prime science targets are to look at areas in this channel and evaluate whether there is or could have been water and life present.

- Location: 2.8 S, 74.62 W

- The closest area that has already been studied is at the Candor Chasma rim where the NASA Mars Odyssey researched.



Its All About…

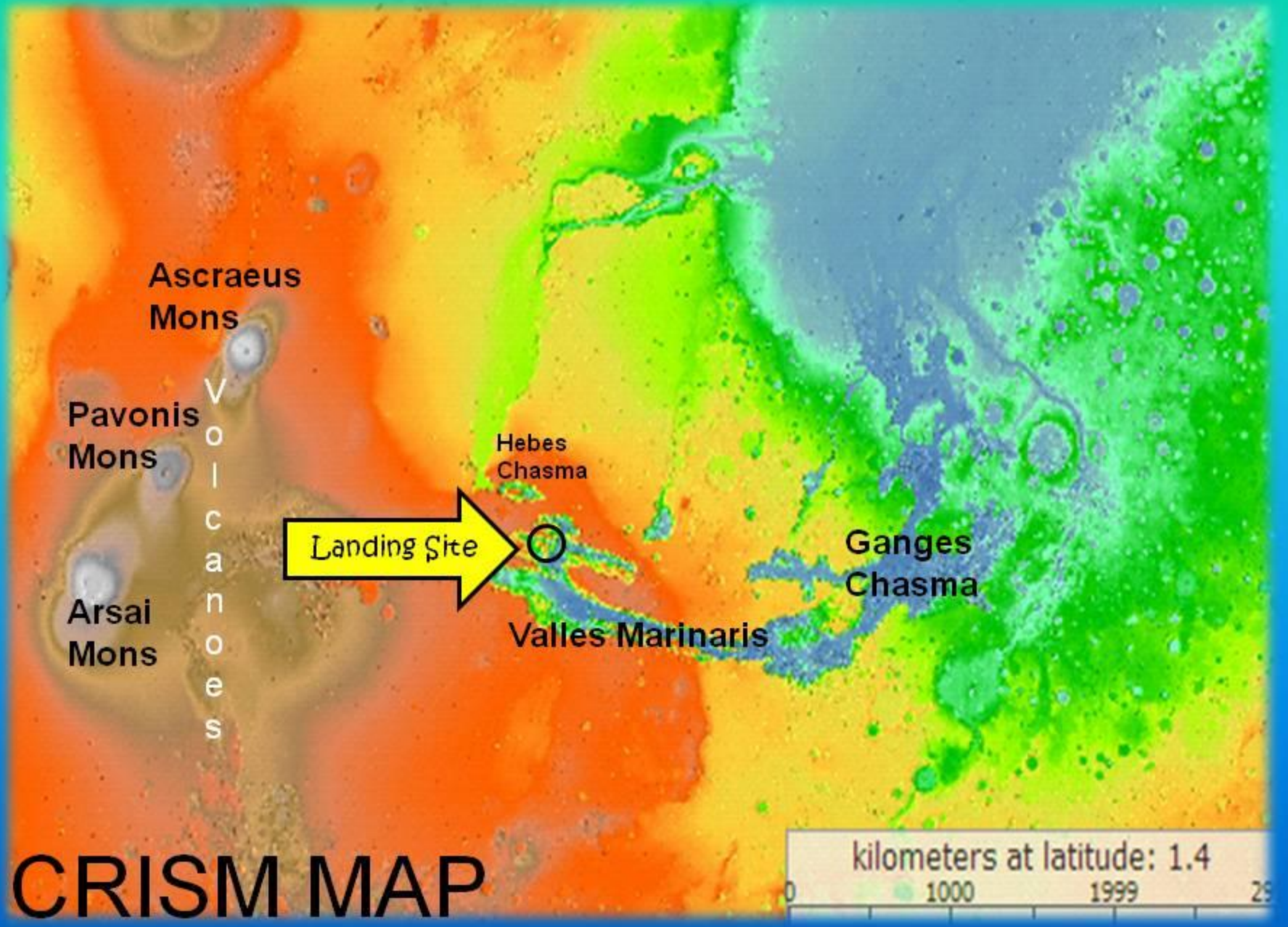
LOCATION, LOCATION, LOCATION!!!

Why Mars?

- It is important for us to research places outside of earth because earth's history has been washed away over time.
- Maybe earth used to look like Mars…
- We won't know unless we use our time and knowledge to research places outside of our planet.

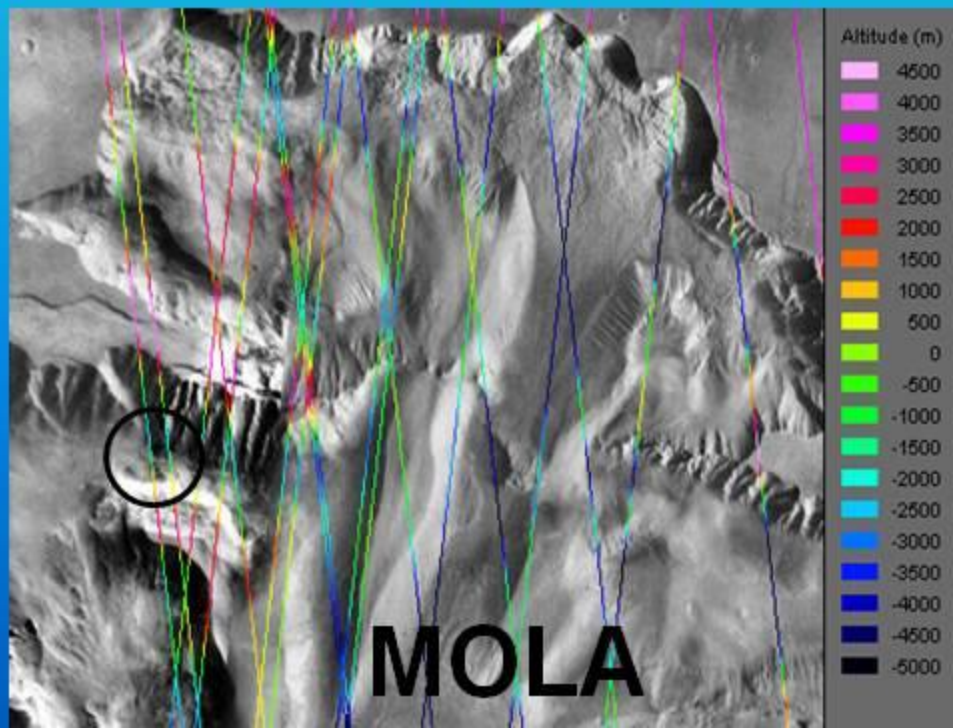
Adventure is out there!!

UP. 2009. Graphic. The New York Times, New York. Web. 26 Mar 2012


Ascraeus
Mons
Pavonis
Mons
Volcanoes
Arsai
Mons
Hebes
Chasma
Landing Site
Ganges
Chasma
Valles Marinaris
kilometers at latitude: 1.4
0
1000
1999
CRISM MAP

Engineering Constraints of the MSL (Mars Science Laboratory) Rover

- The wind levels: unknown
- If winds blow our rover off course dusty areas could wreck the rover.
- Slopes around area could be a hazard if blown off course.
- The MSL Rover needs to land at an elevation less than 1000m.
- Our elevation is -2500m compared to MOLA.
- The location is along the equator giving it plenty of light for photo electric power which ensures the rover wont have the possibility of freezing.



Methods

- We targeted this area because it looks similar to areas on Earth. We wanted to know whether the area could have been created the same way it is on Earth because they look so similar.
- We observed the targeted area using a variety of instruments
- To assess the elevation and lay of the land we used MOLA
- For a higher resolution image of the region we used THEMIS
- To analyze the minerals present we used CRISM and JCAT

Geologic History

- This area has:
  - Differences of elevations.
  - Different levels of calcium pyroxene in different layers.
  - There are volcanoes to the west.
  - These pieces of evidence cause us to conclude that lava has hardened into igneous rocks called basalt forming many layers.

Hypothesis on the Formation of Candor Chasma

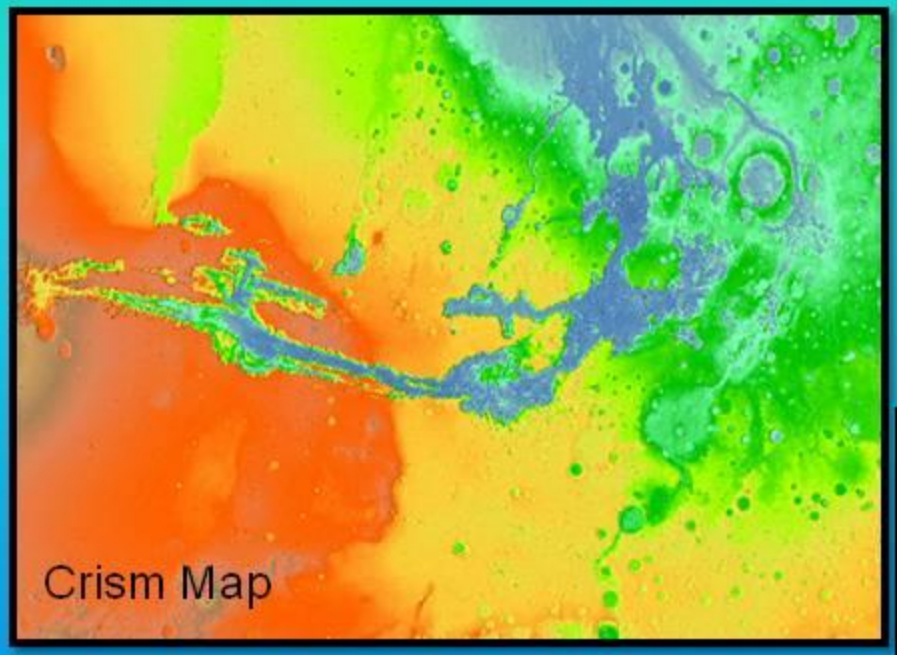
- Scientists propose that magma pooling underneath the surface caused swelling in the area where Valles Marinaris is found.
- This swelling caused a large crack to form.
- This cracking is called extensional fracturing.
- Water may have flowed through this area to make the crack expand.

Channeled Scablands

"Outflow Channels." *Euro Planet IDIS*. 07/06/2010. Web. 24 Apr 2012. <http://europlanet.dlr.de/node/index.php?id=404>.

- During the Ice Ages, A huge glacial lake burst and tremendous amounts of water flowed from Montana into Eastern Washington to form the Channeled Scablands.
- Notice the wide circled channel.

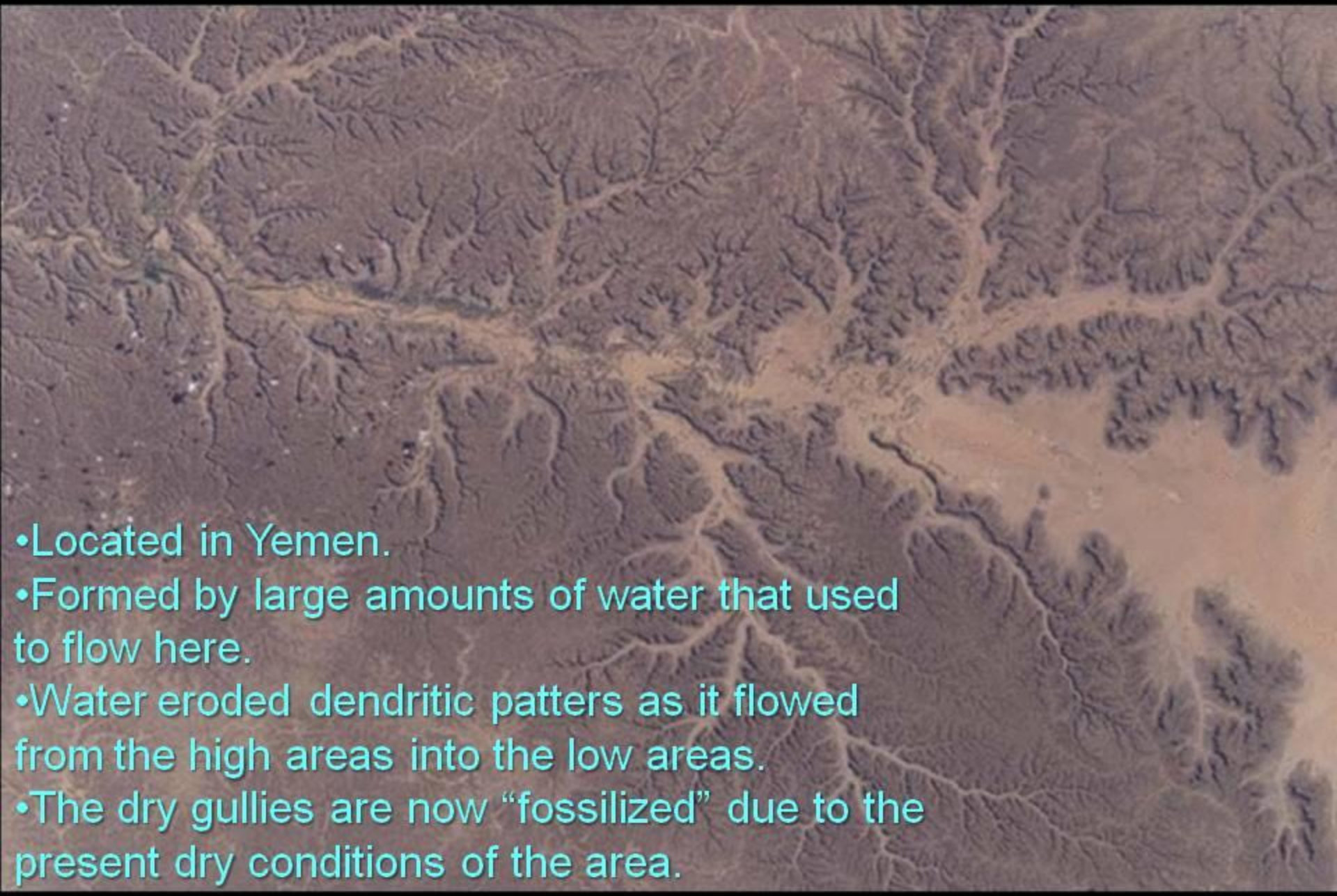
Mars vs. Earth



Channel on Mars

Channel on Earth

"Outflow Channels." *Euro Planet IDIS*. 07/06/2010. Web. 24 Apr 2012. <http://europlanet.dlr.de/node/index.php?id=404>.



- Located in Yemen.
- Formed by large amounts of water that used to flow here.
- Water eroded dendritic patters as it flowed from the high areas into the low areas.
- The dry gullies are now “fossilized” due to the present dry conditions of the area.

"Outflow Channels." *Euro Planet IDIS*. 07/06/2010. Web. 24 Apr 2012. <http://europlanet.dlr.de/node/index.php?id=404>.

Mars vs. Earth

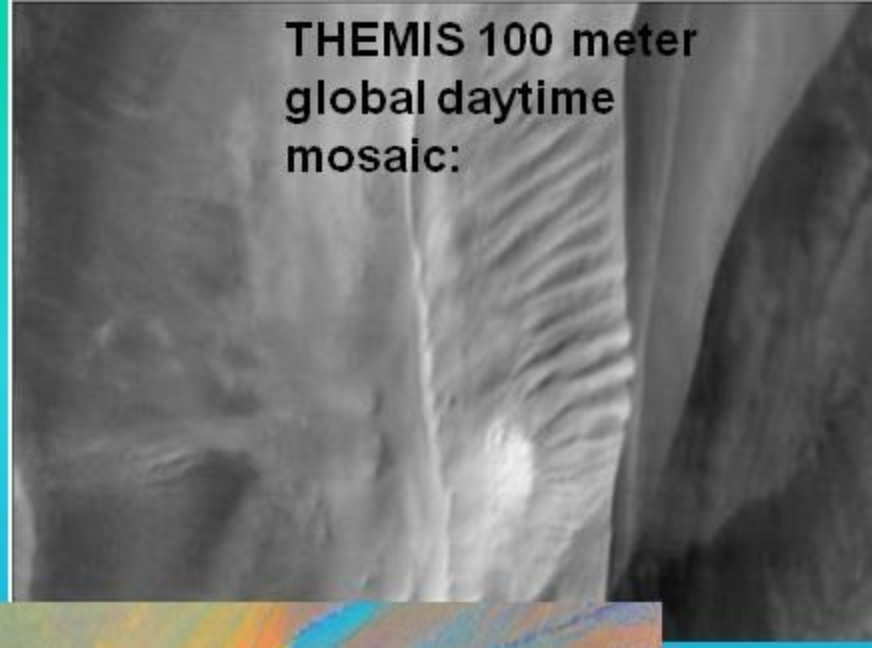
Channel on Mars

Channel on Earth

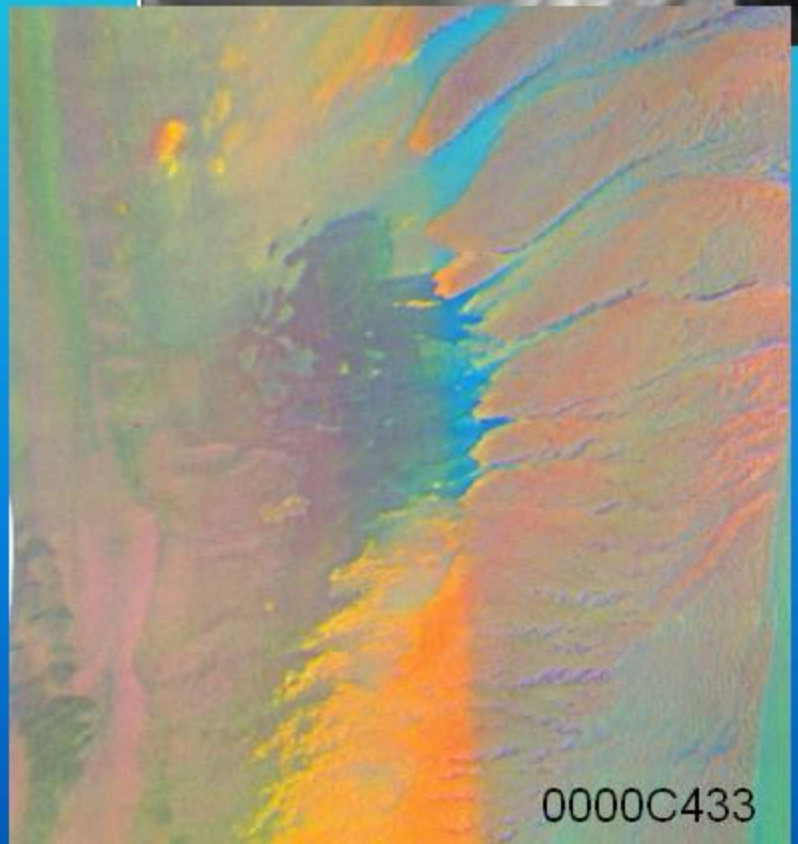
"Outflow Channels." *Euro Planet IDIS*. 07/06/2010. Web. 24 Apr 2012. <http://europlanet.dlr.de/node/index.php?id=404>.

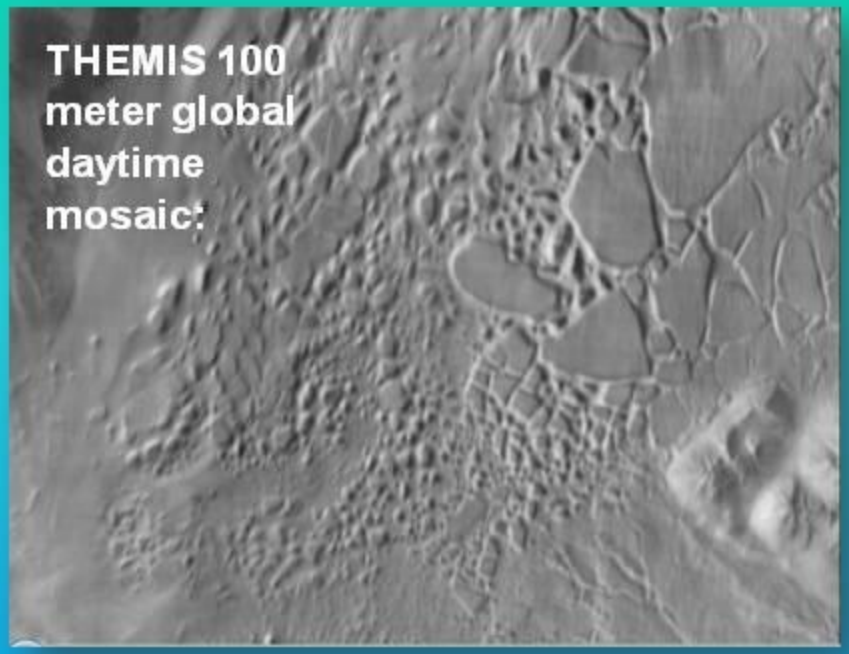
Slope Streaks

- Red is covered by dust
- Blue is clear of dust



- Something is clearing the dust off of parts of the slope
- This could be caused by wind, water, or ice.





Chaos Terrain On Mars

Death Valley California

Californian
Geological Survey

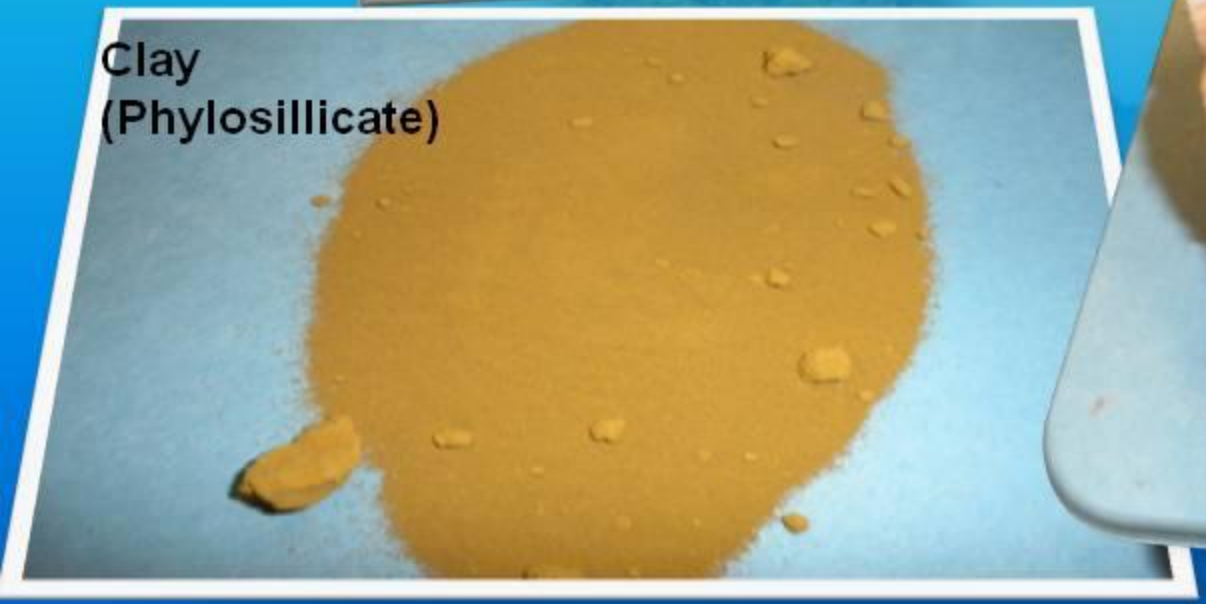
Water's Influence

- Even though scientists who study Mars theorize that Valles Marinaris was geologically formed there is surface feature evidence to suggest it has been altered by water.
  - Possible enlargement by flooding.
  - Surface erosion causing dendritic drainage patterns.
  - Chaos terrain caused by evaporation.
- There is also mineralogical evidence of water in this area.

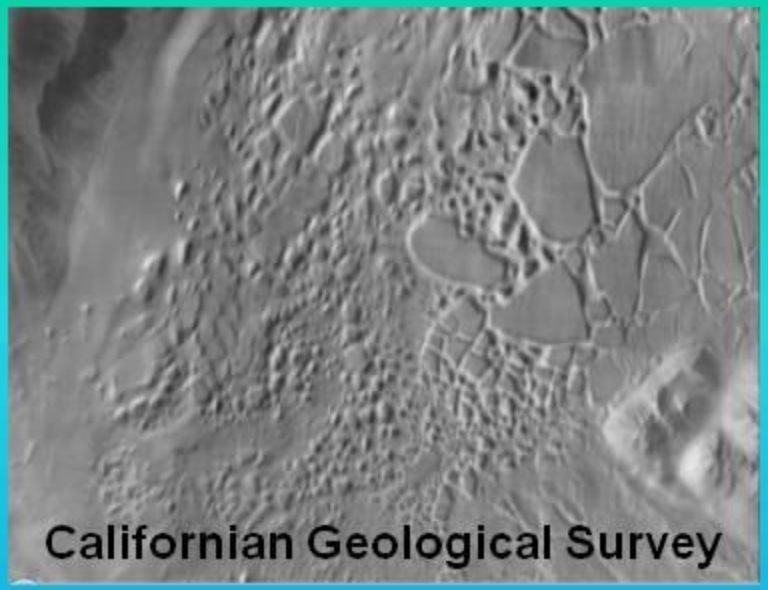
Important Minerals

- Hydrated aluminum phylosillicates (clays) were found in these areas.
- Phylosillicates are mostly formed in the presence of water.
- We also found minerals absorbed, dissolved, or bound by water which is an indicator of sulfates, which are formed when water evaporates.
- According to "Bacteria Back from the Brink" sulfates have been known to trap and preserve microbes in salt valleys for thousands to millions of years.

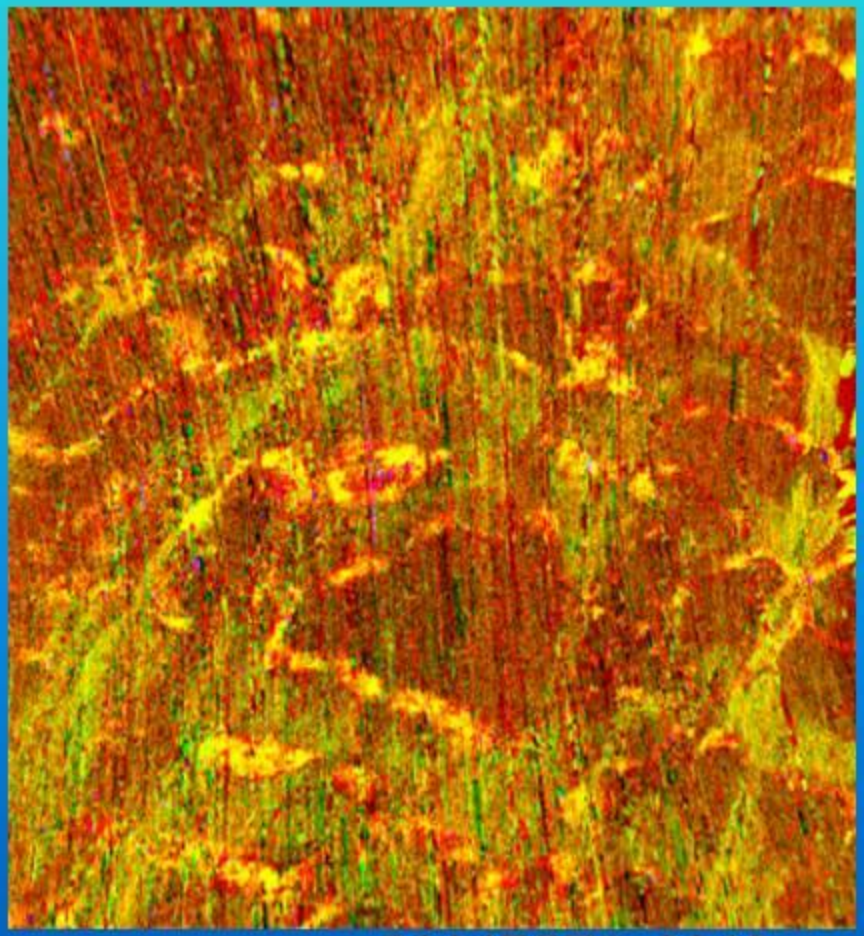
Basalt
(Pyroxene and Olivine)



Chaos Terrain On Mars



- Red indicates evaporate minerals
- Yellow indicates monohydrated sulfates
- These same minerals have been known to trap halobacteria in salt valleys



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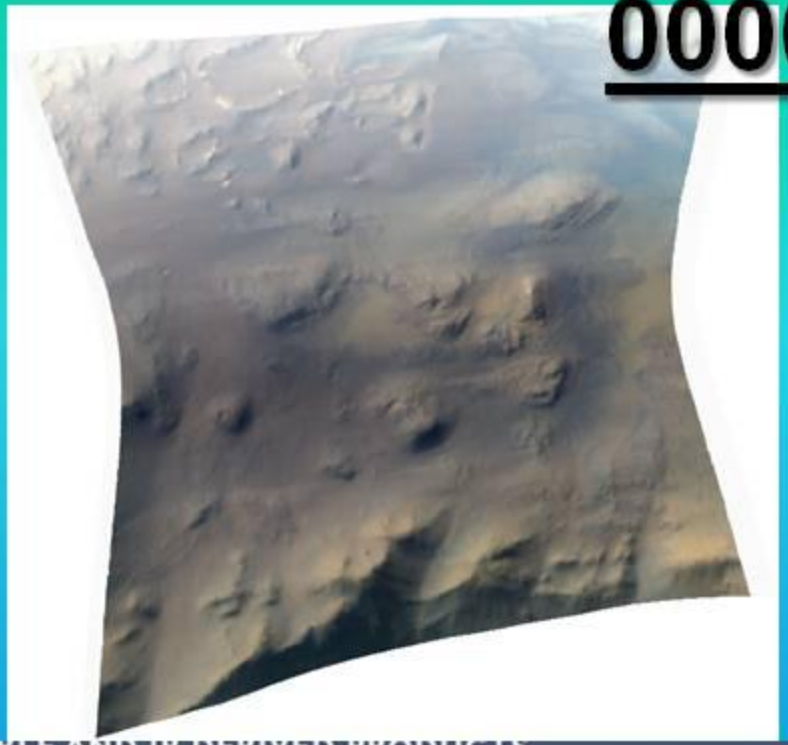

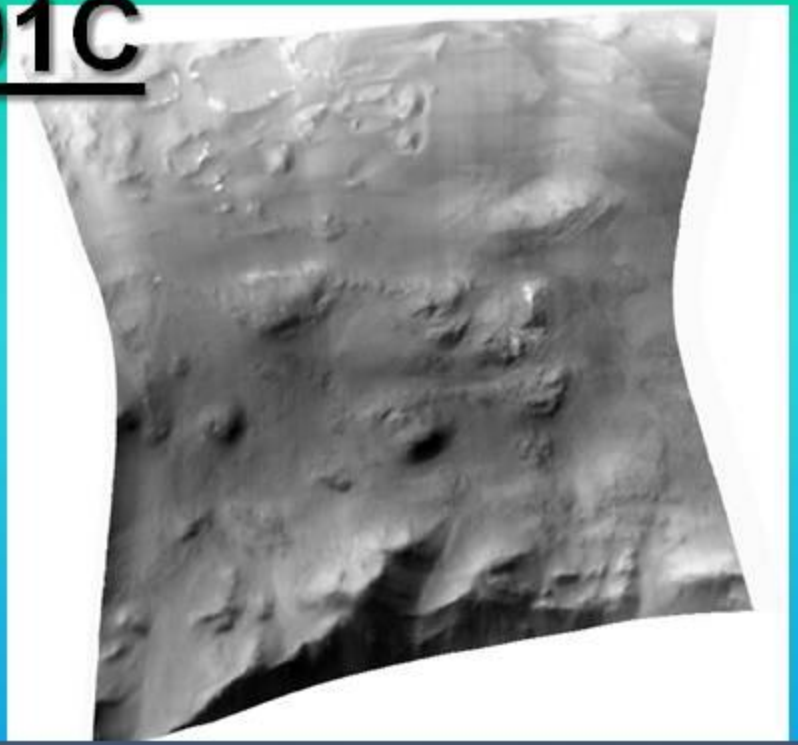

VISIBLE AND IR DERIVED PRODUCTS

vnir_fem

Oxidized iron minerals

red = BD530 (ferric minerals)

green = SH600 nm (coatings)

blue = BDI1000nm (variety of iron minerals)

Click image above to enlarge.

Downloads:
- PNG
- PNG w/ geo_grid
- Map/Stretch Info

ir_maf

Mafic mineralogy

red = OLINDEX (olivine or iron phyllosilicates)

green = LCPINDEX (low-Ca pyroxene)

blue= HCPINDEX (high-Ca pyroxene)

Click image above to enlarge.

Downloads:
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ir_phy

Hydroxylated silicates

red = BD2300 (Fe/Mg phyllosilicate)

green = BD2210 (Al phyllosilicate or hydrated glass)

blue=BD1900 (hydrated sulfates, clays, glass, or water ice)

Click image above to enlarge.

Downloads:
- PNG
- PNG w/ geo_grid
- Map/Stretch Info

ir_hyd

Bound water

red = SINDEX (water-containing minerals or water ice)

green = BD2100 (monohydrated sulfates or water ice)

blue = BD1900nm. (hydrated sulfates, clays, glass, or water ice)

Click image above to enlarge.

Downloads:
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- PNG w/ geo_grid
- Map/Stretch Info

ir_ice

Water and CO2 ice

red = BD1900 (water ice or hydrated sulfates, clays, or glass)

green = BD1500 (water ice)

blue=BD1435 (CO2 ice)

Click image above to enlarge.

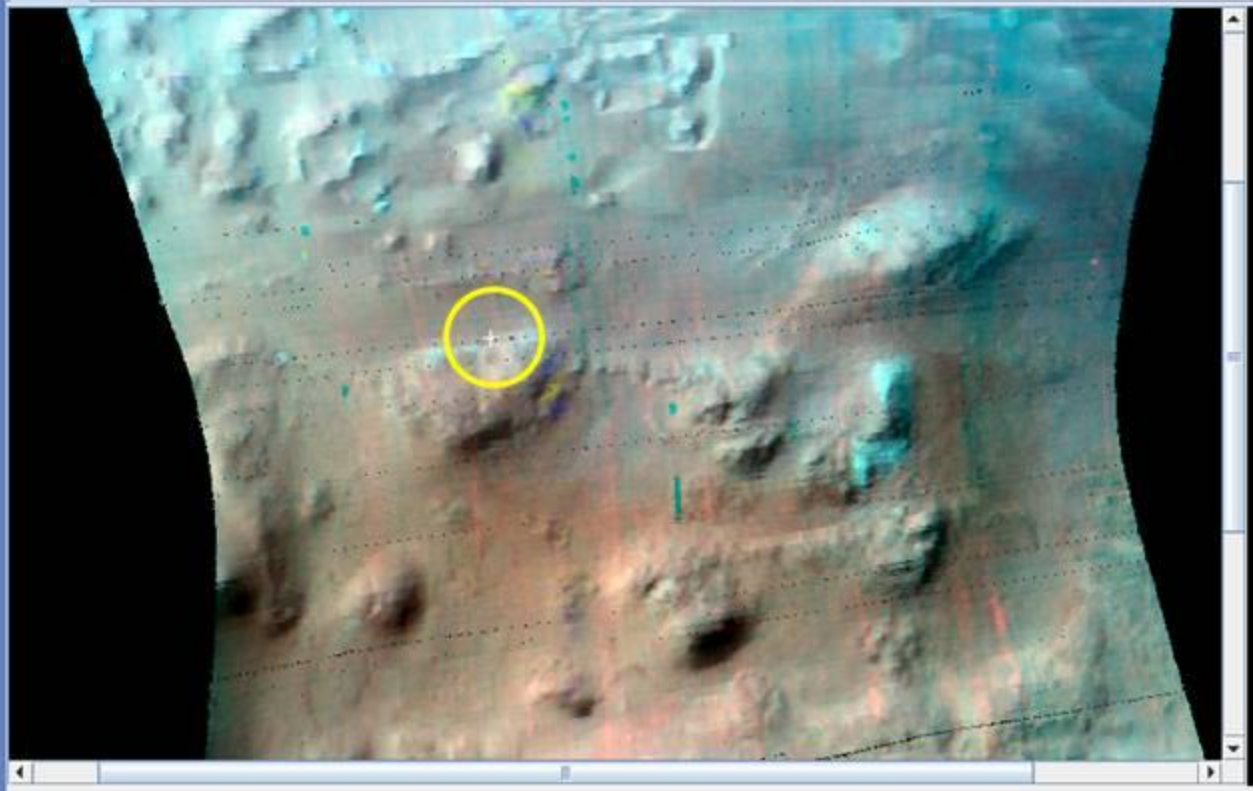
Downloads:
- PNG
- PNG w/ geo_grid
- Map/Stretch Info

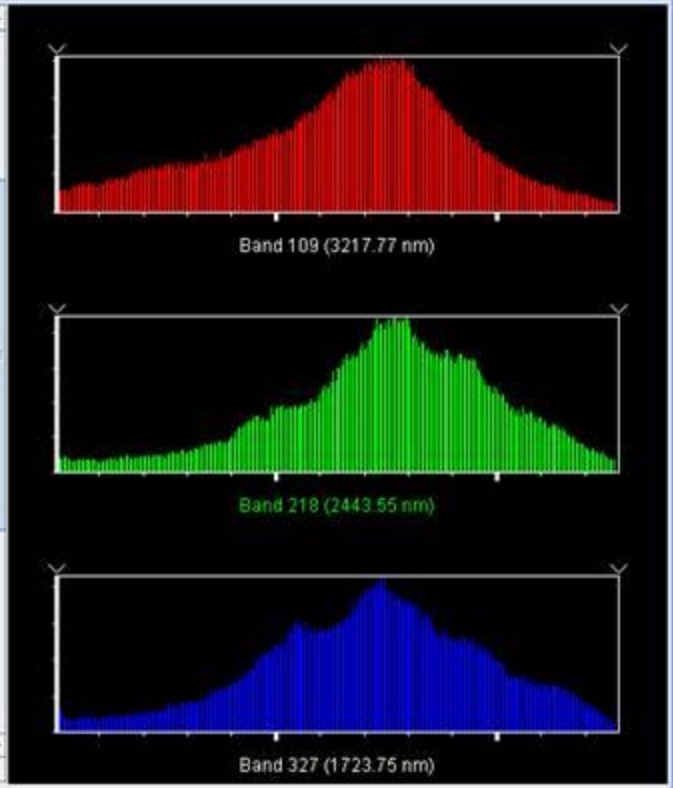
JCAT Image 4 (Stereographic, frt00019904)

Image Histogram Plot Tools

0000A91C

Image





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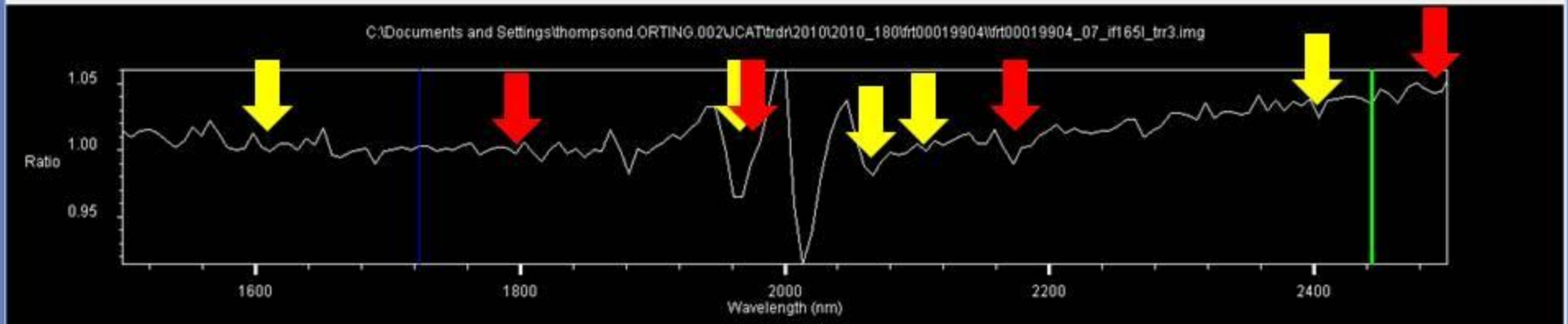
Rerender

Update Histogram



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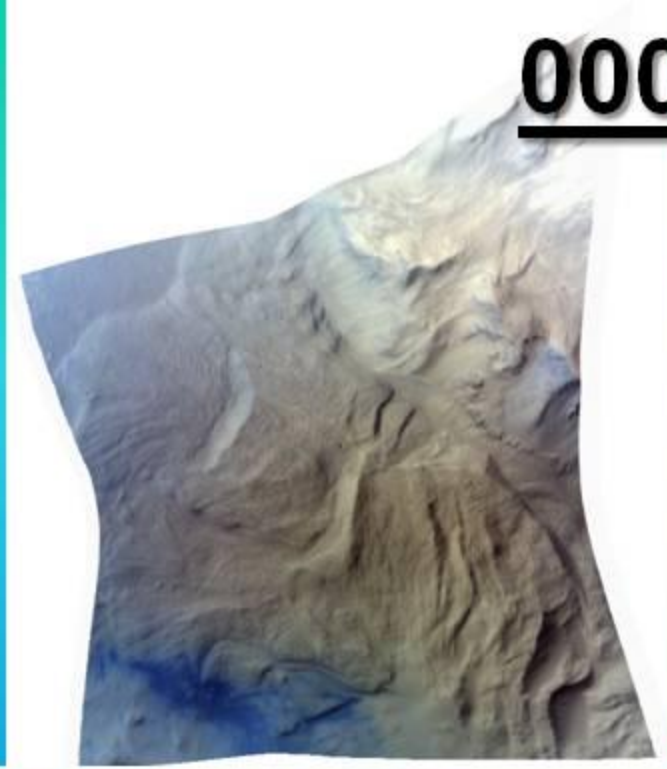

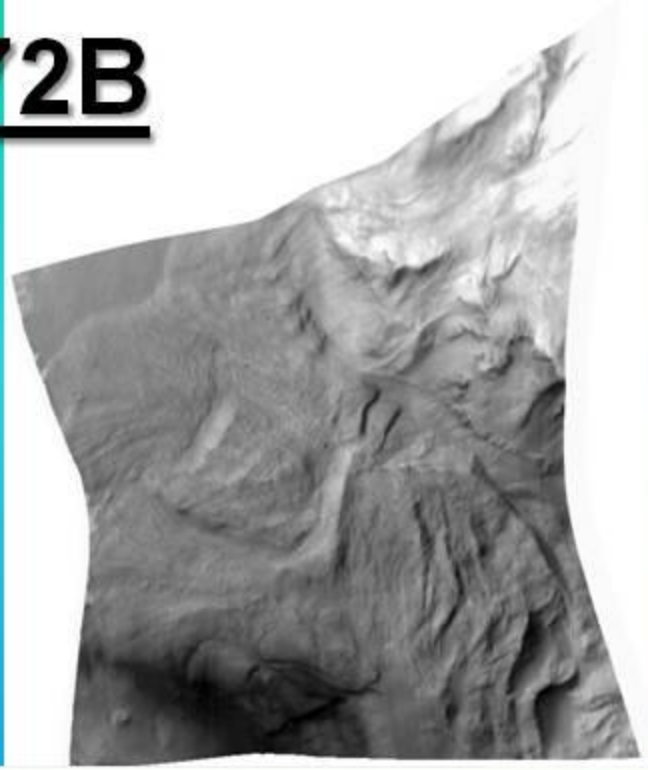

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Downloads:
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ir_hyd

Bound water

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ir_ice

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Click image above to enlarge.

Downloads:
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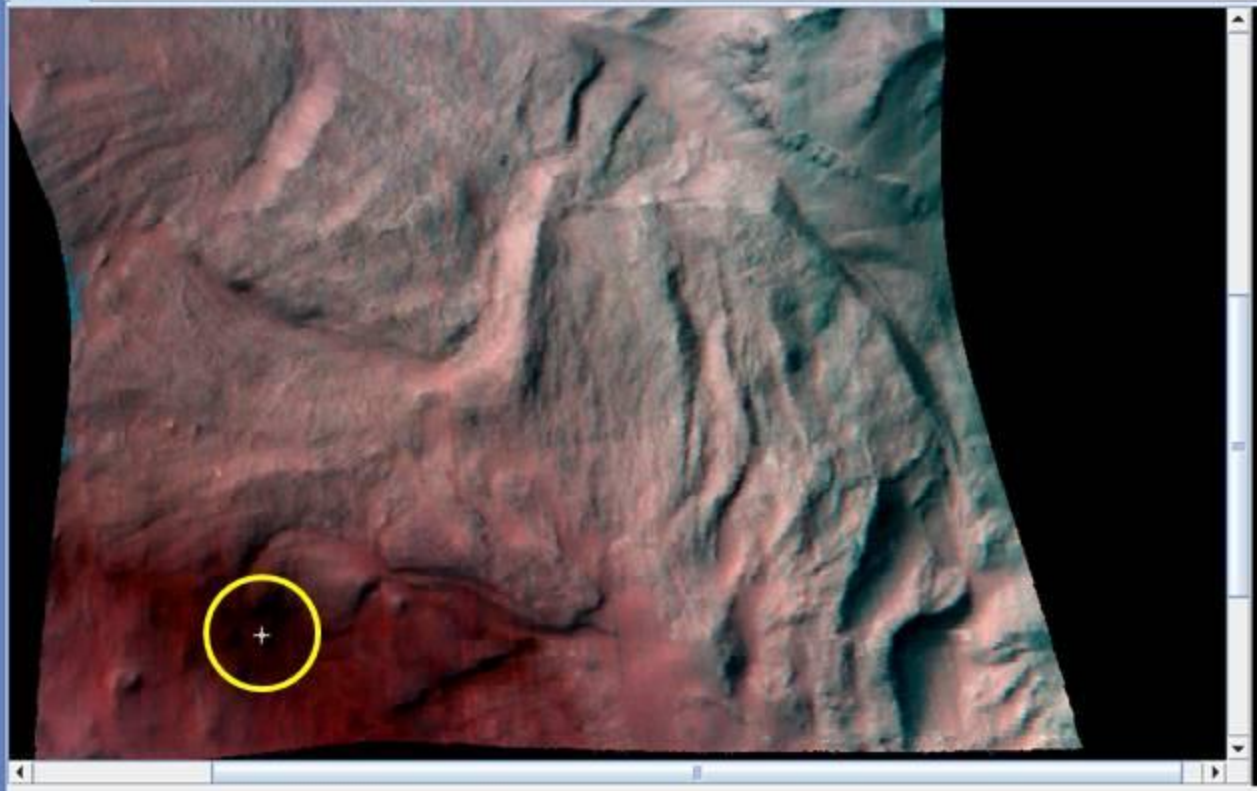
- Map/Stretch Info

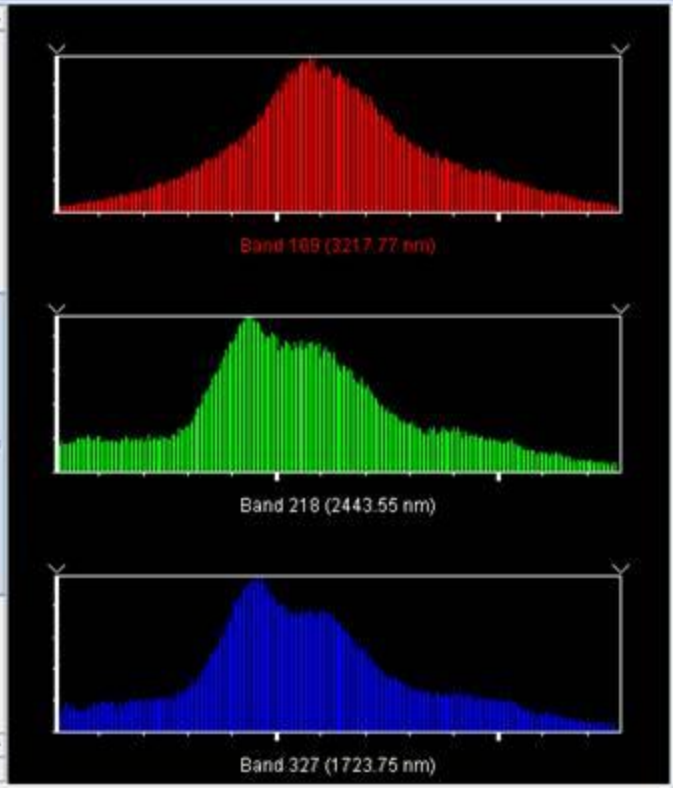
JCAT Image 0 (Stereographic, ftp://pds-g)

Image Histogram Plot Tools

0001672B

Image





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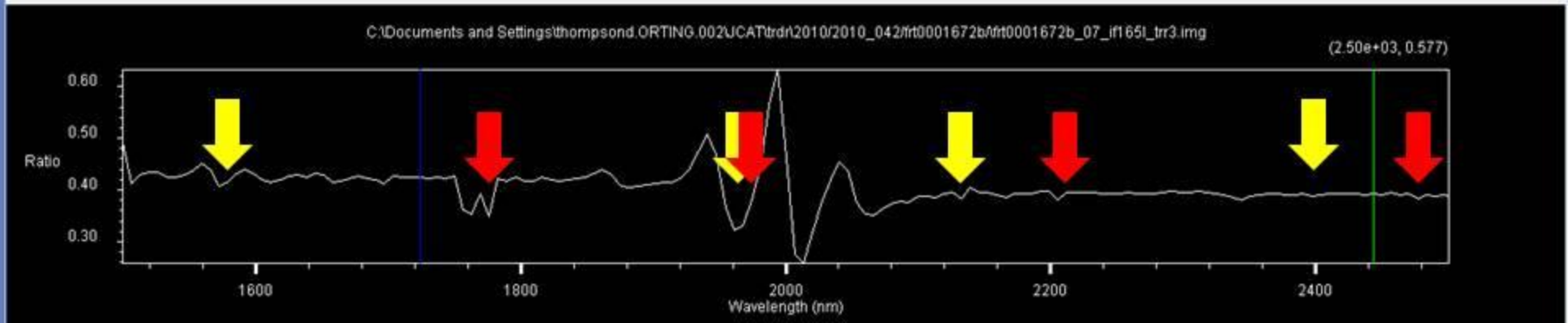
Rerender

Update Histogram



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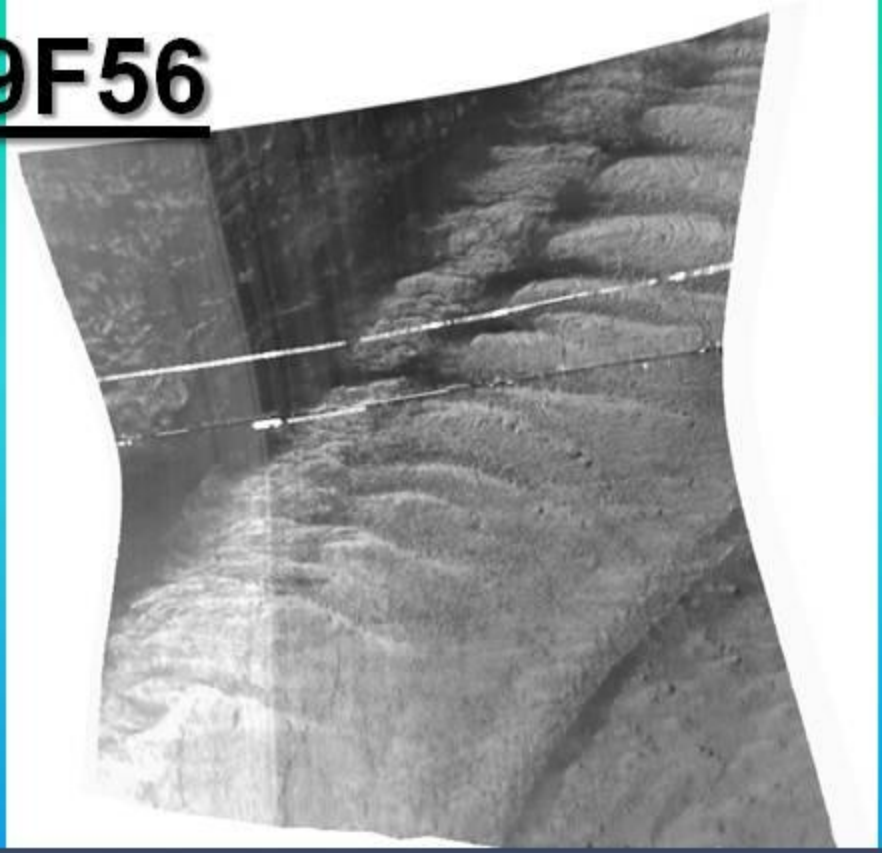

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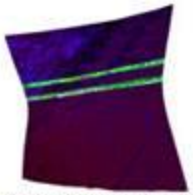
ir_maf

Mafic mineralogy



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green = LCPINDEX (low-Ca pyroxene)

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Click image above to enlarge.

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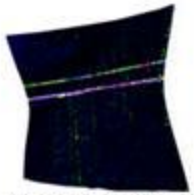
ir_phy

Hydroxylated silicates



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Downloads:
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- PNG w/ geo. grid
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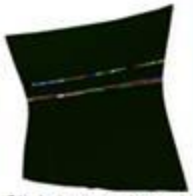
ir_ice

Water and CO2 ice



red = BD1900 (water ice or hydrated sulfates, clays, or glass)

green = BD1500 (water ice)

blue=BD1435 (CO2 ice)

Click image above to enlarge.

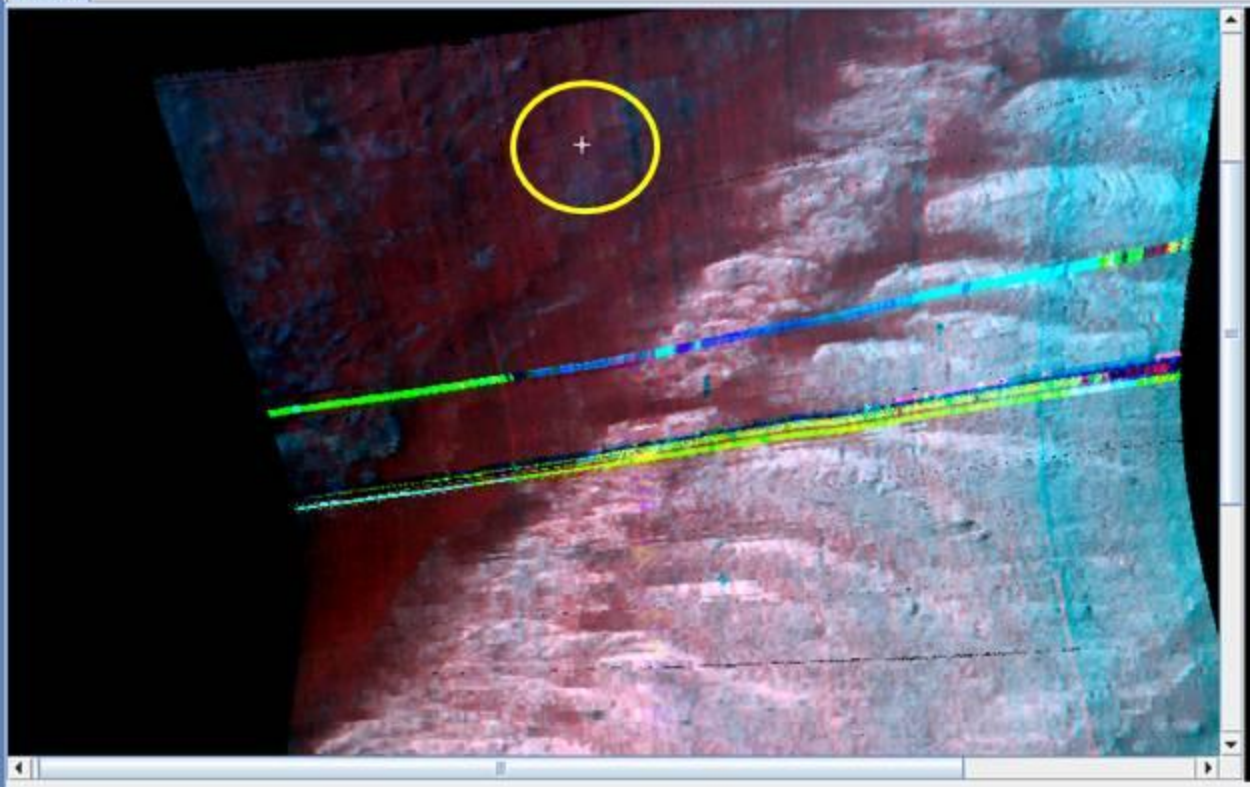
Downloads:
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

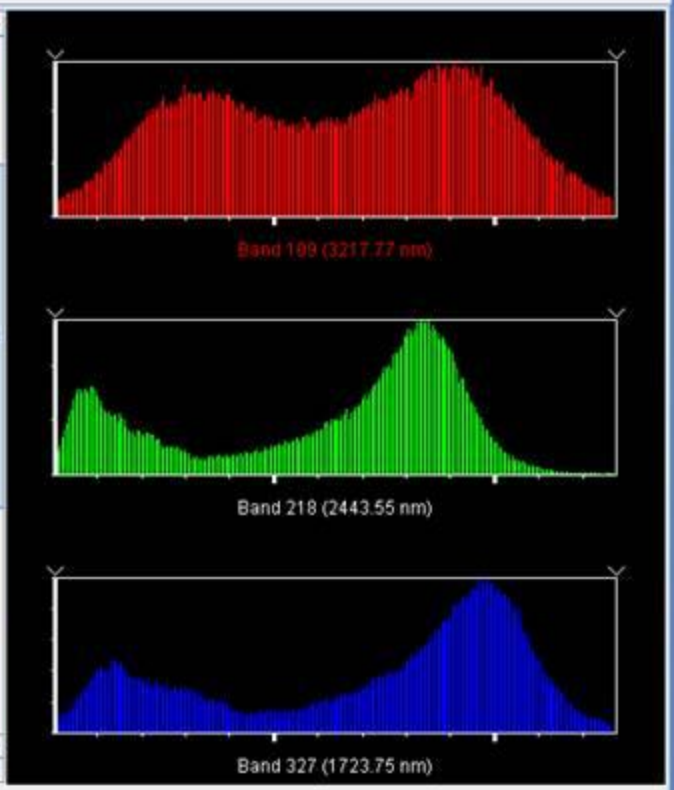
JCAT Image 1 (Stereographic, ftp://pds-g)

Image Histogram Plot Tools

00019F56

Image



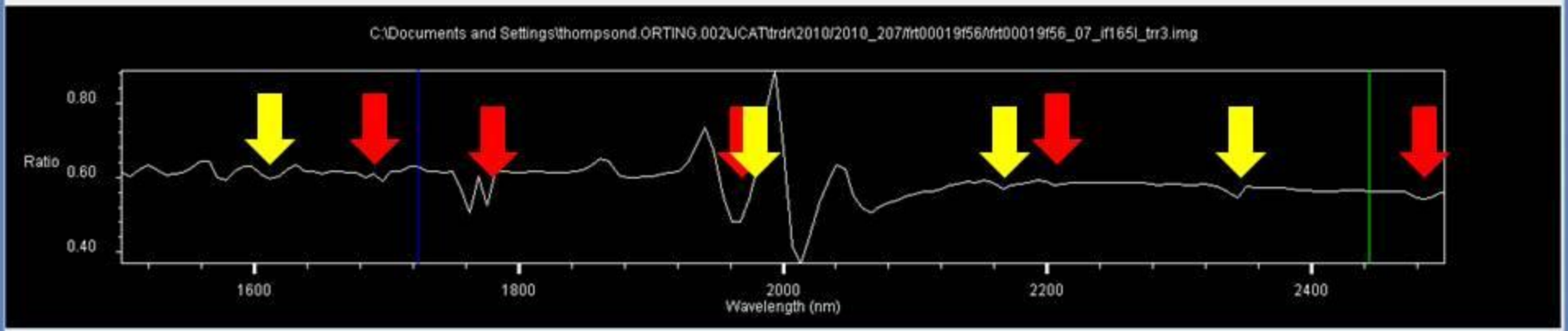


Screen (x, y) = (389, 269)
Data (x, y) = (407, 403)
Background (x, y) = (40, 26)

(R, G, B) = (73, 38, 63)
lat, lon = (-4.8559, -71.5903)
Spectrum Box Size = 5x5

Rerender

Update Histogram



Green- Means fairly clear of dust

Blue- high calcium pyroxene

Black- indicates no aluminum phylosillicates or hydrated silica are found

Red- Minerals dissolved absorbed or bound by water

Black- means no water or CO2 ice was found.

VISIBLE AND IR DERIVED PRODUCTS

vnir_fem

Oxidized iron minerals

Click image above to enlarge.

red = BD530 (ferric minerals)

green = SH600 nm (coatings)

blue = BDI1000nm (variety of iron minerals)

Downloads:
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

ir_maf

Mafic mineralogy

Click image above to enlarge.

red = OLINDEX (olivine or iron phyllosilicates)

green = LCPINDEX (low-Ca pyroxene)

blue= HCPINDEX (high-Ca pyroxene)

Downloads:
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

ir_phy

Hydroxylated silicates

Click image above to enlarge.

red = BD2300 (Fe/Mg phyllosilicate)

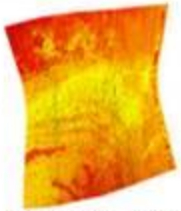
green = BD2210 (Al phyllosilicate or hydrated glass)

blue=BD1900 (hydrated sulfates, clays, glass, or water ice)

Downloads:
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

ir_hyd

Bound water



Click image above to enlarge.

red = SINDEX (water-containing minerals or water ice)

green = BD2100 (monohydrated sulfates or water ice)

blue = BD1900nm. (hydrated sulfates, clays, glass, or water ice)

Downloads:
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

ir_ice

Water and CO2 ice

Click image above to enlarge.

red = BD1900 (water ice or hydrated sulfates, clays, or glass)

green = BD1500 (water ice)

blue=BD1435 (CO2 ice)

Downloads:
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

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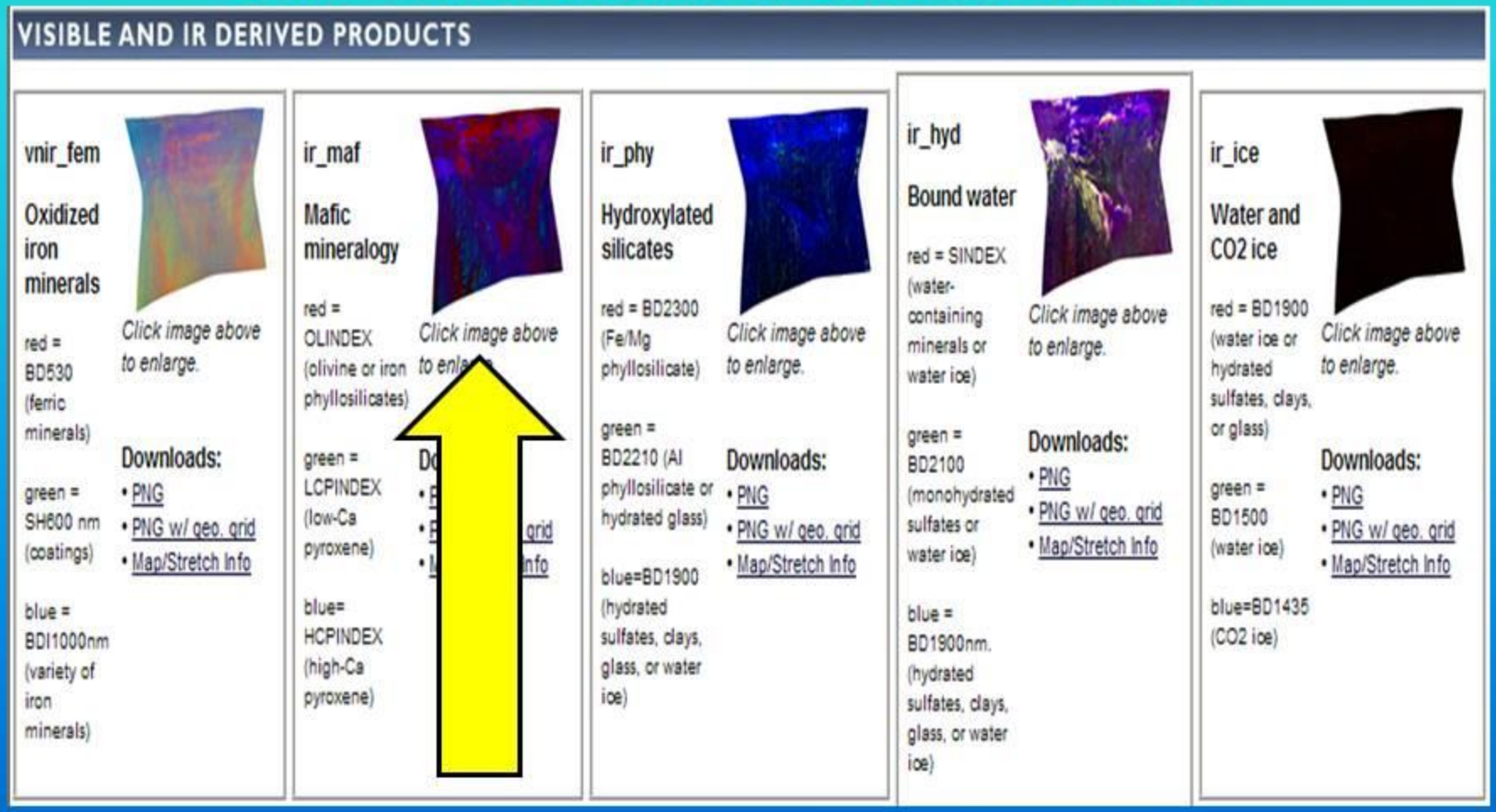
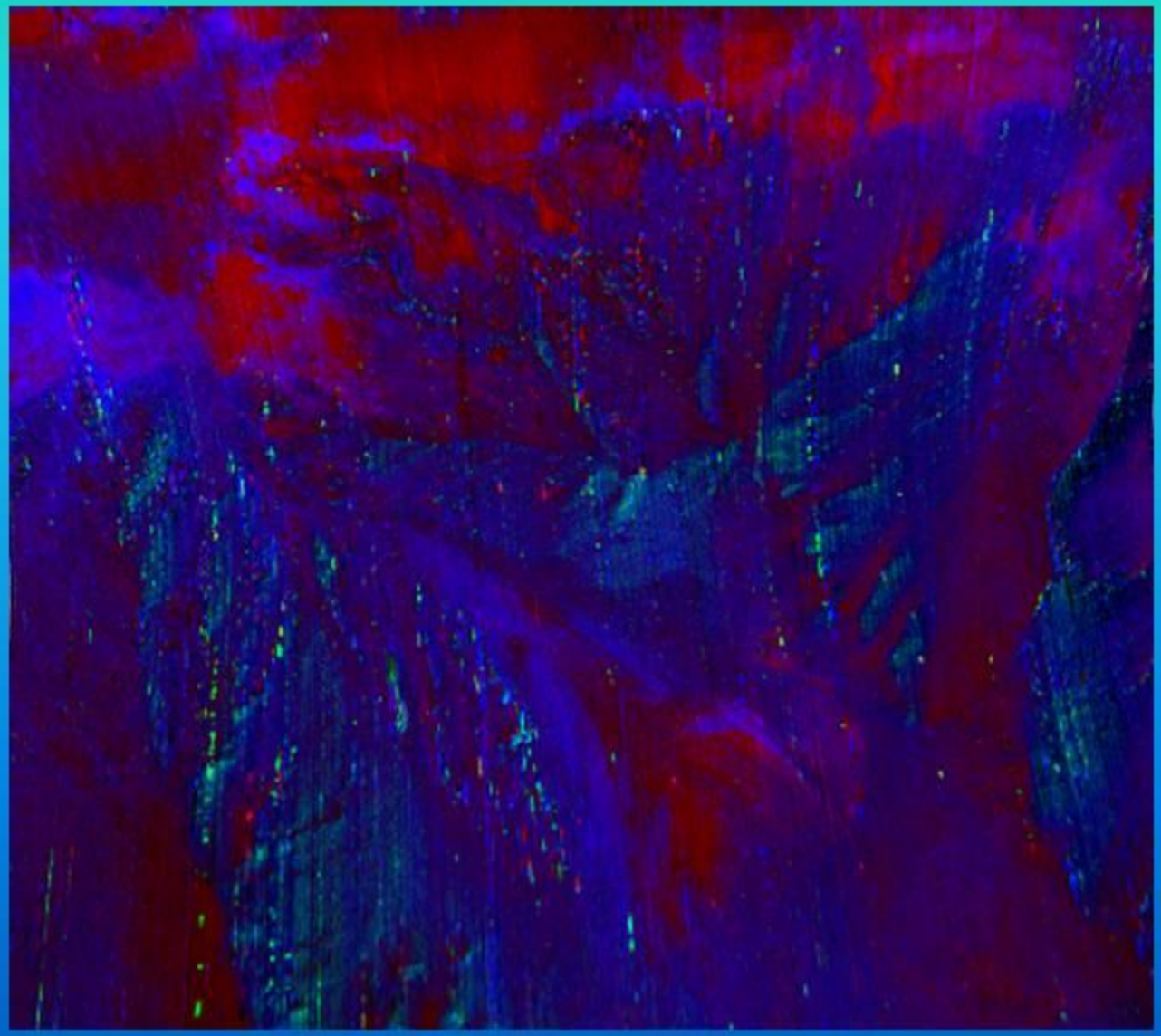
•We analyzed several Browse Products like the one in the previous slide that we were not planning to look at with the MSL rover because we wanted to get more evidence of some kind of erosion or evidence of water.



We especially wanted to look at the calcium pyroxene to know about past lava flows.

BROWSE PRODUCT

Differences of Calcium Pyroxene



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Conclusion:

- Mars and Earth have similar geological features such as channels.
- Similar processes are at work on both planets.
- There is evidence of hydrated minerals and clays that form mostly in the presence of water.
- There is evidence of sulfate minerals that could have trapped microbial evidence.
- There is evidence of that even more sulfates can be found under the existing dust.

These things give us reason to conclude that the channel at 2.8 S, 74.62 W would be a good place to land the MSL to investigate.

Work Cited

Californian Geological Survey. Division of Mines and Geology Special Report 106—Geologic Features of Death Valley CA. web. 26 Mar 2012. < http://www.nps.gov/history/history/online_books/geology/publications/state/cdmg-sr-106/sec1.htm>

"Crism Map." Crism Data Products. N.p., n.d. Web. 13 Jan 2012. <http://crism-map.jhuapl.edu/>.

"Crism Data Products." Crism Map. N.p., n.d. Web. 2 Feb 2012. <http://crism-map.jhuapl.edu/details.php?data=hrl_webmap_polygons&shape=2964&x=-73.82905&y=-5.097975>.

Dictionary.com. N.p., n.d. Web. 6 Feb 2012. <http://dictionary.reference.com/browse/channel>.

Dictionary.com. N.p., n.d. Web. 6 Feb 2012. <http://dictionary.reference.com/browse/Phyllosilicates>.

"Extension Fracture." *Answers.com*. McGraw-Hill Science and Technology Dictionary, Web. 23 Apr 2012. <http://www.answers.com/topic/extension-fracture>.

Francis, Peter & Jones, Pat. "Dendric Drainage Pattern, Yemen." *Lunar and Planetary Institute*. USRA, Oct 1984. Web. 24 Apr 2012. <http://www.lpi.usra.edu/publications/slidesets/geology/sgeo/slide_21.html>.

"Google." *Google Mars*. Web. 24 Apr 2012. <http://www.google.com/mars/>.

"JCAT." Crism Analysis Tool. Web. 13 Jan 2012. <http://crism.jhuapl.edu/JCAT/>.

Lowenstein, Tim. "Bacteria Back from the Brink." *EarthMagazine.org*. April 2011: 36-45. Print.

"Mars Exploration Rovers." Jet Propulsion Laboratory. N.p., n.d. Web. 27 Jan 2012. <http://marsrovers.jpl.nasa.gov/gallery/press/opportunity/20120117a.html>.

"Mars Orbital Laser Altimeter Profiles." Ames Research Center. N.p., n.d. Web. 27 Jan 2012. <http://marsoweb.nas.nasa.gov/MOLA/regions/10_22/>.

"Outflow Channels." *Euro Planet IDIS*. 07/06/2010. Web. 24 Apr 2012. <http://europlanet.dlr.de/node/index.php?id=404>.

Science On a Sphere. N.d. Graphic. NOAAWeb. 3 Feb 2012. <http://sos.noaa.gov/datasets/solar_system/mars.html>.

THEMIS 100 meter global daytime mosaic:. Arizona State University. N.d. Web. 27 Jan 2012. <http://jmars.mars.asu.edu/maps/?layer=thm_dayir_100m_v11>.

"Outflow Channels." *Euro Planet IDIS*. 07/06/2010. Web. 24 Apr 2012. <http://europlanet.dlr.de/node/index.php?id=404>.

Science On a Sphere. N.d. Graphic. NOAAWeb. 3 Feb 2012. <http://sos.noaa.gov/datasets/solar_system/mars.html>.

THEMIS 100 meter global daytime mosaic:. Arizona State University. N.d. Web. 27 Jan 2012. <http://jmars.mars.asu.edu/maps/?layer=thm_dayir_100m_v11>.

UP. 2009. Graphic. The Newyork Times, New York. Web. 26 Mar 2012. <http://movies.nytimes.com/2009/05/29/movies/29up

Using CRISM-Map and JCAT for Data Analysis. N.p., n.d. Web. 27 Jan 2012. <http://www.orting.wednet.edu/education/page/download.php?fileinfo=VXNpbmdfX0pDQVQucGRmOjo6L3d3dzcvc2Nob29scy93YS9vcnRpbmcvaW1hZ2VzL2RvY21nci81NTlmaWxlMzA0NS5wZGY=>.

"Viewing Features of Mars." Crism Data Products. N.p., n.d. Web. 27 Jan 2012. <http://crism-map.jhuapl.edu/details.php?data=hrl_webmap_polygons&shape=3735&x=-72.881835&y=-4.75521>.

"Viewing Features of Mars." Crism Data Products. N.p., n.d. Web. 27 Jan 2012. <http://crism-map.jhuapl.edu/details.php?data=frt_webmap_polygons&shape=3512&x=-73.07561&y=-4.89191>.

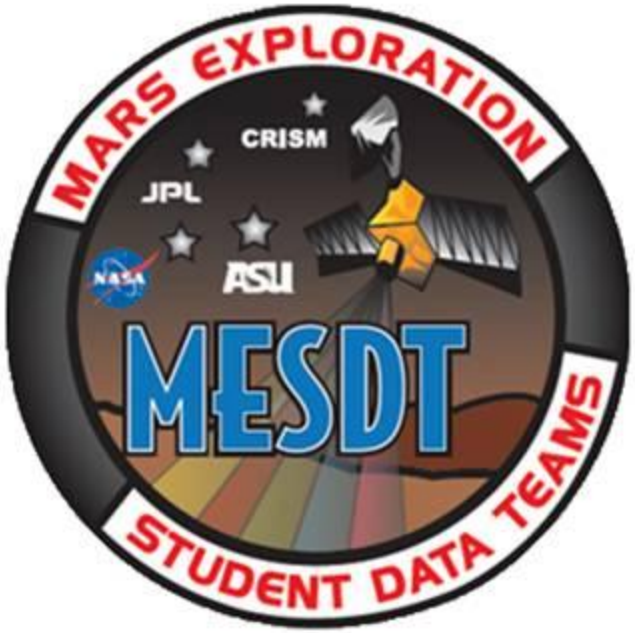
"Viewing Features of Mars." Crism Data Products. N.p., n.d. Web. 27 Jan 2012. <http://crism-map.jhuapl.edu/details.php?data=frt_webmap_polygons&shape=13406&x=-72.953545&y=-5.147205>.

"Viewing Features of Mars." Crism Data Products. N.p., n.d. Web. 27 Jan 2012. <http://crism-map.jhuapl.edu/details.php?data=frt_webmap_polygons&shape=4865&x=-72.61024&y=-4.984415>.

"Viewing Features of Mars." Crism Data Products. N.p., n.d. Web. 27 Jan 2012. <http://crism-map.jhuapl.edu/details.php?data=frt_webmap_polygons&shape=9658&x=-73.23435&y=-5.5569>.

"Viewing Features of Mars." Crism Data Products. N.p., n.d. Web. 27 Jan 2012. <http://crism-map.jhuapl.edu/details.php?data=frt_webmap_polygons&shape=10170&x=-72.75081&y=-5.204735>.

Questions/Comments?



Decisions for funding to be made by May 4th, 2012

Thank you for participating!