

Diverse Noachian Environments

Nili Fossae Trough

Nili Fossae Trough: Exploring the Earliest Noachian
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Impact ejecta and impact glass

Hesperian volcanics

Phyllosilicate-bearing infill of Nili Fossae

Strongly altered Noachian crust

Unaltered Noachian crust

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Noachian crust enriched in low-Ca pyroxene



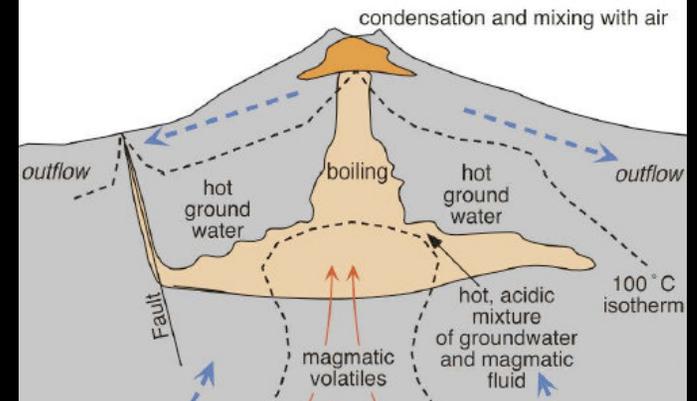
Noachian crust enriched in phyllosilicate

Multiple, Distinct Environments

- Noachian period of phyllosilicate formation
- Hydrothermal systems
 - Fractures as transport pathways for water, mineralization in fractures
- Sedimentary units
 - Infill of trough, formation of sapping channel
 - Regionally, layered units in crater floors, troughs
- Subsurface groundwater or shallow crustal environment
 - Protected from destructive radiation environment
 - Abundant chemical energy sources
 - Evidence for fluid flow in the crust/groundwater
- Impact Glass: high biosignature preservation potential

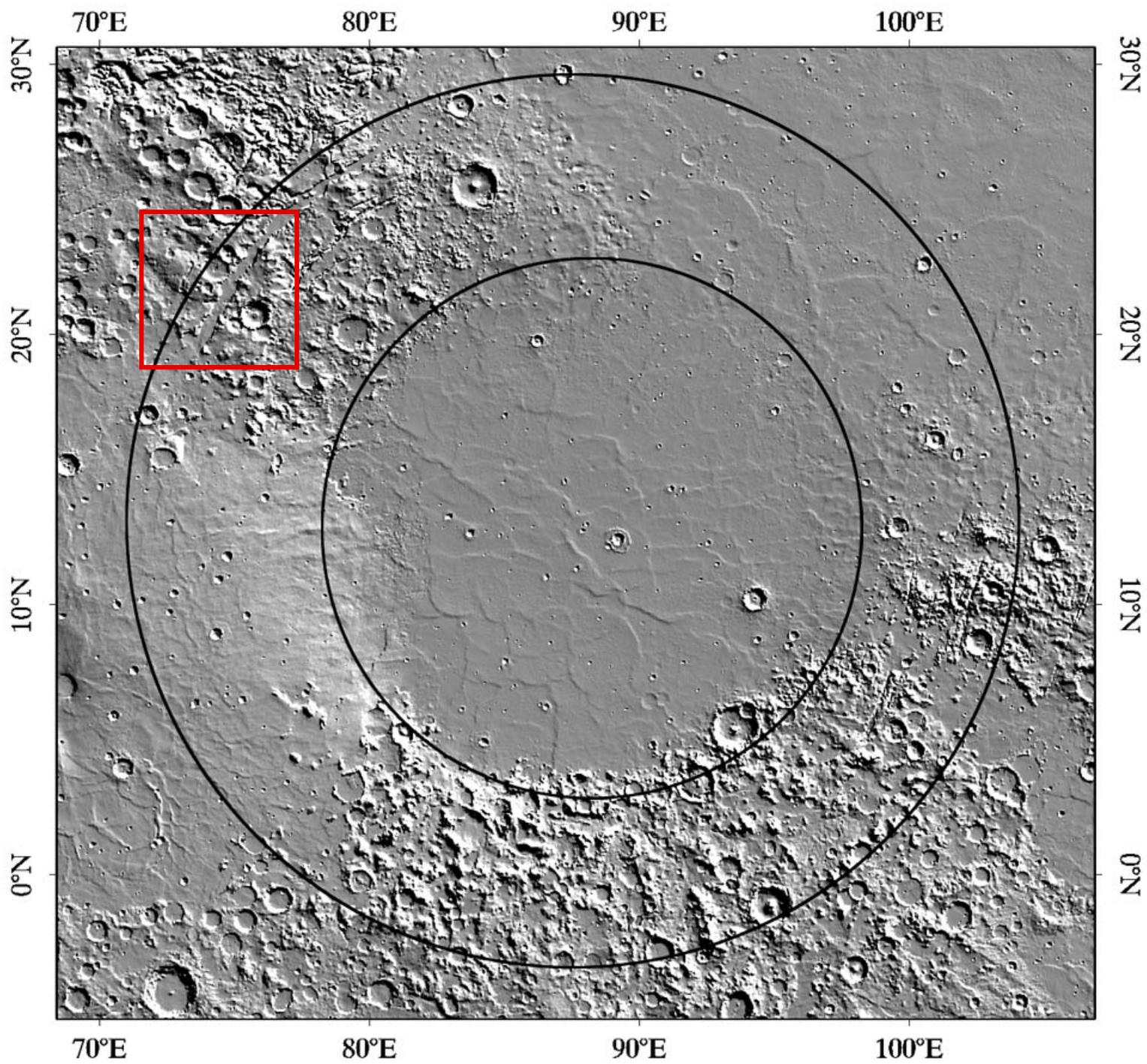


courtesy Mark Allen

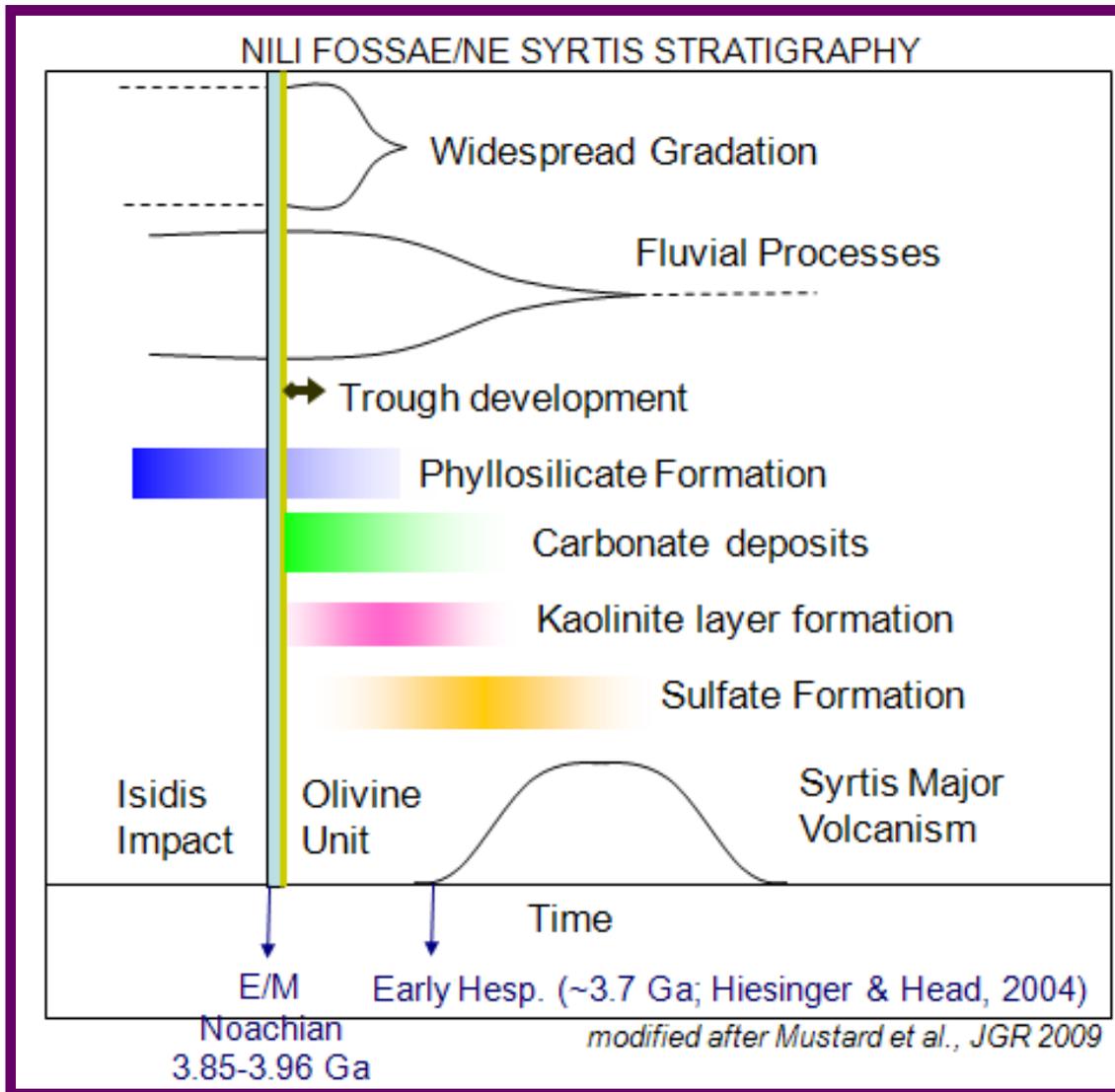


Broad Mars Scientific Objectives

- Noachian Habitable Environments
 - Ancient crust
 - Fluvially transported sediments
 - Hydrothermal systems
- Impact processes
 - Superbly exposed ejecta from 65 km Hargraves crater
 - Ejecta blocks in a phyllosilicate-bearing matrix
 - Probably impact melt: high preservation potential
- Composition and character of ancient, unaltered crust
- Composition, mineralogy, and texture of Hesperian Syrtis Major lava: A datable cratered surface the time stratigraphic marker
- Traverse the Noachian-Hesperian Boundary



Stratigraphy and Processes in Isidis-Nili Fossae

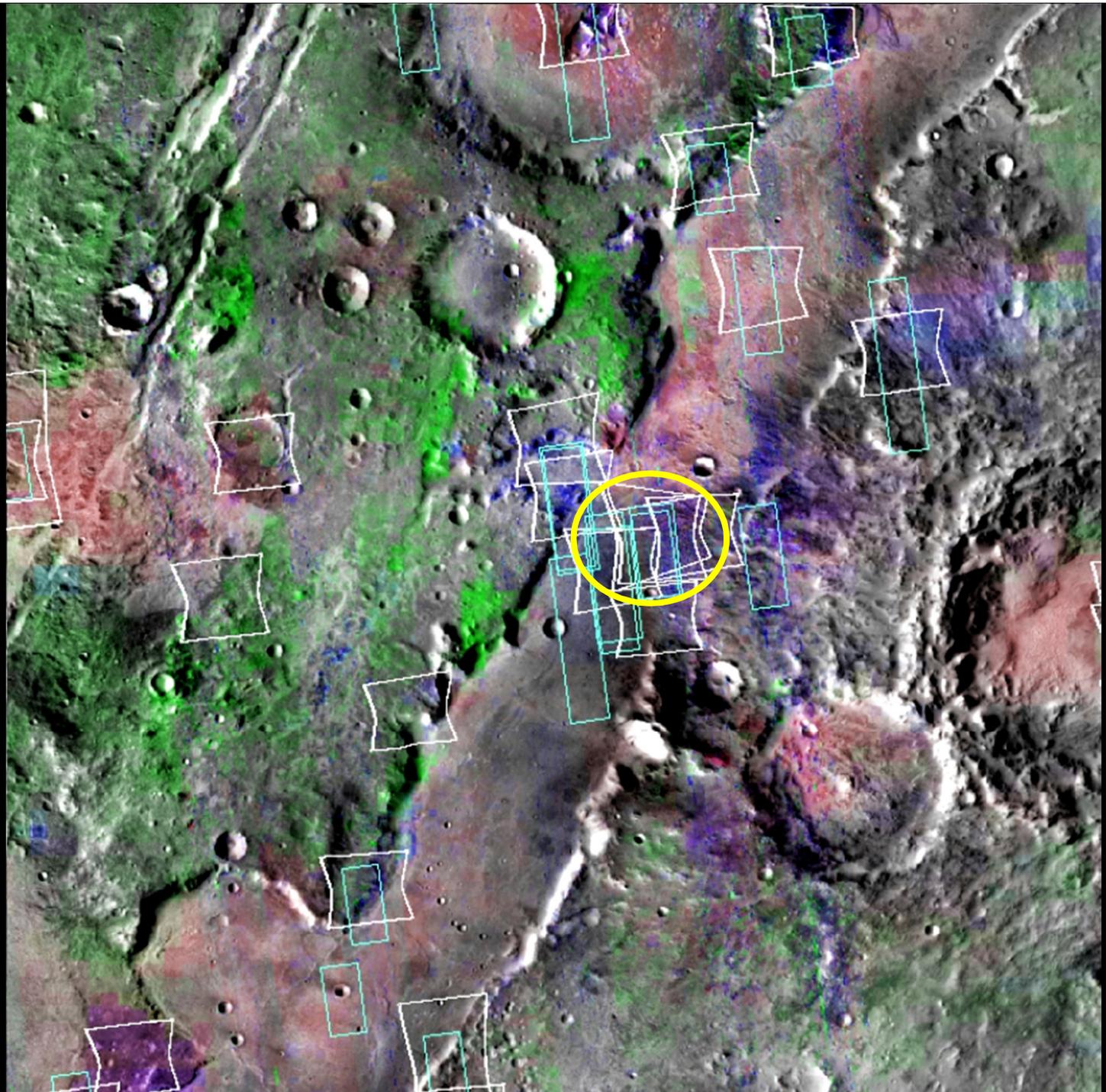


Isidis Basin and Syrtis
Major lavas are major time-
stratigraphic markers

Significant gradation
(sedimentary? aeolian?
alluvial?) between Isidis
basin formation and Syrtis
lava emplacement

Clearly defined wet periods

- Olivine
- Low-Ca Pyroxene
- Phyllosilicate
- Fe-Phyllosilicate

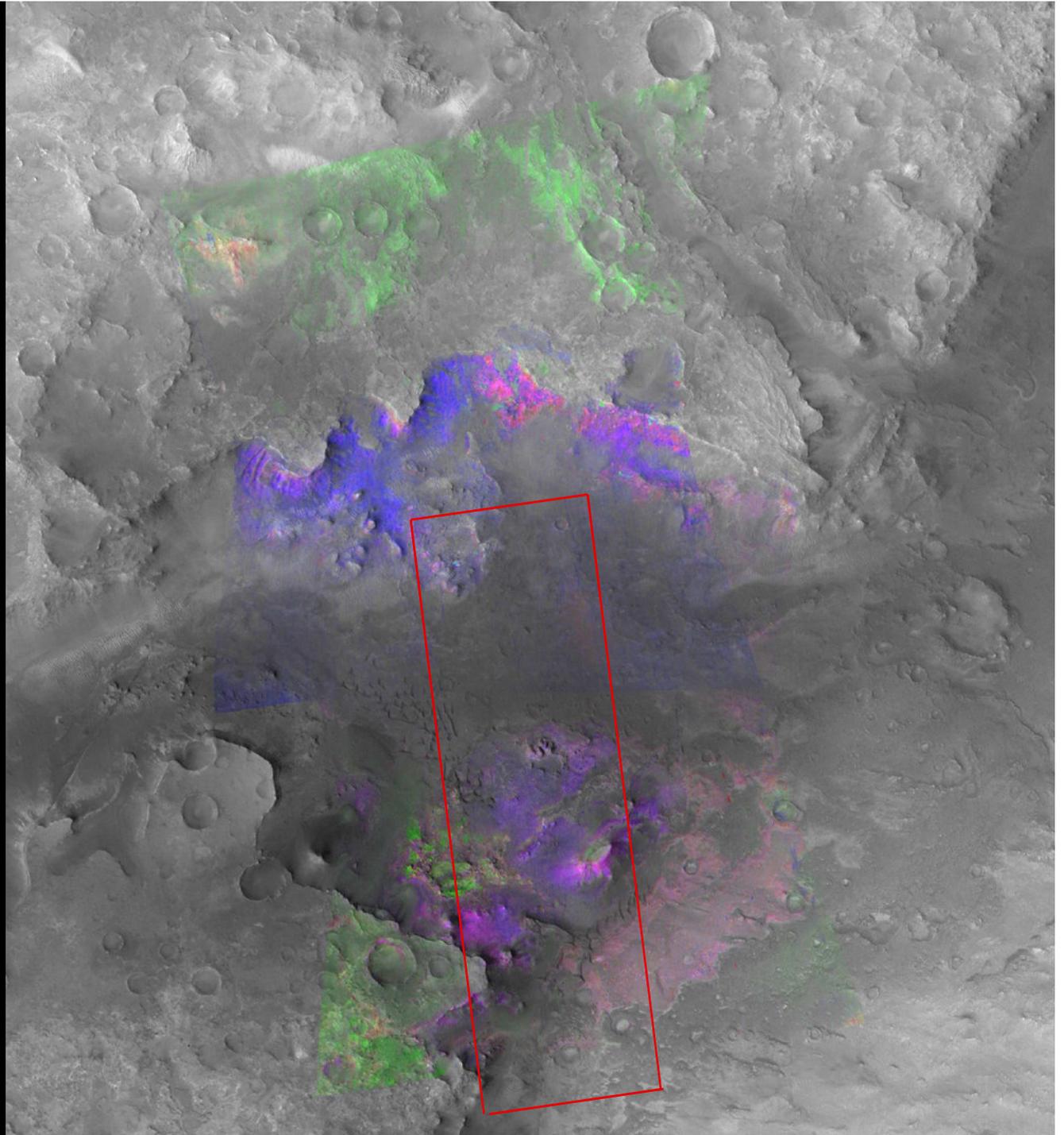


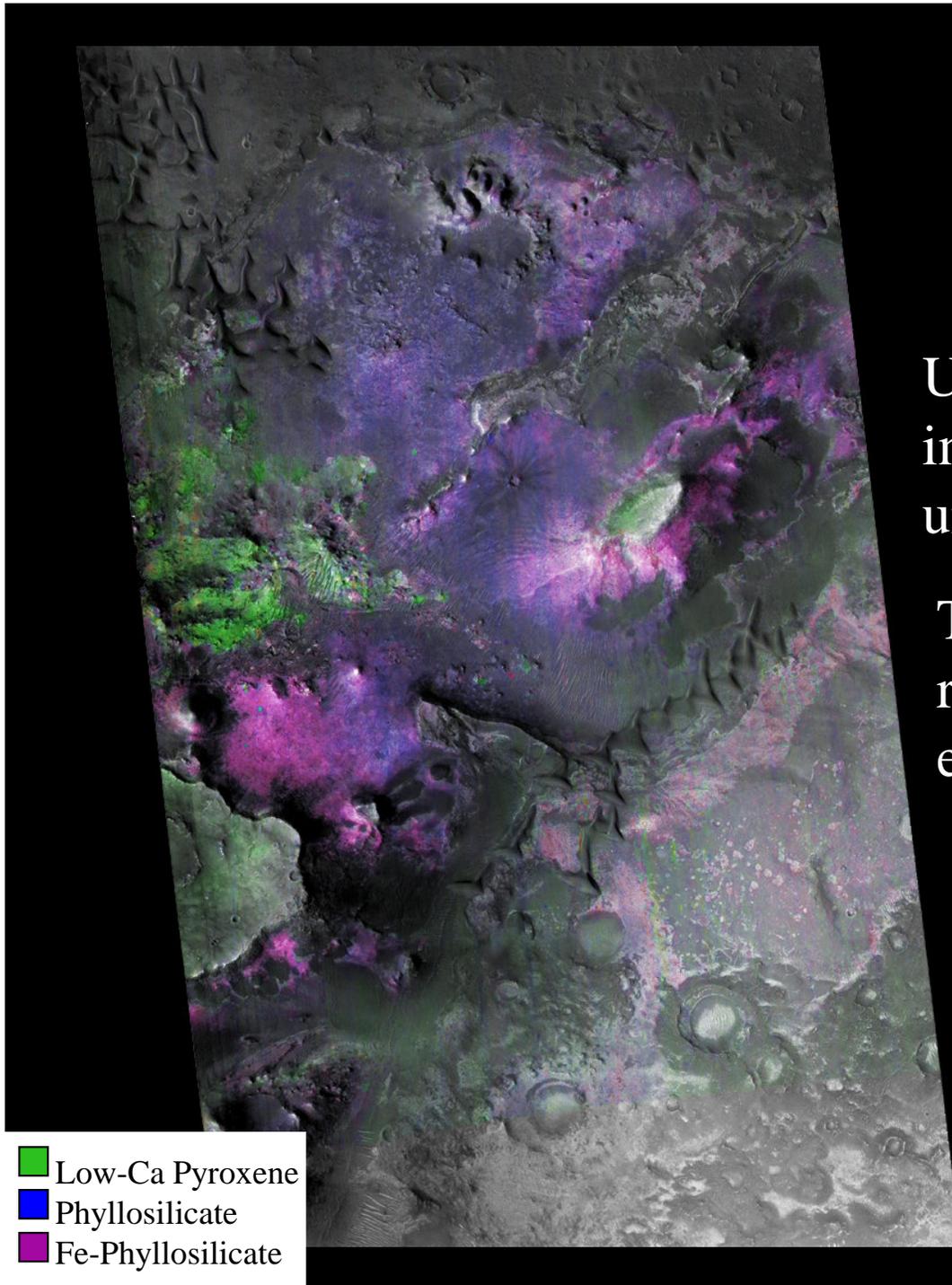
-  Olivine
-  Low-Ca Pyroxene
-  Phyllosilicate
-  Fe-Phyllosilicate

CRISM Observations

FRT00007BC8

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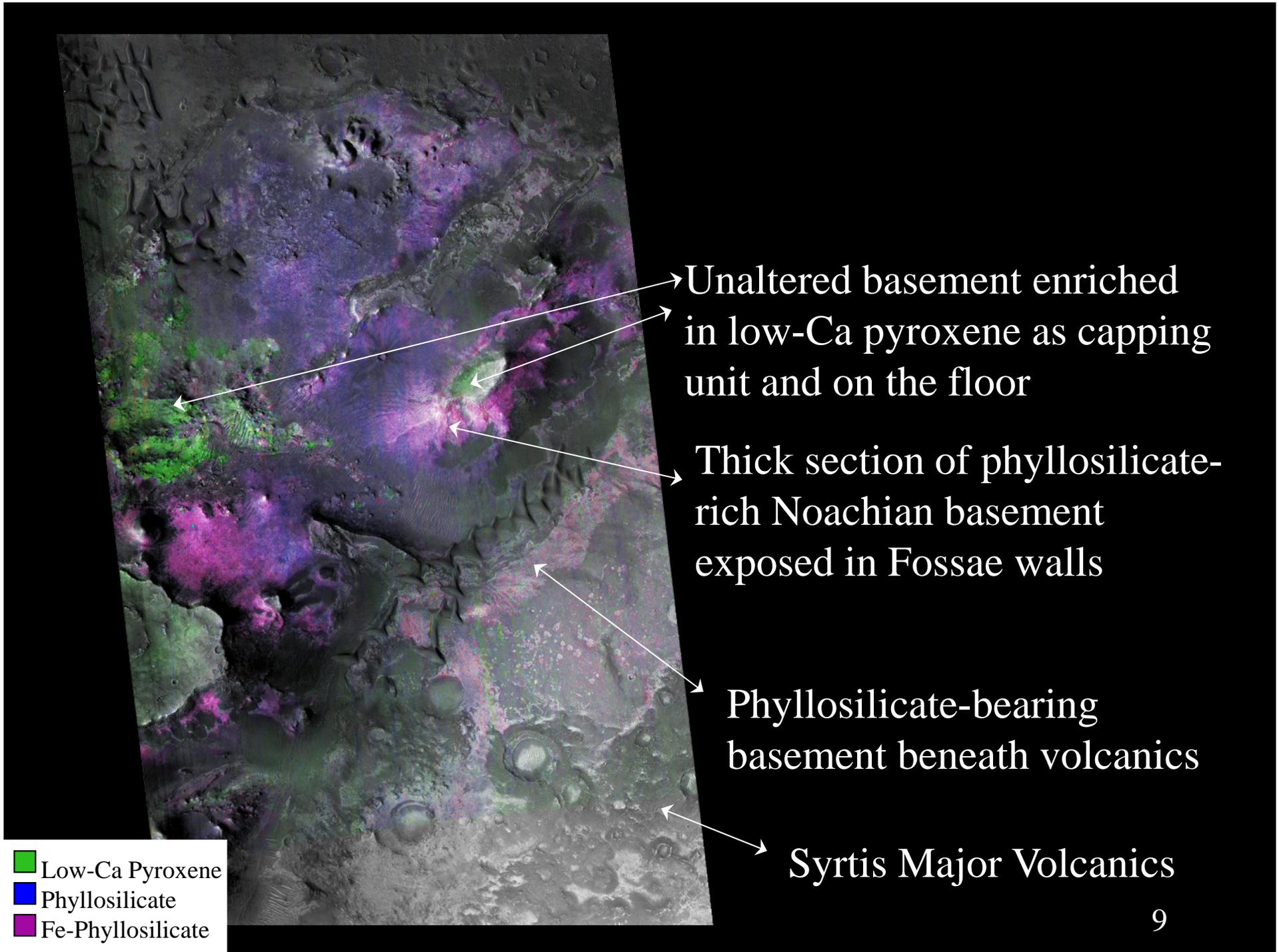


Unaltered basement enriched
in low-Ca pyroxene as capping
unit and on the floor

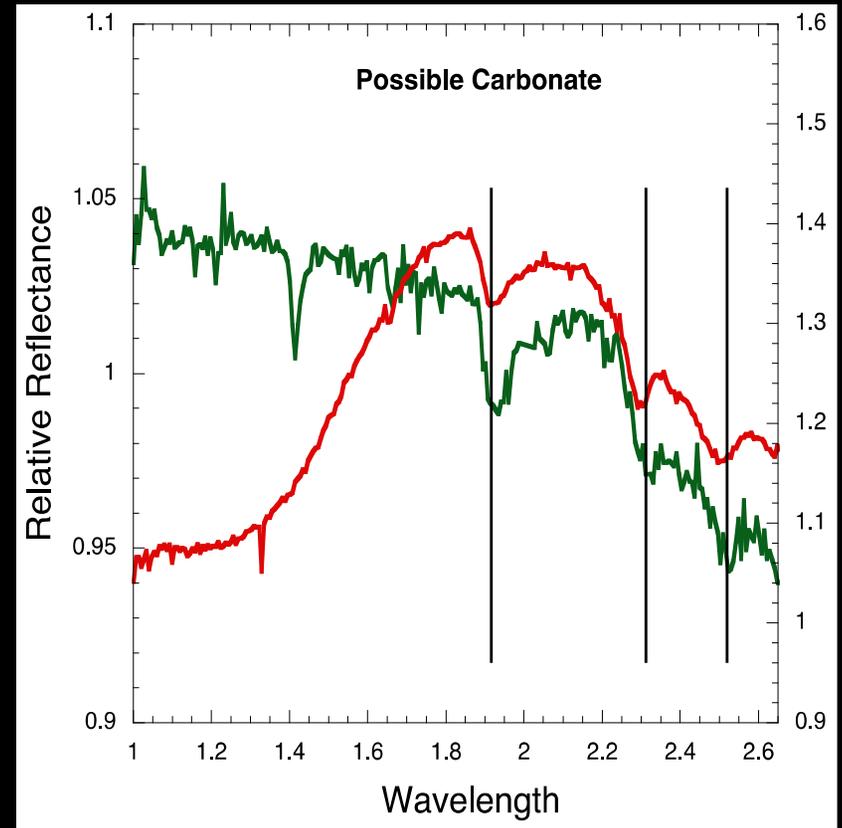
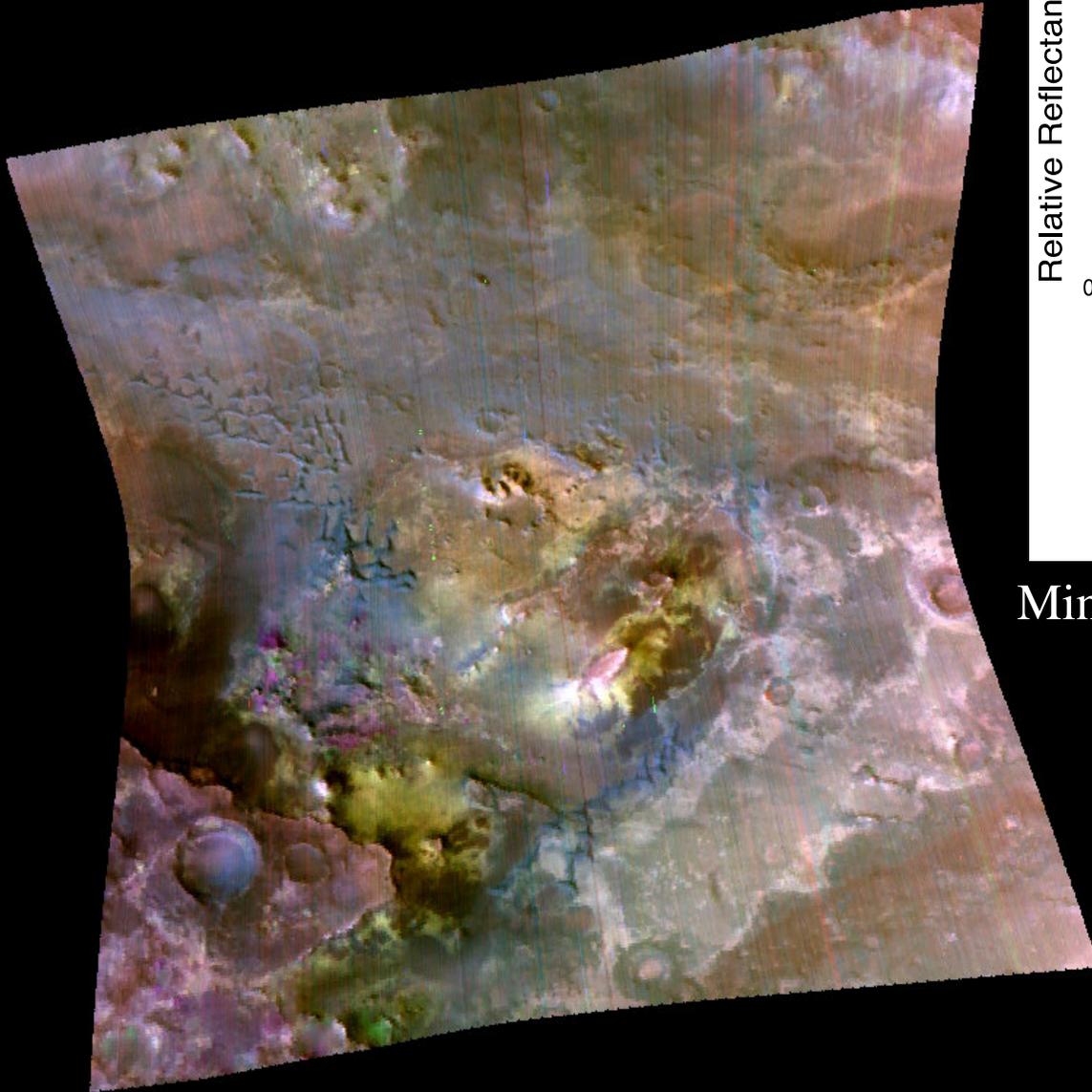
Thick section of phyllosilicate-
rich Noachian basement
exposed in Fossae walls

Phyllosilicate-bearing
basement beneath volcanics

Syrtis Major Volcanics



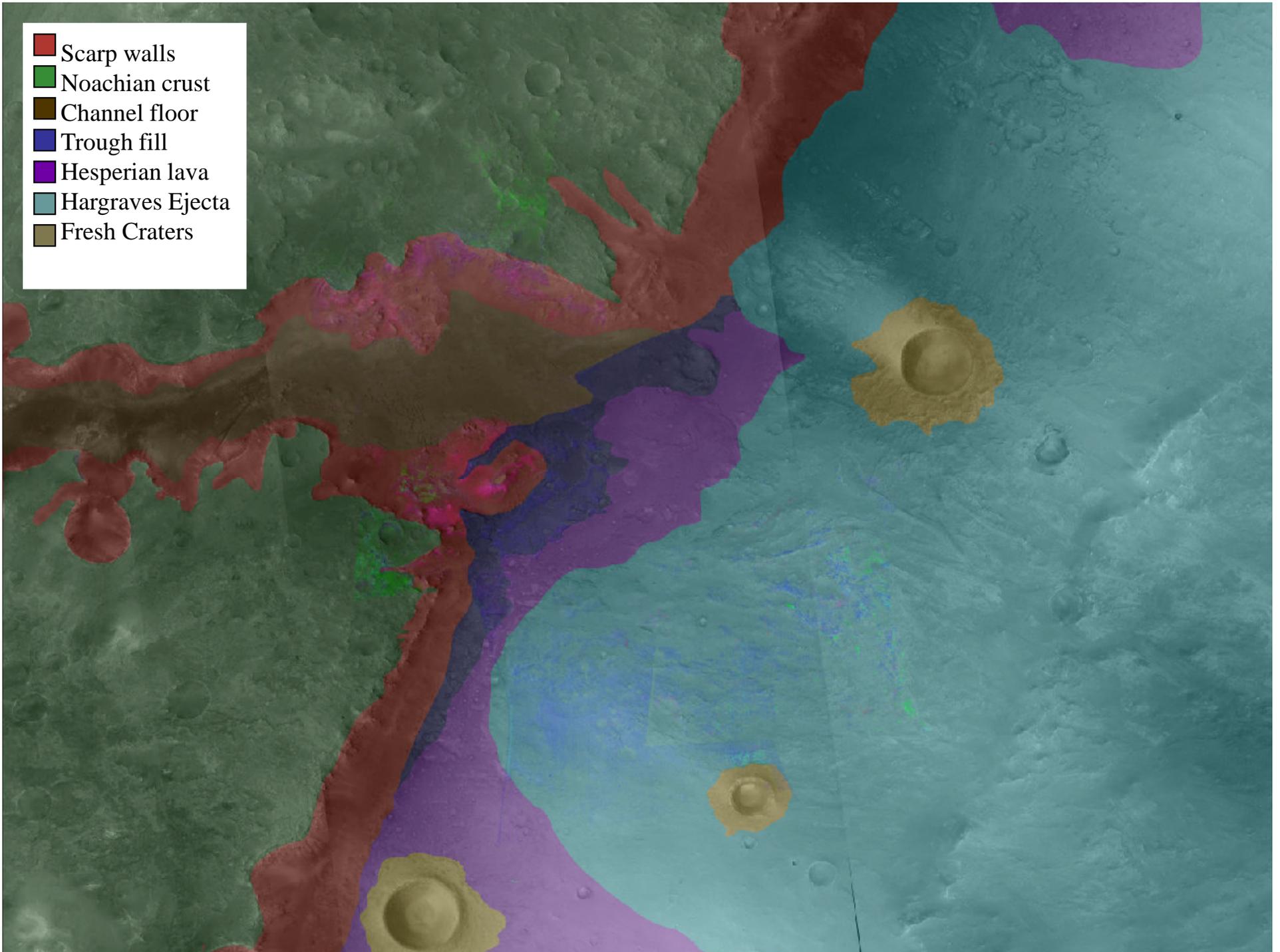
FRT000064D9:
2.4, 1.8, 1.15 μm RGB



Mineralogy identified

Fe-oxide and crystalline hematite
Fe/Mg Smectite with variety of
band positions, H_2O content
Kaolinite
Carbonate
Pyroxene (Low and High Ca)
Olivine

- Scarp walls
- Noachian crust
- Channel floor
- Trough fill
- Hesperian lava
- Hargraves Ejecta
- Fresh Craters



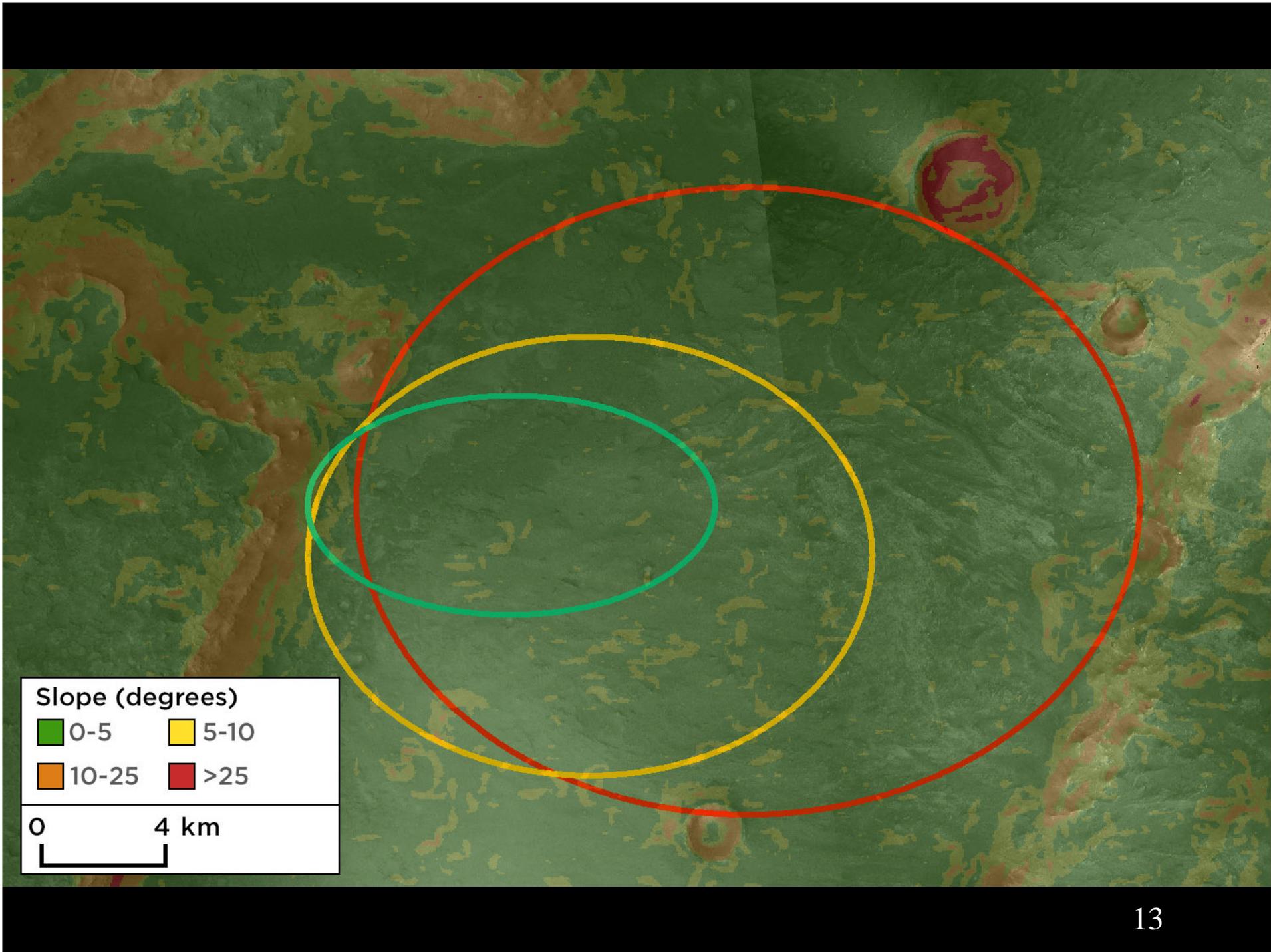
25x20 km

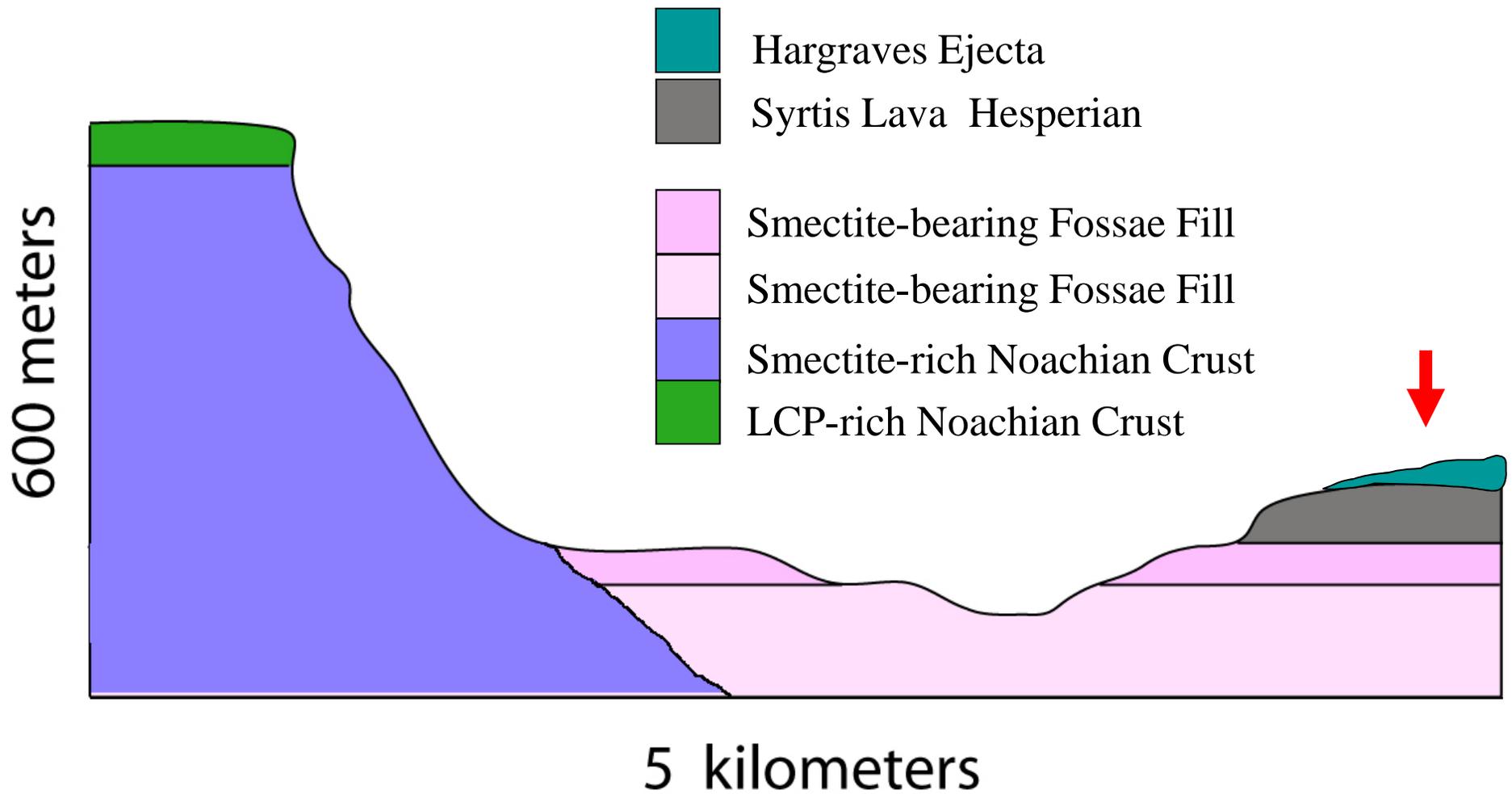
18x14 km

13x7 km

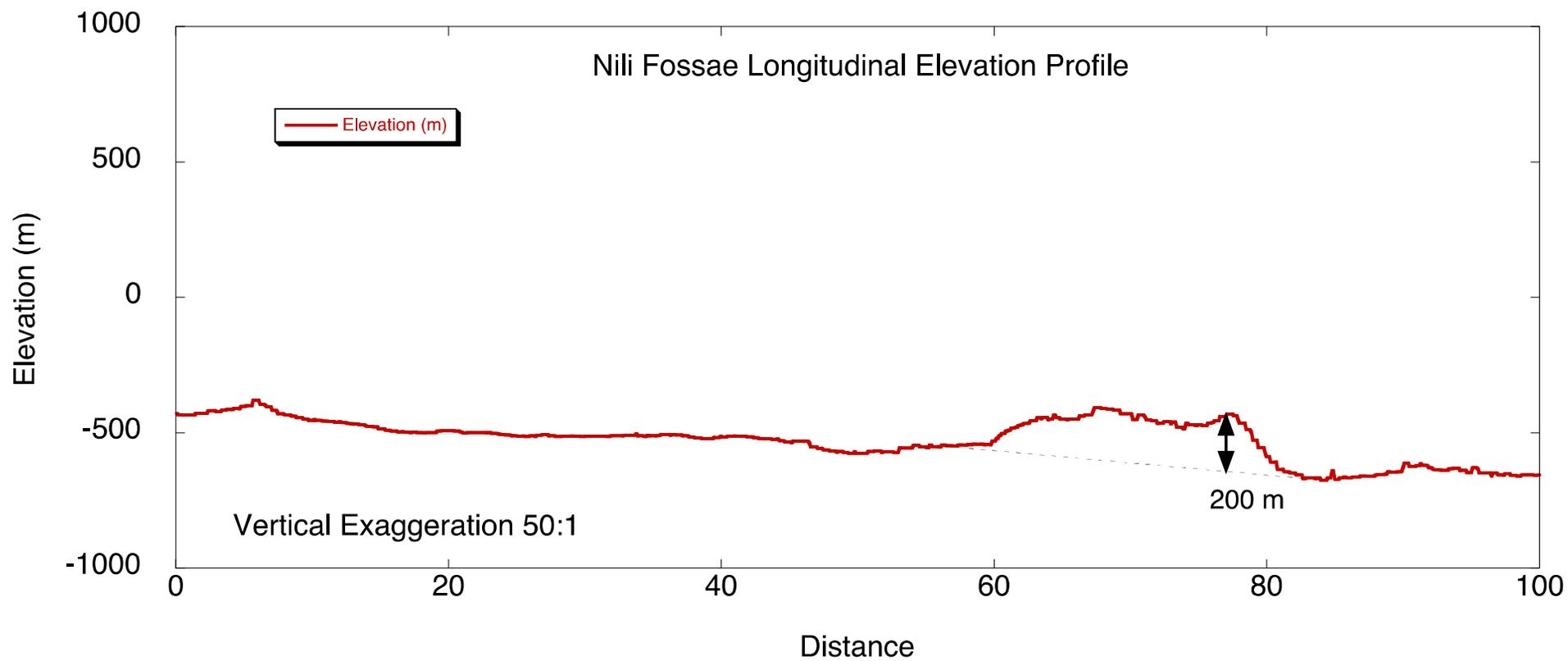
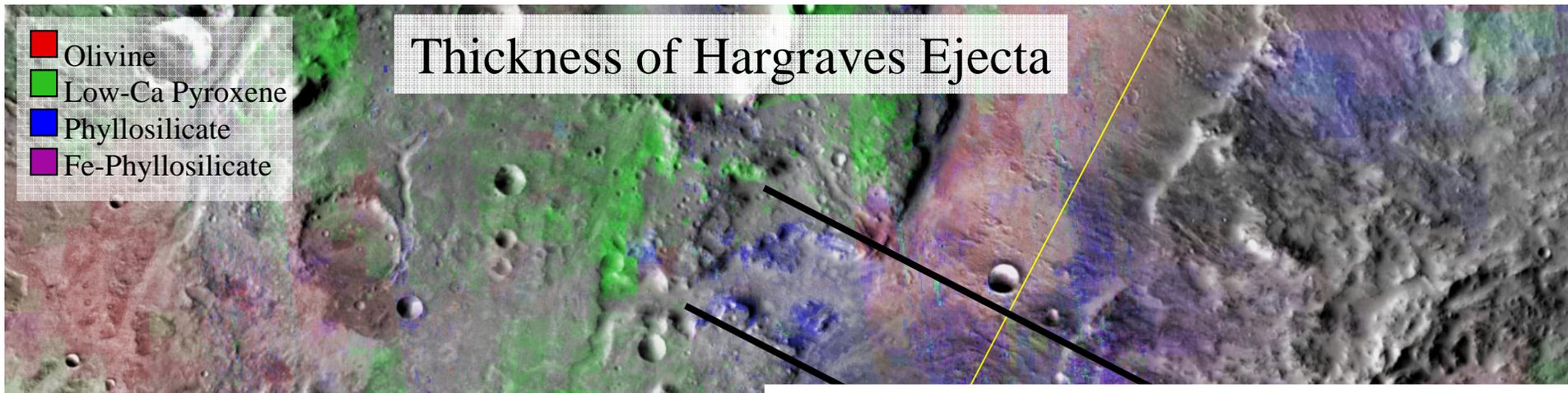
0 5 km



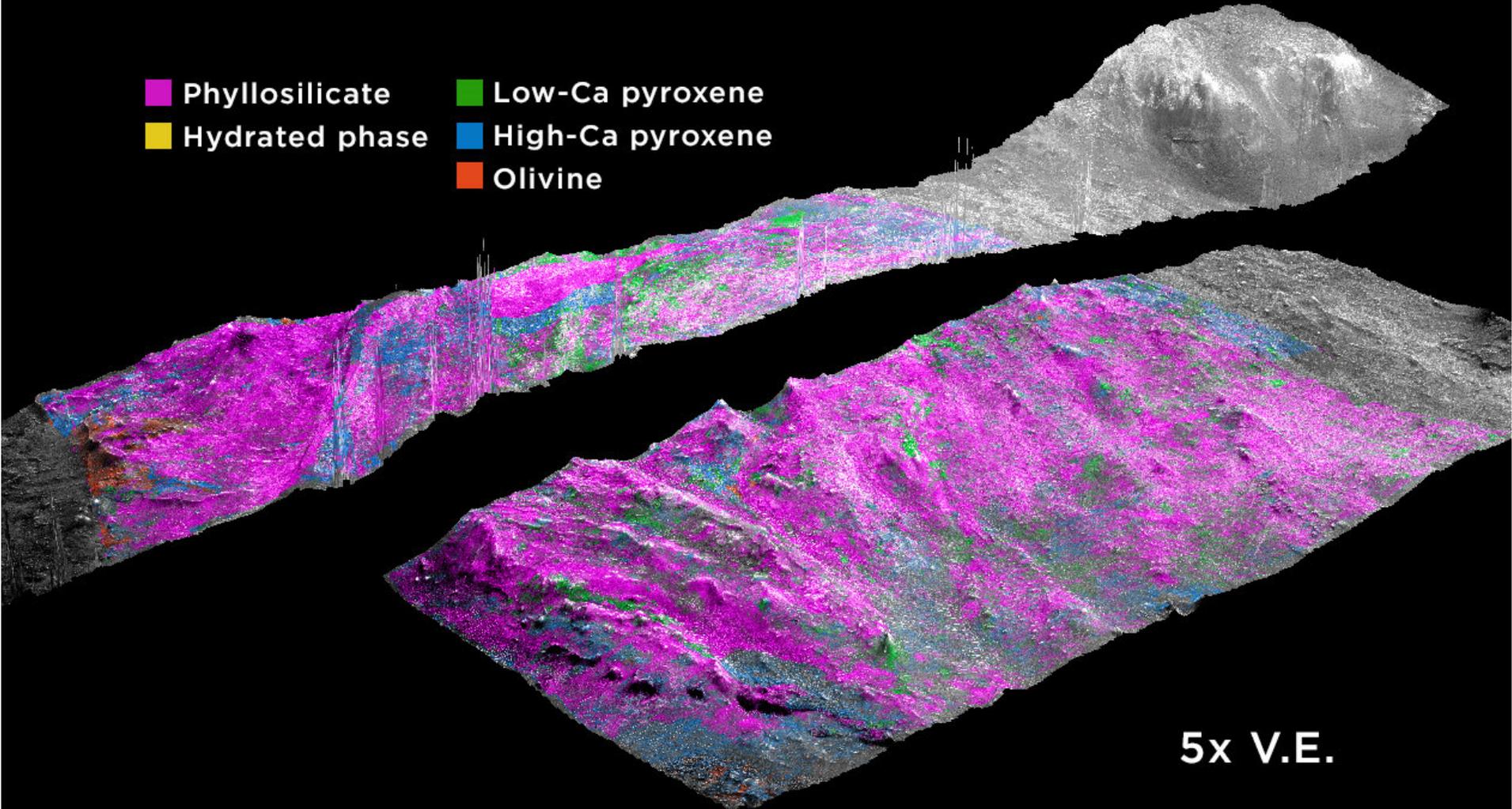




(Representative vertical and horizontal distances, not to scale)

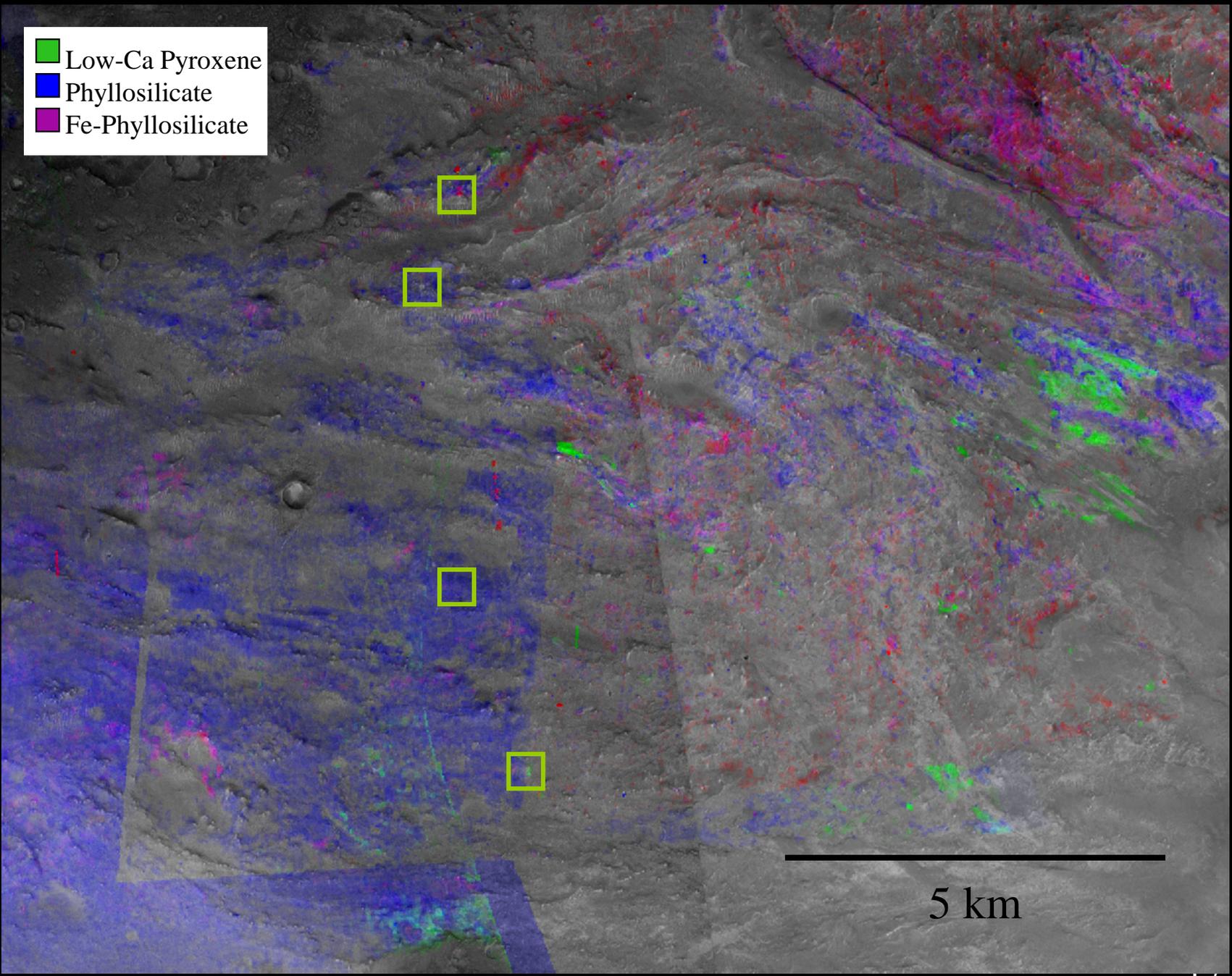


- Phyllosilicate
- Hydrated phase
- Low-Ca pyroxene
- High-Ca pyroxene
- Olivine

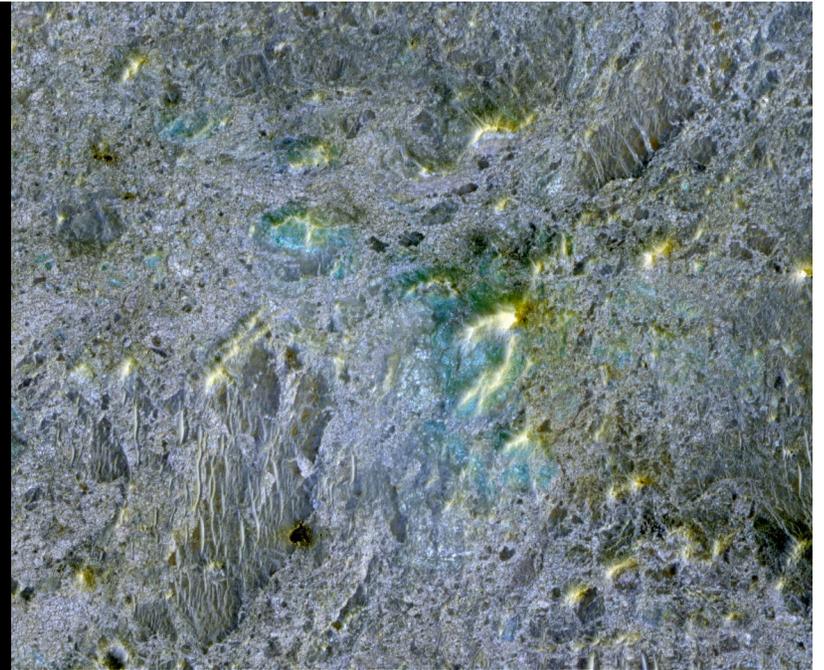
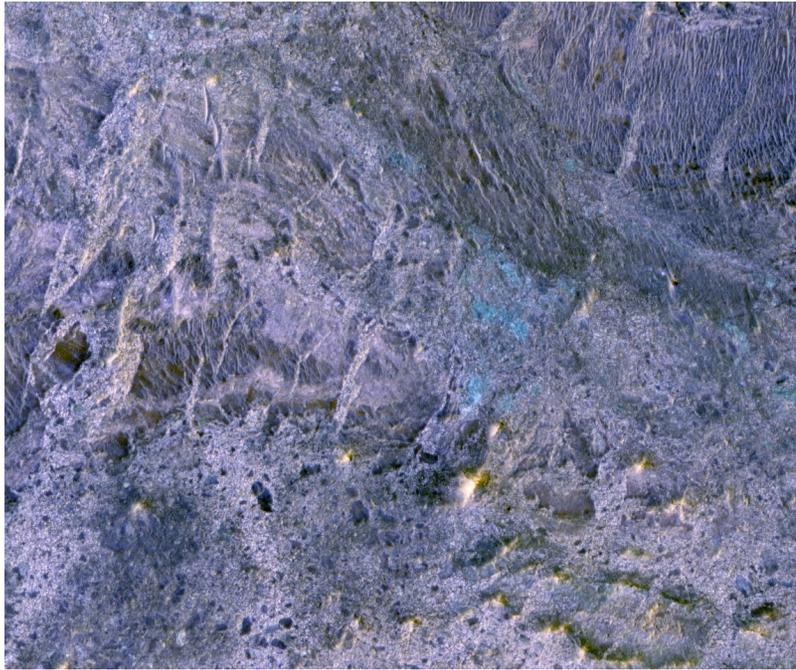


5x V.E.

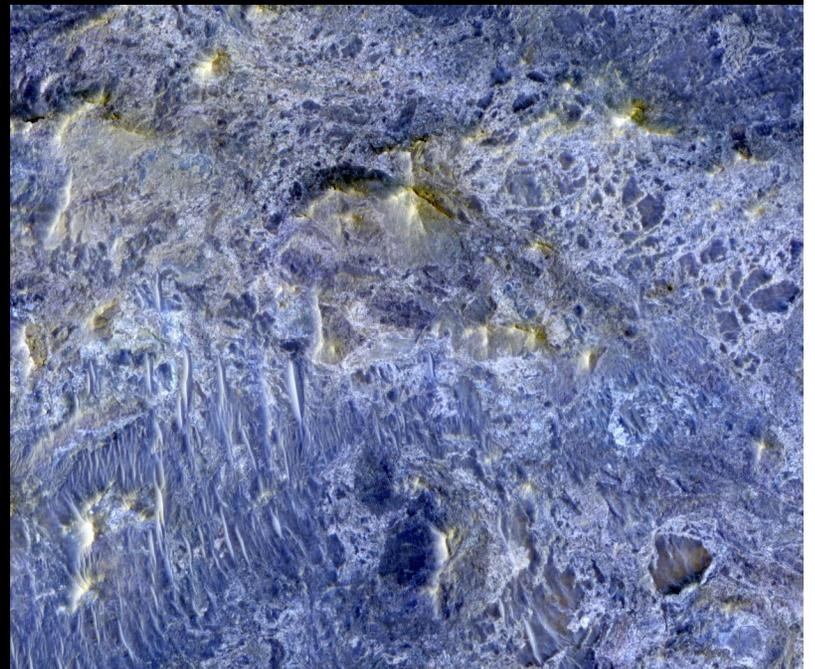
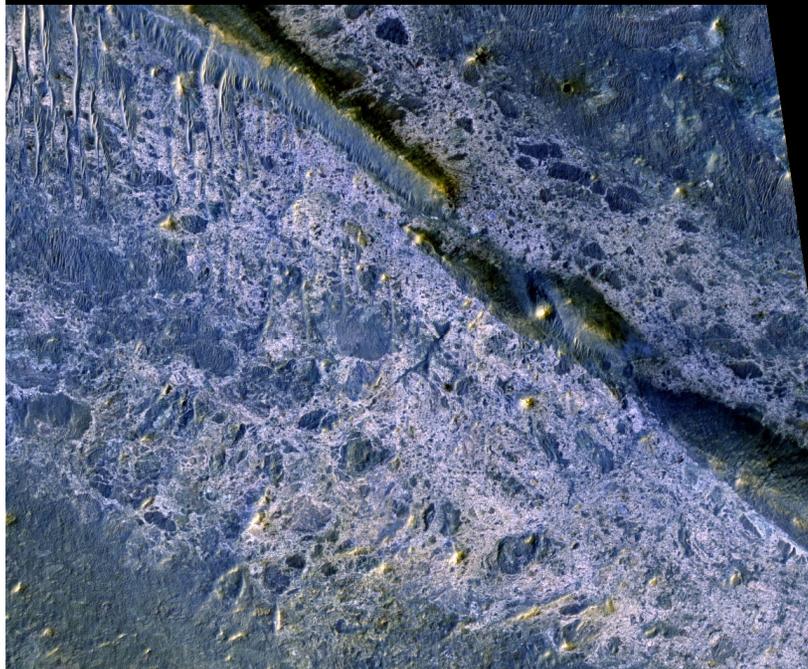
- Low-Ca Pyroxene
- Phyllosilicate
- Fe-Phyllosilicate



5 km



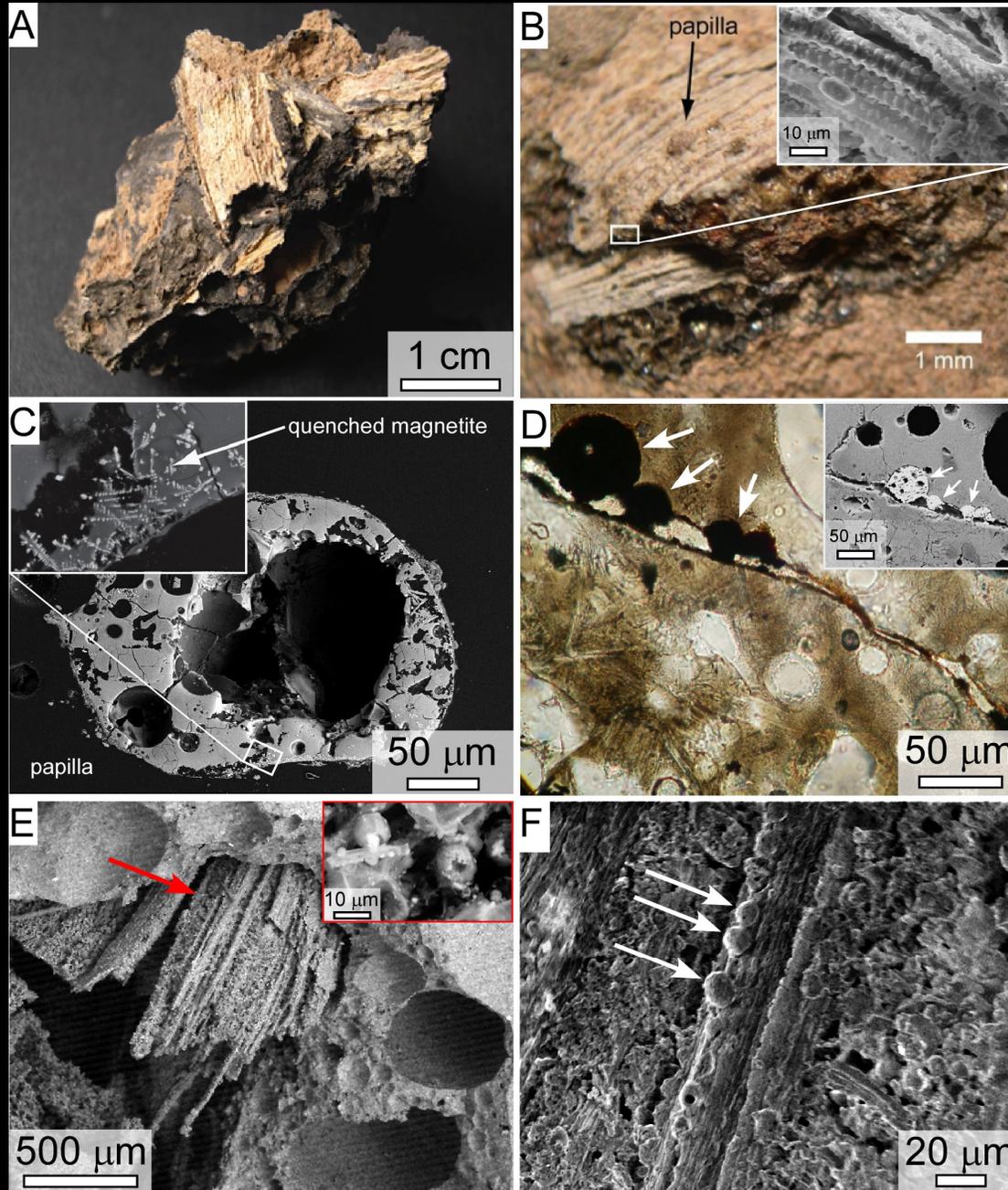
250 m



Impact Glass Biosignature Preservation Potential

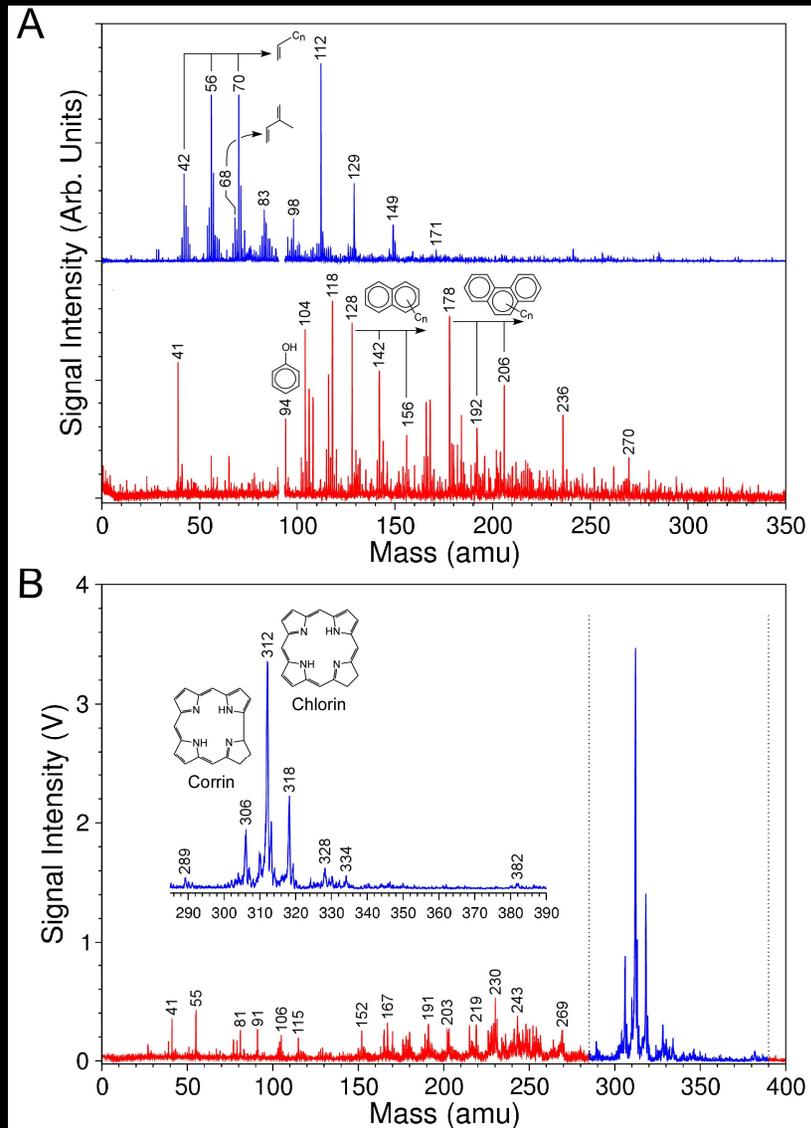
Schultz et al.,
Geology 2014

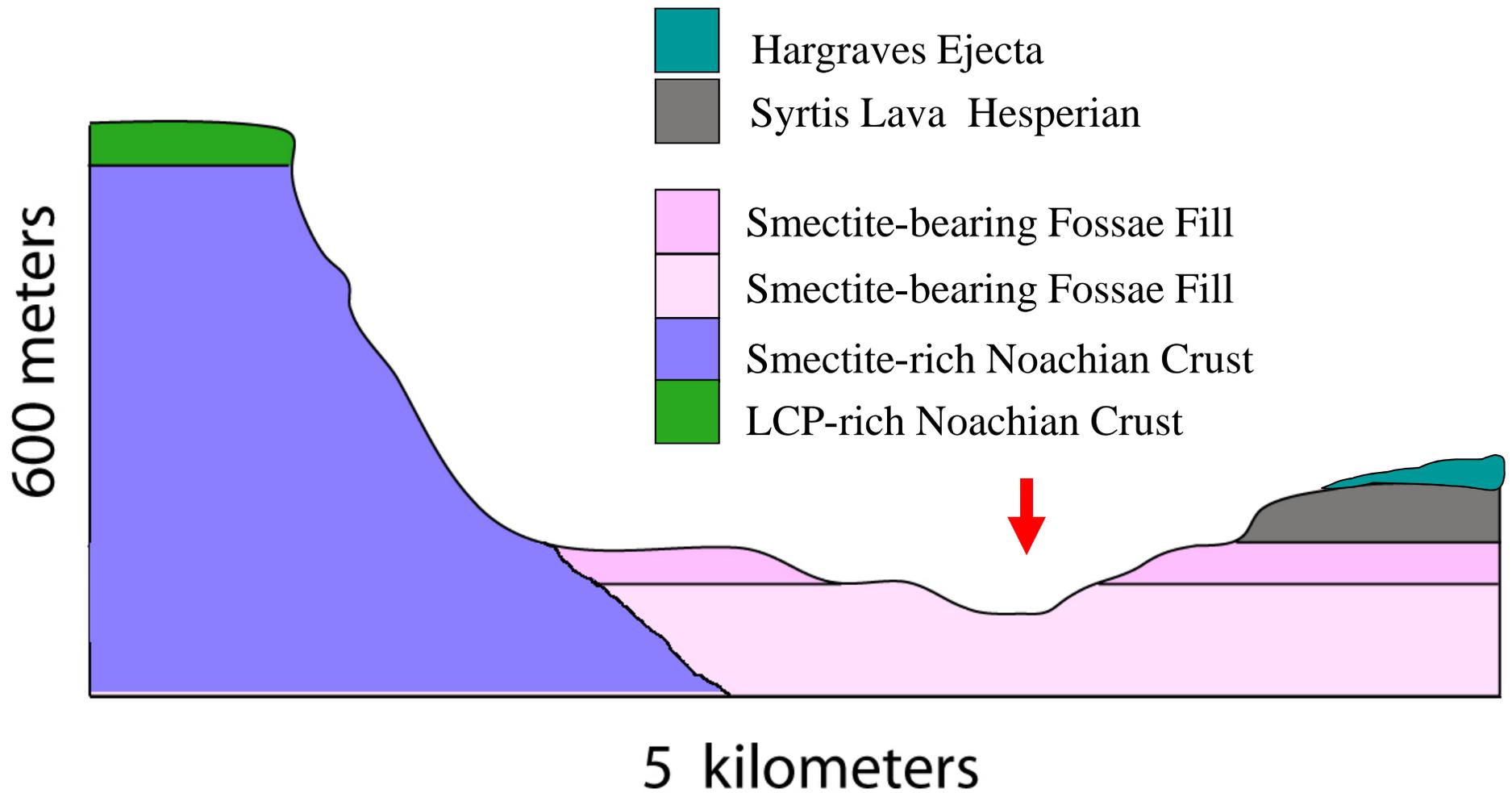
Instantaneous
encapsulation
of biological
material:
macro and
molecular
preservation



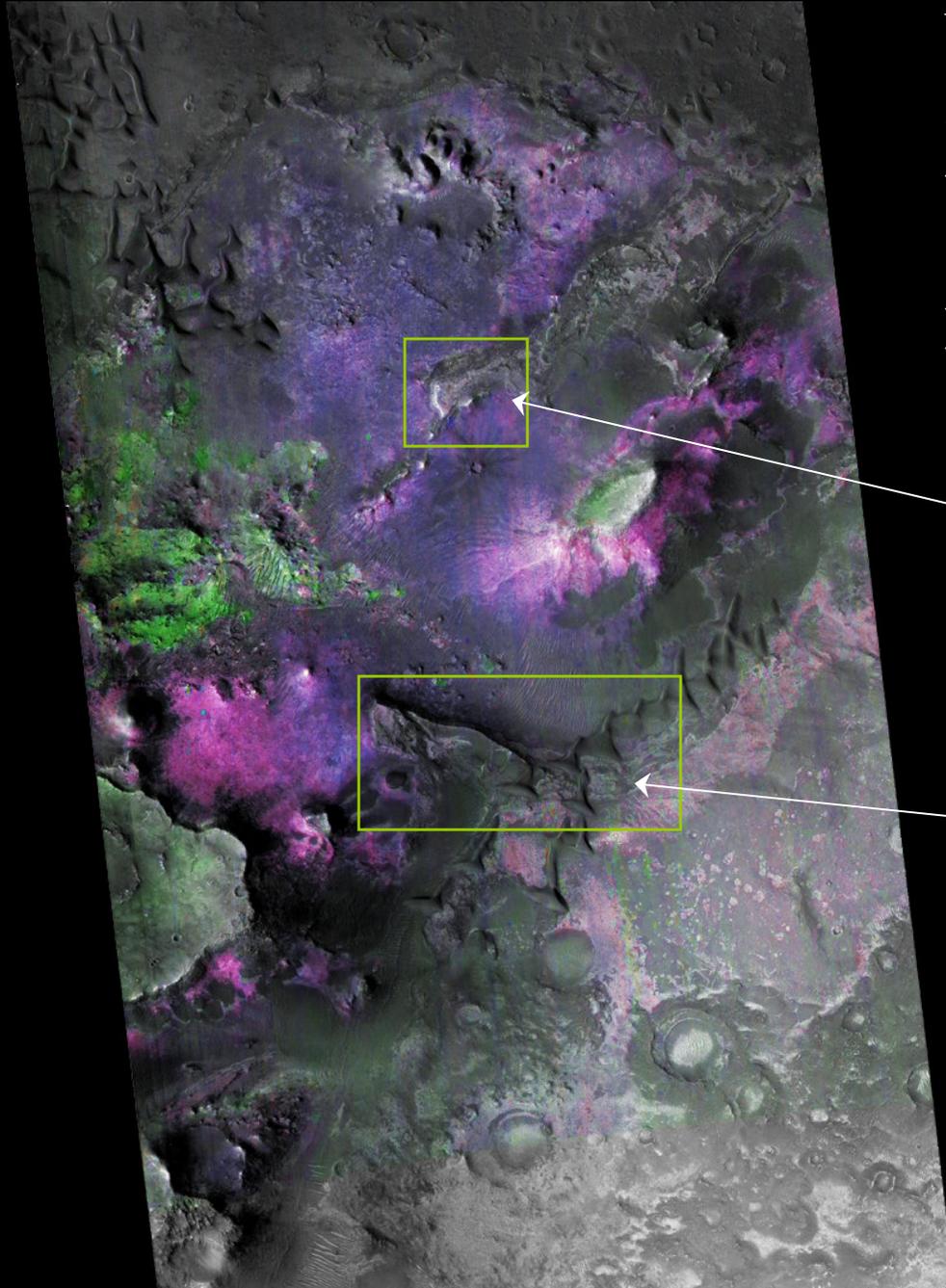
Impact Grass Biosignature Preservation Potential

Schultz et al.,
Geology 2014





(Representative vertical and horizontal distances, not to scale)

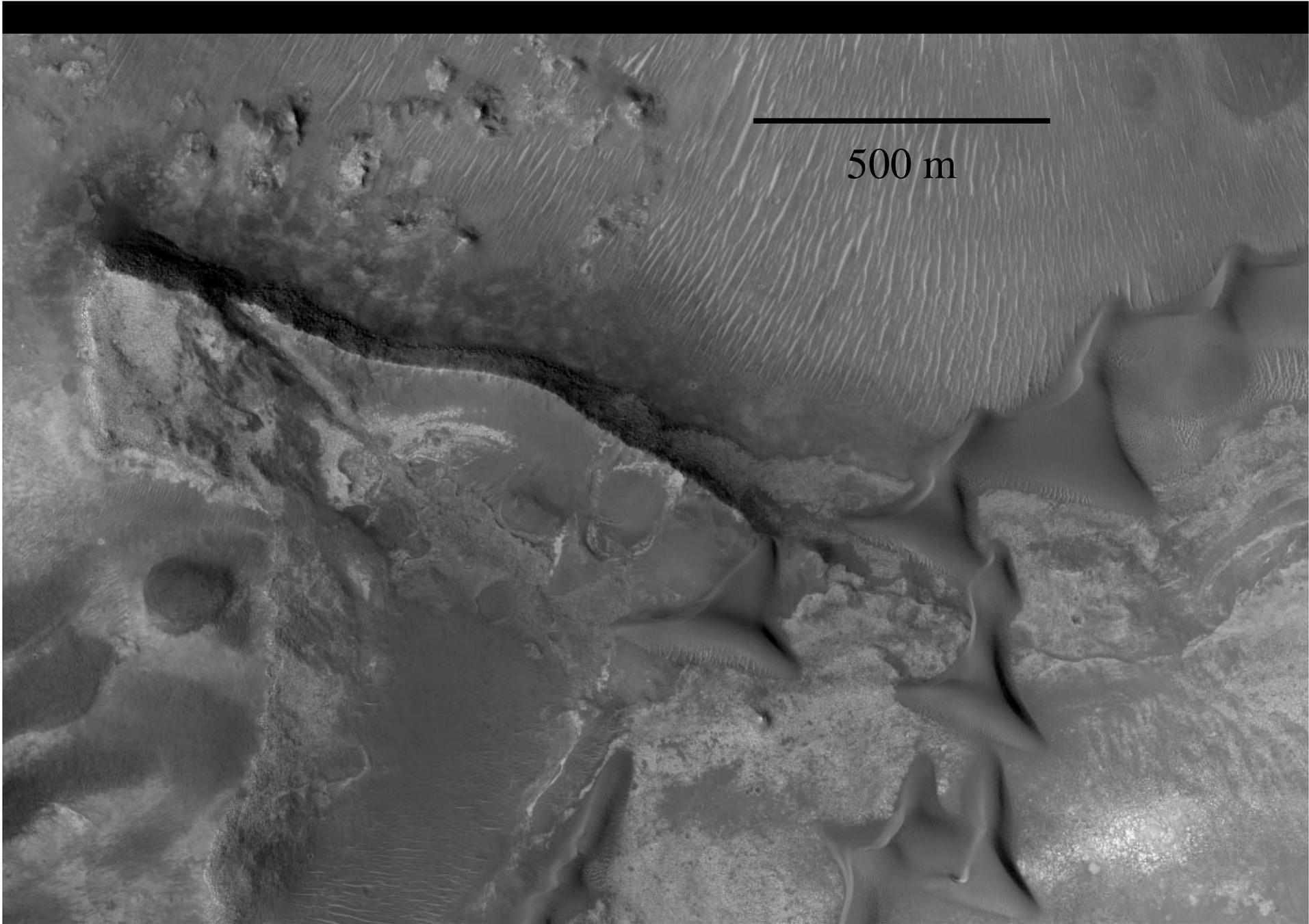


Widespread gradation by alluvial
and fluvial processes has filled in
topographic lows
1 km thickness in impact craters
Deposited in Nili Fossae troughs

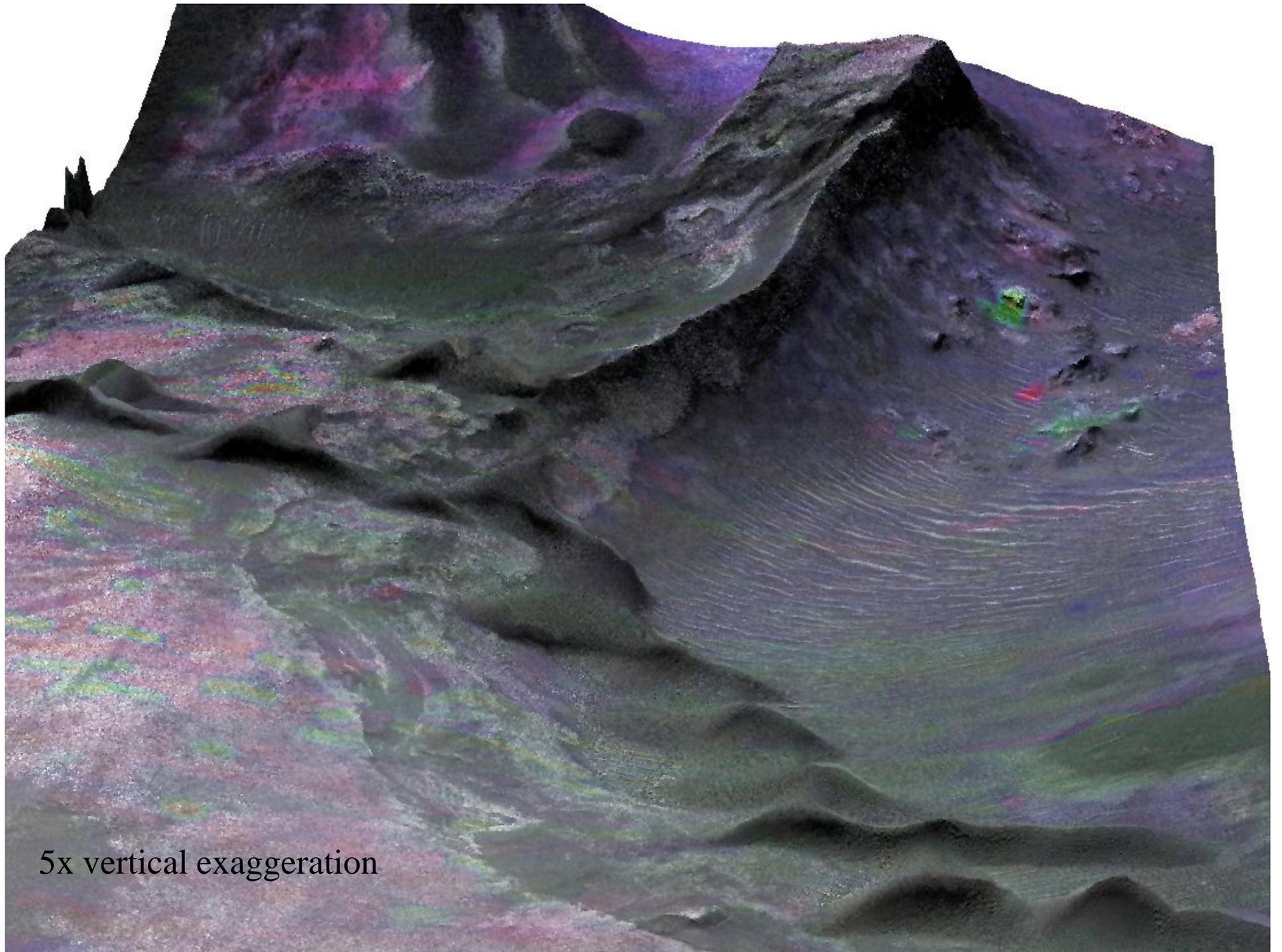
Layered material on the
floor of the sapping
channel

Trough fill

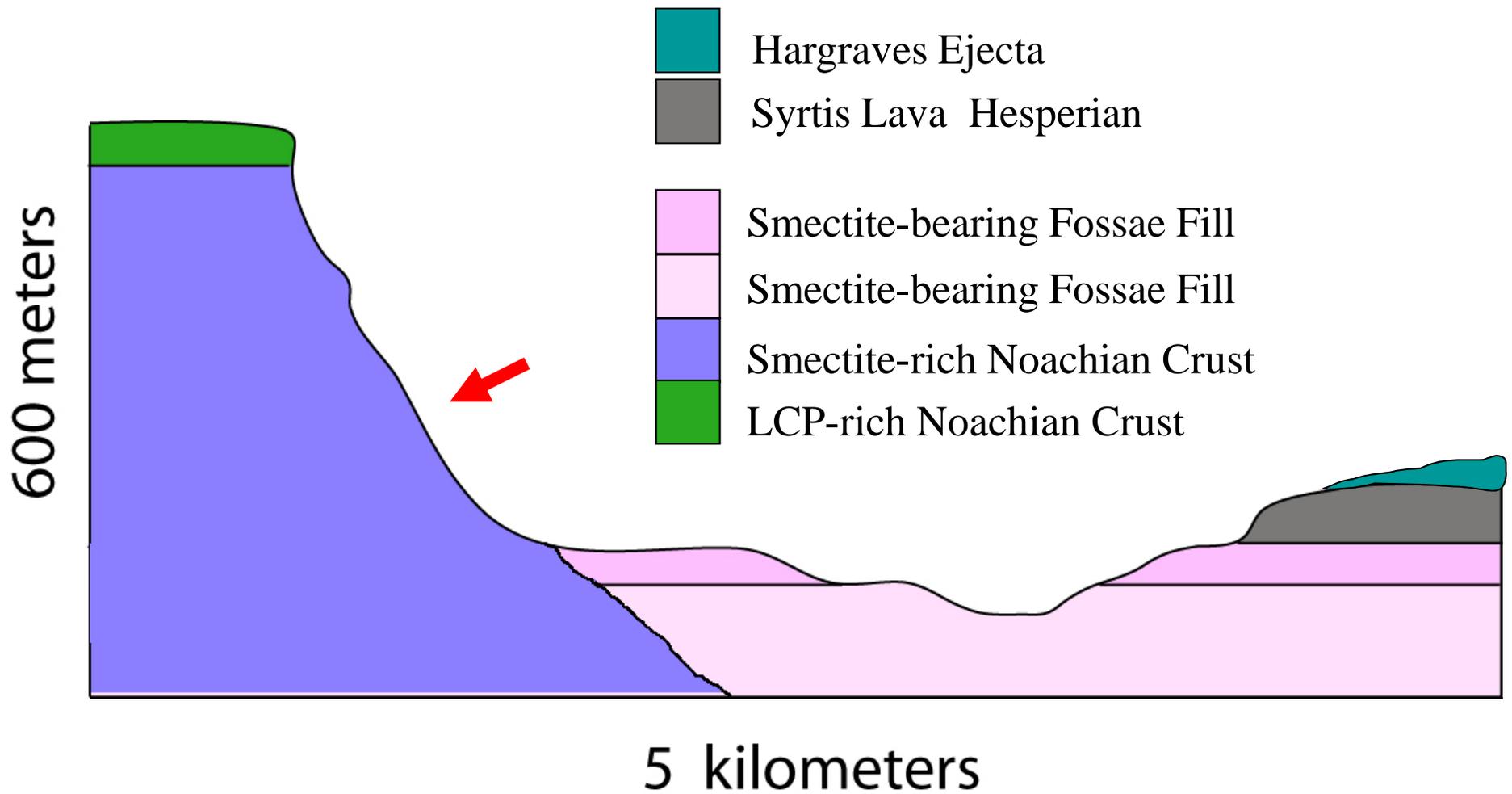
Transported phyllosilicate-
bearing alluvial/fluvial
deposits in the go-to site



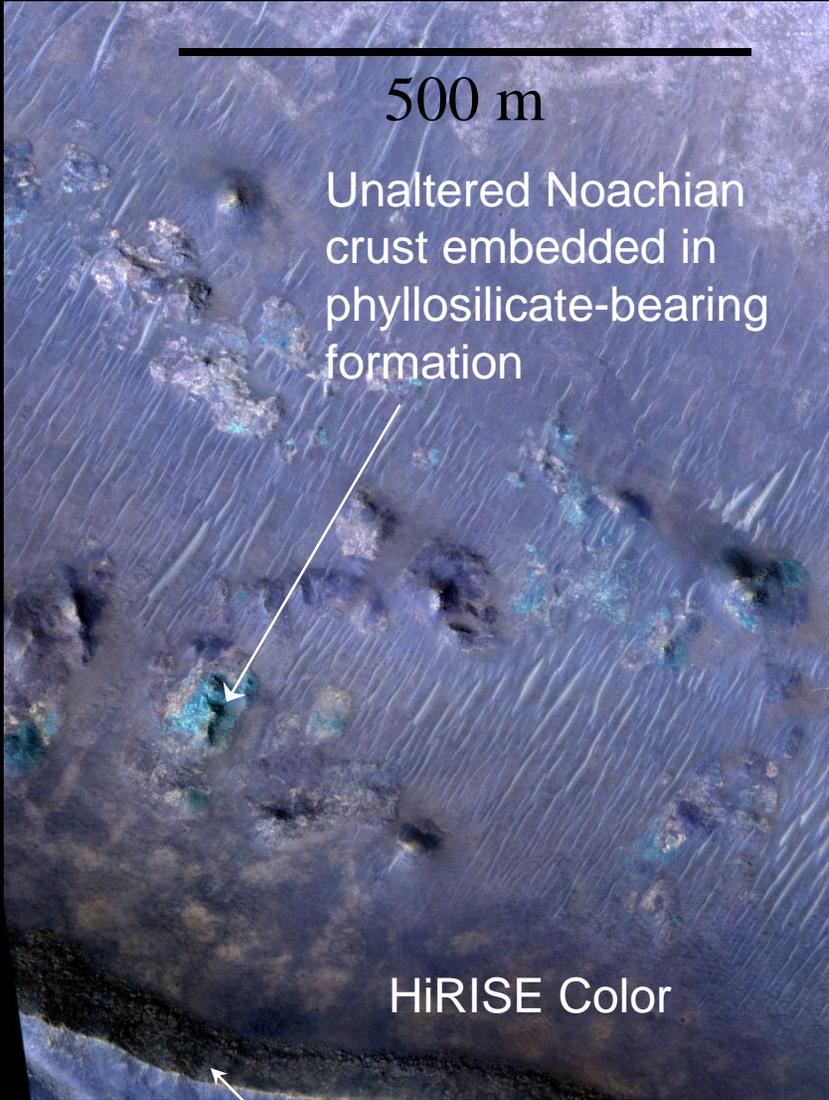
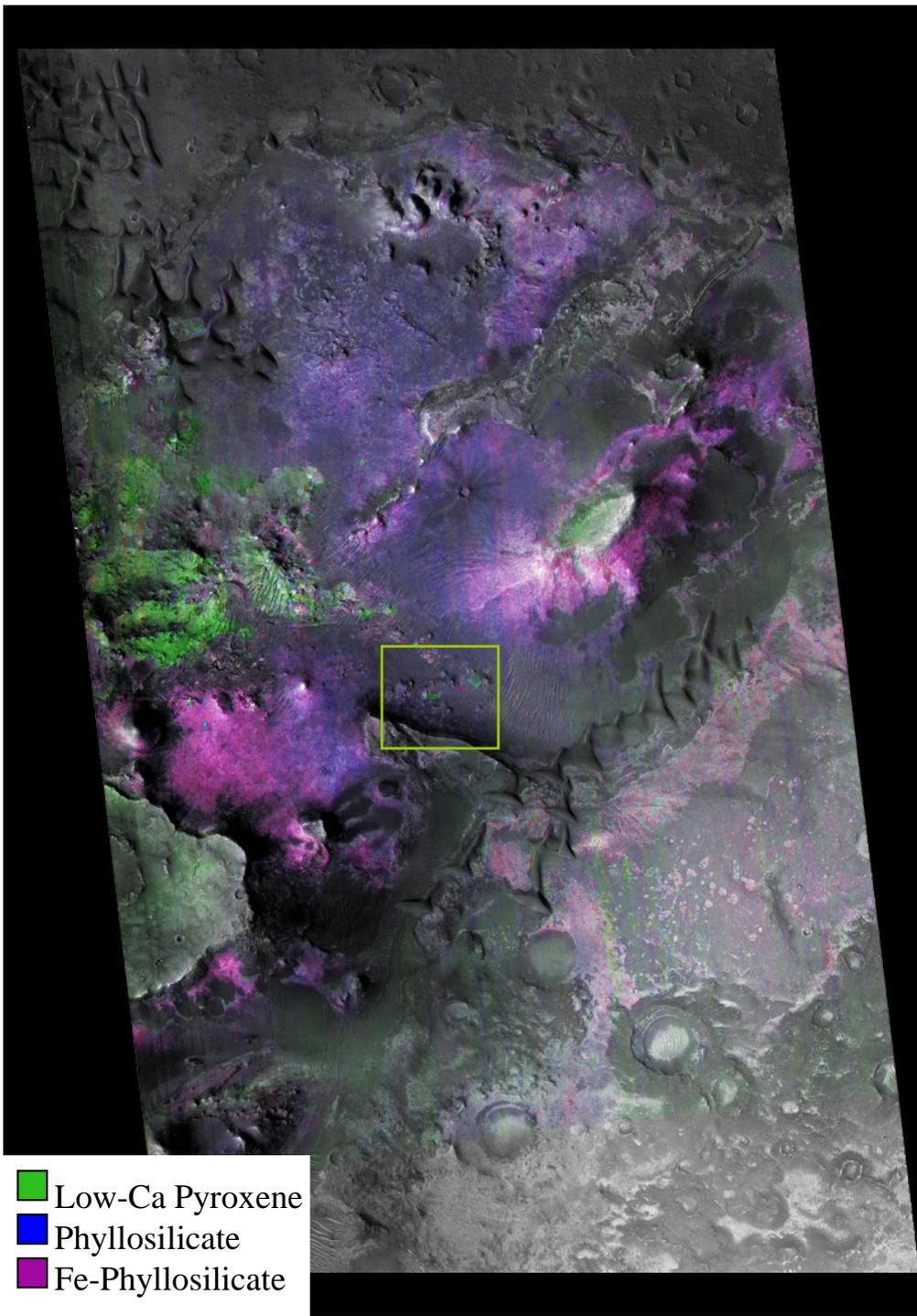
500 m

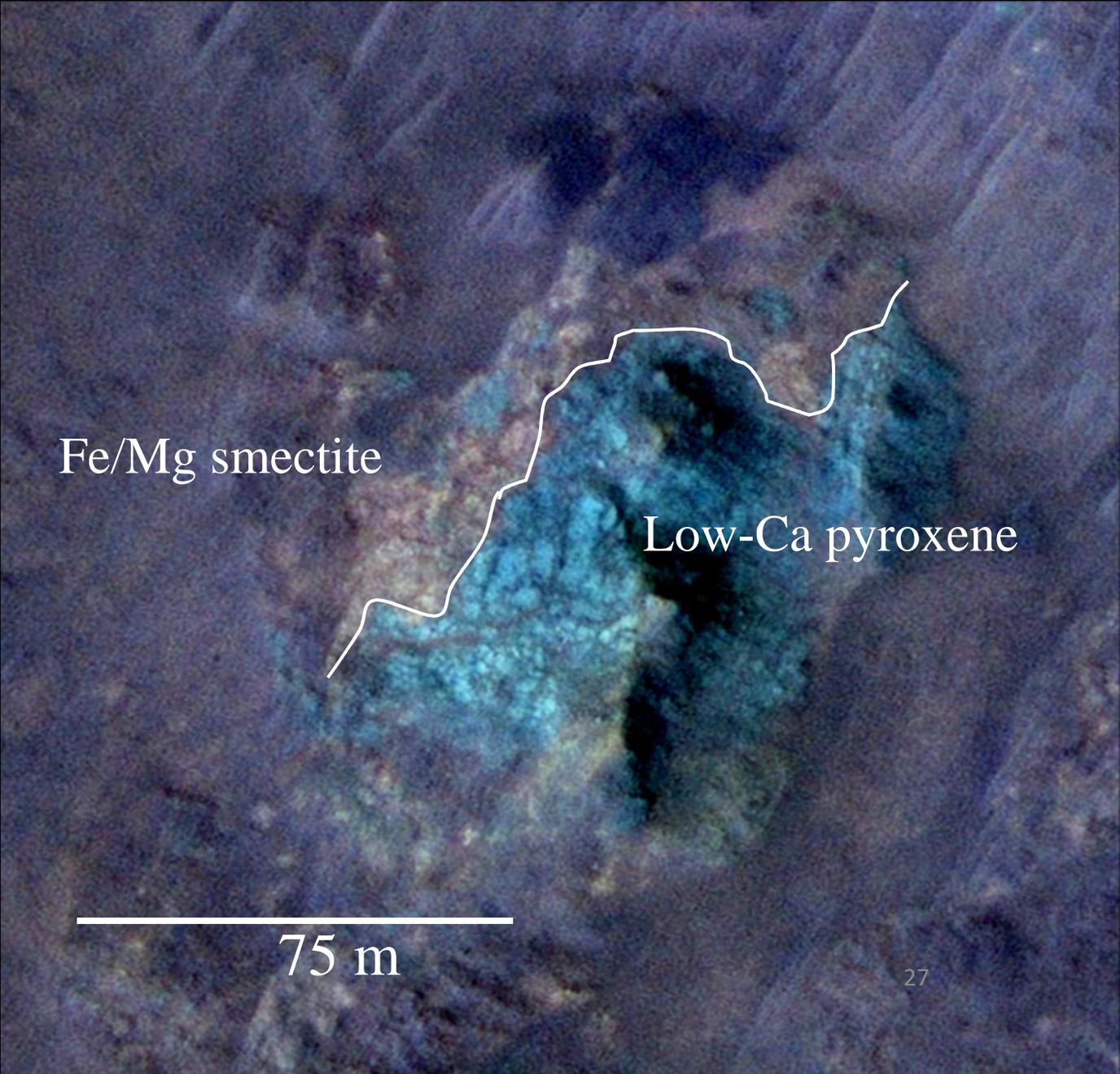


5x vertical exaggeration



(Representative vertical and horizontal distances, not to scale)





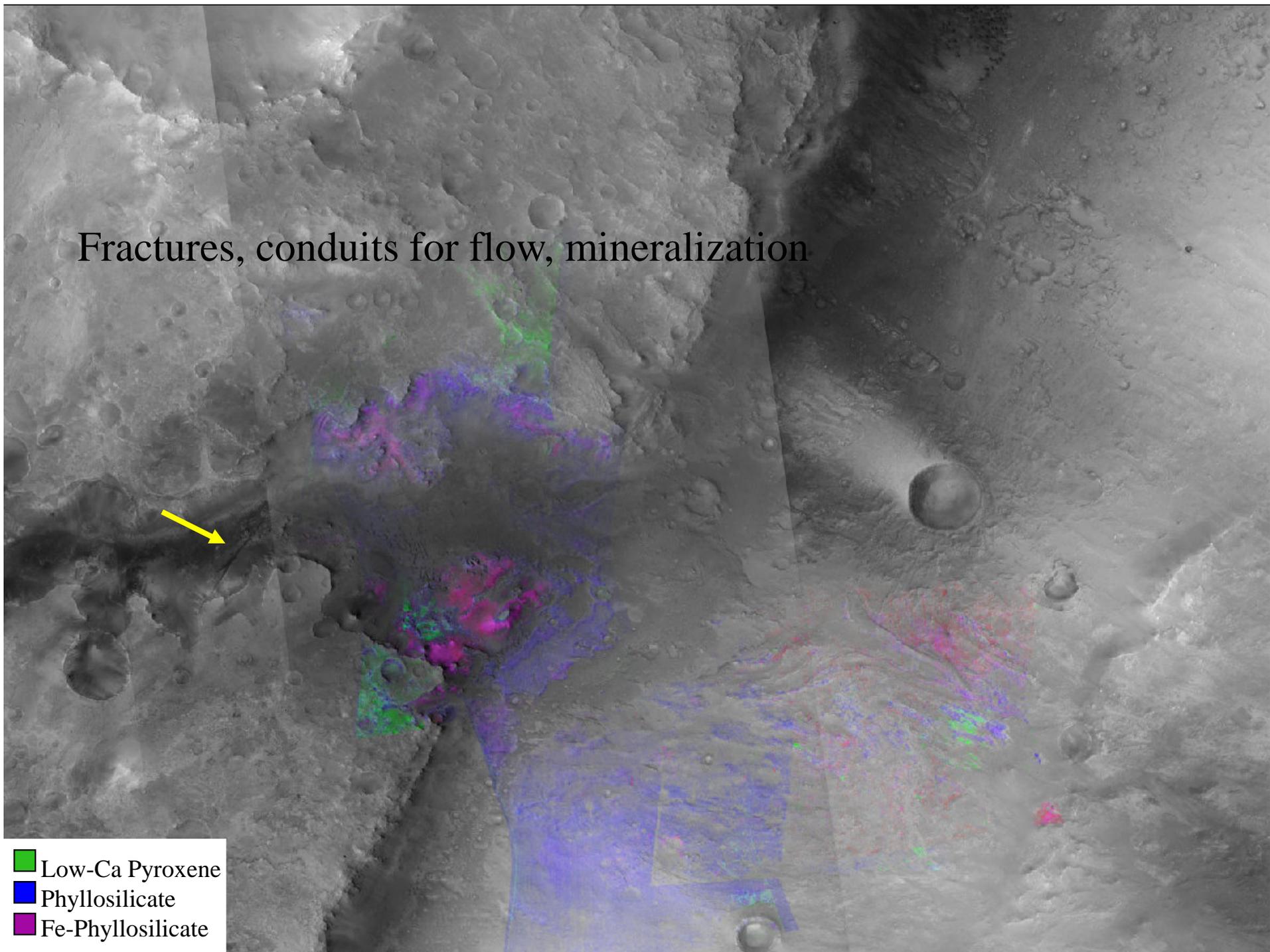
Fe/Mg smectite

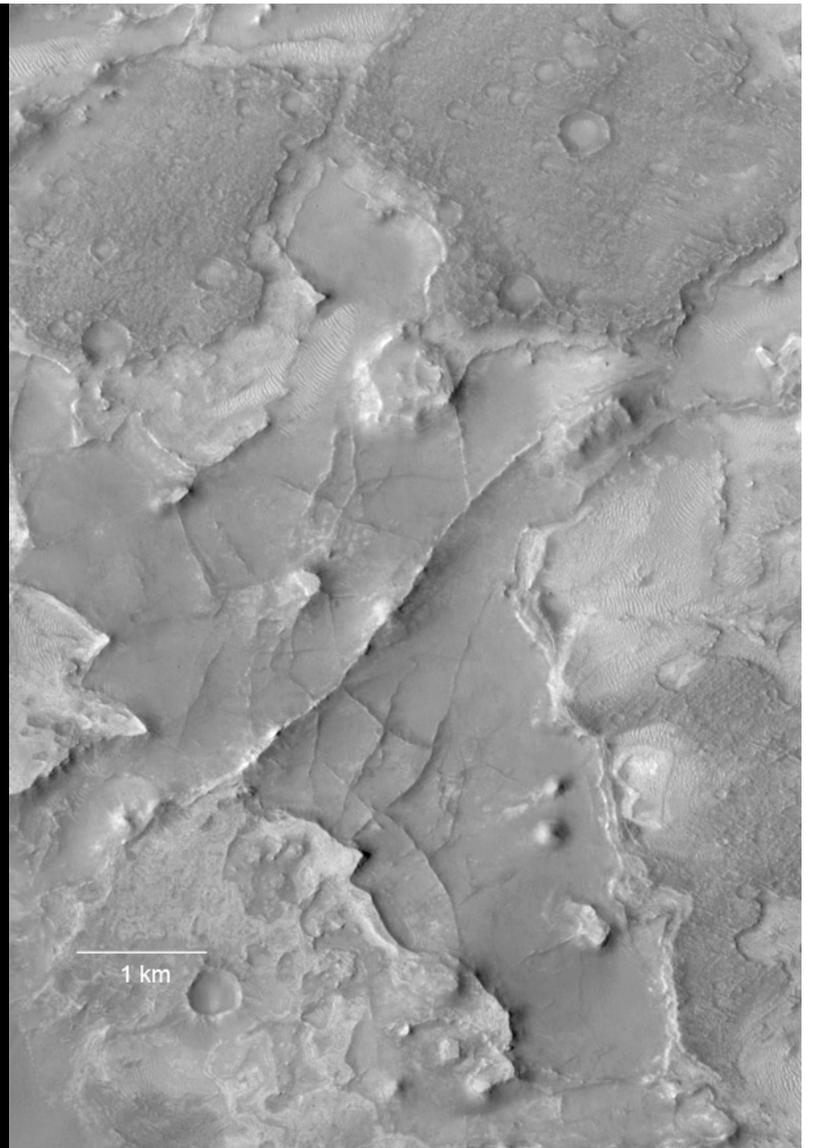
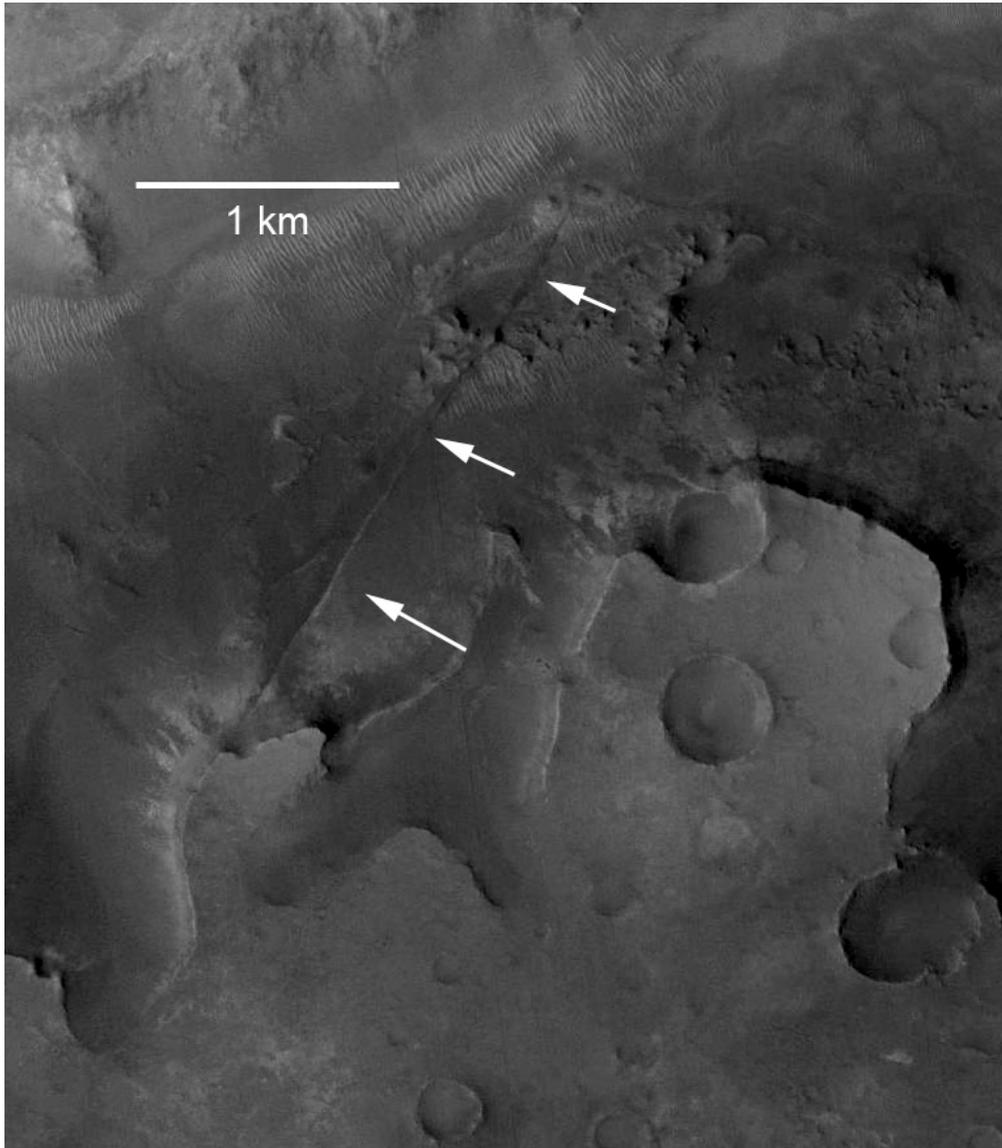
Low-Ca pyroxene

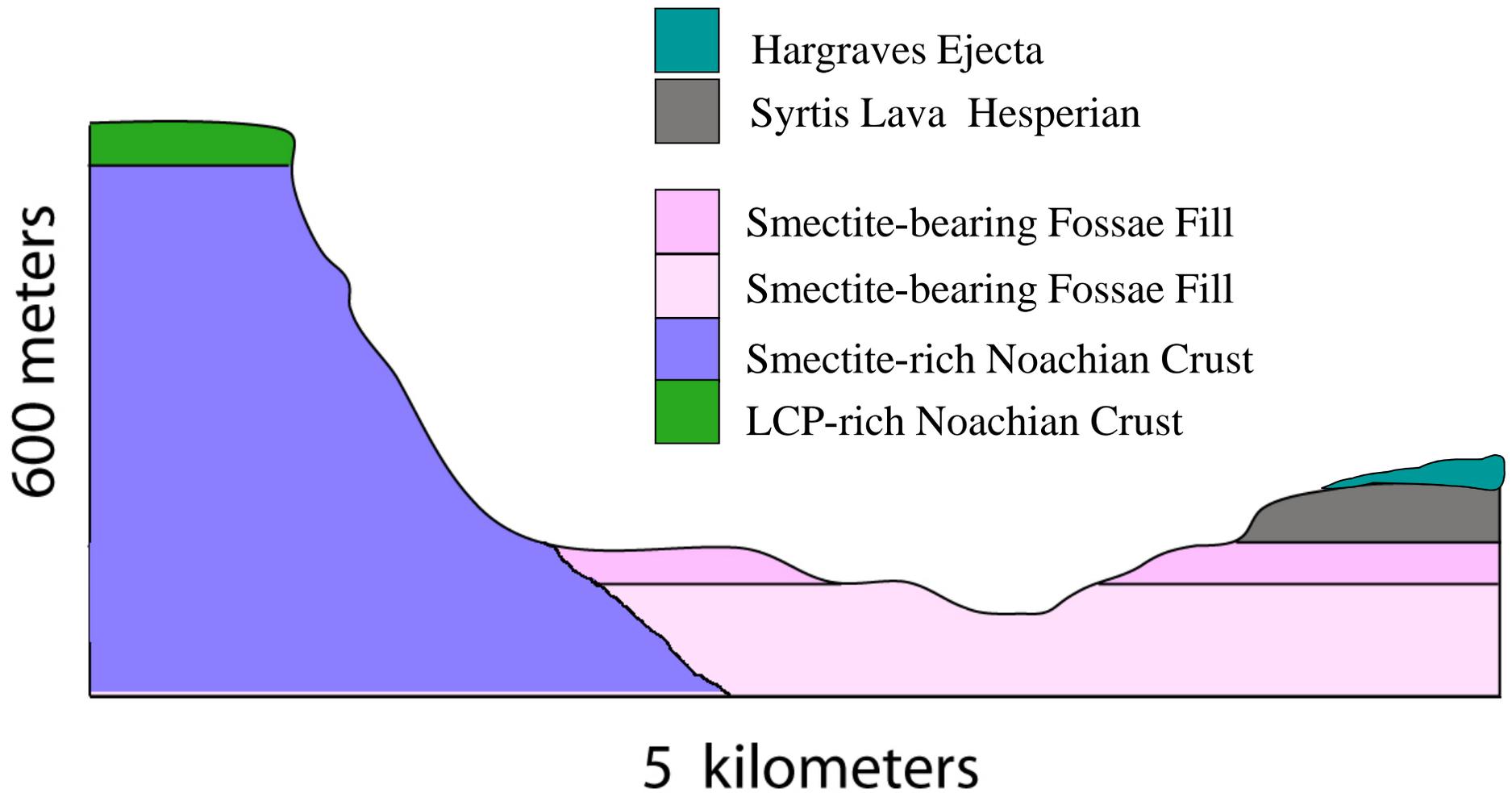
75 m

27

Fractures, conduits for flow, mineralization







(Representative vertical and horizontal distances, not to scale)

Nili Fossae Trough

- Diverse Noachian environments present throughout the landing site
- Regional geology, represented in the landing site, indicates sustained interaction of water with the crust over an extended period as a consequence of multiple episodes of distinct character
 - Fe/Mg Phyllosilicates with variation in band position, strength of water absorption
 - Smectite clay transported and deposited in fluvial systems
 - Regional episode of kaolinite formation
 - Carbonate formation in association with olivine
 - Chlorite, zeolite, and hydrated silicate in association with impacts
- The region north east of Syrtis Major was persistently wet and the geologic context for understanding the interaction of water is extraordinarily well preserved and exposed
- The Nili Fossae Trough landing site sits within this region and provides exciting access to a diverse suite of environments