Landing Site Selection for ExoMars 2020

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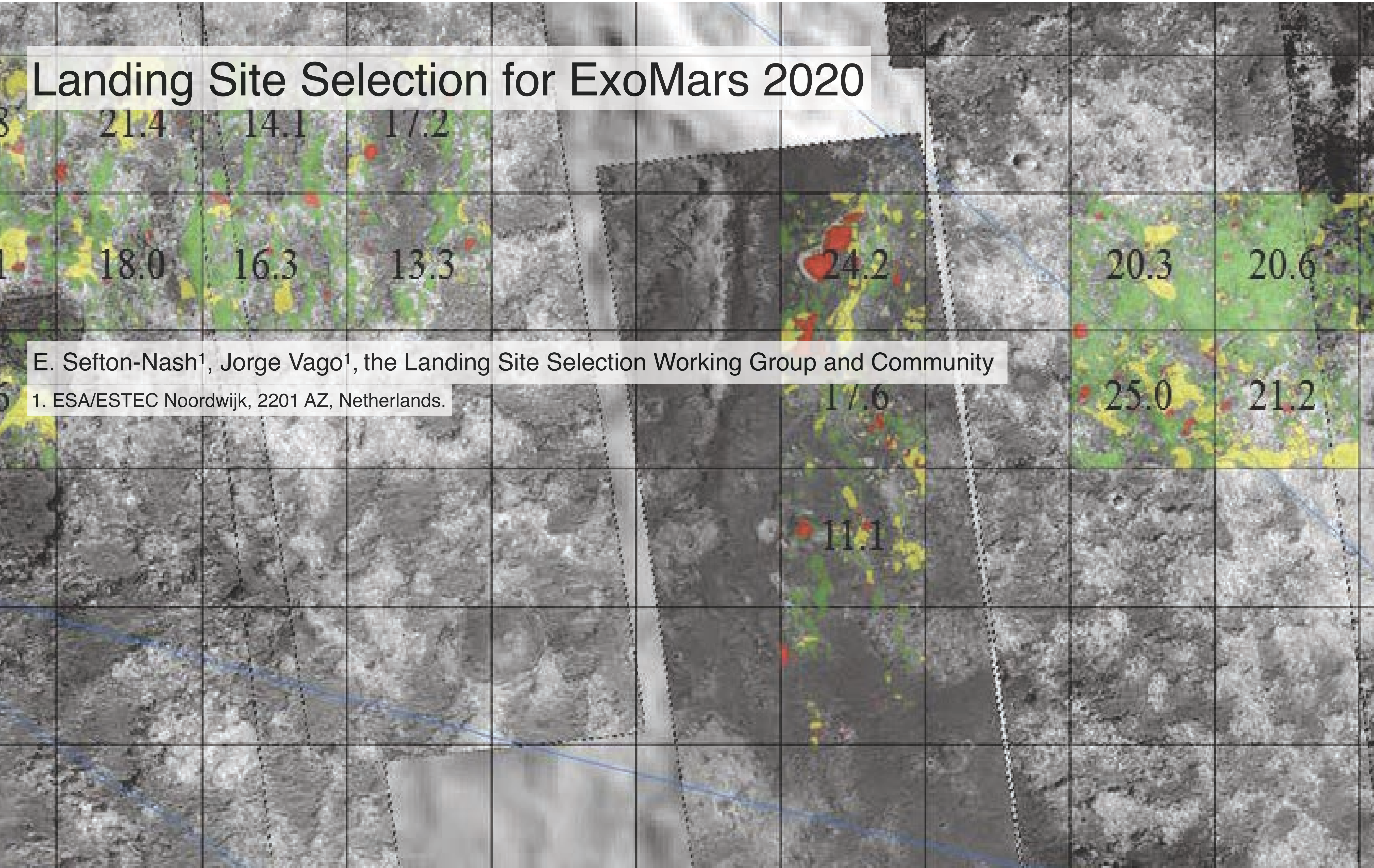
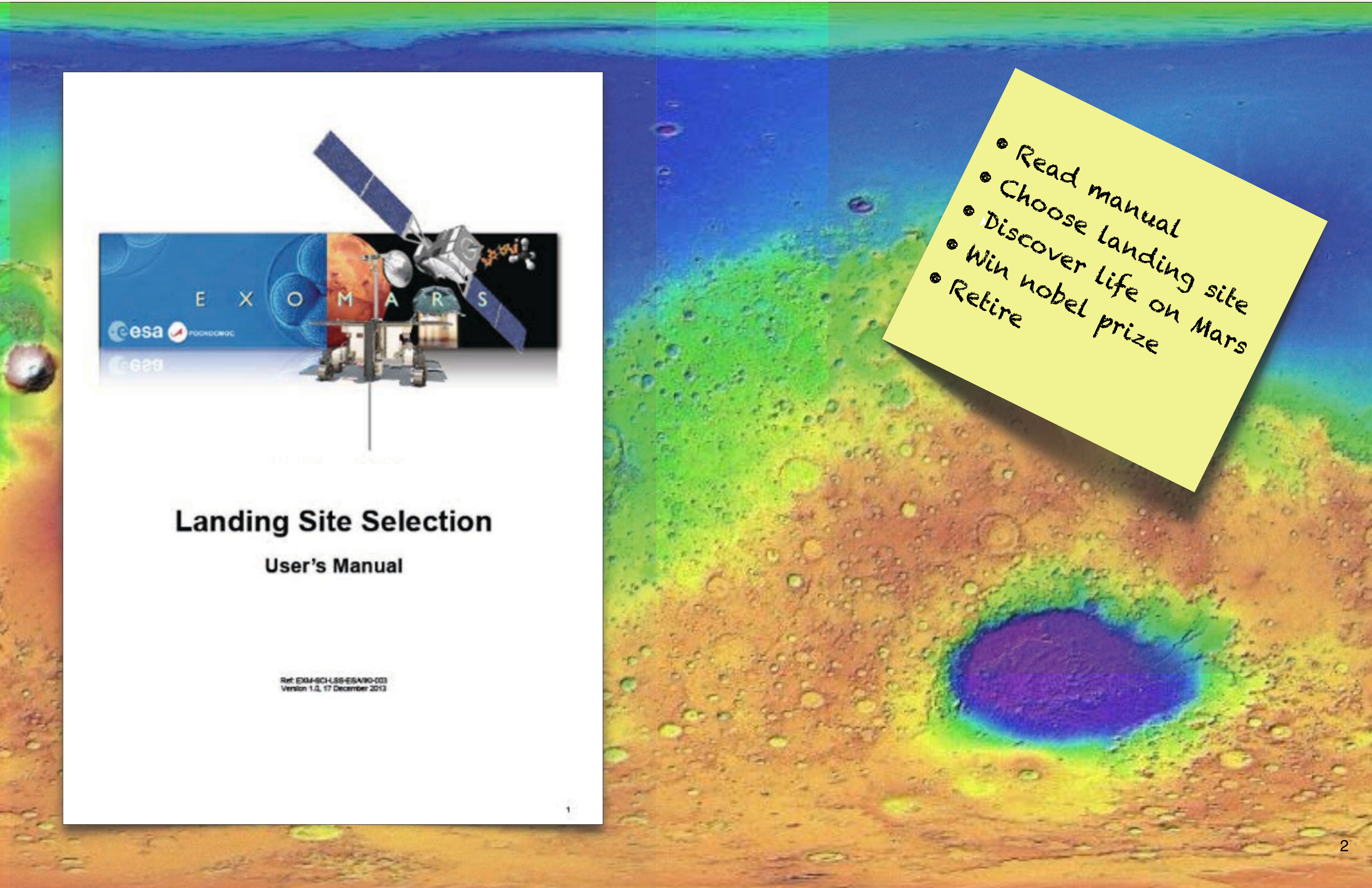
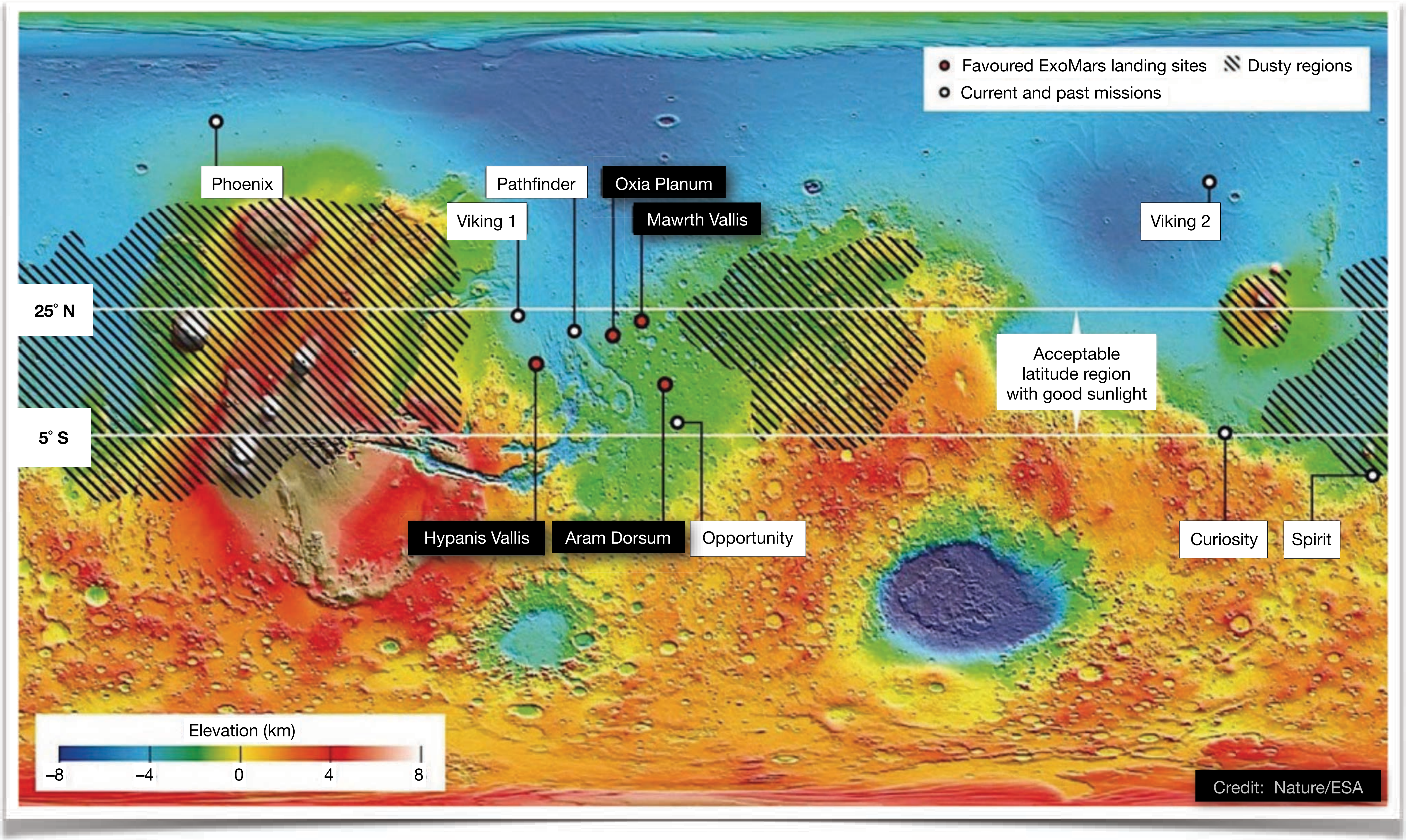


How to choose a landing site



MOLA MEDGR 128 ppd (Smith et al., 2003)

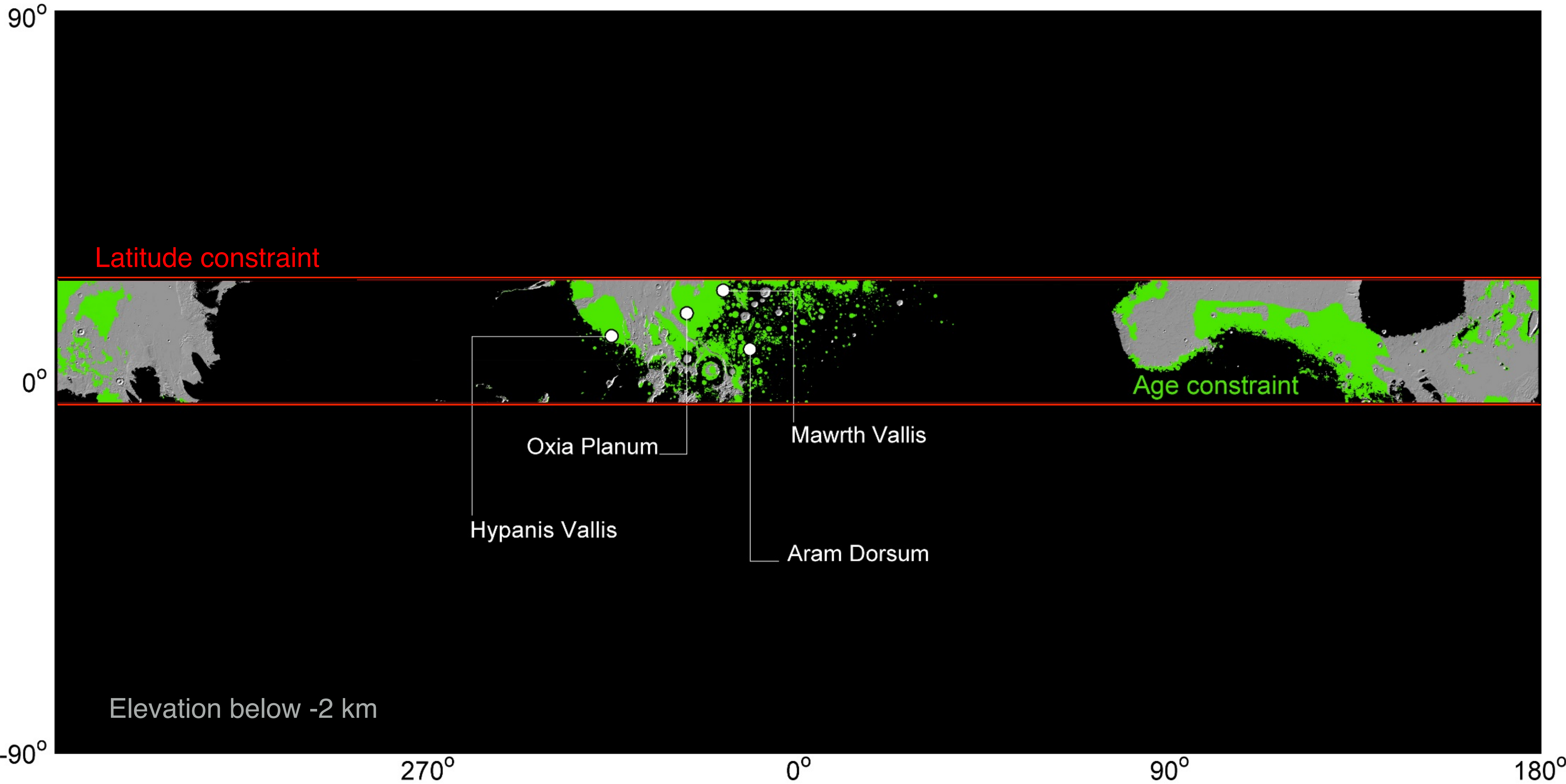
How to actually choose a landing site



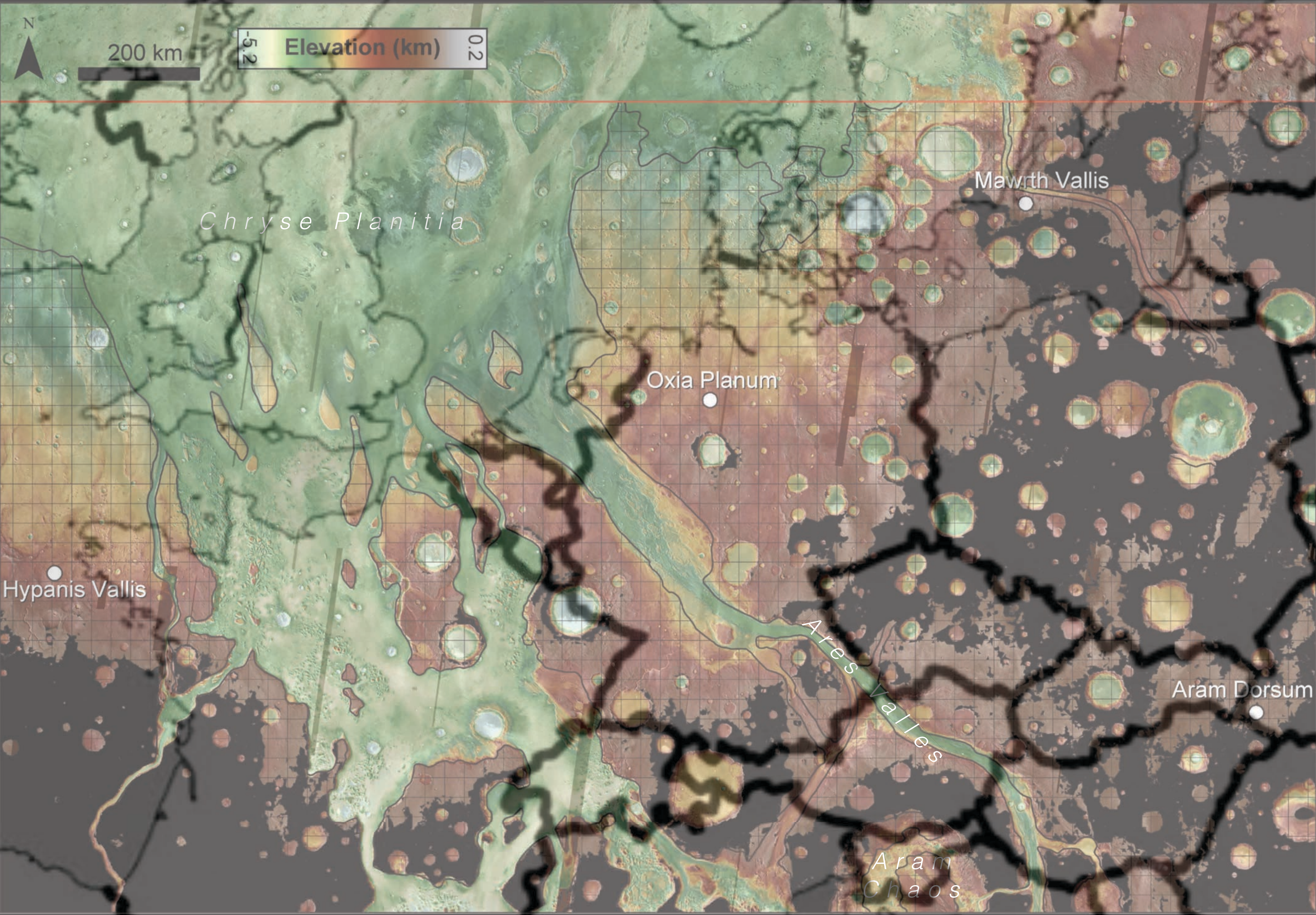
Process of elimination

Science: > 3.6 Ga formation age & 'young' exposure age, (recently exposed by wind erosion), morphological and mineralogical evidence for ancient aqueous activity during Noachian, low dust cover…

Engineering: 5°S ≤ latitude ≤ 25°N, elevation ≤ -2km W.R.T. MOLA areoid, rock abundance (areal extent) ≤ 7%, thermal inertia ≥ 150 J m^{-2} $s^{-0.5}$ K^{-1}, 0.1 ≤ visible albedo ≤ 0.26, slopes ≤ 15° @ 2 m, ≤ 12.5° @ 7 m, ≤ 8.6° @ 330 m & ≤ 3° @ 2 km…



Credit: P. Grindrod/Birkbeck, U. of London



Credit: P. Grindrod/Birkbeck, U. of London

ExoMars 2020 Landing Site Selection Schedule

- **Dec. 2013** — Open call issued to science community for landing site proposals.

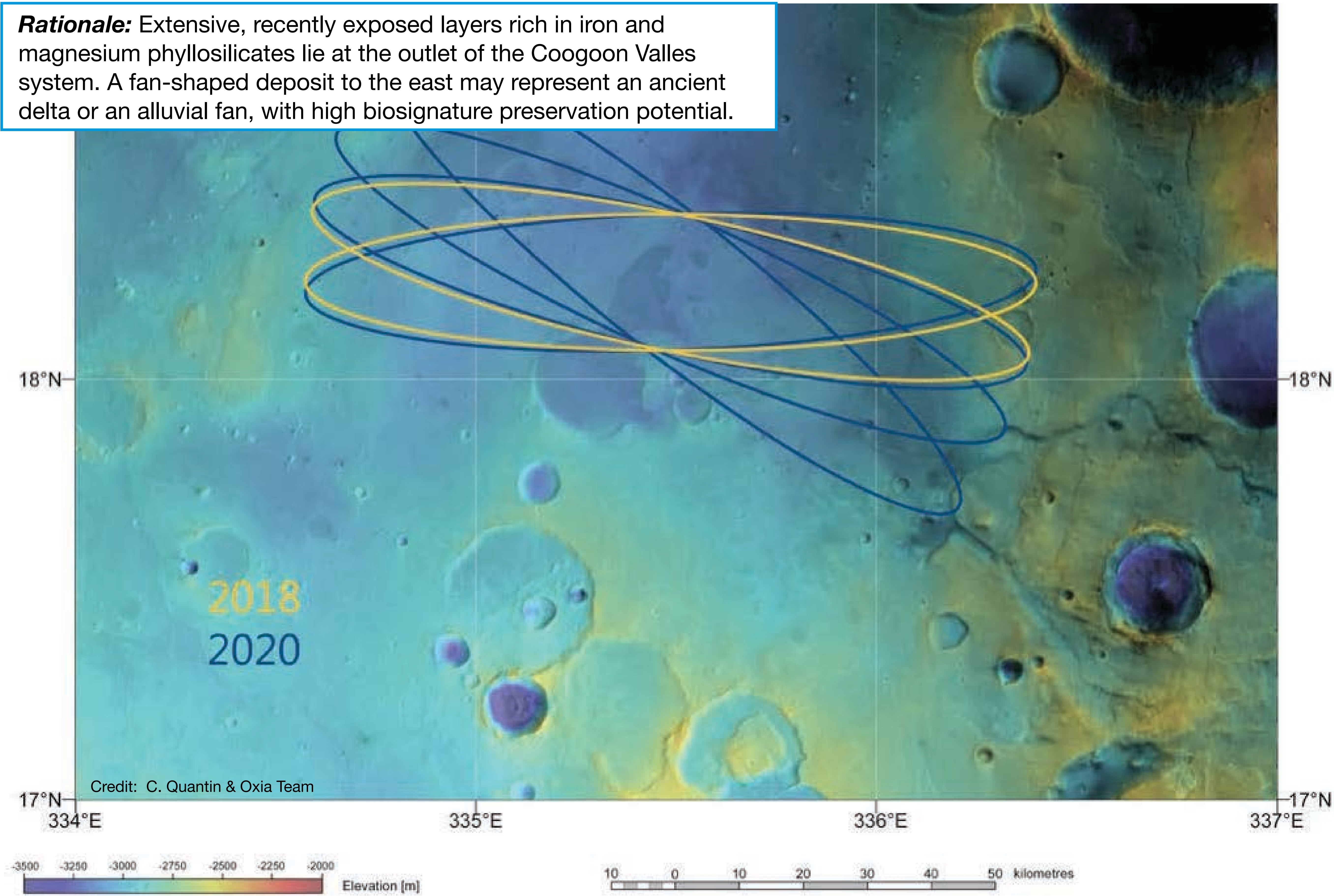
  Included "Landing Site User's Manual", specifying science and engineering requirements.

- **Feb. 2014** — 8 proposals received.
- **Mar. 2014** — Landing Site Selection Workshop (LSSW) #1: Proposing teams invited to present sites to LSSWG and community.
- **Oct. 2014** — Outcome of LSSW#1 announced: down-selection from 8 to 4 sites (Aram Dorsum, Hypanis Vallis, Oxia Planum and Mawrth Vallis).
- **Dec. 2014** — LSSW#2: Presentation of new work by science and engineering teams. All 4 sites retained for further study.
- **Oct. 2015** — LSSW#3: Down-selection from 4 to 3 candidate sites. One site selected for "certification" (detailed terrain characterisation and Entry-Descent Landing [EDL] analysis).
- **Mar. 2017** — LSSW#4: 3 sites presented in detail. One additional site selected for certification.
- **Before ~mid-2019** — Primary site will be selected from the 2 certified sites.

Credit: P. Grindrod/Birkbeck, U. of London

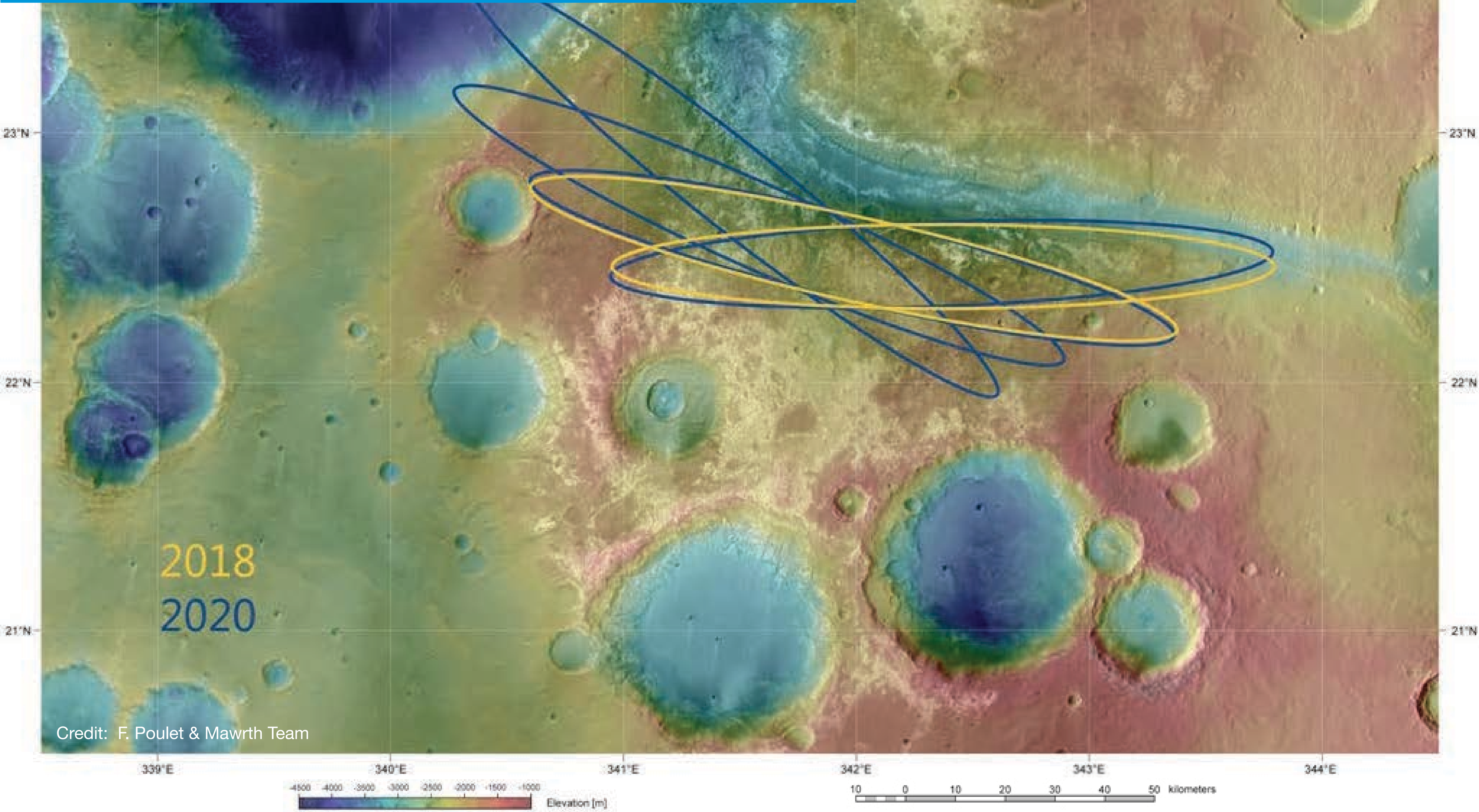
Oxia Planum (18°N, 336°E)

Rationale: Extensive, recently exposed layers rich in iron and magnesium phyllosilicates lie at the outlet of the Coogoon Valles system. A fan-shaped deposit to the east may represent an ancient delta or an alluvial fan, with high biosignature preservation potential.



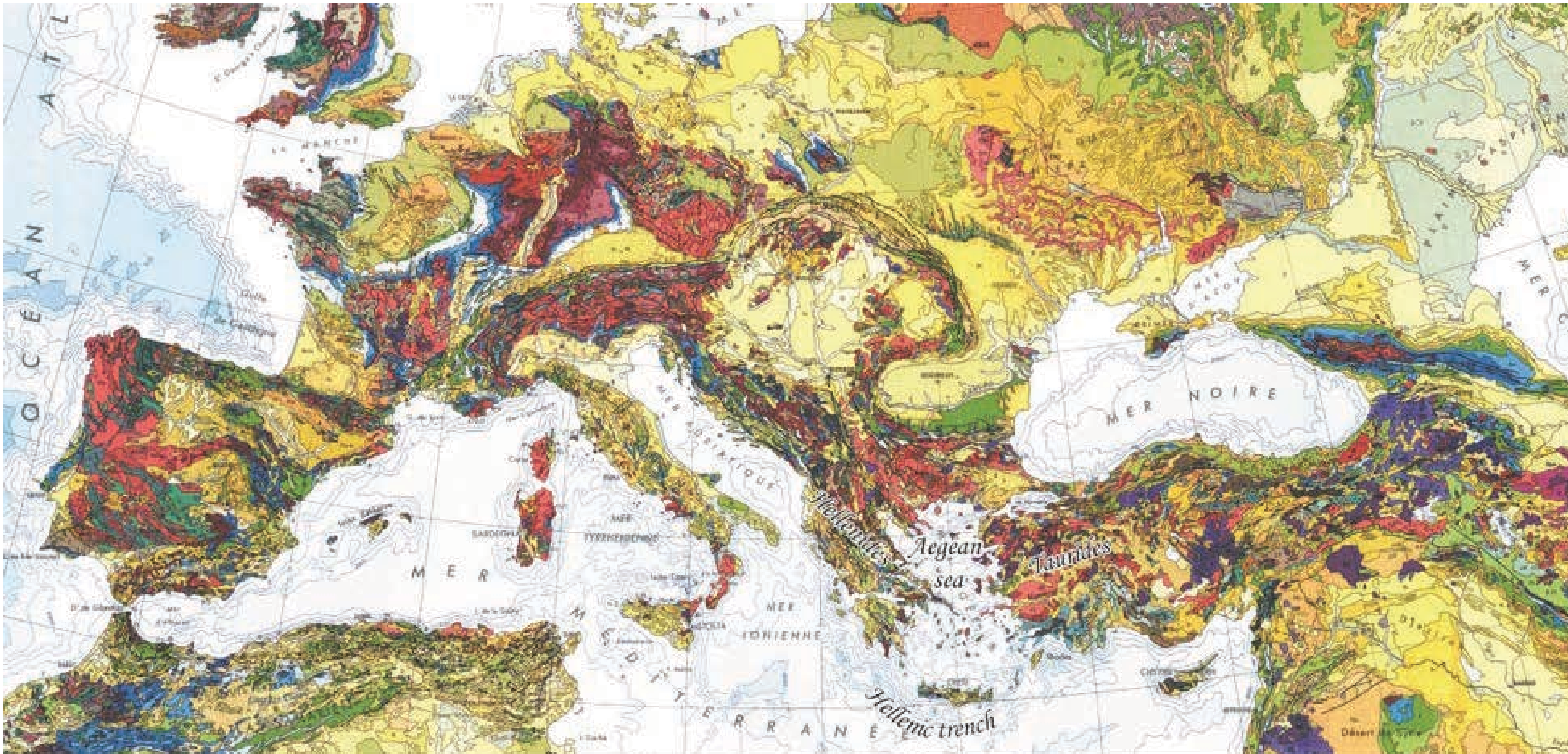
Mawrth Vallis (22°N, 342°E)

Rationale: Deposits south of Mawrth Vallis channel are some of the most extensive layered clay-rich deposits on Mars. Water-altered mineralogy is compositionally stratified and probably records a long and multi-episodic aqueous history laid down under different environmental epochs on early Mars.

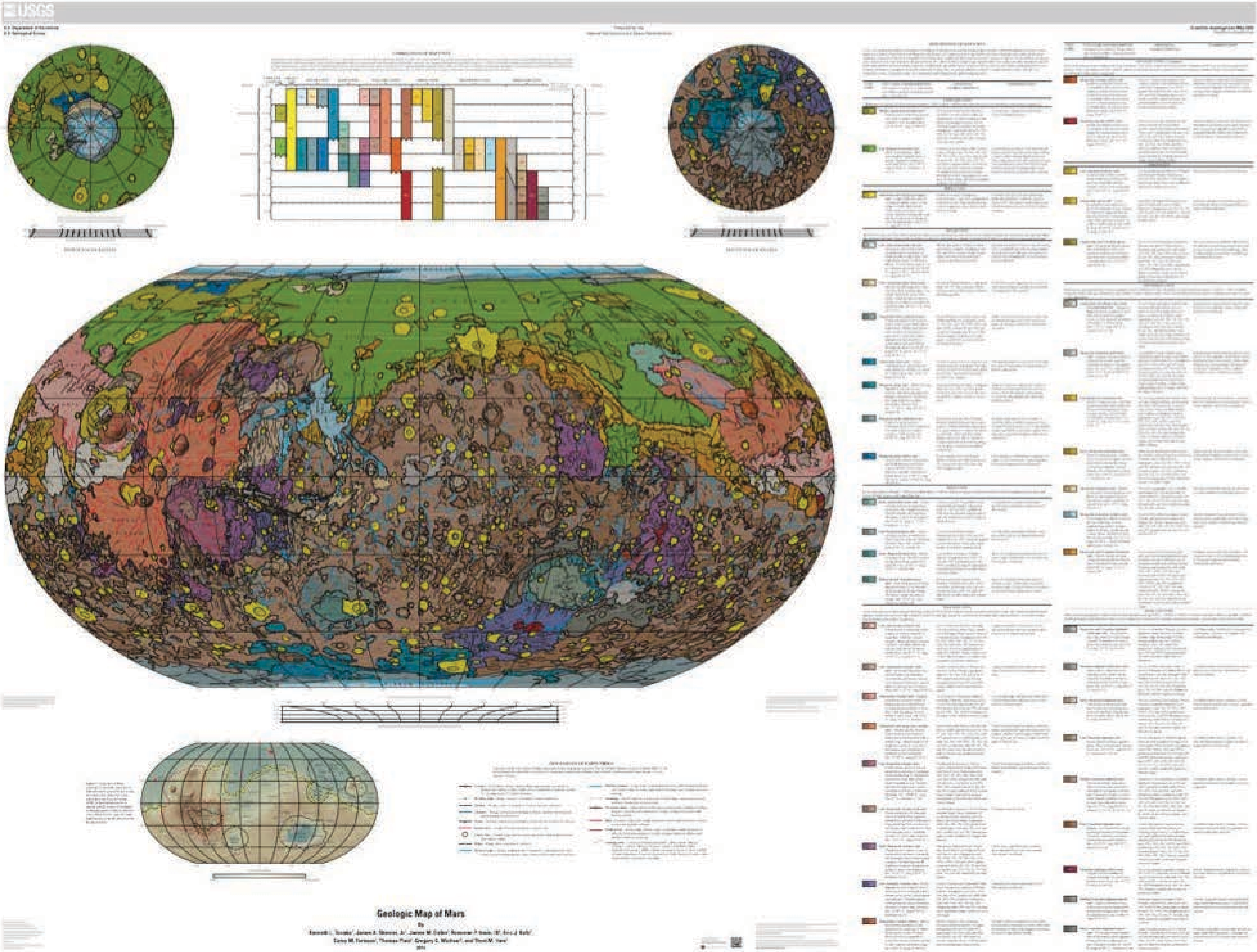


Planetary Geology from Remote Sensing

Geologic Mapping

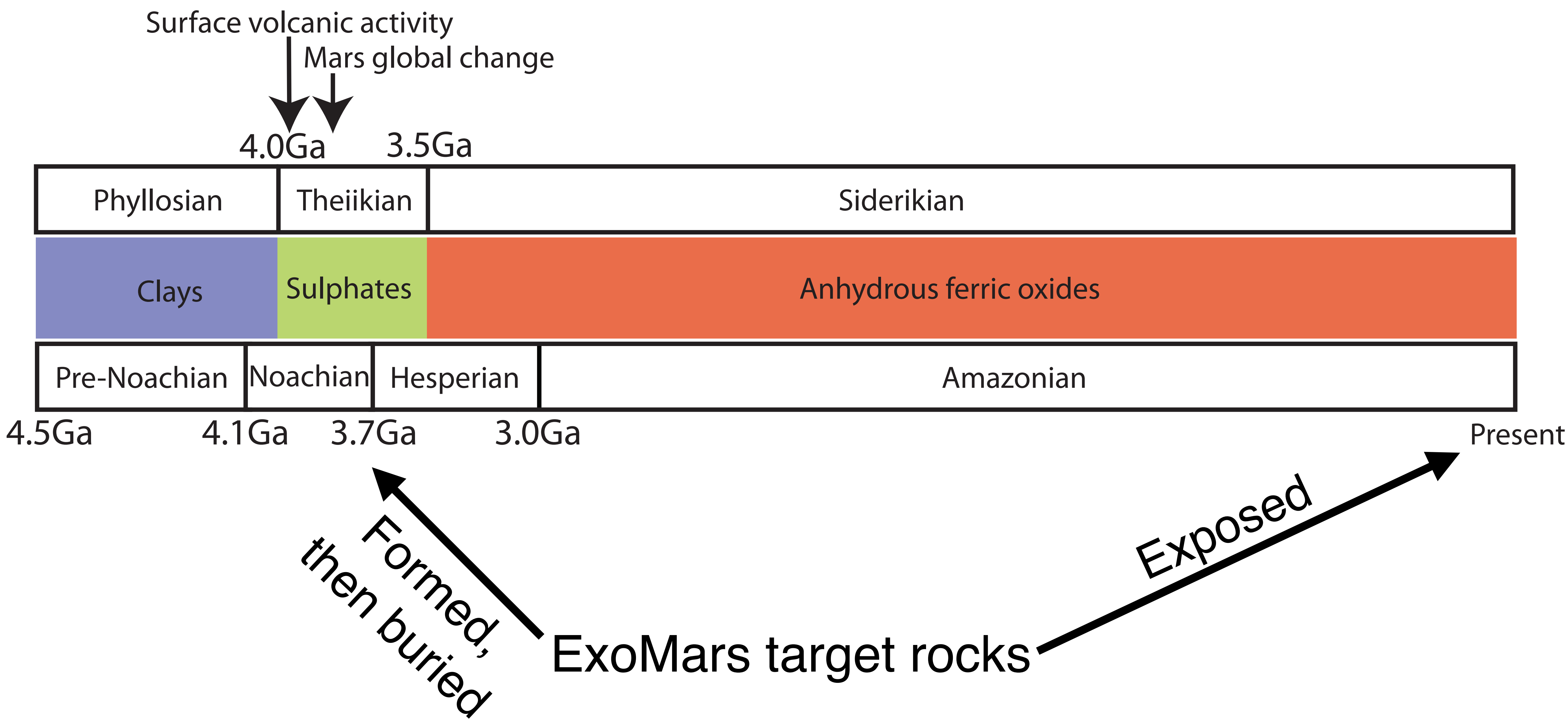


virtualexplorer.com



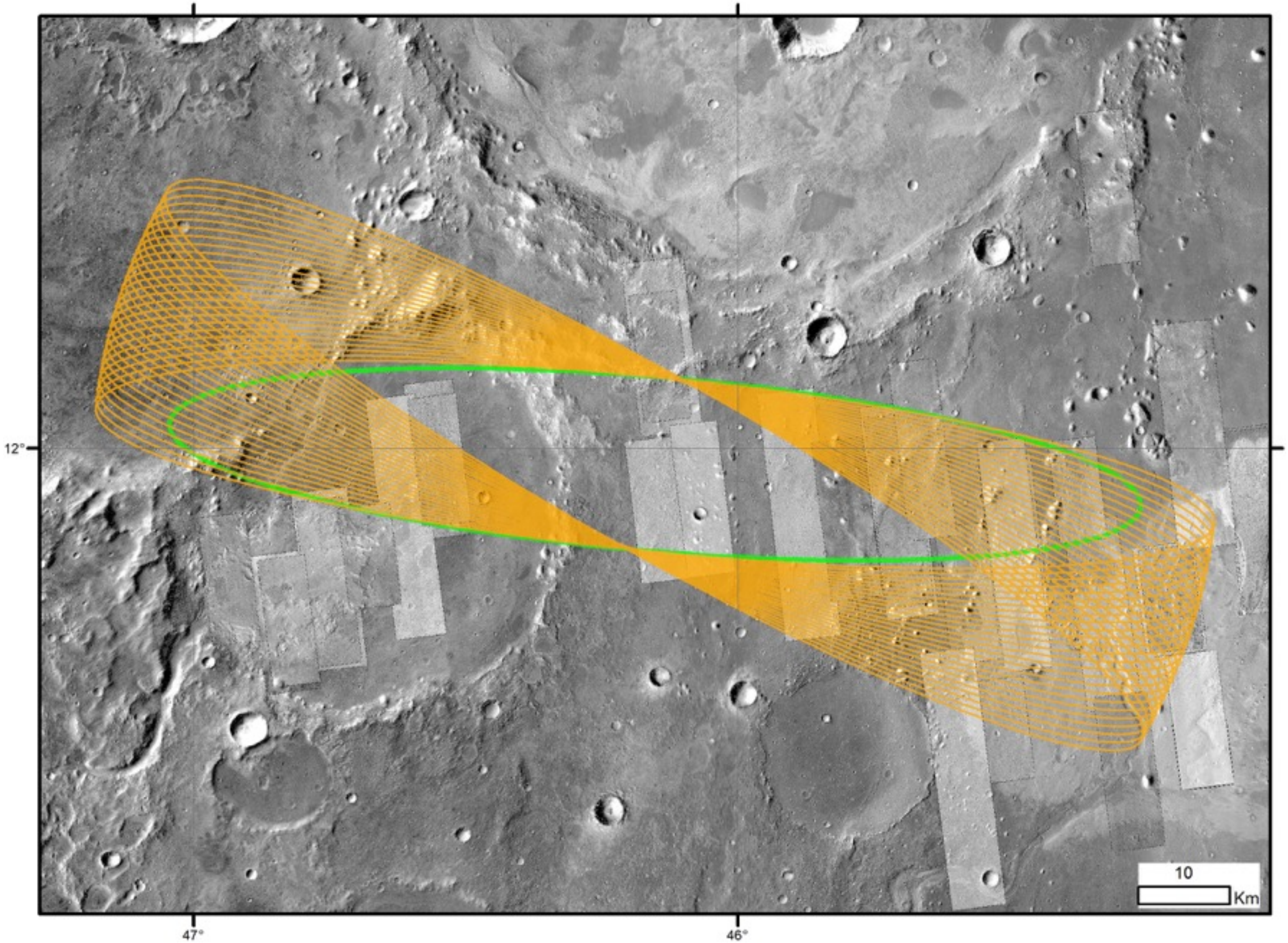
Tanaka et al. (2014), USGS

Mars Geologic Time



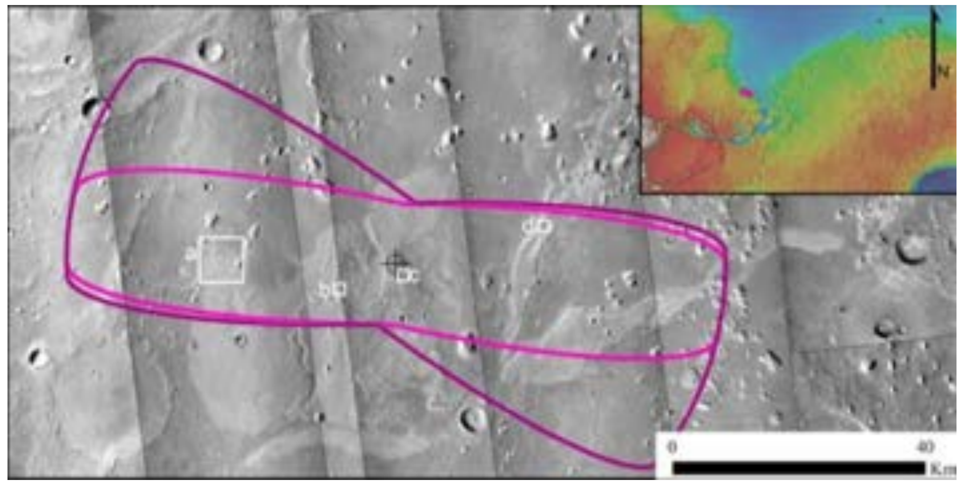
Adapted from Bibring et al. 2006

Where to land to study the interesting rocks?



Photogeology

CTX overview of Hypanis fluvial fan/deltaic system with MOLA inset, and 2018 (pink) & 2018-2020 (purple) landing ellipses (Gupta et al., 2014).



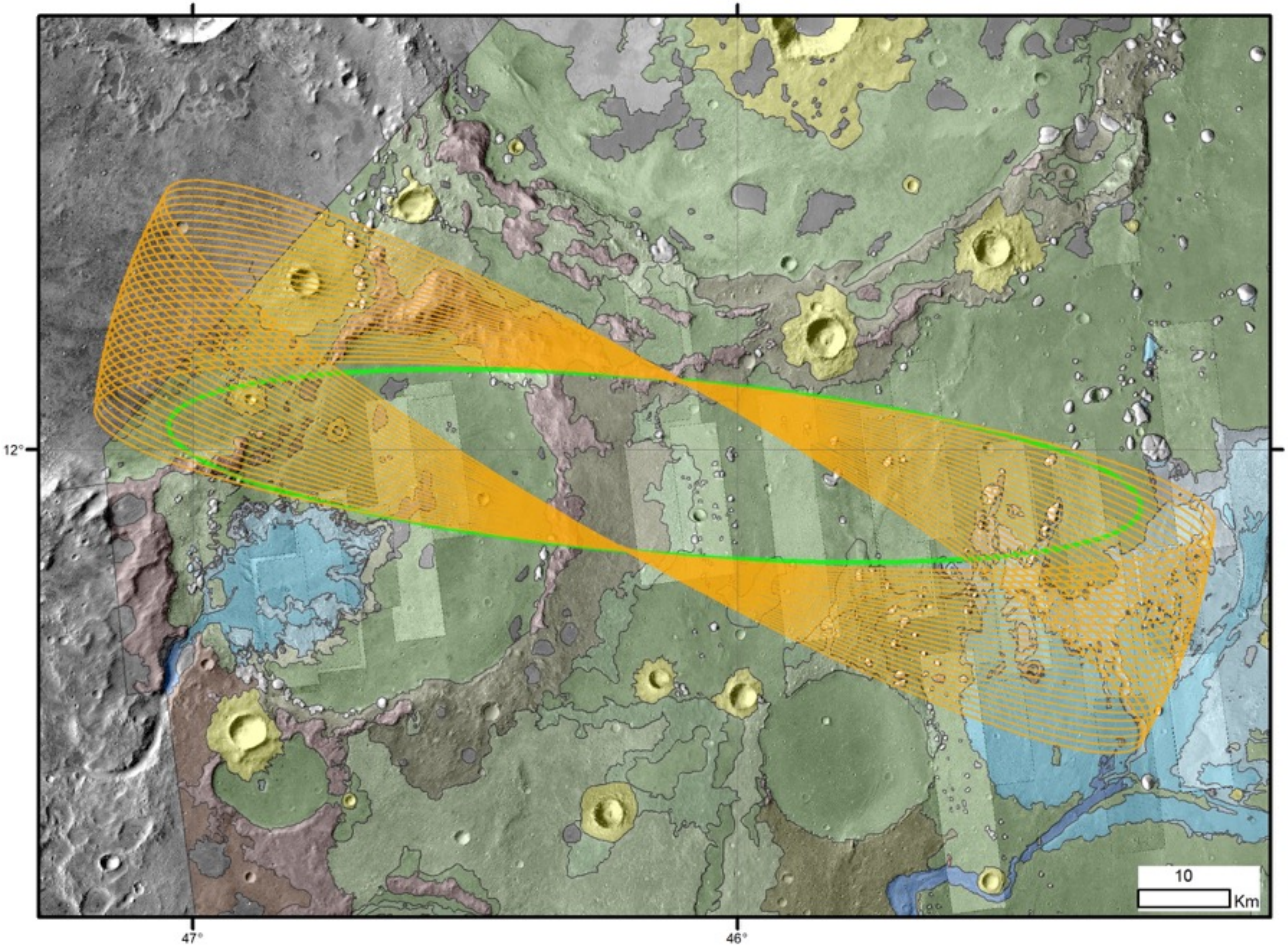
Datasets

Viking - MDIM
MGS - MOLA, MOC WA/NA
Odyssey - THEMIS VIS/IR
MEx - HRSC*
MRO - CTX, HiRISE*
TGO (2016) - CaSSIS*

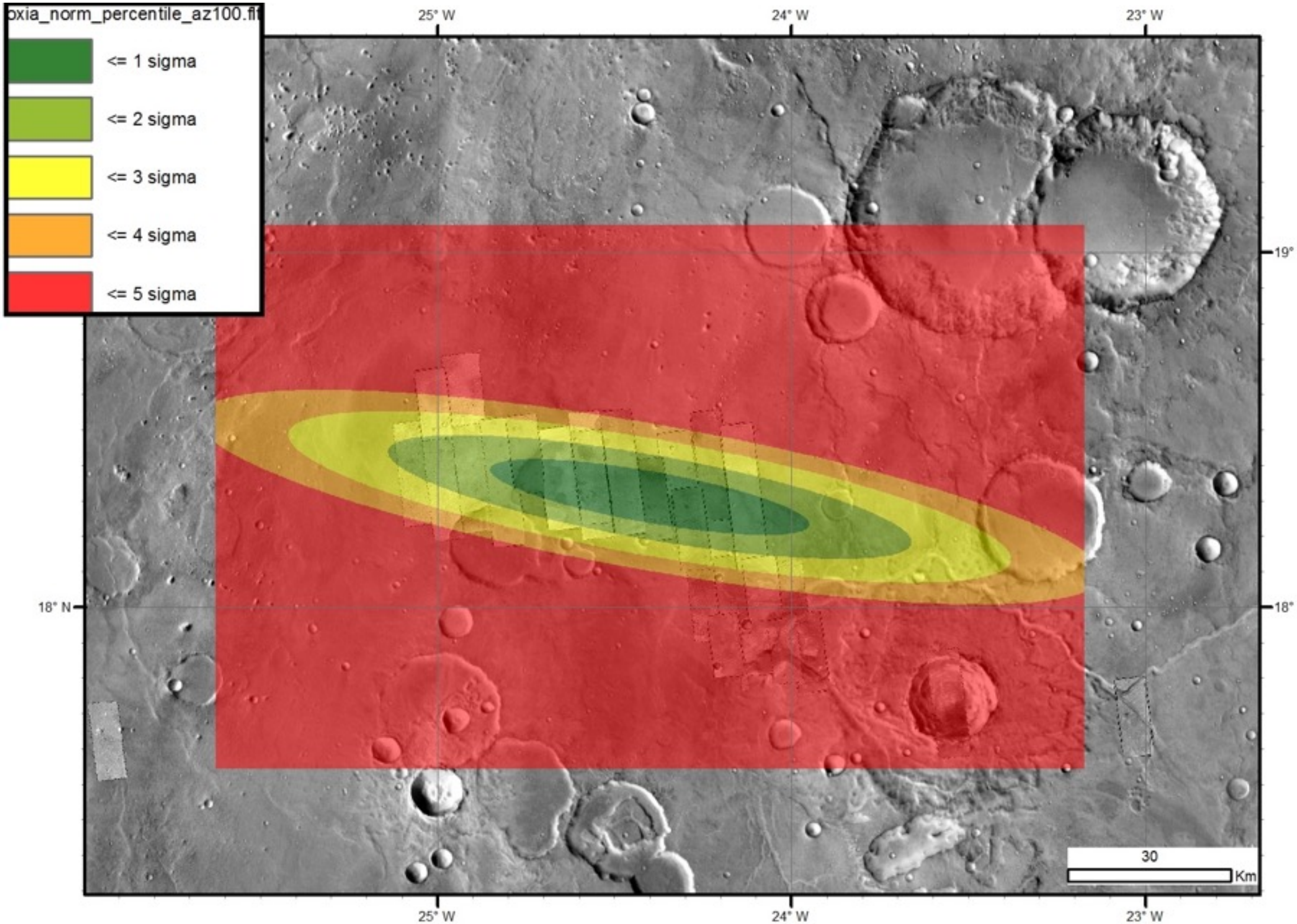
*camera dataset with stereo-derived DTMs

Attribute	Information
Fluvial landforms	Channel precedence • energy of depositional environment • flow rate • ponding volume
Stratigraphy	Sedimentary sequences • depositional environment
Erosional habit	Fissility • degree of induration • effects of diagenesis
Crater retention age	Unit chronology • exposure age of exhumed deposits
Terrain softening	Dust cover • low thermal inertia material unsuitable for traverse
Slope distribution (at base-length)	Traverse planning • rock abundance • areas that satisfy engineering constraints (RADAR reflectivity, fuel consumption, altitude error, surface stability).

Geologic Mapping (at 6 m/pix)

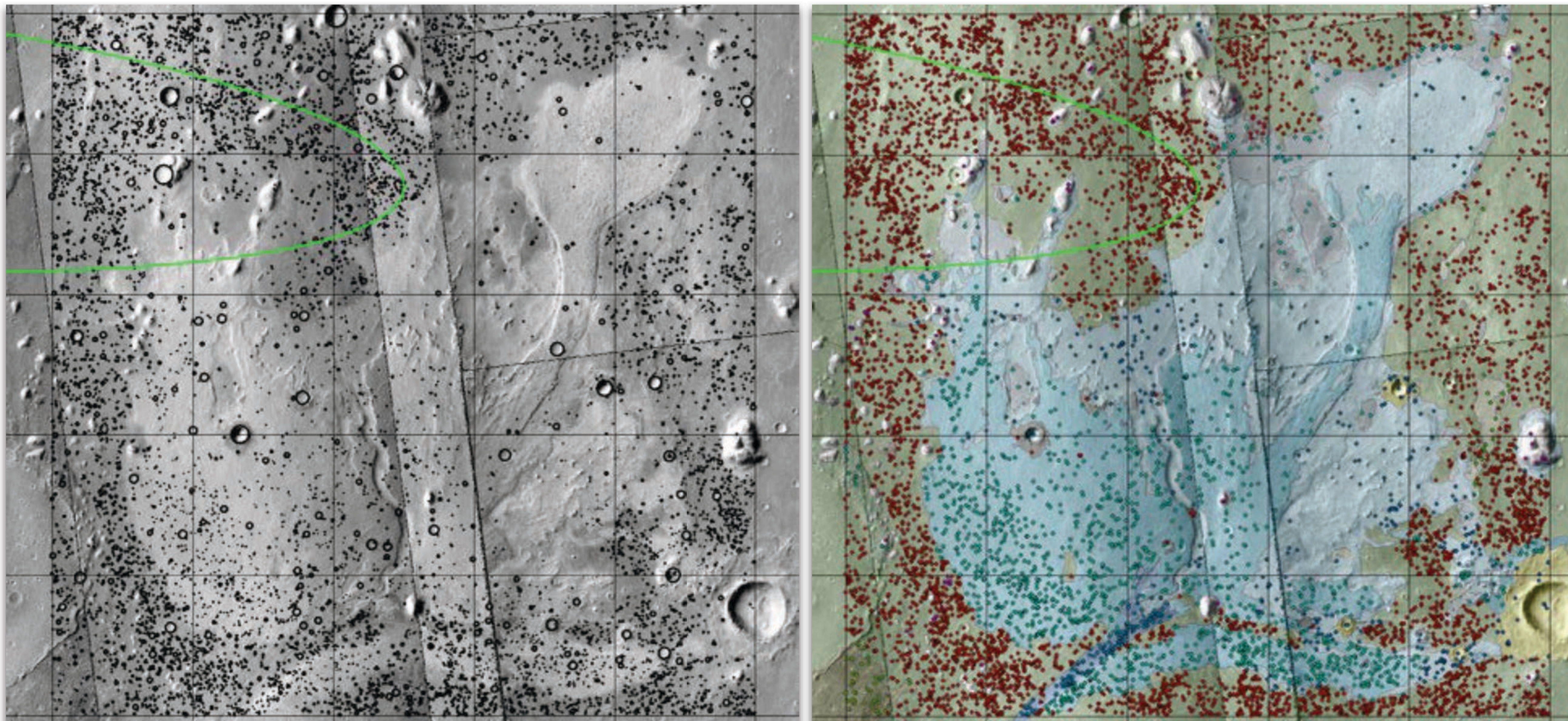


Landing probability distribution



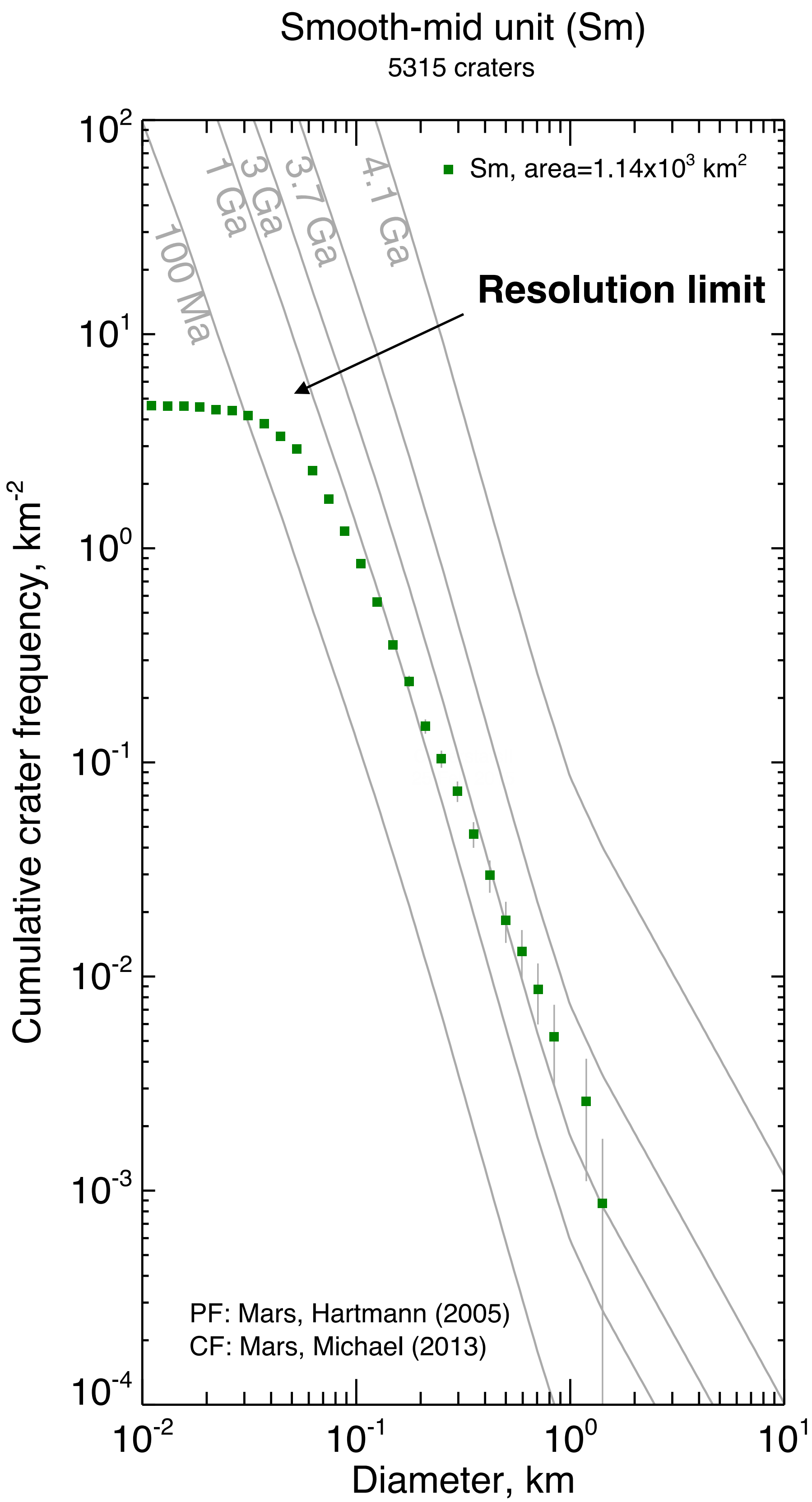
Today

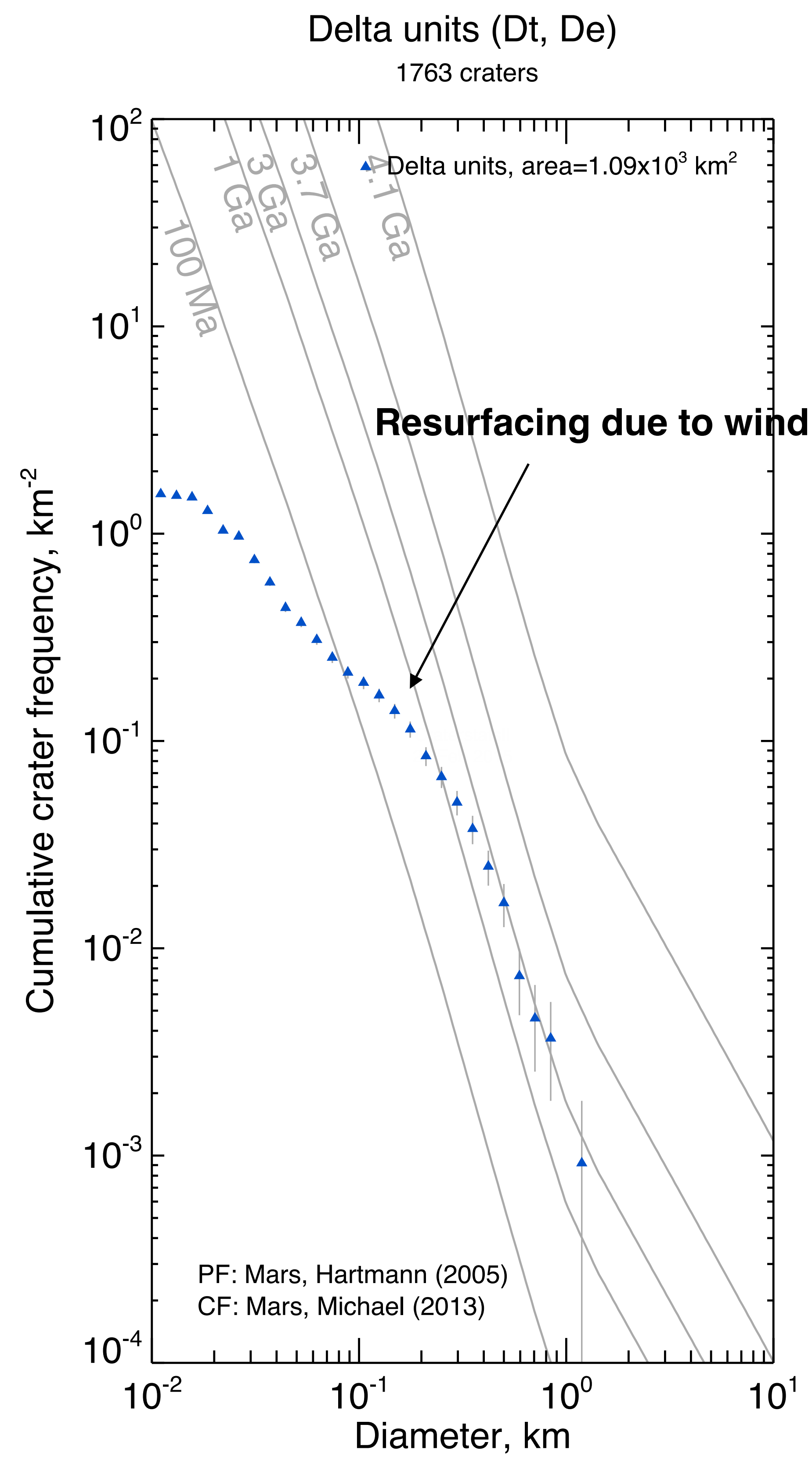
How old is the surface? 'Crater retention age'



7552 craters counted at MRO CTX resolution (6 m/pixel) in 2500 km^2 on Hypanis delta

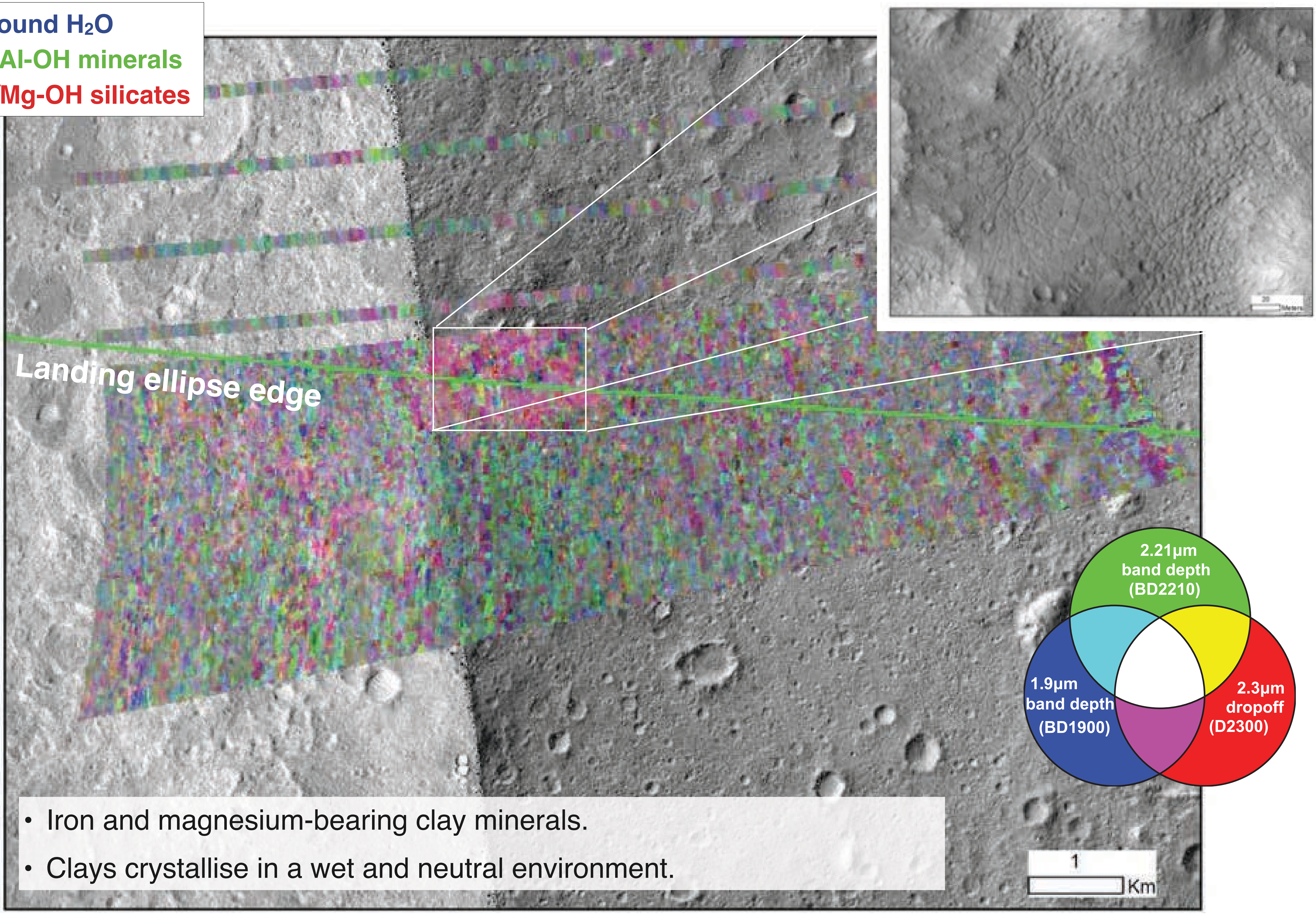
Deriving crater retention age





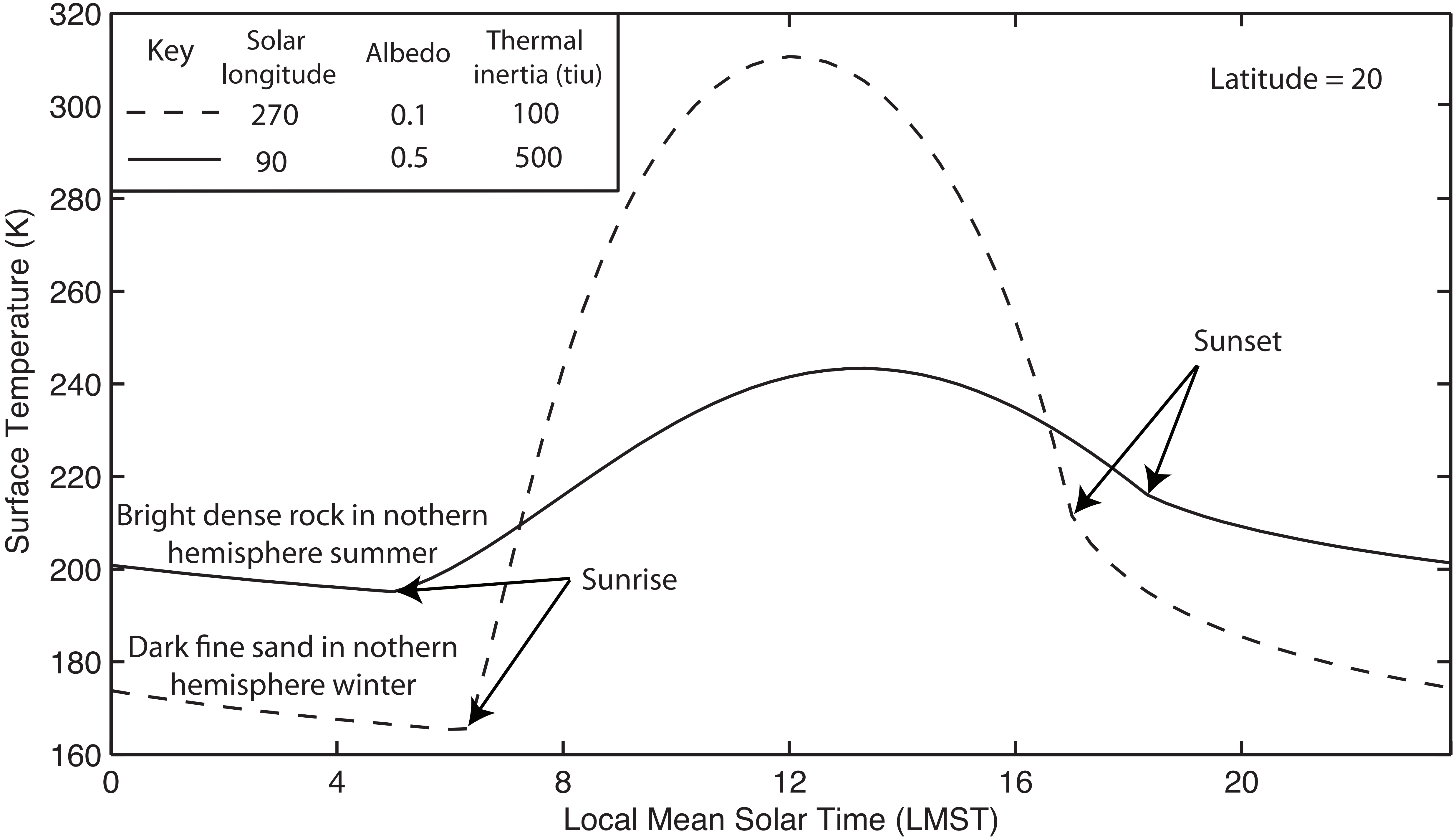
Orbital IR spectroscopy shows composition

BLUE: Bound H_2O
GREEN: Al-OH minerals
RED: Fe/Mg-OH silicates



- Iron and magnesium-bearing clay minerals.
- Clays crystallise in a wet and neutral environment.

Hot or not?



Key
Solar longitude
Albedo
Thermal inertia (tiu)
270
0.1
100
90
0.5
500
Latitude = 20
Surface Temperature (K)
320
300
280
260
240
220
200
180
160
0
4
8
12
16
20
Local Mean Solar Time (LMST)
Sunset
Sunrise
Bright dense rock in nothern hemisphere summer
Dark fine sand in nothern hemisphere winter

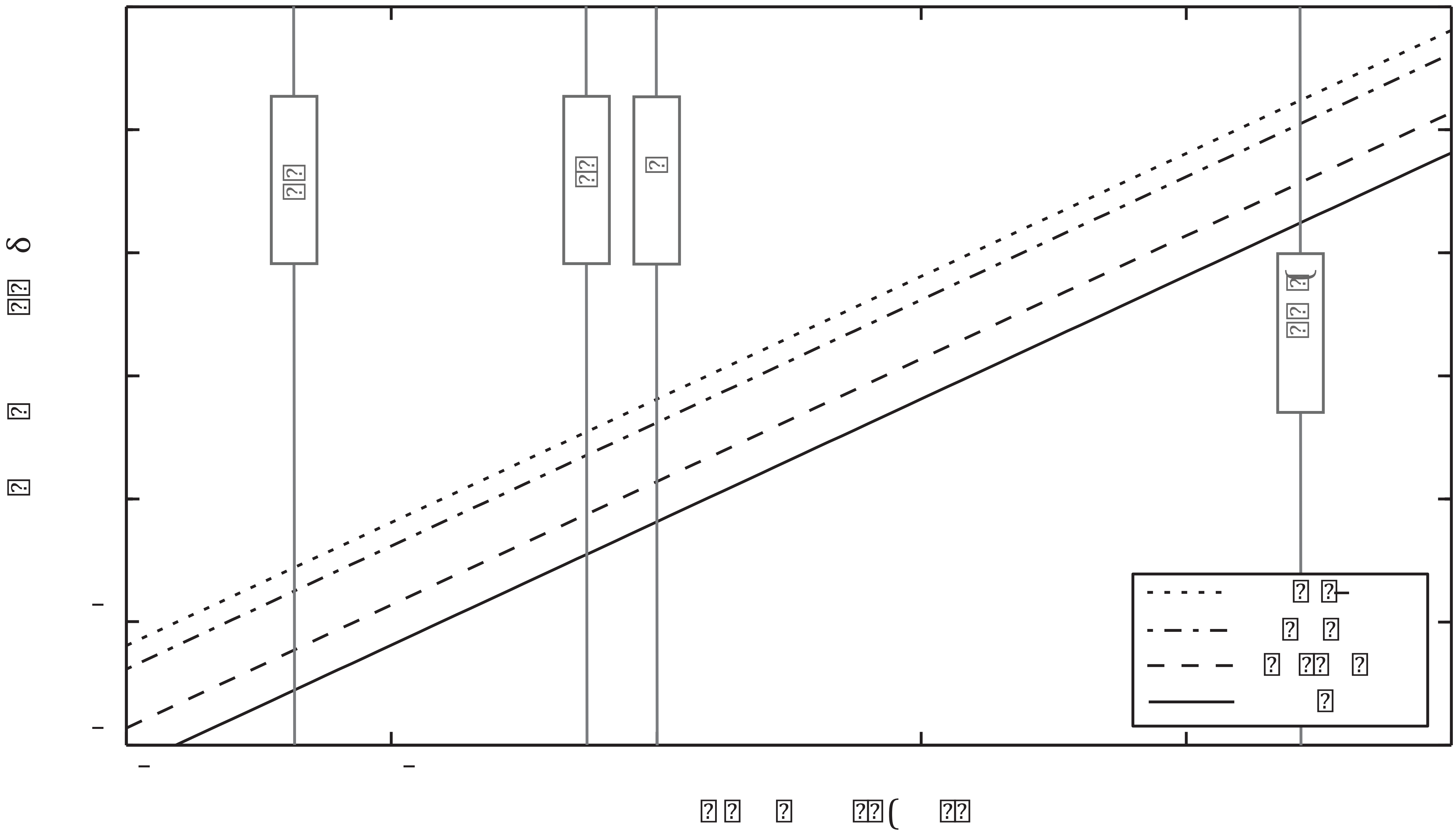
What can infrared observations tell us about rocks?

Thermal inertia: $I = \sqrt{\kappa \rho c}$

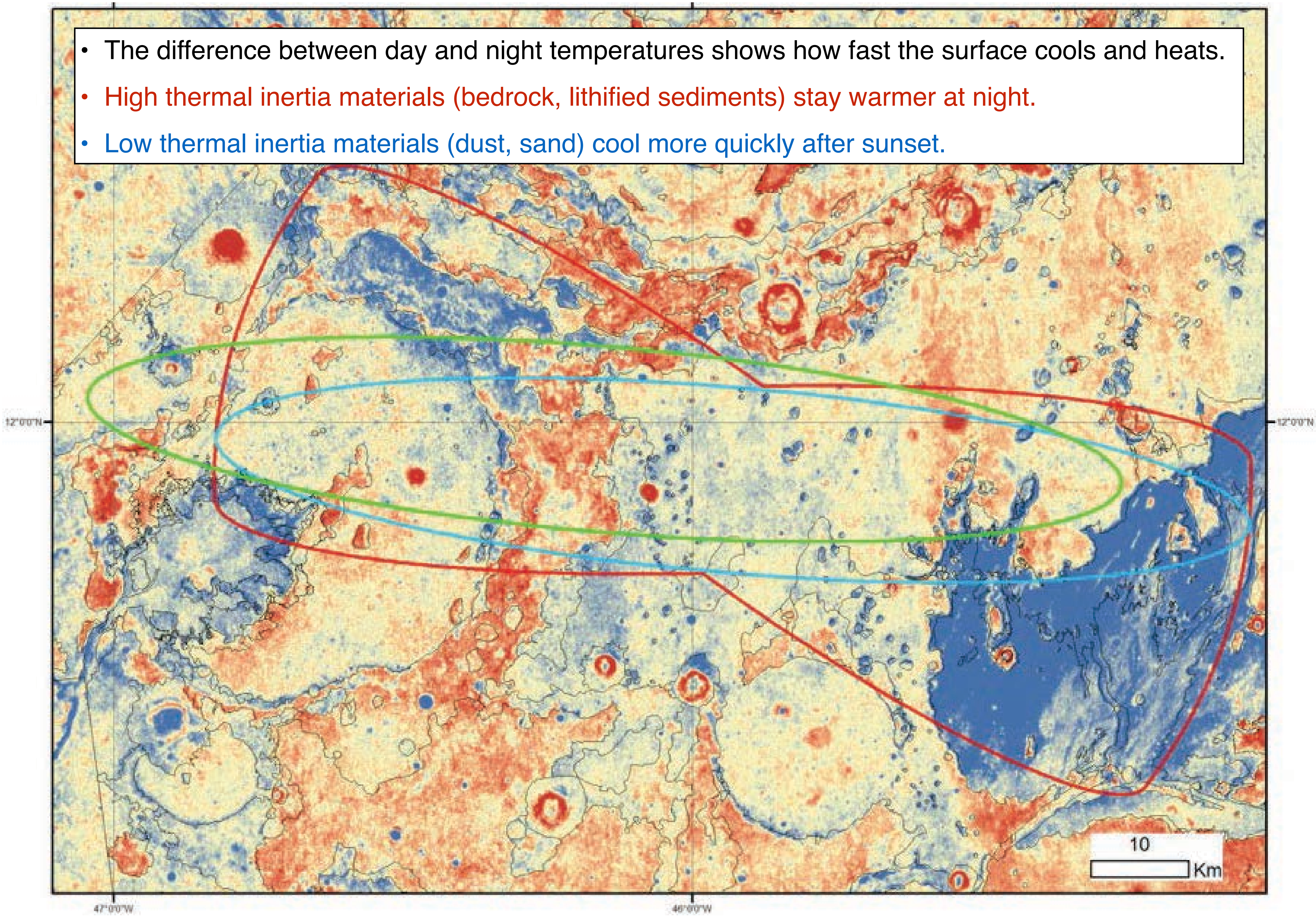
Thermal skin depth: $\delta = \sqrt{\dfrac{\kappa P}{\rho c \pi}}$

Geologic material	ρ (kg m^{-3})	c(Jkg^{-1}K^{-1})	κ(Js^{-1}K^{-1}m^{-1})	I (tiu)
Fine sand	1500^a	800^a	0.02^b	155
Coarse sand	1500^a	800^a	0.10^b	346
H_2O–ice	1000^a	1700^a	2.5^c	2062
Basalt	2500^a	850^a	1.3^d	1662

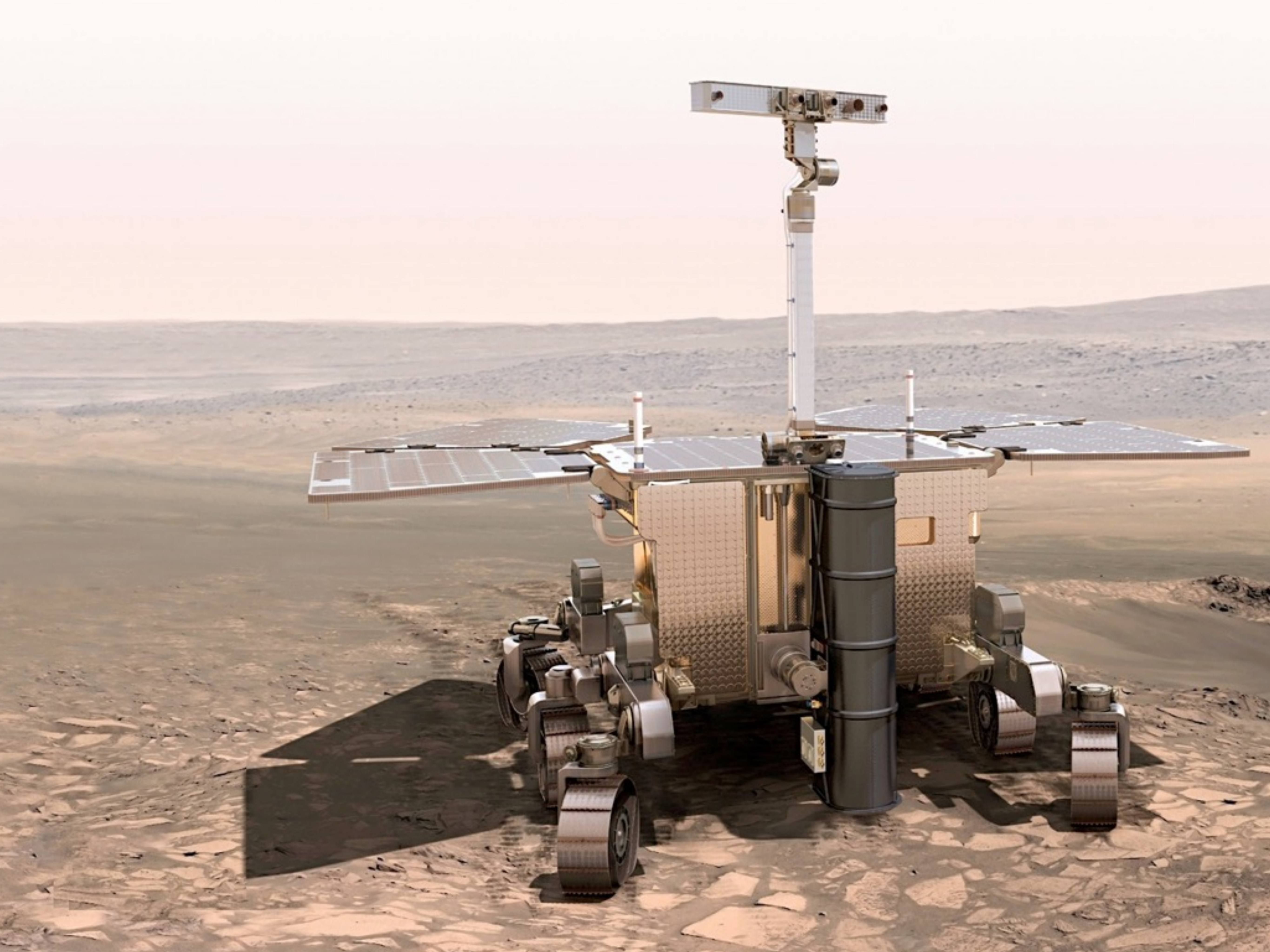
What can infrared observations tell us about rocks?

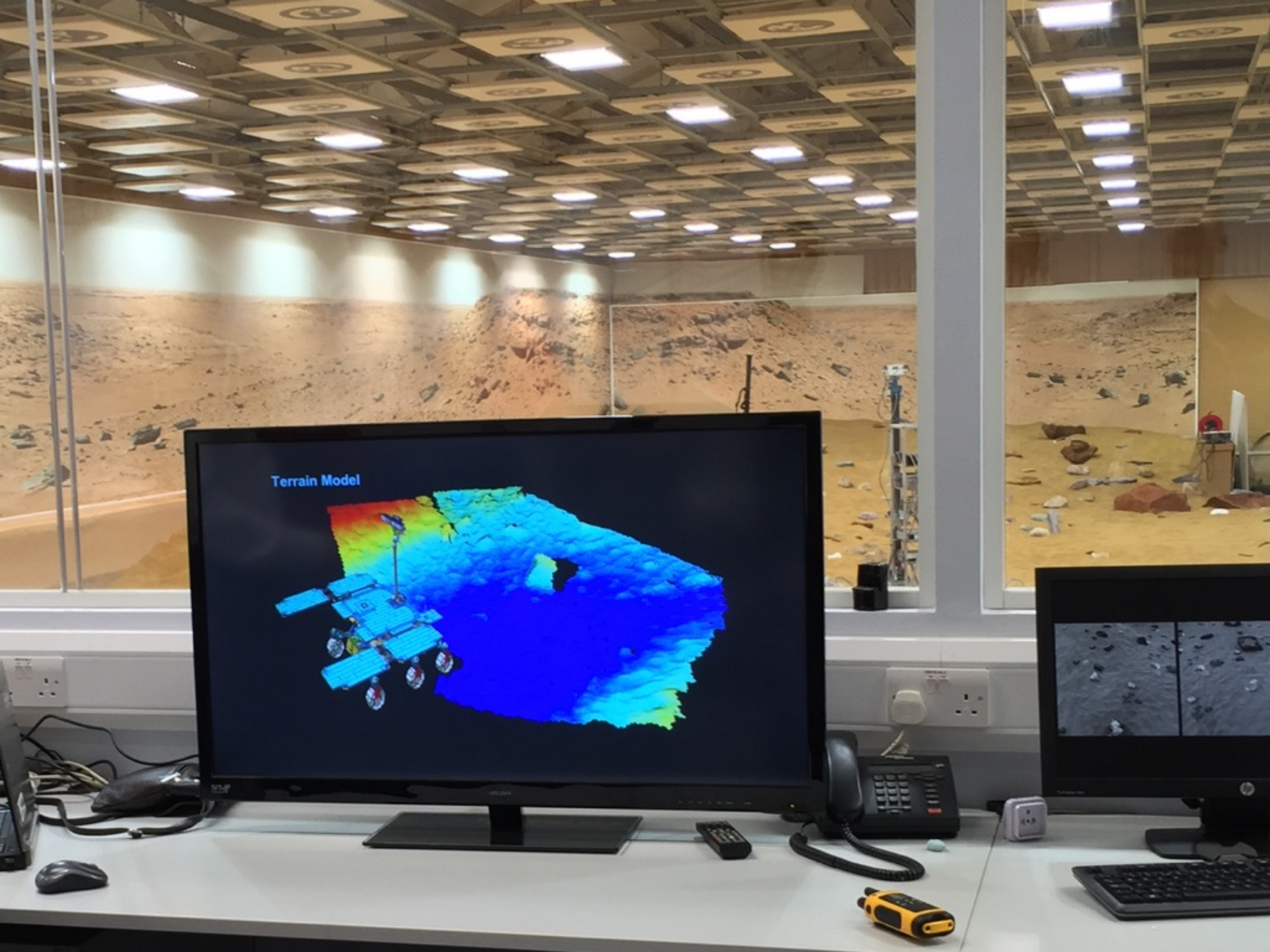


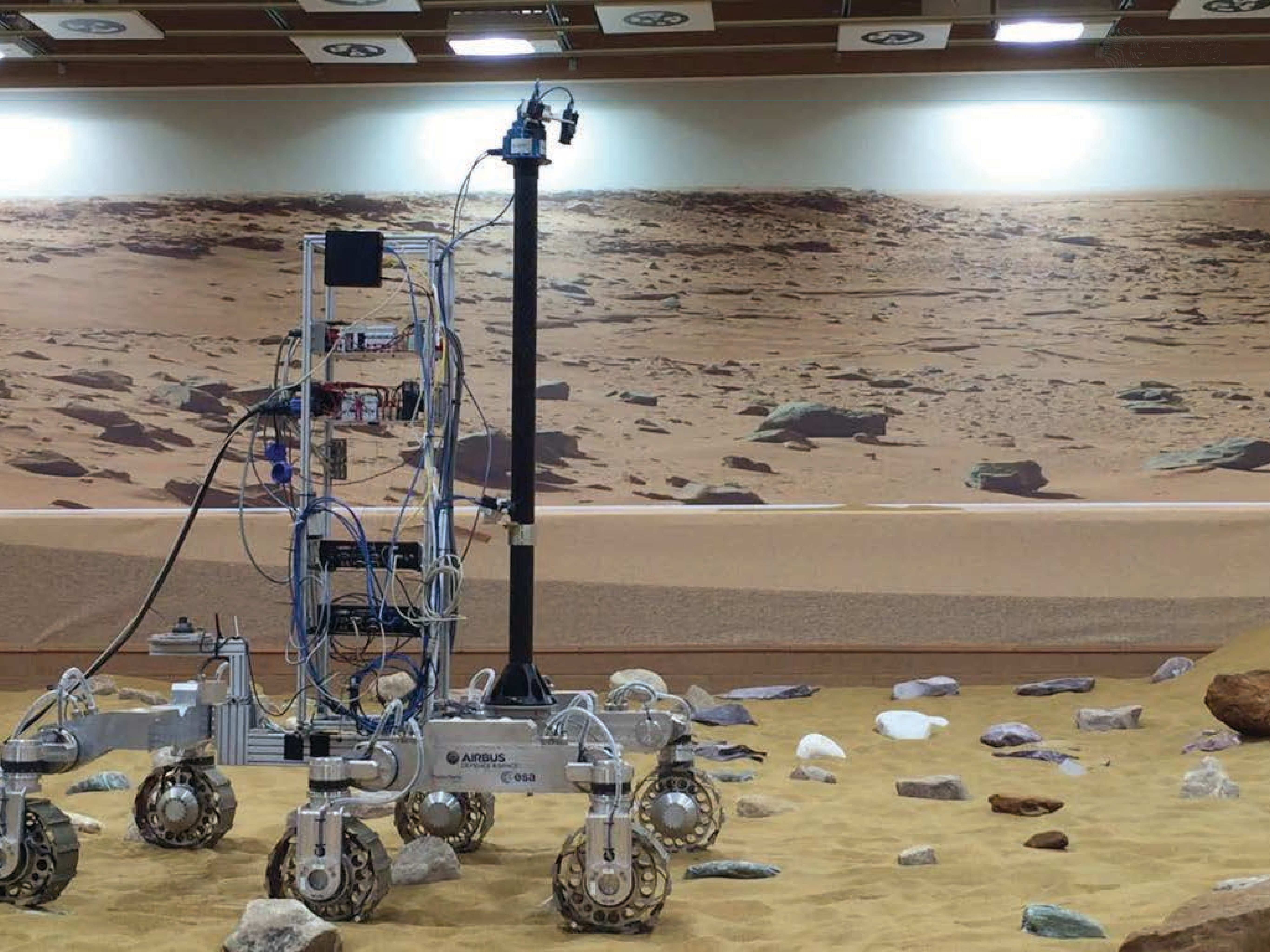
Nighttime infrared observations are sensitive to 'thermal inertia'



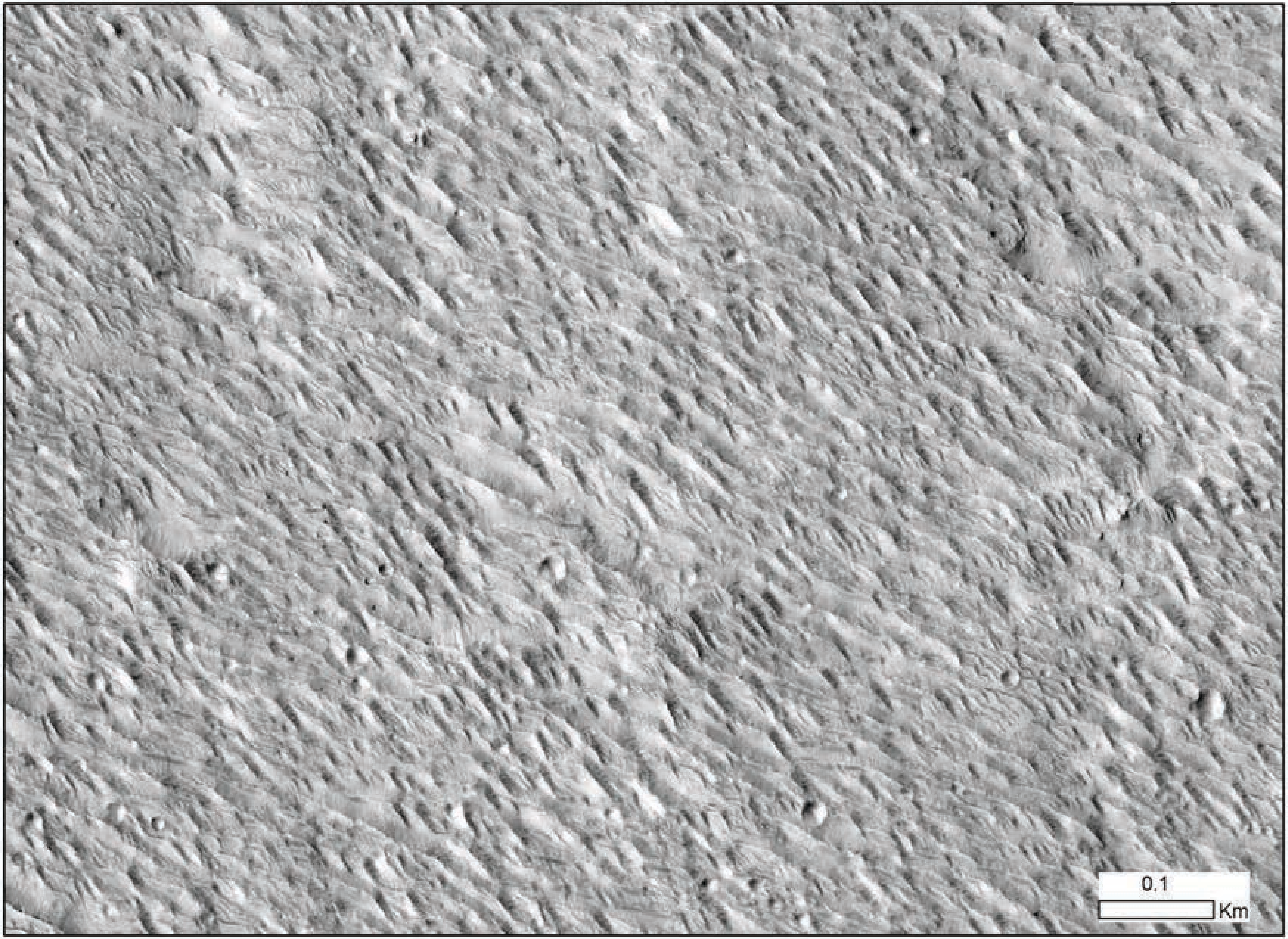
Credit: Nighttime 100 m/pix THEMIS global mosaic (Christensen et al. 2013)

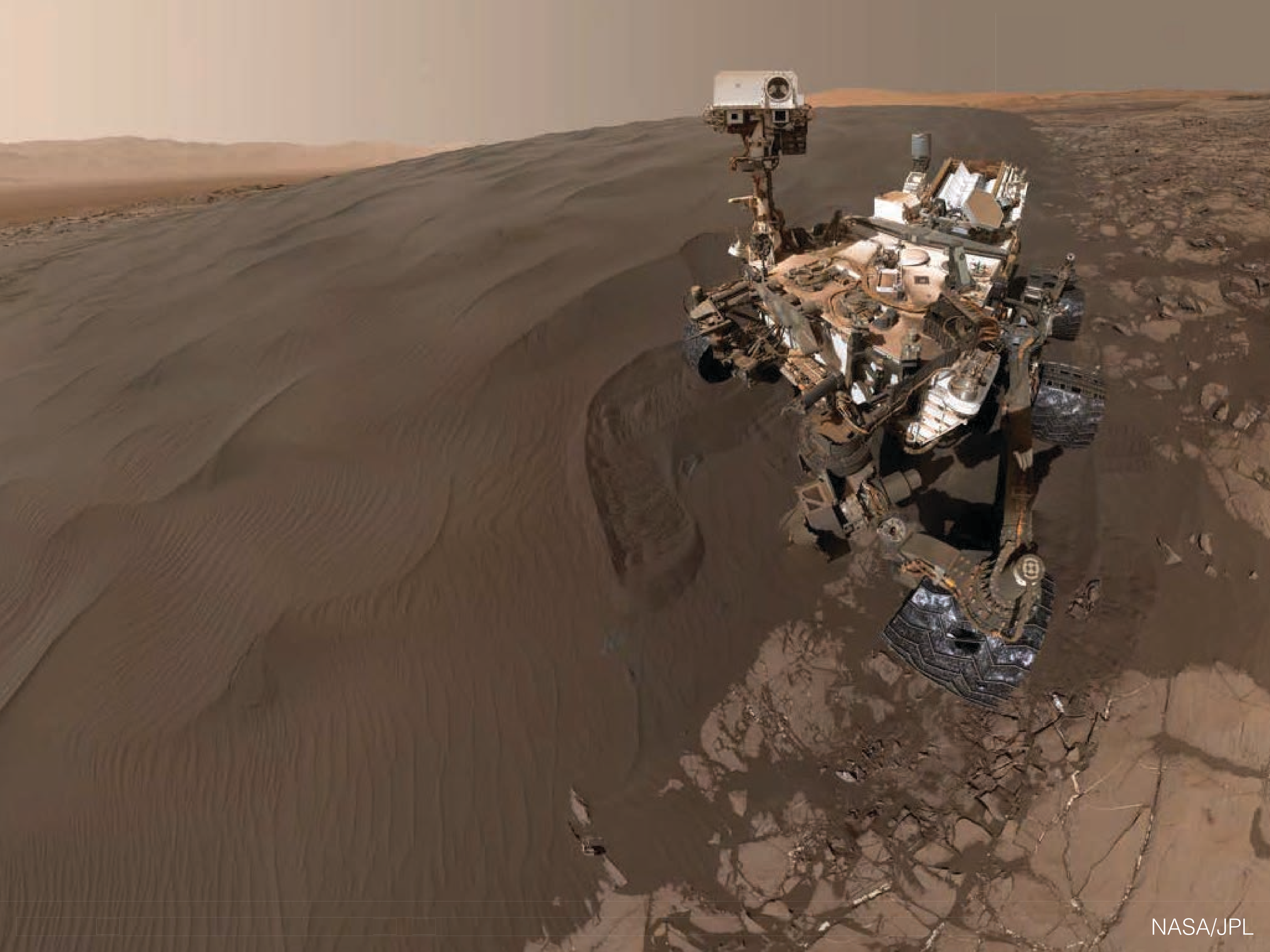



Terrain Model

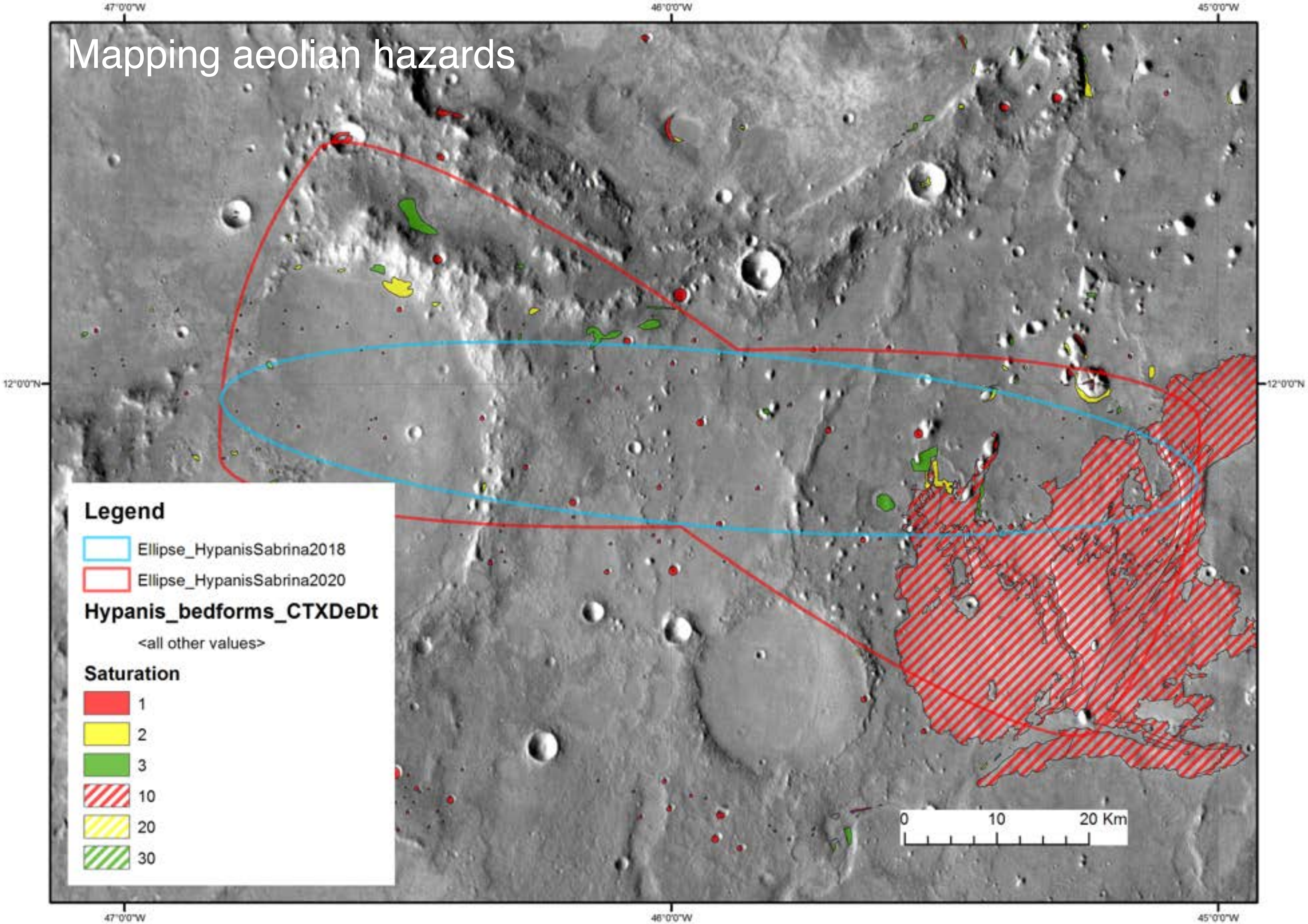

AIRBUS
esa

Ripples, dunes and transverse aeolian ridges

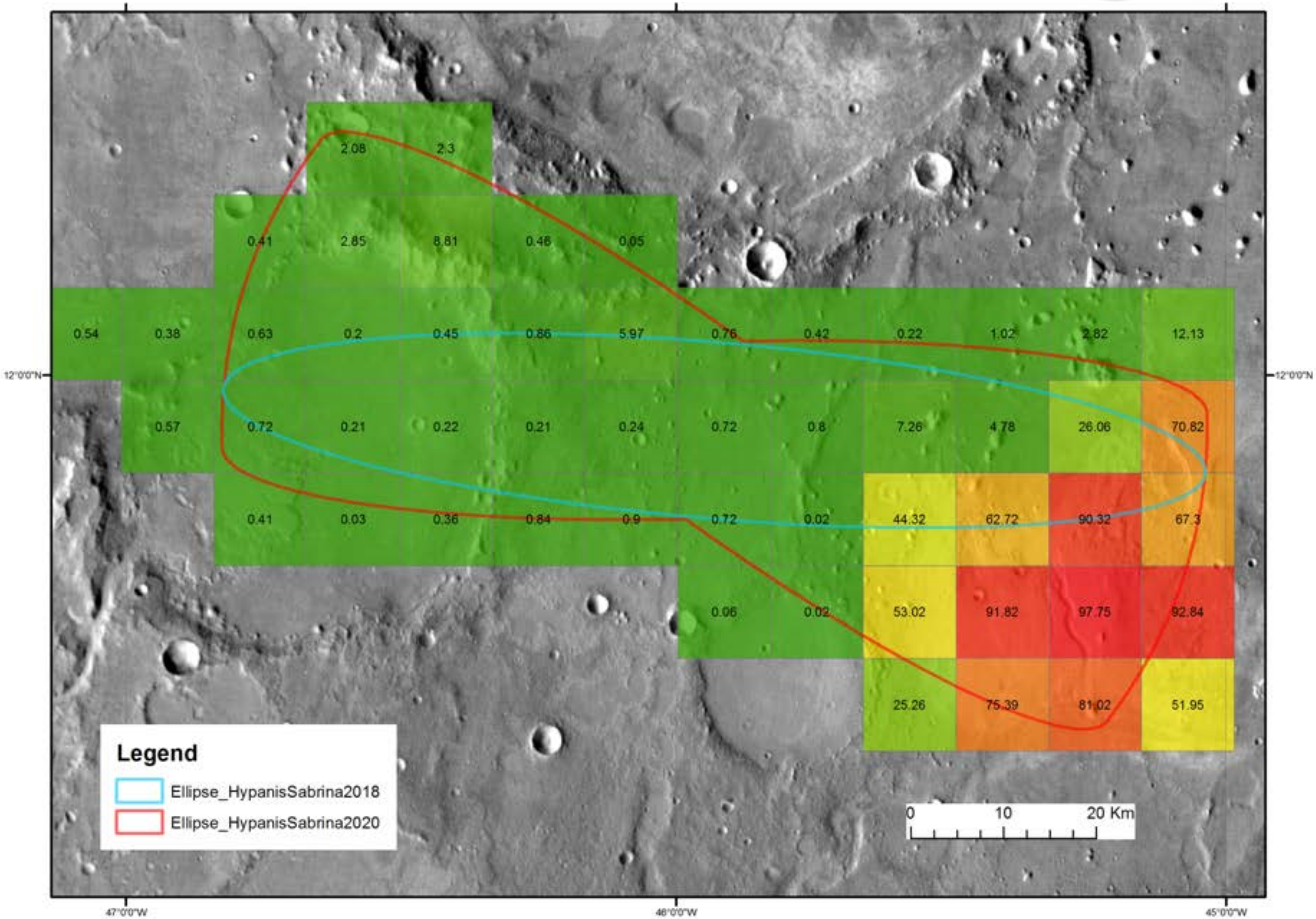


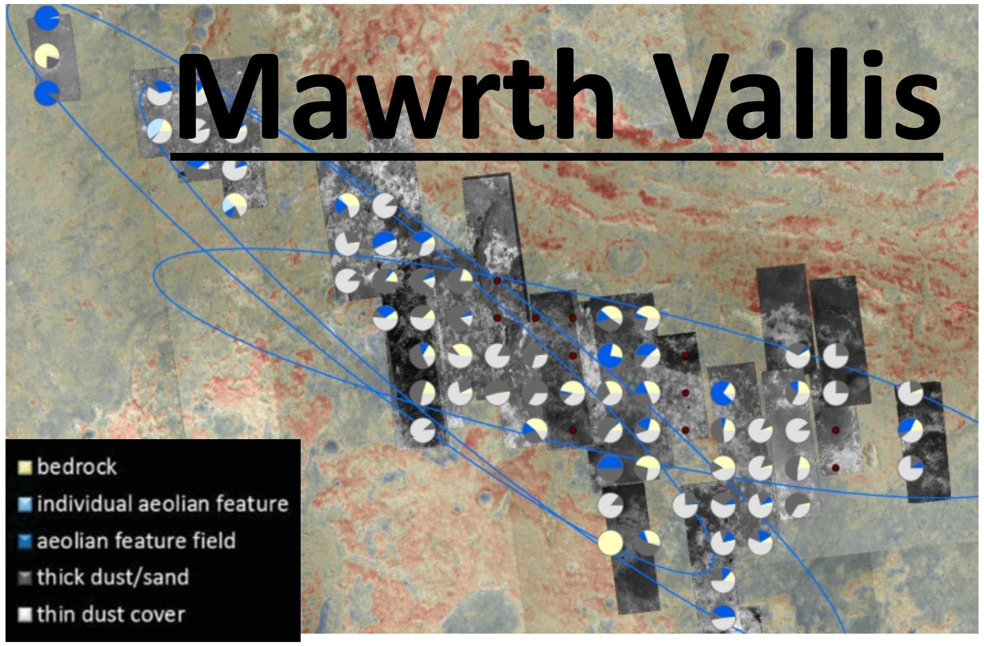


NASA/JPL

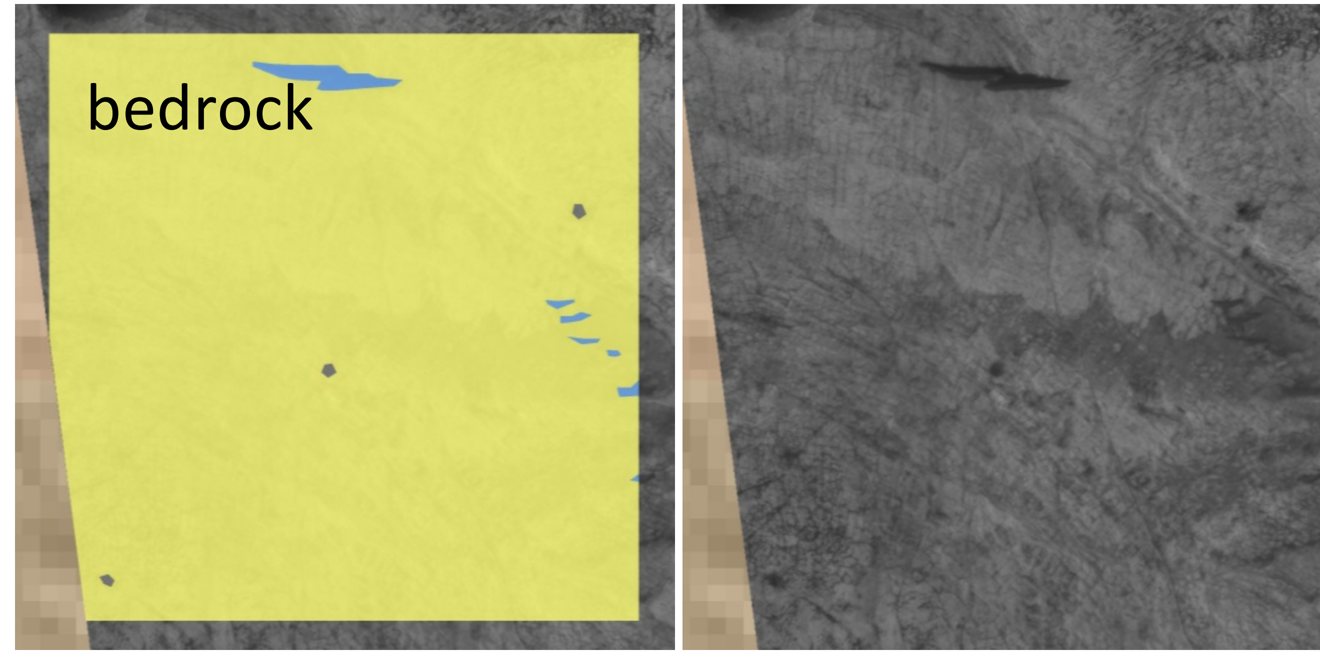

Mapping aeolian hazards
47°0'0"W
46°0'0"W
45°0'0"W
12°0'0"N
Legend
Ellipse_HypanisSabrina2018
Ellipse_HypanisSabrina2020
Hypanis_bedforms_CTXDeDt
<all other values>
Saturation
1
2
3
10
20
30
0
10
20 Km

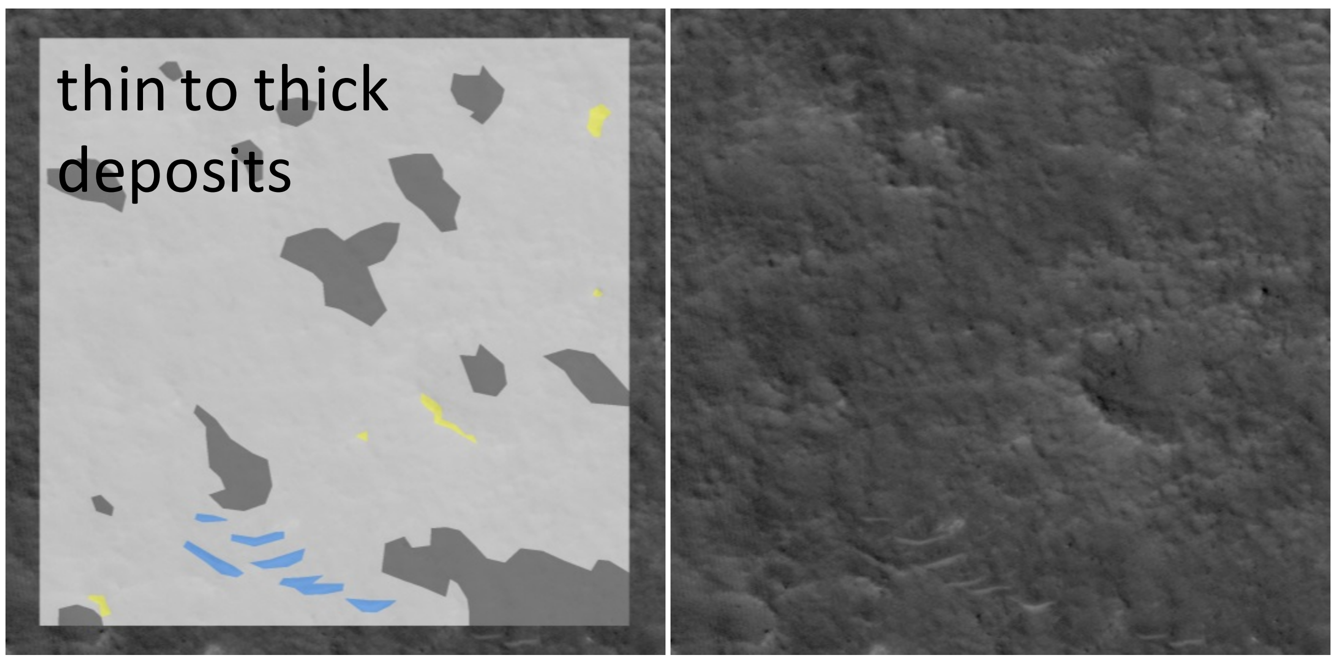
Mapping aeolian hazards

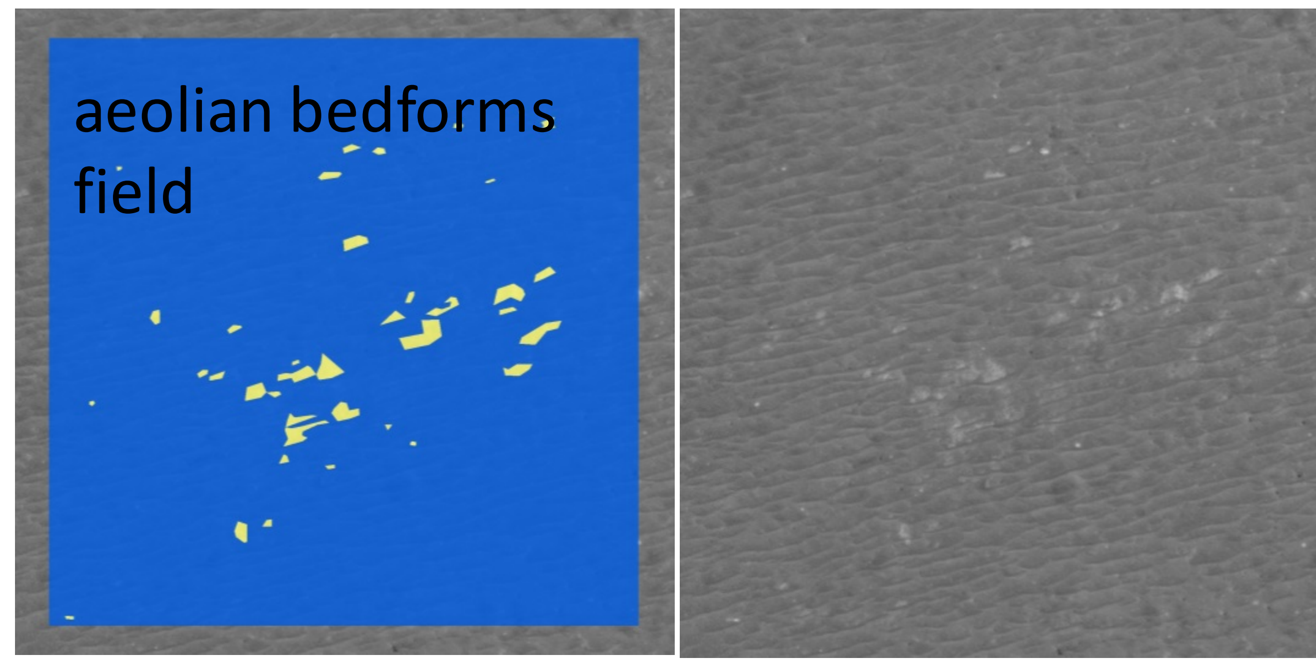


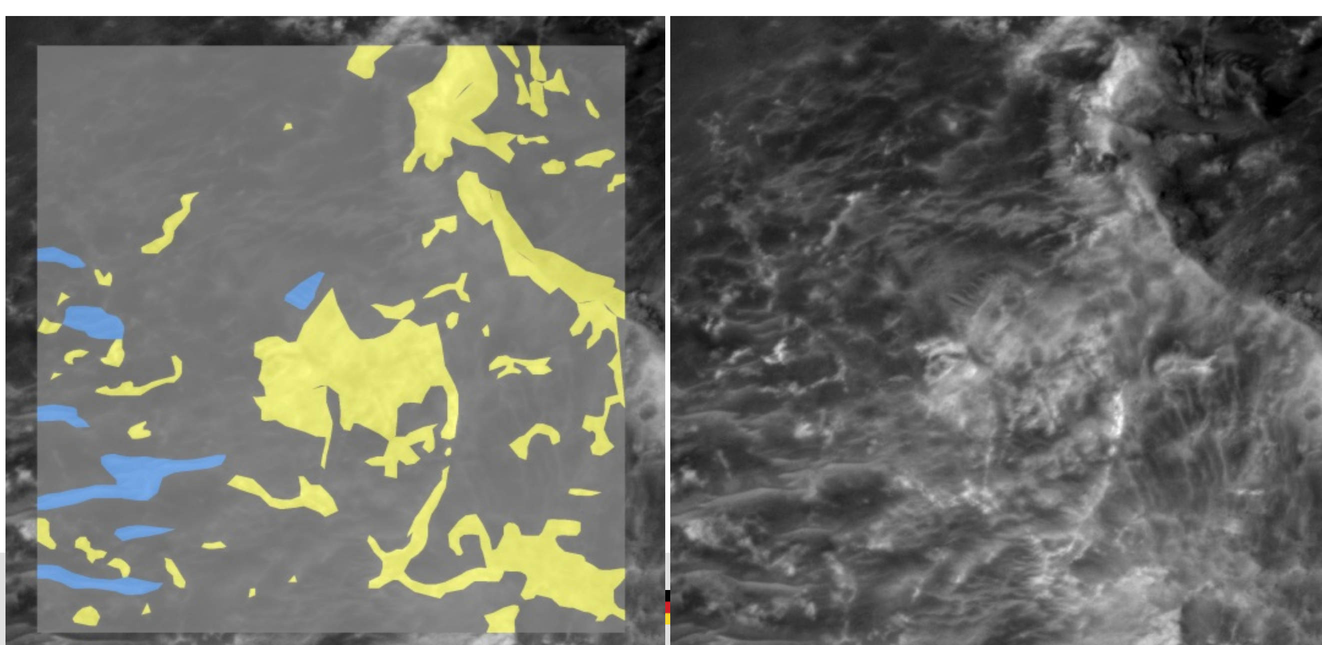


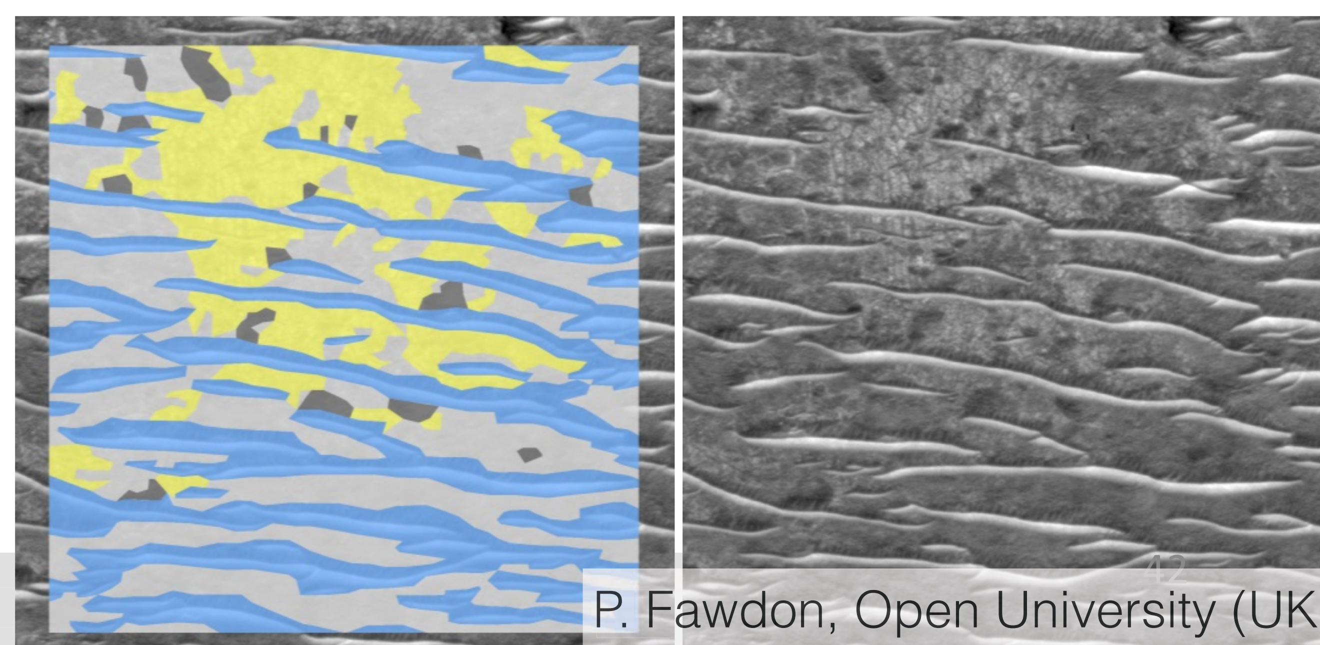
sample diversity





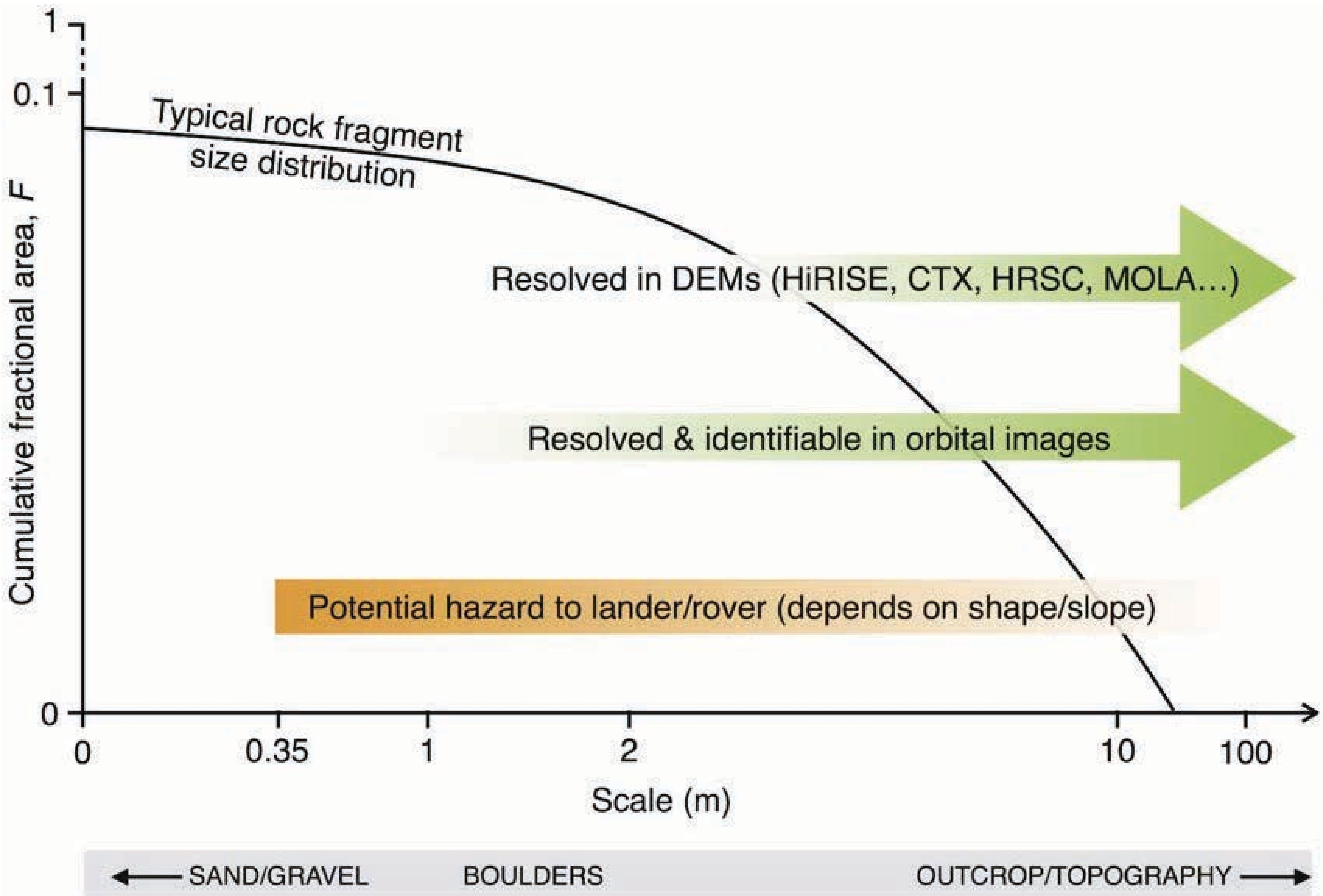






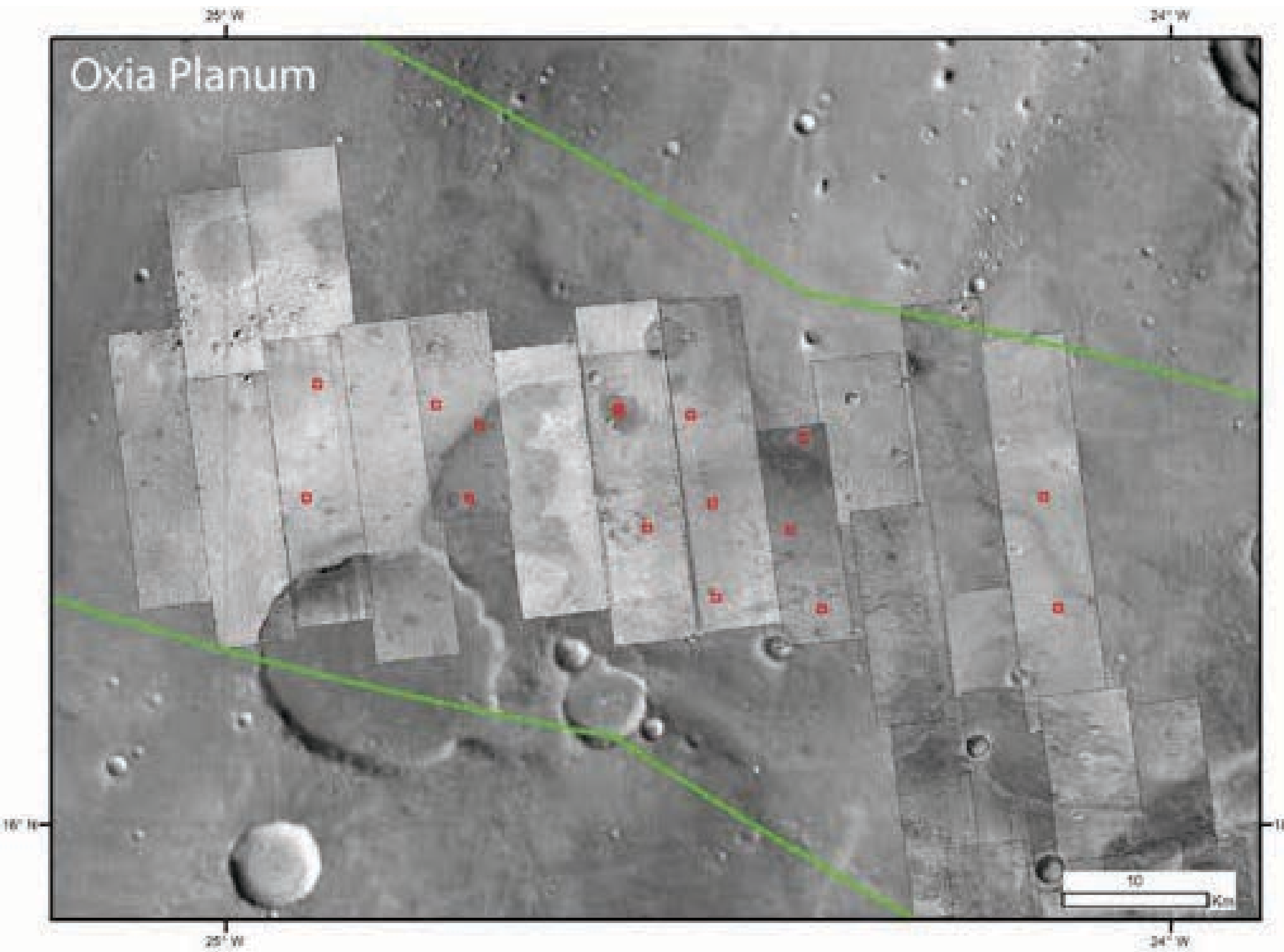
P. Fawdon, Open University (UK)

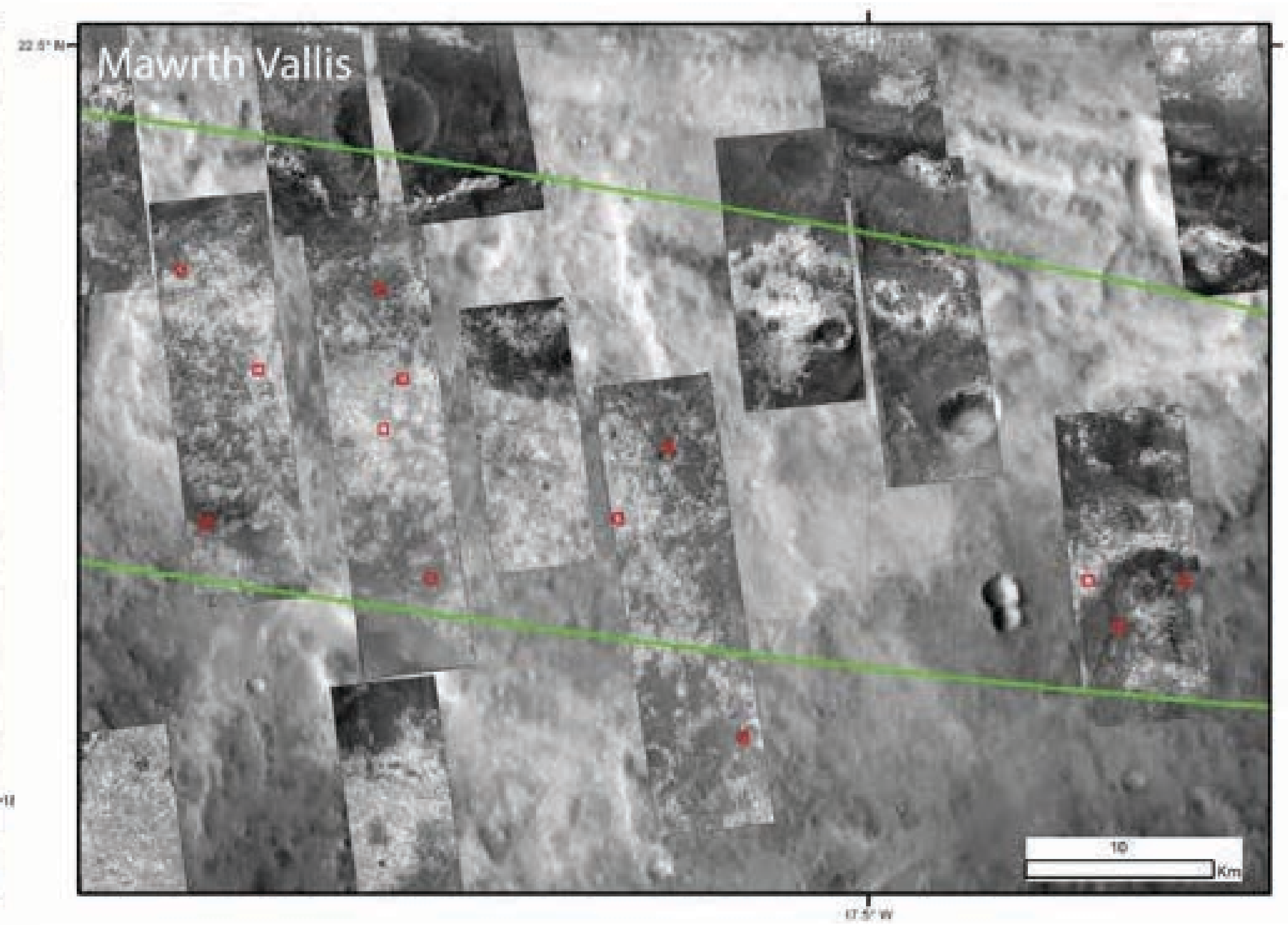
Rock abundance



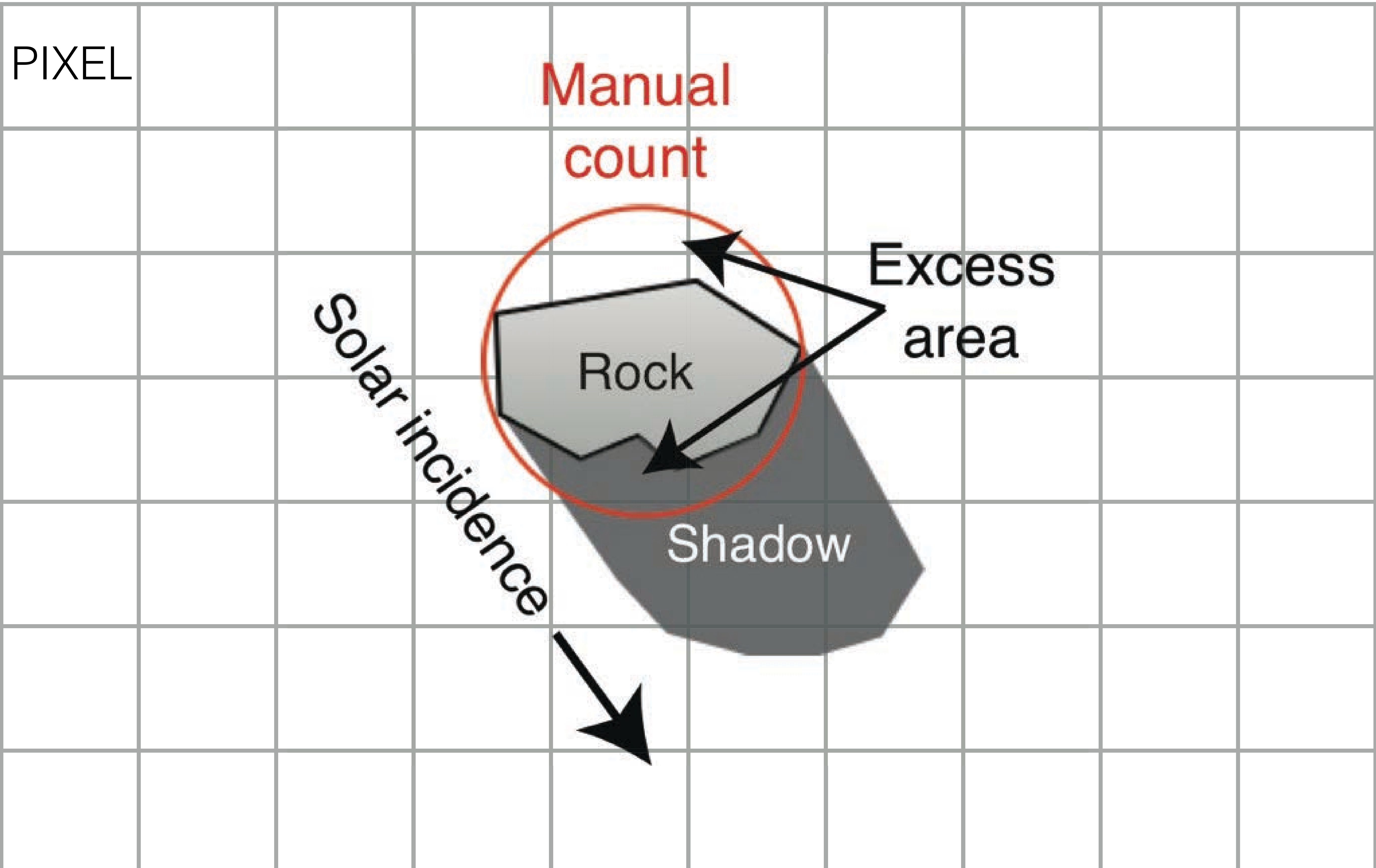

NASA/JPL

'Counting rocks in HiRISE images can be mind-numbingly boring, but it is mind-blowingly important.' — Anon. 2017



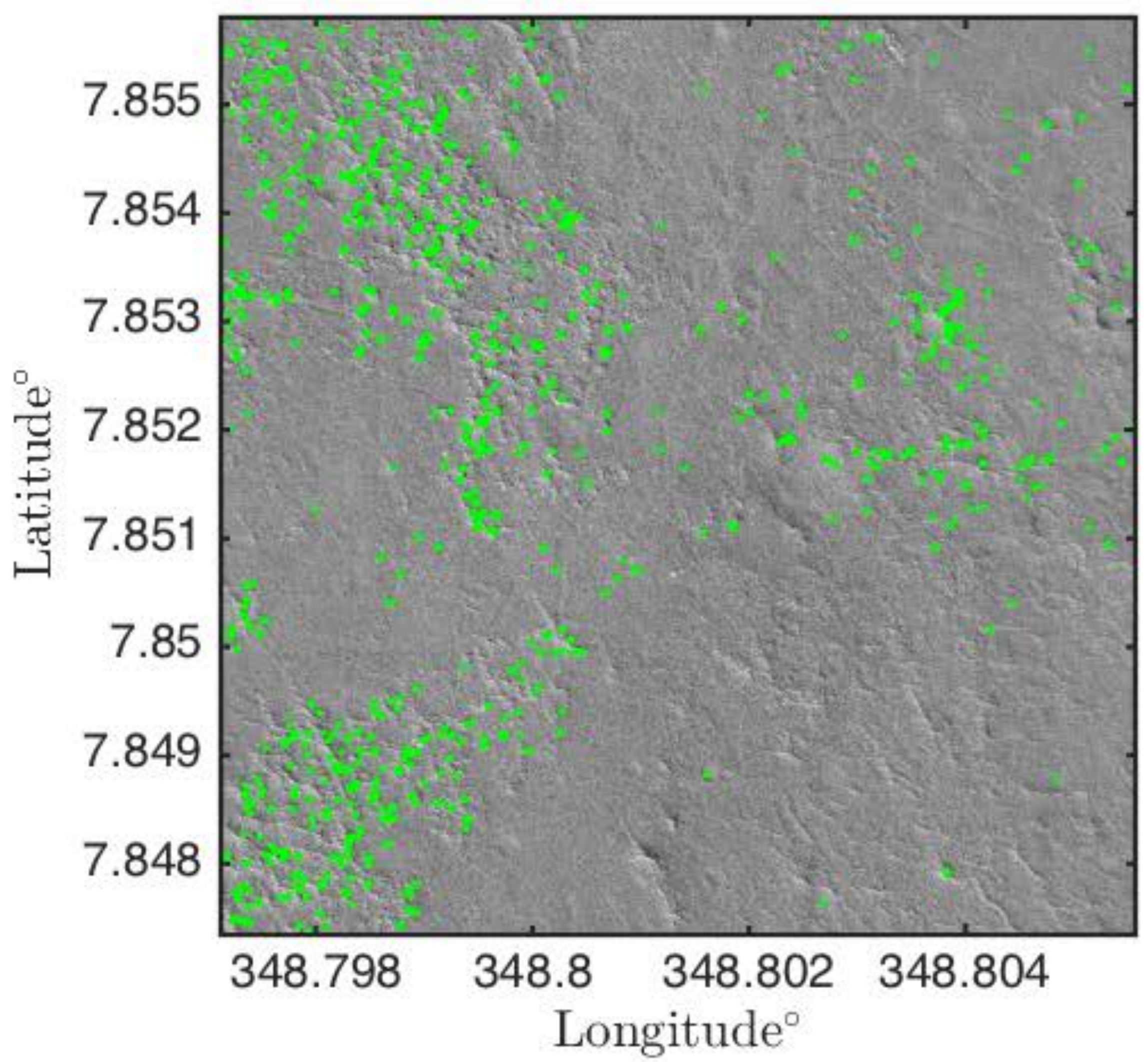


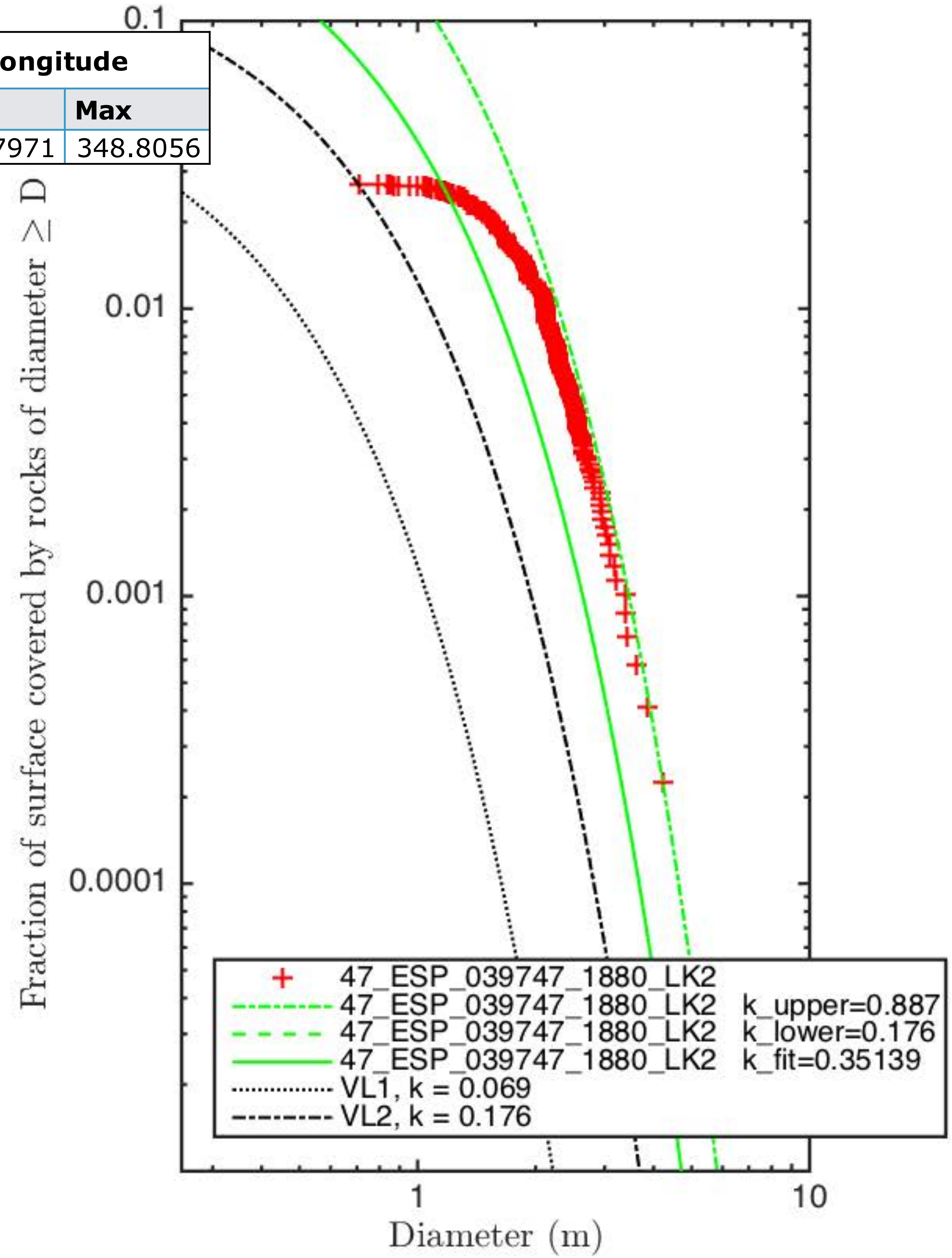
School of rock (abundance)



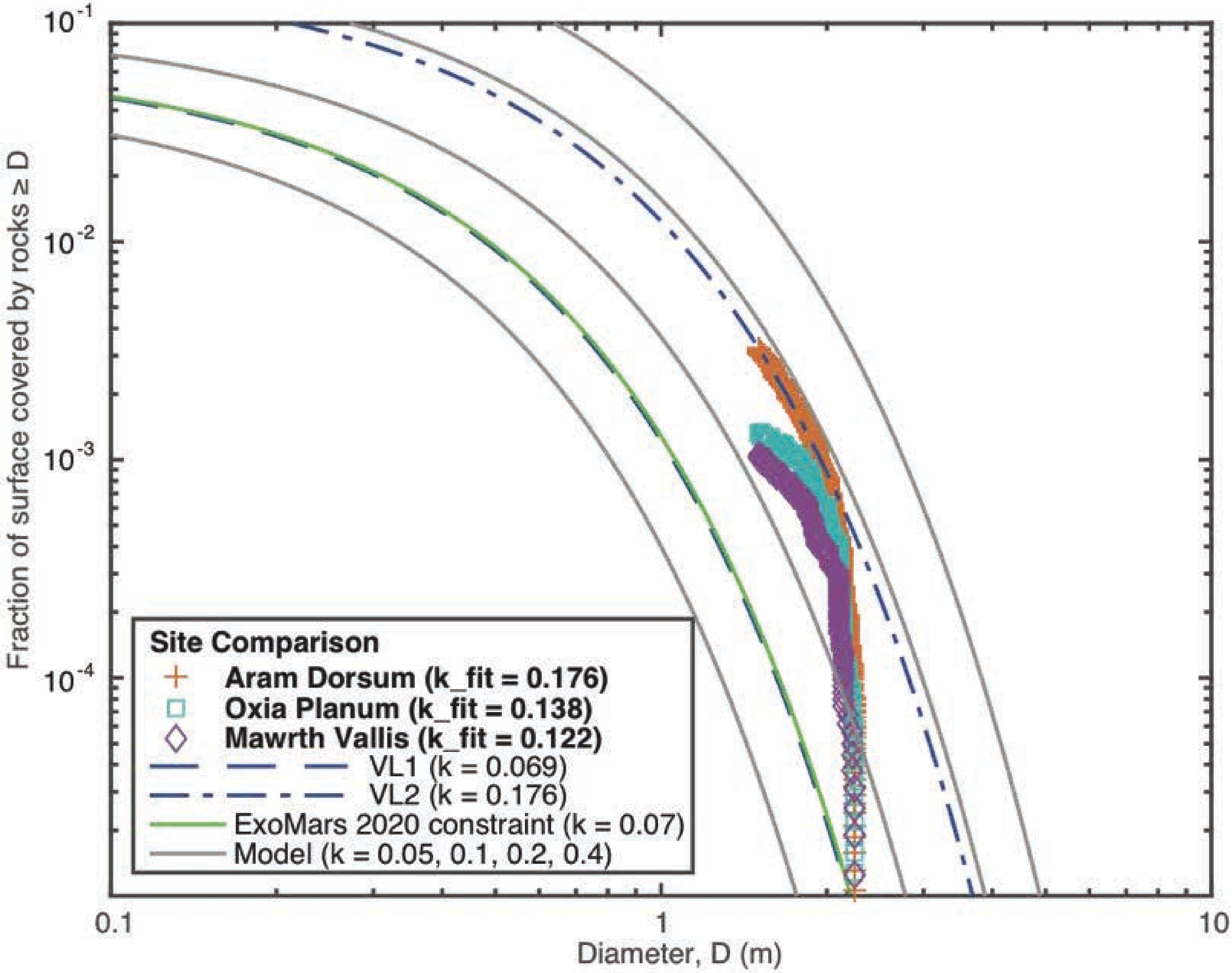
Example: Aram Dorsum

Count ID	Site	Counter	Area ID	Latitude		Longitude	
				Min	Max	Min	Max
87	aram	LK2	47	7.8474	7.8558	348.7971	348.8056





Compiling statistics and comparing sites



Landing Site Study/Workshop Information Online

4th exomars lss workshop

esa

4th ExoMars LSS Workshop » Supporting Materials

- Home
- Registration
- Supporting Materials

SUPPORTING MATERIALS FOR THE 4TH EXOMARS LANDING SITE SELECTION WORKSHOP

In the file browser below you may find documents to support the 4th ExoMars Landing Site Selection Workshop. Two important categories of materials exist:

SITE REPORTS

Prior to the workshop, the proposing teams were provided with a request to assemble and submit an information package regarding various aspects of the site they have proposed.

The responses from each team, and the original request for information, or 'checklist', are available in the 'Site Reports' directory. The Landing Site Selection Working Group and other workshop attendeees are encouraged to review these materials prior to attending the workshop.

PRESENTATIONS

Presentations made at the 2-day workshop are available in the Sol 1 and Sol 2 directories, where they are organised by thier scheduled time as listed on the agenda. Please note that due to file size constraints, embedded videos have been removed from some presentations, and PDFs generated from presentations have been optimized such that very high resolution images are downsampled and/or compressed without significant reduction in fidelity.

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Title	Size
Agenda LSSW4 v12.pdf	290k
Site Reports	--
Sol 1	--
Sol 2	--

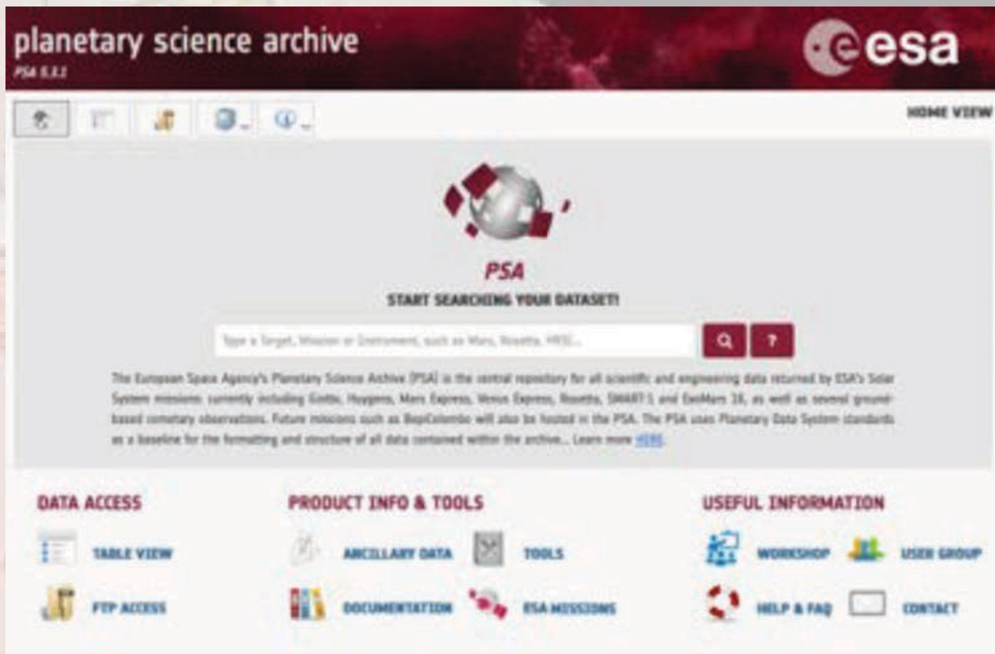
cosmos.esa.int/web/4th-exomars-lss-workshop/supporting-materials

Landing Site Selection Working Group (LSSWG)

- Open call for applications to the LSSWG was announced Nov. 2013
- Membership from the academic science community and experts from ESA ExoMars 2020 Project Team.
- Expertise covers broadest possible range of science to be done by the Rover Surface Platform Mission.
- Interaction via online discussions, teleconferences and face-to-face meetings.

- **Important Responsibilities:**
  - Identify gaps in knowledge. Improve our understanding of landing sites.
  - Run landing site selection workshops to assess science and engineering merits of candidate sites.
  - Making formal recommendations to the ExoMars Project on site selection.

Planetary science data is free and available!



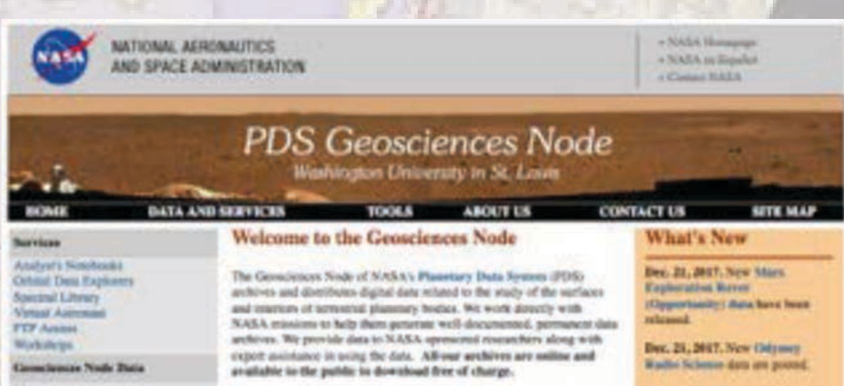
psa.esa.int

hrscview.fu-berlin.de

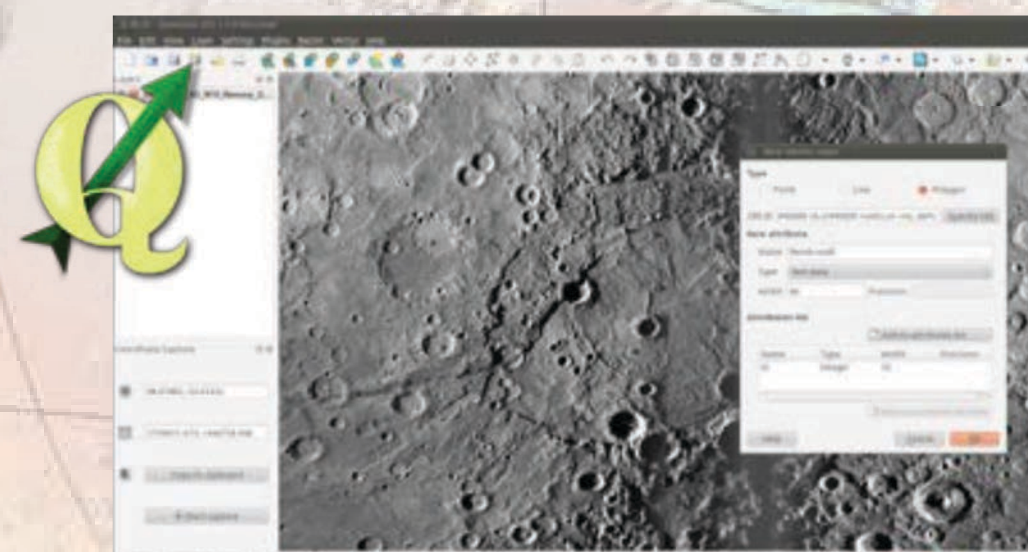
jmars.asu.edu

marstrek.jpl.nasa.gov

astrogeology.usgs.gov



pds-geosciences.wustl.edu



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