Compositional Diversity in Eos Chasma

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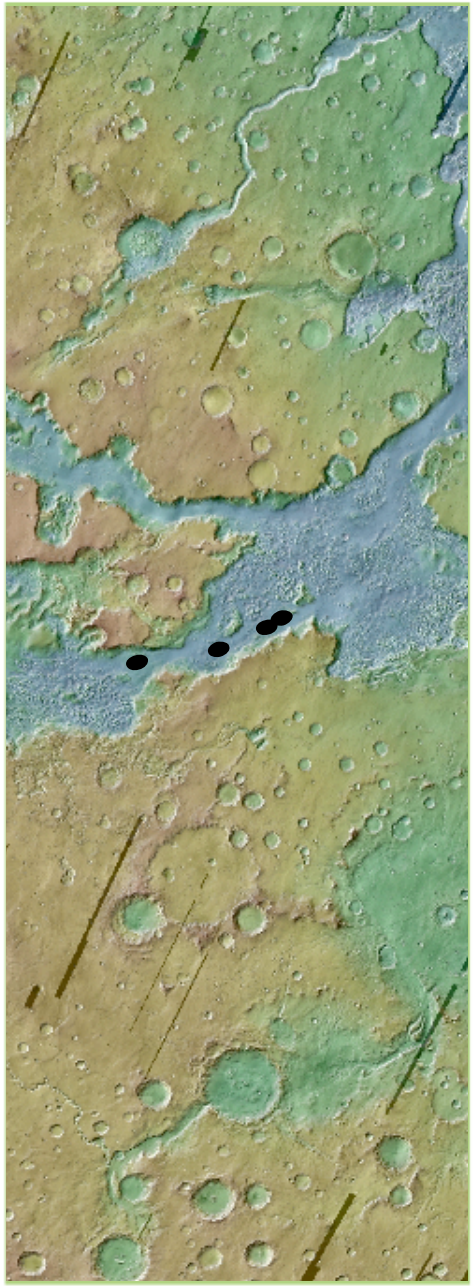
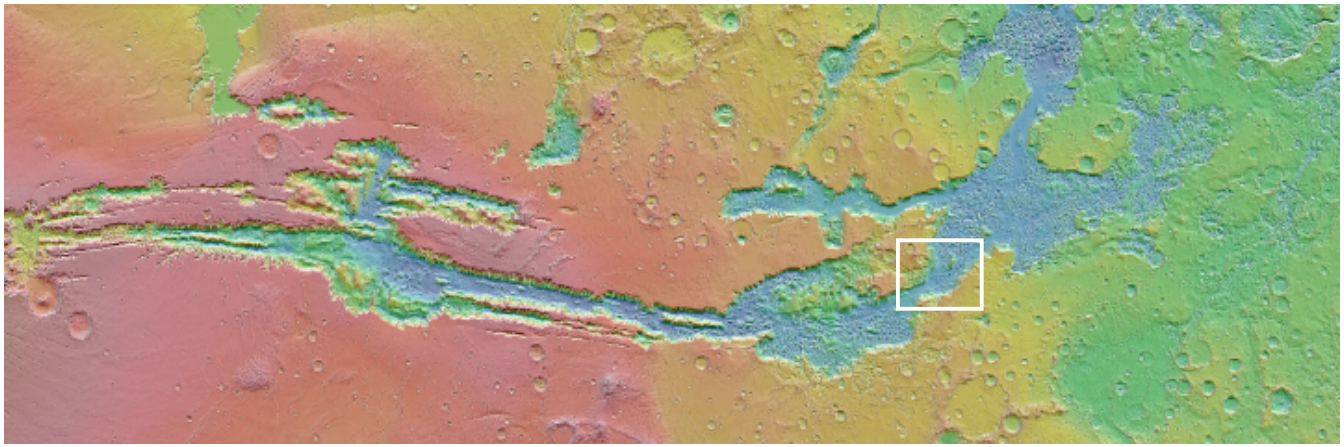
Additional CRISM analysis:
Amy Trueba Knudson



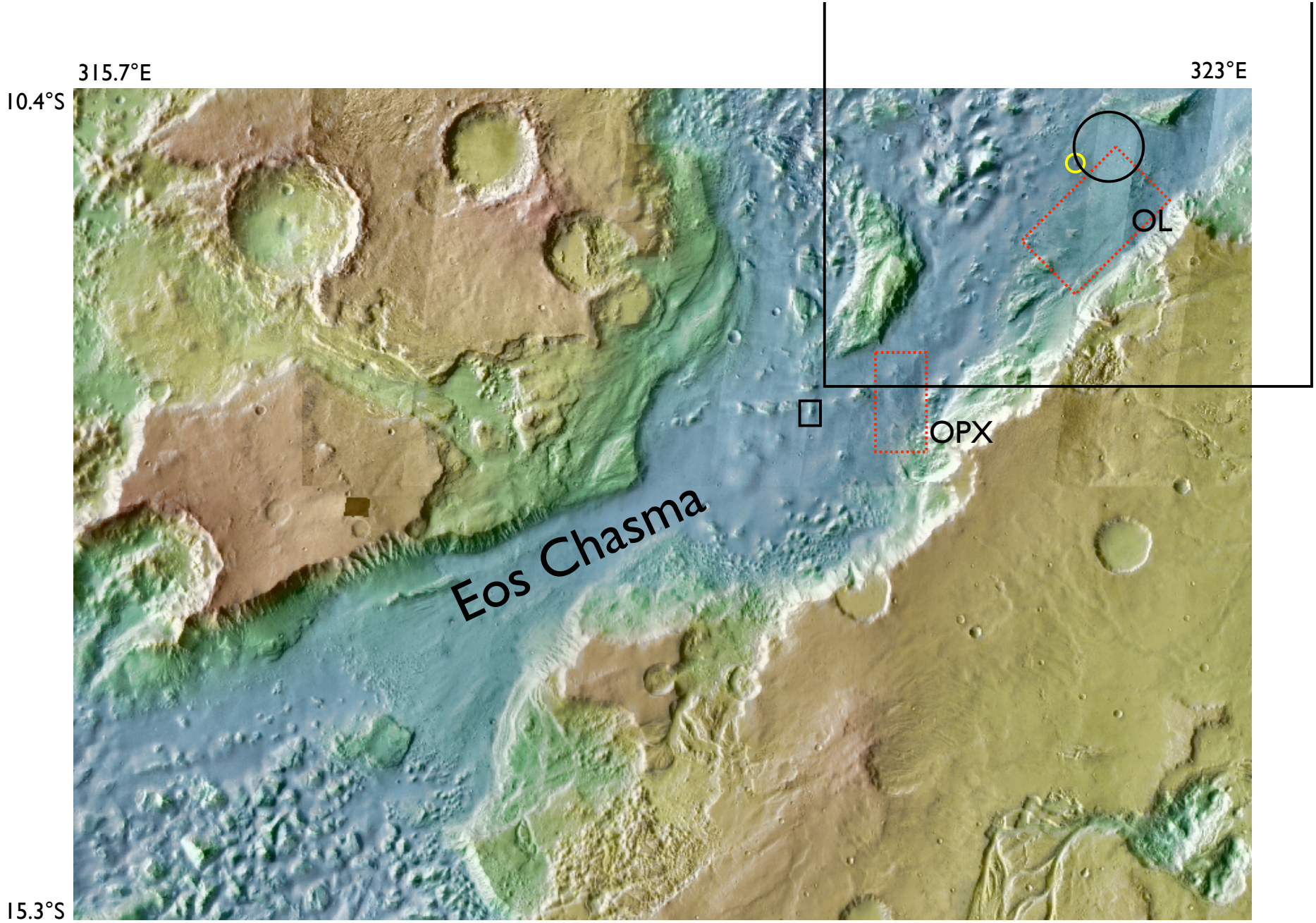
Overview

- Geographic orientation
- THEMIS identification of quartz/silica-bearing materials
- CRISM observations of regional materials
- Quartz/Silica-forming processes
- Images of ellipse/engineering
- Science criteria

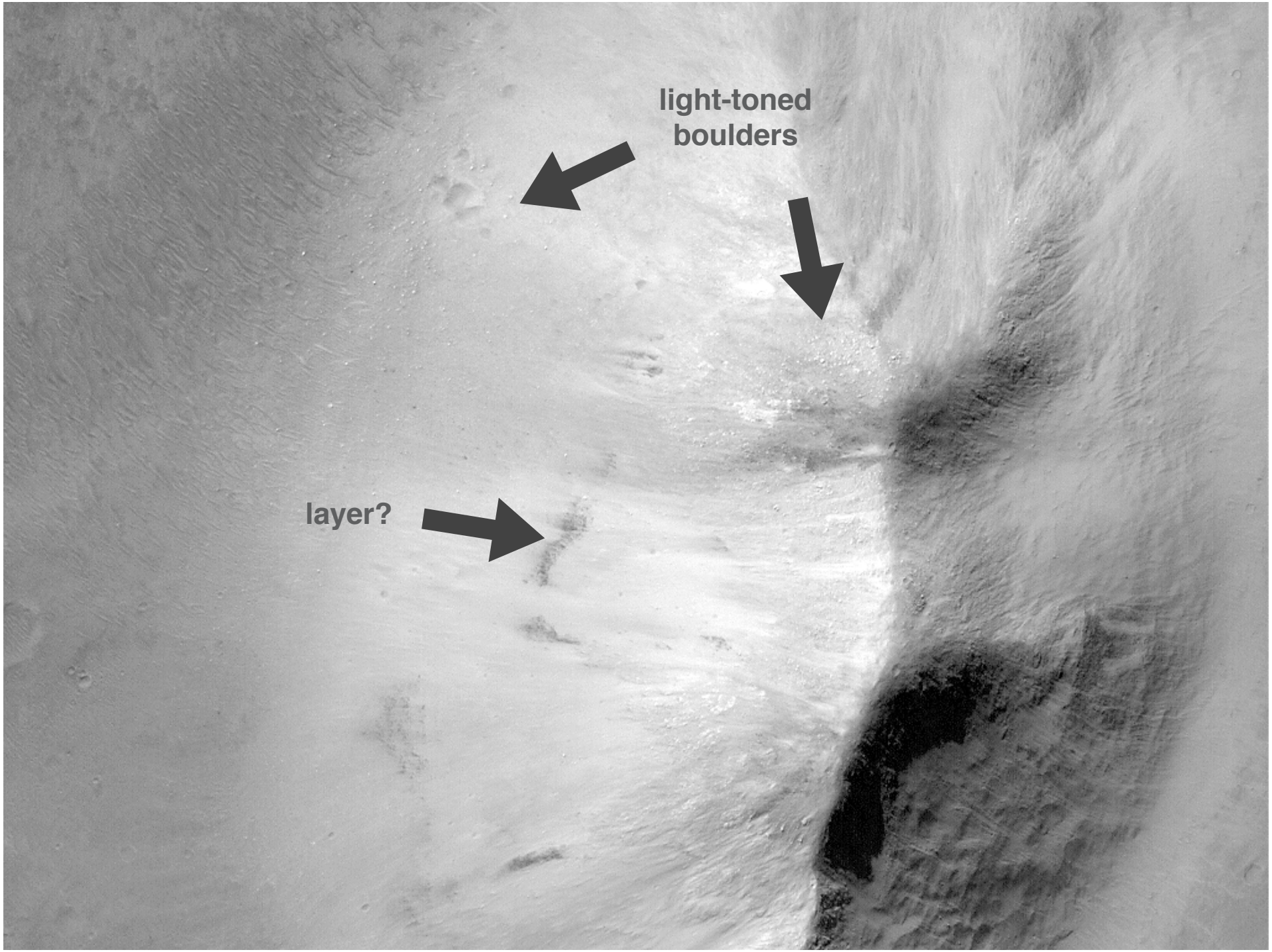


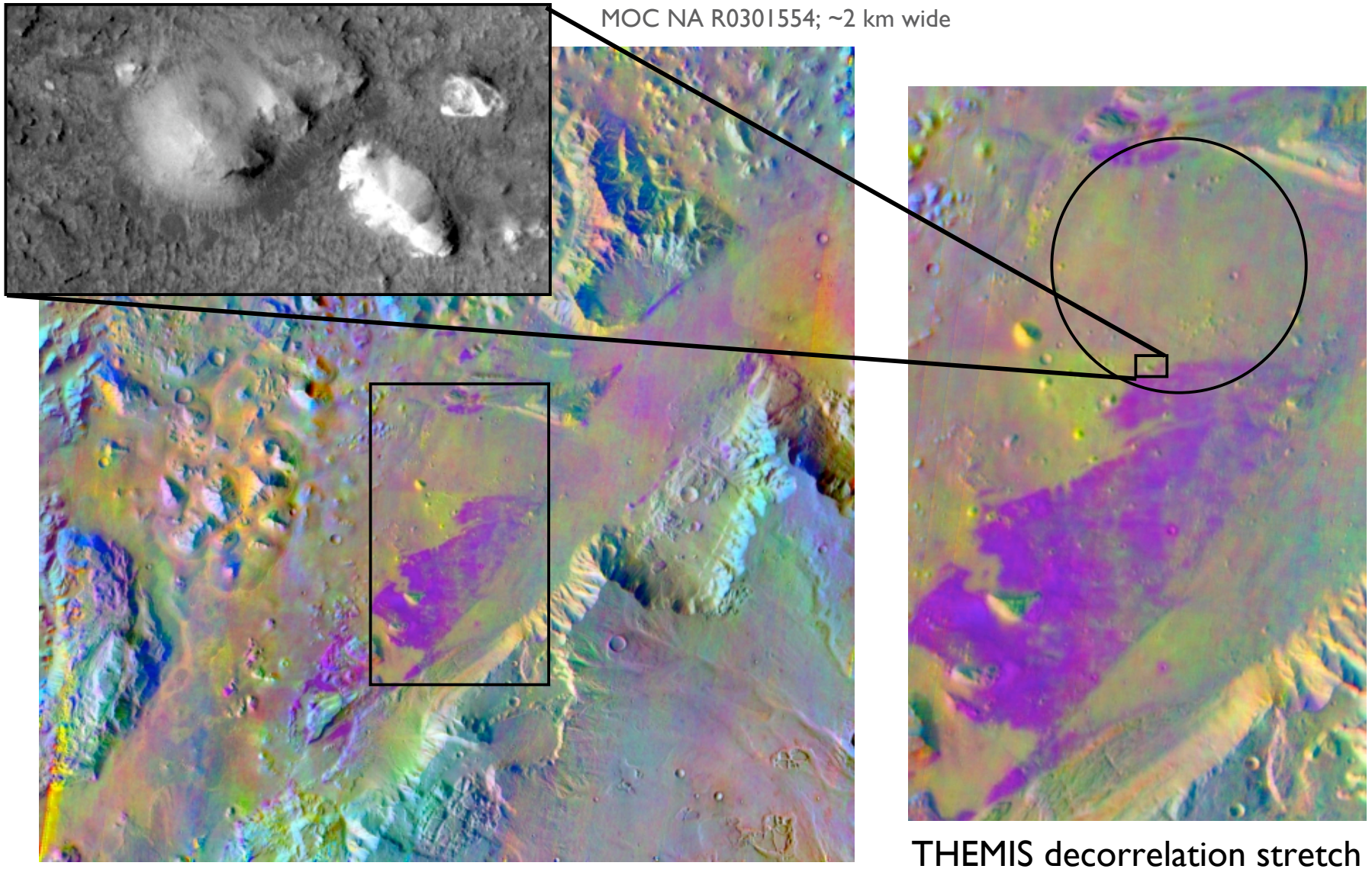
Silica

- Any SiO_2 phase or lithology
- Amorphous SiO_2
  - Volcanic glass (e.g., obsidian)
  - Opals (e.g., opal-A, opal-C, opal-CT)
- Crystalline SiO_2
  - mineral polymorphs (e.g., quartz, tridymite, cristobalite, coesite)
  - rock form (e.g., chert, sinter)
- SiO_2-rich phases? (e.g., feldspar, zeolite)



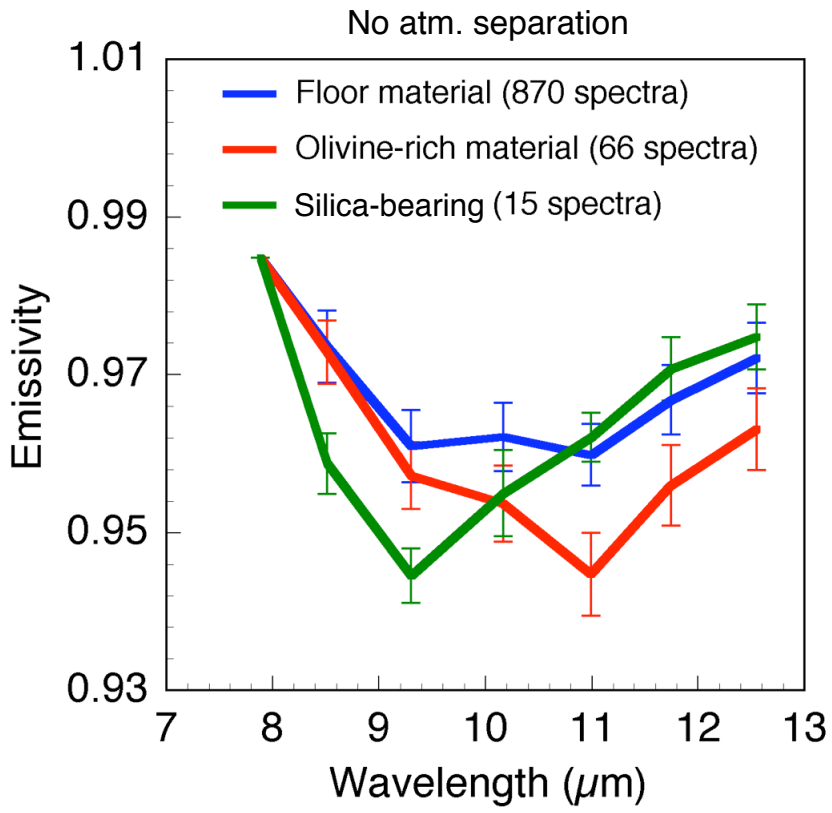
Colorized MOLA elevation over THEMIS IR


light-toned
boulders
layer?

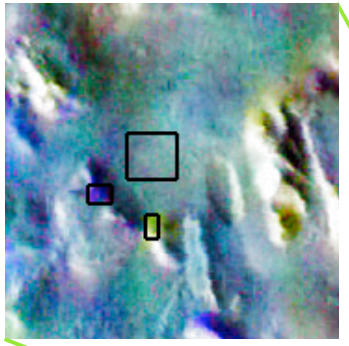


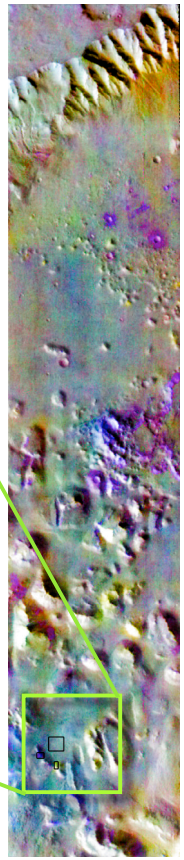
Originally "go to" site, but maybe not.

THEMIS IR Spectra

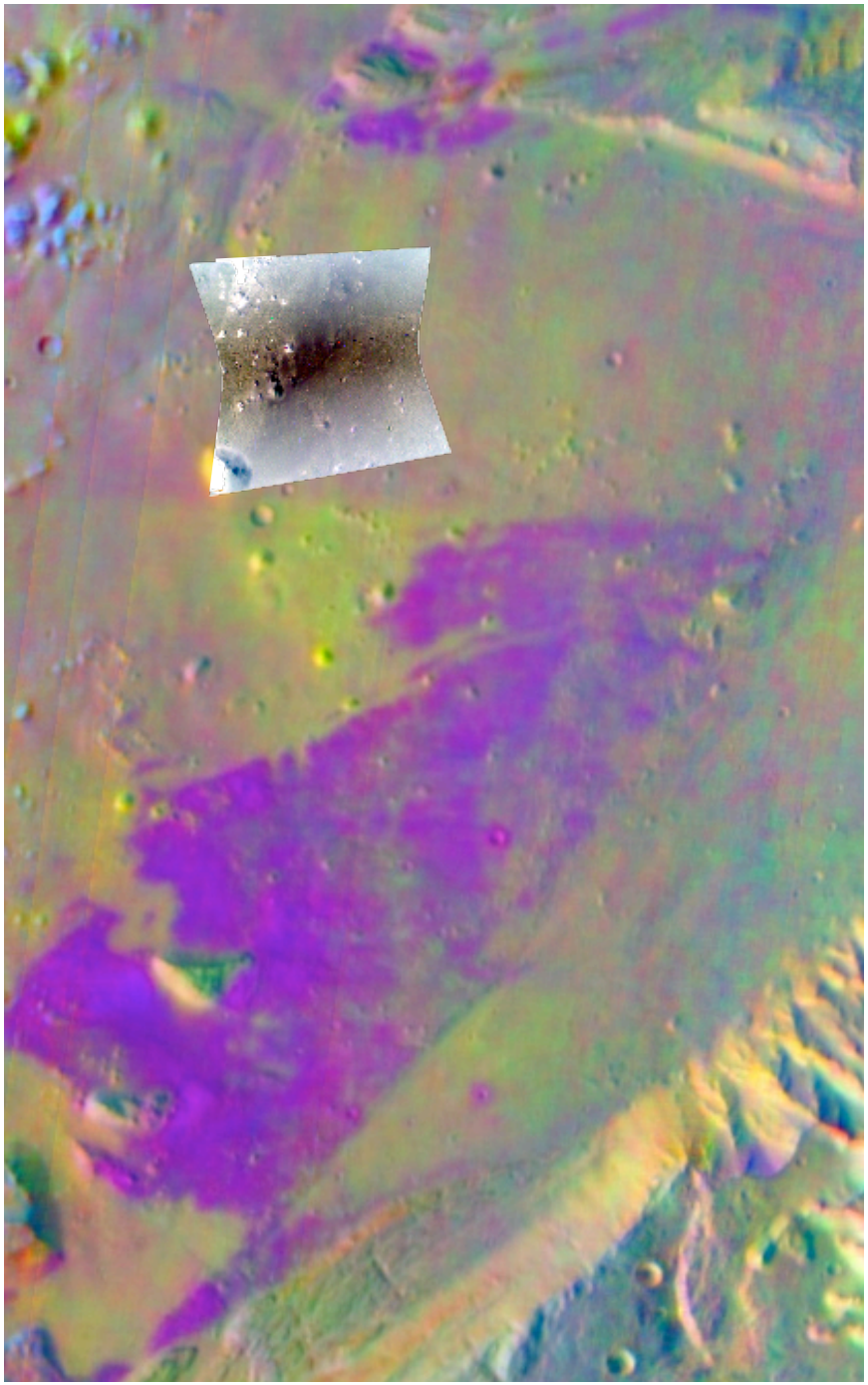


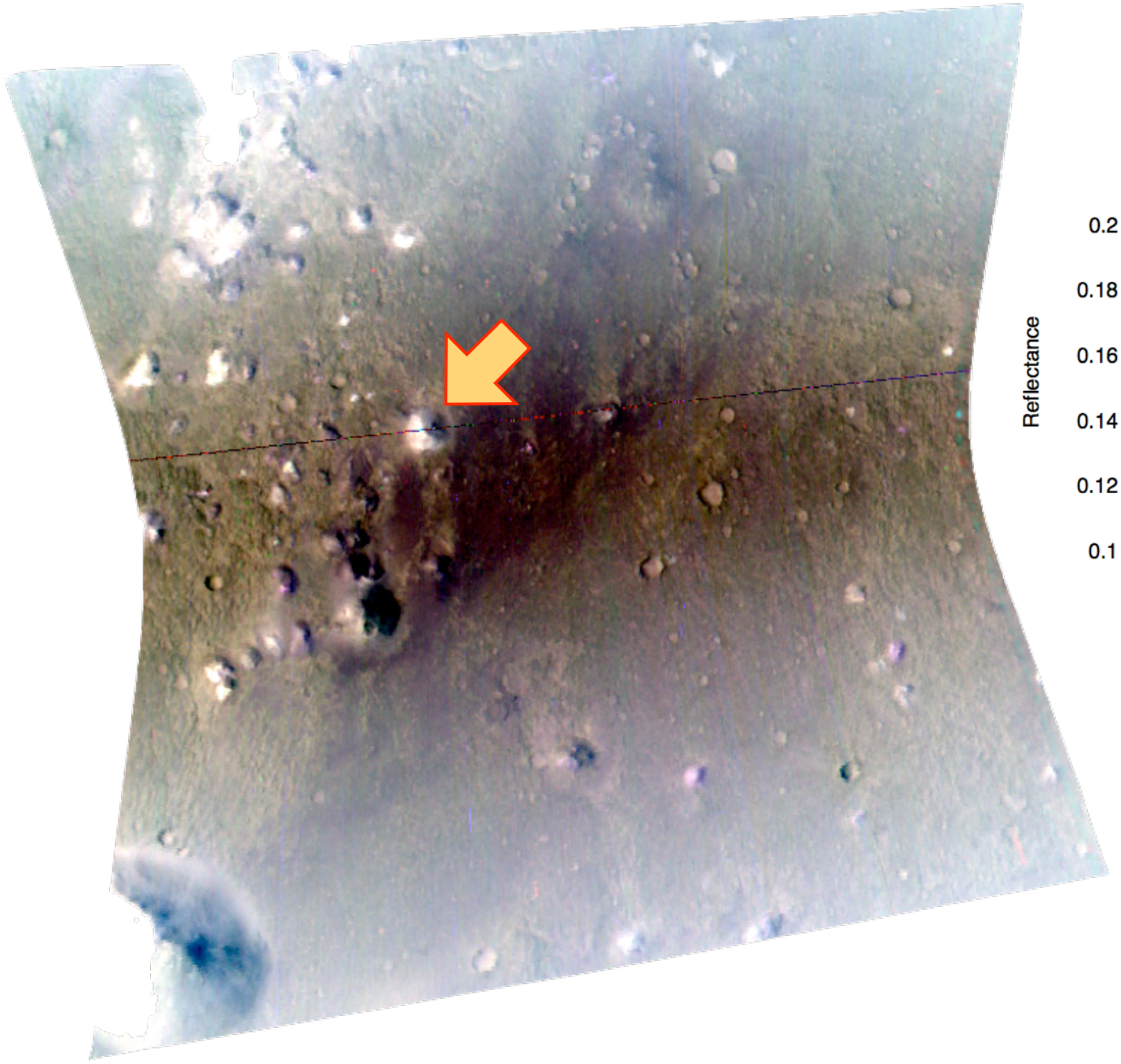
Magenta/Violet: ol-rich
Yellow: silica-bearing

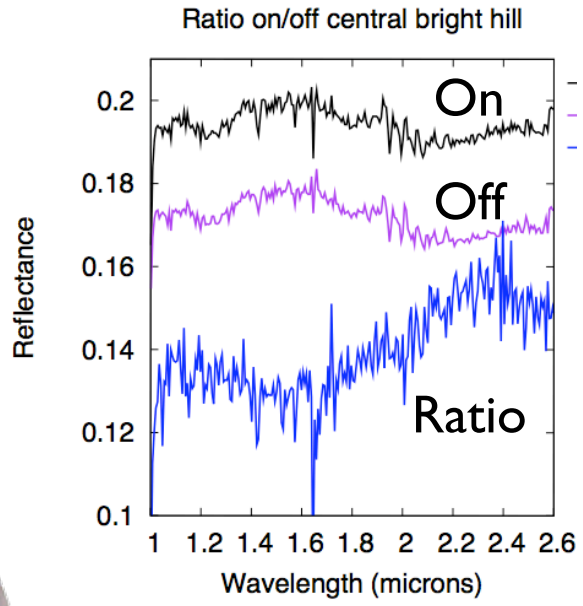




THEMIS I07592002
DCS 8/7/4; ~32 km wide







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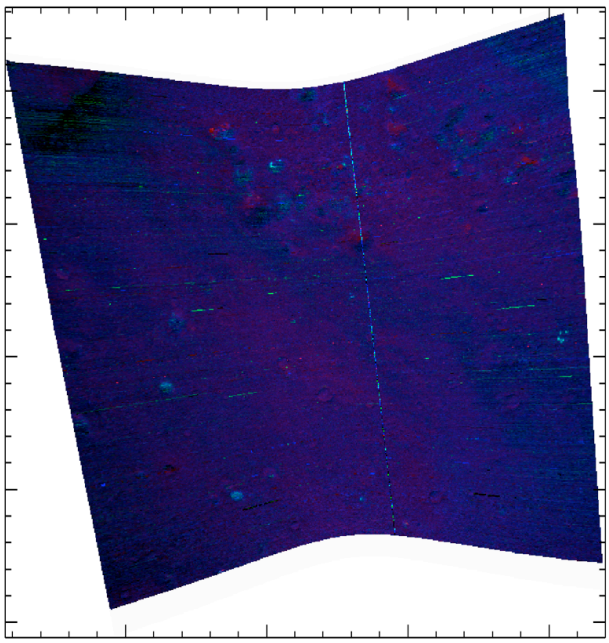
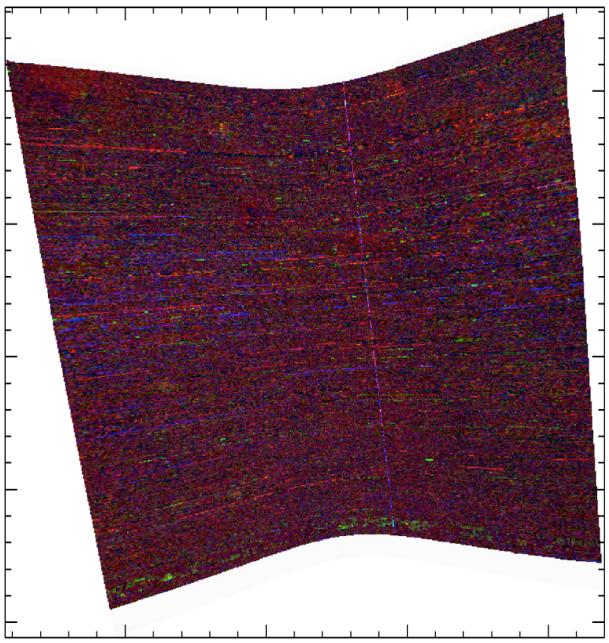
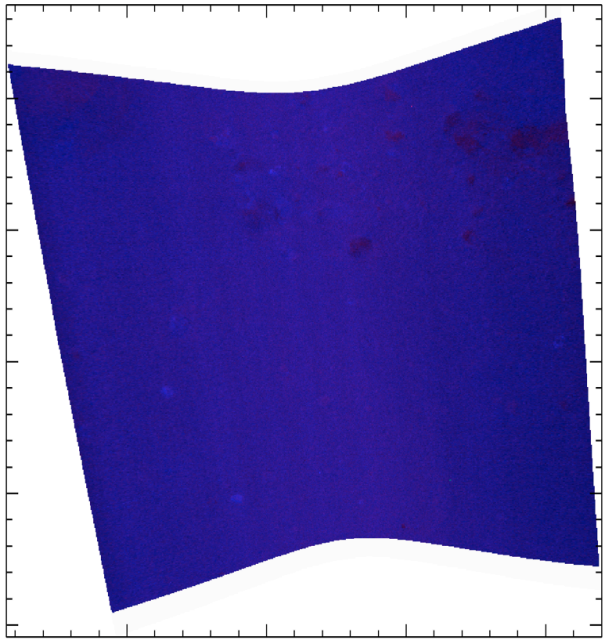
Mafics

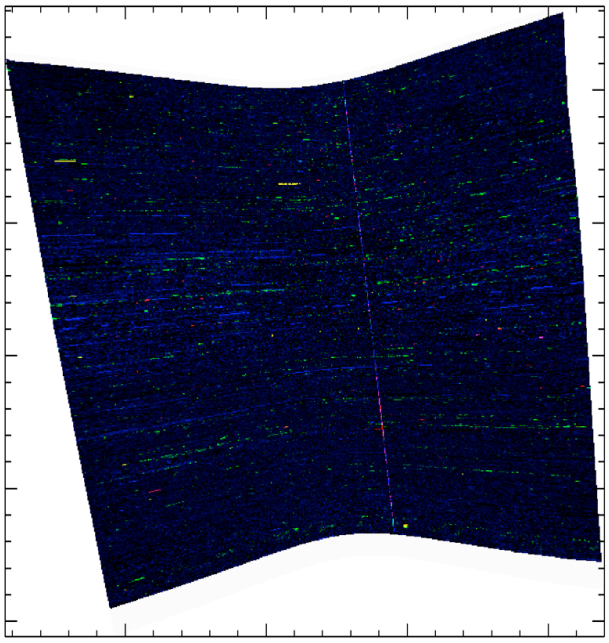


Bound water





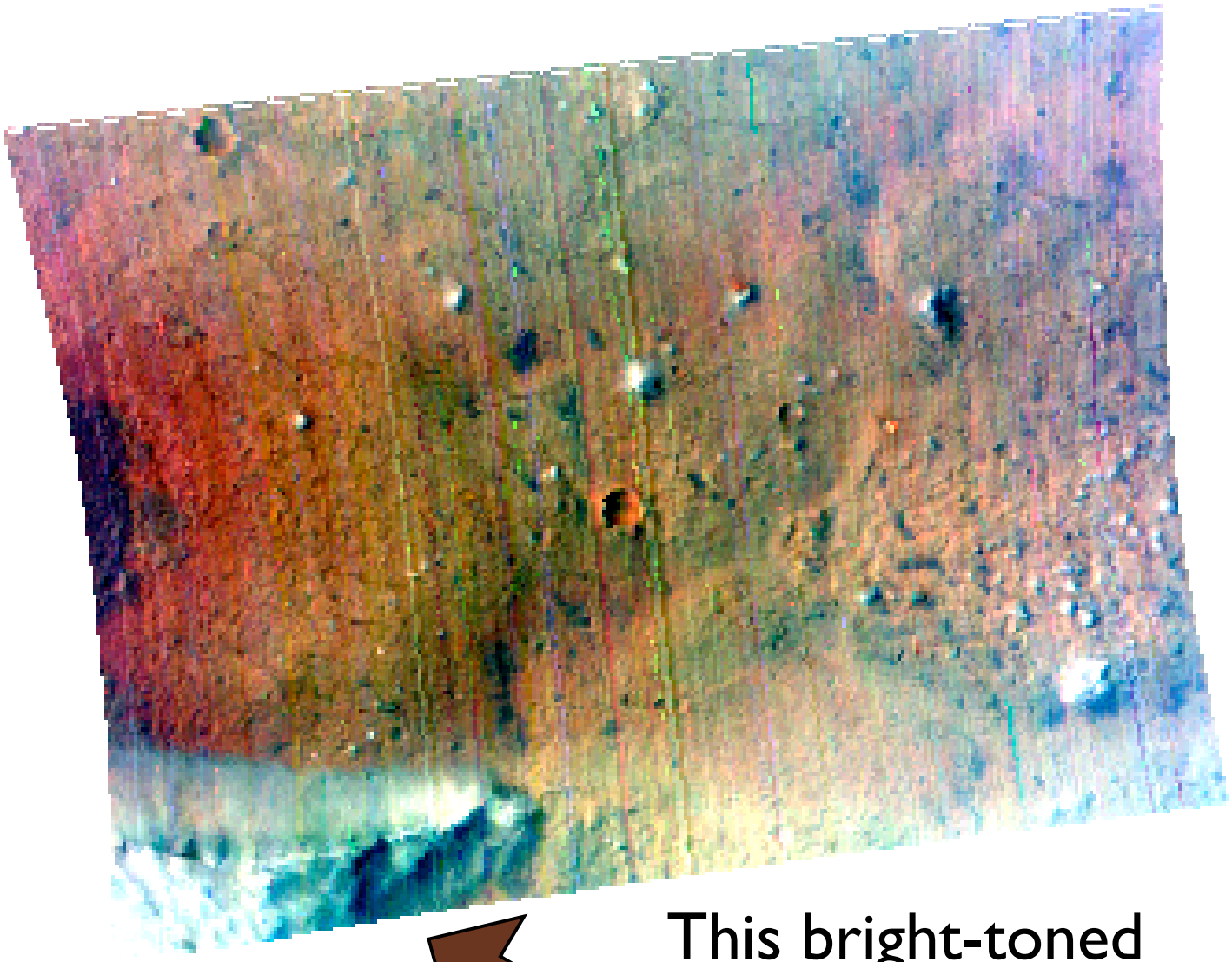
Oxidized Fe minerals



Hydroxylated silicates

VNIR Spectra of Cherts

- VNIR spectra of terrestrial cherts show variable ferric iron, water, other features that are diagnostic
- Not all cherts have strong hydration features, should not expect to detect on Mars



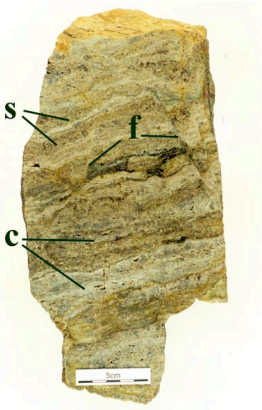
This bright-toned material is mafic-rich!

HRS00003619

Quartz- and Silica-Forming Processes

- A variety of processes produce quartz, and many of these processes involve aqueous activity
  - Evolved igneous activity - crystalline quartz
  - Metamorphism - crystalline quartz
  - Precipitation from hydrothermal fluids - vein quartz
  - Precipitation from ambient fluids - quartz, sinter, "cements"
  - Replacement of evaporites/carbonates - chert (chalcedony)
  - Diagenesis of abiotically precipitated opaline silica - chert
  - Diagenesis of biotically precipitated opaline silica - chert

Bedding plane that has been case hardened by a layer of chert a few millimeters thick [*McBride et al.*, 1999]

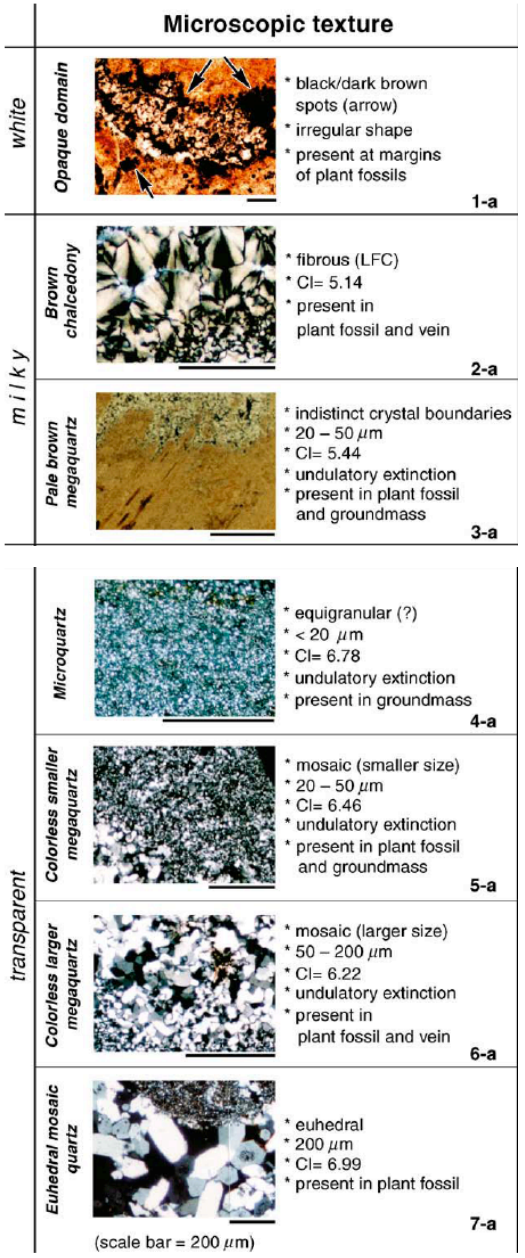


s - sandstone
f - fractures
c - chert

v - vugs
p - plant stems

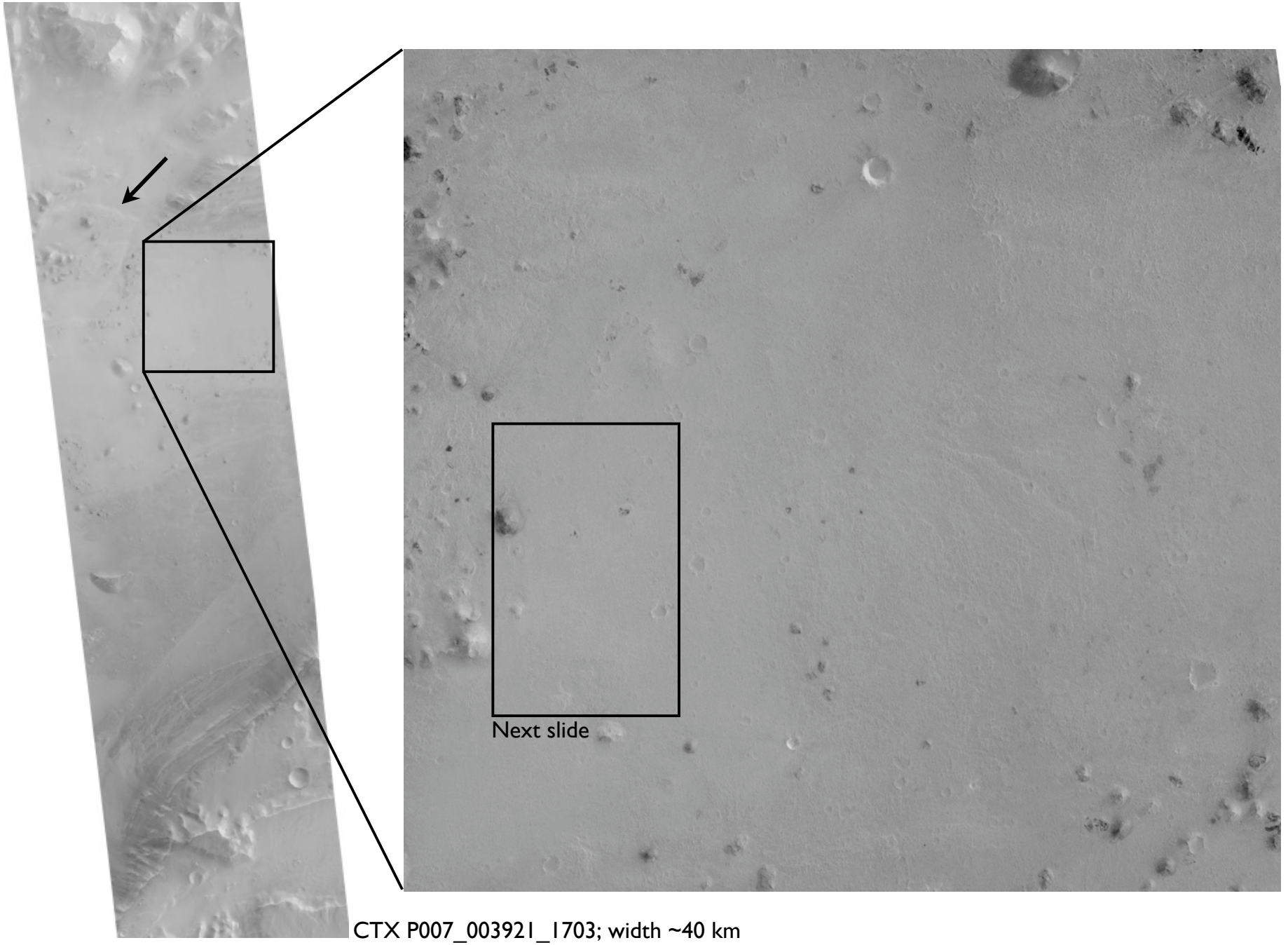
n - nodular chert
b - brecciated chert

Trewin et al. (http://www.abdn.ac.uk/rhynie/texture.htm)

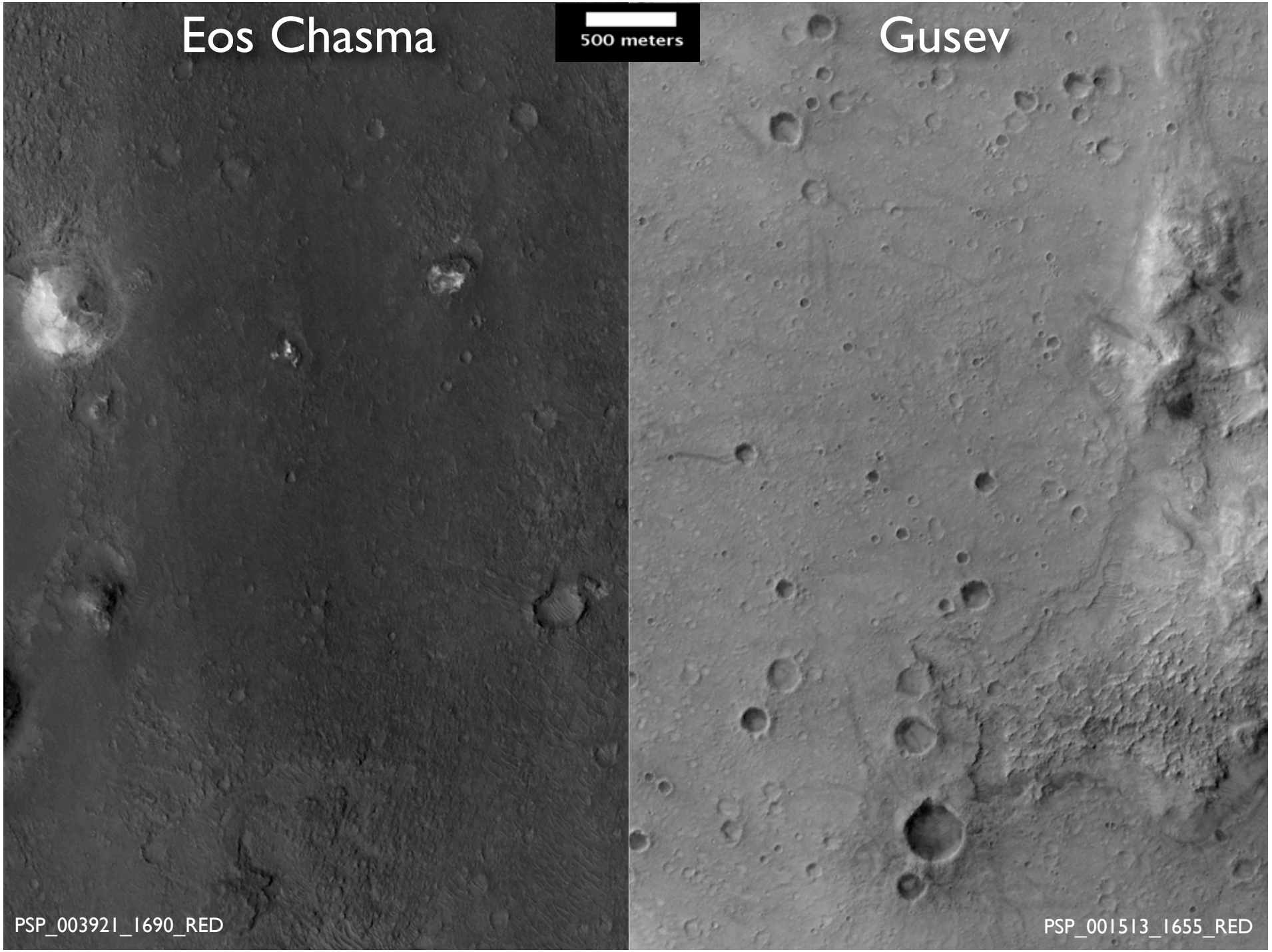


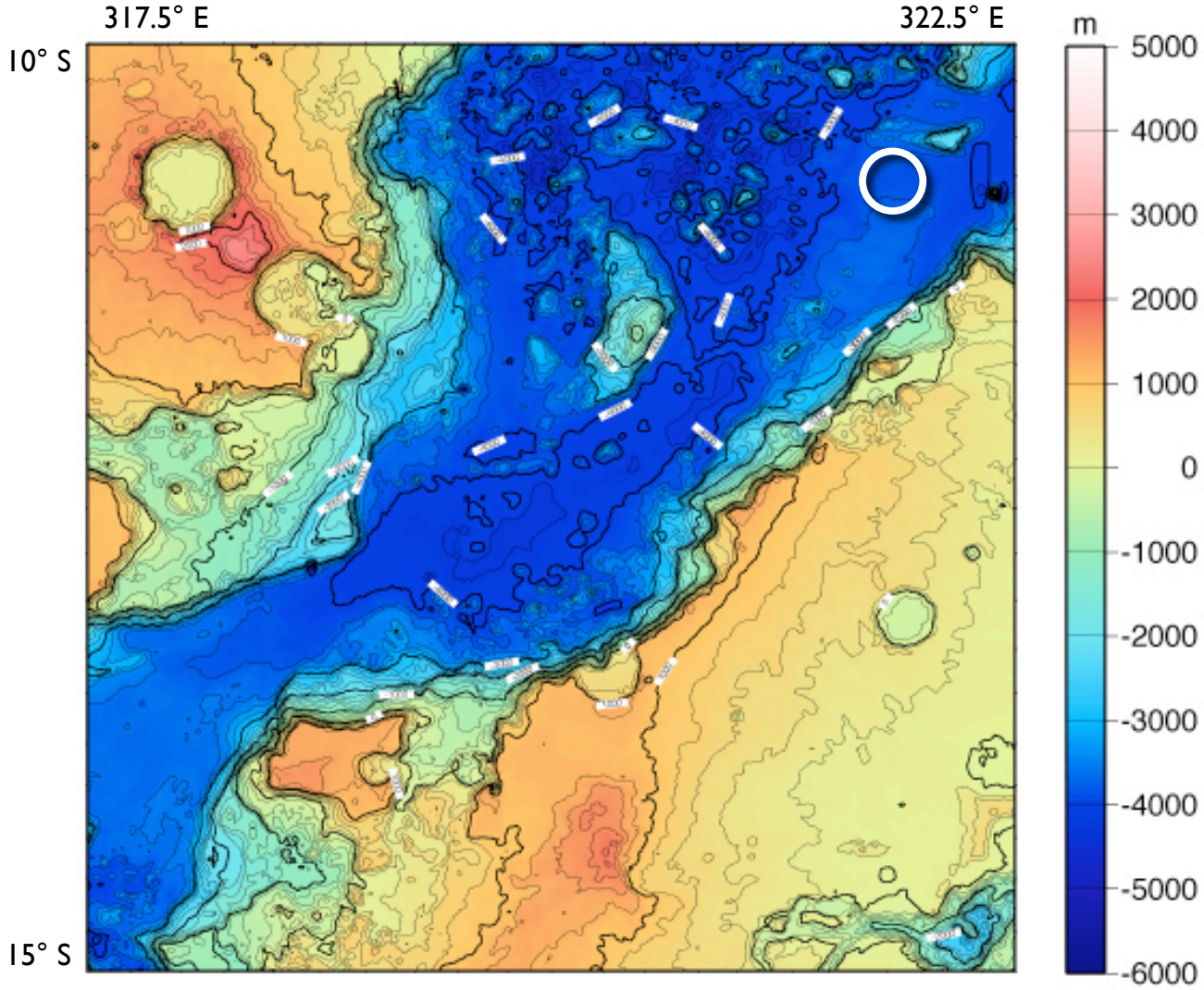
Tests for the Mars Science Laboratory

- The MSL payload can test hypotheses for the origin of quartz and/or silica in situ:
  - What is the distribution of the phase in relation to macroscopic textural features of the rock?
  - What is the structure and chemistry of the phase?
  - What other minerals are present?
  - Are any precursor opaline phases present?
  - Chemical or morphological biosignatures?
- So what about the ellipse?



CTX P007_003921_1703; width ~40 km

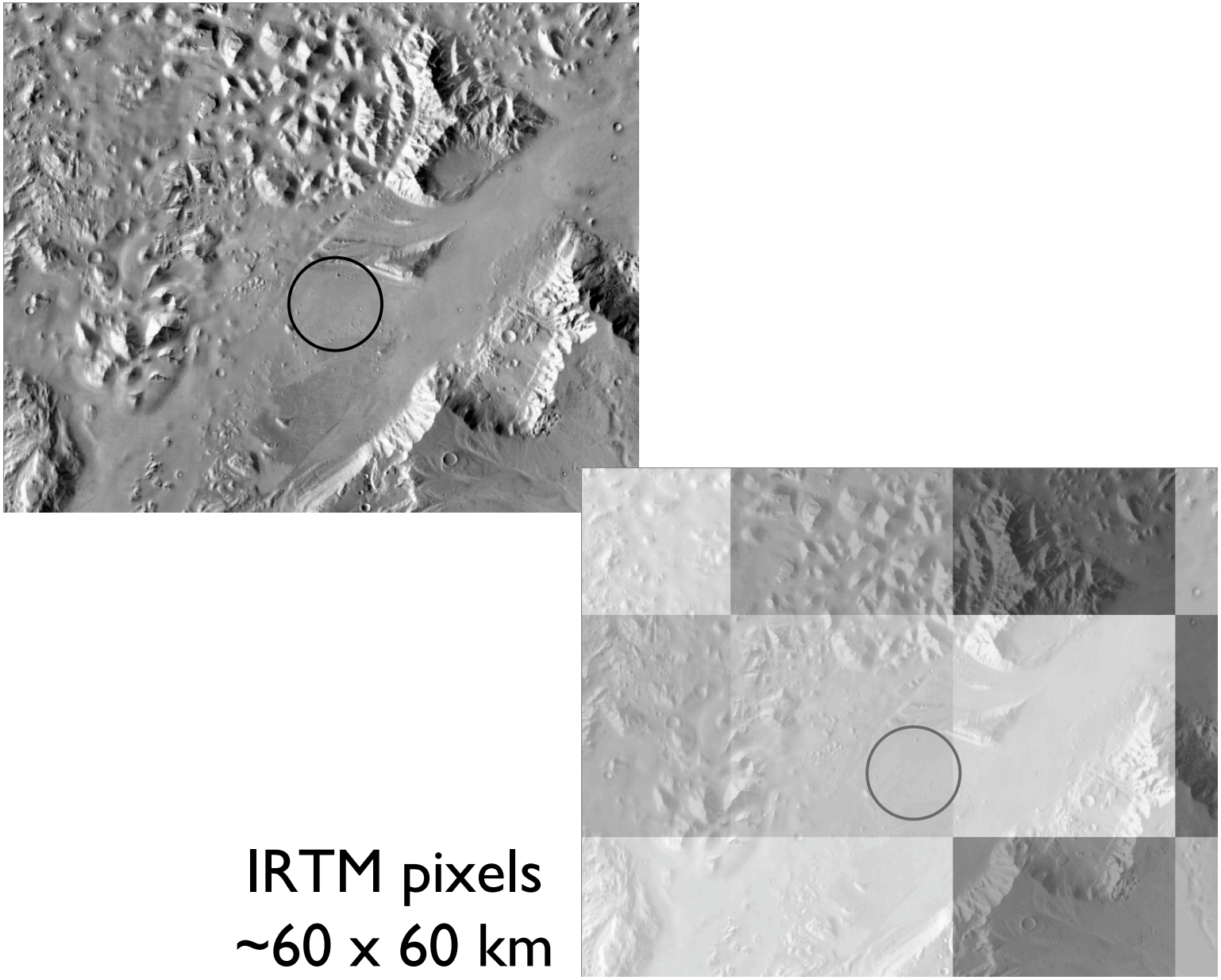

Eos Chasma
500 meters
Gusev
PSP_003921_1690_RED
PSP_001513_1655_RED



MOLA Elevation

Engineering Requirements

Parameter	Requirement	Actual
Latitude	30°N to 30°S	-10.7°
Elevation	≤ +1 km	-3.8 km
Slopes	2-10 km: ≤20°	"green"
	1-2 km: 43 m @1km (2.5°); 720 m @2km	"yellow"
	200-1000 m: ≤43 m relief	"yellow"
	2-5 m	"red" - elevation trade?
Rock Abundance	"low to moderate"	IRTM "red" (but HUGE pixels include walls/mesas of VM)



IRTM pixels
~60 x 60 km

Engineering Requirements

Parameter	Requirement	Actual
Winds (0-10 km)	Steady State Vertical: ≤20 m/s	TBD
Wind gusts	<30 m/s	TBD
Radar Reflectivity	Ka band reflective (> -20 dB and <15 dB)	TBD
Load Bearing Surface	TI >100 SI units	TES TI range: 400 - 520 SI units
	Albedo: <0.25	Albedo range: 0.11 - 0.12

Summary…

- Eos Chasma/outflow region exhibits abundant geomorphic evidence of aqueous activity
- Quartz/Silica-bearing materials identified in Eos Chasma; materials likely present in landing ellipse, some outcrop deposits just in ellipse, others at ellipse edge
- Hypotheses of formation offer a wide range of tests ideally suited to MSL payload
  - Many processes of formation involve water
    - Some mechanisms of formation involve biological processes
      - These mechanisms commonly preserve biomarkers

Science Criteria
Mars Science Laboratory

- *Ability to Assess Biological Potential w/MSL payload*
  - Analysis for organics in silica phase(s), evaluation of texture/structure of minerals will provide clues to environment
  - Outcrops of interest in ellipse, larger outcrops at edge
- *Evidence for habitable environment, aqueous environment, type of habitable environment*
  - Small stream-like features in and around ellipse
  - Not layered (but not lacustrine)
  - Outflow environment style and duration unknown; previous environment unknown; possible groundwater, hydrothermal

Science Criteria
Mars Science Laboratory

- *Preservation of biosignatures*
  - Ranges from very good (chert) to not very good (granite) - a testable hypothesis
  - Just because silica-rich materials may not preserve biosignatures, the environments and water that have affected the area may mean other preserving materials exist
- *Ability to characterize geologic/geochemical context within geologic timescale & geologic/geomorphic setting*
  - Yes, to the degree that ages of canyon floor materials are known
  - LCP- and olivine-enriched materials very nearby - context

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