SIMUD VALLIS FLOOR

A DEEP LOOK INTO A MARTIAN ALLUVIAL ENVIRONMENT

**Maurizio Pajola, Sandro Rossato, Emanuele Baratti, Clara Mangili,
Francesca Mancarella, Karen McBride & Marcello Coradini**

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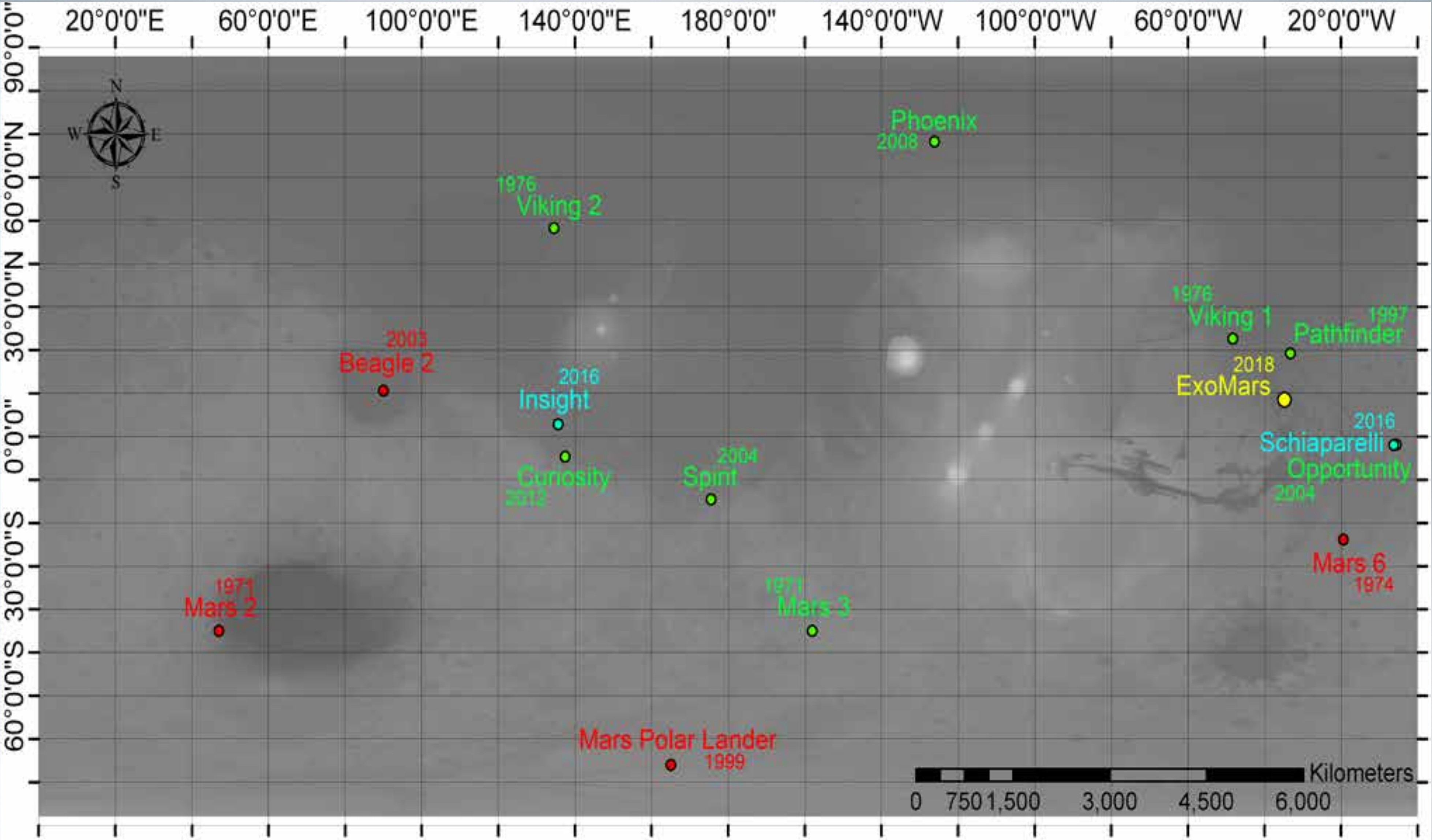
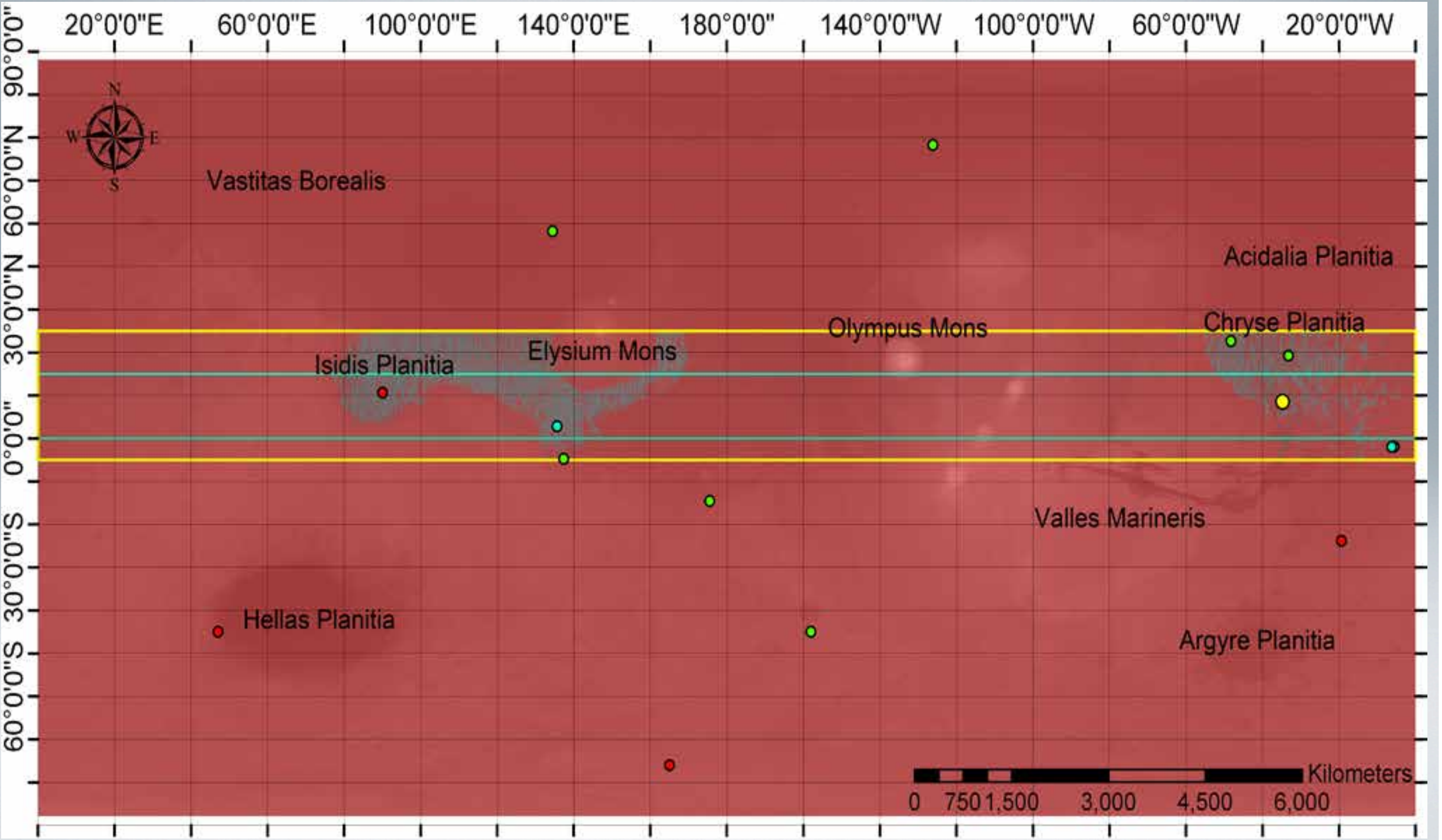
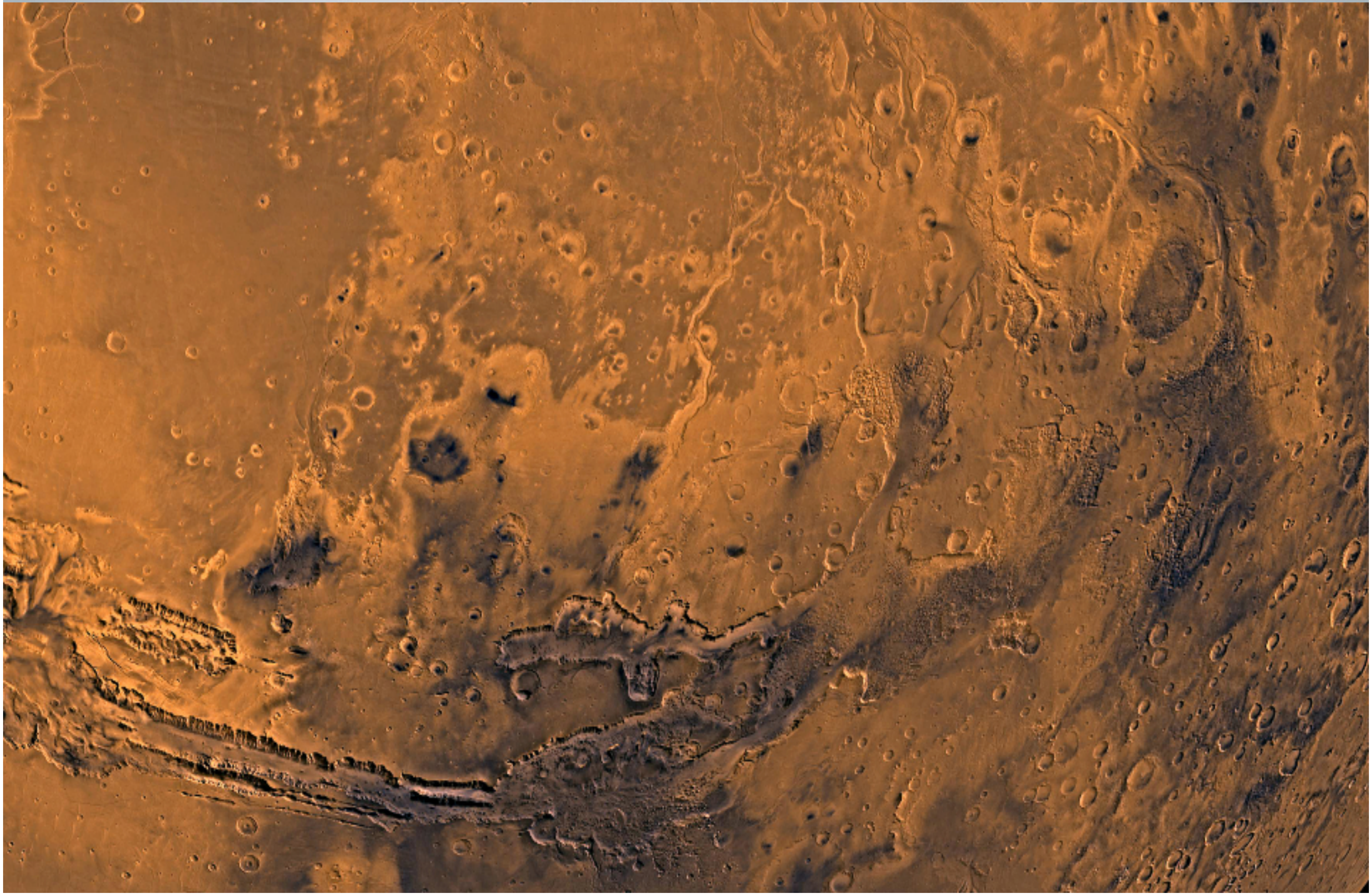
Introduction



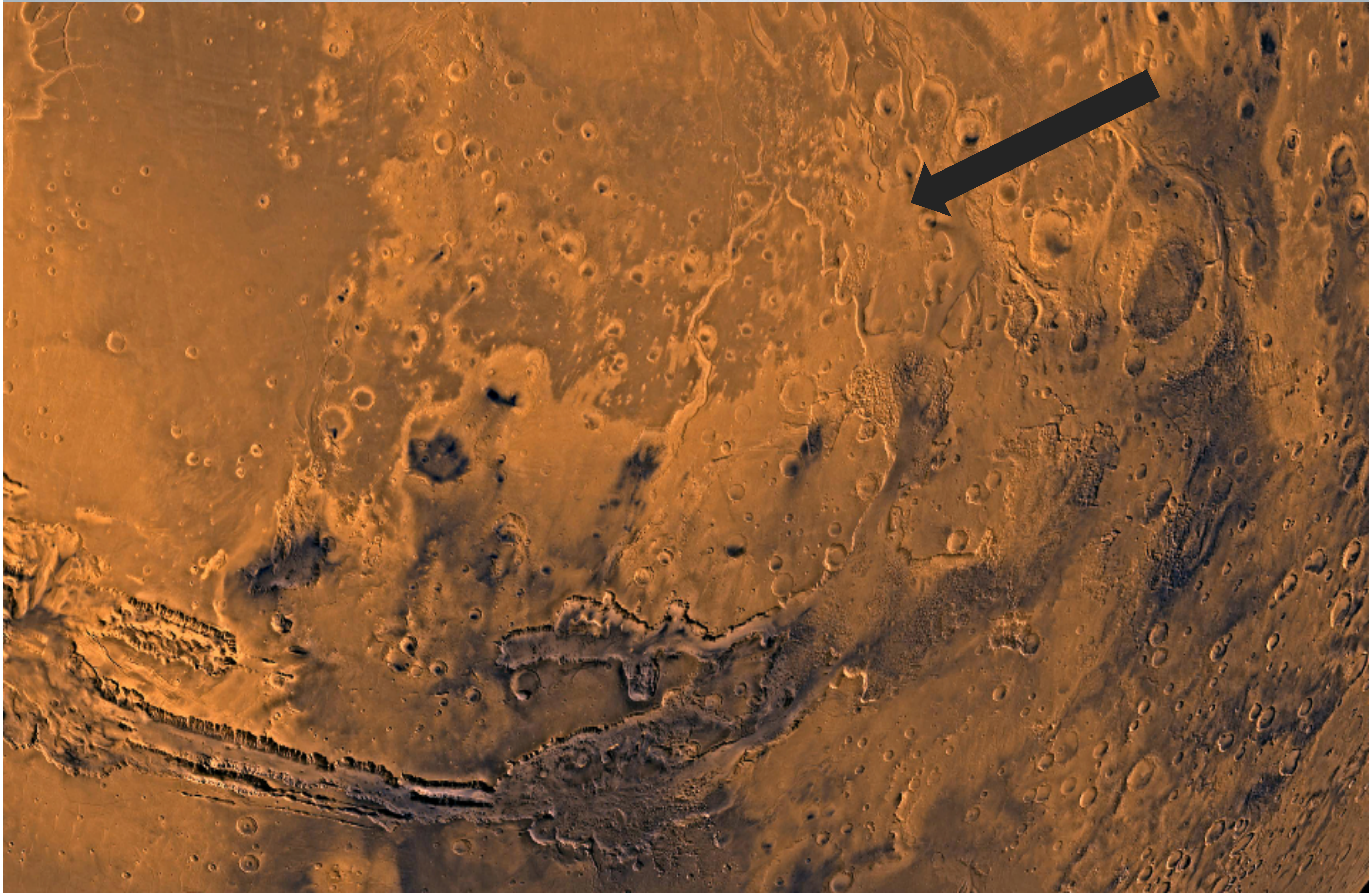
Planetary Engineering Constraints - I



Was there water?

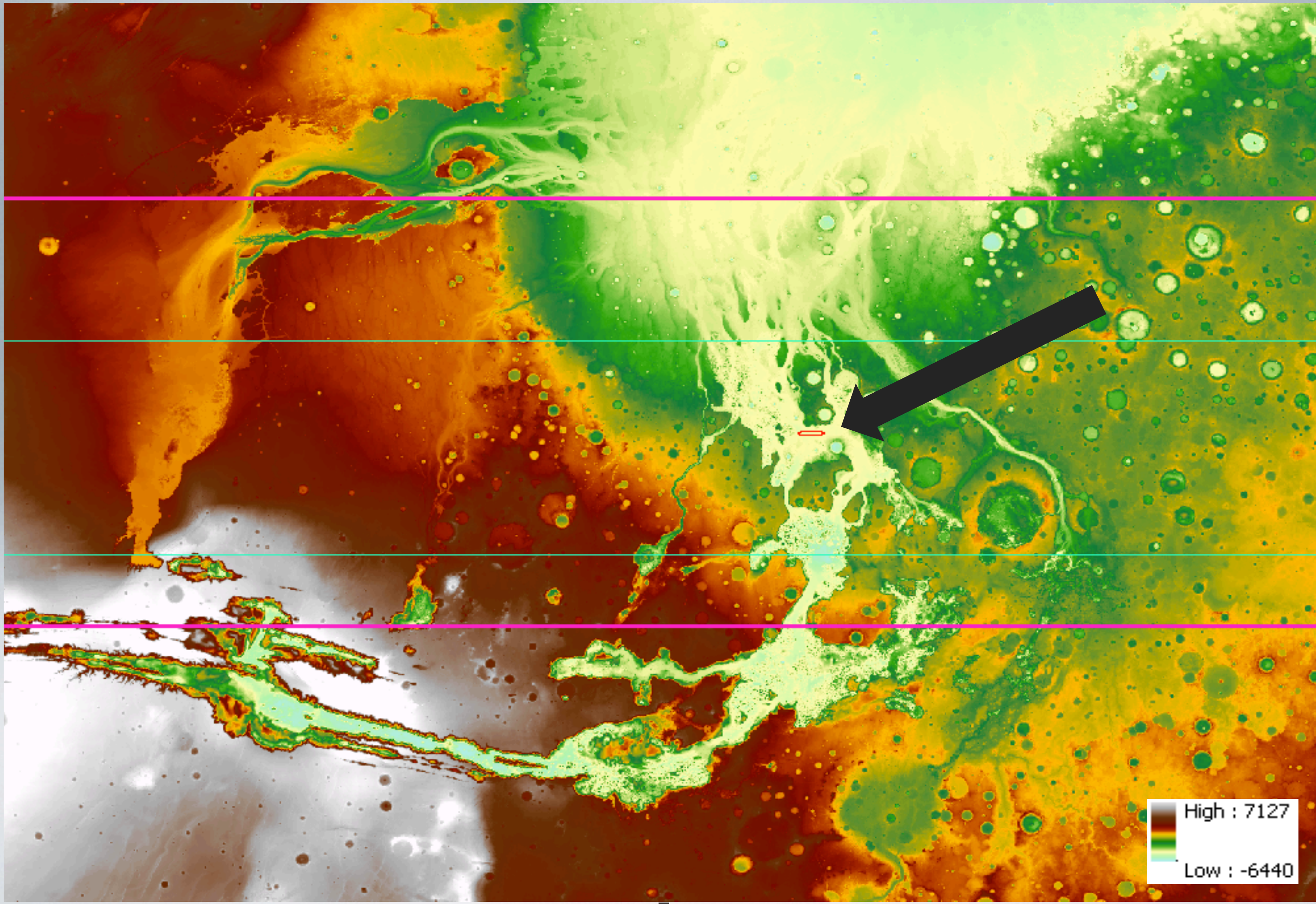


Was there water?

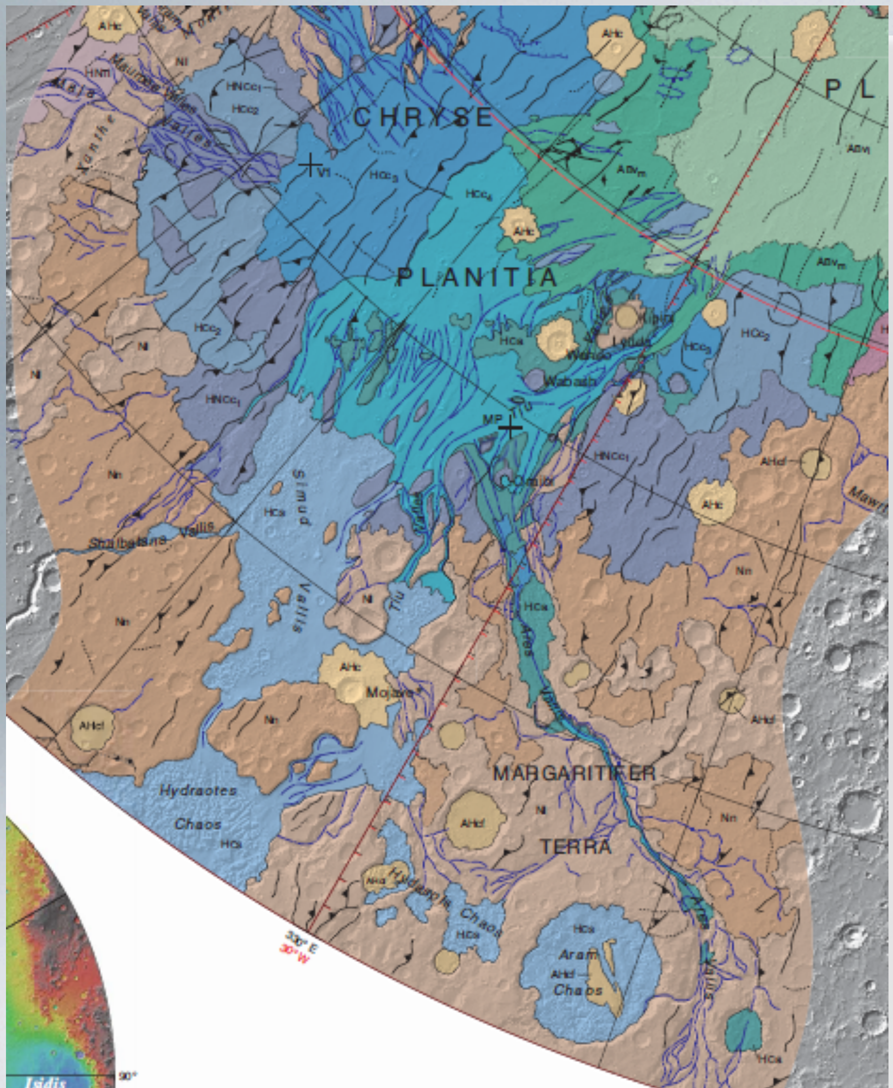


Landing Ellipse Location

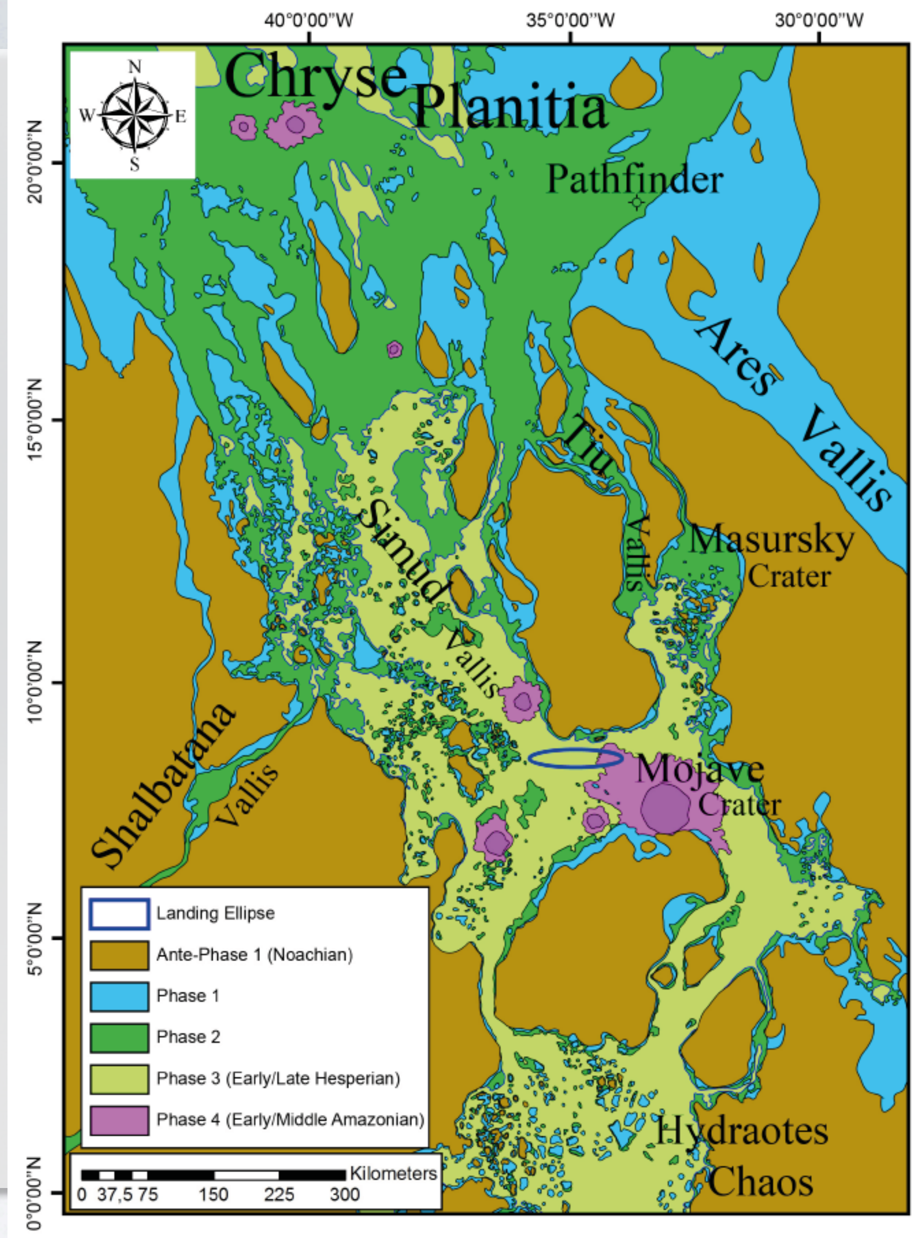
E X O M A R S



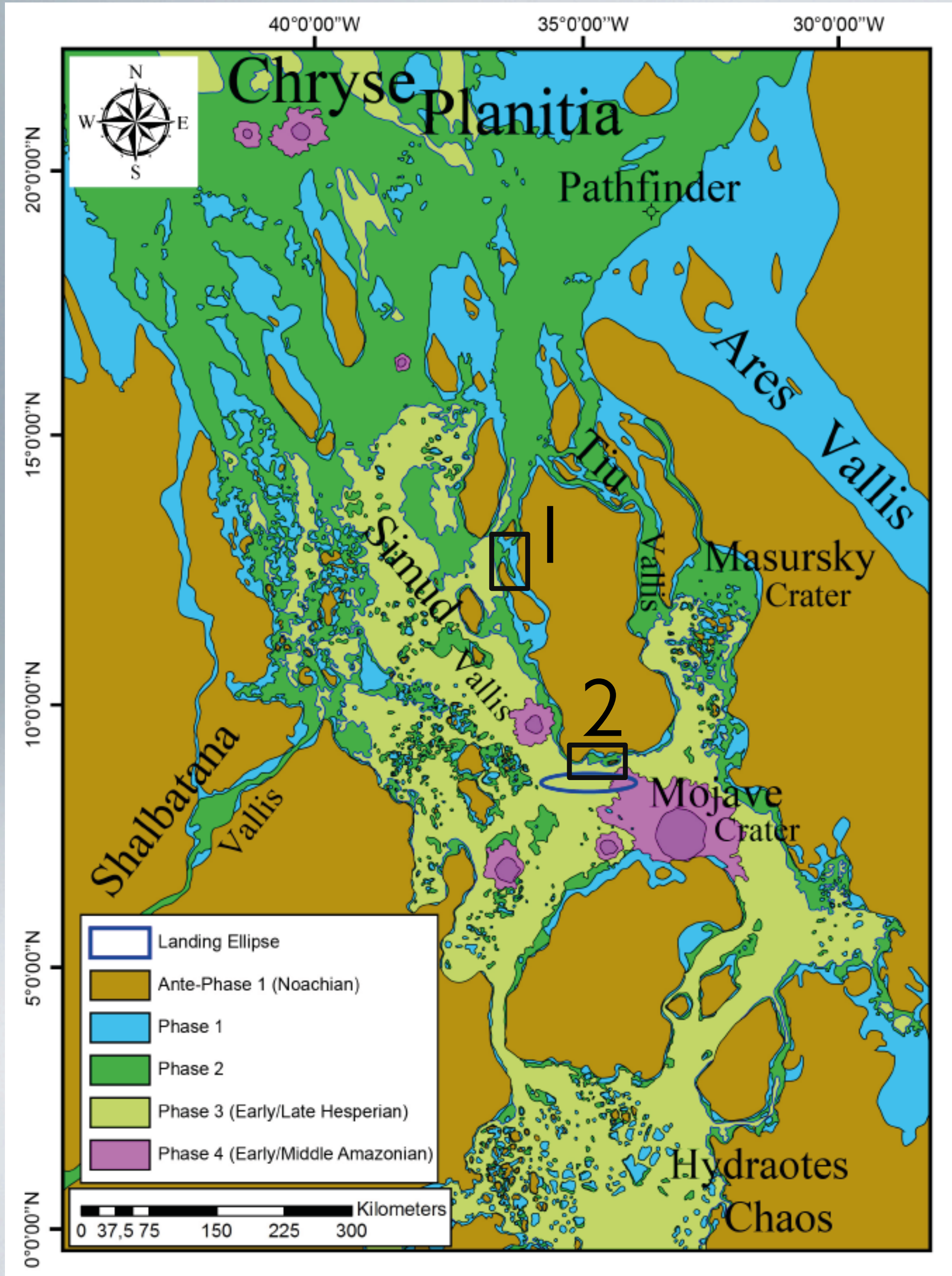
Geological Context

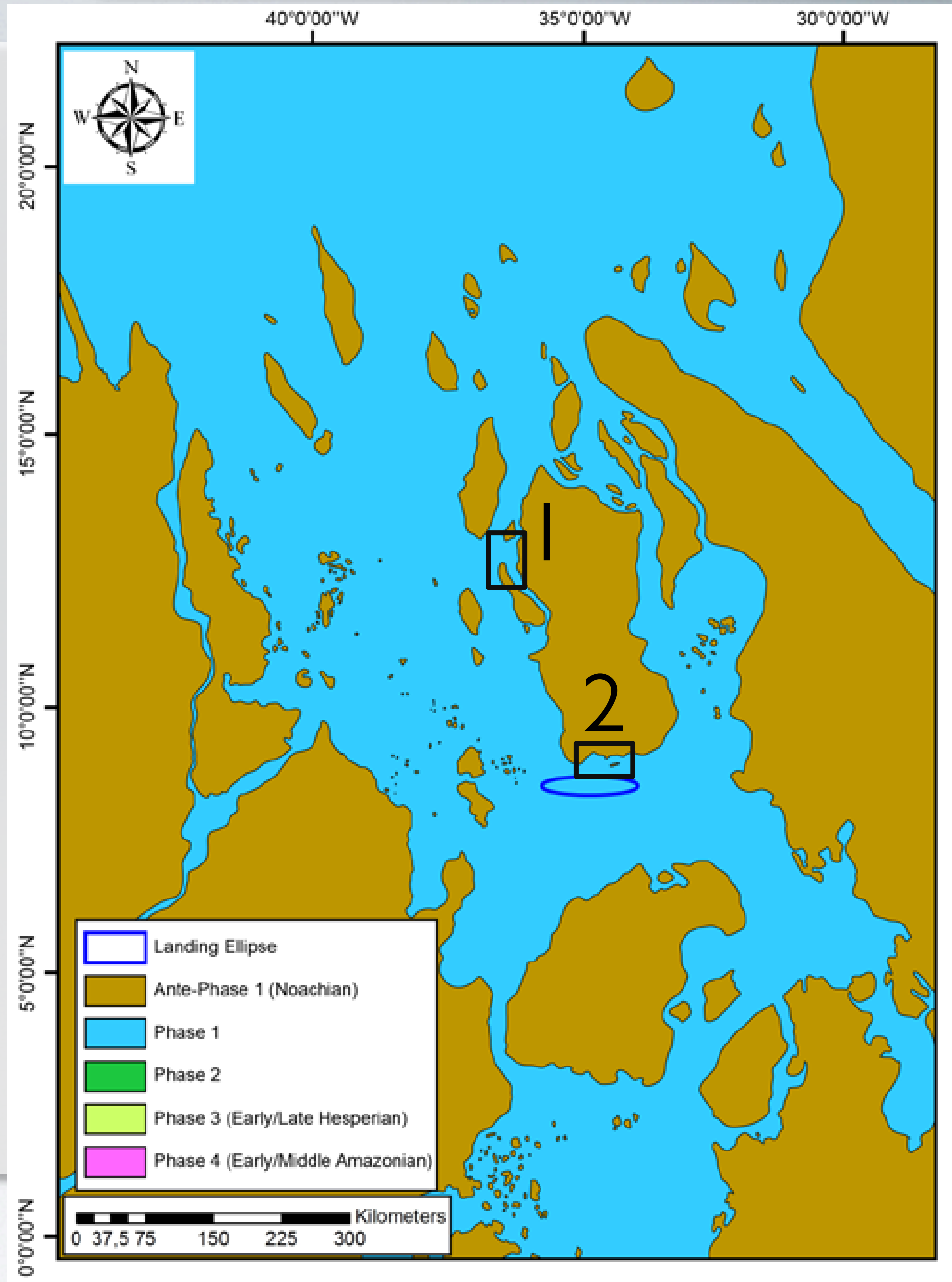


Geologic Map of the Northern Plains of Mars
By
Kenneth L. Tanaka, James A. Skinner, Jr., and Trent M. Hare
2005

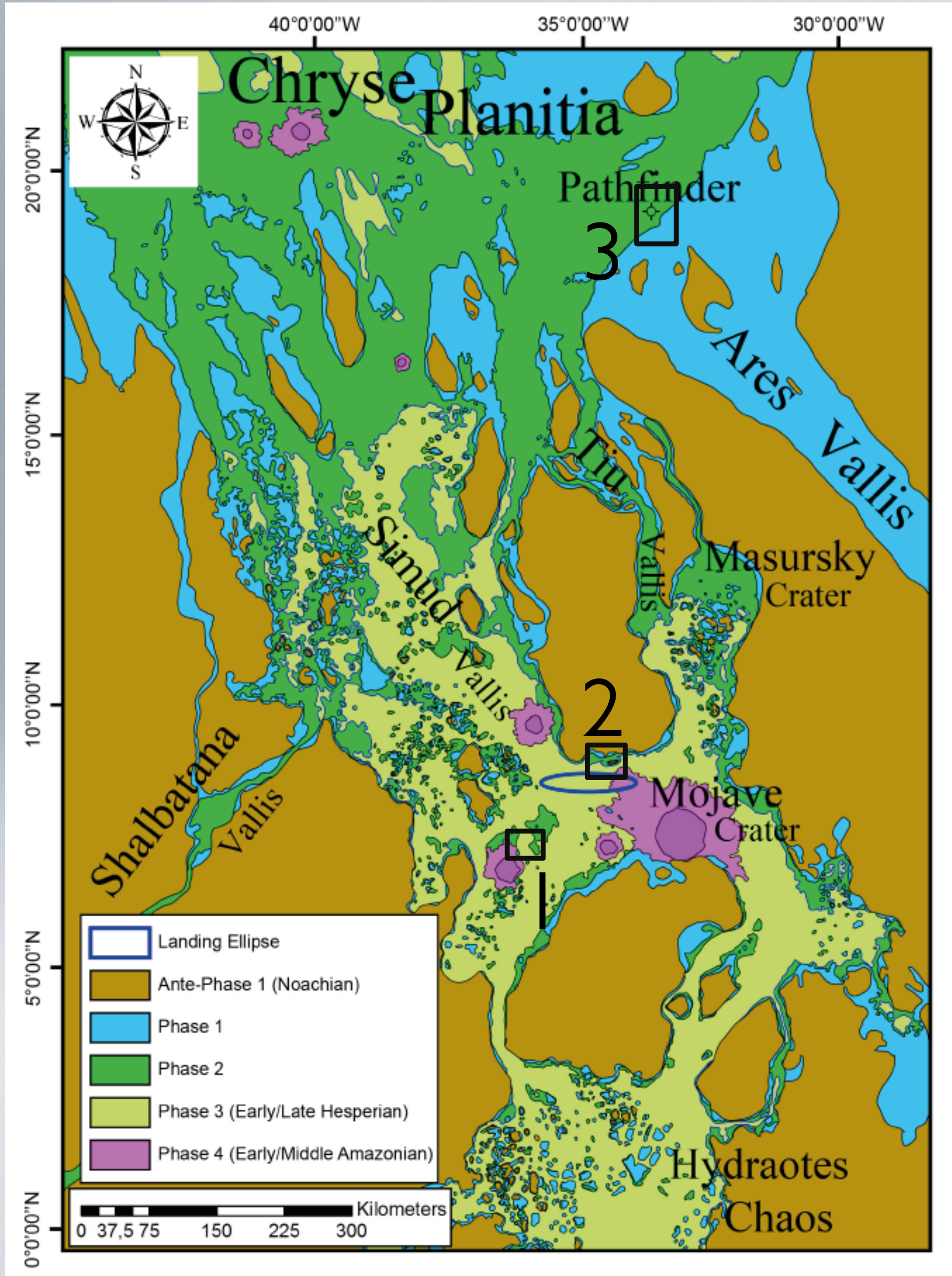


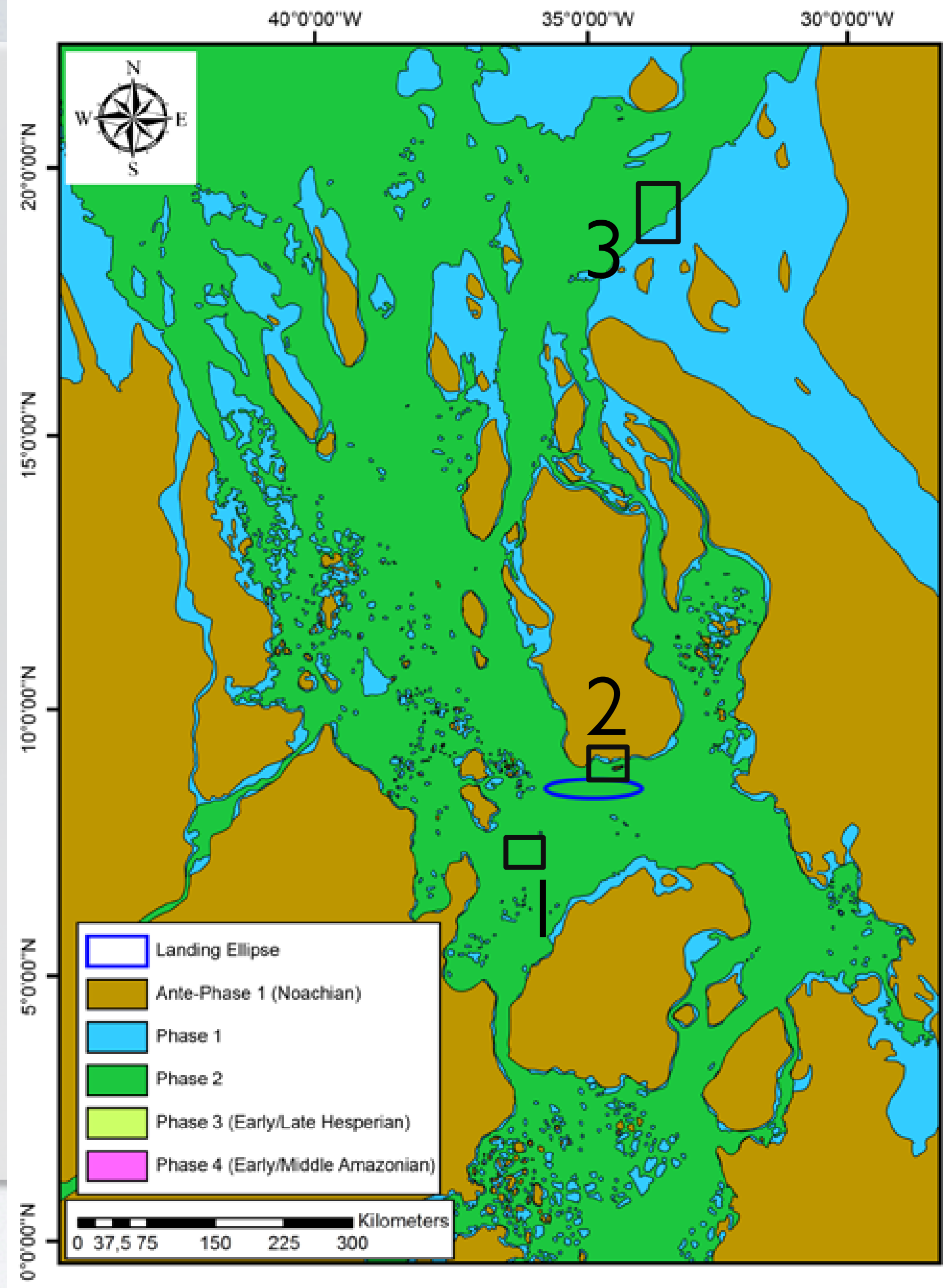
Phase 1 - Reconstruction





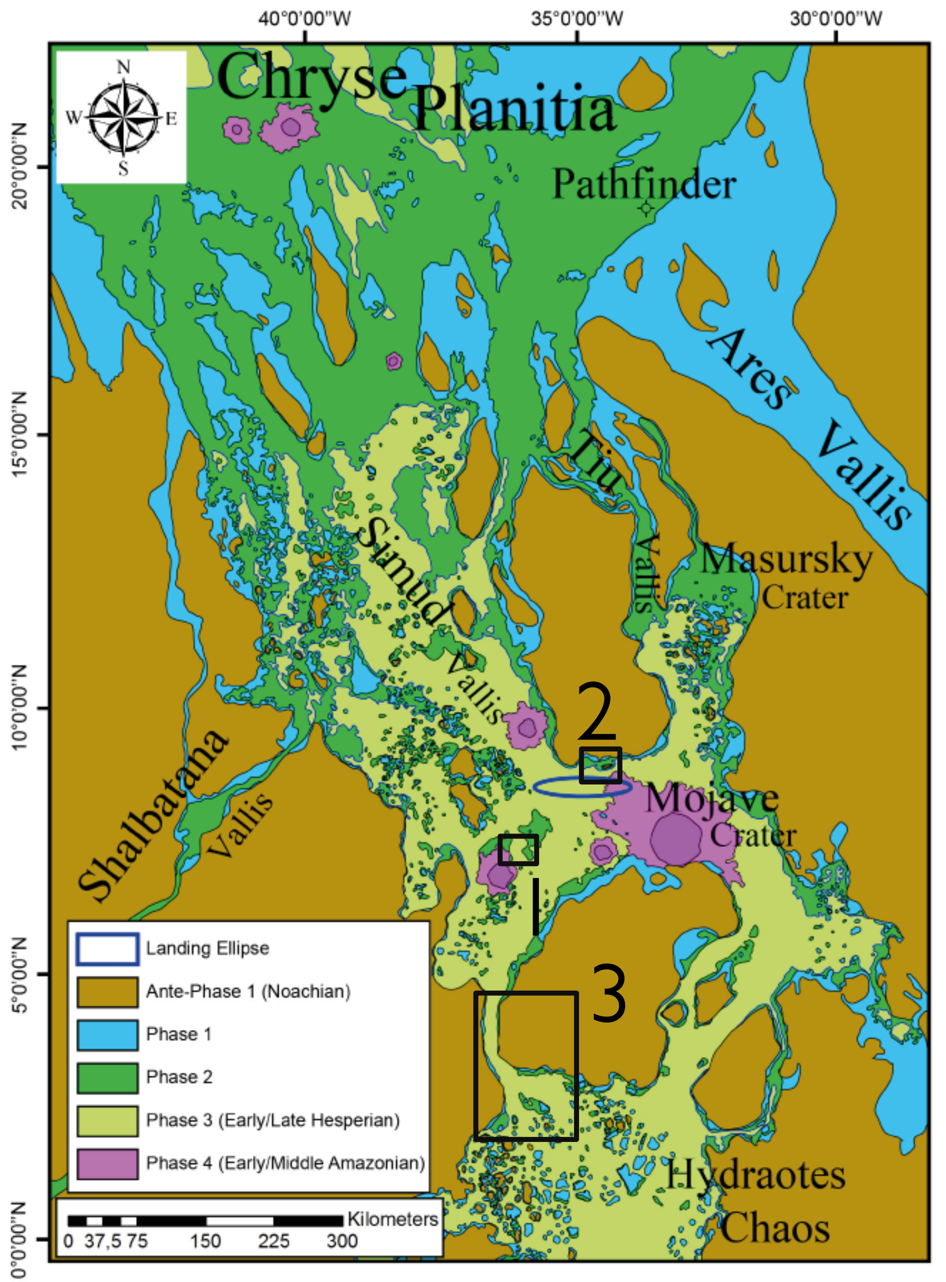
Phase 2 - Reconstruction

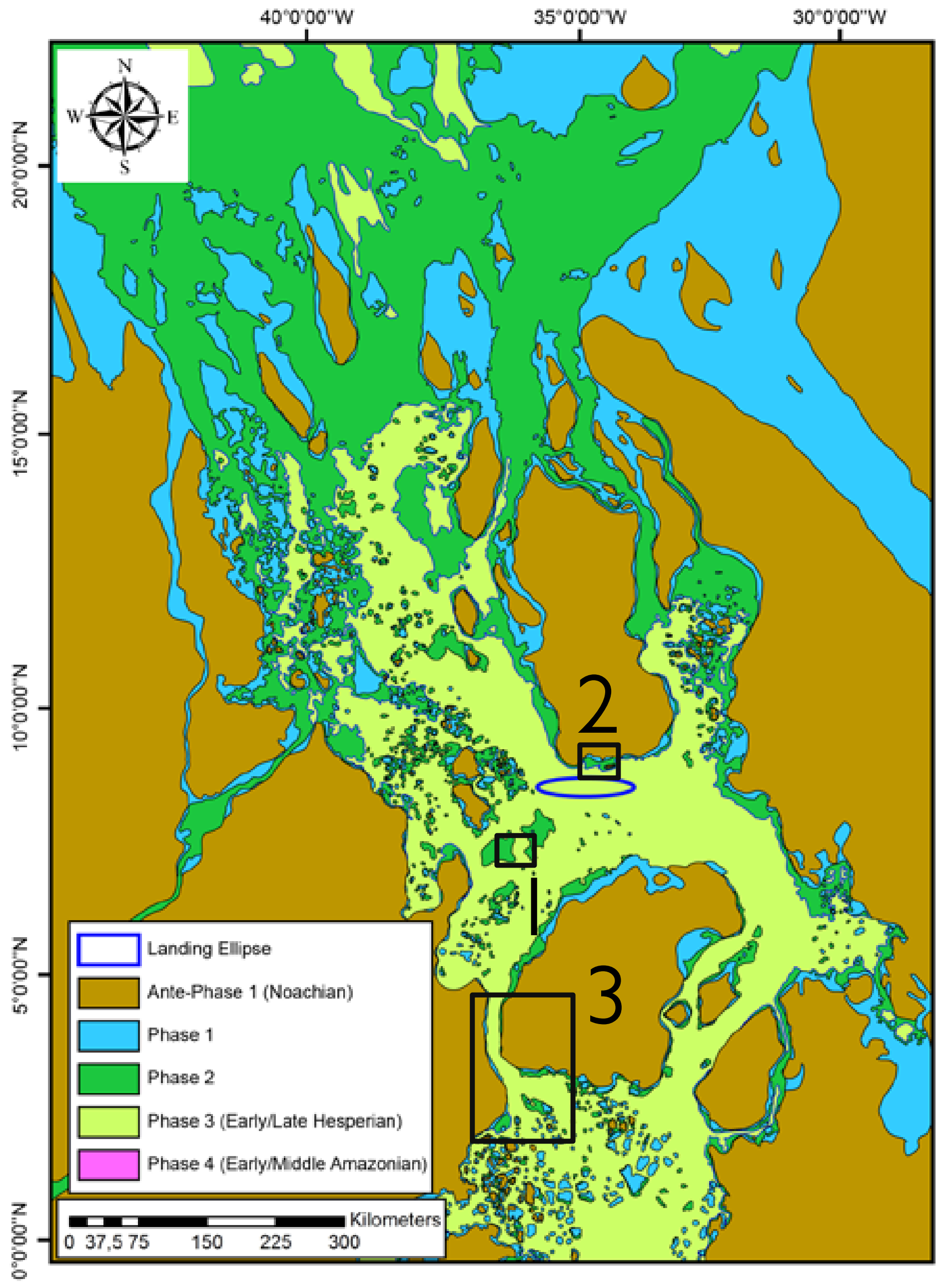




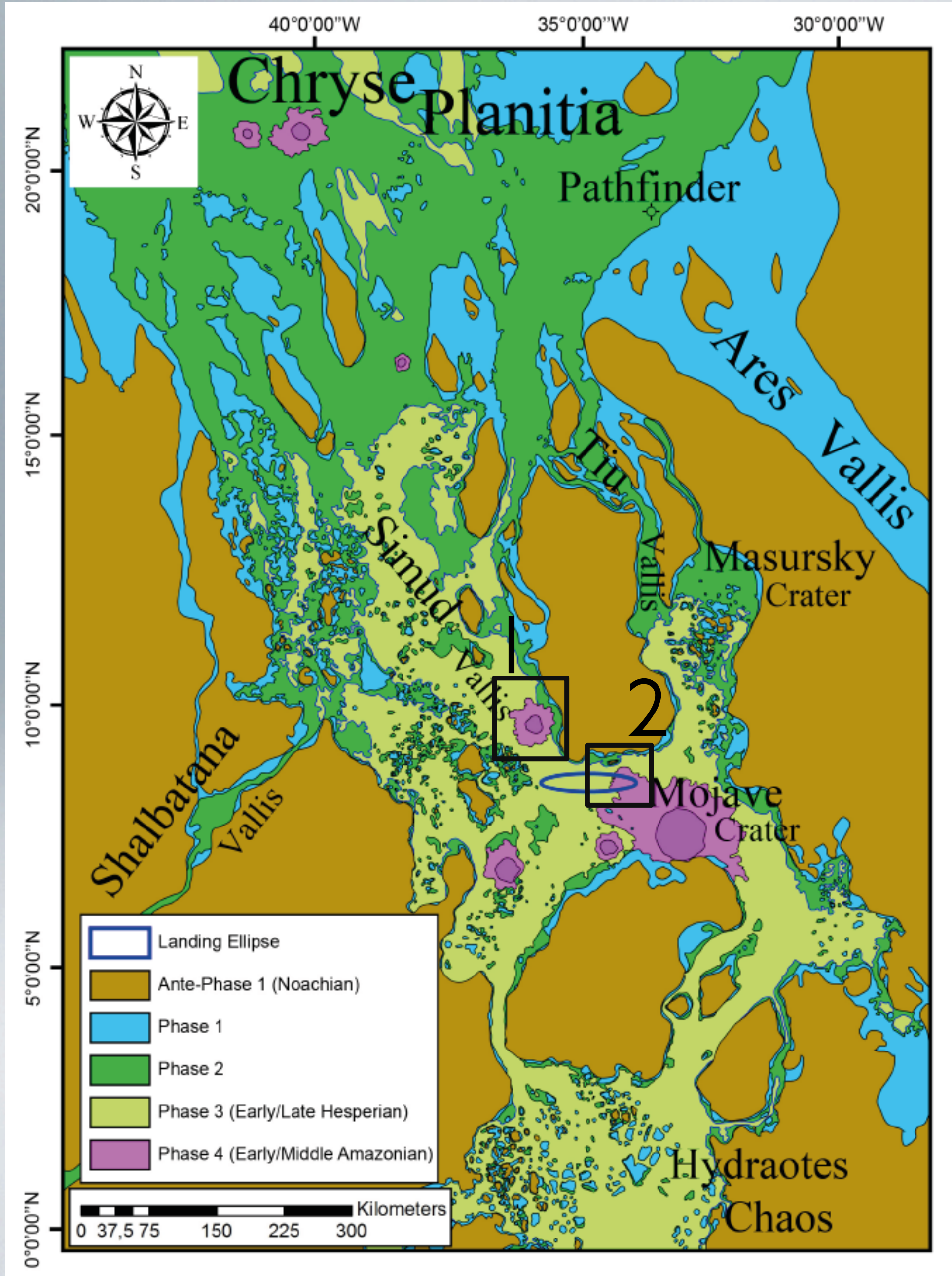
Phase 3 - Reconstruction

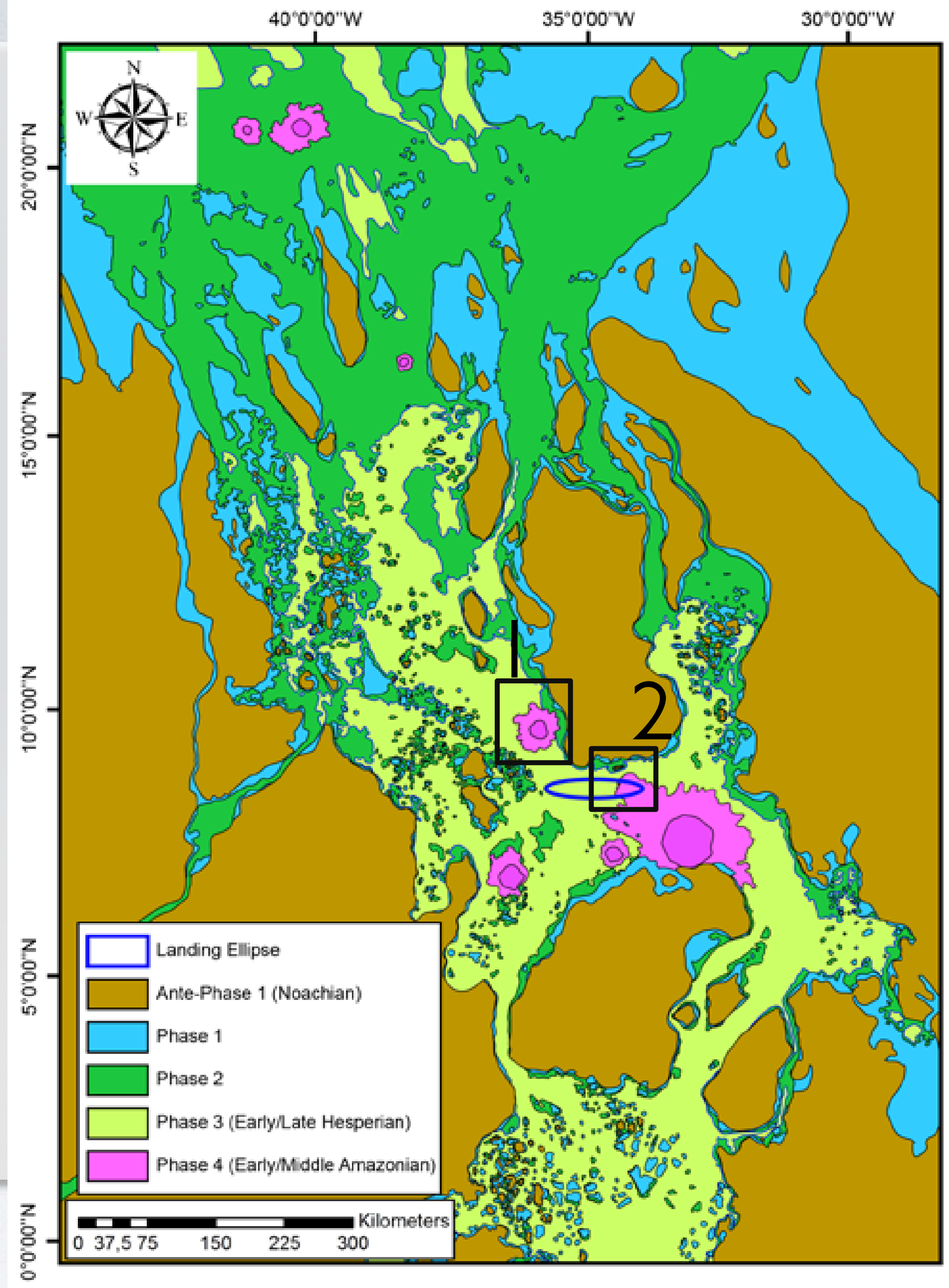
E X O M A R S





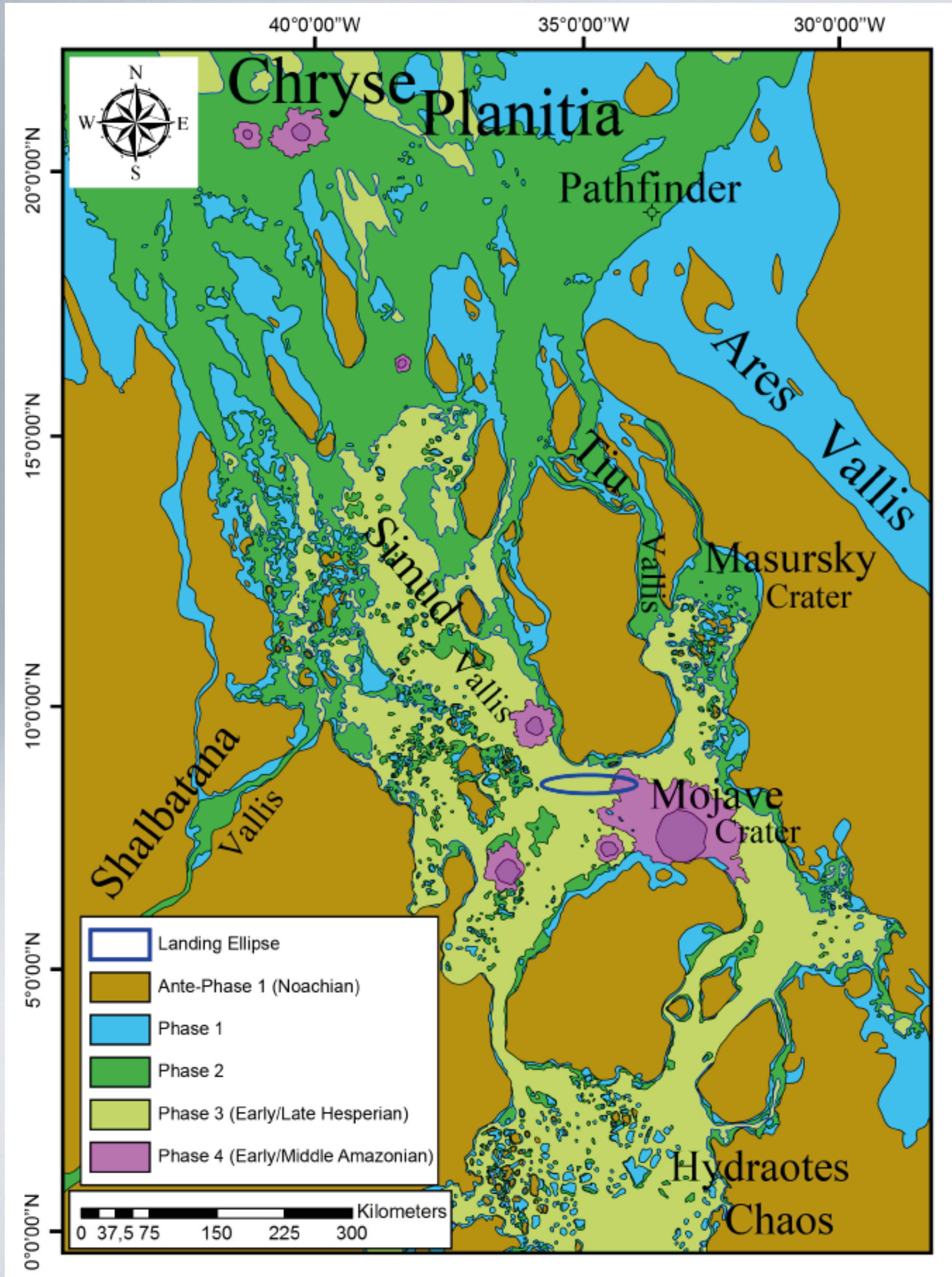
Phase 4 - Reconstruction





Geological units ages

E X O M A R S



Bedrock

Noachian (Tanaka et al., 2005)

Simud Vallis Floor

Crater counting

Mojave crater & ejecta

Still debated. Being conservative: Late Hesperian to Amazonian (Williams and Malin, 2008)

Units Age – Simud Vallis Floor

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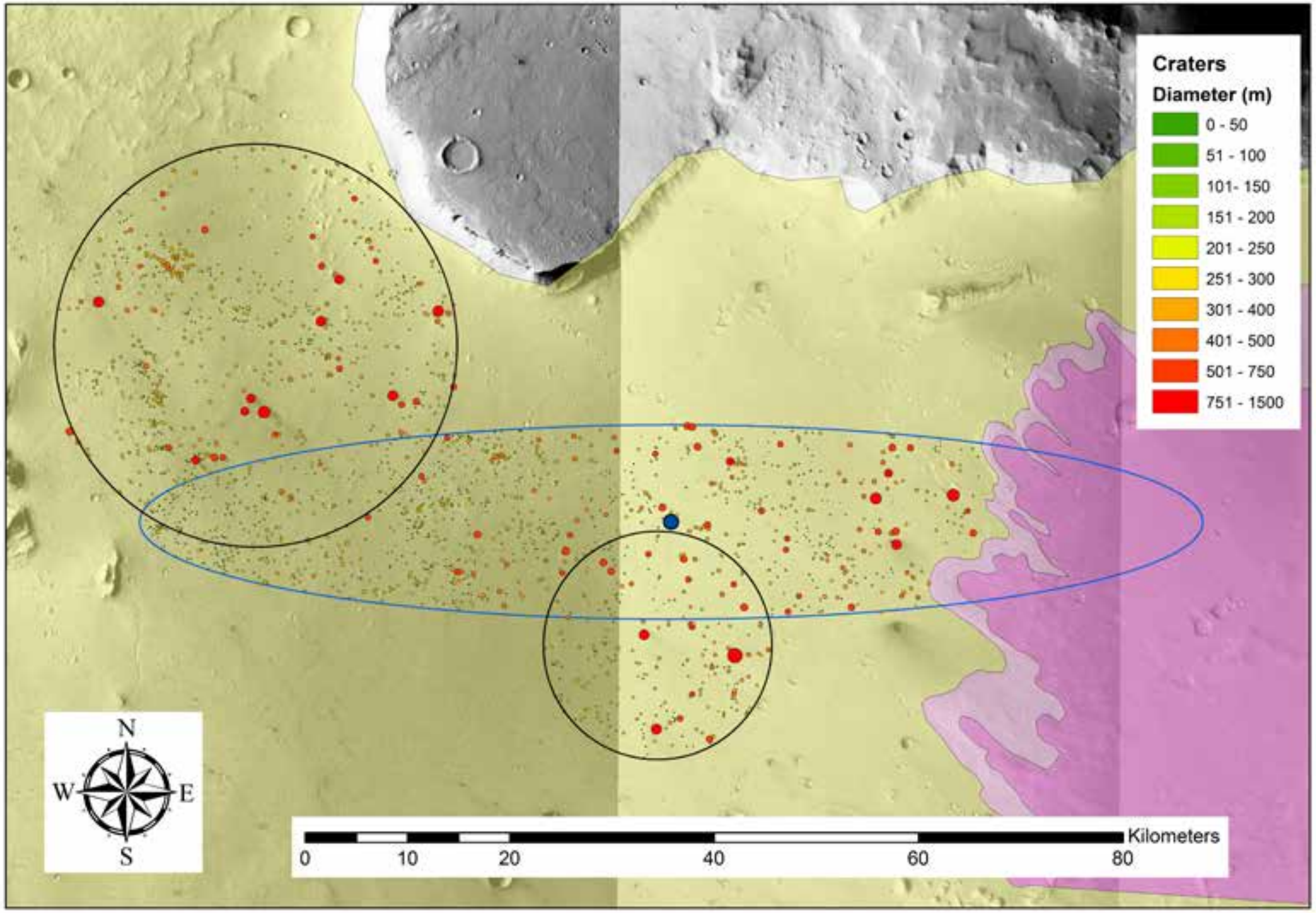
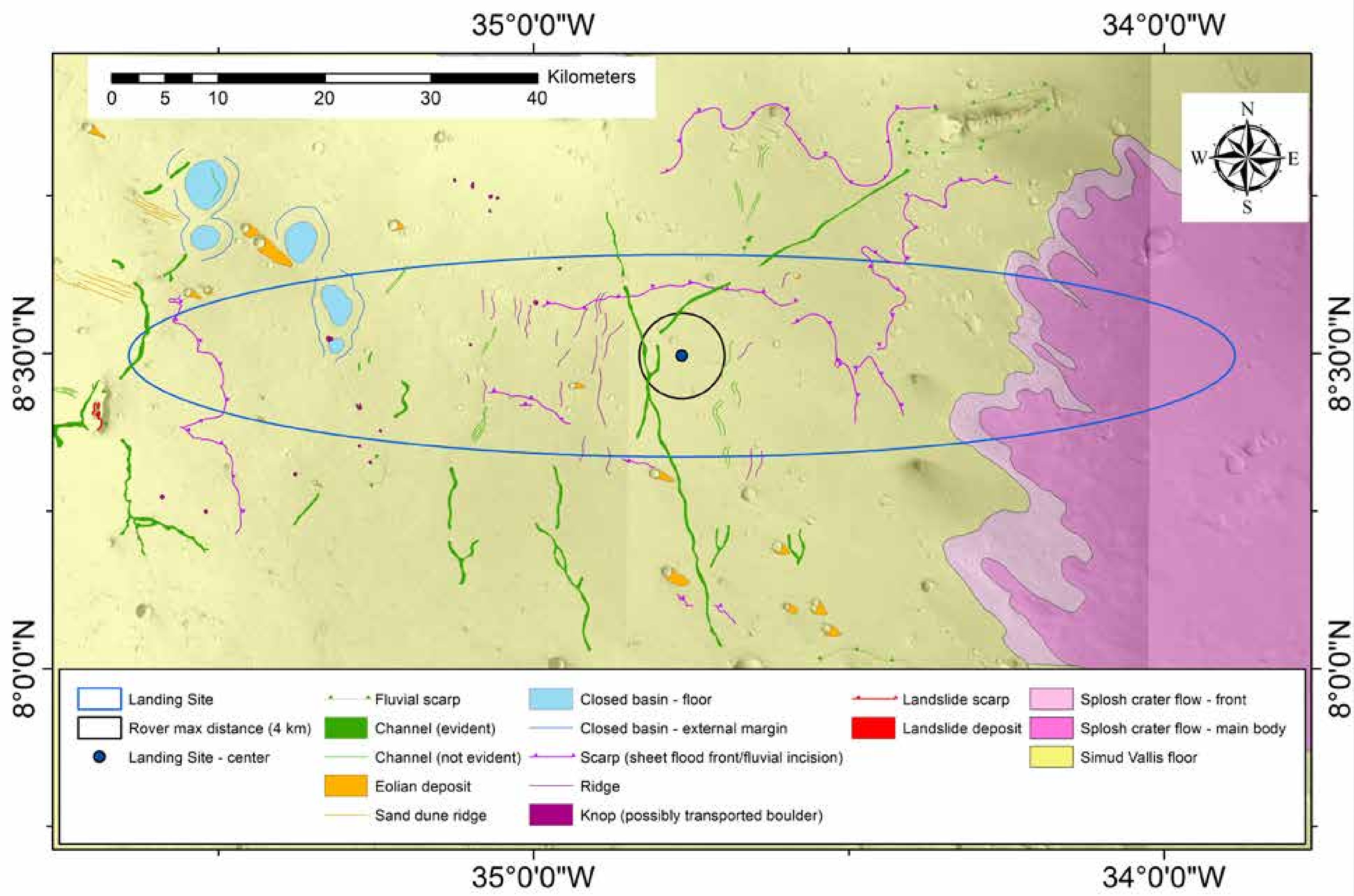


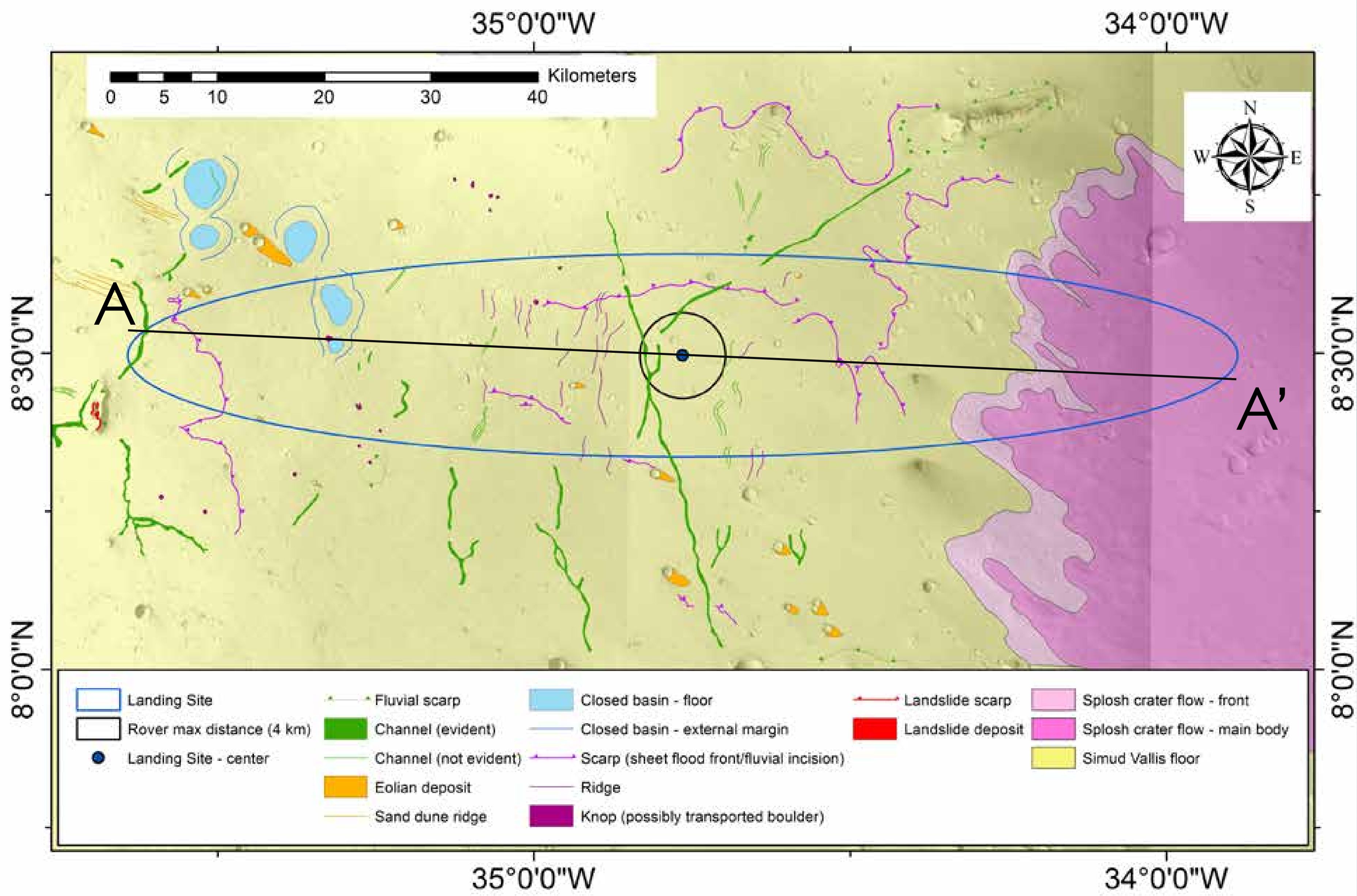
Geomorphological Map

EXOMARS

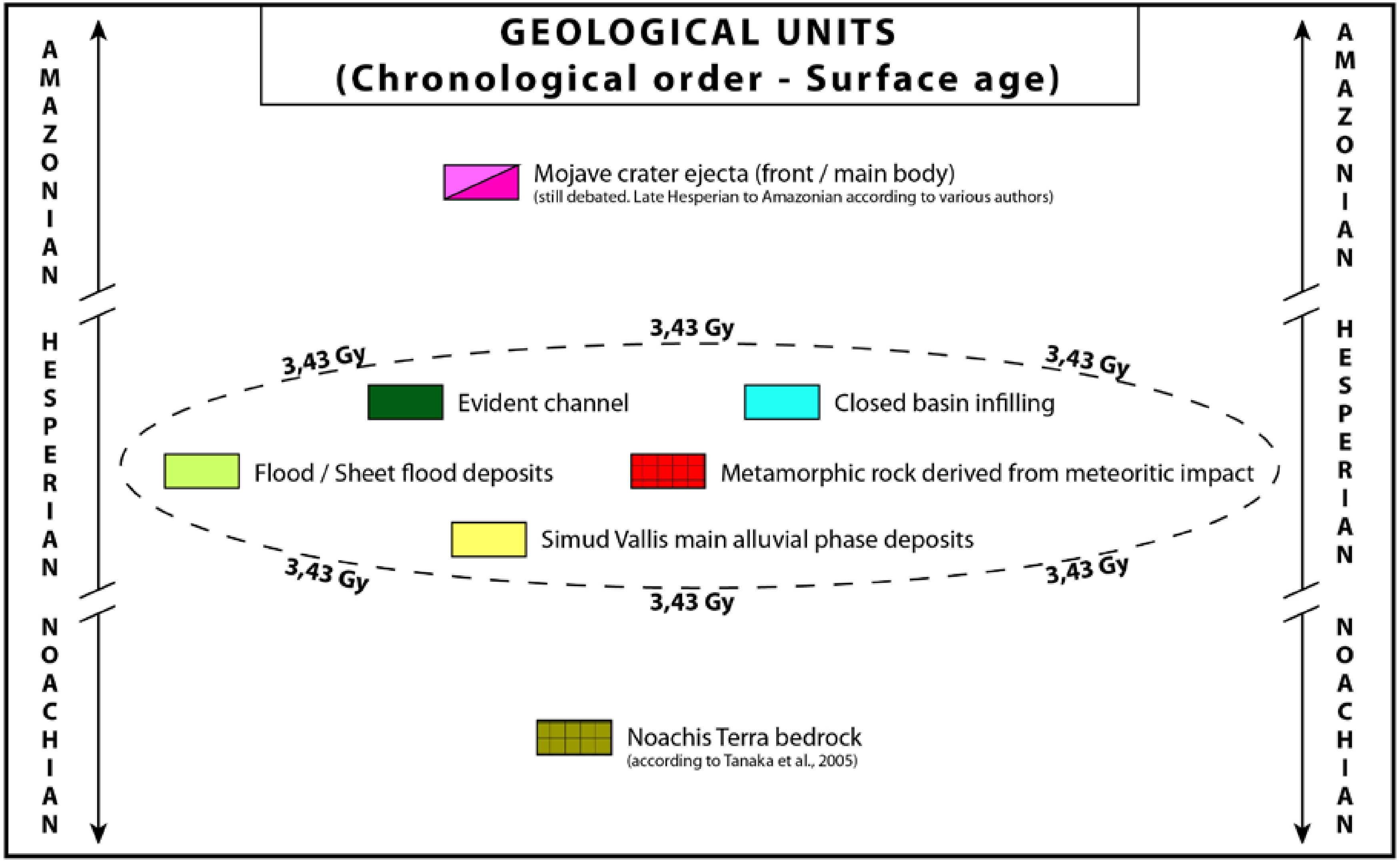


What about the subsurface?

EXOMARS

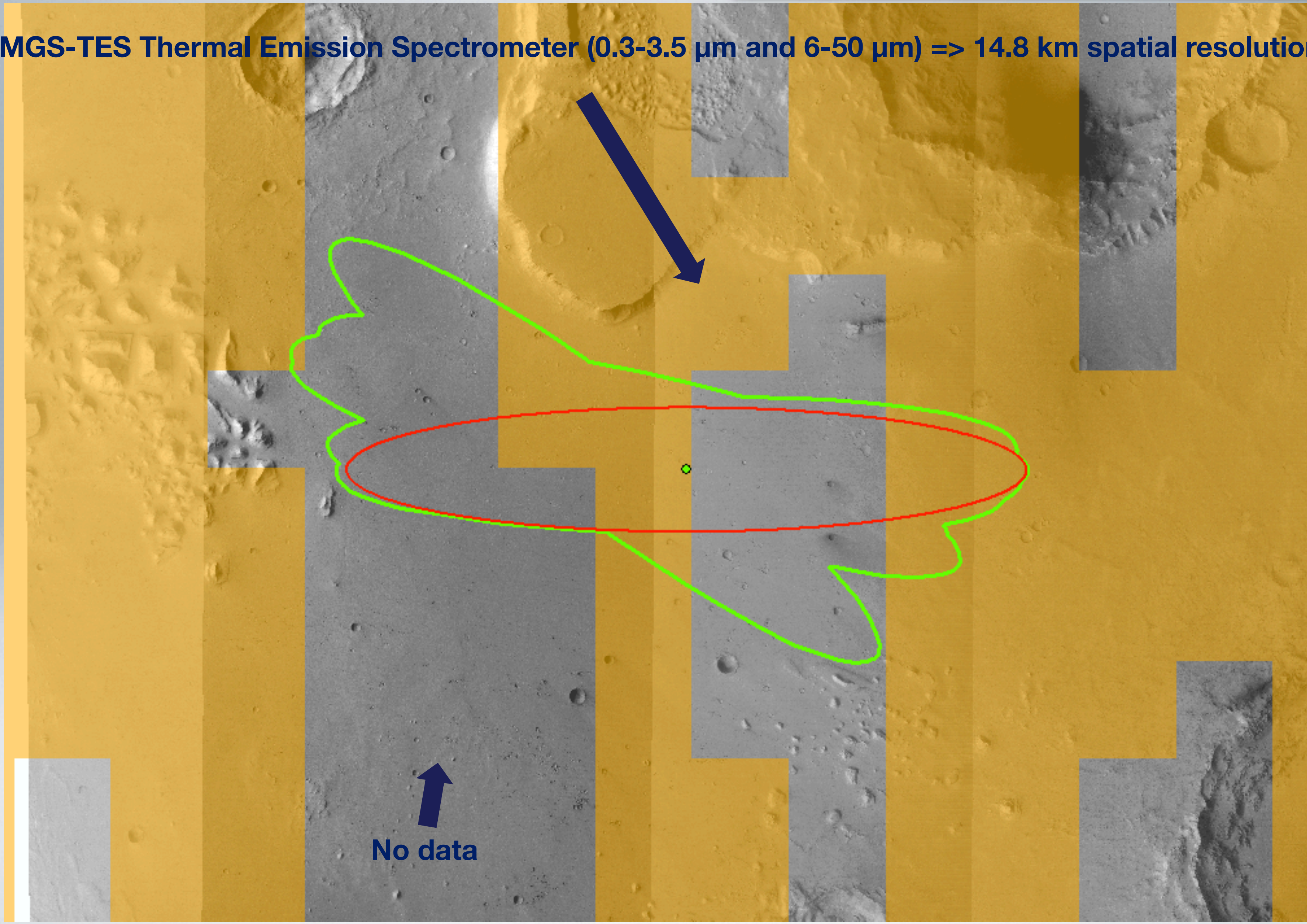


Chronological synthesis



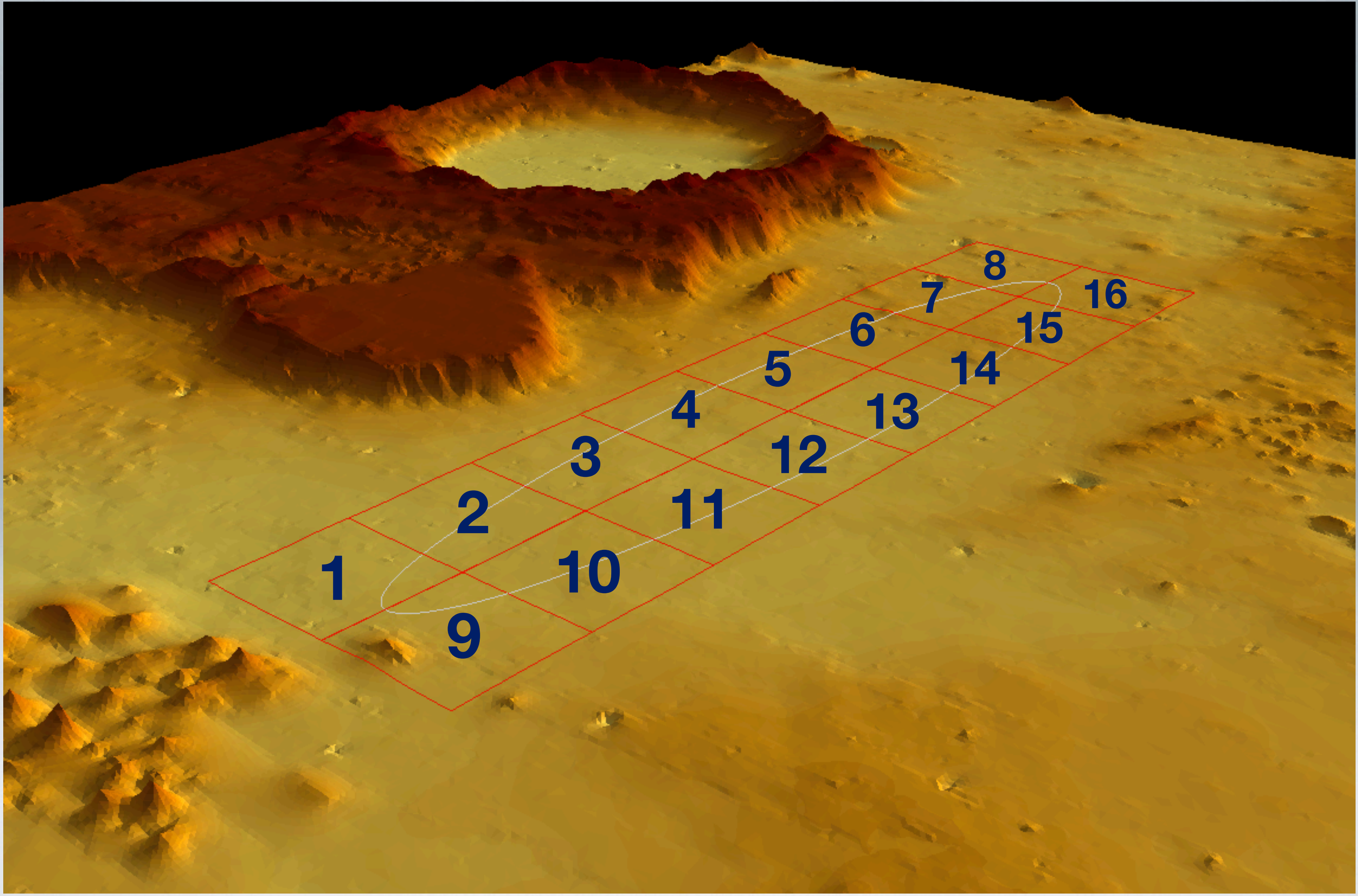
Mineralogical Description

E X O M A R S



Mineralogical Description

MGS-TES Thermal Emission Spectrometer (0.3-3.5 µm and 6-50 µm) => 14.8 km spatial resolution



Mineralogical Description

EXOMARS

Mineralogical Description

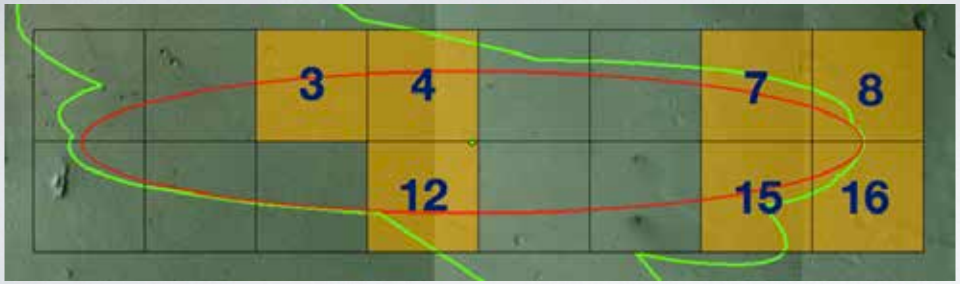
E X O M A R S

MARS Global Data Sets
MARS SPACE FLIGHT FACILITY

ARIZONA STATE UNIVERSITY

TES Mineral Maps (Emissivity) => Bandfield, J.L., *J. Geophys. Res.*, 107, 2002.

Mineral	Quartz	K-Feldspar	Plagioclase	Amphibole	Low Ca Pyroxene	High Ca Pyroxene	Olivine	Hematite	Carbonates	Sulfates	Sheet Silicates
TES Max	0,064	0,147	0,783	0,122	0,320	0,282	0,174	0,224	0,266	0,164	0,733
Area 3	0,001	0,024	0,063	0,000	0,028	0,000	0,000	0,092	0,045	0,064	0,077
%/Max	1,1	16,5	8,0	0,0	8,7	0,0	0,0	41,1	16,7	38,8	10,5
Area 4	0,000	0,044	0,049	0,000	0,000	0,040	0,000	0,000	0,040	0,048	0,121
%/Max	0,0	29,6	6,2	0,0	0,0	14,2	0,0	0,0	15,0	29,2	16,5
Area 7	0,000	0,014	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,025	0,030
%/Max	0,0	9,4	0,5	0,0	0,0	0,0	0,0	0,0	0,0	15,4	4,1
Area 8	0,000	0,011	0,000	0,000	0,000	0,022	0,000	0,000	0,026	0,029	0,063
%/Max	0,0	7,8	0,0	0,0	0,0	7,9	0,0	0,0	9,8	17,9	8,5
Area 12	0,000	0,044	0,046	0,000	0,017	0,027	0,000	0,000	0,043	0,058	0,143
%/Max	0,0	29,8	5,8	0,0	5,3	9,7	0,0	0,0	16,2	35,4	19,5
Area 15	0,000	0,016	0,000	0,000	0,000	0,002	0,000	0,000	0,024	0,033	0,049
%/Max	0,0	10,7	0,0	0,0	0,0	0,9	0,0	0,0	8,9	19,9	6,7
Area 16	0,000	0,015	0,000	0,000	0,000	0,024	0,000	0,000	0,027	0,035	0,021
%/Max	0,0	10,5	0,0	0,0	0,0	8,6	0,0	0,0	10,0	21,2	2,9



Mineralogical Description

EXOMARS

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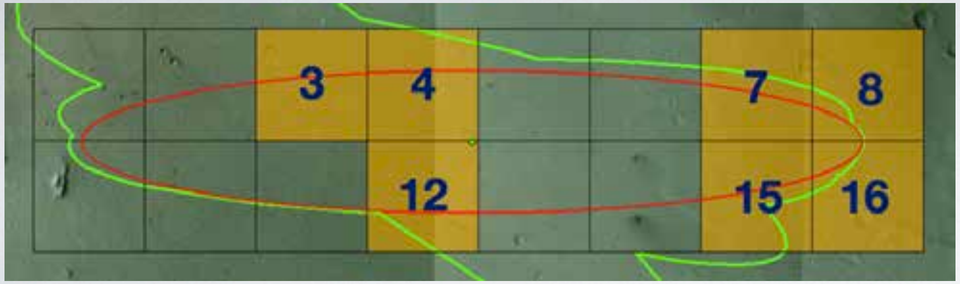
%/Max	1,1	16,5	8,0	0,0	8,7	0,0	0,0	41,1	16,7	38,8	10,5
Area 4	0,000	0,044	0,049	0,000	0,000	0,040	0,000	0,000	0,040	0,048	0,121
%/Max	0,0	29,6	6,2	0,0	0,0	14,2	0,0	0,0	15,0	29,2	16,5
Area 7	0,000	0,014	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,025	0,030
%/Max	0,0	9,4	0,5	0,0	0,0	0,0	0,0	0,0	0,0	15,4	4,1
Area 8	0,000	0,011	0,000	0,000	0,000	0,022	0,000	0,000	0,026	0,029	0,063
%/Max	0,0	7,8	0,0	0,0	0,0	7,9	0,0	0,0	9,8	17,9	8,5
Area 12	0,000	0,044	0,046	0,000	0,017	0,027	0,000	0,000	0,043	0,058	0,143
%/Max	0,0	29,8	5,8	0,0	5,3	9,7	0,0	0,0	16,2	35,4	19,5
Area 15	0,000	0,016	0,000	0,000	0,000	0,002	0,000	0,000	0,024	0,033	0,049
%/Max	0,0	10,7	0,0	0,0	0,0	0,9	0,0	0,0	8,9	19,9	6,7
Area 16	0,000	0,015	0,000	0,000	0,000	0,024	0,000	0,000	0,027	0,035	0,021
%/Max	0,0	10,5	0,0	0,0	0,0	8,6	0,0	0,0	10,0	21,2	2,9



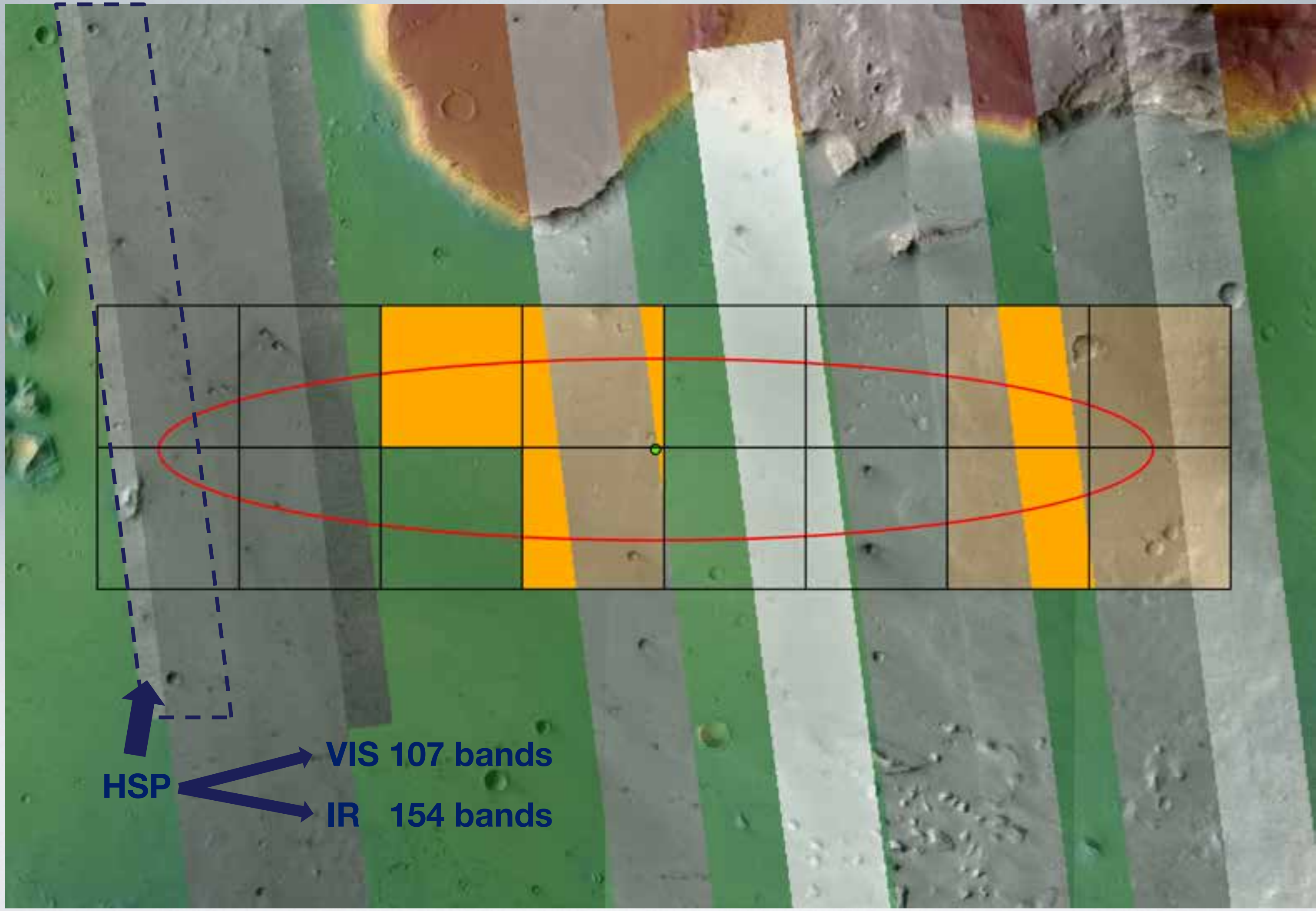
Carbonates -> Calcite, Dolomite as end members

Sulfates -> Anhydrite and Gypsum as end members

Mineralogical Description

MRO-CRISM (0.4-3.5 µm) slanted swaths => 150 m spatial resolution

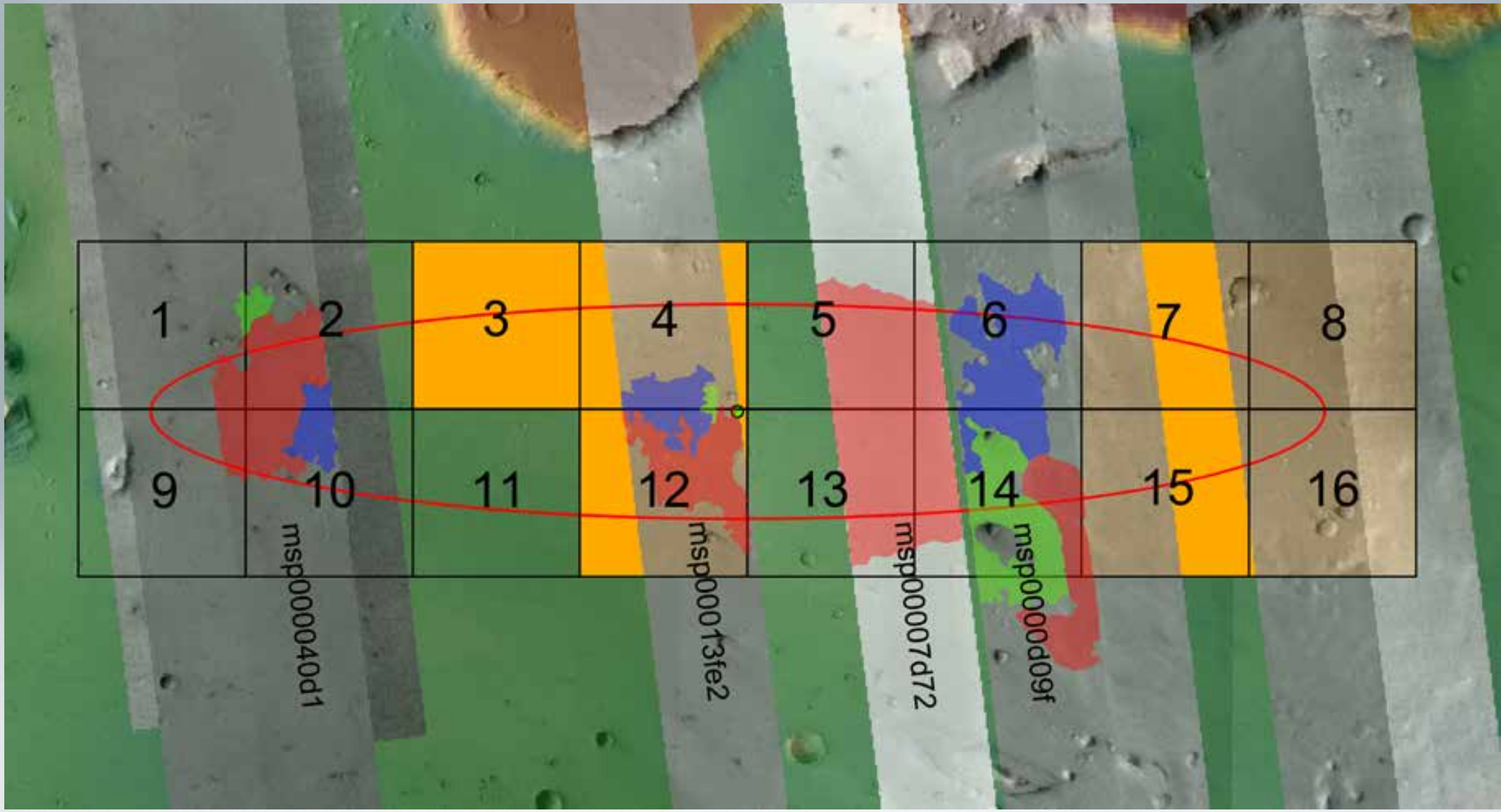
MSP: VIS 19 bands; IR 55 bands



Mineralogical Description

EXOMARS

VIS Region of Interest ROIs => MSP

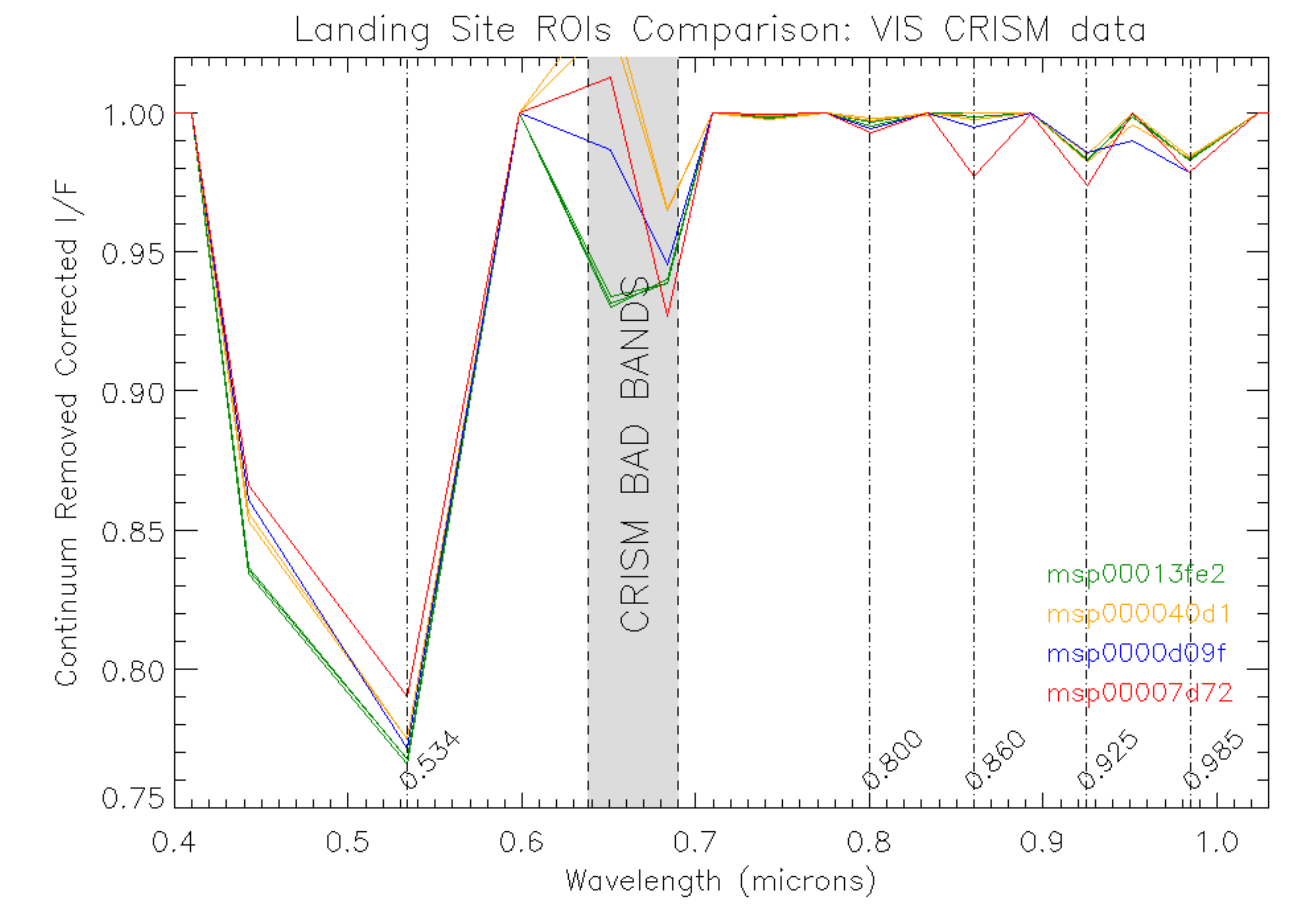


The ROIs are created from geomorphological similarities

Mineralogical Description

EXOMARS

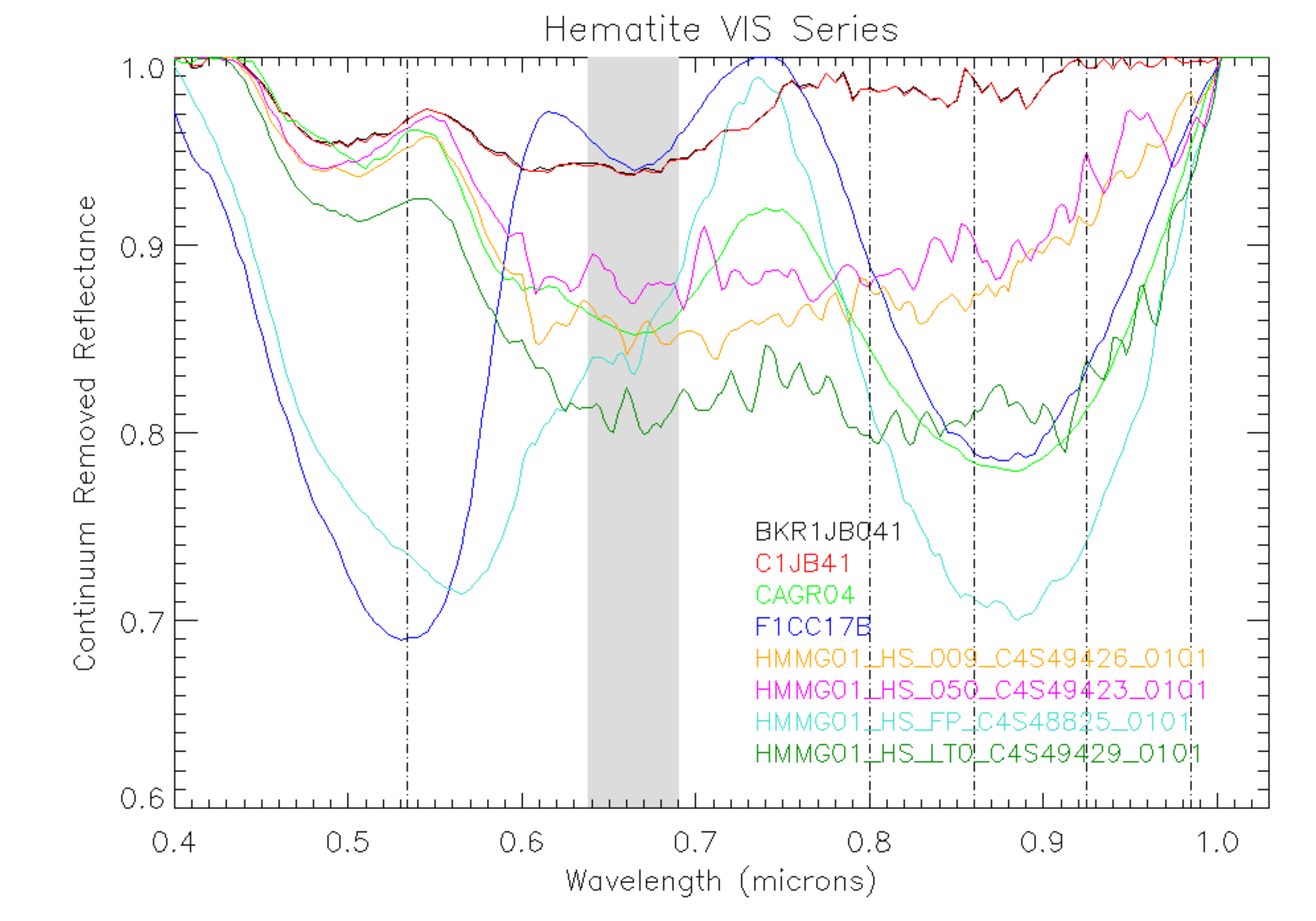
VIS Region of Interest ROIs => MSP



Mineralogical Description

E X O M A R S

VIS Region of Interest ROIs => MSP

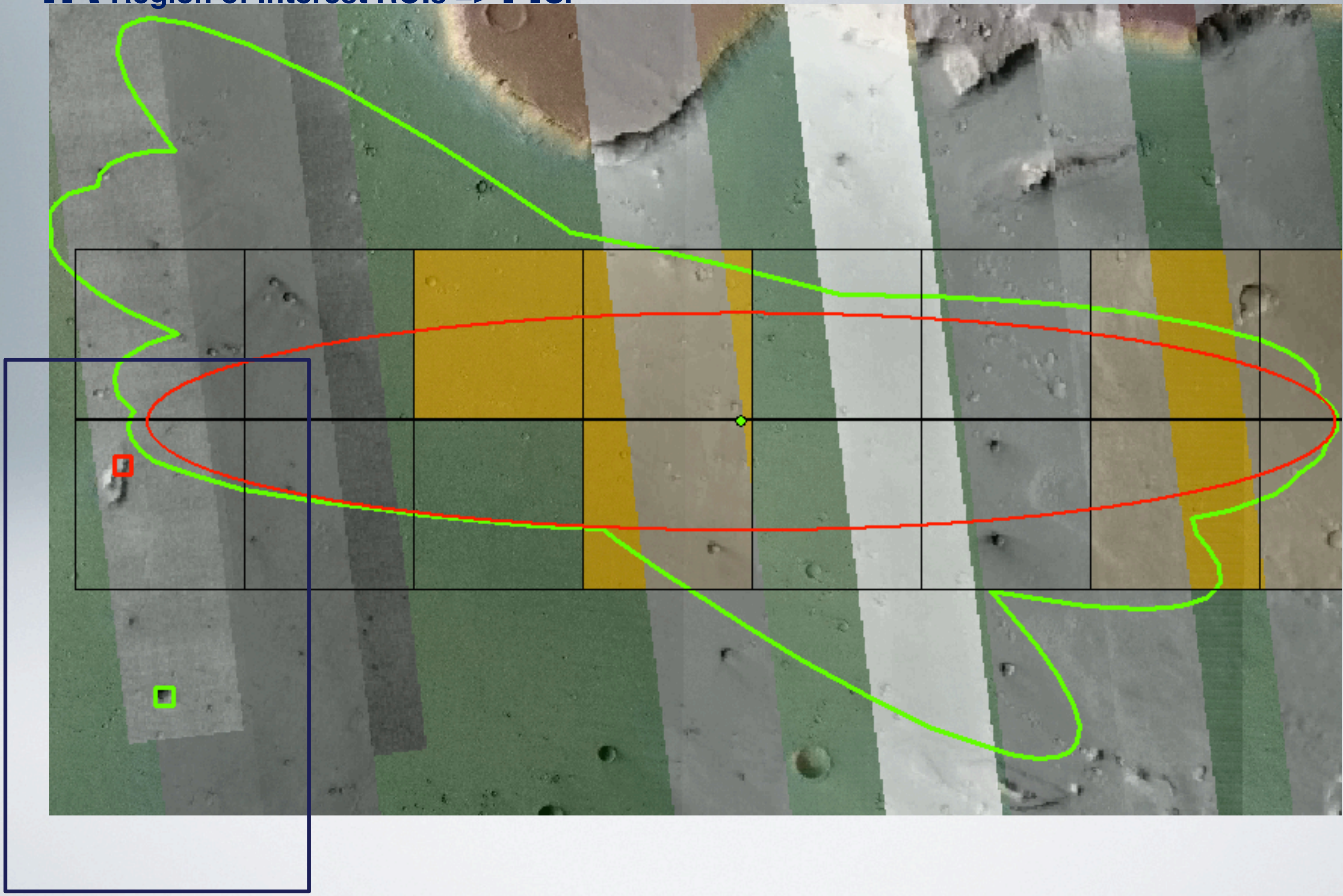


VIS Detection of Hematite/Iron Oxides

Mineralogical Description

EXOMARS

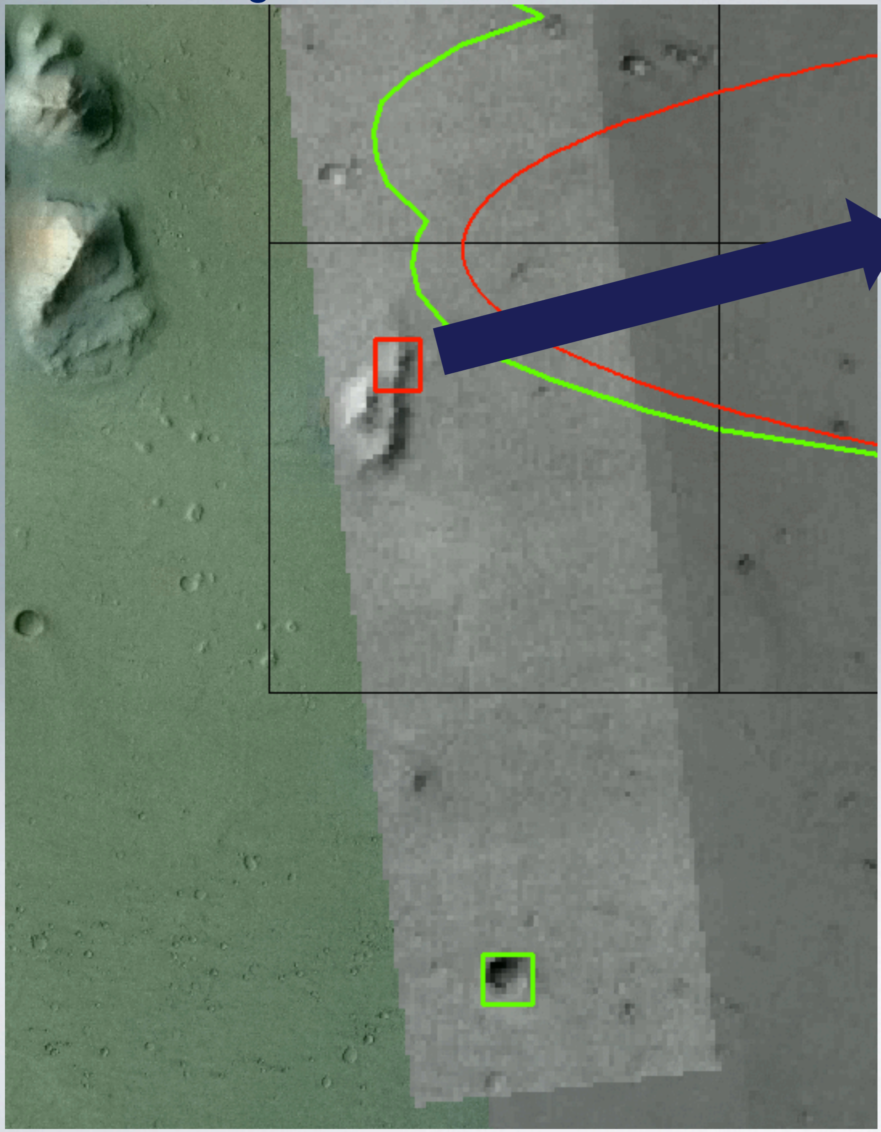
IR Region of Interest ROIs => HSP

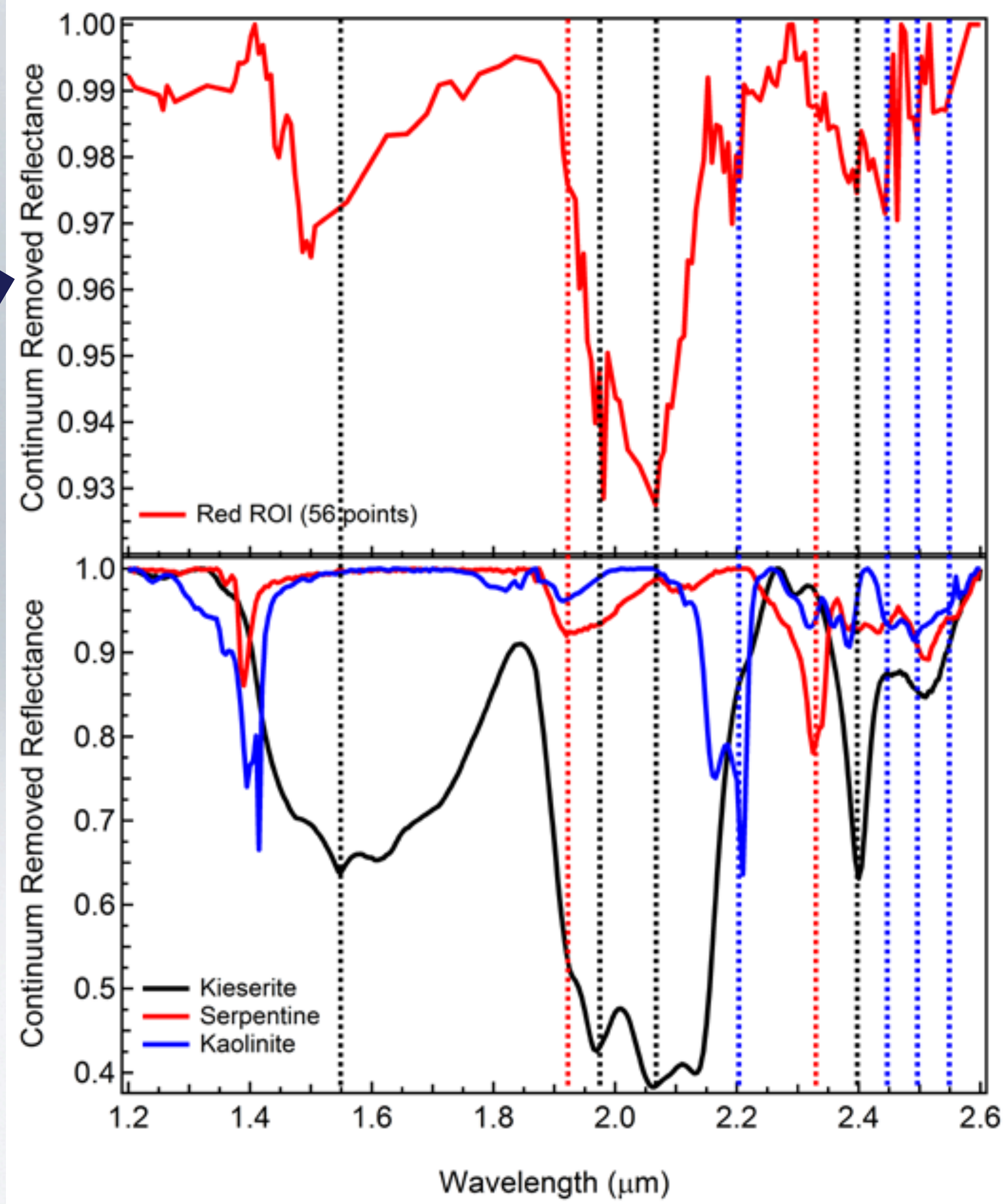


Mineralogical Description

E X O M A R S

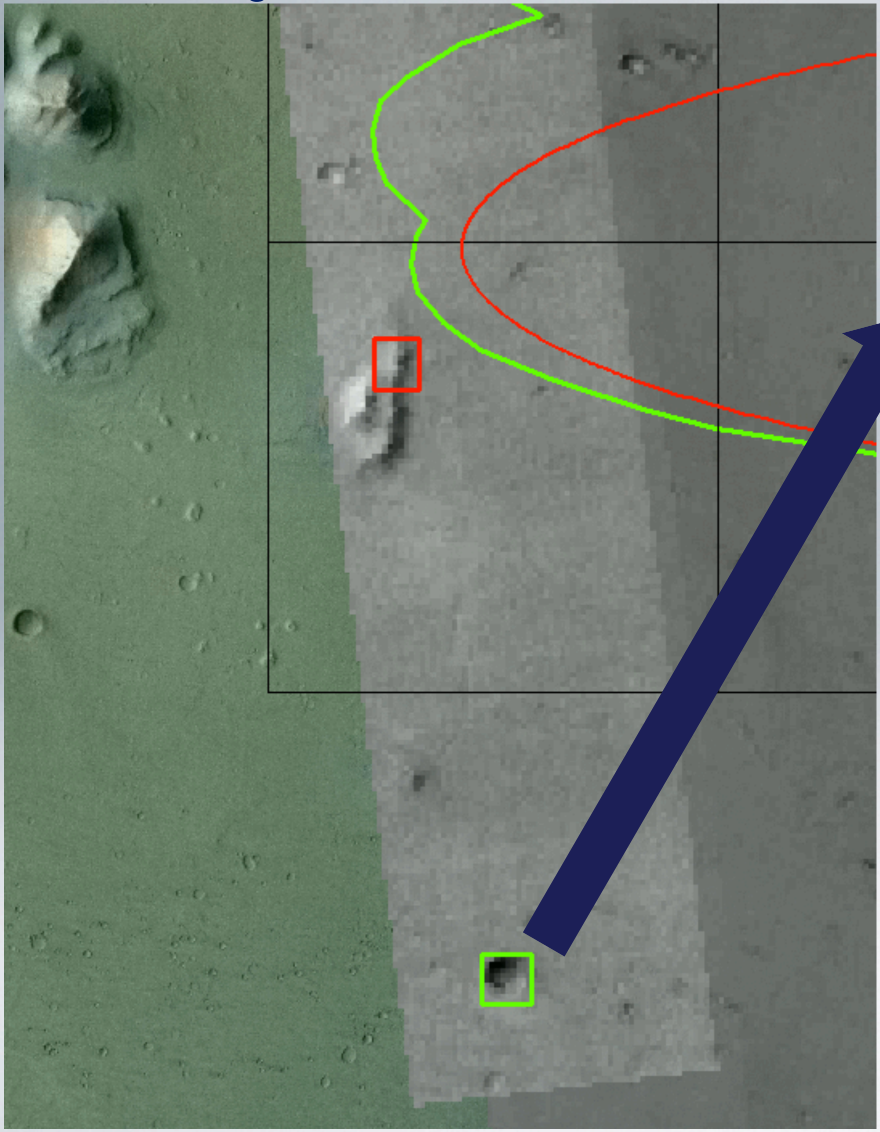
IR Region of Interest ROIs => HSP

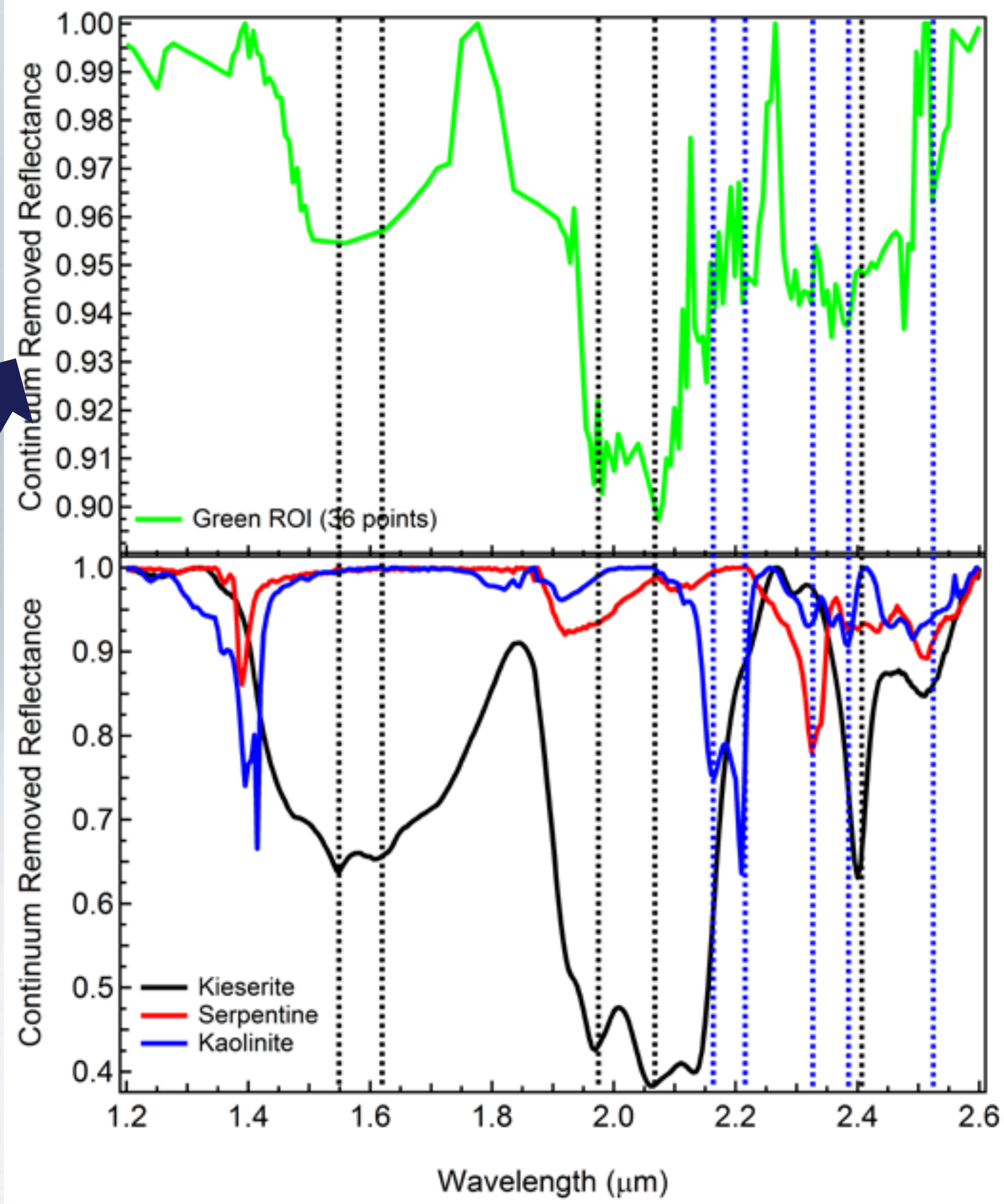




Mineralogical Description

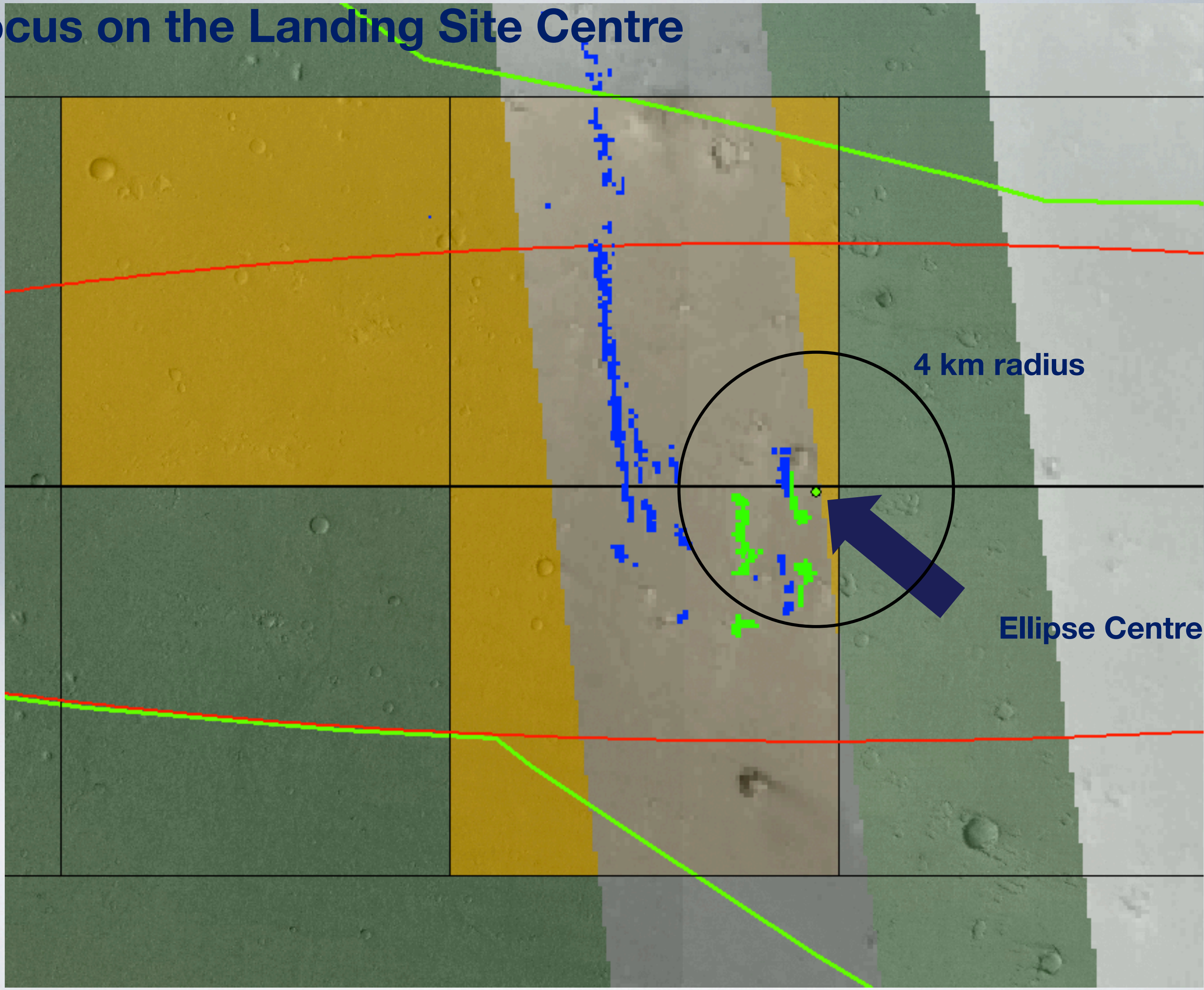
IR Region of Interest ROIs => HSP





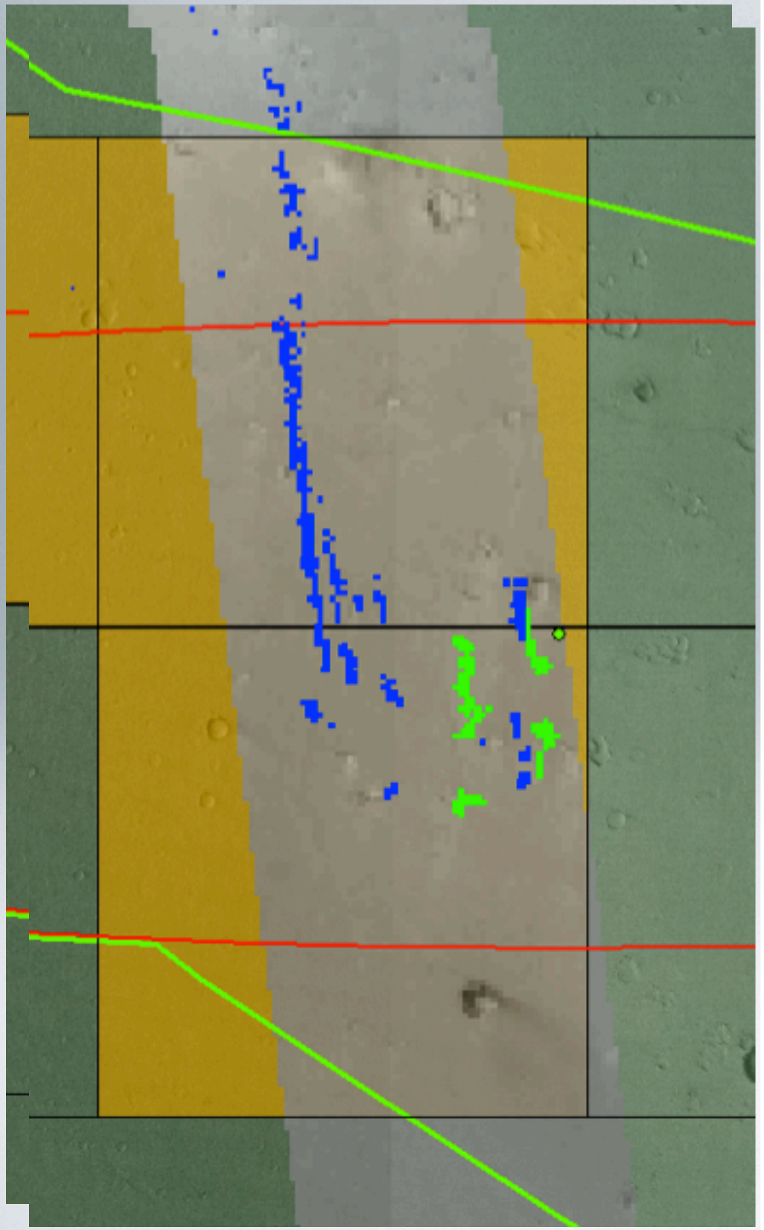
EXOMARS

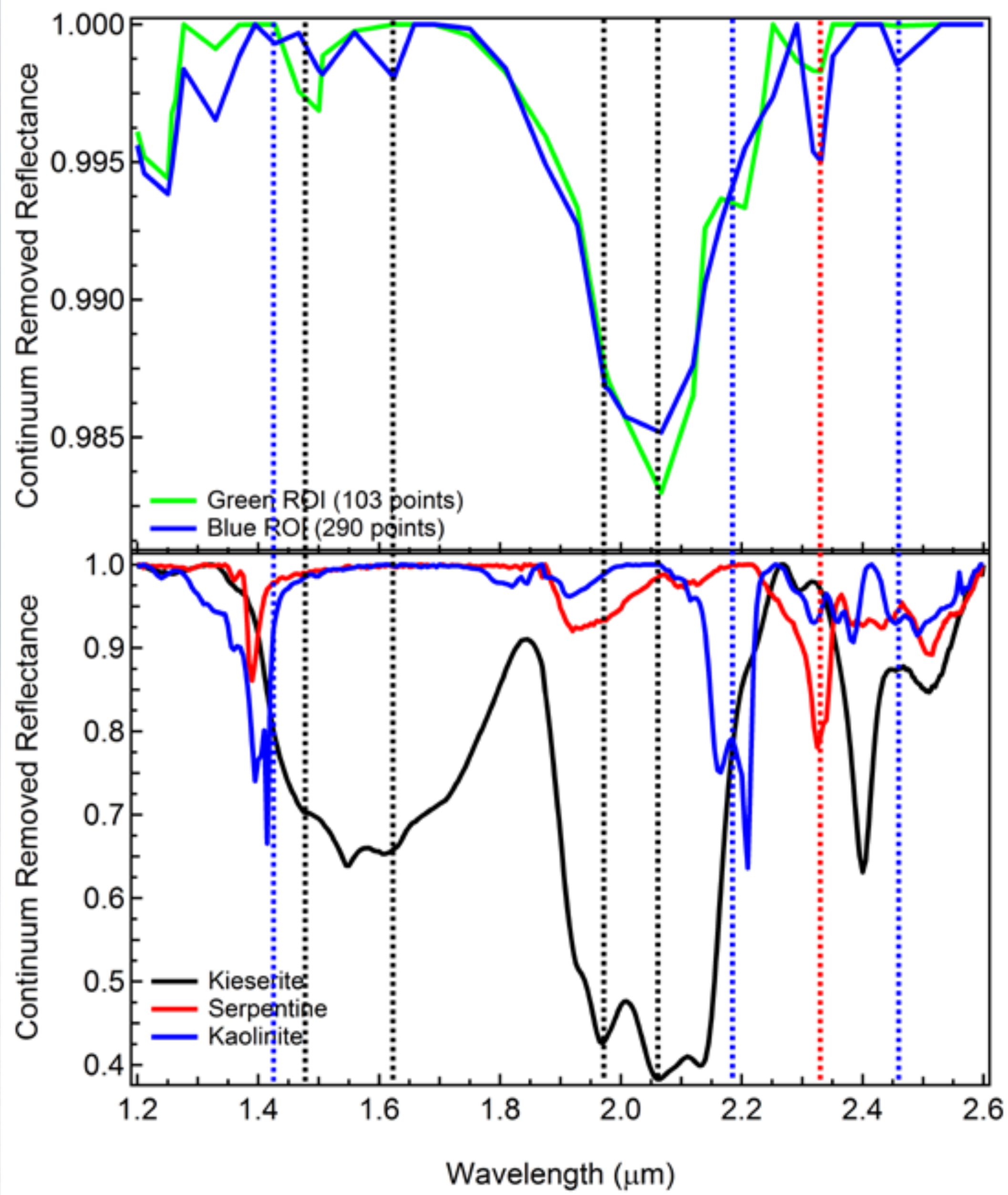
Let's focus on the Landing Site Centre



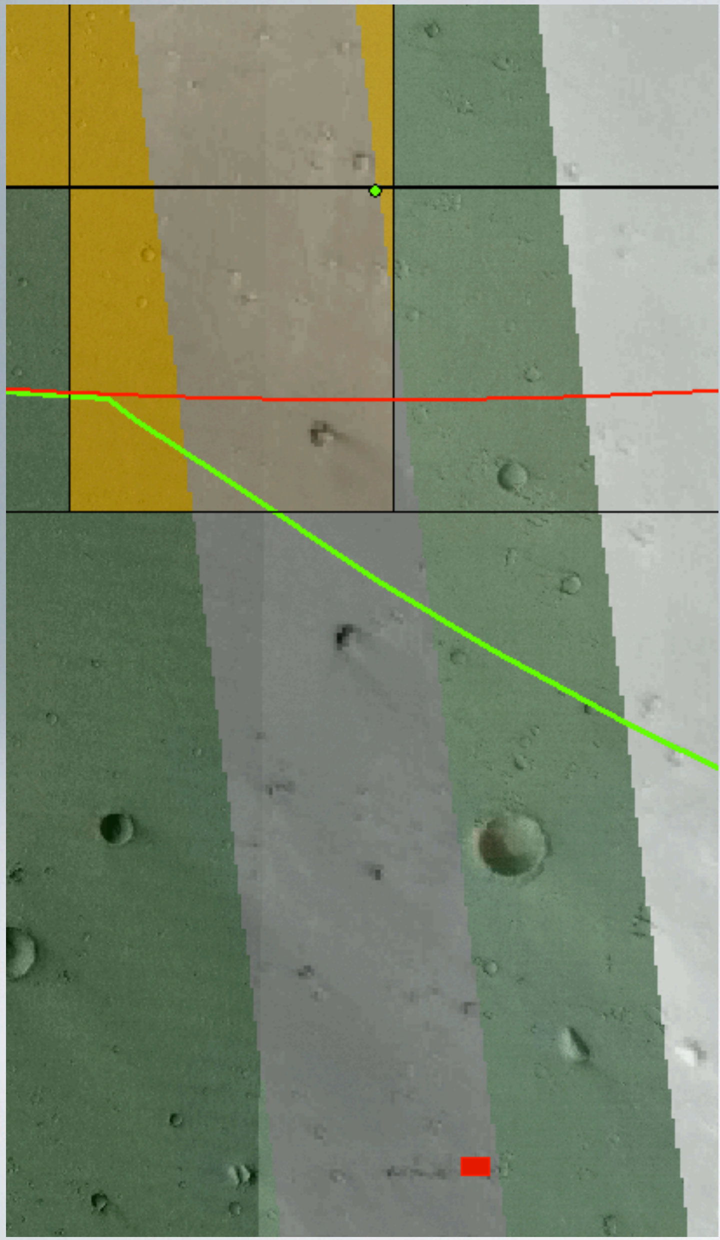
Mineralogical Description

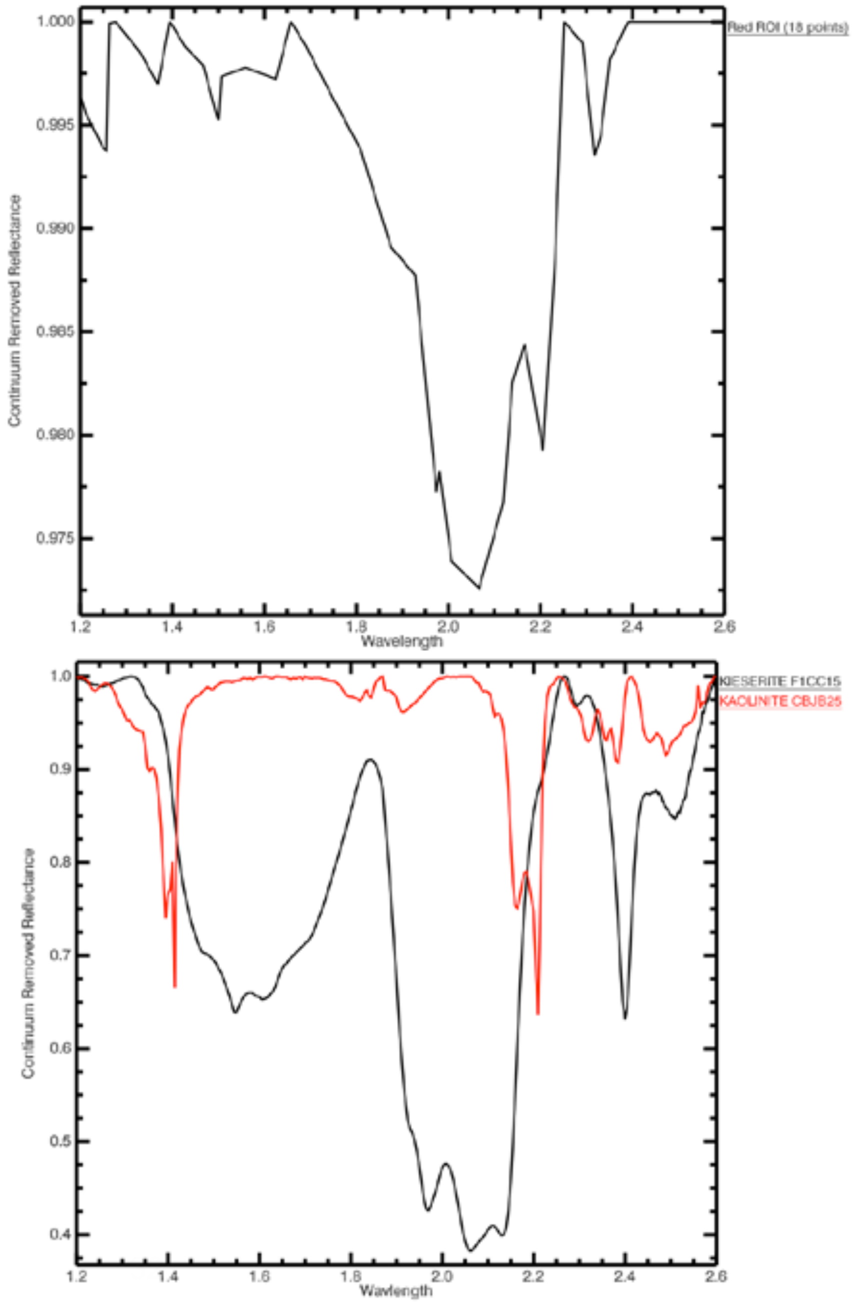
E X O M A R S





Mineralogical Description



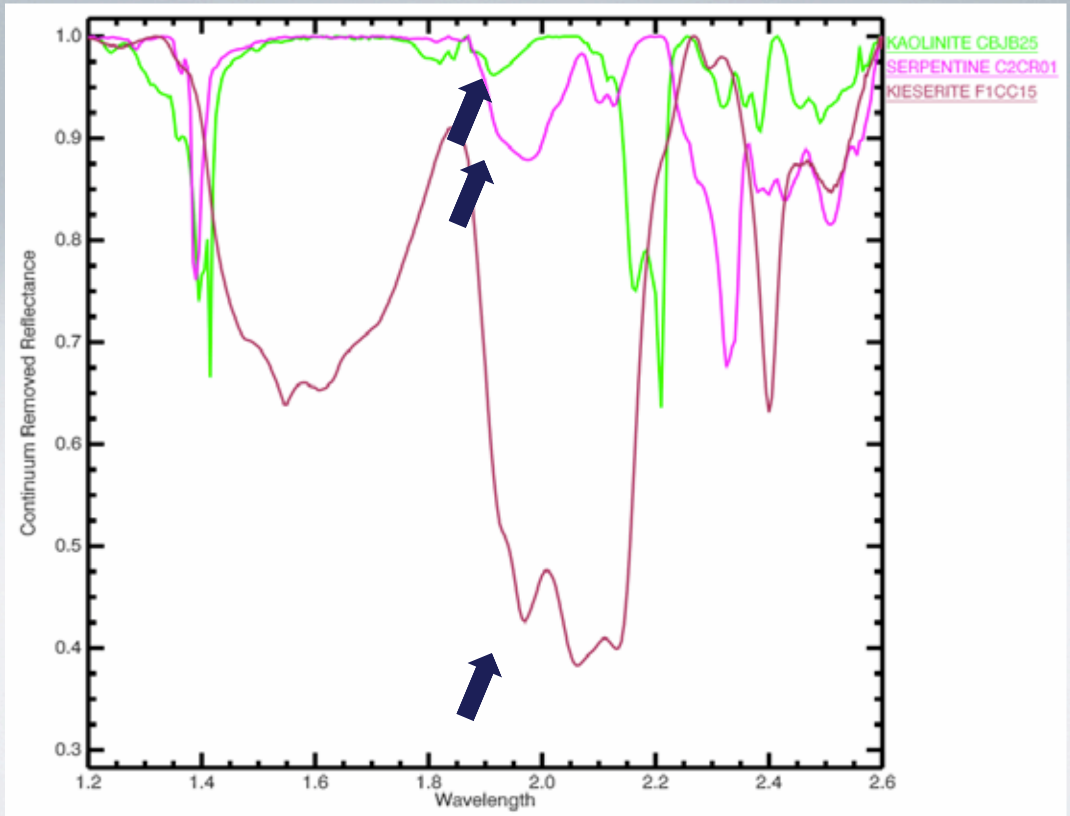


Mineralogical Description

E X O M A R S

The ROIs are created from highest values of spectral parameters associated to the detection of phyllosilicates and sulfates => we then averaged the spectra and compared them to those from spectral library (CRISM/RELAB), after removing the continuum.

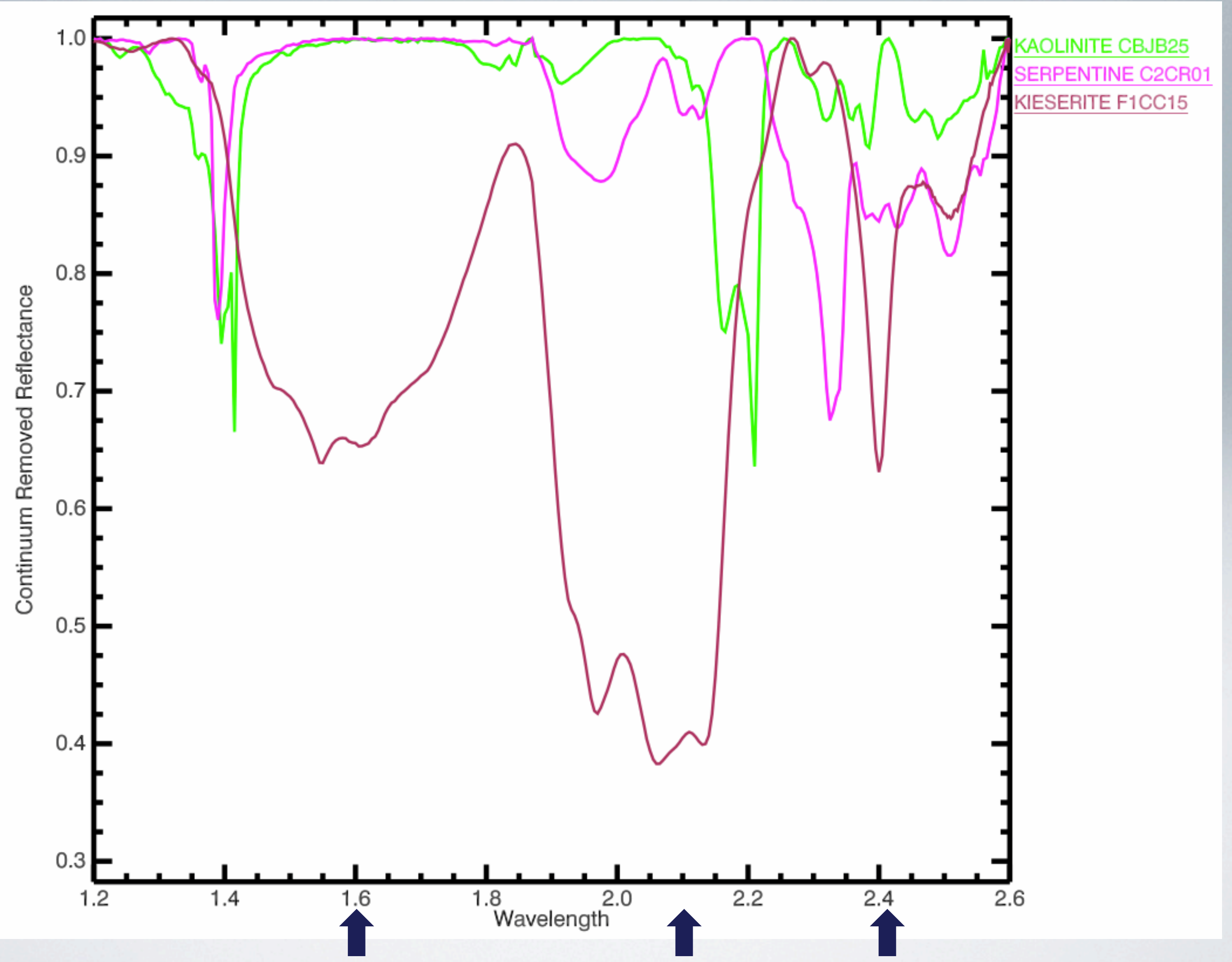
All hydrated minerals, including <u>hydrated silica (such as serpentine), sulfate (such as kieserite), phyllosilicates (such as kaolinite), and carbonates</u>, show a broad band at about 1.9 µm due to the presence of H_2O in their crystalline lattice. So, in order to understand which class of hydrated mineral is present, other absorption bands are necessary.



Mineralogical Description

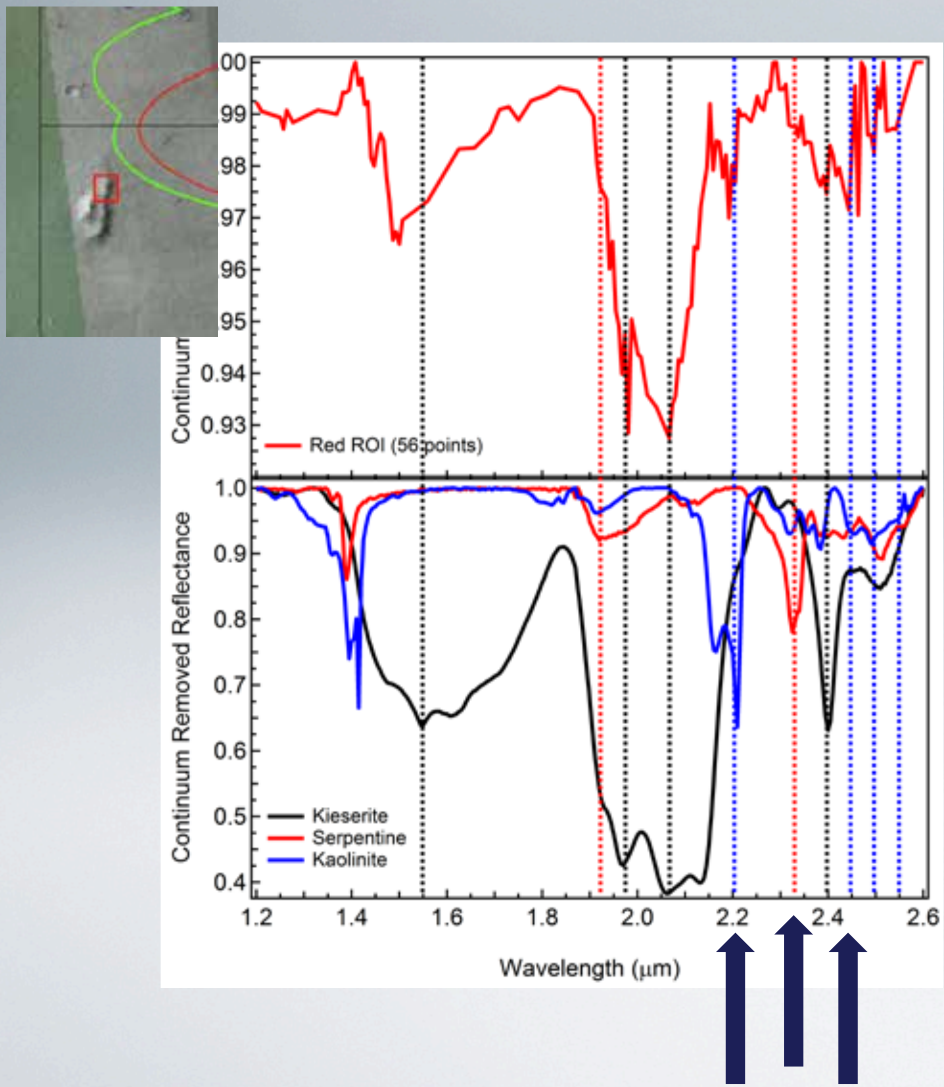
E X O M A R S

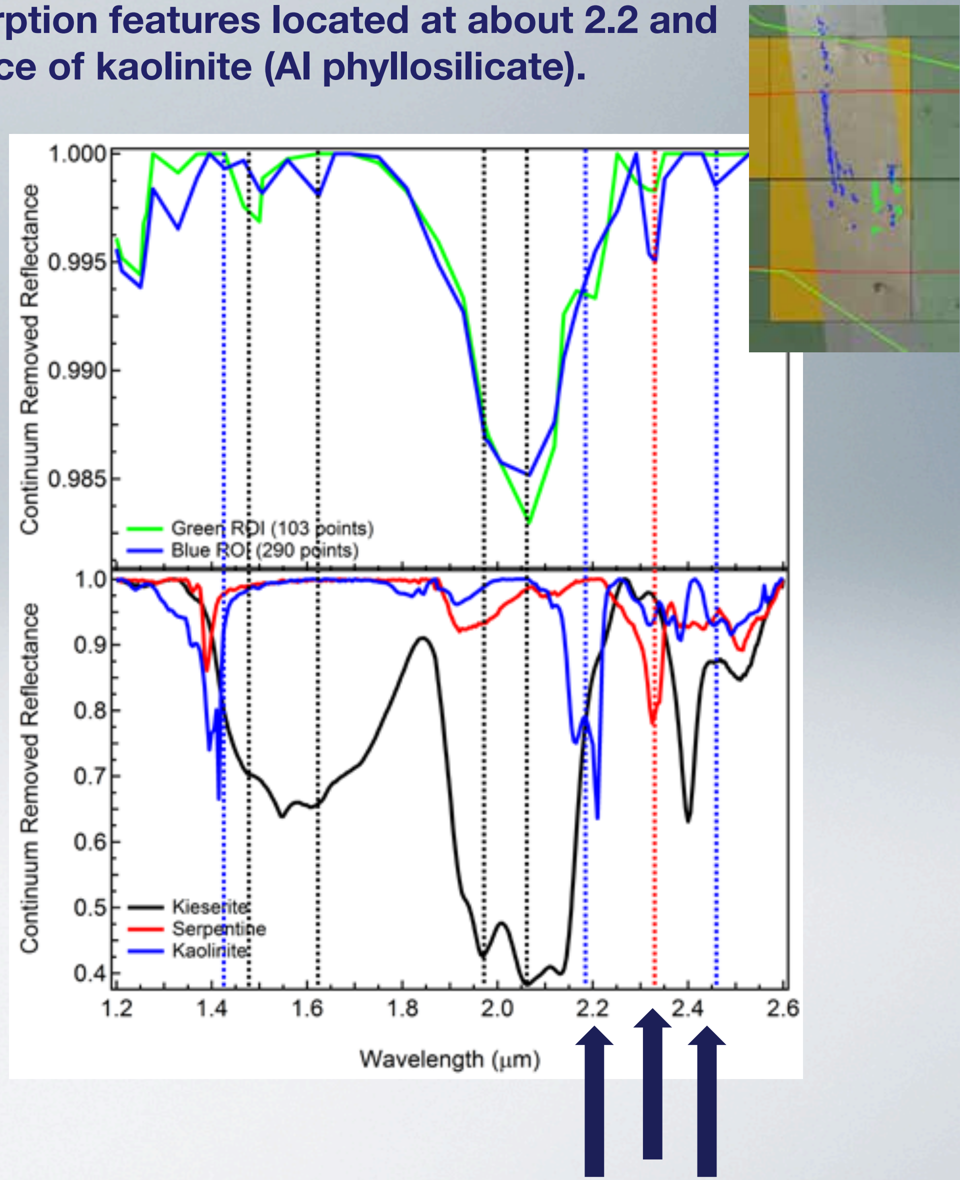
The presence of a broad absorption bands centered at about 1.6 and 2.1 µm, respectively, as well as a drop off in reflectance near 2.4 µm allow to indicate the presence of kieserite (sulfate) in both observations (CRISM CONFIRMATION OF TES)



Mineralogical Description

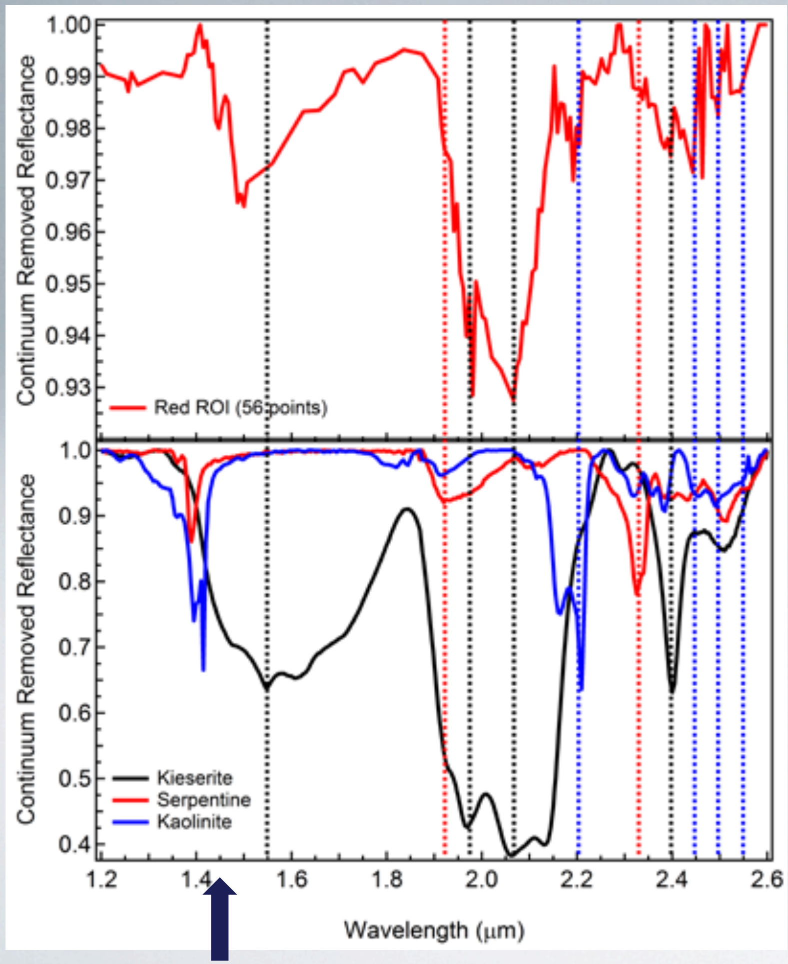
The presence of serpentine (hydrated silica) is indicated by the presence of a drop off of the spectrum at about 2.35 µm (RED ROI of HSP0000163EF and BLUE ROI of MSP00013FE2). On the other hand, the absorption features located at about 2.2 and 2.45 µm in all the spectra indicate the presence of kaolinite (Al phyllosilicate).





Mineralogical Description

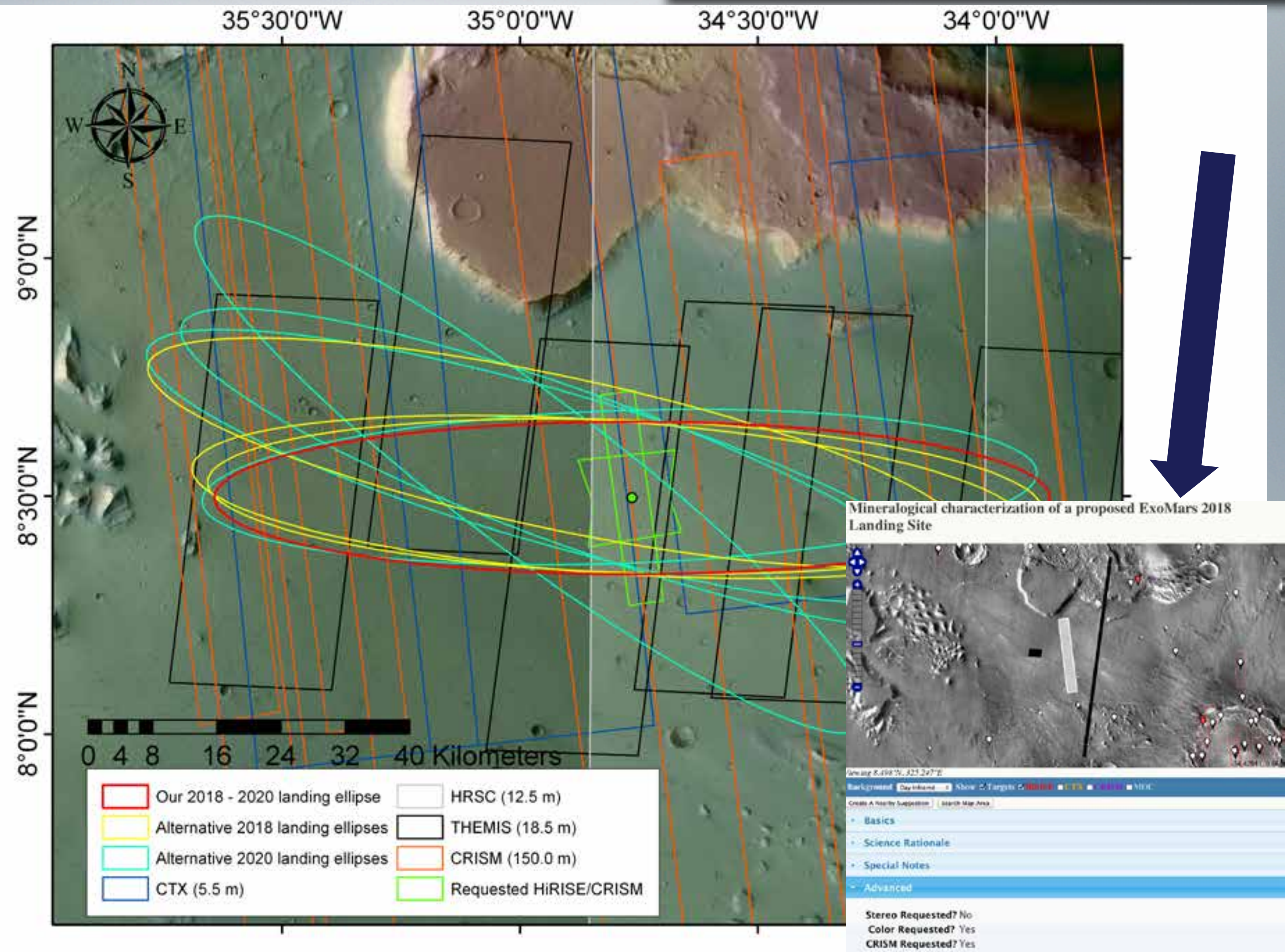
The absorption band at about 1.45 μm, clearly visible in RED ROI of HSP0000163EF is probably due to the presence polyhydrated sulfates, such as hexahydrite.
The absence of the 1.4 μm band of phyllosilicates is probably due to the strong presence of sulfates. Spectrally, in the region around 1.4 μm, the steep slope of the sulfate spectrum could mask the low intensity phyllosilicates band.



The <u>low spectral resolution</u> of MSP00013FE2 and the <u>low spatial resolution</u> of HSP0000163EF have made difficult confirmation of carbonate deposits (found on TES data!)

CRISM FRT data required (HiWISH)

HiRISE, CTX, CRISM, HRSC



Mineralogical Description

The Mineralogical analysis was made using MGS-TES and MRO-CRISM dataset

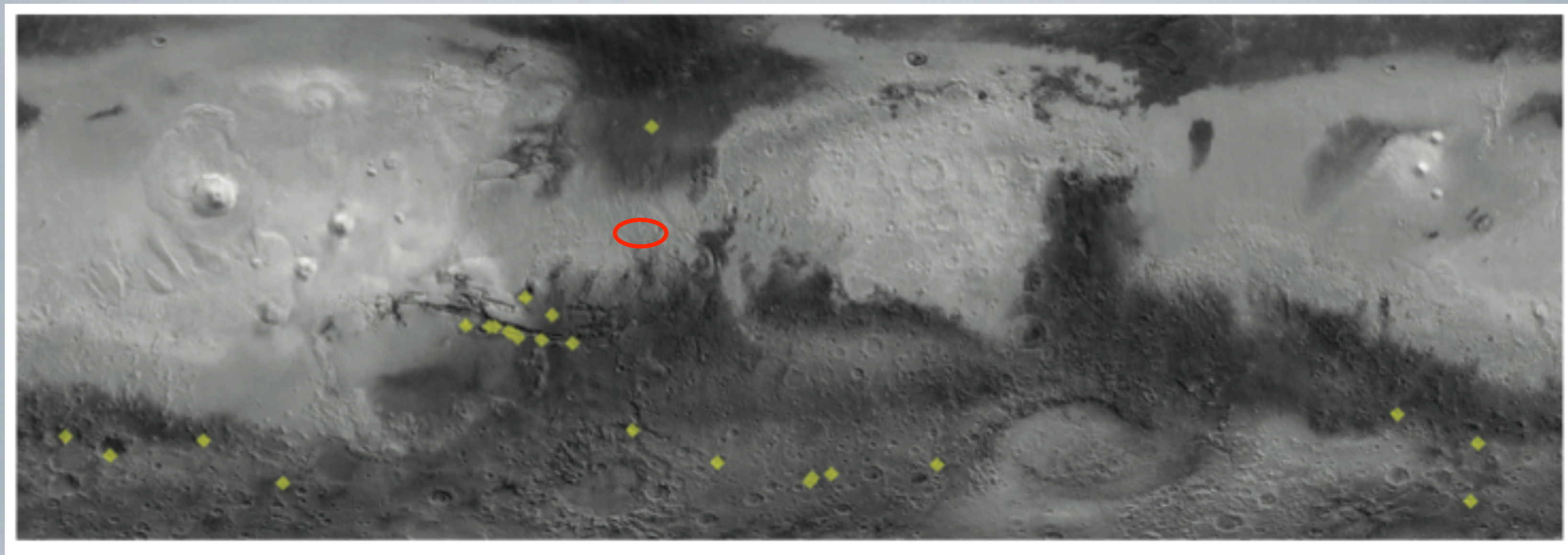
Support to access and analyze MEX-OMEGA data is more than welcome

The possibility to interact with the MEX-OMEGA team would be perfect to have a complete mineralogical study of this interesting site

Planetary Protection RSL

E X O M A R S

From McEwen et al., 2014, and Ojha et al., 2014, all Recurrent Slope Lineae sites are in areas with TES albedo < 0.20. → Our LS albedo is 0.23!



With only one exception, RSL appear at elevations above -1800 m and Latitudes below -30°

Our LS elevation is at -4000 m and it is at 8.49°N!

At a 5.5 m CTX resolution we found no occurrences of dark streaks or RSL as presented by McEwen and Ojha. There are not even candidate on our Landing Site!

Engineering Constraints

EXOMARS

Engineering Parameter	Requirement	Notes
Landing Latitude	5º S to 25º N	Driven by Surface Platform and Rover design. Latitudes beyond this range would cause either degraded electrical power, or challenging thermal conditions. Latitudes within the 0°–15° N band maximise the rover's travelling capabilities.
Landing Elevation	≤ –2 km MOLA	For sufficient atmospheric braking during EDL.
Landing Ellipse Dimensions	Major axis: 104 km Minor Axis: 19 km	Landing ellipse dimensions where all listed constraints must be verified.
Landing ellipse Orientation	88° to 127º	Azimuth angles measured clockwise from north. Ellipse Orientation will vary slightly depending on the landing site's latitude.
Slopes at 2- to 10-km length scale	≤ 3.0°	To ensure slant and incidence compatible with radar.
Slopes at 330-m length scale	≤ 8.6º	To ensure proper fuel consumption during powered descent.
Slopes at 7-m length scale	≤12.5º	To ensure proper altitude error in the touchdown phase.
Slopes at 2-m length scale	≤15.0º	To ensure stability at landing
Rock abundance	K < 7 %	Drives the rover traverse performance and also drives the probability of encountering a rock during landing
Thermal Inertia	≥ 150 J m^{-2} $s^{-0.5}$ K^{-1}	Driven by rover thermal design constraints and by the need to have a load-bearing surface.
Albedo	0.1 ≤ albedo ≤ 0.26	Driven by rover thermal design constraints
Radar Reflectivity	Ka band radar backscatter cross-section at nadir: > –15 dB and < 27.5 dB	The terrain backscatter characteristics are key for the proper functioning of the radar. These values are relevant to nadir backscatter. Other conditions are described in the dedicated section.

Engineering Constraints

Engineering Parameter	Requirement	Notes
Landing Latitude	5° S to 25° N	Driven by Surface Platform and Rover design. Latitudes beyond this range would cause either degraded electrical powe[illegible] challenging thermal conditions. Latitudes within the 0[illegible] N band maximise the rover's travelling capa[illegible]es.
Landing Elevation	≤ –2 km MOLA	For sufficient atmospheric braking during EDL.
Landing Ellipse Dimensions	Major axis: 104 km Minor Axis: 19 km	Landing ellipse dimensions where all listed constraints must be verified.
Landing ellipse Orientation	88° to 127°	Azimuth angles measured clockwise from north. Ellipse Orientation will[illegible]y slightly depending on landing site's latitude.
Slopes at 2- to 10-km length scale	≤ 3.0°	To ensure slant and i[illegible]nce compatible with radar.
Slopes at 330-m length scale	≤ 8.6°	To ensure proper fuel consumption during powered descent.
Slopes at 7-m length scale	≤12.5°	To ensure proper altitude error in the touchdown phase.
Slopes at 2-m length scale	≤15.0°	To ensure stability at landing
Rock abundance	K < 7 %	Drives the rover traverse performance and also drives the probability of encountering a rock during landing
Thermal Inertia	≥ 150 J m^{-2} $s^{-0.5}$ K^{-1}	Driven by rover thermal design constraints and by the need to have a load-bearing surface.
Albedo	0.1 ≤ albedo ≤ 0.26	Driven by rover thermal design constraints
Radar Reflectivity	Ka band radar backscatter cross-section at nadir: > –15 dB and < 27.5 dB	The terrain backscatter characteristics are key for the proper functioning of the radar. These values are relevant to nadir backscatter. Other conditions are described in the dedicated section.

Landing Ellipse Properties

EXOMARS

Dimensions: 104 km x 19 km

Area: 1551.95 km^2

Azimuth angle: 90°

Coordinates centre:

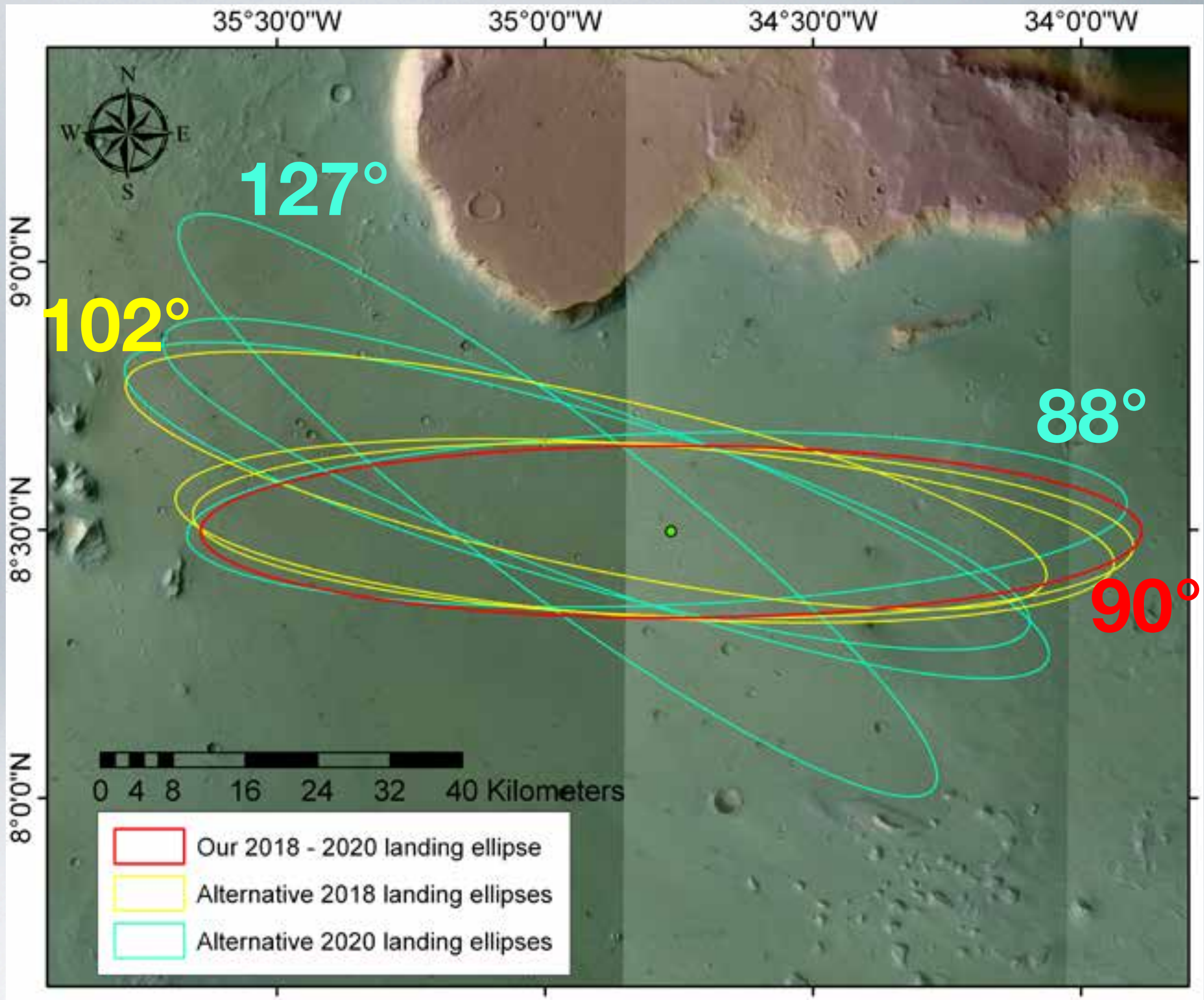
34.76°W (325.24°E) Longitude

8.49°N Latitude

Lat range: 8.66°N – 8.33°N

Long range: 35.64°W – 33.88°W

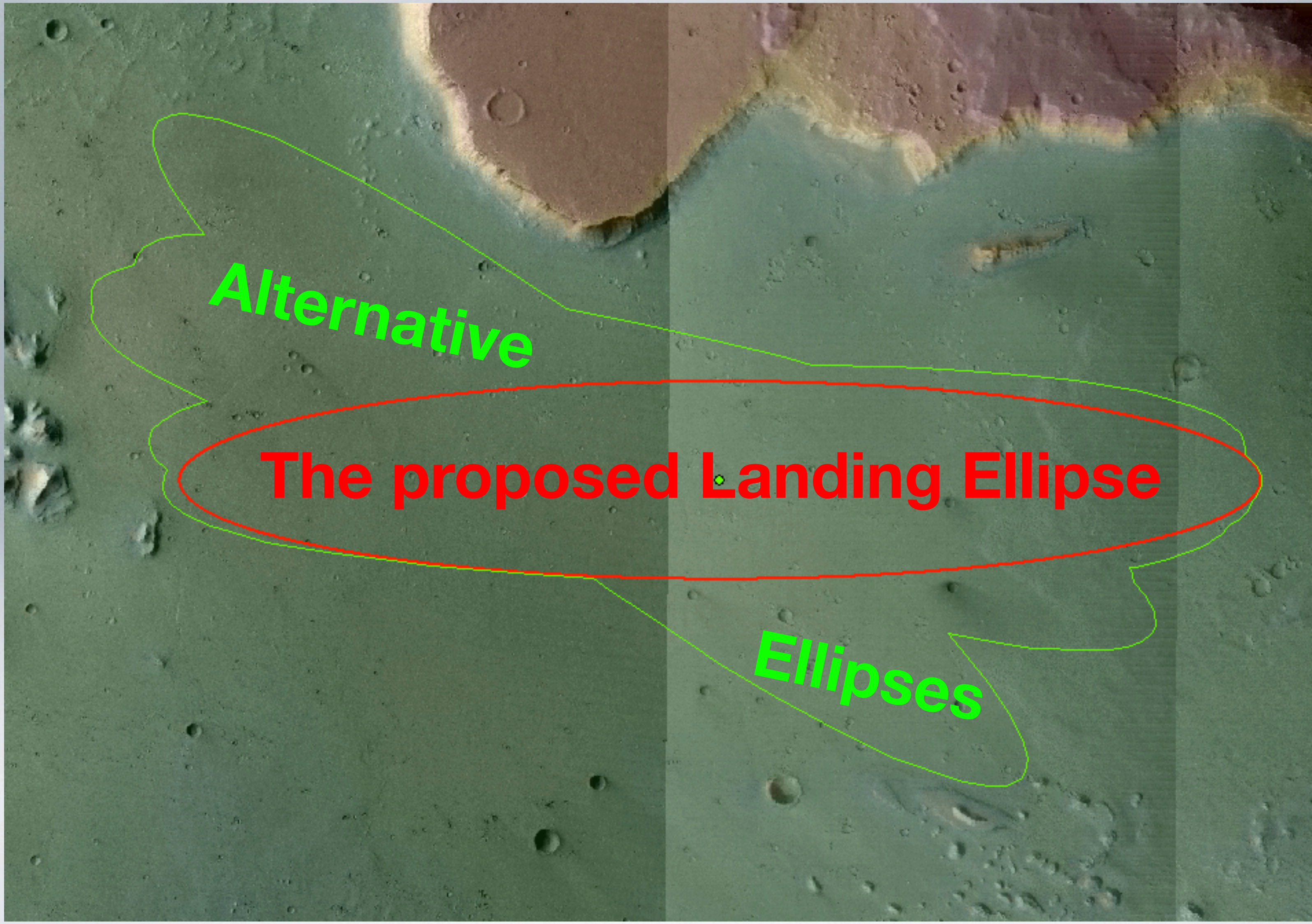
FULLY INSIDE THE 0°-15°N LAT BAND MAXIMIZING THE ROVER'S TRAVELING CAPABILITIES



Further proposed orientations: 2018 => 90° to 102° => COMPLETE AVAILABILITY

2020 => 88° to 127° => COMPLETE AVAILABILITY

Landing Ellipse Properties



Landing Ellipse Properties

E X O M A R S

Constraint: Landing Elevation ≤ -2 km MOLA

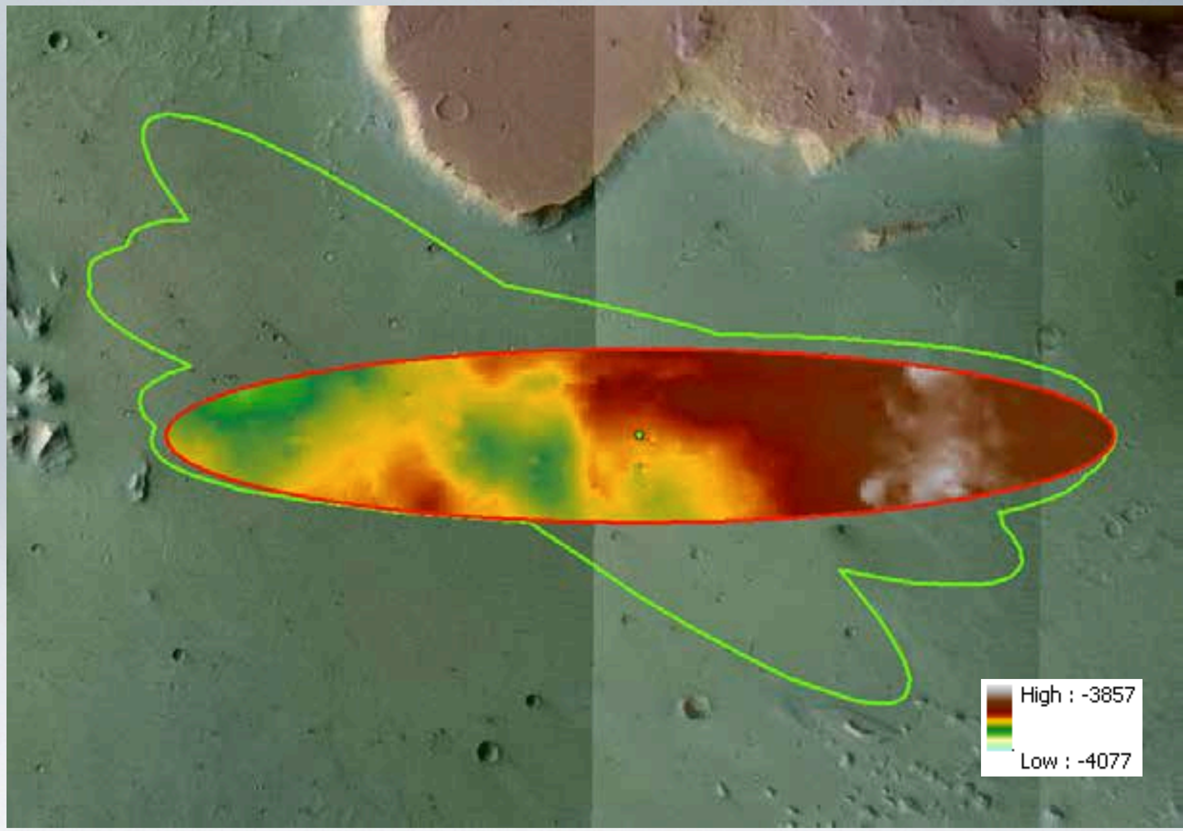
Elevation compliance (MOLA) :

Minimum -4077.00 m

Maximum -3857.00 m

Mean -3979.64 m

Standard Deviation 50.06 m



-3979.64 m

1979 m BELOW THE ENGINEERING REQUIREMENT ALLOWING MORE THAN SUFFICIENT ATMOSPHERIC BRAKING DURING THE EDL PHASE.

Landing Ellipse Properties

Constraint: Landing Elevation ≤ -2 km MOLA

Elevation compliance (MOLA) :

Minimum -4149.00 m

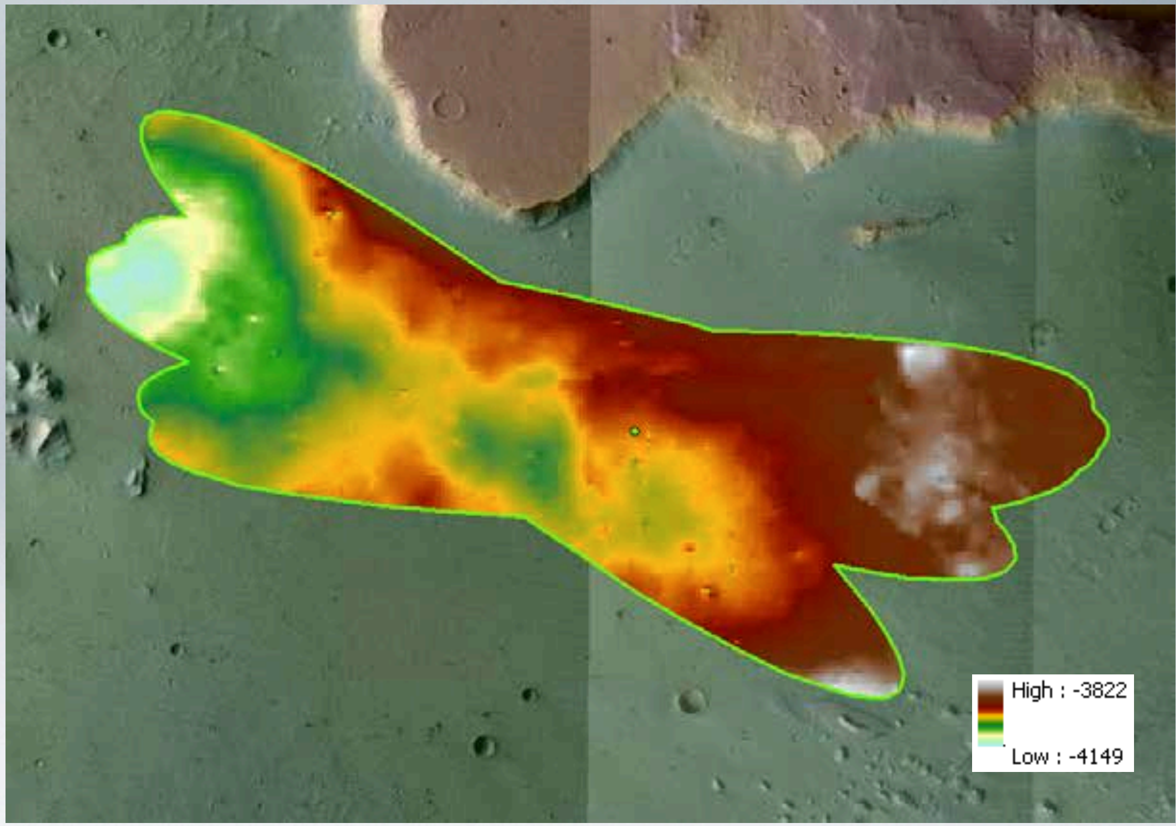
Maximum -3822.00 m

Mean -3990.03 m

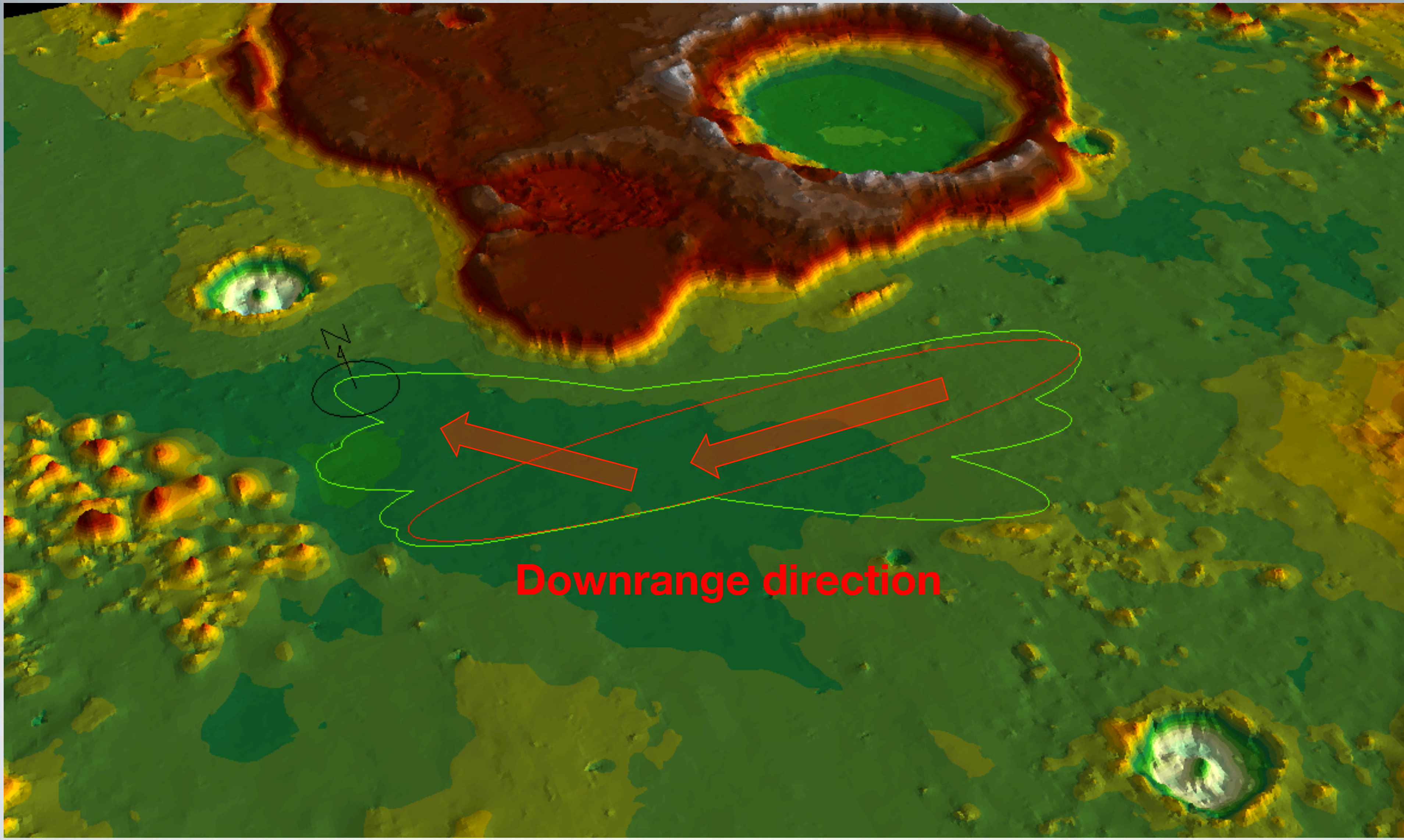
Standard Deviation 60.28 m

-3990.03 m

1990 m BELOW THE ENGINEERING REQUIREMENT ALLOWING MORE THAN SUFFICIENT ATMOSPHERIC BRAKING DURING THE EDL PHASE.



Landing Ellipse Properties (TIN)



Landing Ellipse Slopes

To compute the landing ellipse slopes we used the ARCGIS10 Slope tool (the same used by Golombek et al., 2012)

For each cell, the Slope tool calculates the maximum rate of change in value from that cell to its neighbors. Basically, the maximum change in elevation over the distance between the cell and its eight neighbors identifies the steepest downhill descent from the cell. Conceptually, the tool fits a plane to the z-values of a 3 x 3 cell neighborhood around the processing or center cell. The slope value of this plane is calculated using the average maximum technique (Burrough et al., 1998). The direction the plane faces is the aspect for the processing cell. The lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain.

The Slope algorithm

The rates of change (delta) of the surface in the horizontal (dz/dx) and vertical (dz/dy) directions from the center cell determine the slope. The basic algorithm used to calculate the slope is:

$$\textit{slope radians} = \mathrm{ATAN}\ (\ \sqrt{\ ([dz/dx]^2 + [dz/dy]^2)}\ )$$

Slope is commonly measured in degrees, which uses the algorithm:

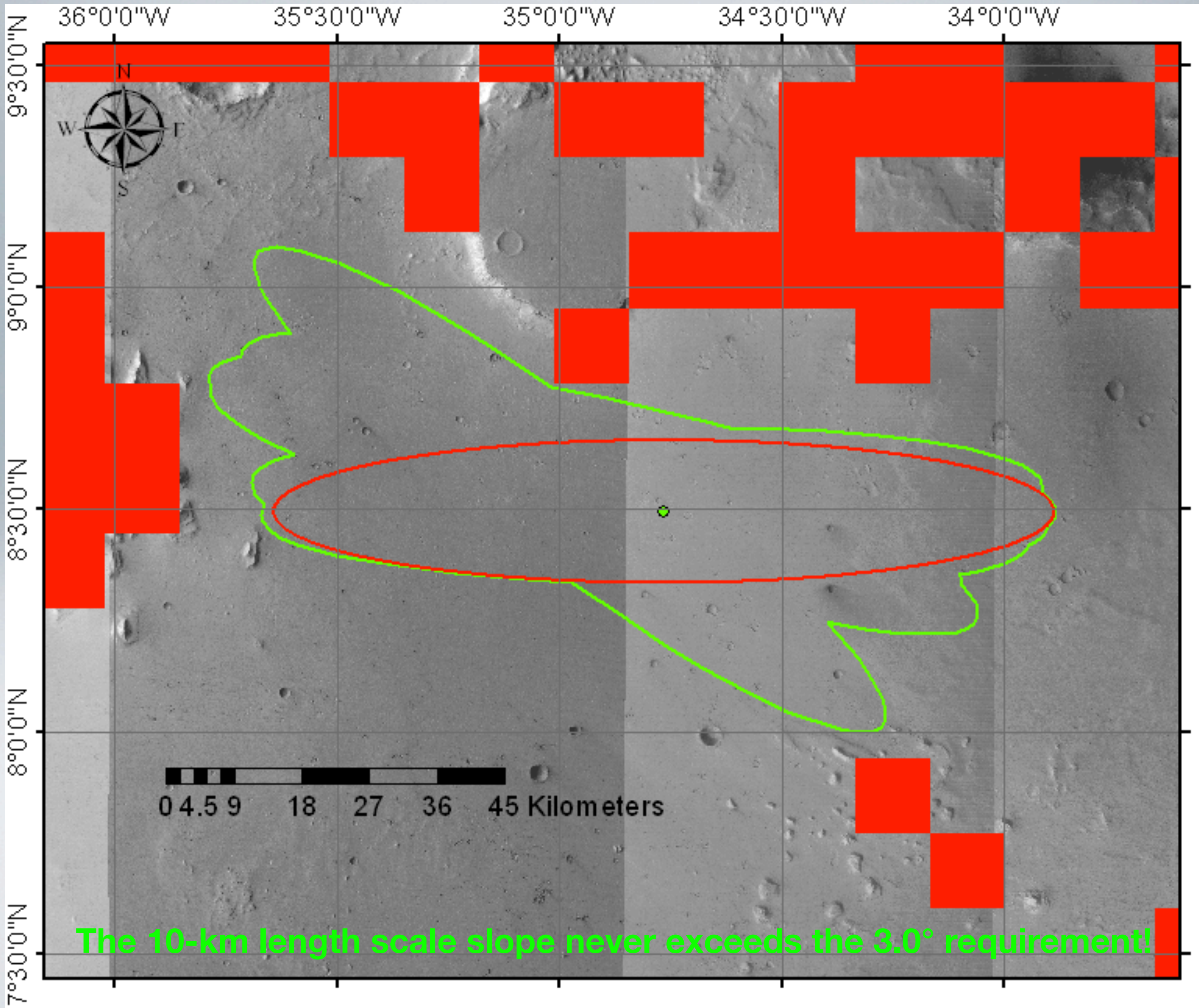
$$\textit{slope degrees} = \mathrm{ATAN}\ (\ \sqrt{\ ([dz/dx]^2 + [dz/dy]^2)}\ ) * 57.29578$$

Landing Ellipse Slopes

E X O M A R S

MGS-MOLA Slopes at 10-km length scale

Constraint: Slopes at 10-km length scale ≤ 3.0°

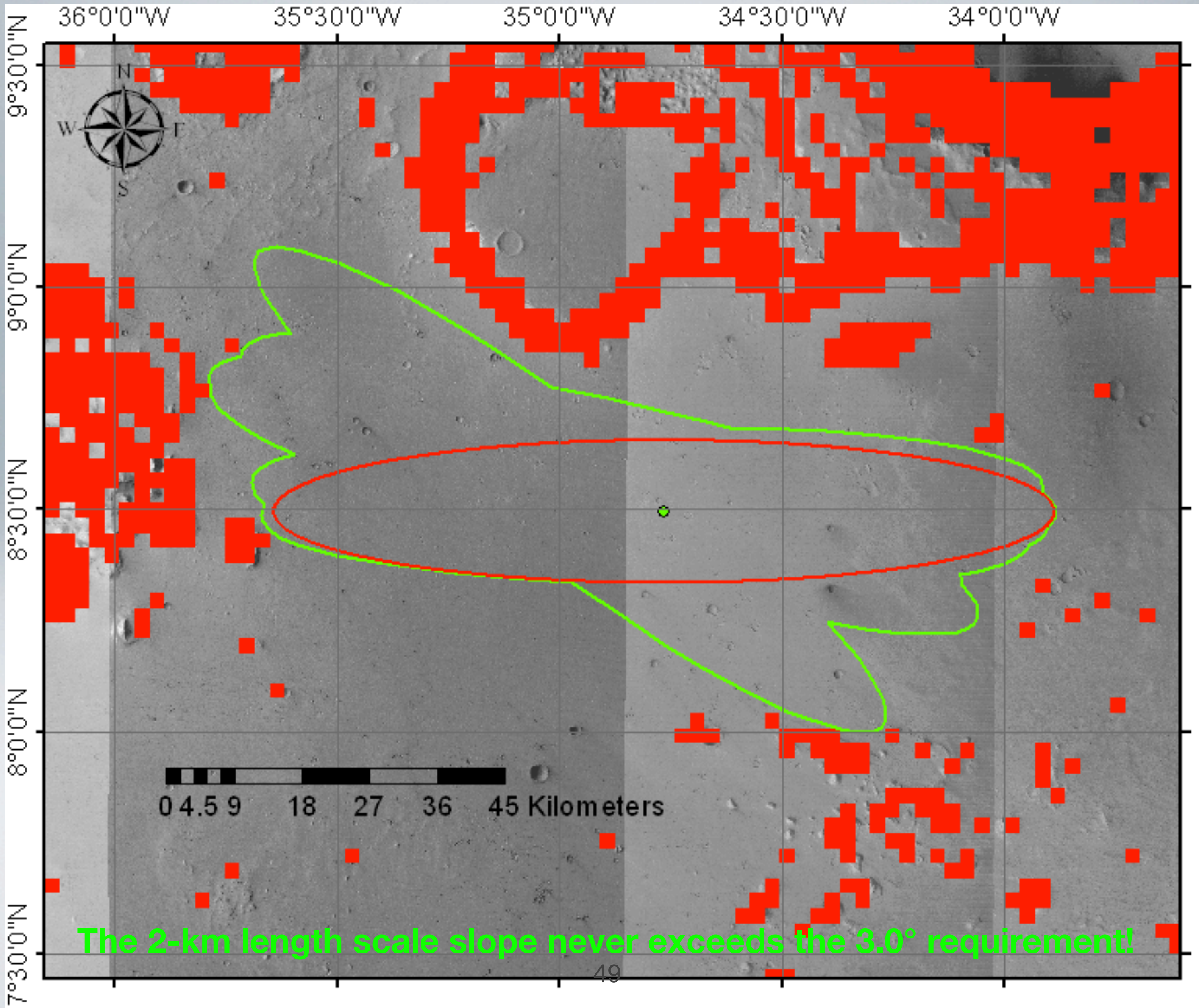


Landing Ellipse Slopes

EXOMARS

MGS-MOLA Slopes at 2-km length scale

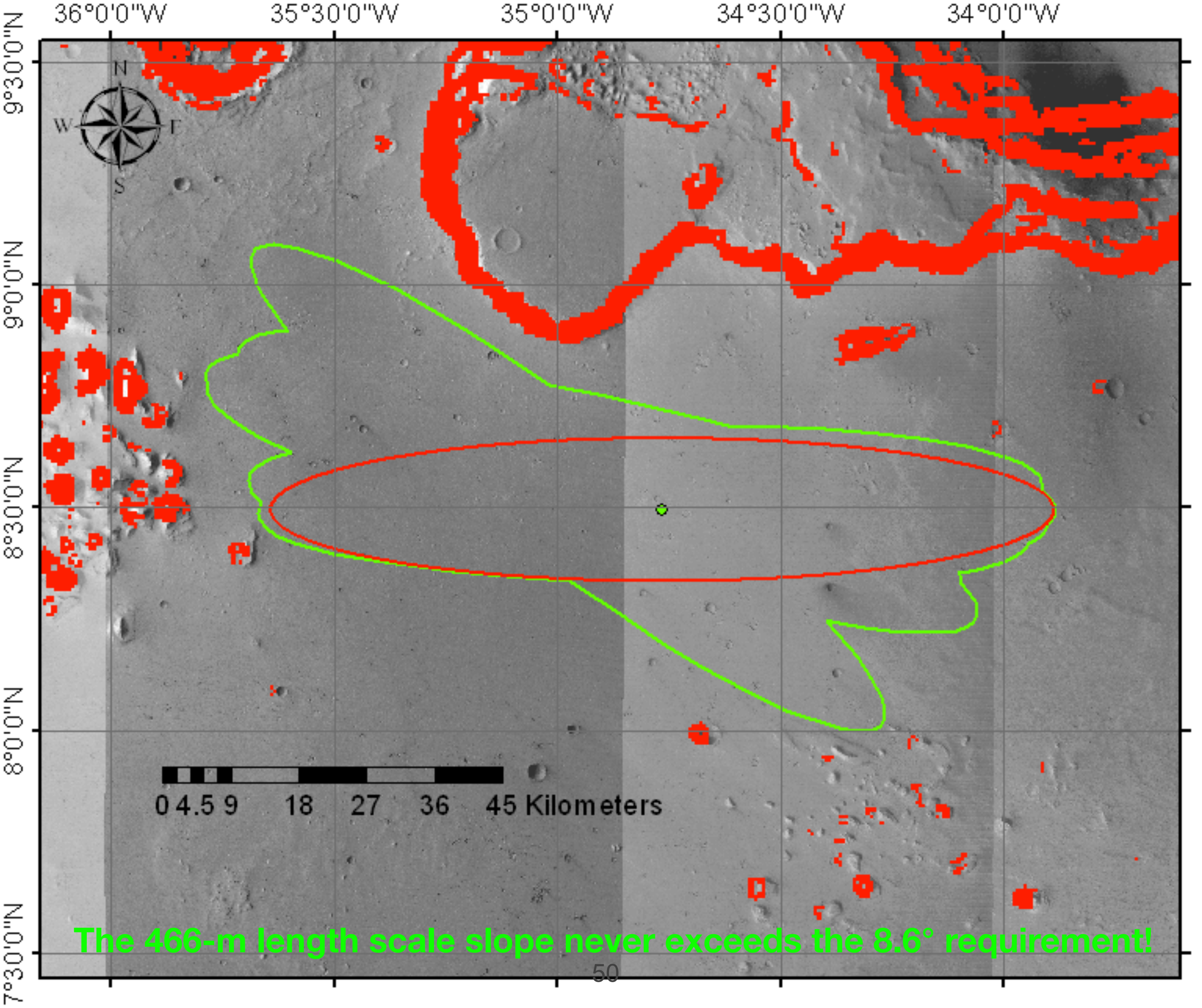
Constraint: Slopes at 2-km length scale ≤ 3.0°



Landing Ellipse Slopes

E X O M A R S

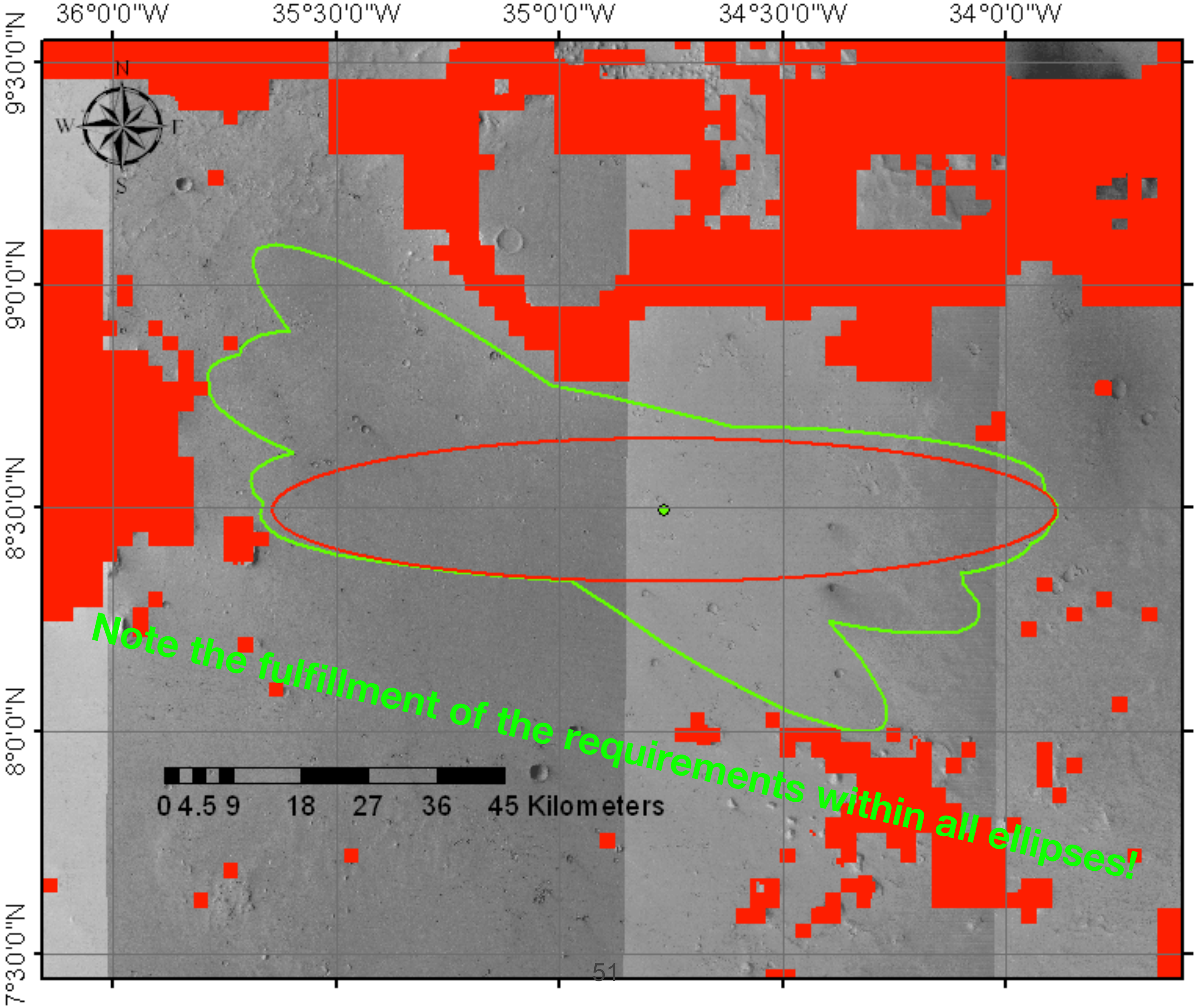
MGS-MOLA Slopes at 466-km length scale (this is the MOLA maximum spatial resolution)



Landing Ellipse Slopes

EXOMARS

MGS-MOLA Slopes from 10-km to 466-m length scale

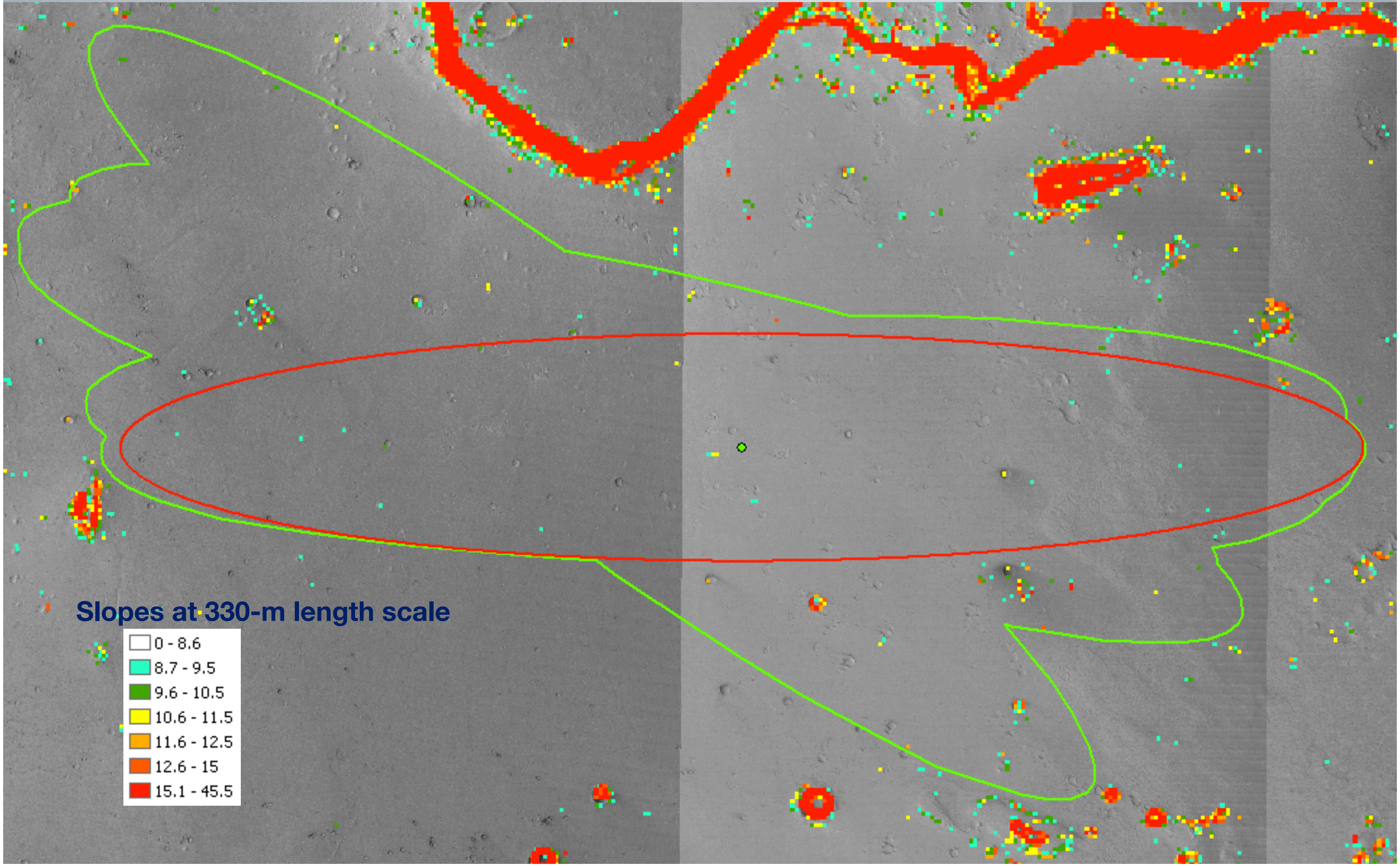


Landing Ellipse Slopes

E X O M A R S

MEX-HRSC Slopes at 330-m length scale

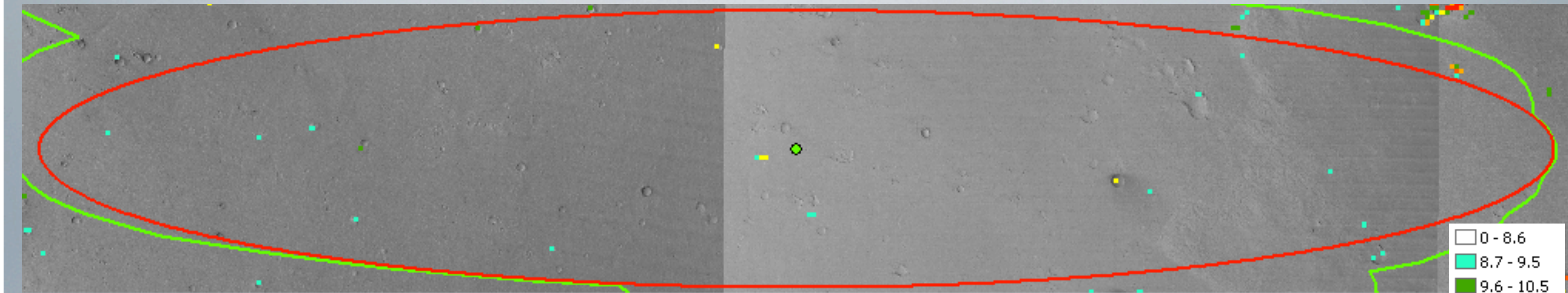
Constraint: Slopes at 330-m length scale ≤ 8.6°



Landing Ellipse Slopes

MEX-HRSC Slopes at 330-m length scale

Constraint: Slopes at 330-m length scale ≤ 8.6°



Within the proposed landing ellipse (in red) we have:

i) An area of 1.416 km^2 (normalized 0.091%) exceeding the 8.6° constraint between 8.7° and 9.5°;

ii) An area of 0.218 km^2 (normalized 0.014%) between 9.6° and 10.5°;

iii) An area of 0.436 km^2 (normalized 0.028%) between 10.6° and 11.5°.

At a scale of 330 m there are no slopes above 11.5°. The total hazard risk above the 8.6° (but below 11.5°) covers an area of 2.07 km^2, equivalent to the 0.133% with respect to the total area of the landing ellipse (1551.95 km^2).

99.867% of ellipse is below acceptability threshold; 0.133% of ellipse is above

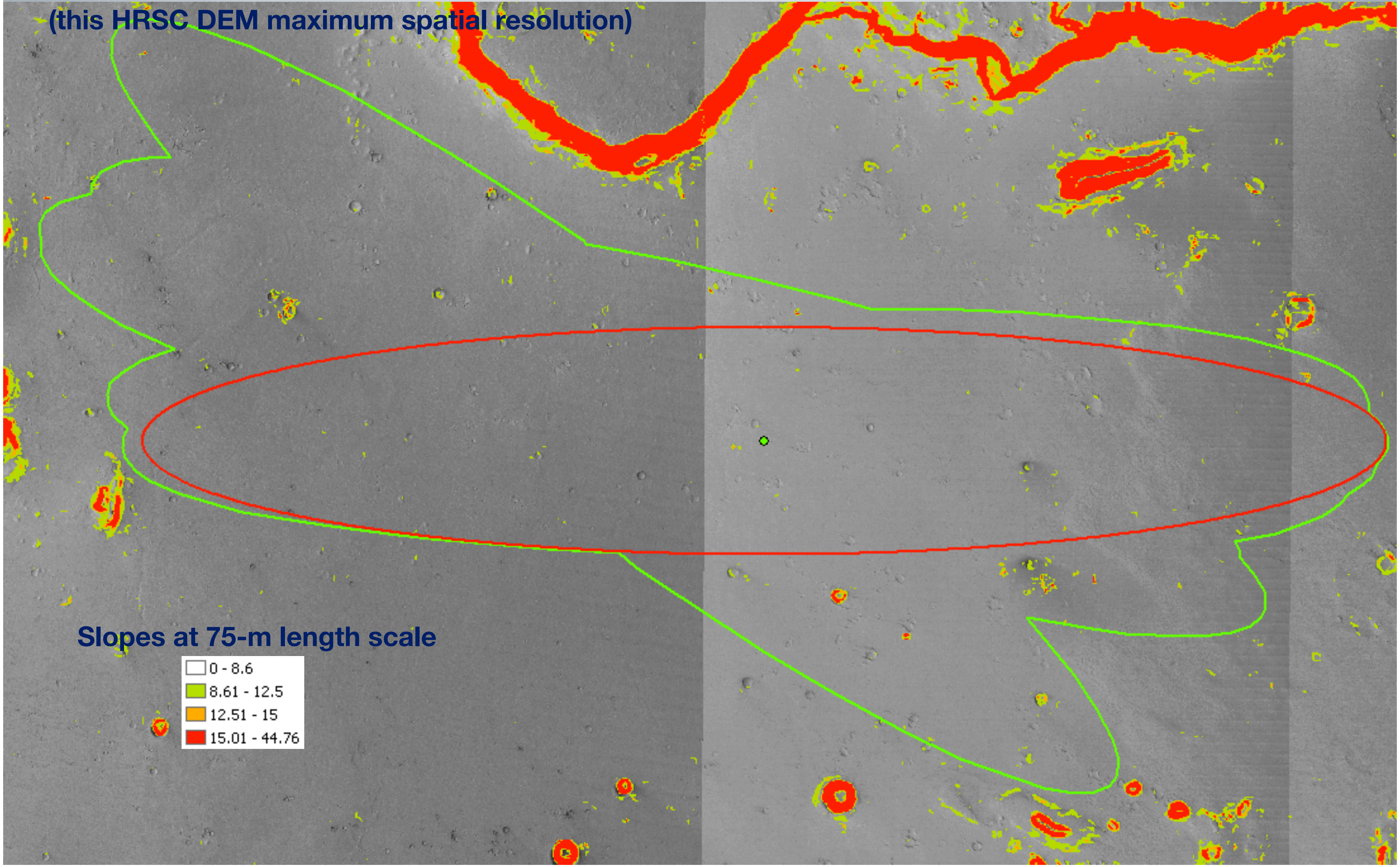
Landing Ellipse Slopes

E X O M A R S

MEX-HRSC Slopes at 75-m length scale

Constraint: Slopes between 7 - 330-m length scale ≤ 12.5°

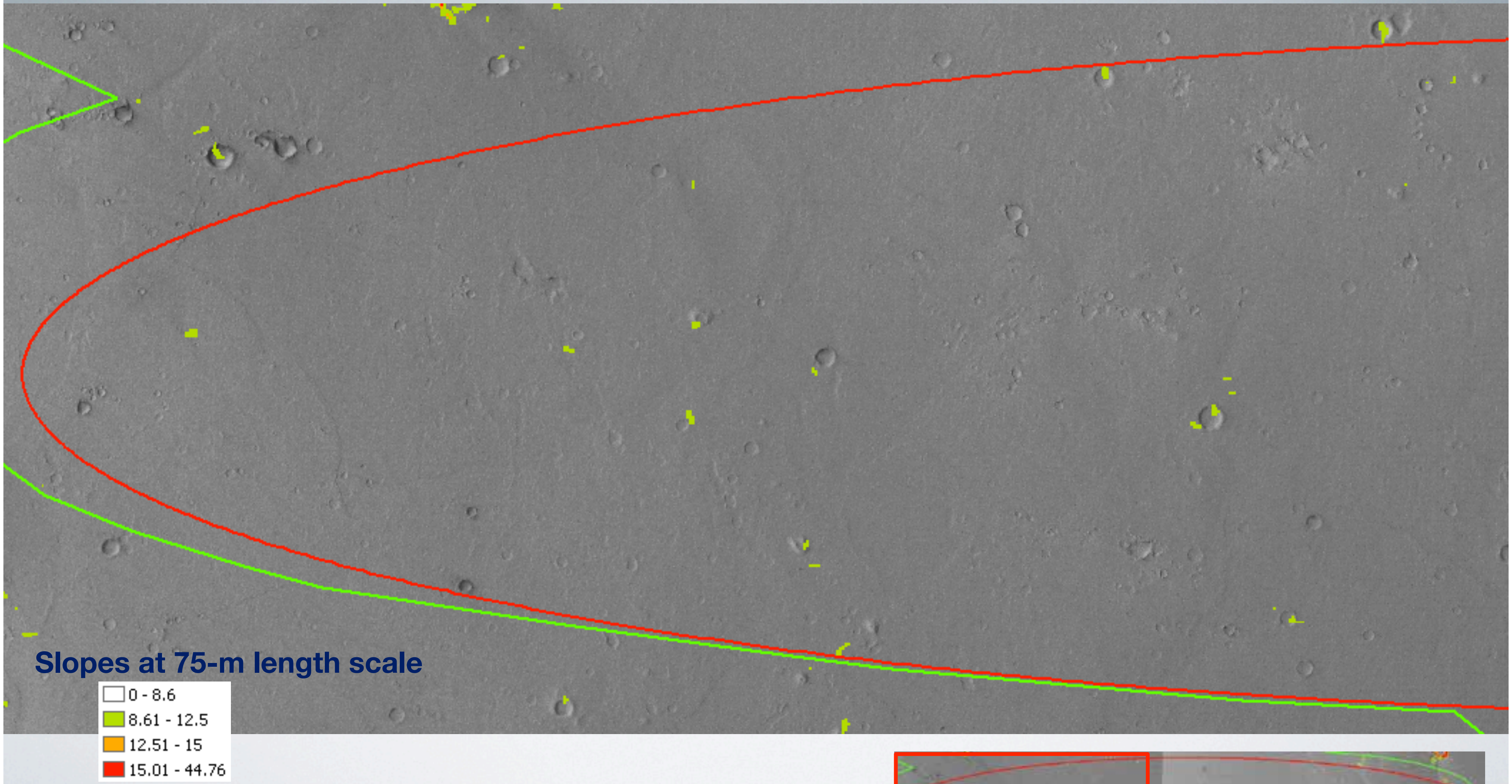
(this HRSC DEM maximum spatial resolution)



Landing Ellipse Slopes

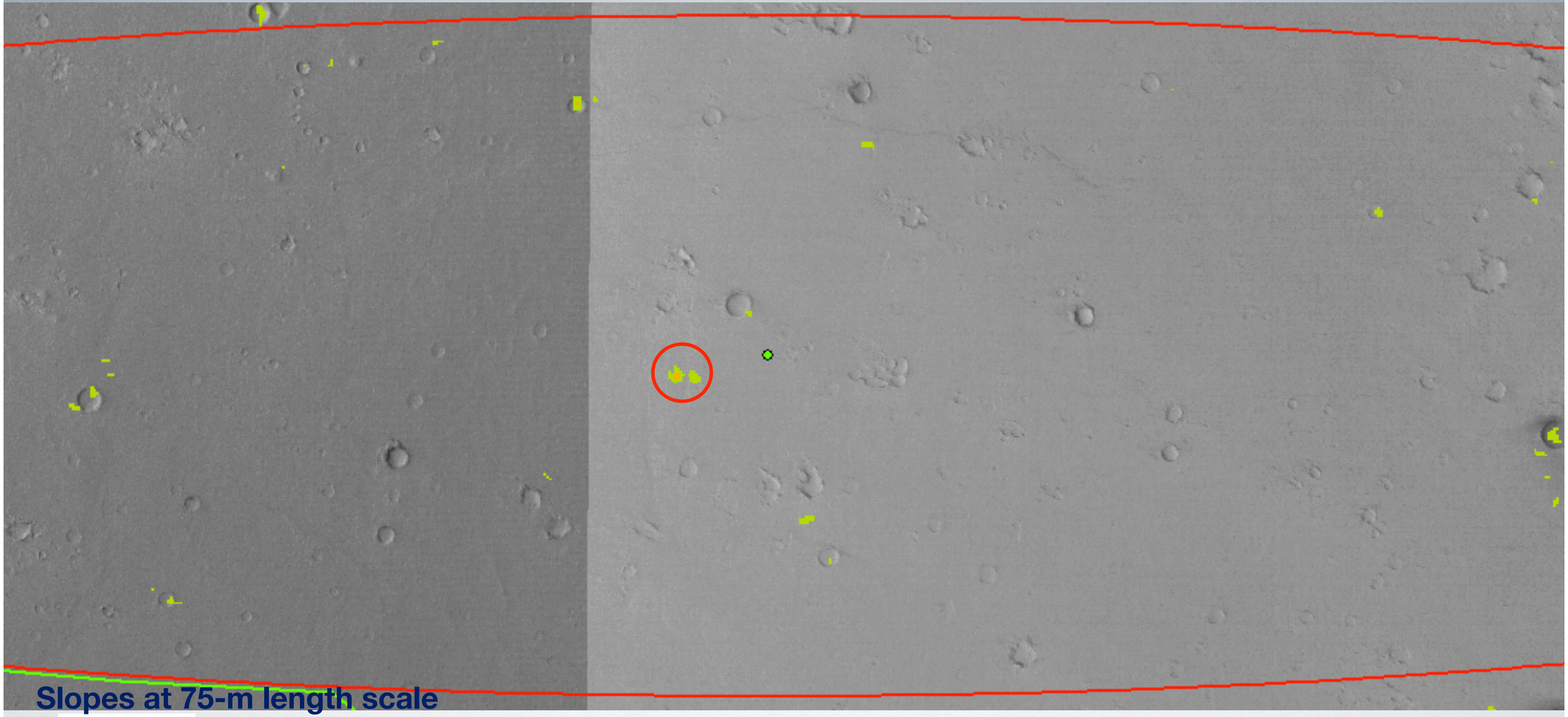
EXOMARS

MEX-HRSC Slopes at 75-m length scale (this HRSC DEM maximum spatial resolution)



Landing Ellipse Slopes

MEX-HRSC Slopes at 75-m length scale (this HRSC DEM maximum spatial resolution)



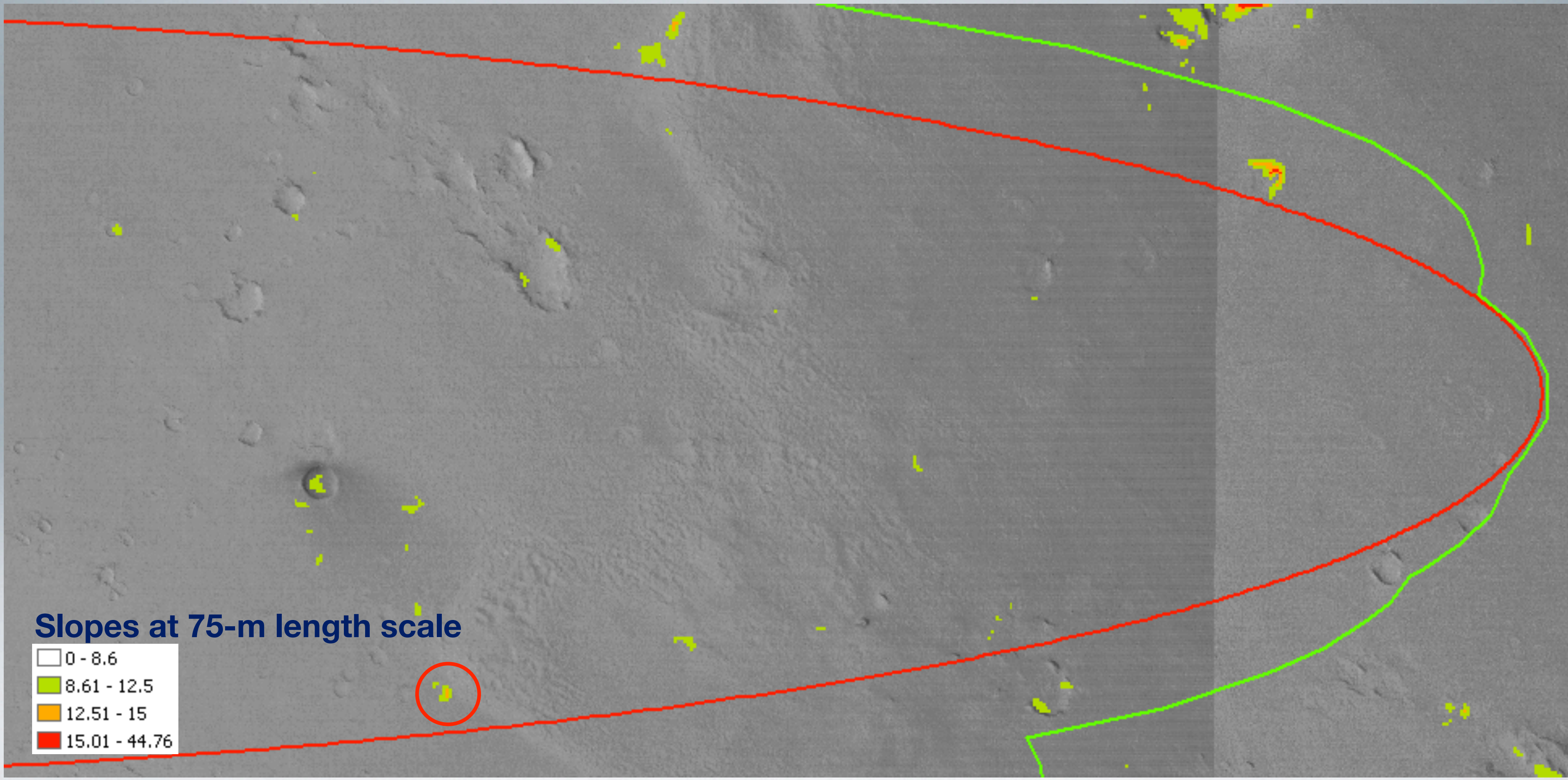
Slopes at 75-m length scale

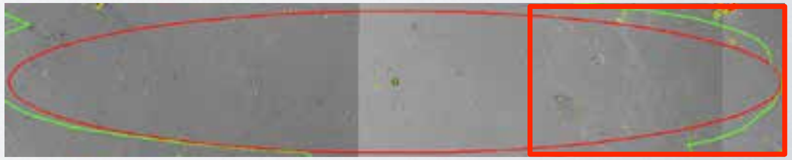
- 0 - 8.6
- 8.61 - 12.5
- 12.51 - 15
- 15.01 - 44.76

Landing Ellipse Slopes

EXOMARS

MEX-HRSC Slopes at 75-m length scale (this HRSC DEM maximum spatial resolution)





Landing Ellipse Slopes

E X O M A R S

MEX-HRSC Slopes at 75-m length scale (this HRSC DEM maximum spatial resolution)

Within the proposed landing ellipse (in red) we have:

i) **An area of 0.017 km^2 (normalized 0.001%) exceeding the 12.5° constraint between 12.6° and 13.5°;**

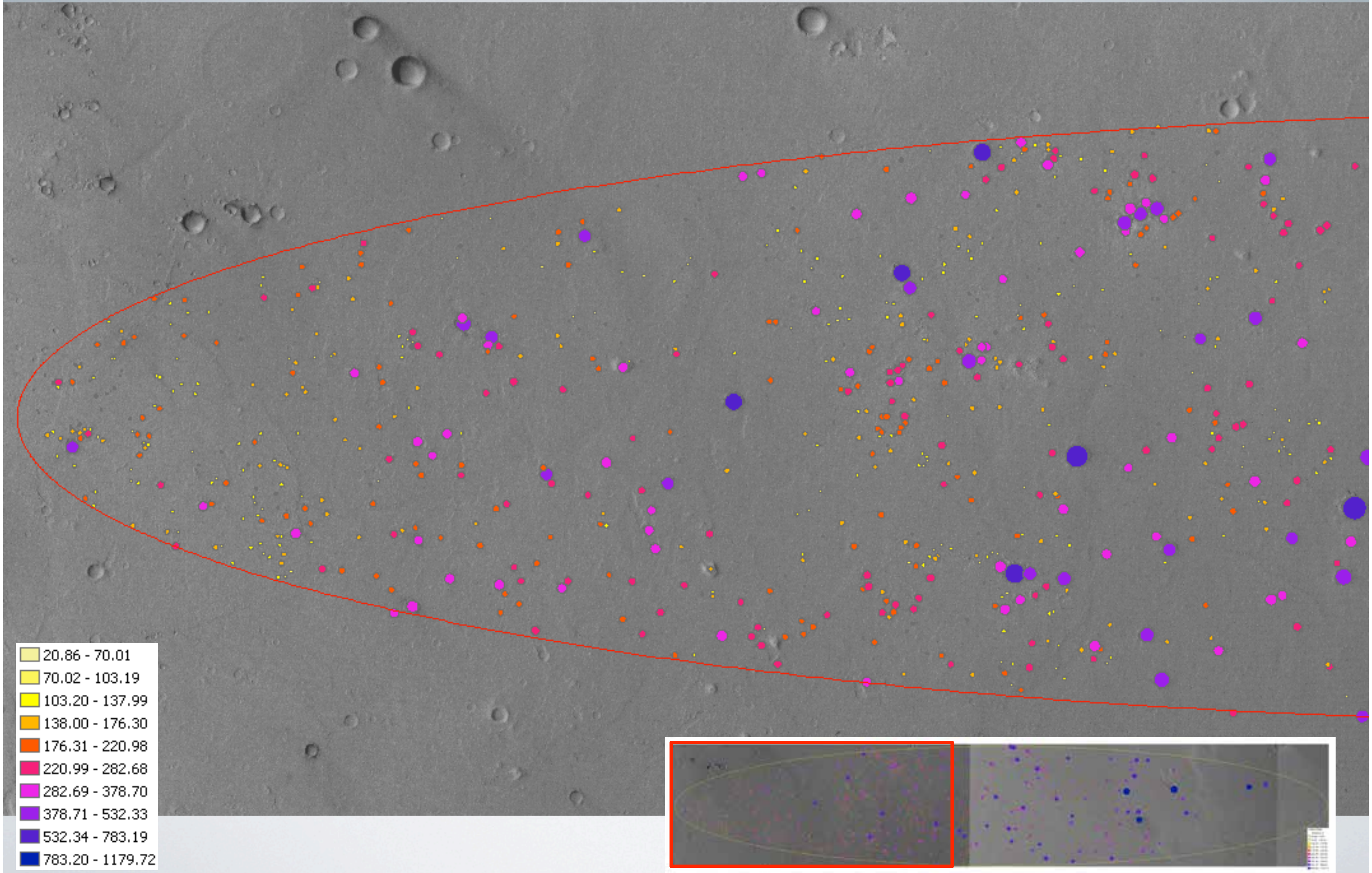
ii) **An area of 0.022 km^2 (normalized 0.001%) between 13.6° and 14.5°;**

iii) **An area of 0.006 km^2 (normalized 0.0004%) between 14.6° and 15.0°.**

At a scale of 75 m there are no slopes above 15.0°. The total hazard risk above the 12.5° (but below 15.0°) covers an area of 0.045 km^2, equivalent to the 0.003% with respect to the total area of the landing ellipse (1551.95 km^2).

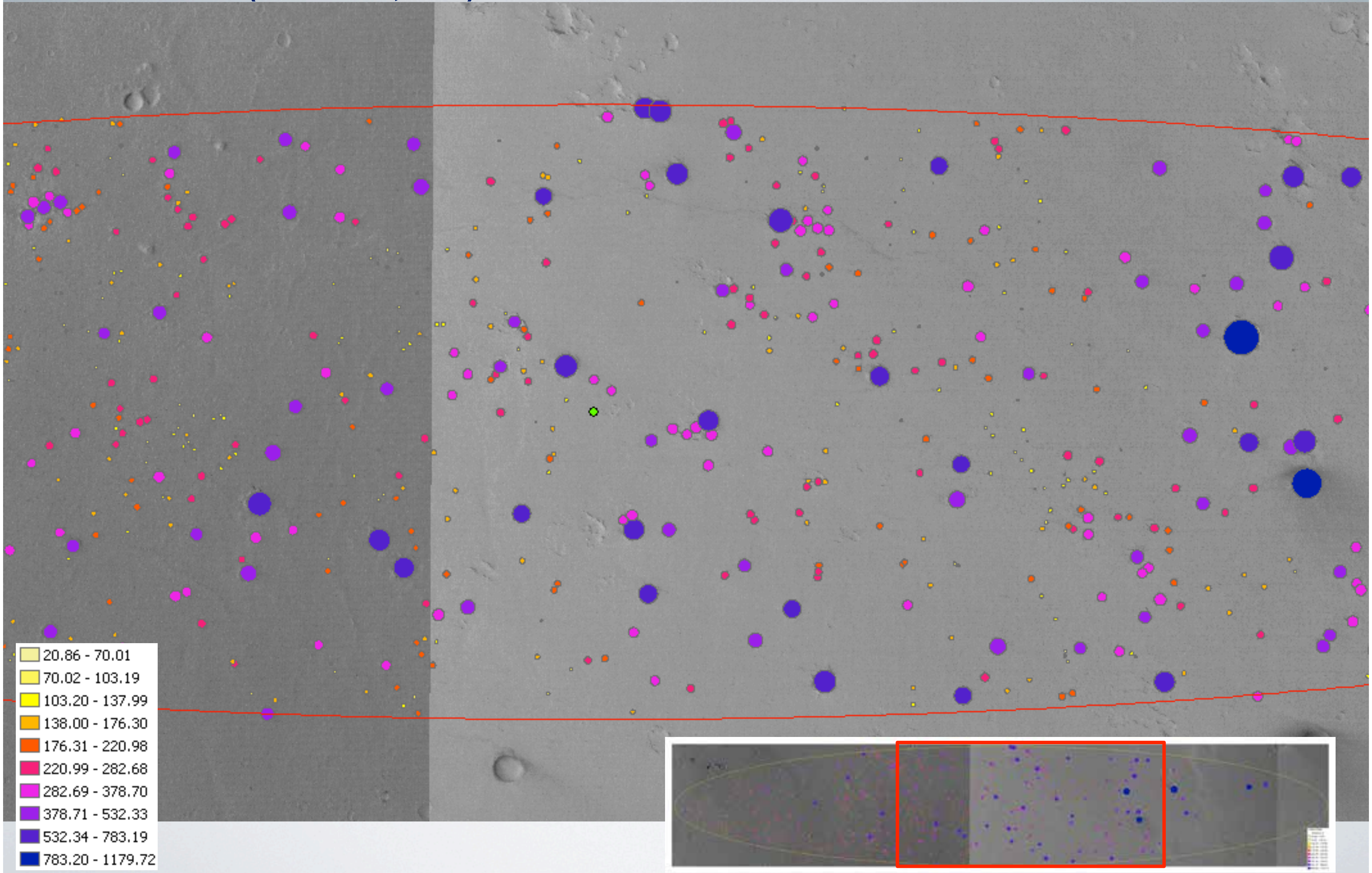
99.997% of ellipse is below acceptability threshold; 0.003% of ellipse is above

Cratering Hazard



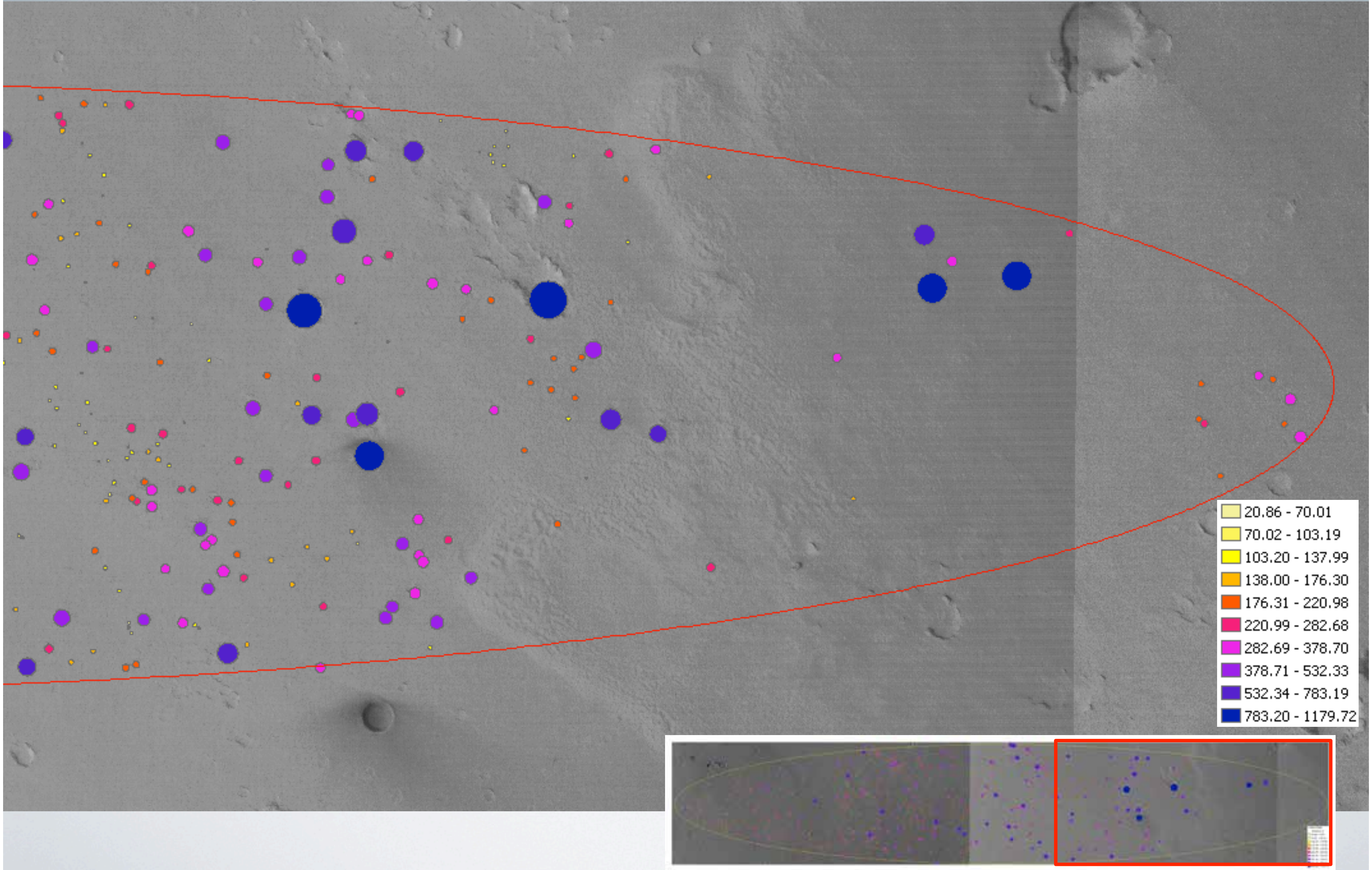
Cratering Hazard

MRO-CTX data (Malin et al., 2007) => 5.6 m resolution



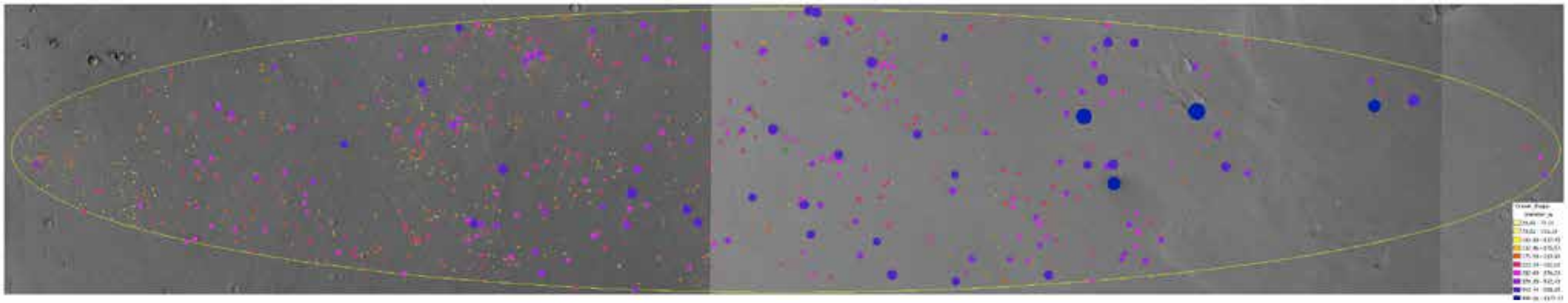
Cratering Hazard

MRO-CTX data (Malin et al., 2007) => 5.6 m resolution



Cratering Hazard

MRO-CTX data (Malin et al., 2007) => 5.6 m resolution



Crater Counting made on the CTX images covering the entire ellipse (5.6 m resolution)

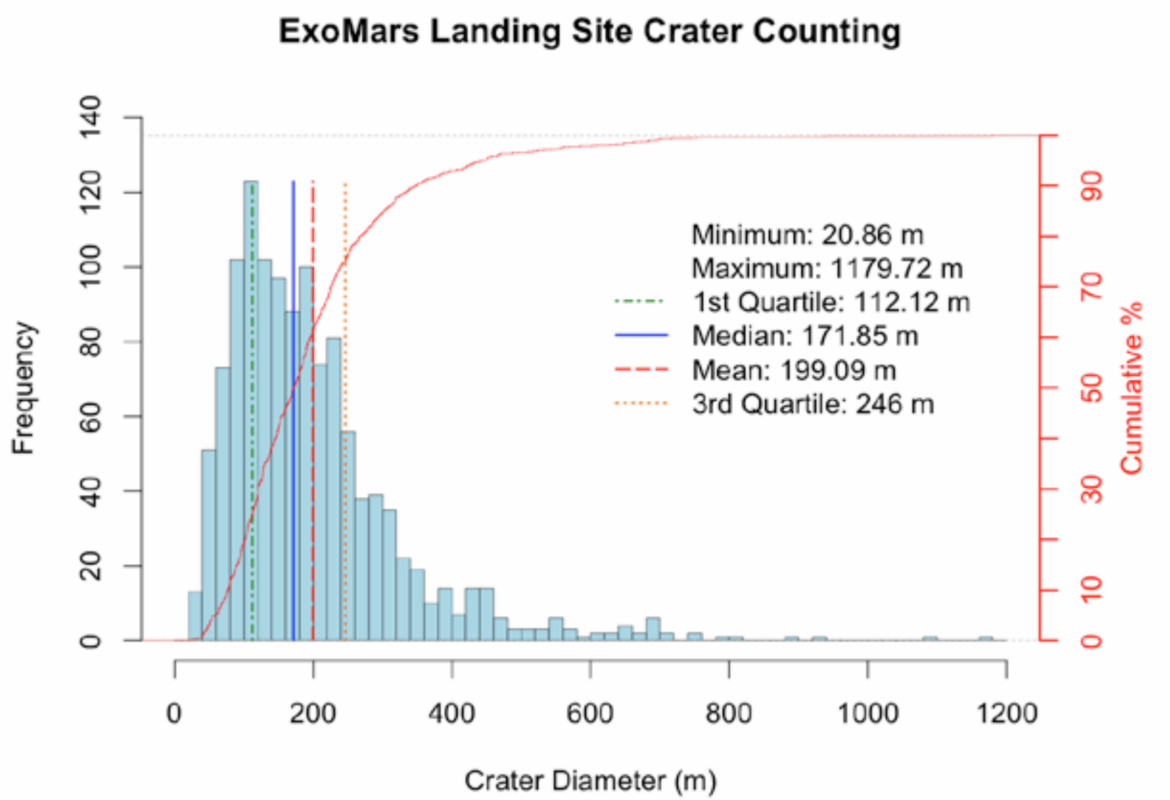
Total Number of Craters: 1223

Total Crater Area: 54.603 km^2

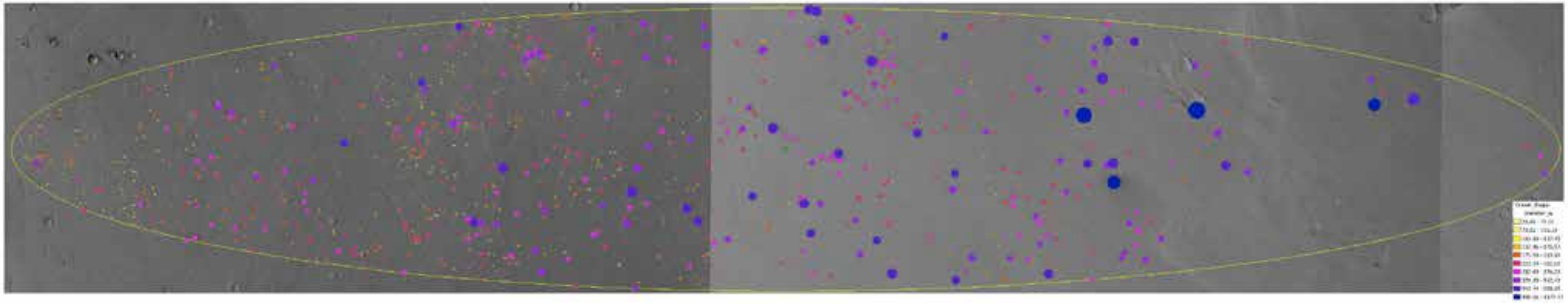
Normalized Area: 3.53%

Minimum Diameter: 20.86 m

Maximum Diameter: 1179.72 m



Cratering Hazard



The maximum DEM resolution of the landing site is 75 m (HRSC DEMs) => NO 7-m length scale SLOPES

We use an extremely conservative approach:

We consider the whole cratered surface (3.54% wrt the total area) as hazardous as the rims and we attribute a slope bigger than 15.0° to this 3.54 % => NOTE that the crater floor can be totally safe and flat, as from Garvin et al., 2003, 2005, BUT WE STILL CONSIDER IT TOTALLY RISKY ANYWAY!

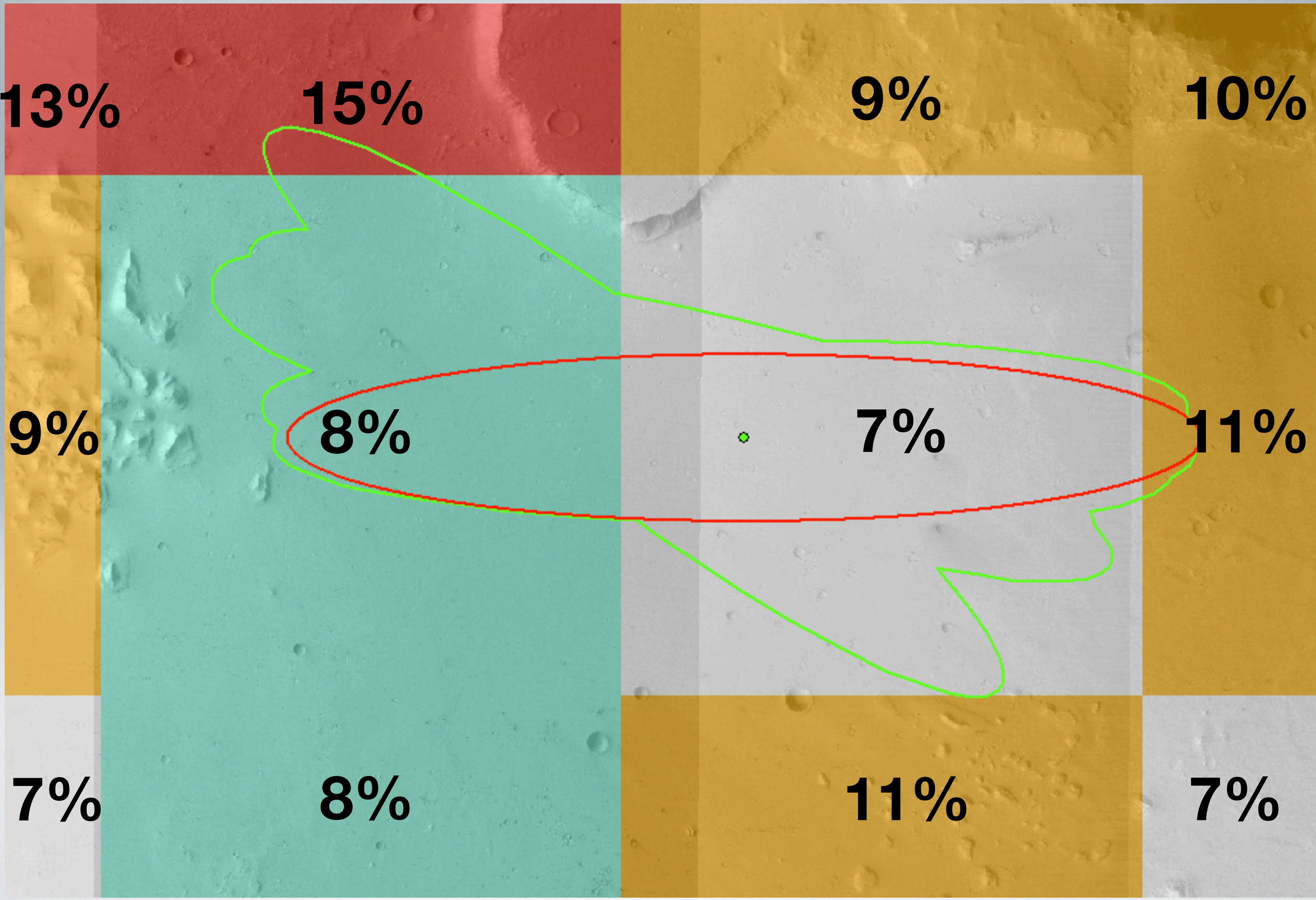
We derive a total area of 55 km^2 not respecting the 15.0° slope

96.46% of ellipse is below acceptability threshold, 3.54% of the ellipse is above

Rock Abundance

Viking IRTM data (Christensen 1986a, 1986b) => 60 km resolution

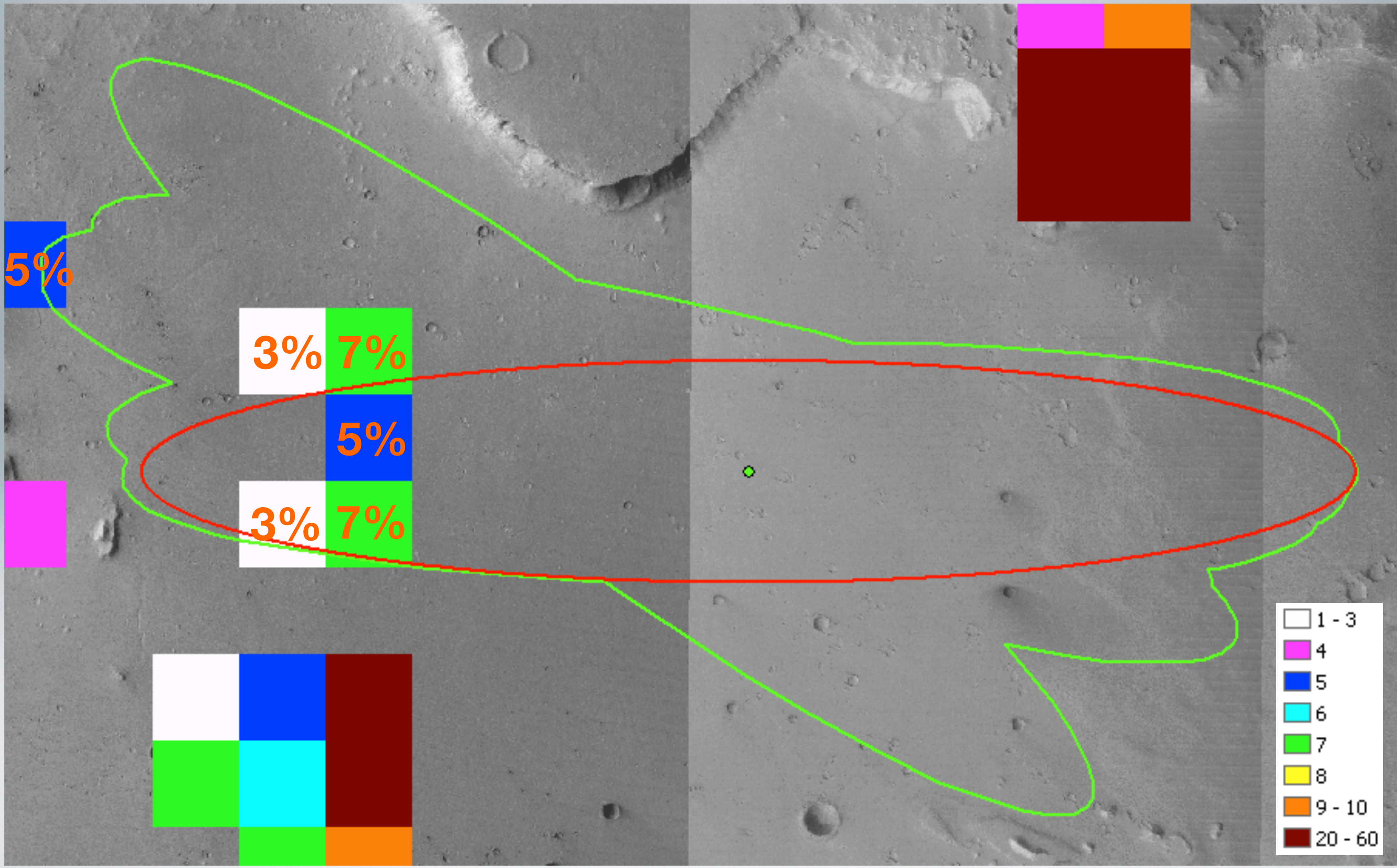
Constraint: Rock Abundance ≤ 7%



Rock Abundance

MGS-TES data (Novicki et al., 2007) => 7.4 km resolution

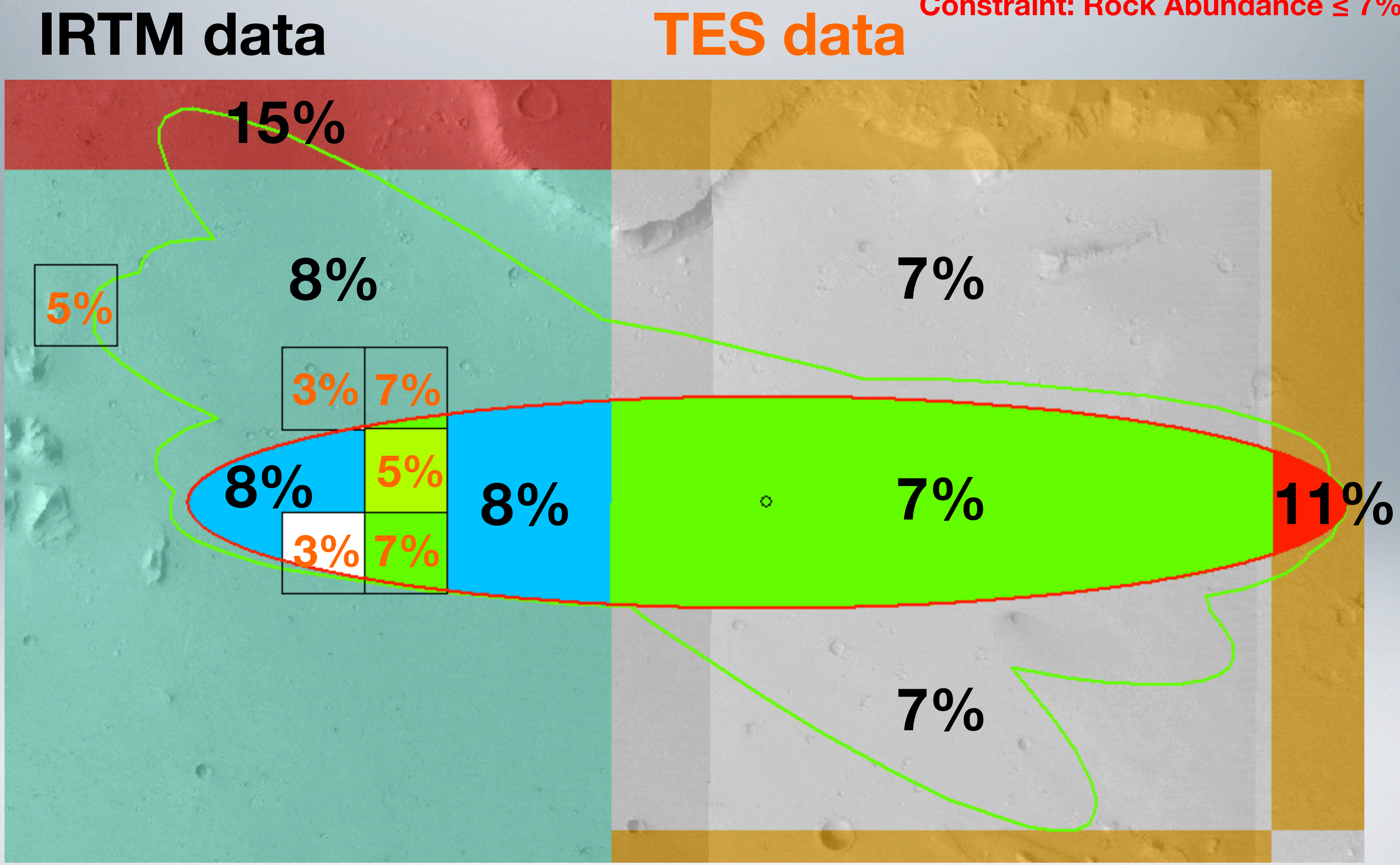
Constraint: Rock Abundance ≤ 7%



Rock Abundance

EXOMARS

Constraint: Rock Abundance ≤ 7%

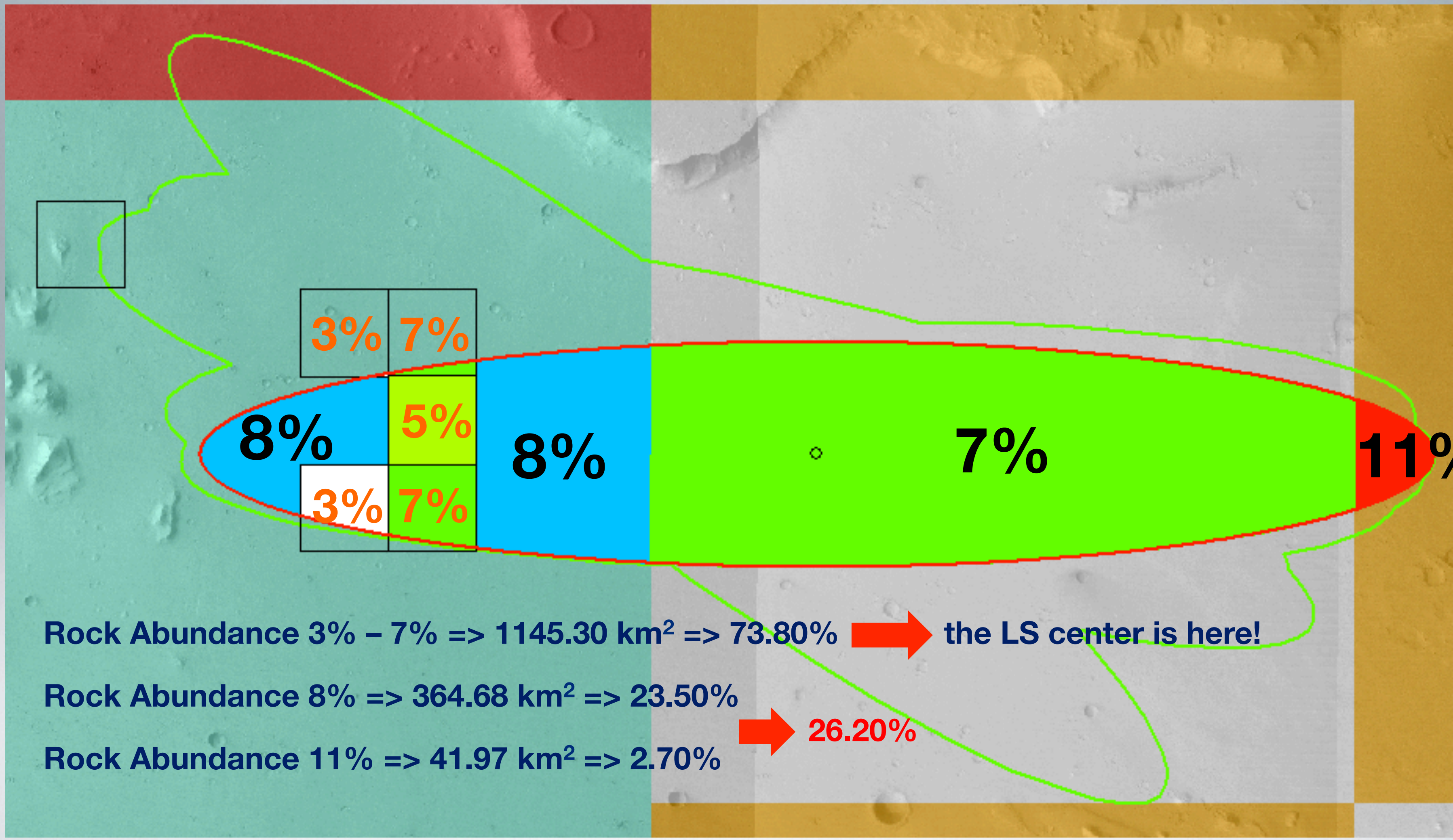


Rock Abundance

Constraint: Rock Abundance ≤ 7%

IRTM data

TES data



Rock Abundance 3% – 7% => 1145.30 km^2 => 73.80% → the LS center is here!

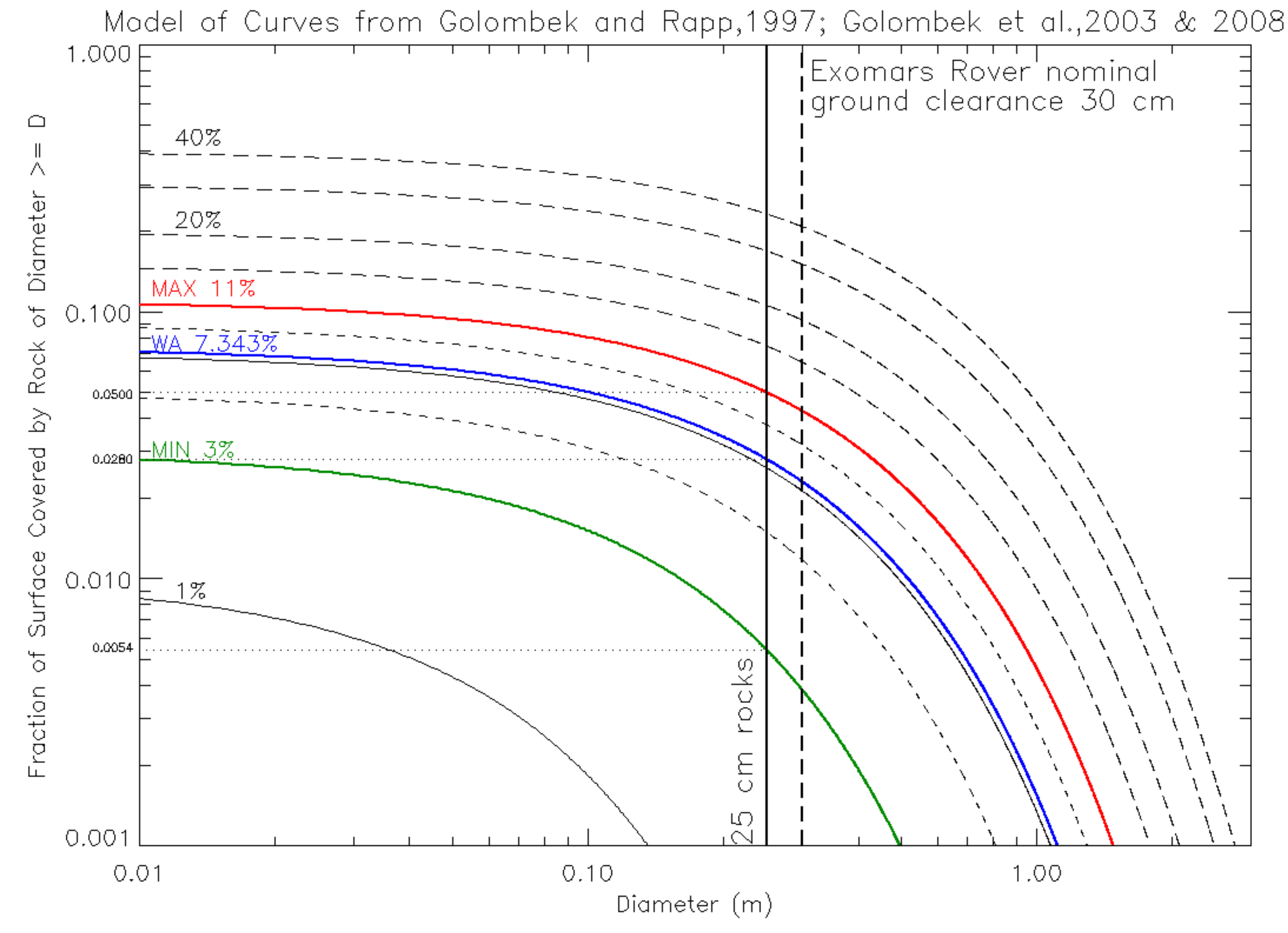
Rock Abundance 8% => 364.68 km^2 => 23.50%

Rock Abundance 11% => 41.97 km^2 => 2.70%

→ 26.20%

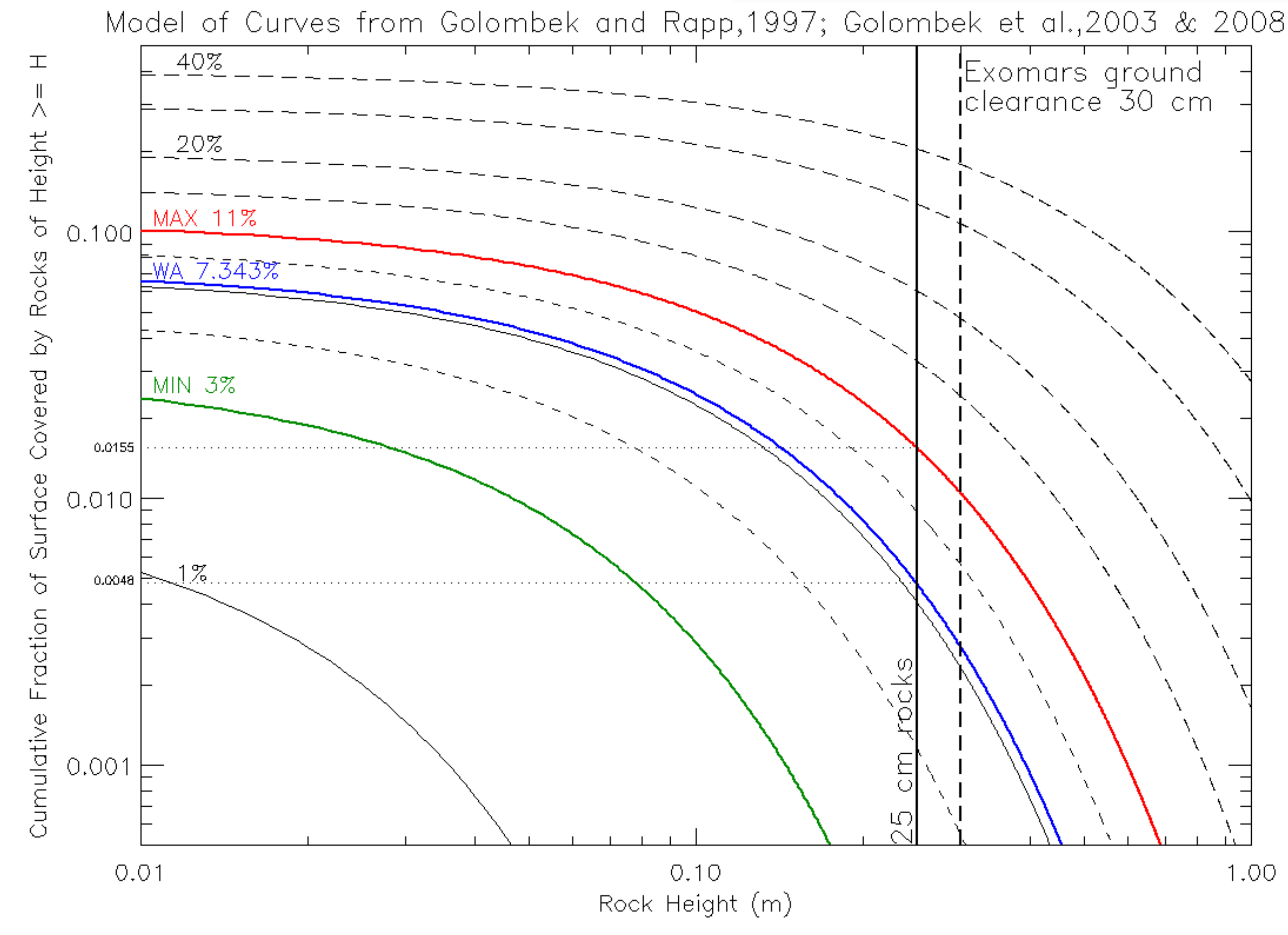
It is clear that this work requires rock counting on HiRISE images

Rock Abundance

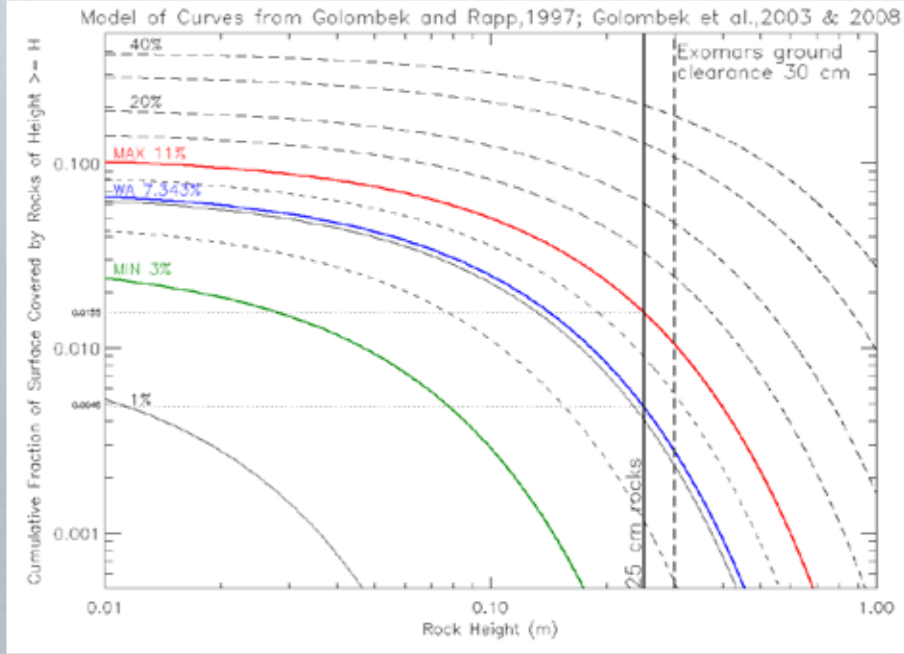


Rock Abundance

EXOMARS



Rock Abundance



Even though the IRTM estimates are at a spatial resolution of 1 degree bins (60 km) (Christensen, 1986), comparisons with rock counts at the surface at much smaller scales have been remarkably successful at all 6 landing sites (Moore and Jakosky, 1989; Christensen and Moore, 1992; Golombek et al., 1999, 2005, 2008) in terms of the total area covered by rocks as well as the cumulative fractional area versus diameter distribution matching the exponential model for rocks >10 cm.

Rock Abundance

E X O M A R S

Pathfinder IRTM RA: 18-22%

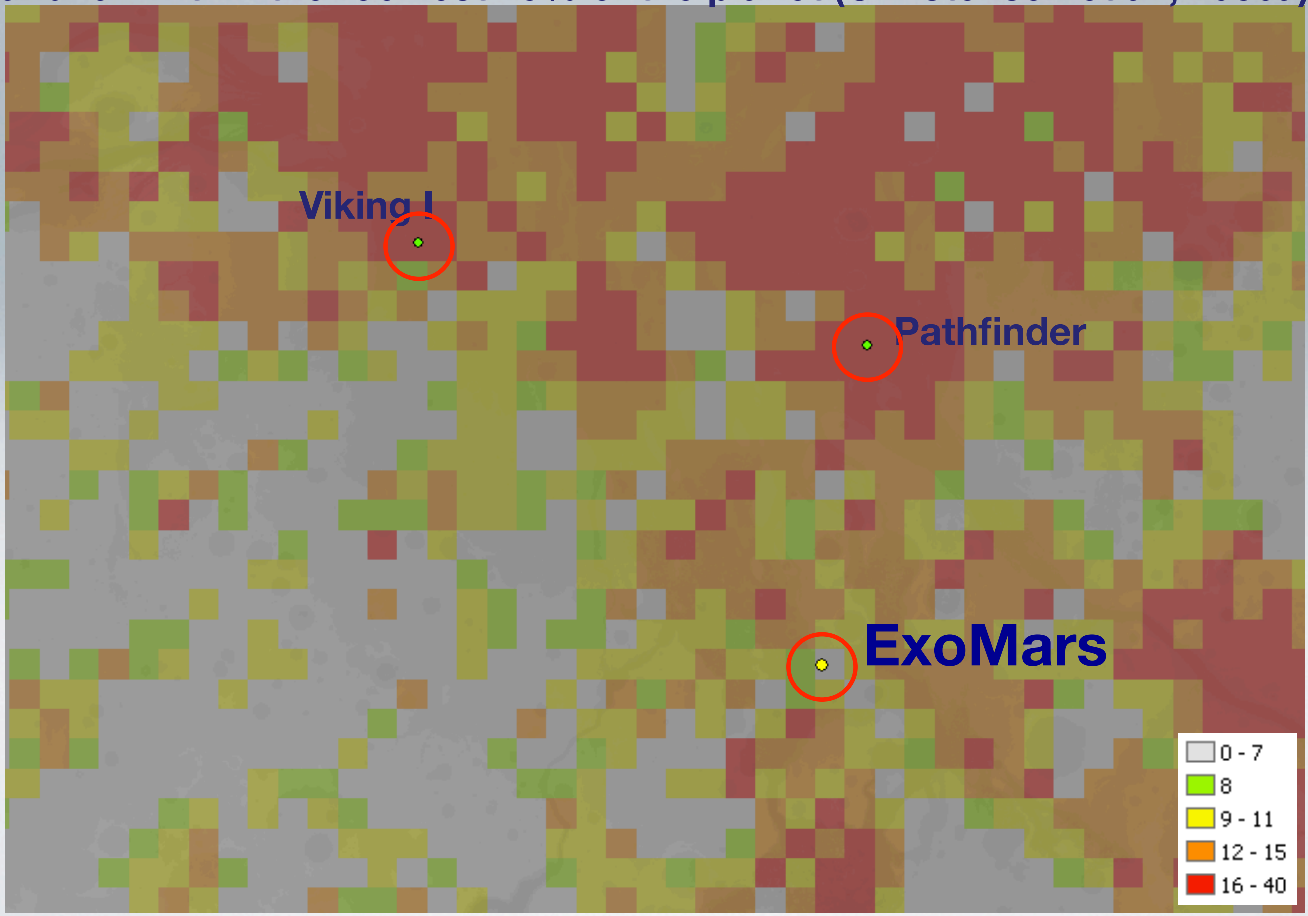
Constraint: Rock Abundance ≤ 7%

Viking I IRTM RA: 8-19%

Simud Vallis Floor IRTM RA: 3-11%, WA 7.343%

Viking II IRTM RA: 15-23%

As from Golombek et al., 2003, the two Viking and the Pathfinder sites have total rock abundances of 15-20%, and fall within the rockiest 15% of the planet (Christensen et al., 1986a)

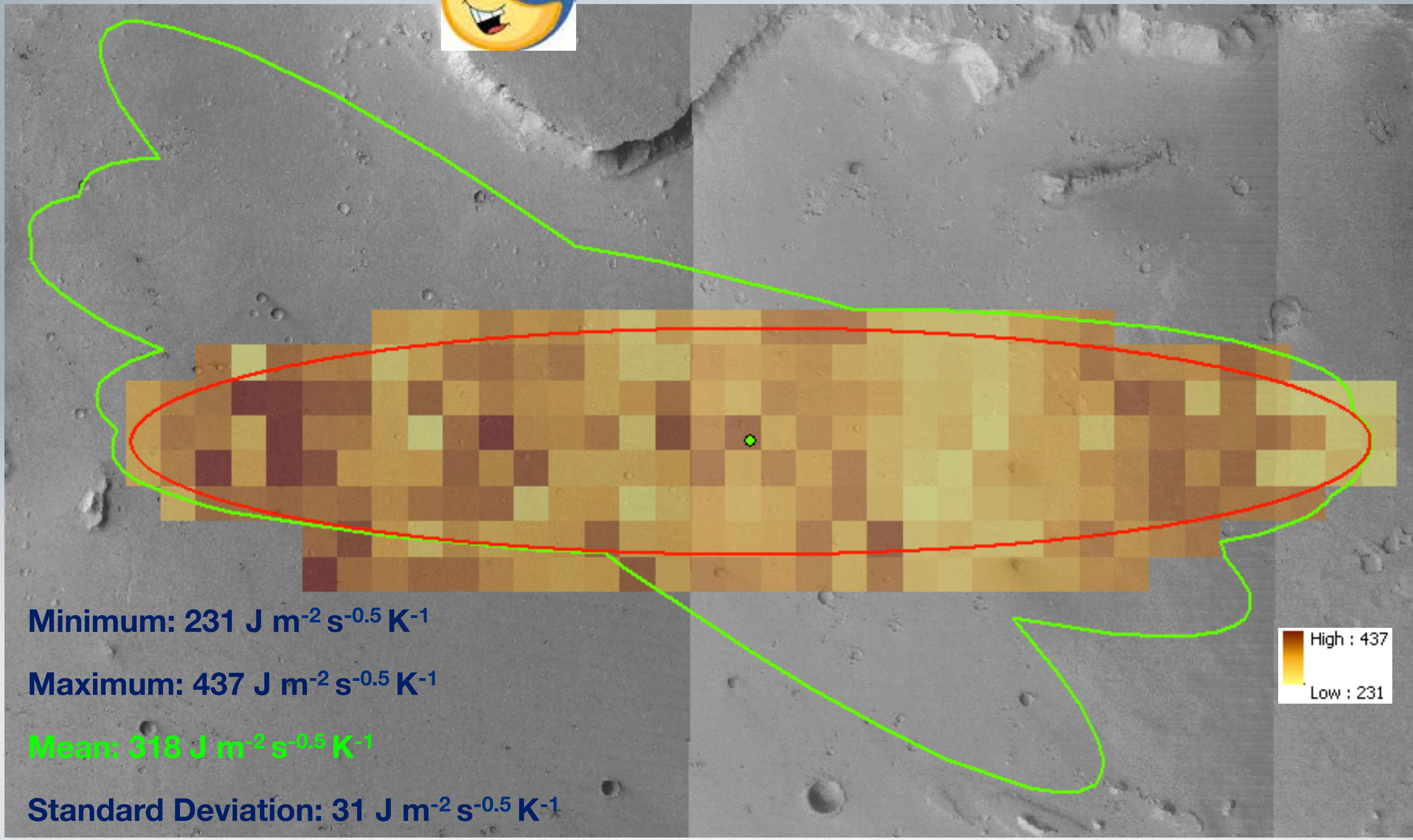


Thermal Inertia

MGS-TES data (Novicki et al., 2007, Putzig et al., 2005, 2007) => 3 km resolution

Night-side Thermal Inertia Map

Constraint: Thermal Inertia ≥ 150 J m^{-2} $s^{-0.5}$ K^{-1}



Minimum: 231 J m^{-2} $s^{-0.5}$ K^{-1}

Maximum: 437 J m^{-2} $s^{-0.5}$ K^{-1}

Mean: 318 J m^{-2} $s^{-0.5}$ K^{-1}

Standard Deviation: 31 J m^{-2} $s^{-0.5}$ K^{-1}

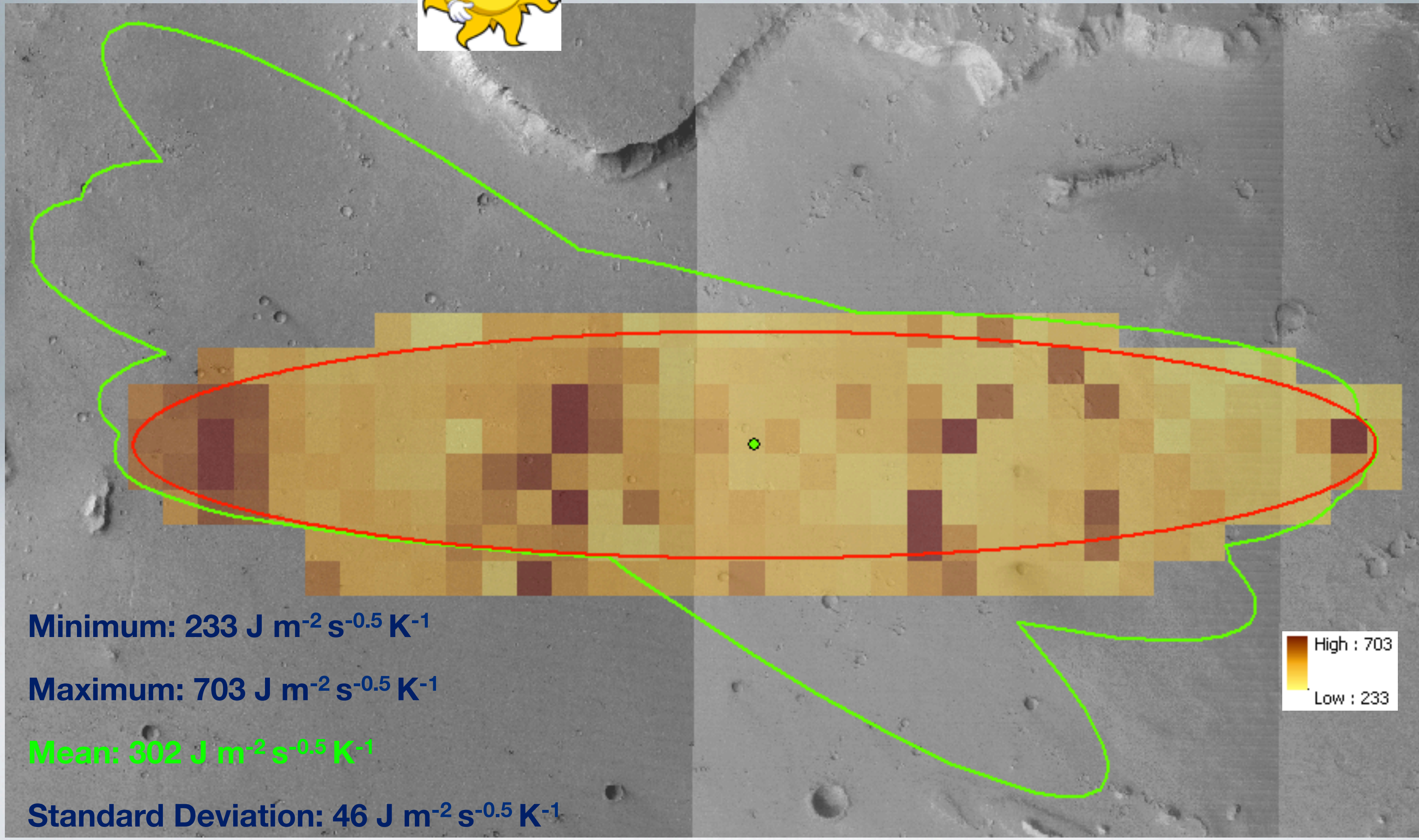
Thermal Inertia

EXOMARS

MGS-TES data (Novicki et al., 2007, Putzig et al., 2005, 2007) => 3 km resolution

Day-side Thermal Inertia Map

Constraint: Thermal Inertia ≥ 150 J m^{-2} $s^{-0.5}$ K^{-1}



Minimum: 233 J m^{-2} $s^{-0.5}$ K^{-1}

Maximum: 703 J m^{-2} $s^{-0.5}$ K^{-1}

Mean: 302 J m^{-2} $s^{-0.5}$ K^{-1}

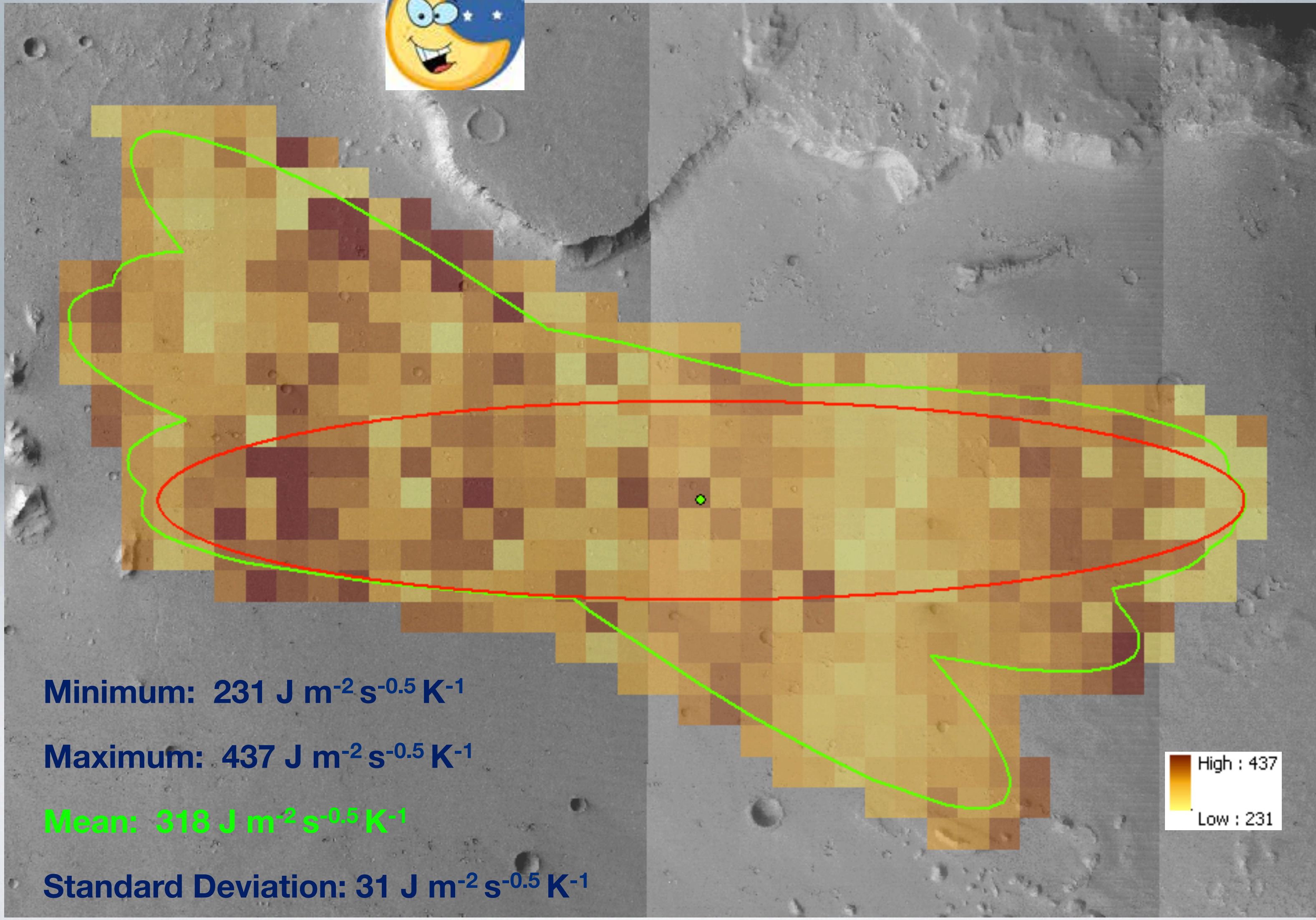
Standard Deviation: 46 J m^{-2} $s^{-0.5}$ K^{-1}

Thermal Inertia

MGS-TES data (Novicki et al., 2007, Putzig et al., 2005, 2007) => 3 km resolution

Night-side Thermal Inertia Map

Constraint: Thermal Inertia ≥ 150 J m^{-2} $s^{-0.5}$ K^{-1}



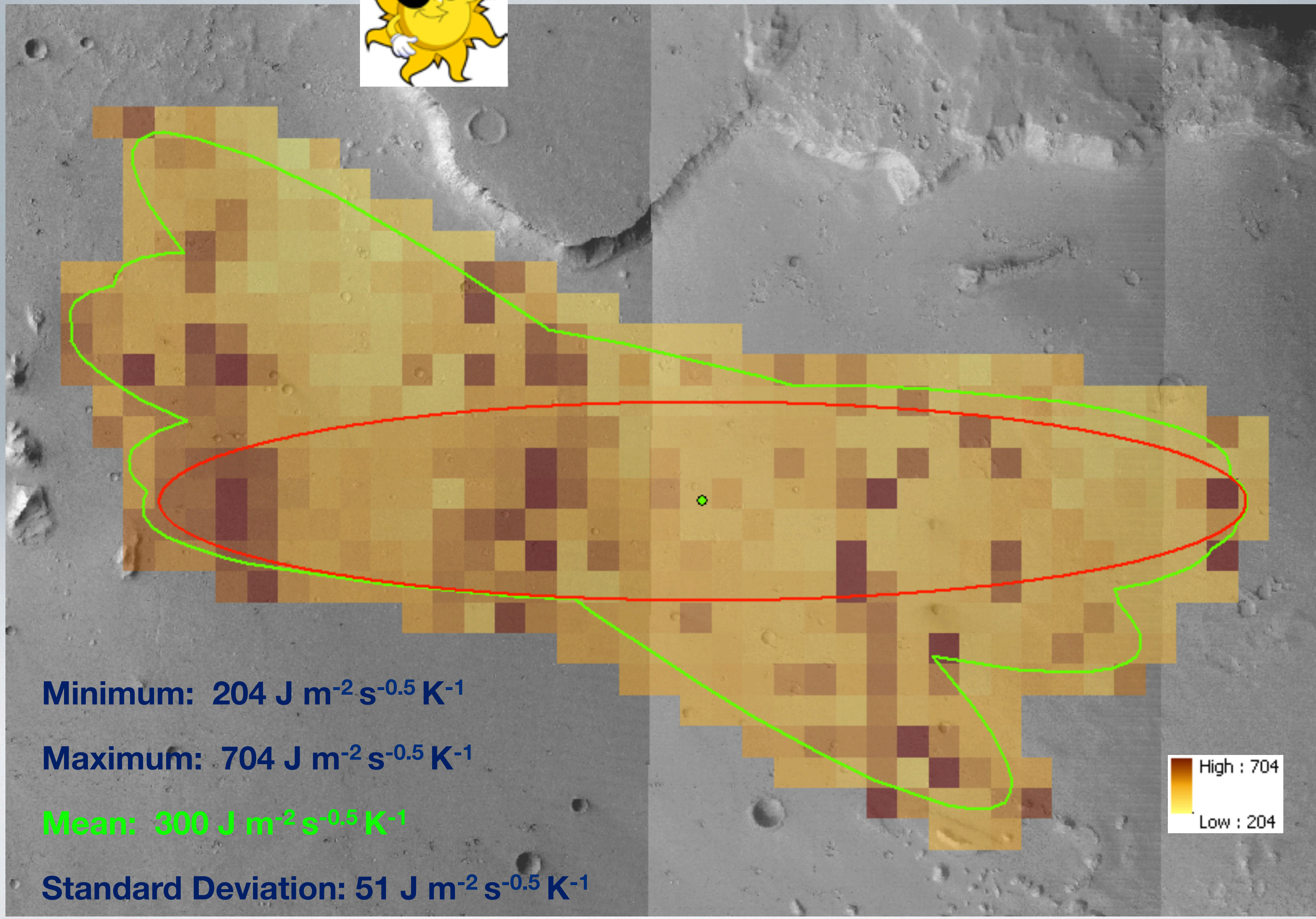
Thermal Inertia

E X O M A R S

MGS-TES data (Novicki et al., 2007, Putzig et al., 2005, 2007) => 3 km resolution

Day-side Thermal Inertia Map

Constraint: Thermal Inertia ≥ 150 J m^{-2} $s^{-0.5}$ K^{-1}



Minimum: 204 J m^{-2} $s^{-0.5}$ K^{-1}

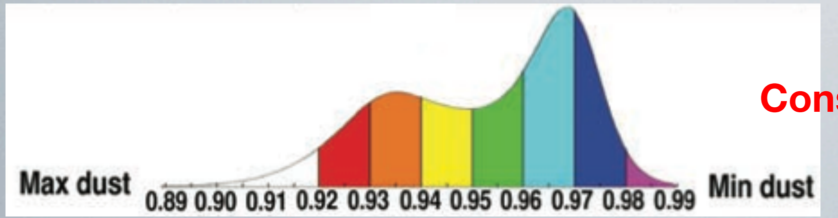
Maximum: 704 J m^{-2} $s^{-0.5}$ K^{-1}

Mean: 300 J m^{-2} $s^{-0.5}$ K^{-1}

Standard Deviation: 51 J m^{-2} $s^{-0.5}$ K^{-1}

Dust Coverage

Dust Coverage Map (Ruff et al., 2002) => 3.5 km resolution

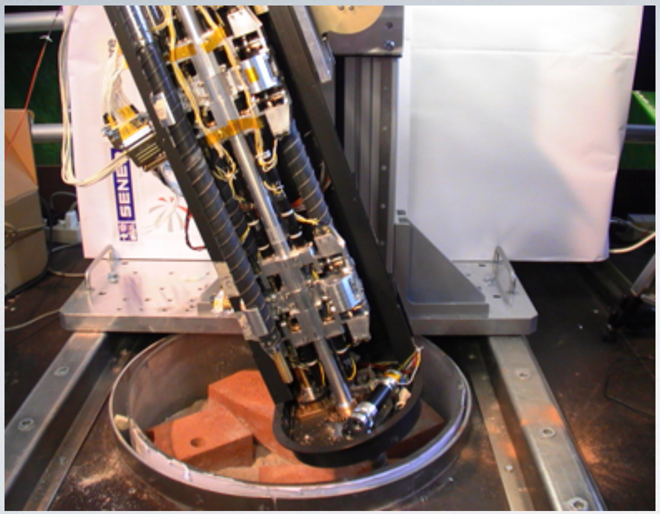


Constraint: This site must have “little” dust coverage

Dust Covered Surfaces, i.e. low Dust Content Index (DCI) values, have a TI < 150 J m^{-2} $s^{-0.5}$ K^{-1}

NOTE We have ALWAYS e a Thermal Inertia > 200 J m^{-2} $s^{-0.5}$ K^{-1}, with a mean of 300 J m^{-2} $s^{-0.5}$ K^{-1}

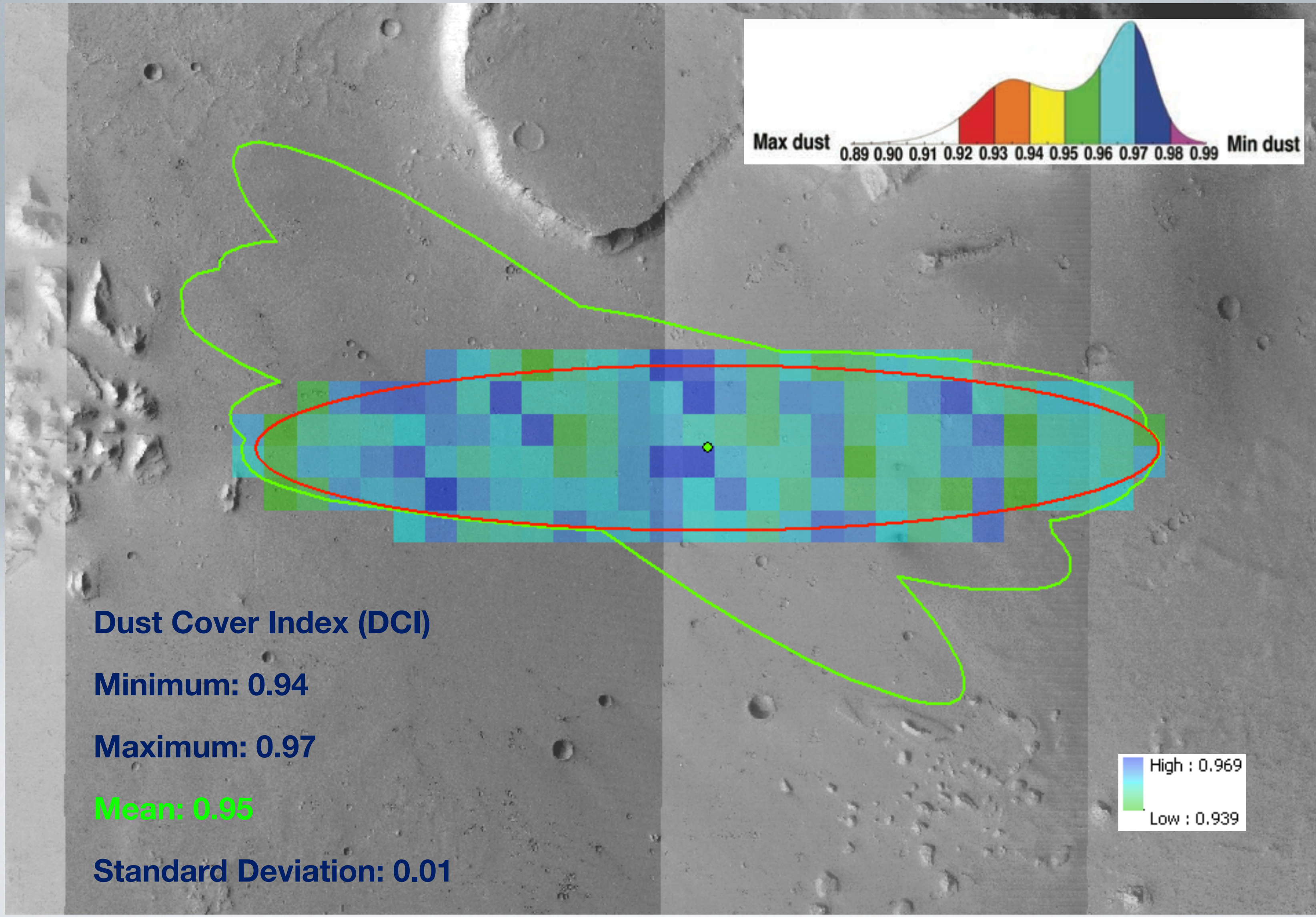
Our computed DCI (next slide), together with the TI values we presented, demonstrate that the proposed landing site is characterised by **PAUCITY OF DUST COVERAGE** fulfilling the engineering rover requirements and supporting the usefulness of a drill.



Dust Coverage

Dust Coverage Map (Ruff et al., 2002) => 3.5 km resolution

Constraint: "little" dust coverage



Dust Cover Index (DCI)

Minimum: 0.94

Maximum: 0.97

Mean: 0.95

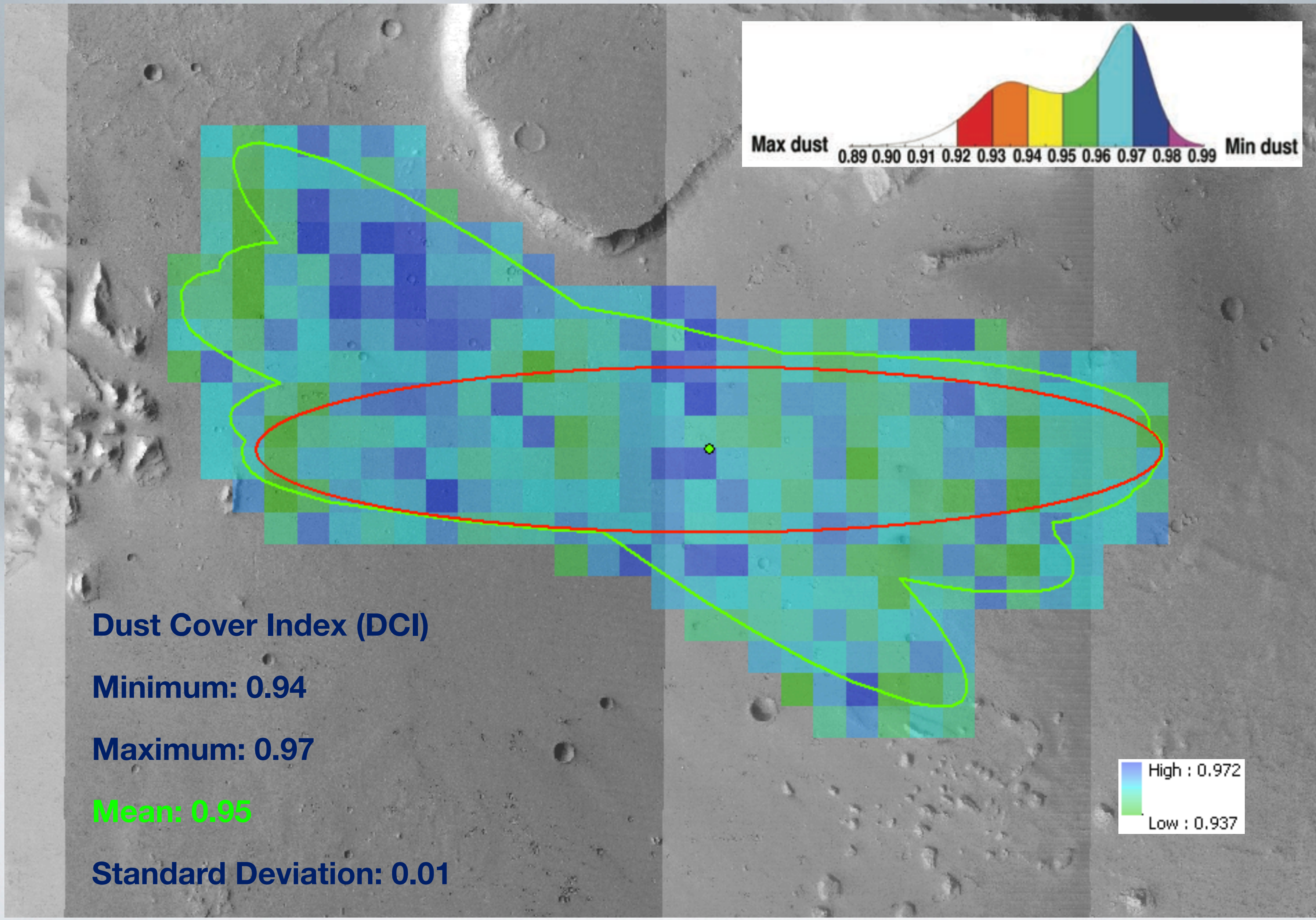
Standard Deviation: 0.01

Dust Coverage

EXOMARS

Dust Coverage Map (Ruff et al., 2002) => 3.5 km resolution

Constraint: "little" dust coverage



Dust Cover Index (DCI)

Minimum: 0.94

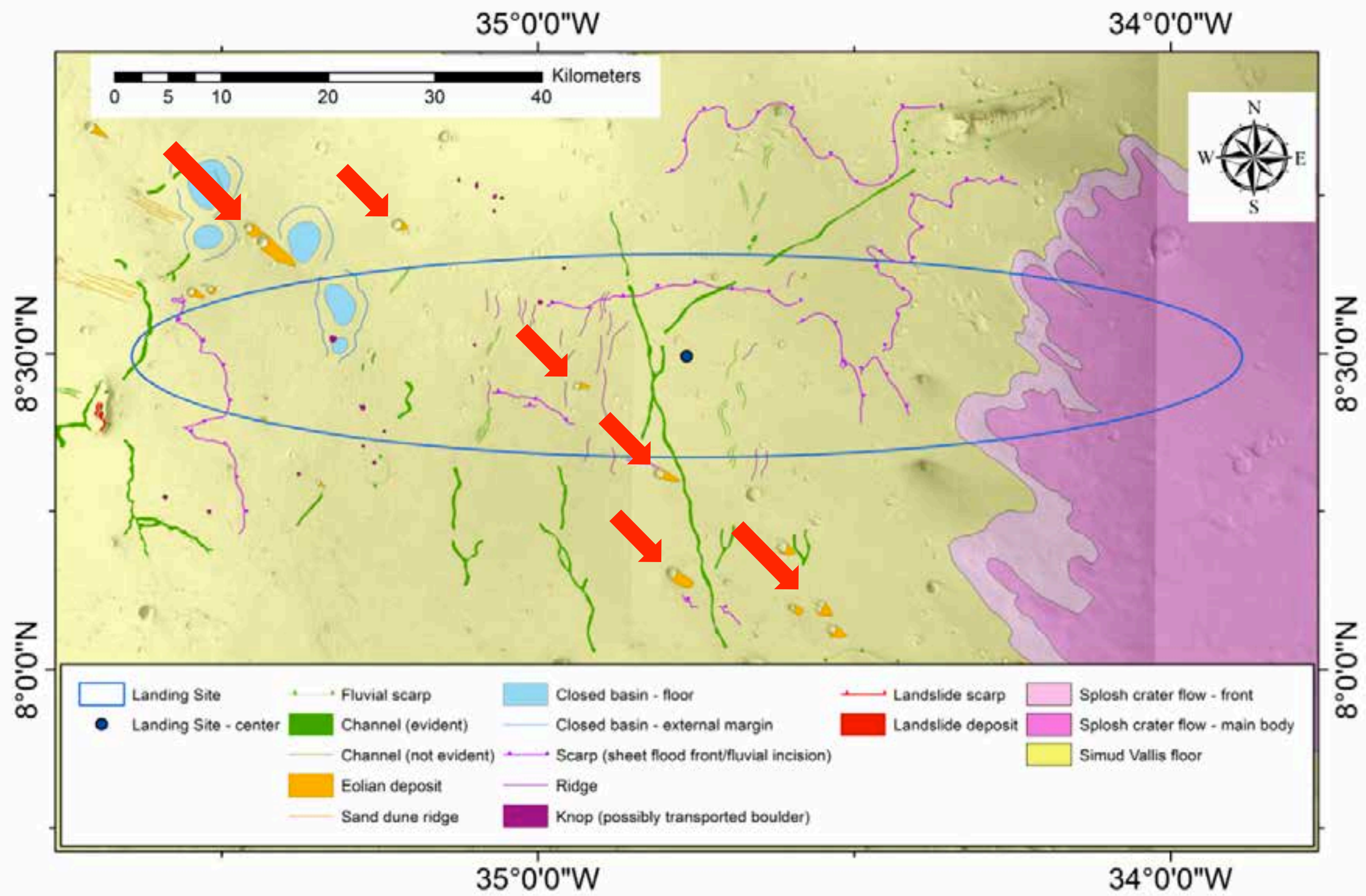
Maximum: 0.97

Mean: 0.95

Standard Deviation: 0.01

Dust Coverage & Wind

EXOMARS



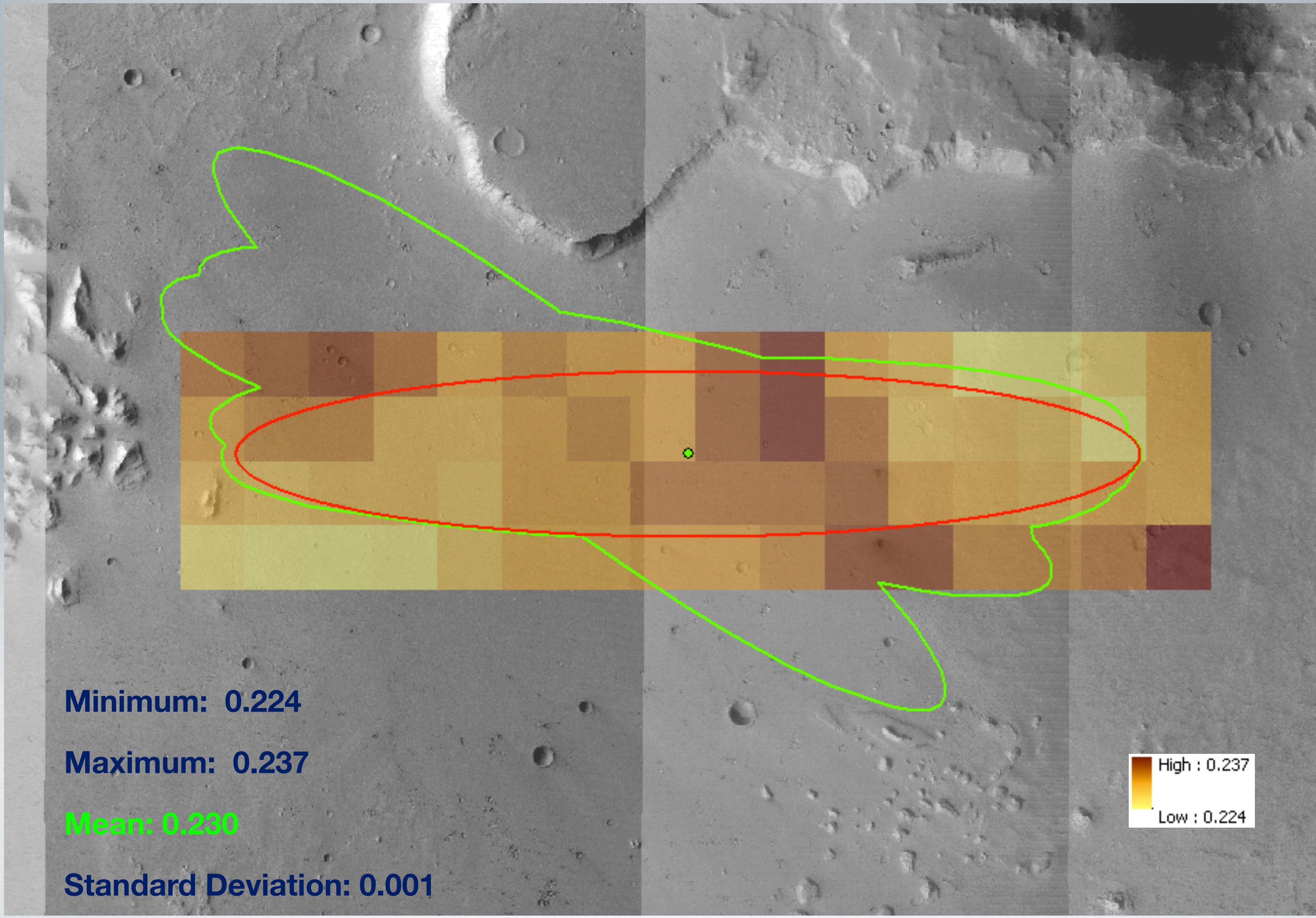
Rare Eolian deposits, located downwind of few craters, implying WNW/ESE wind-flow directions

The small GCM study describing the global wind regimes at the planned landing times for different atmospheric dust loading scenarios performed by the LSSWG.

Albedo

MGS-TES data (Christensen et al., 2001) => 7.4 km resolution

Constraint: 0.1 ≤ Albedo ≤ 0.26



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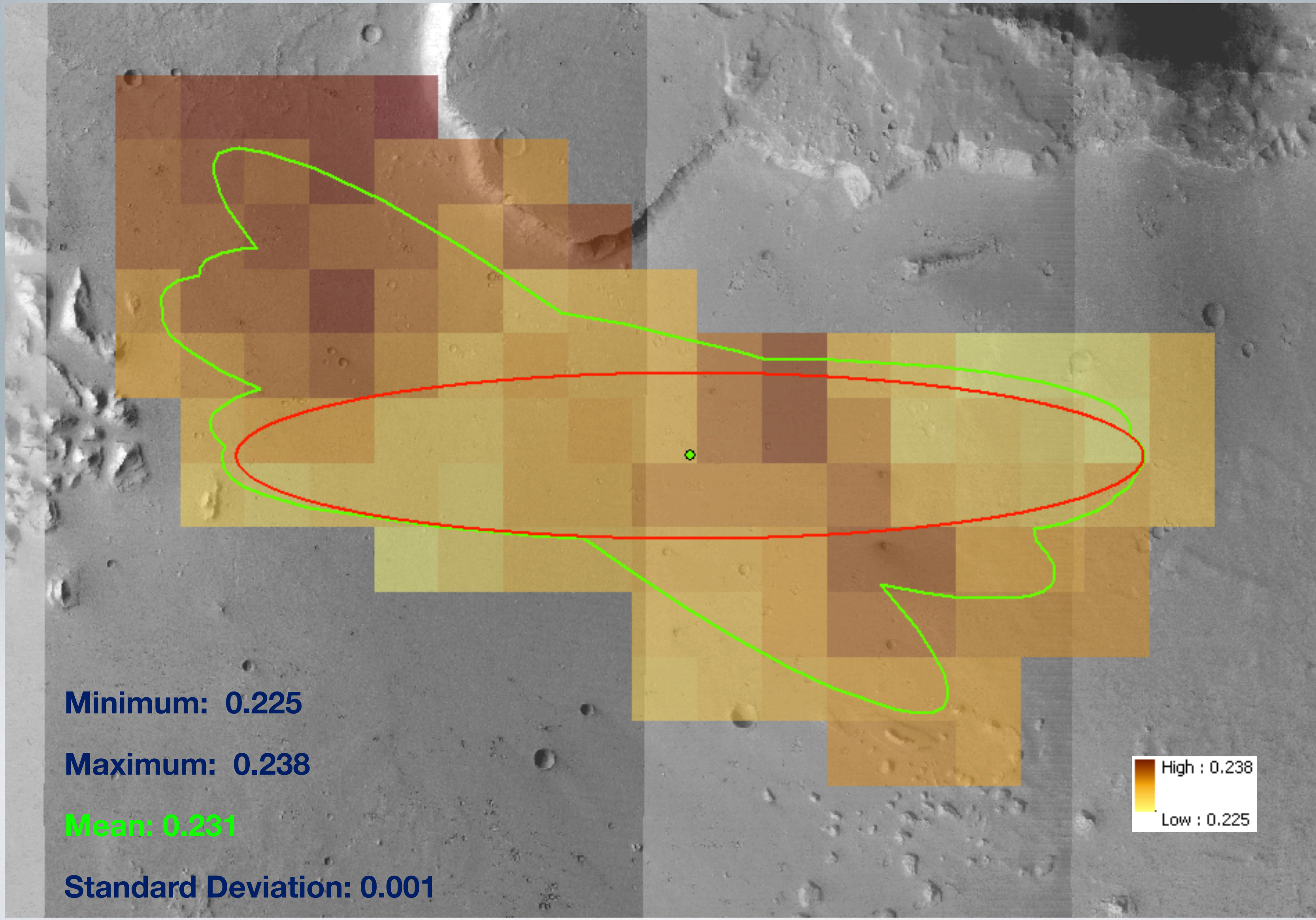
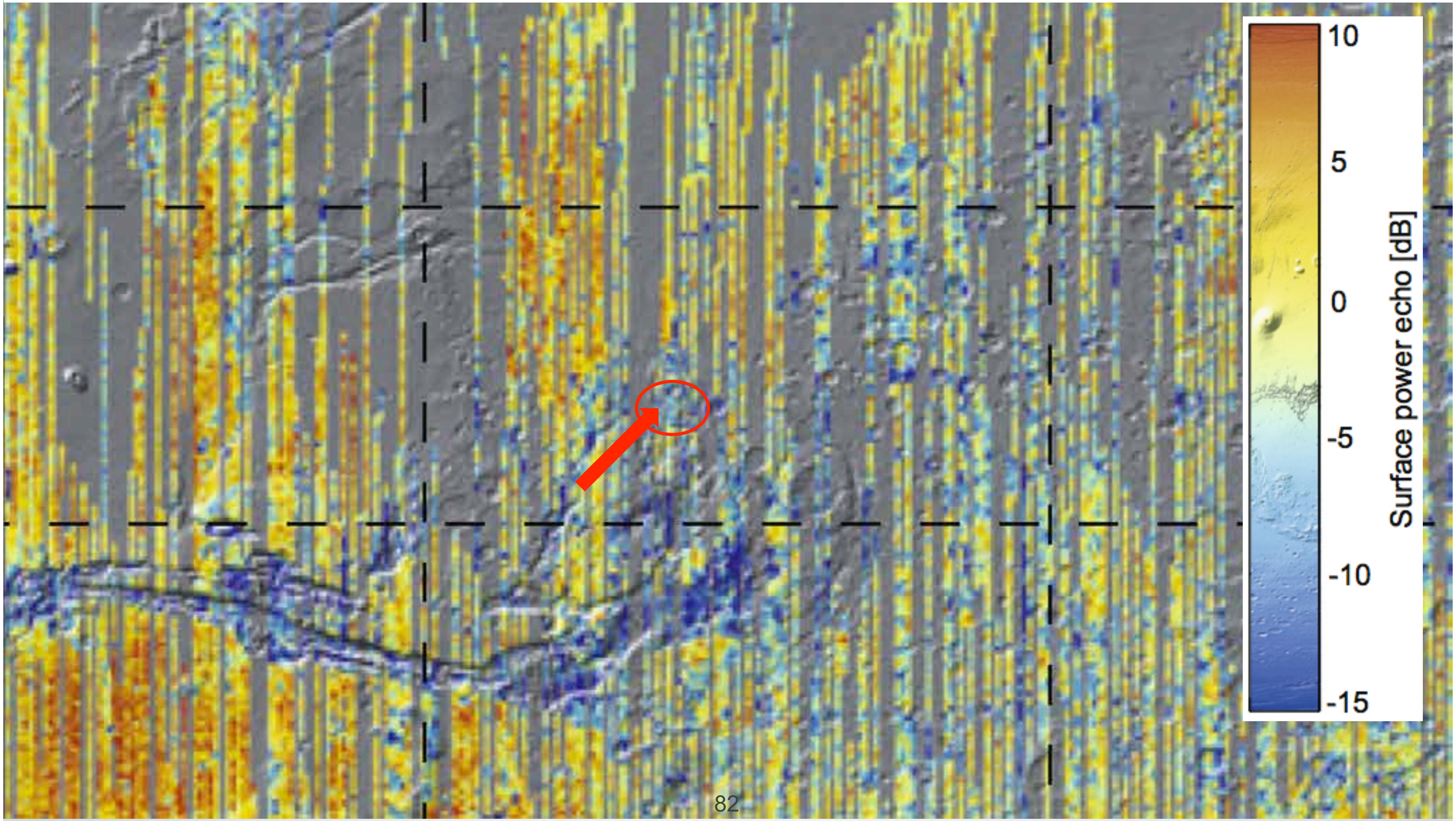


Radar

MEX-MARSIS 3-5 MHz data (Mouginot et al., 2010) => <u>NO GIS MAPS</u>

Constraint: -15 dB < Radar Reflectivity < 27.5 dB



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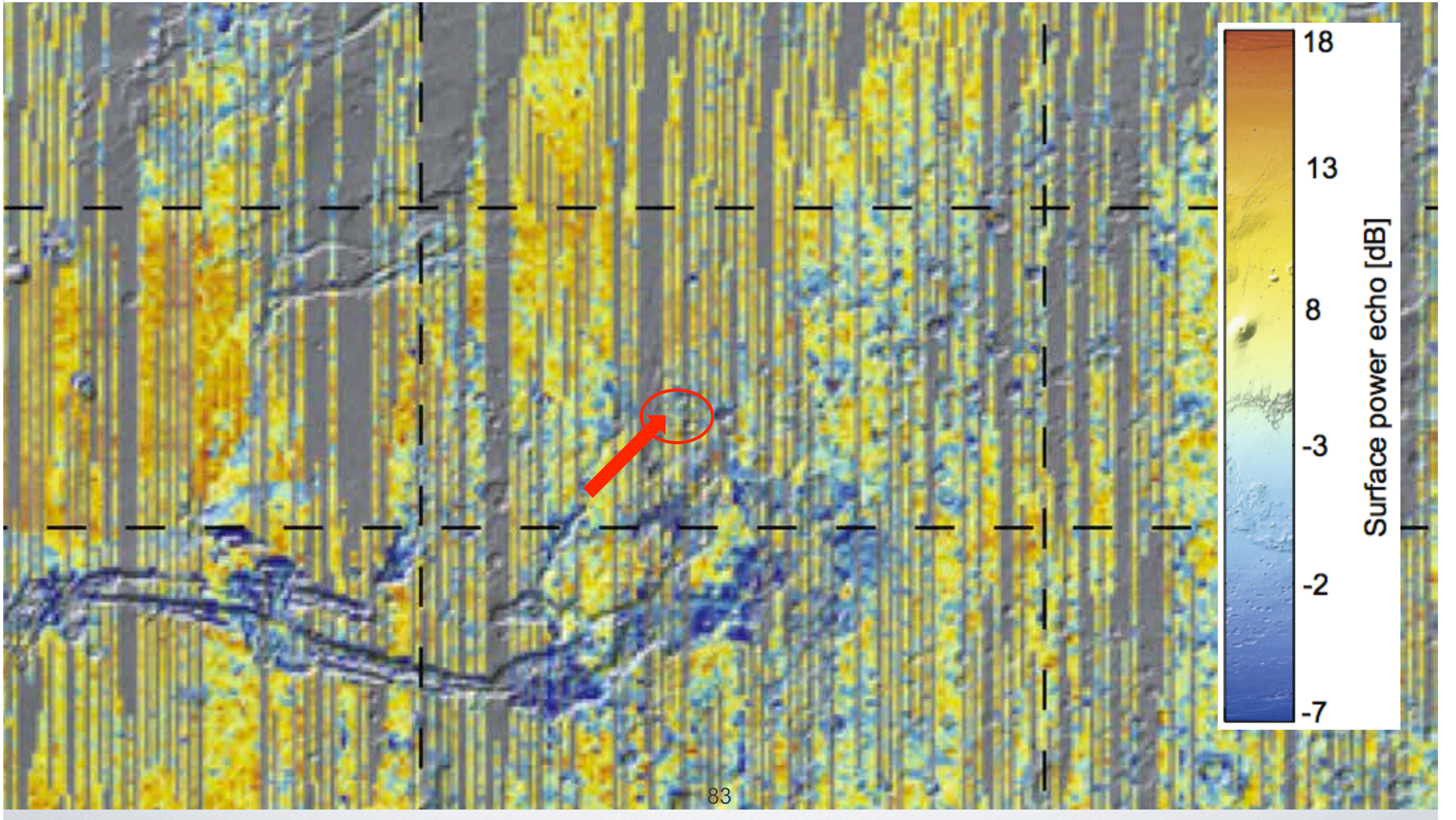

E X O M A R S

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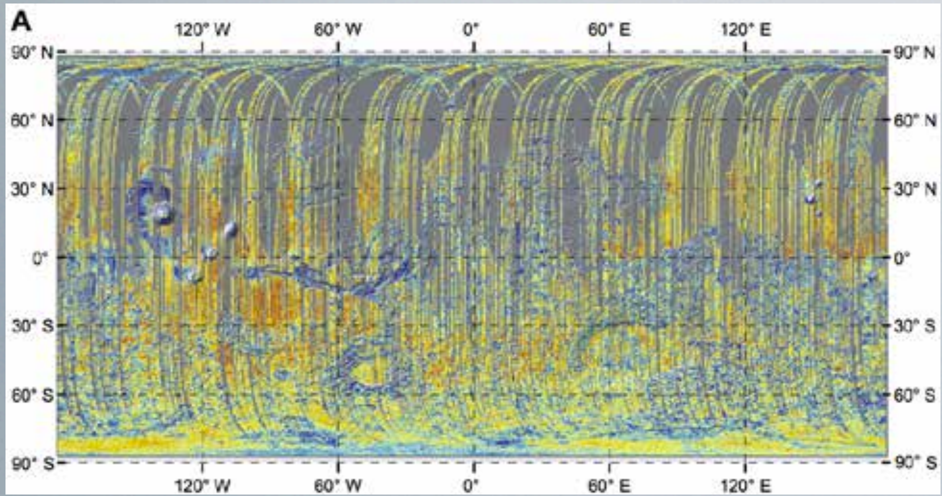
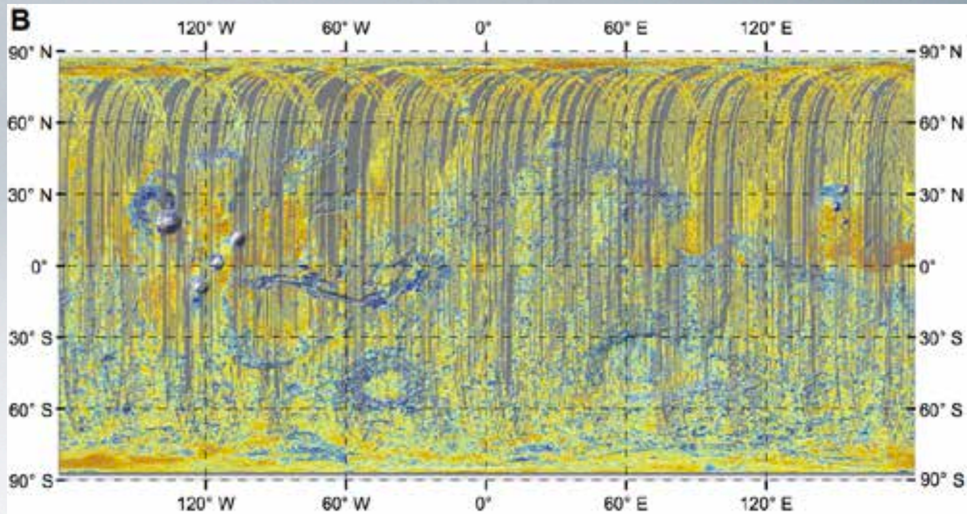




By using the Mouginot et al., 2010, maps

we evaluated a **surface power echo**

which reaches a minimum at -10 dB

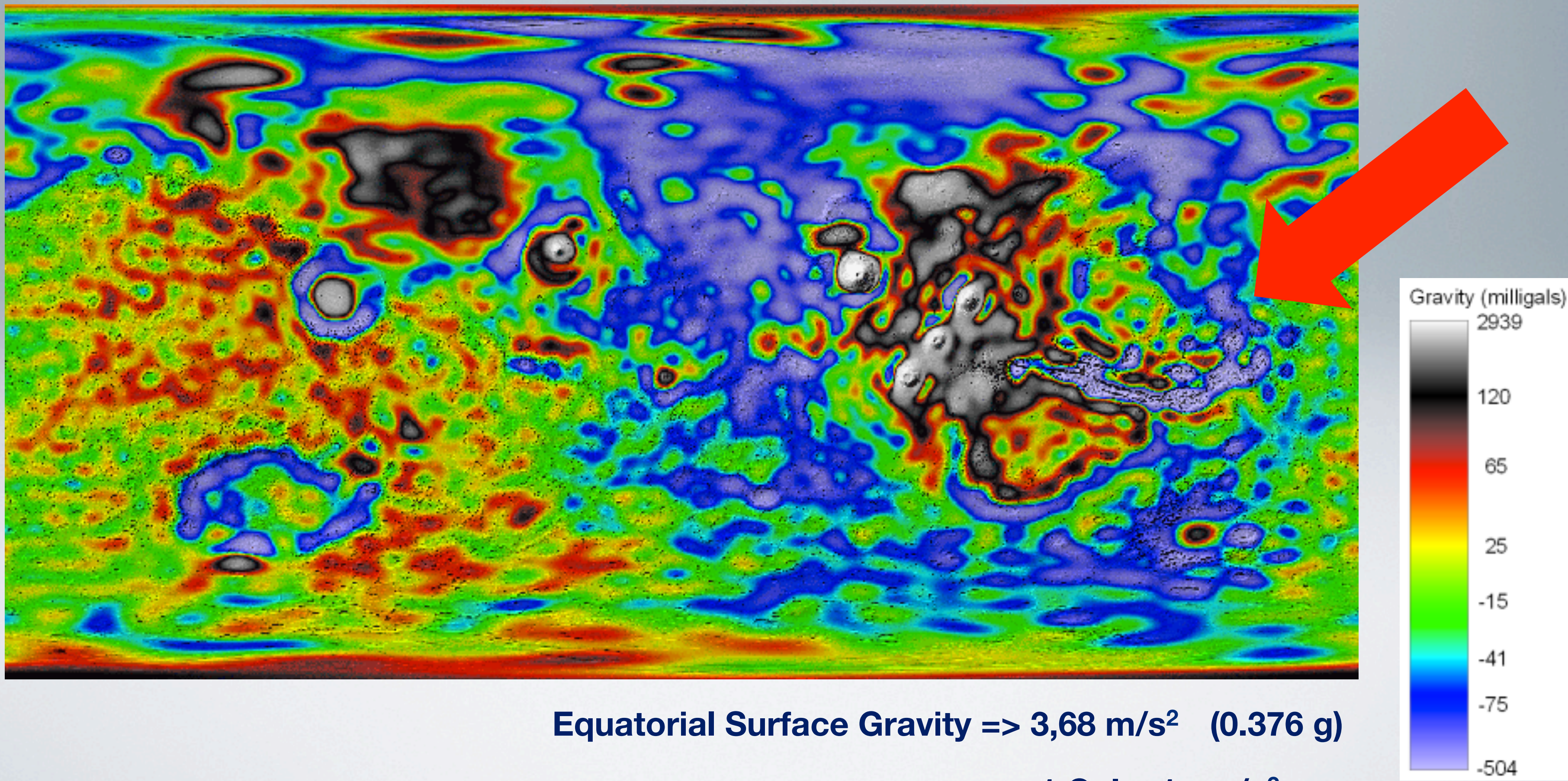
and a maximum of 15 dB.

More detailed data are required => we need access to public and GIS available maps

Gravity Anomalies Map

MGS-Tracking data (Lemoine et al., 2001) evaluated for the MGM1025 model

The Mars Global Surveyor spacecraft entered its low altitude mapping orbit on February 4, 1999, and since then has been tracked continuously by the Deep Space Network (DSN). The radiometric tracking data and the Mars Orbiter Laser Altimeter (MOLA) data have been used in the derivation of geopotential solutions in spherical harmonics.

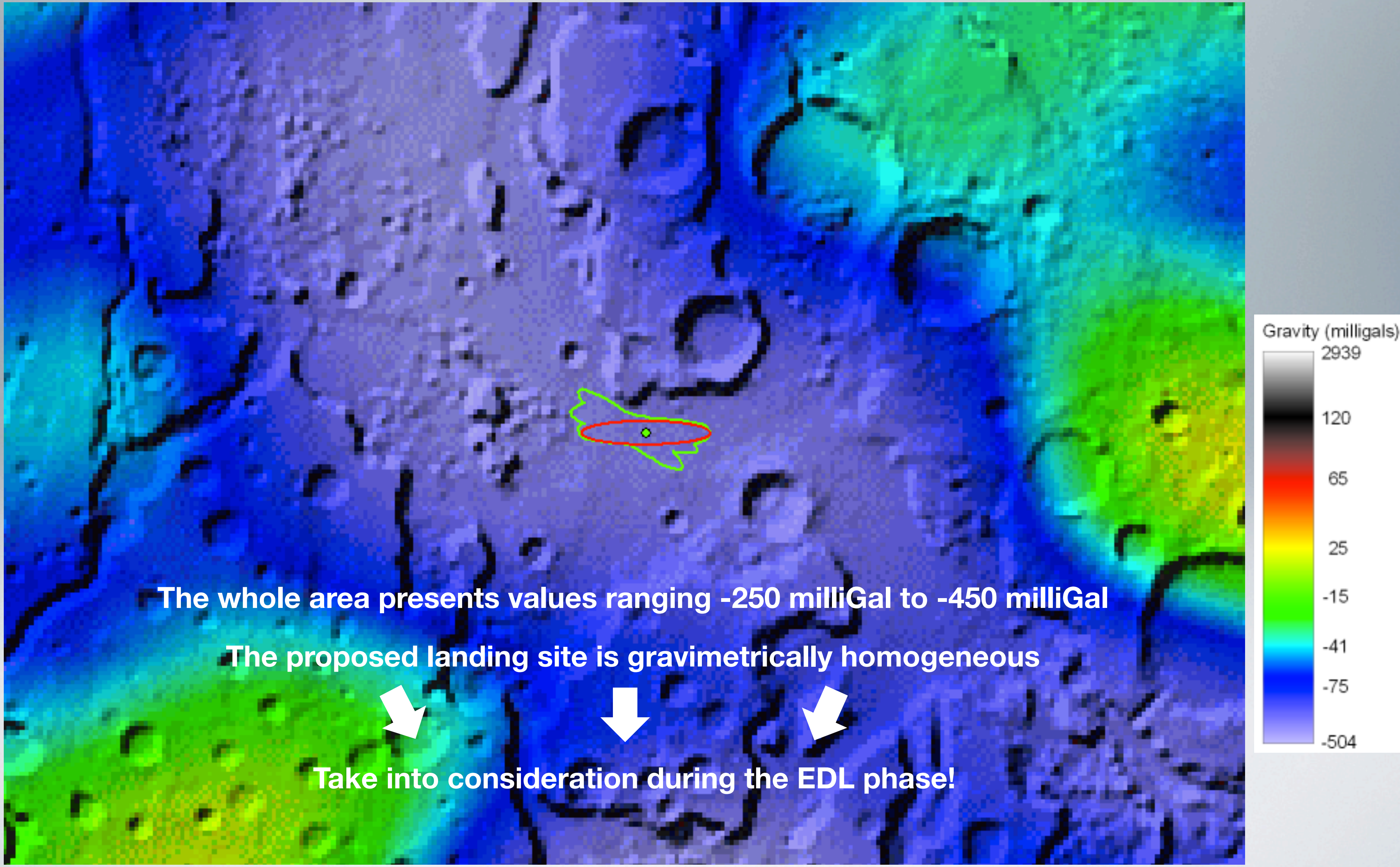


Equatorial Surface Gravity => 3,68 m/s^2 (0.376 g)

1 Gal = 1 cm/s^2

Gravity Anomalies Map

MGS-Tracking data (Lemoine et al., 2001) evaluated for the MGM1025 model

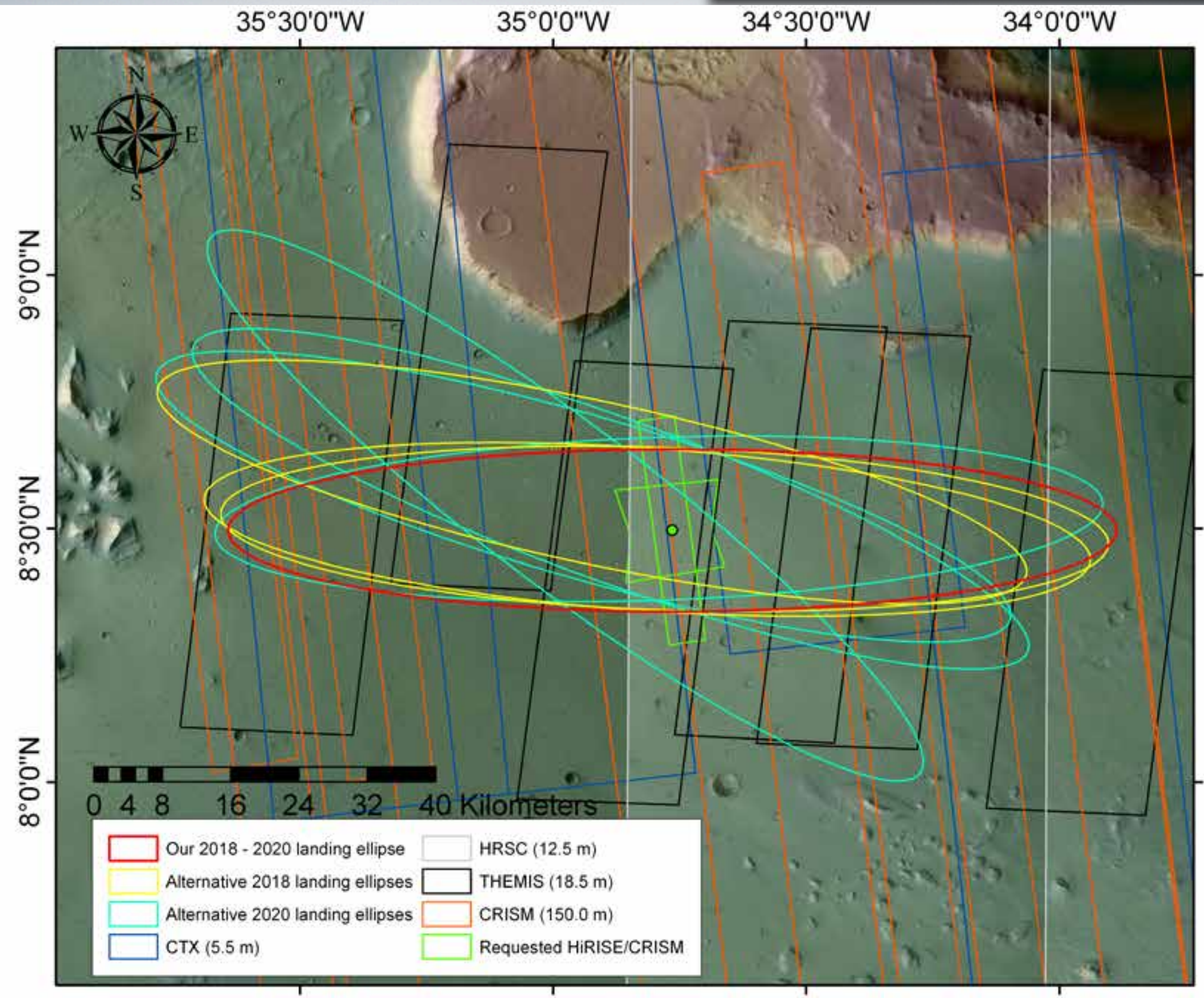


The whole area presents values ranging -250 milliGal to -450 milliGal

The proposed landing site is gravimetrically homogeneous

Take into consideration during the EDL phase!

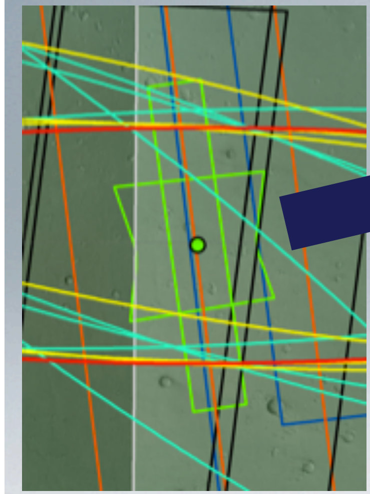
HiRISE, CTX, CRISM, HRSC

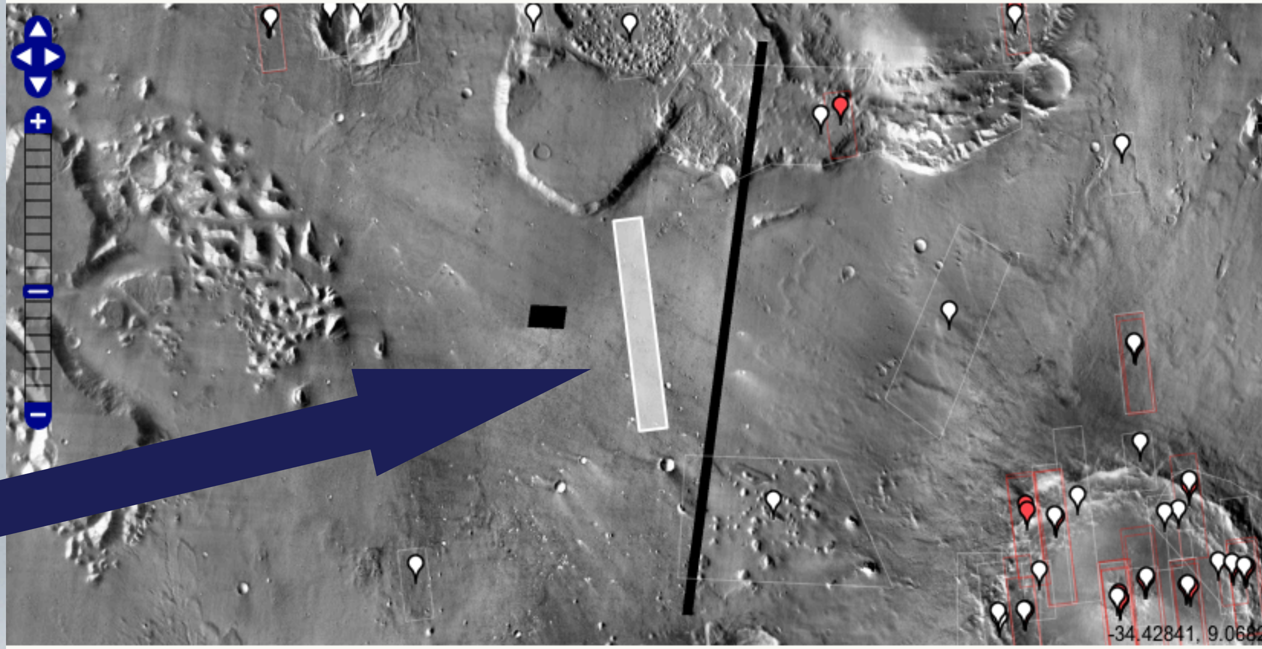


Requested HiRISE, CRISM

EXOMARS

Mineralogical characterization of a proposed ExoMars 2018 Landing Site





Viewing 8.498°N, 325.247°E

Background Day Infrared Show ☑ Targets ☑ HiRISE ☐ CTX ☐ CRISM ☐ MOC

Create A Nearby Suggestion | Search Map Area

- Basics
- Science Rationale
- Special Notes
- Advanced

Stereo Requested? No

Color Requested? Yes

CRISM Requested? Yes

Possible HiRISE, CRISM, CTX

New Requests:

CRISM + HiRISE image @ 35.26°W (324.74°E) Long, 8.54°N Lat

Possible HiRISE, CRISM, CTX

CTX images @ 35.62°W (324.38°E) Long, 8.49°N Lat

@ 35.25°W (324.75°E) Long, 8.49°N Lat

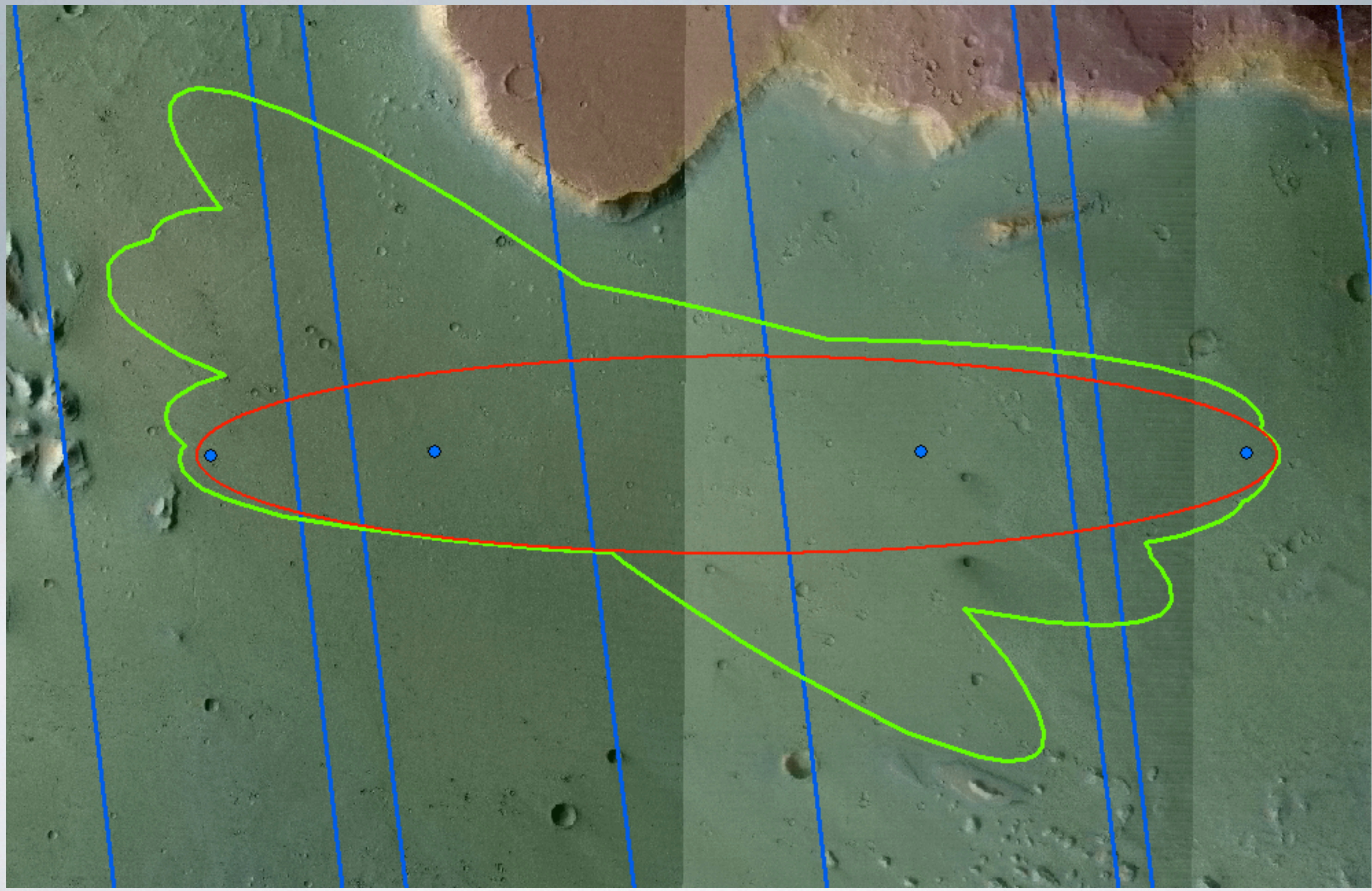
@ 34.47°W (325.53°E) Long, 8.49°N Lat

@ 33.93°W (326.07°E) Long, 8.49°N Lat

we can get the total ellipse DEM

with a spatial resolution of 18 m

(Riccardo Pozzobon @ UNIPD)



Larger Ellipse Pattern

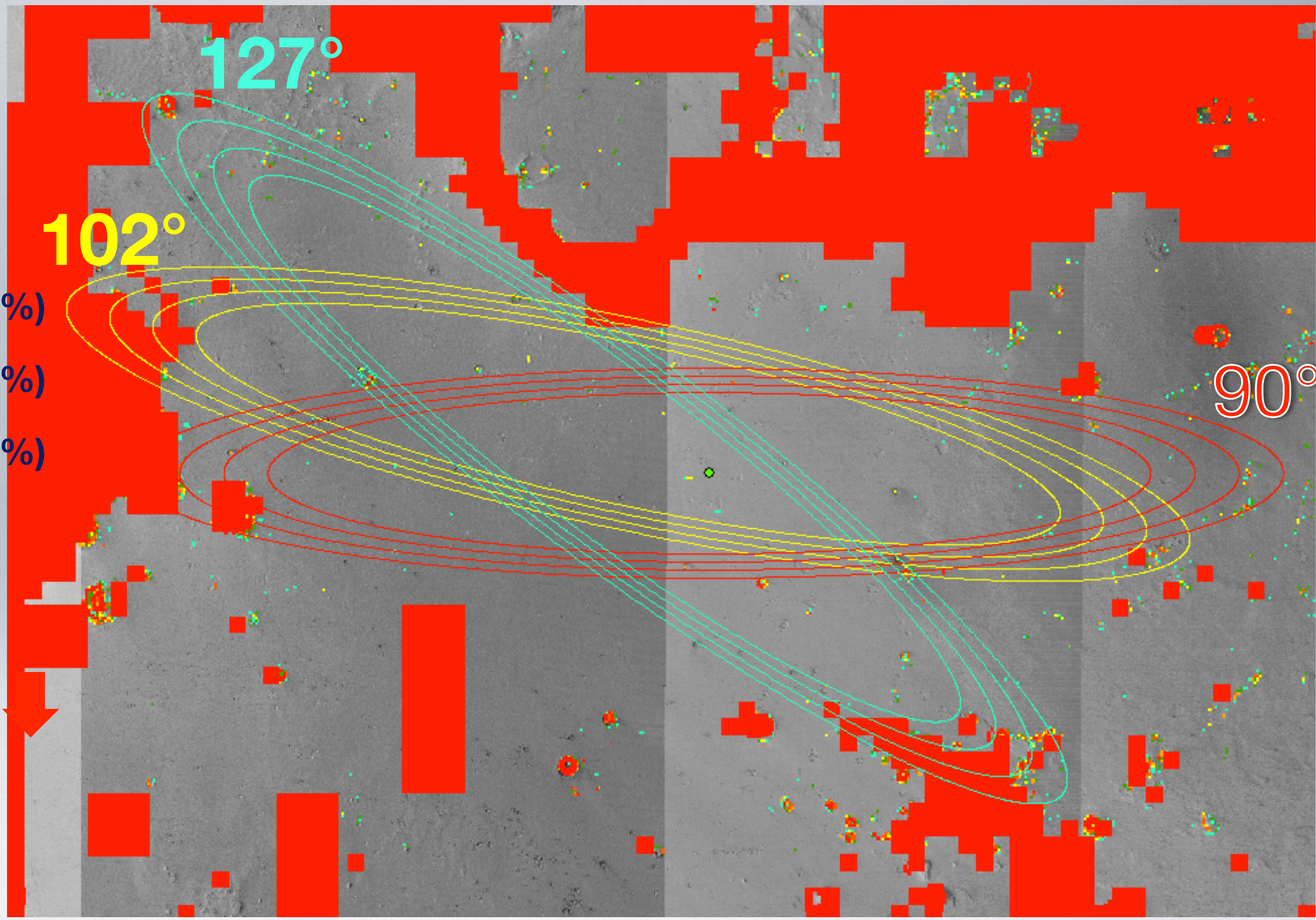
EXOMARS

1.0: 104 km x 19 km

1.1: 114.4 km x 20.9 km (+10%)

1.2: 124.8 km x 22.8 km (+20%)

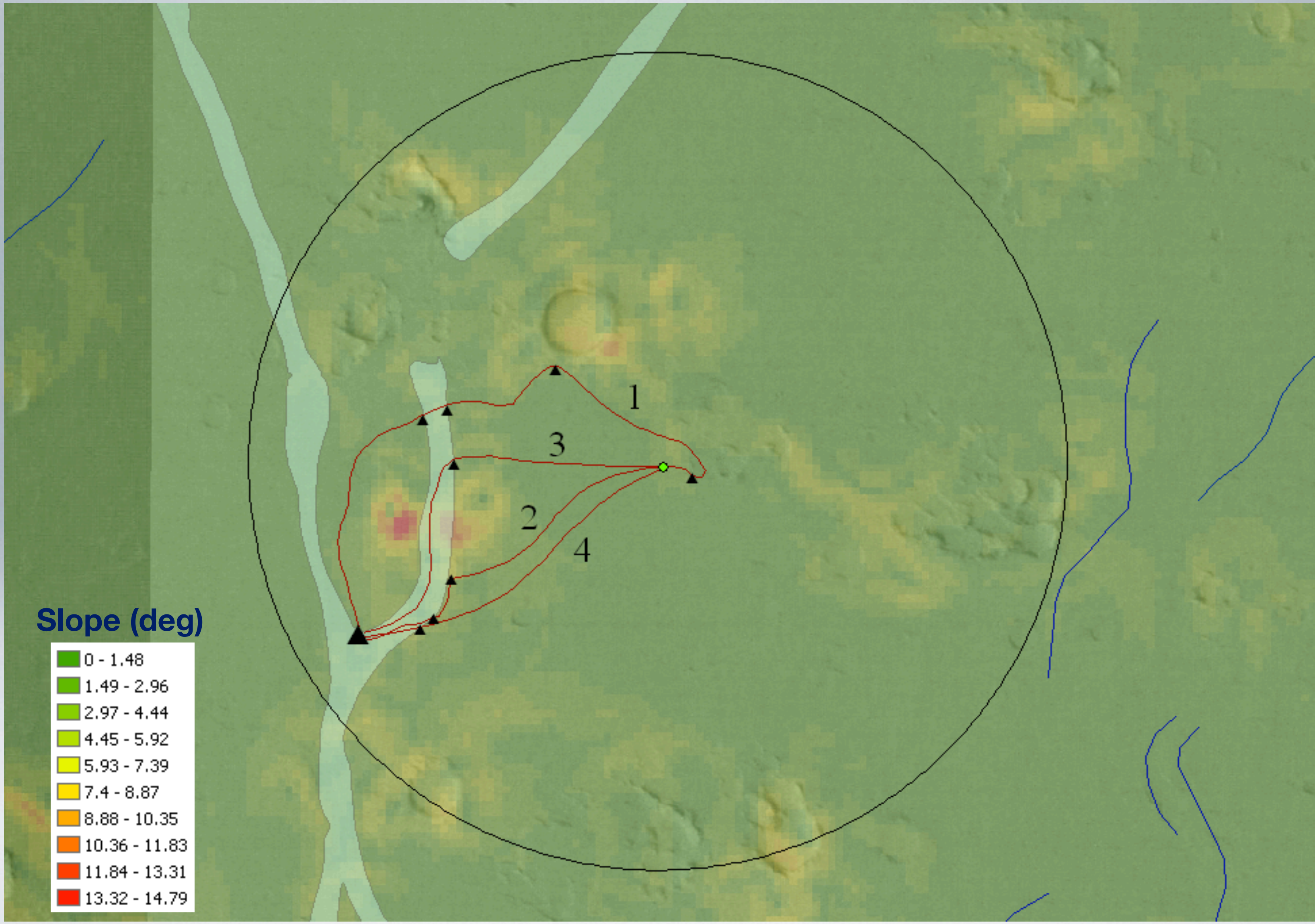
1.3: 135.2 km x 24.7 km (+30%)



NO PROBLEM AT ALL!

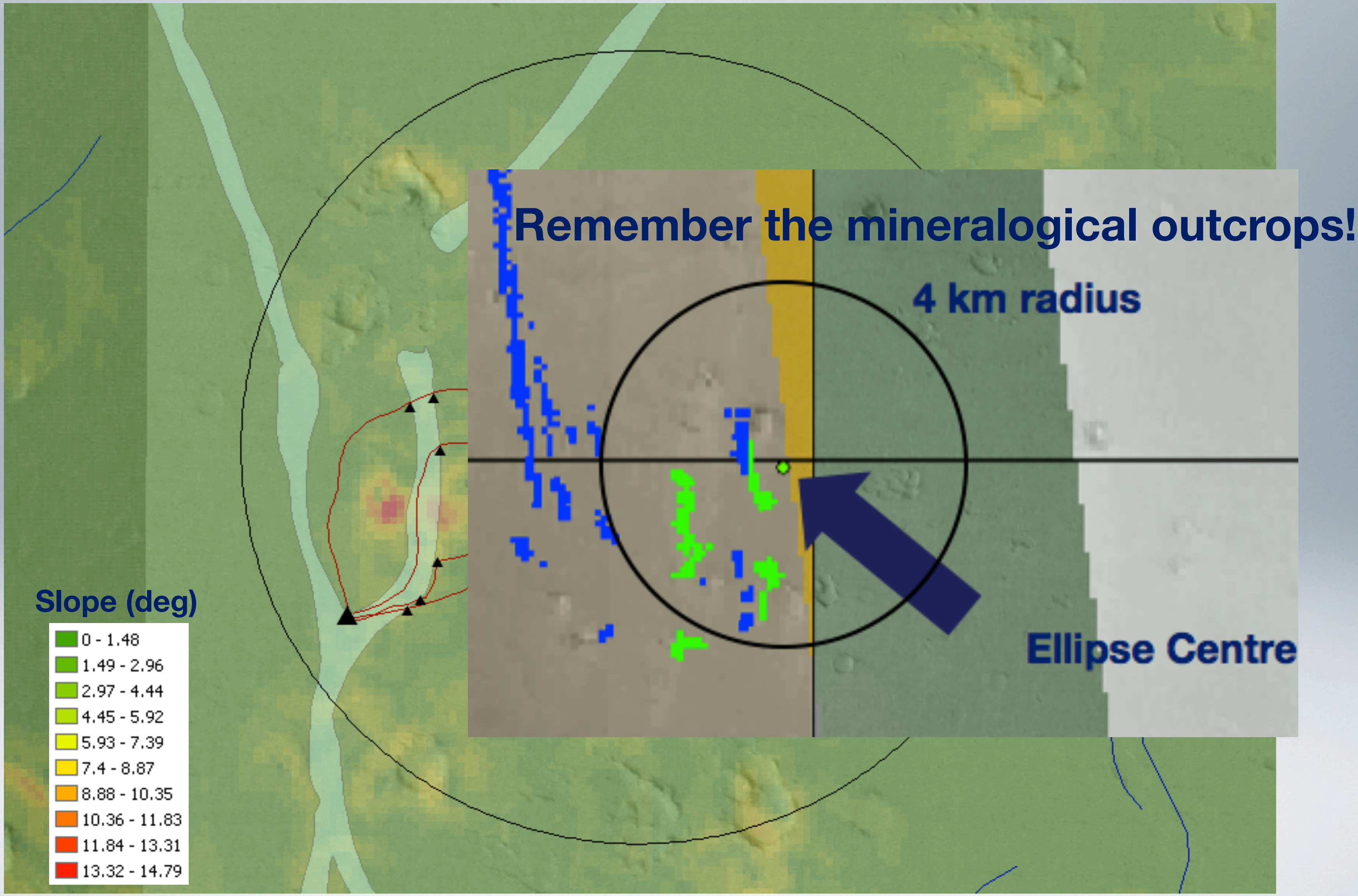
Bigger ellipse proposed dimensions => only an area of 3% (with a 30% bigger ellipse!!!) is then affected by red values!

Possible Traverse Paths

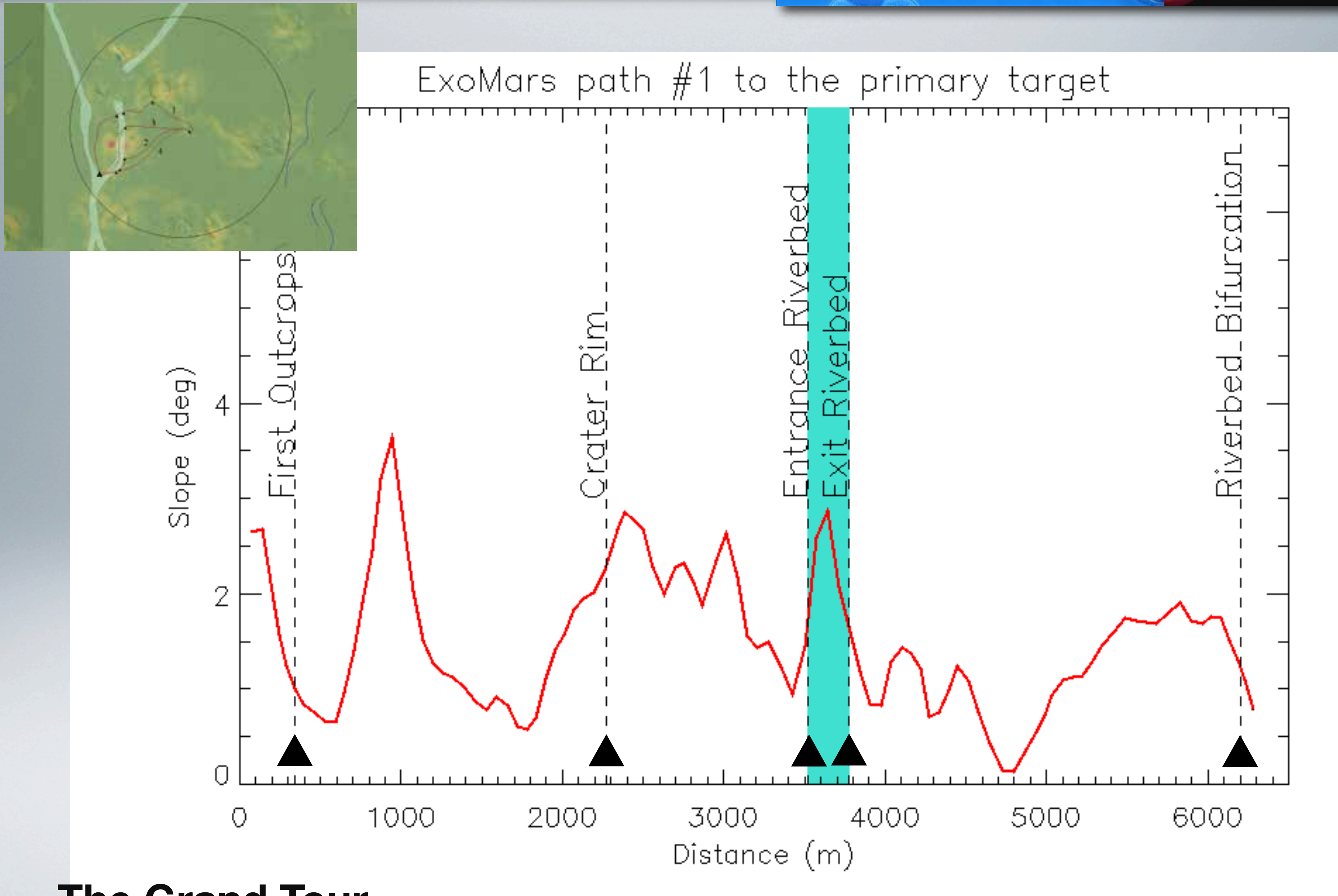


▲ Point of Interest

Possible Traverse Paths

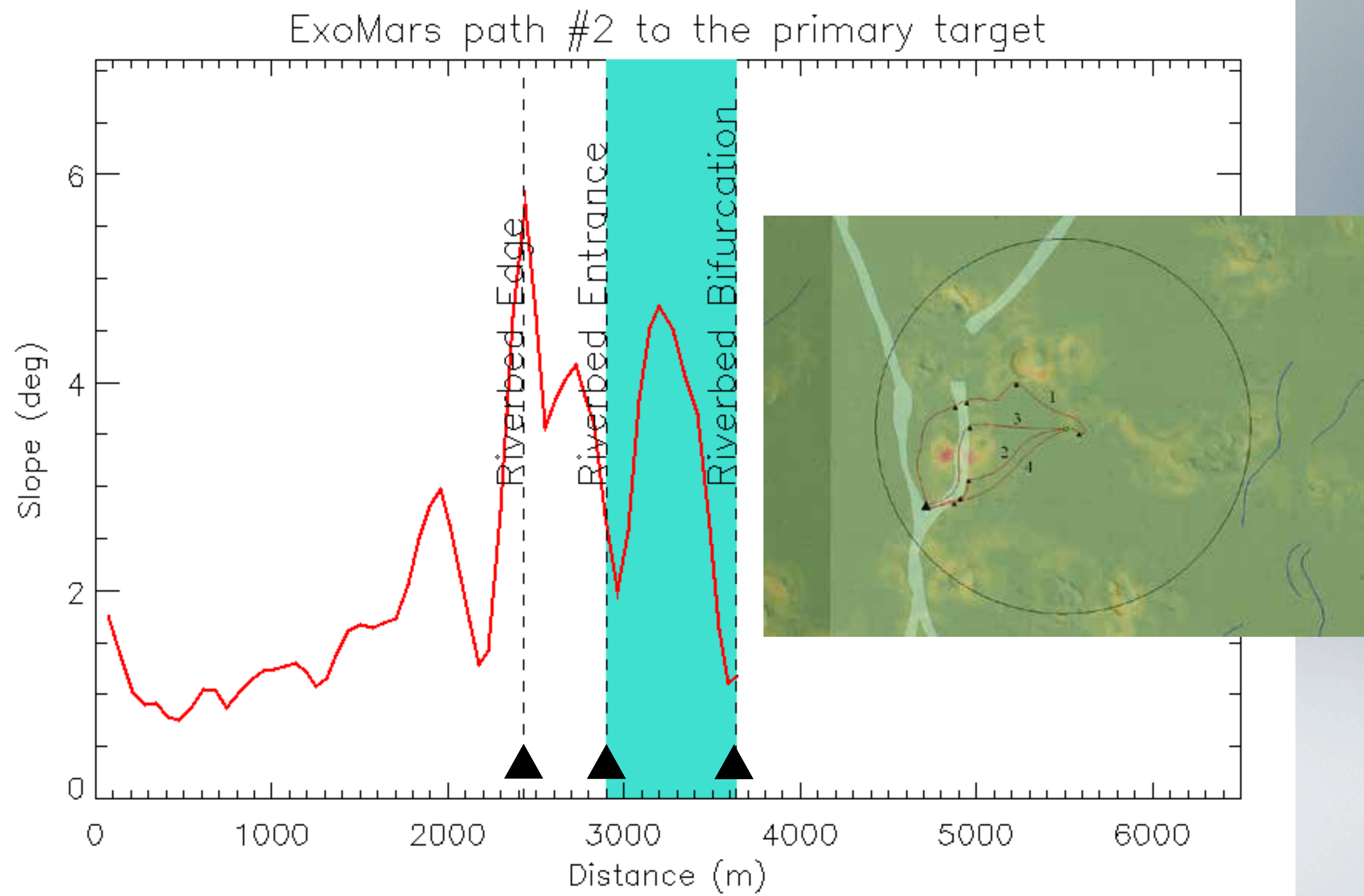


Possible Traverse Paths



The Grand Tour

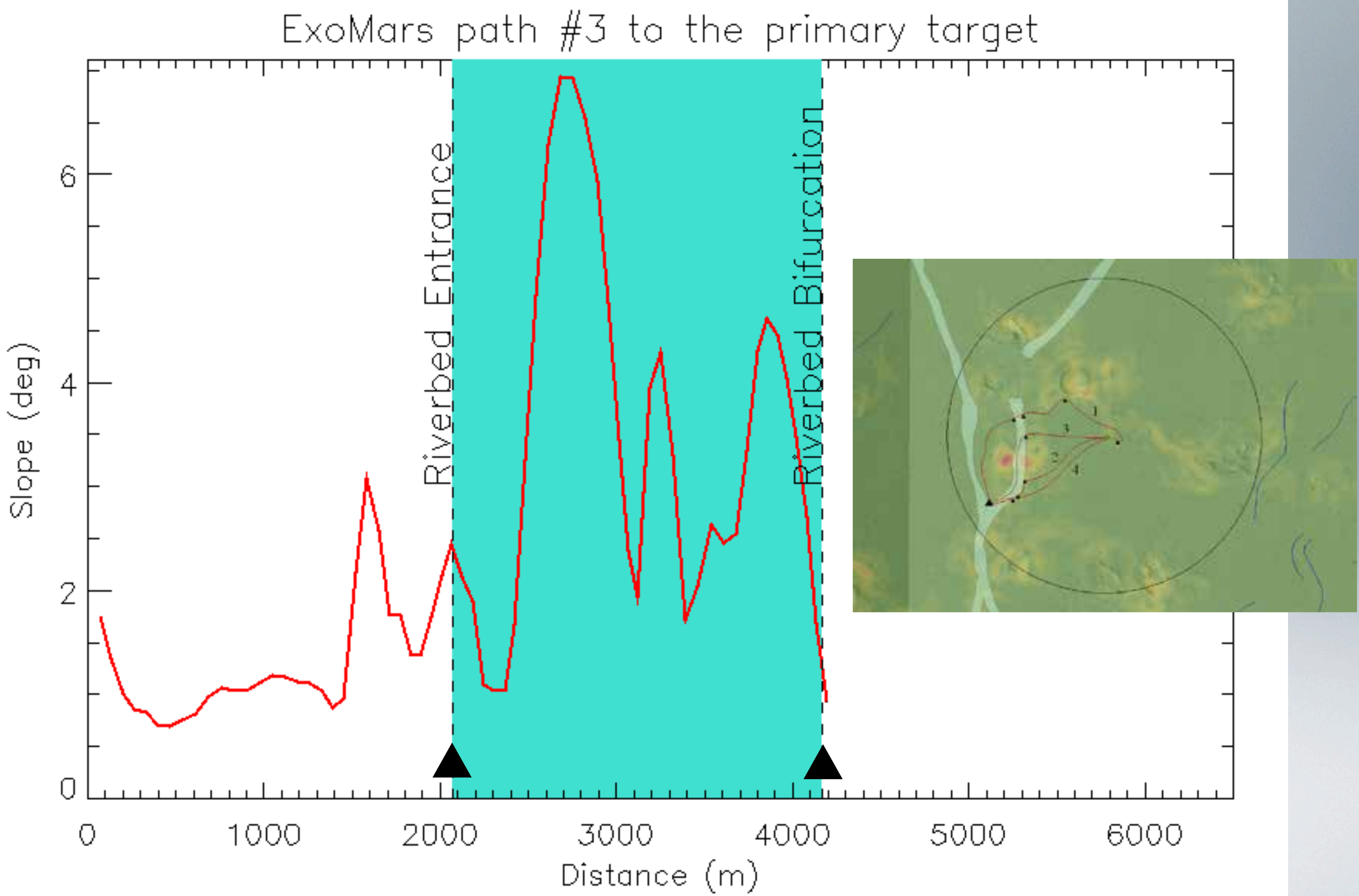
Possible Traverse Paths



The right mix between outcrops surface and riverbed floor

Possible Traverse Paths

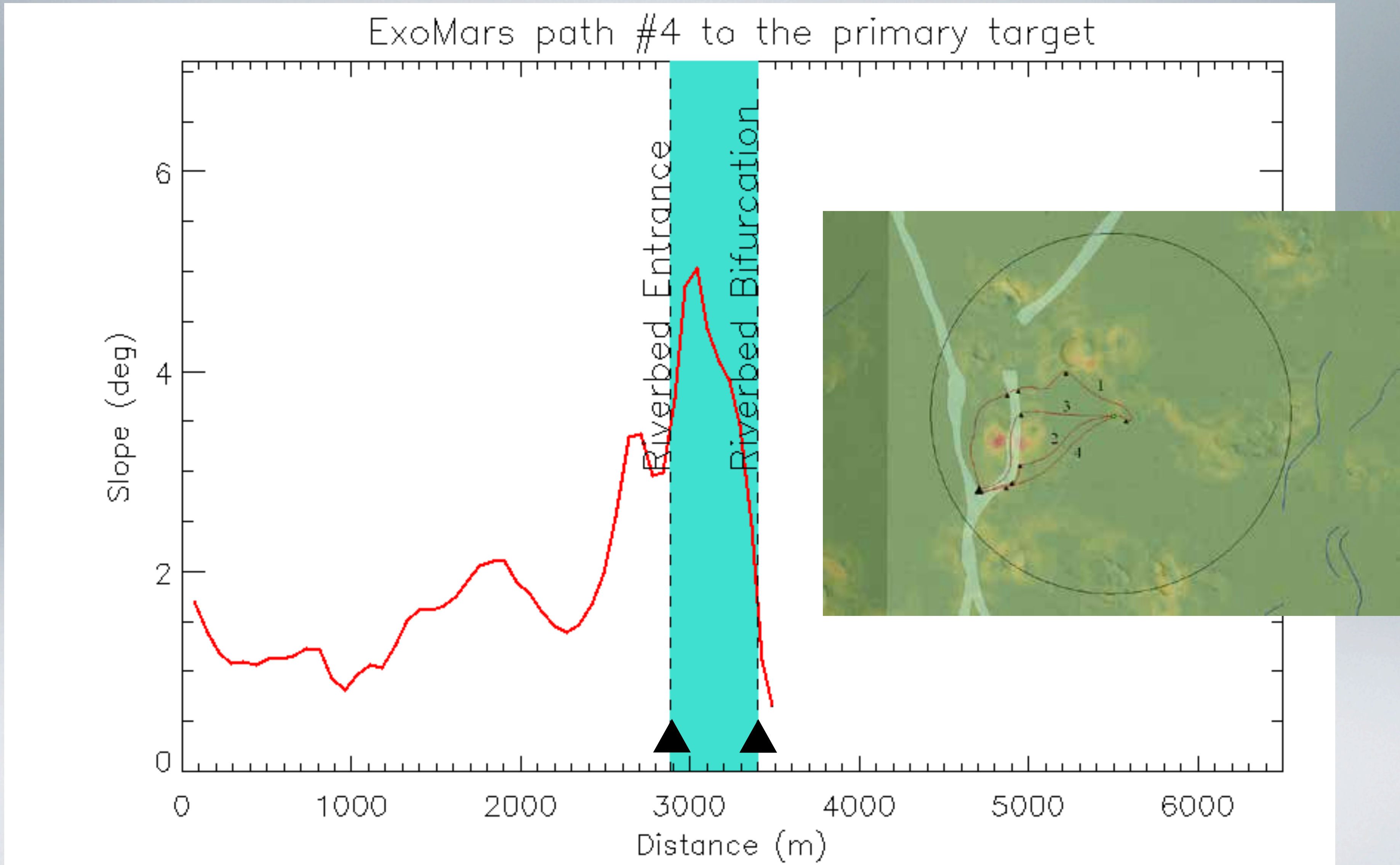
E X O M A R S



Wandering inside the paleoriverbed network

Possible Traverse Paths

EXOMARS



Straight forward to the riverbed bifurcation

Summary 1

EXOMARS

- Our landing site, Simud Vallis Floor, lays at the junction between the Simud/Tiu Valles, two outflow channels carved by water during the Noachian/ Late Hesperian.
- The proposed site experienced a complex geomorphological evolution, including an inversion of the water flux direction.
- Though in the middle of an outflow channel, our ellipse is characterized by fine grained material, thus constituting a possible site where to look for traces of past life.
- Within the ellipse, various outcrops are present; amongst them, closed basin infillings and riverbeds.
- Carbonates, sulphates and hematite were detected in the ellipse and indicate past presence of water in the area.
- Crater counting in the ellipse indicates a Late Hesperian age for the proposed landing site.

Summary 2

EXOMARS

Criterion	Specification	Data Used	SIMUD VALLIS Landing Site
Latitude	5° S to 25° N	MOLA	100% of ellipse is in spec
Elevation	≤ -2 km MOLA	MOLA	100% of ellipse is in spec
Slopes 10 km	≤ 3.0°	MOLA	100% of ellipse is in spec
Slopes 2 km	≤ 3.0°	MOLA	100% of ellipse is in spec
Slopes 330 m	≤ 8.6°	HRSC	99.87% in spec, 0.13% no => 0.13% below 11.5°
Slopes 7 m	≤ 12.5°	CTX Crater Counting	96.46% in spec, 3.54% no
Slopes 2 m	≤ 15.0°	CTX Crater Counting	96.46% in spec, 3.54% no
Rock Abundance	K ≤ 7 %	IRTM-TES	73.80% in spec, 26.20% no => 23.50% with K ≤ 8%
Dust Cover	little dust coverage	TES	100% of ellipse is in spec
Thermal Inertia	≥ 150 $J\ m^{-2}\ s^{-0.5}\ K^{-1}$	TES	100% of ellipse is in spec
Albedo	0.1 ≤ albedo ≤ 0.26	TES	100% of ellipse is in spec
Radar Reflectivity	-15 dB ≤ Ka band radar backscatter cross-section at nadir ≤ 27.5 dB	MARSIS	100% of ellipse is in spec (MARSIS)
Horizontal Wind 1 m - 10 km	≤ 0.25 m/s	GCM	LSSWG presentation
Horizontal Wind 1 m	≤ 0.30 m/s	GCM	LSSWG presentation

THANK YOU

Questions are welcome ☺

THANK YOU!!!