Coogoon Valles

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EXOMARS 2018 LANDING SITE PROPOSAL: COOGOON VALLES

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1) Abstract:

Coogoon Valles is a Mars feature with clear indications of past water activity, including flow channels, scablands, layered sedimentary deposits, craters with fluidized ejecta and high albedo materials of special interest because their associate origin with aqueous solutions.

The proposed landing site ellipse is centered at 16º29´N 23º 28´W (Fig. 1). Coogoon is a new region to explore; practically it is not studied yet, with a low references regarding this place. However there are recent data from last (actual?-ongoing) missions which show their potential as an interesting landing site. Images of particular interest used for the preparation of this proposal were HIRISE PSP_005740_1970, ESP_012214_1970, ESP_011937_1970 and CRISM 0000A3DE, 00008438, 00011725 and 00010FE9. Starting with deeper studies during the preparation phase of the mission in order to get the necessary information for mission's development is mandatory, as for example, the geological mapping needs to be refined during the preparation phase.

The main identified features of interest are the presence of water flow channels over the landing ellipse with special interest in short water flow features within rover distance traverse from the center of the ellipse (Fig. 2). Other remarkable features within 1 km distance range from the center of the ellipse are sedimentary deposits and high albedo materials congruent with the presence of phyllosilicates and polyhydrated sulfates.

2) Suitability of the proposed landing site to address the ExoMars 2018 science objectives—in particular the search for signs of life and ExoMars engineering restrictions but ancient requirements as well.

Proposed site is ancient (older than 3.6 Ga)— Noachian (Phyllosian) following the main requirement of ExoMars mission landing site selection process. Materials of ancient age are clearly identified over the landing ellipse as it is reflected in the appropriate map.

Site shows abundant morphological and mineralogical evidence for long-duration, or frequently reoccurring, aqueous activity, but also sedimentary rock outcrops in different locations of the ellipse were identified. Regular distribution of interesting features over de landing ellipse, as it is summarized on the table below, were located as well. Further studies are needed in order to measure real distance to those different features for final identification of the most proximal easy to reach from the ellipse center. The site has in general little to nothing dust coverage.

In order to unveil the composition of the light toned material that is broadly distributed from the center to the northeast of the ellipse, MRO CRISM hyperspectral images at the northeast were processed (Murchie et al., 2007). Here we show the summary products designed to identify hydroxylated silicates, mafic mineralogy and oxidized iron minerals (as described in Pelkey et al., 2007) for the FRT00008438 cube (NE of the ellipse). CTX images indicate that the geological units and features are easily correlated to those at the center of the ellipse. Those indicate a wide extension of outcropping phyllosilicate bearing material overlapping the light toned deposits. These smectite bearing deposit show a Fe-rich like signature – as in nontronite - with band centers near 1.43 mm and 2.29 mm (Figure 3, profile 3). Those are distributed in the pink colored areas (Figure 3), meanwhile other Al-rich smectites that typically display absorptions at 1.41 mm and 2.21 mm also are identifiable (green patches and Profiles 1 and 2 in Figure 3) (Bishop et al., 2002, 2008; Clark et al., 1990). The iron phyllolisicates distribution is also evident in through OLINDEX (Pelkey et al., 2007; red in Figure 4, left) and the 0.53 mm band depth (also red in Figure 4, right). Polyhydrated sulfates are probably present in the area as well, as is shown in blue color (Fig. 3).

Landing Site's Engineering Constraints are considered and this site doesn´t violates any of mission requirements.

Proposed Site Latitude: 16º29´N clearly included in the appropriate range.
Elevation: -2671 m following ≤ –2 km elevation with respect to the MOLA geoid as requested from the engineering constraints.
Landing Ellipse: 104 km x 19 km aprox.
Landing Ellipse Azimuth: we followed the recommended 88° to 127° (clockwise from the North direction).
Four landing ellipses for the 2018 launch, ellipse azimuth between 90° and 102°, are proposed (in black color) and two for the 2020 (backup) launch, with ellipse azimuth from 113°–127° also prosed, in white color in the image.
The terrain relief and slopes in the proposed landing ellipse, as it is represented in figure 5, follow the recommendations.
≤ 3.0° slopes for length scales 2–10 km.
≤ 8.6° at 330-m length scale.
≤ 12.5° at 7-m length scale.
≤ 15.0° slopes at 2-m length scale.

3) Location information

Several images reflecting topography and landing ellipses location are included. The ellipses are centered at 16º29´N 23º28´W with azimuth following the recommendations of 88° to 127° (clockwise from the North direction). Four landing ellipses for the 2018 launch, ellipse azimuth between 90° and 102°, are proposed (in black color) and two for the 2020 launch, with ellipse azimuth from 113°–127° also proposed in white color in the image.

Site Name	Coogoon Valley
Ellipse pattern centre's latitude, longitude, and size	16º29´N 23º 28´W
Elevation (for centre, max, min)	-2671 m -2595 m -2815 m
Prime science targets	Layered high albedo materials Sedimentary materials Water flow features (channels, scablands)
Distance of prime science targets from ellipse centre	< 1 km
Distance of other science targets from ellipse centre	> 1.5 water flow features (channels)
Overall distribution of science targets in ellipse	In different locations around the ellipse center.
Occurrences of dark streaks	No
Occurrences of RSL	No

4) References.

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Bishop, J.L., Lane, M.D., Dyar, M.D., Brown, A.J., 2008. Reflectance and emission spectroscopy study of four groups of phyllosilicates: smectites, kaolinite-serpentines, chlorites and micas. Clay Miner. 43, 35–54.

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5) Anexes

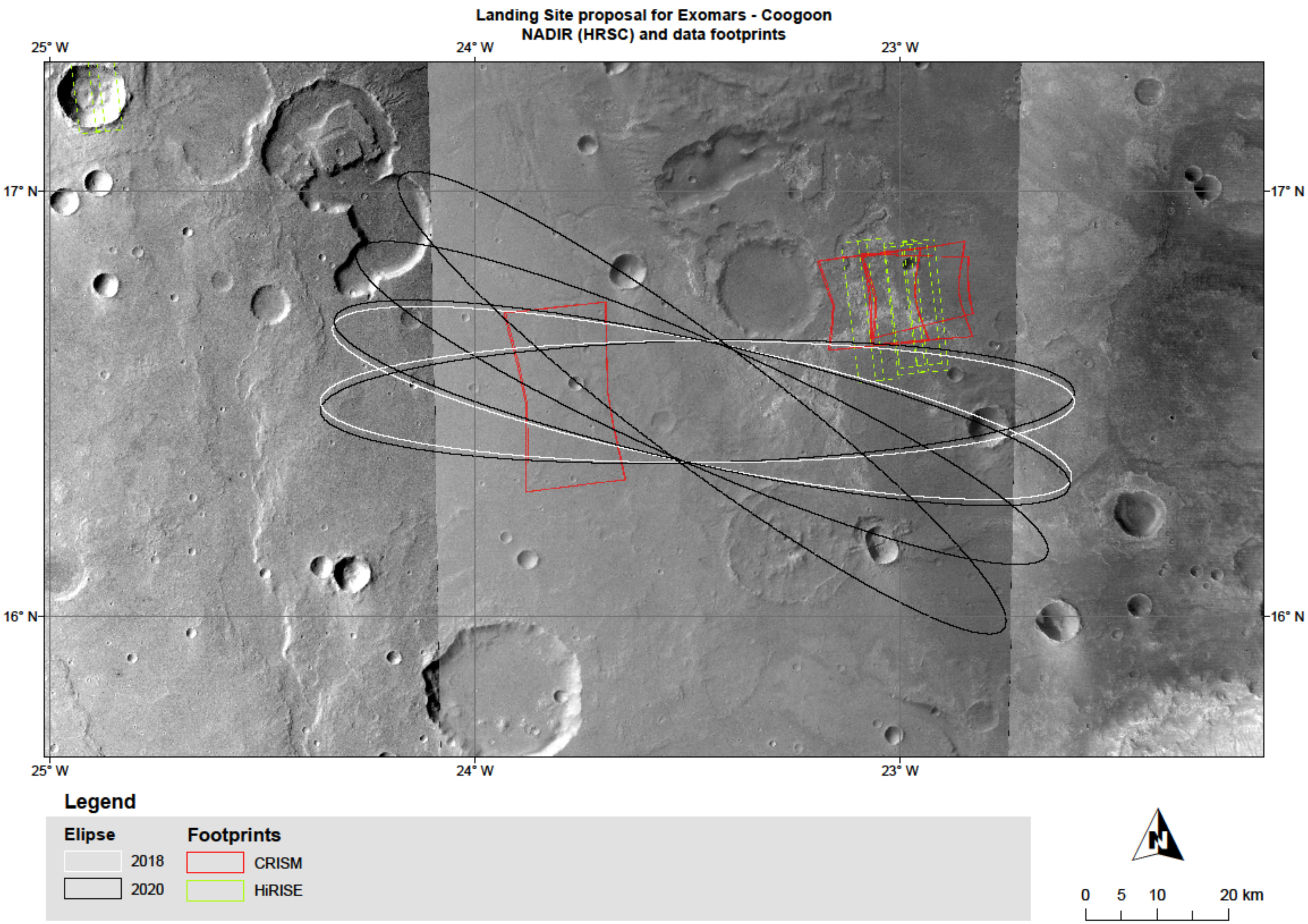


Fig. 1 Landing ellipse location

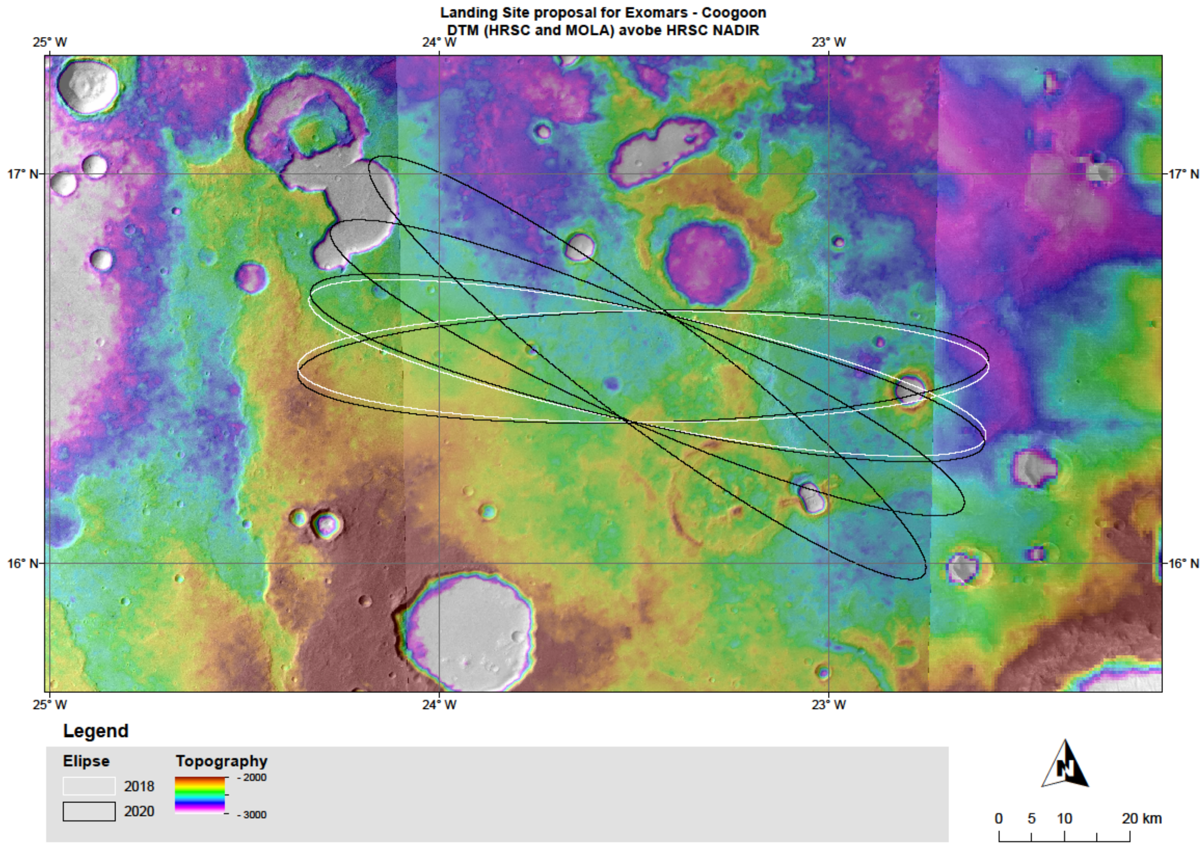


Fig.2: Topography map with proposed landing ellipse location.

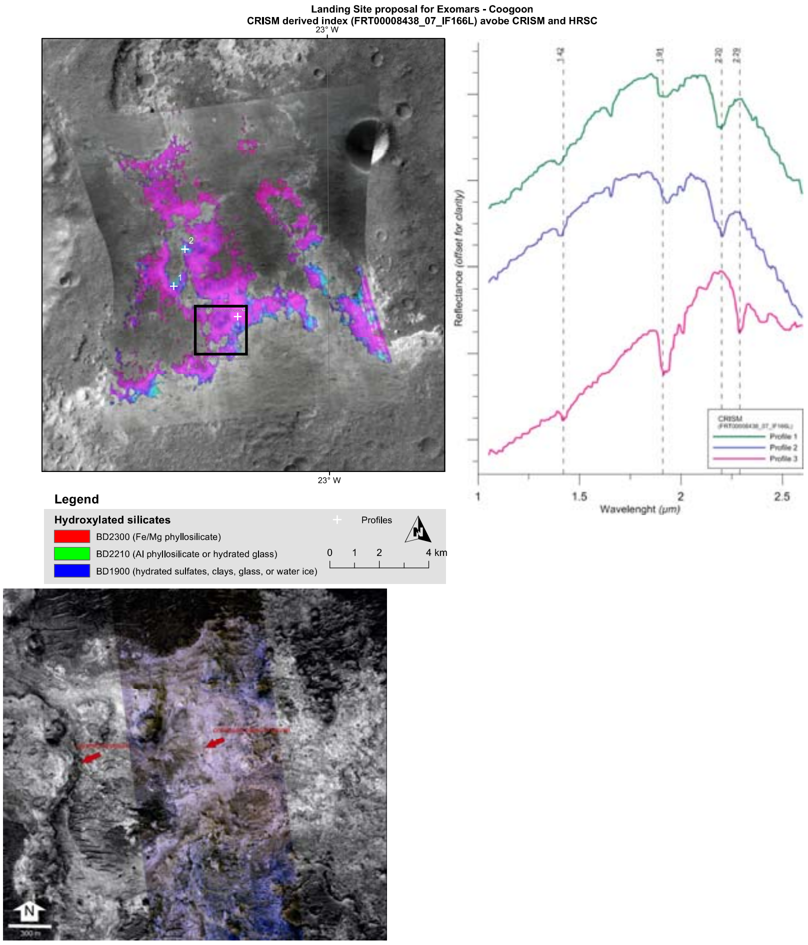


Figure 3: CRISM hyperspectral images. The image on the bottom is a HIRISE image (black square on the image at the top).

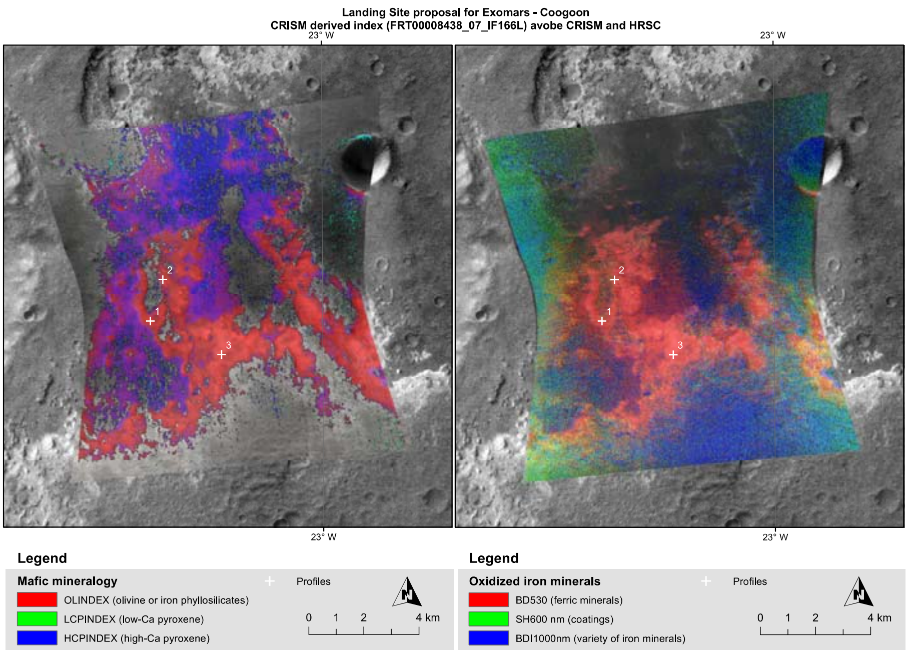


Figure 4: Iron phyllosilicates distribution in site of interest.

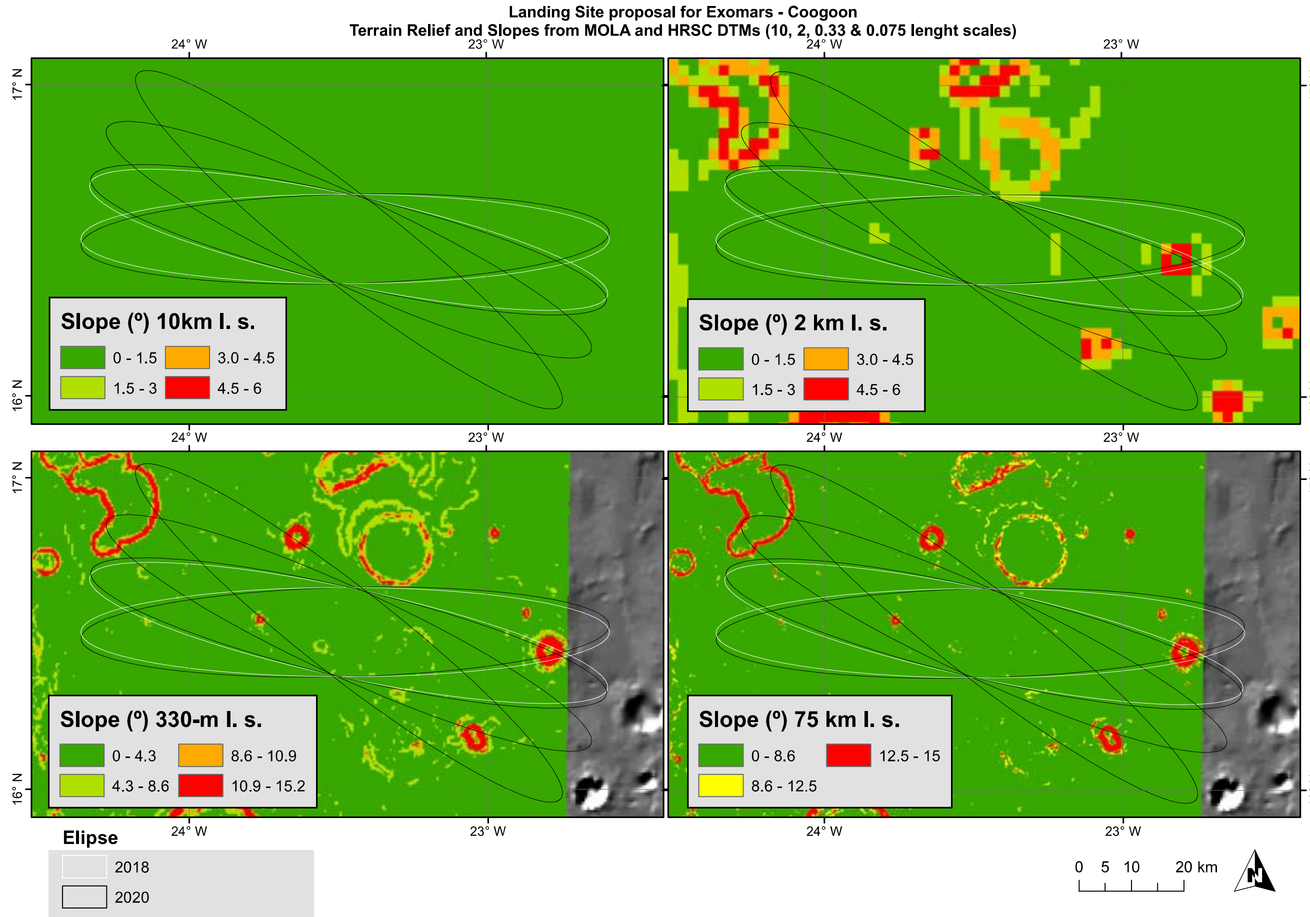
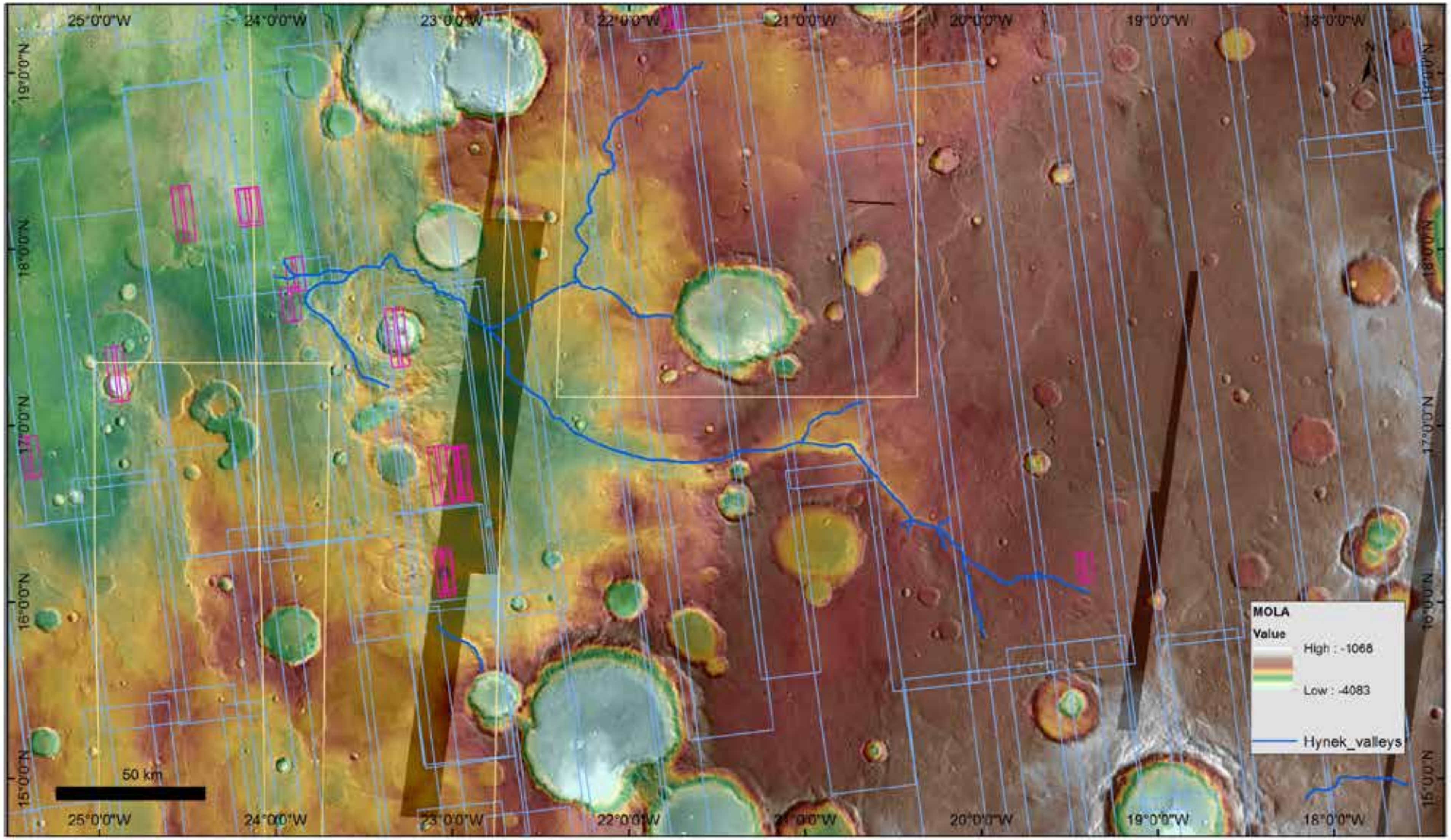


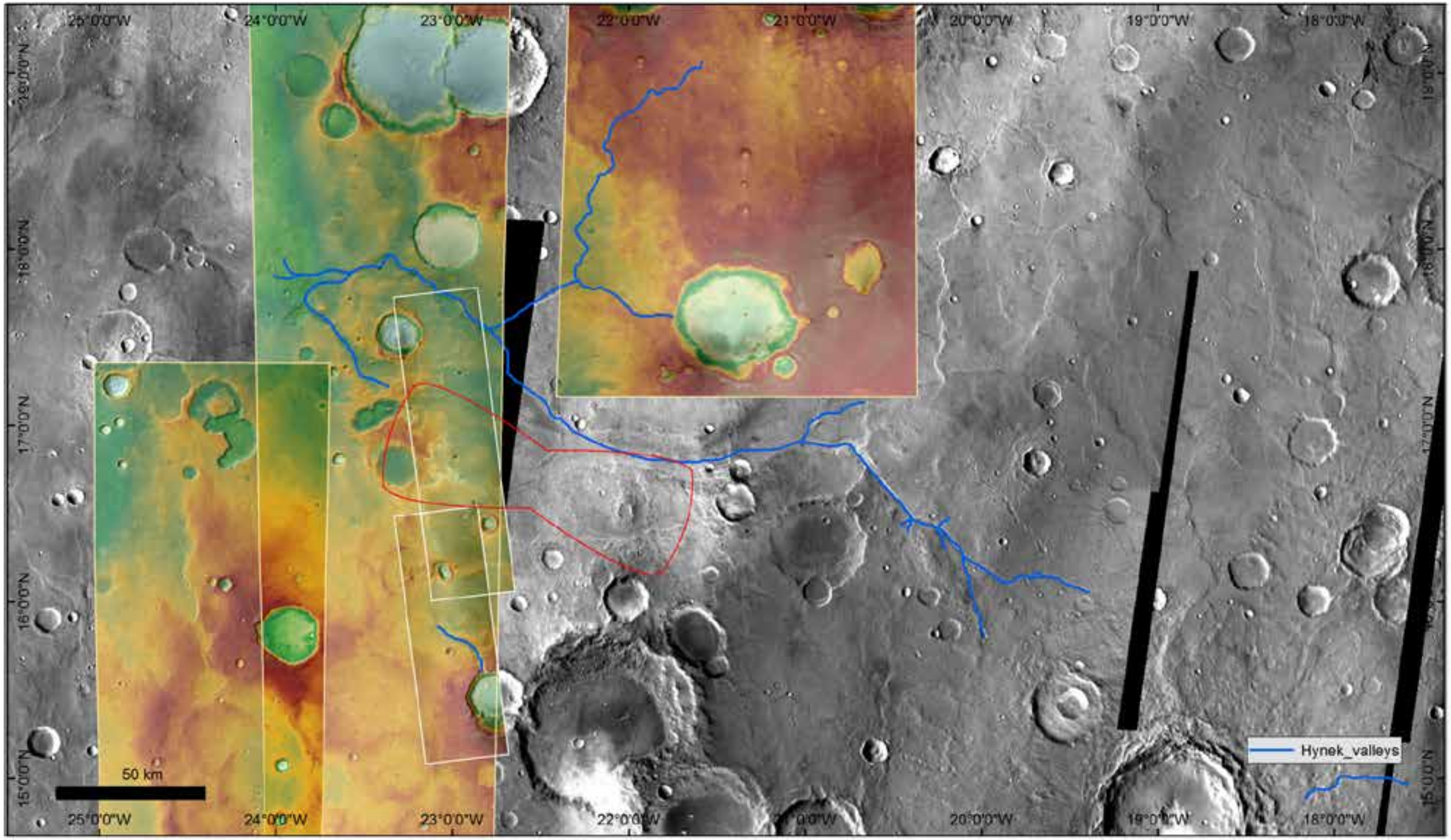
Figure 5: Terrain relief and slopes by scales ranges.

COOGOON VALLES (mate)

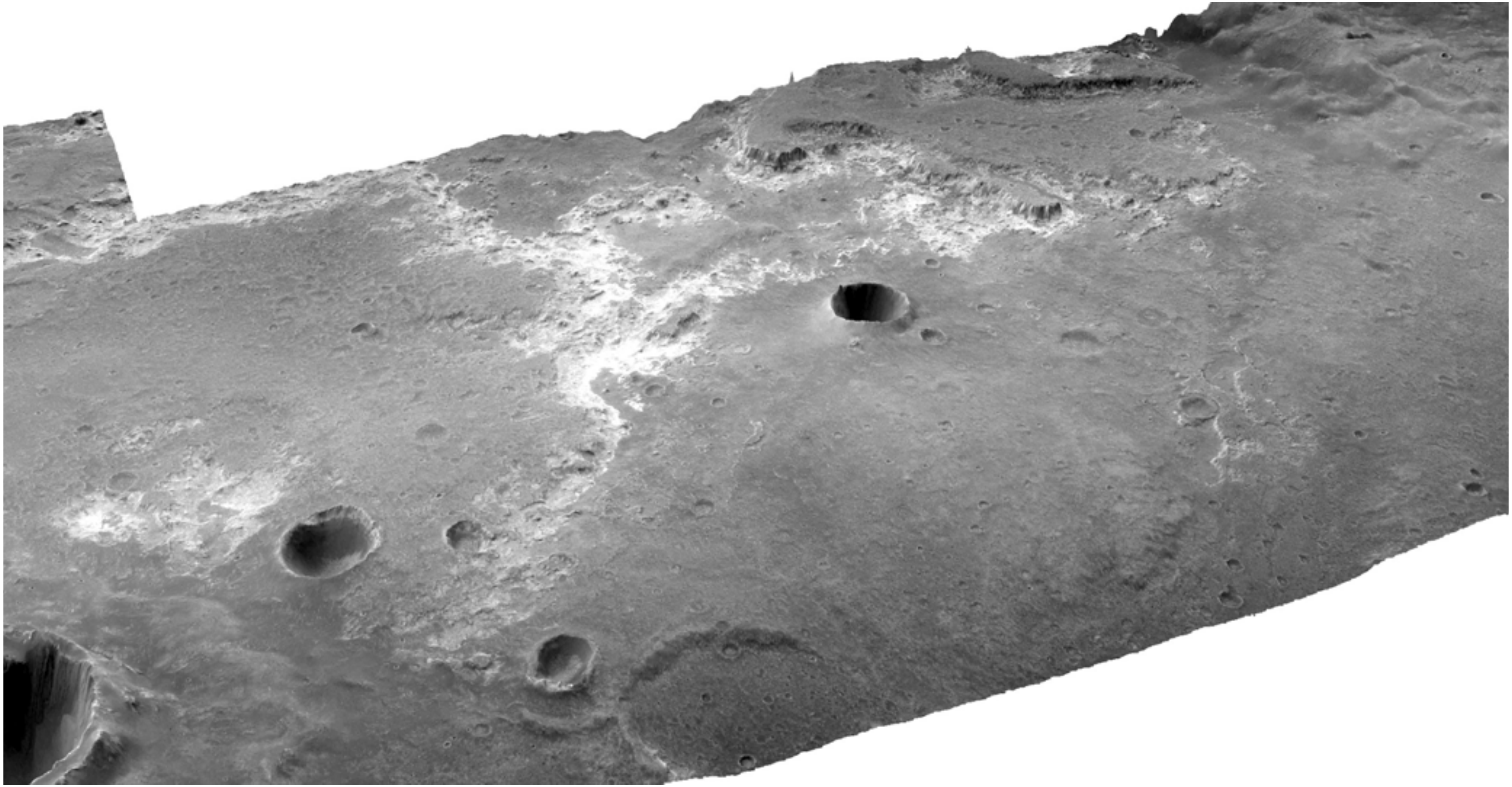
Overview



450 km SW of Mawrth Vallis, so 7 – 8° in latitude.


25°0'0"W
24°0'0"W
23°0'0"W
22°0'0"W
21°0'0"W
20°0'0"W
19°0'0"W
18°0'0"W
18°0'0"N
17°0'0"N
16°0'0"N
15°0'0"N
50 km
Hynek_valleys

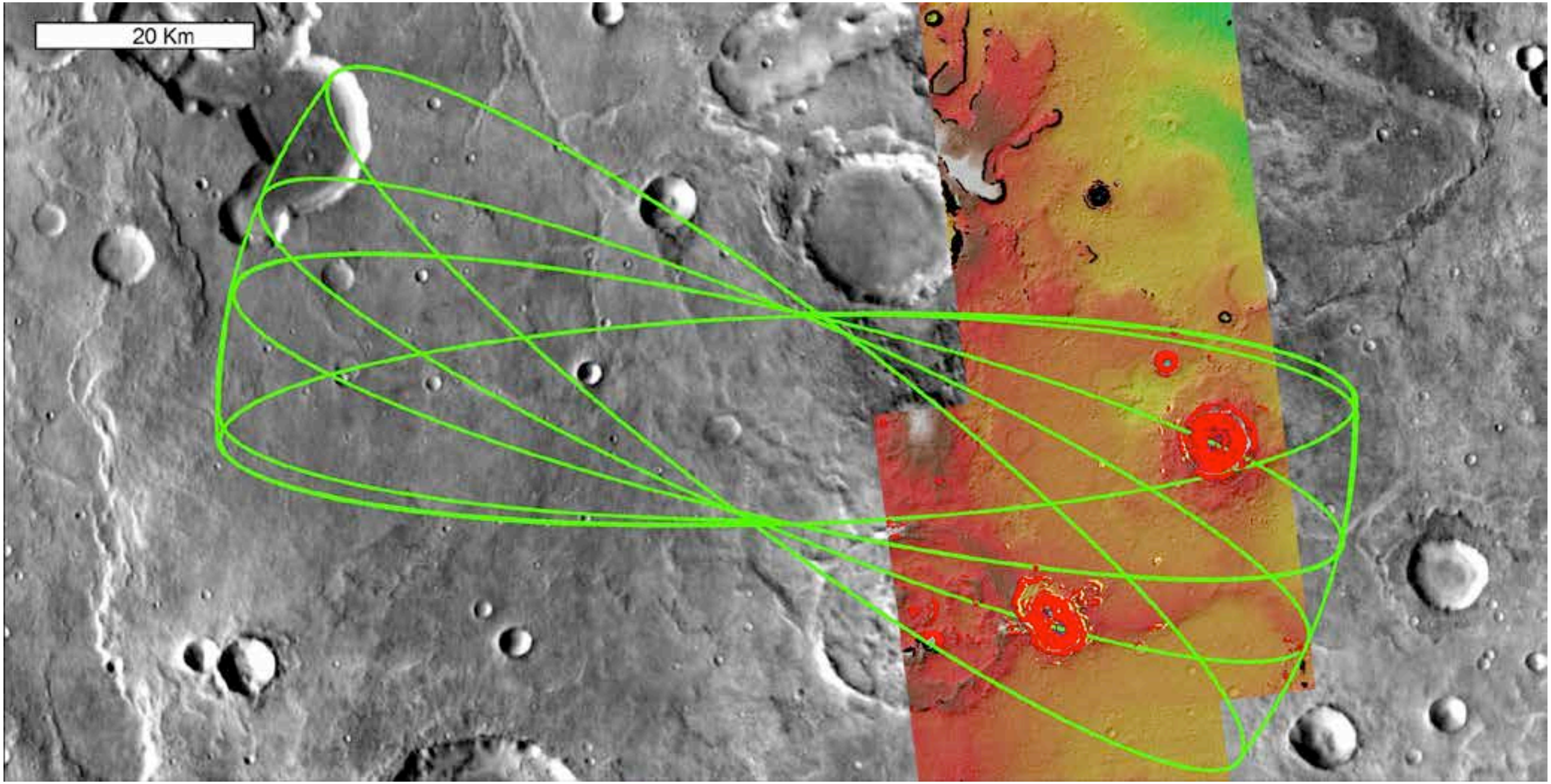
CTX stereo DTMs



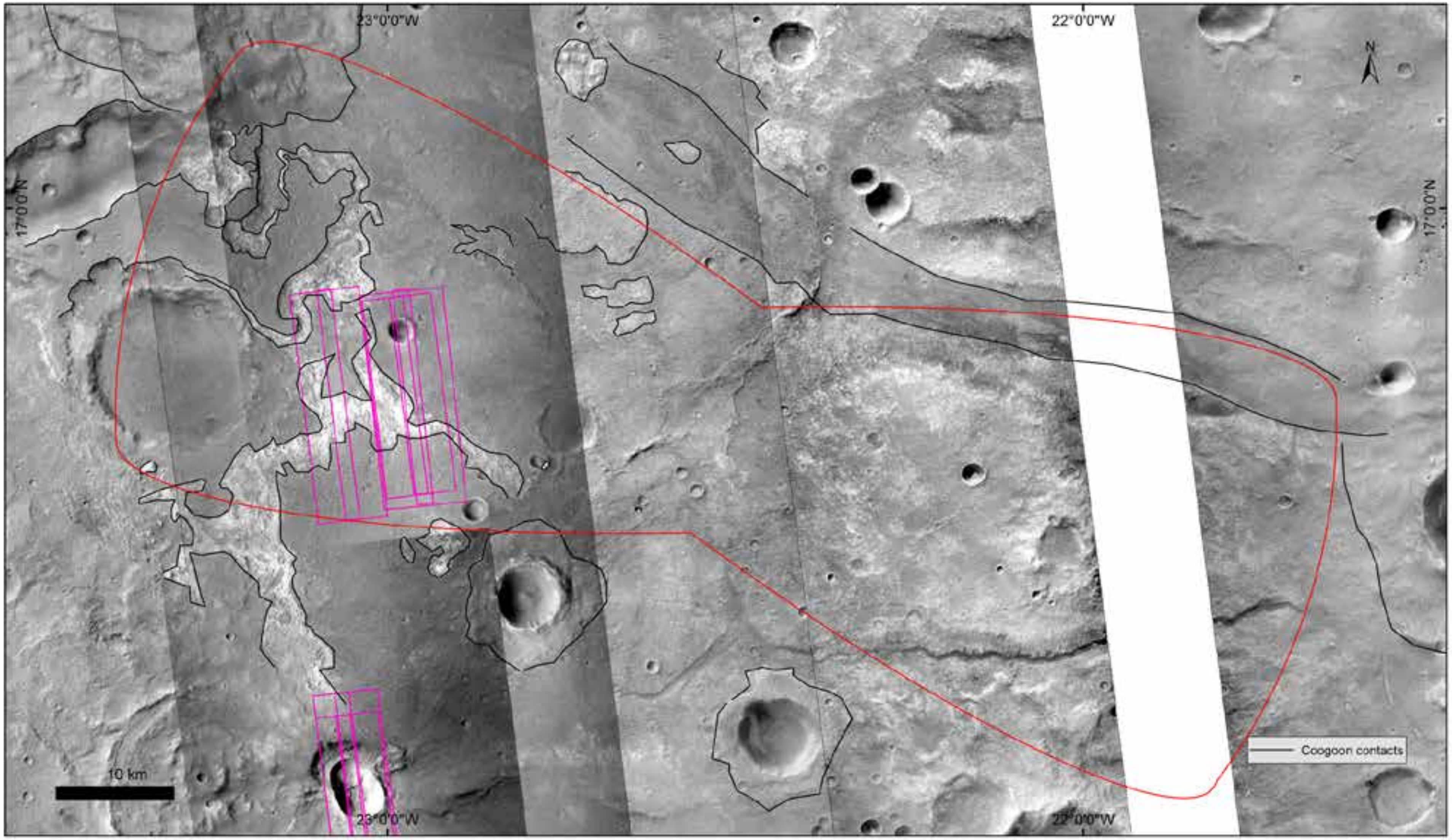
CTX stereo DTMs

Slope constraints

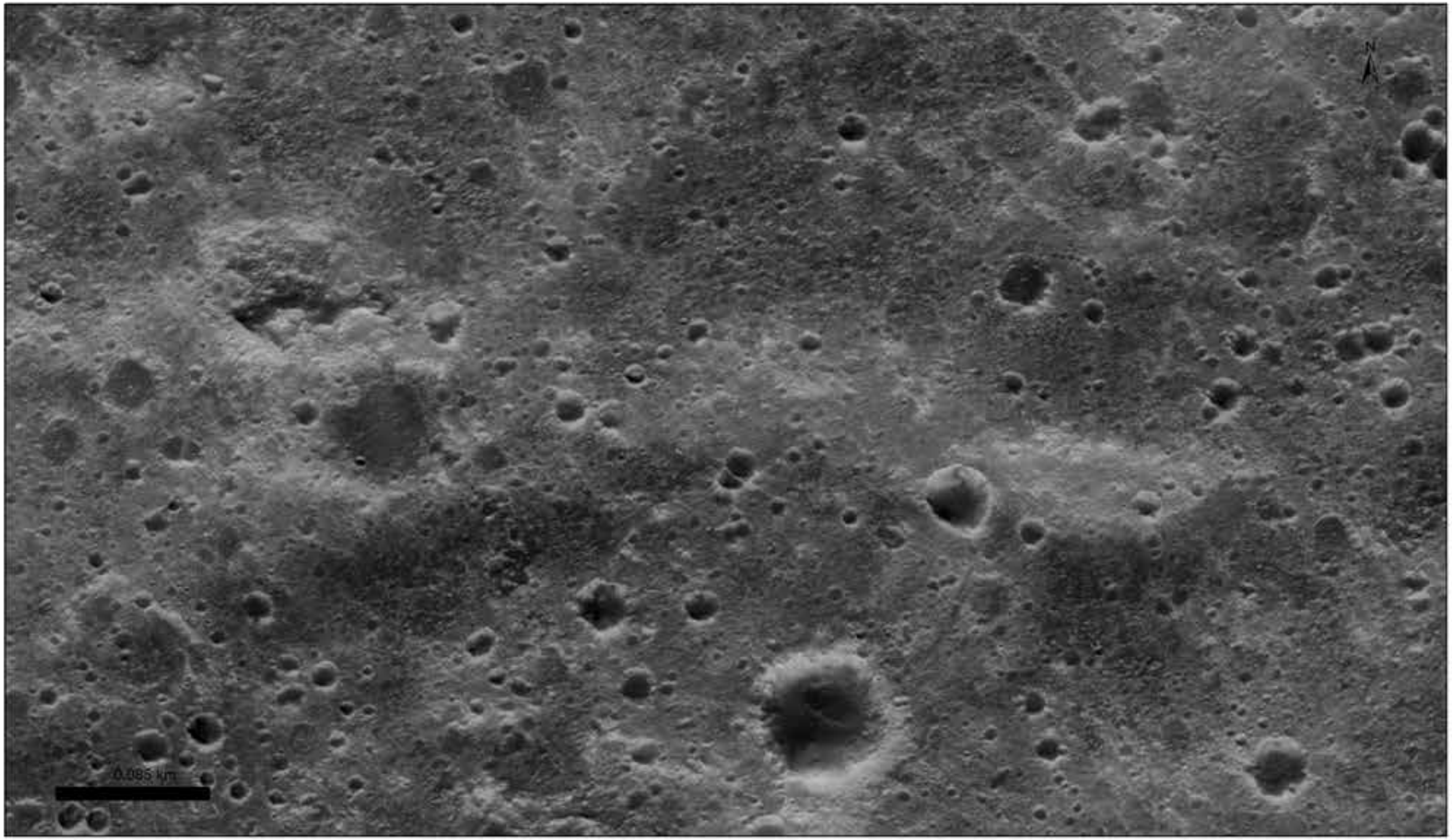
330 m baseline CTX DTM slope (8.6°) 5.7% non-compliant



Ellipse + (rough) contacts

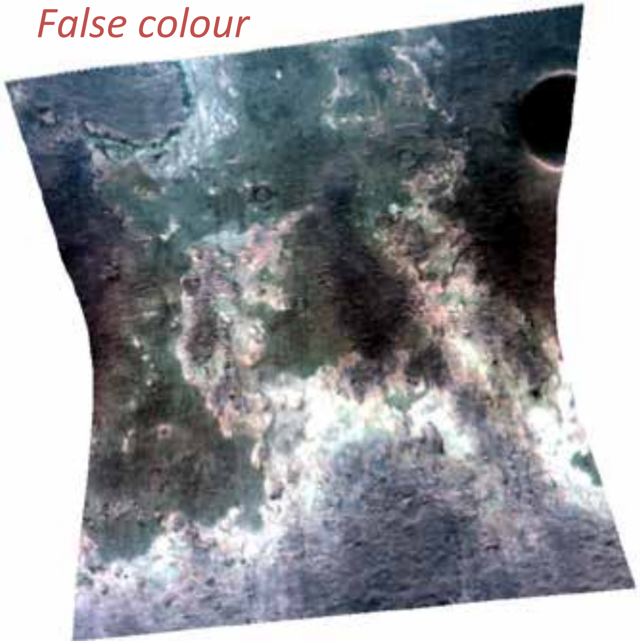


HiRISE e.g. texture

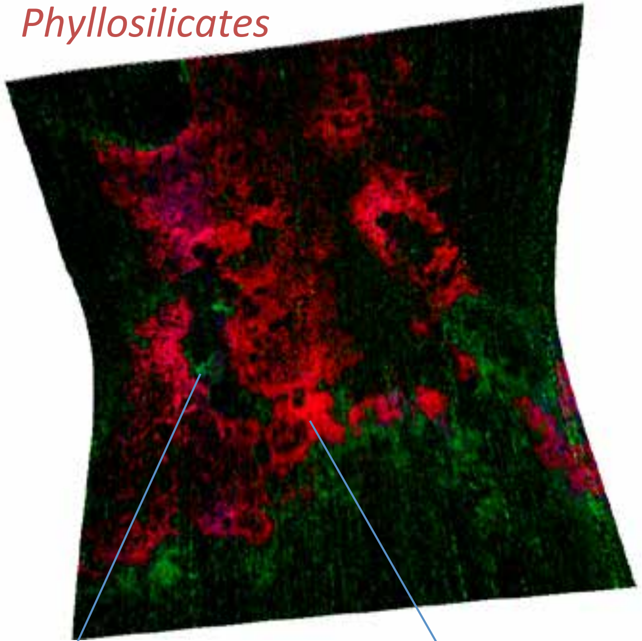


CRISM e.g. mineralogy (FRT00008438)

False colour

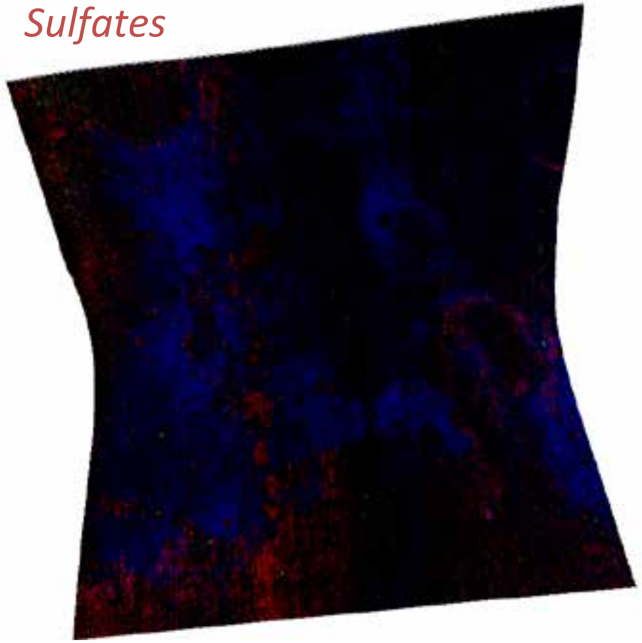


Phyllosilicates

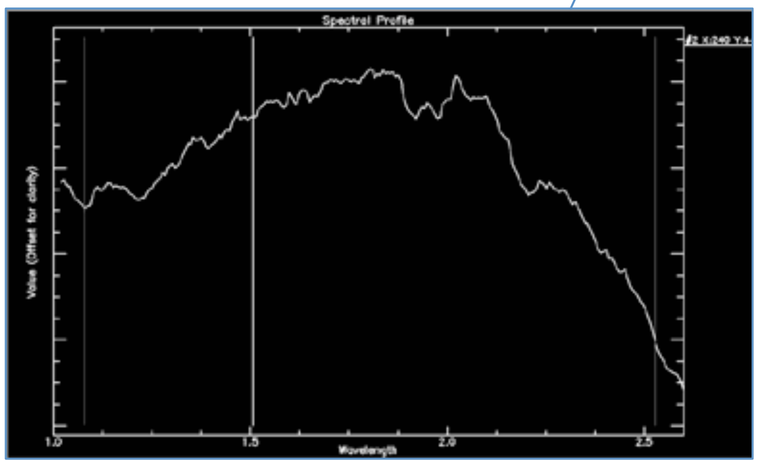


R:2300 G:2210 B:1900

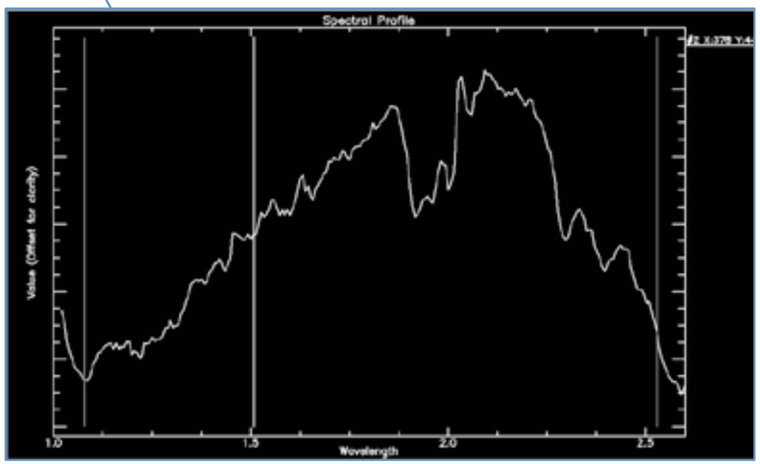
Sulfates



R:SINDEX G:2100 B:1900



2.2 µm
Al phyllosilicates



2.3 and 2.4 µm
Fe-Mg phyllosilicates

How does this area meet the ExoMars science goals?

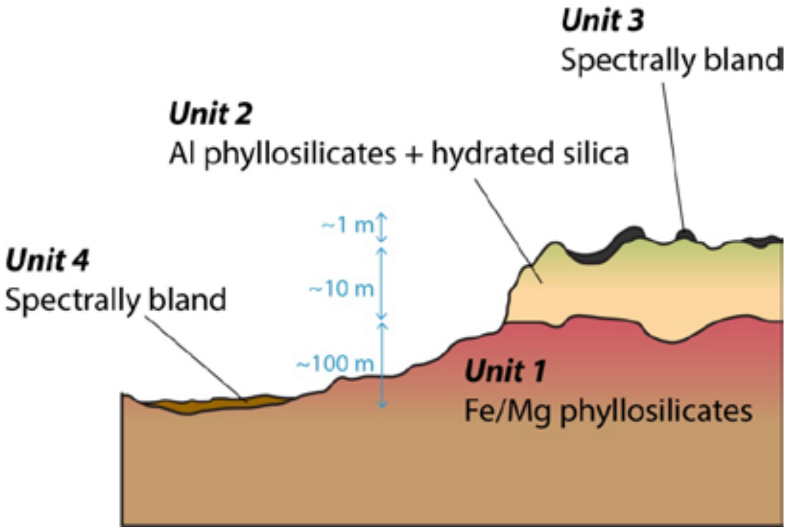
• Are there extensive layers visible, or can extensive layers be inferred?	*Yes*
• Do these layered terrain meet the depositional environment requirements?	*Don't know*
• Are there enough targets inside the ellipses and what is the distribution?	*Poss. not*
• What age ranges are represented within the ellipses?	*N-EH*
• What evidence is there for a high biomarker preservation potential?	*Clays*

What key data are available/missing?

• HRSC DEMs	*Need more*
• HiRISE images	*Need lots more*
• CRISM	*Need more*
• OMEGA	*??*

Are there any publications to support this site?

- Summary of conclusions of publications



- Formation of mineralogy separated from formation of LTDs.

- ***Hypotheses***:
    1. Fluiviolacustrine deposition ☹
    2. Diagenesis ☺
    3. Pedogenesis 😐
    4. Hydrothermal alteration 😐

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Mineralogy and stratigraphy of phyllosilicate-bearing and dark mantling units in the greater Mawrth Vallis/west Arabia Terra area: Constraints on geological origin

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[1] Analyses of MRO/CRISM images of the greater Mawrth Vallis region of Mars affirm the presence of two primary phyllosilicate assemblages throughout a region ~1000 × 1000 km. These two units consist of an Fe/Mg-phyllosilicate assemblage overlain by an Al-phyllosilicate and hydrated silica assemblage. The lower unit contains Fe/Mg-smectites, sometimes combined with one or more of these other Fe/Mg-phyllosilicates: serpentine, chlorite, biotite, and/or vermiculite. It is more than 100 m thick and finely layered at meter scales. The upper unit includes Al-smectite, kaolin group minerals, and hydrated silica. It is tens of meters thick and finely layered as well. A common phyllosilicate stratigraphy and morphology is observed throughout the greater region wherever erosional windows are present. This suggests that the geologic processes forming these units must have occurred on at least a regional scale. Sinuous ridges (interpreted to be inverted channels) and narrow channels cut into the upper clay-bearing unit suggesting that aqueous processes were prevalent after, and possibly during, the deposition of the layered units. We propose that layered units may have been deposited at Mawrth Vallis and then subsequently altered to form the hydrated units. The Fe/Mg-phyllosilicate assemblage is consistent with hydrothermal alteration or pedogenesis of mafic to ultramafic rocks. The Al-phyllosilicate/hydrated silica unit may have formed through alteration of felsic material or via leaching of basaltic material through pedogenic alteration or a mildly acidic environment. These phyllosilicate-bearing units are overlain by a darker, relatively unaltered, and indurated material that has probably experienced a complex geological history.

Citation: Noe Dobrea, E. Z., et al. (2010), Mineralogy and stratigraphy of phyllosilicate-bearing and dark mantling units in the greater Mawrth Vallis/west Arabia Terra area: Constraints on geological origin, *J. Geophys. Res.*, *115*, E00D19, doi:10.1029/2009JE003351.

1. Introduction

[2] One of the largest contiguous exposures of phyllosilicates on Mars occurs on the highland plains around Mawrth Vallis. This exposure is known to extend discontinuously for about 300 km southward from the edge of the dichotomy boundary, covering an area greater than 200 × 300 km over an elevation range of ~2000 m (Figure 1) [e.g., *Poulet et al.*, 2005; *Noe Dobrea and Michalski*, 2006; *Michalski and Noe Dobrea*, 2007; *Loizeau et al.*, 2007]. At least three different types of hydrated phyllosilicates (Fe/Mg- and Al-phyllosilicates), as well as examples of hydrated silica (e.g., hydrated glass), have been identified in OMEGA and CRISM data based on absorption bands near 2.3 and 2.2 μm [e.g., *Poulet et al.*, 2005; *Bishop et al.*, 2008b]. These hydrated units are generally associated with layered, indurated light-toned outcrops with complex spatial and stratigraphic relationships, and are unconformably overlain by a darker, indurated, more heavily cratered unit [*Michalski*

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0148-0227/10/2009JE003351

What are the potential hazards of going here?

- Engineering constraints

  Terrain relief and slopes – not all of ellipse good

- Science goals

  1. The site must be ancient (older than 3.6 Ga)—from Mars' early, habitable period: Pre- to late-Noachian (Phyllosian), possibly extending into the Hesperian;

  2. The site must show abundant morphological and mineralogical evidence for long-duration, or frequently reoccurring, aqueous activity;

  3. The site must include numerous sedimentary rock outcrops;

  4. The outcrops must be distributed over the landing ellipse to ensure that the rover can get to some of them (typical rover traverse range is a few km);

  5. The site must have little dust coverage.

Overall, what are the pros and cons of this site?

Pros: reasonably diverse mineralogy, some sedimentary outcrops, reasonably safe.

Cons: Formation (therefore organics)? Only part of ellipse meets science + safety goals.

Similar to Mawrth, but less well-exposed?

What are the big uncertainties left to be defined – both science and/or safety?

Science: How are mineralogy and geomorphology linked? How did it all form?

Safety: Can ellipse be moved to still include targets but avoid craters?