

Regional Geology and Fluvial/Alluvial Events:

Nicolas Mangold

Regional Mineralogy and Evidence for Persistent Wetness:

Bethany Ehlmann

TES View of Mineralogy:

Josh Bandfield

Habitable Environments of the Nili Trough:

Jack Mustard

Potential for Habitability and Fossil/Biosignature Preservation

: Dave Desmarais

Diverse Noachian Habitable Environments Nili Fossae

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Investigation of Diverse Habitable Noachian Environments
(Hydrothermal, alluvial/fluvial, shallow crust/pedogenic)

Sampling and characterizing

Impact ejecta

Hesperian volcanics

Phyllosilicate-bearing infill of Nili Fossae

Strongly altered Noachian crust

Unaltered Noachian crust



Noachian crust enriched in low
-Ca pyroxene



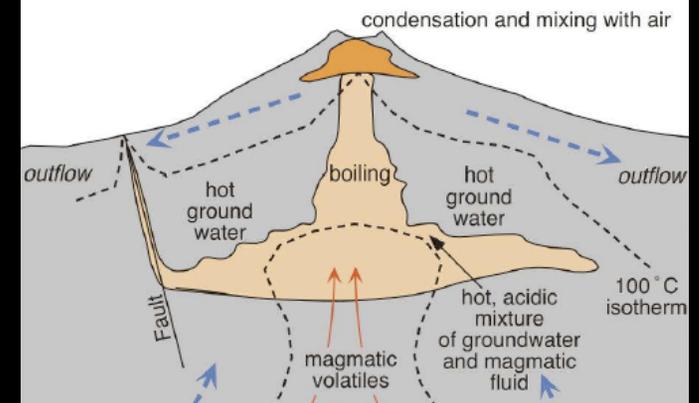
Noachian crust enriched in
phyllosilicate

Multiple, Distinct Environments

- Noachian is when phyllosilicate formation was most intense: Access to the source environments
- Hydrothermal system
 - Fractures as transport pathways for water, mineralization in fractures
 - No mounds, spring deposits, but those are surface features and not expected to survive to the present
- Sedimentary units
 - Infill of trough, formation of sapping channel
 - Regionally, layered units in crater floors, troughs
 - Erosion in go-to site leaves outcrops of remnants of these processes
- Subsurface groundwater or shallow crustal environment
 - Protected from destructive radiation environment
 - Abundant chemical energy sources
 - Fluid flow in the crust/groundwater transported nutrients/energy

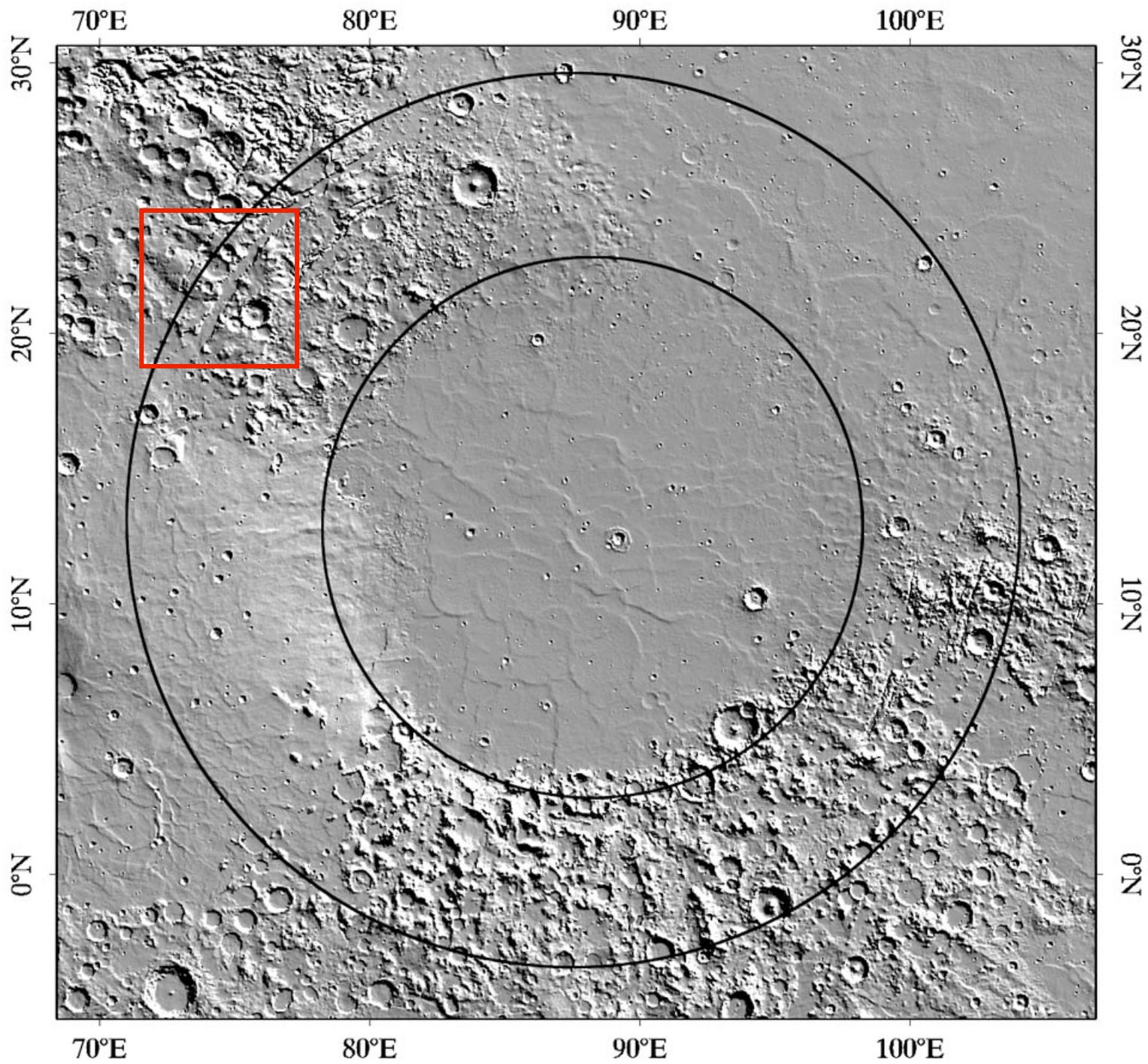


courtesy Mark Allen

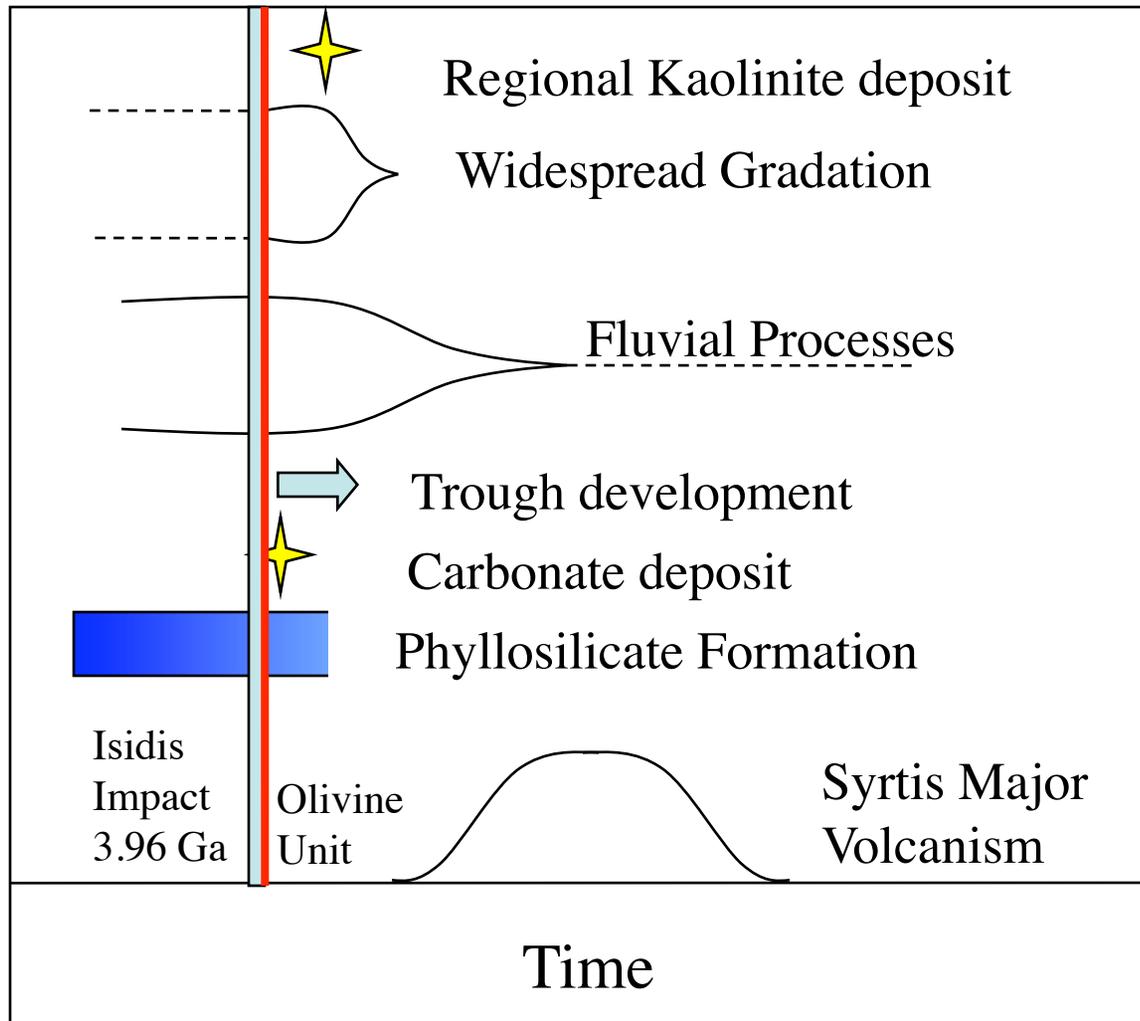


Broad Scientific Objectives

- Noachian Habitable Environments
 - Ancient crustal and genesis region
 - Fluvially transported sediments
 - Hydrothermal systems
- Impact processes
 - Superbly exposed ejecta from 65 km Hargraves crater
 - Ejecta blocks in a phyllosilicate-bearing matrix
 - Transport, fluidization, alteration
- Composition and character of ancient, unaltered crust
- Composition, mineralogy, and texture of Hesperian Syrtis Major lava
- Traverse the Noachian-Hesperian Boundary
- Phyllosilicate-Transported
- Phyllosilicate-In Place



Stratigraphy and Processes in Isidis-Nili Fossae



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

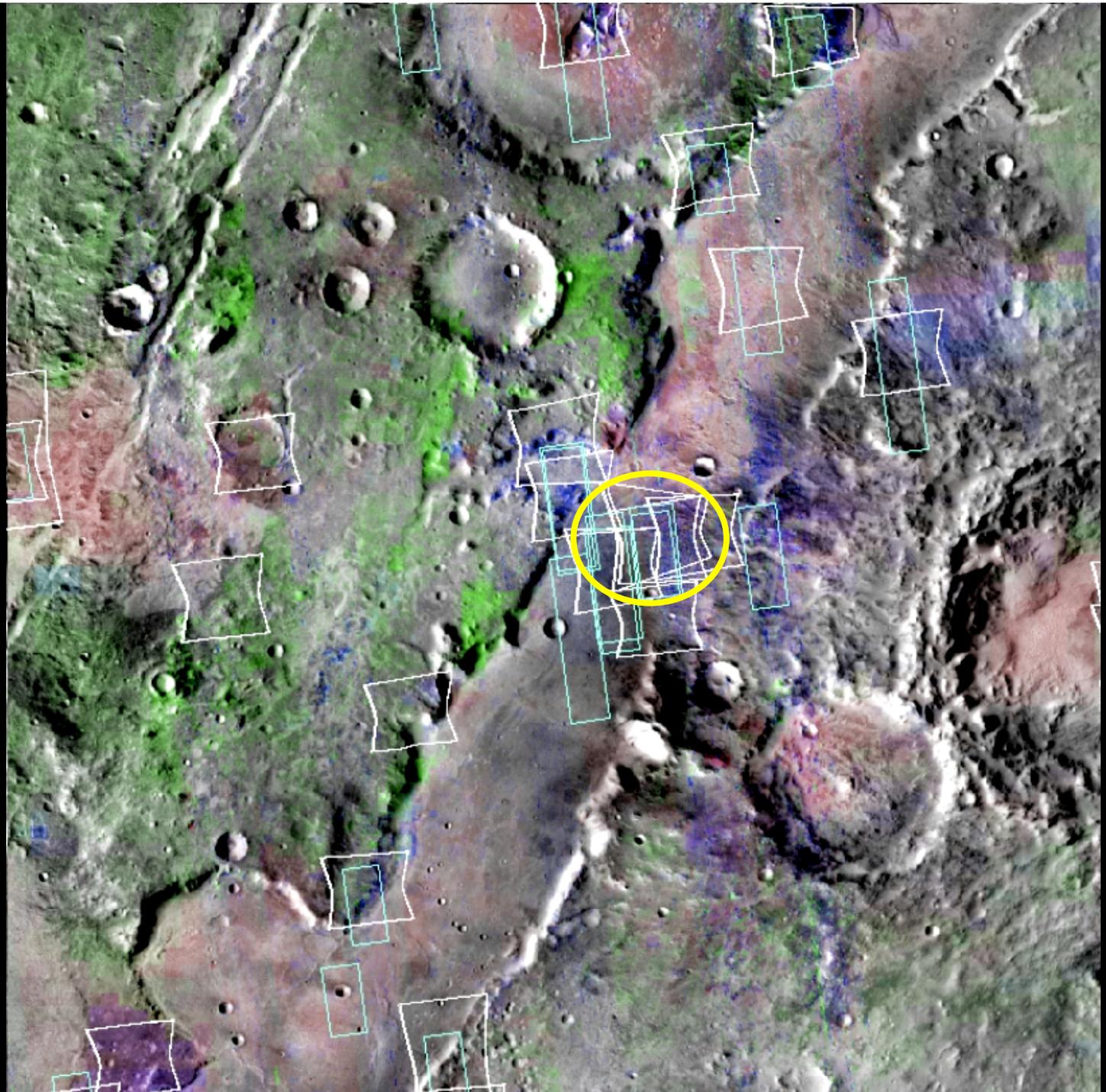
Significant gradation
(sedimentary? aeolian?
alluvial?) between Isidis
basin formation and Syrtis
lava emplacement

Clearly defined wet periods

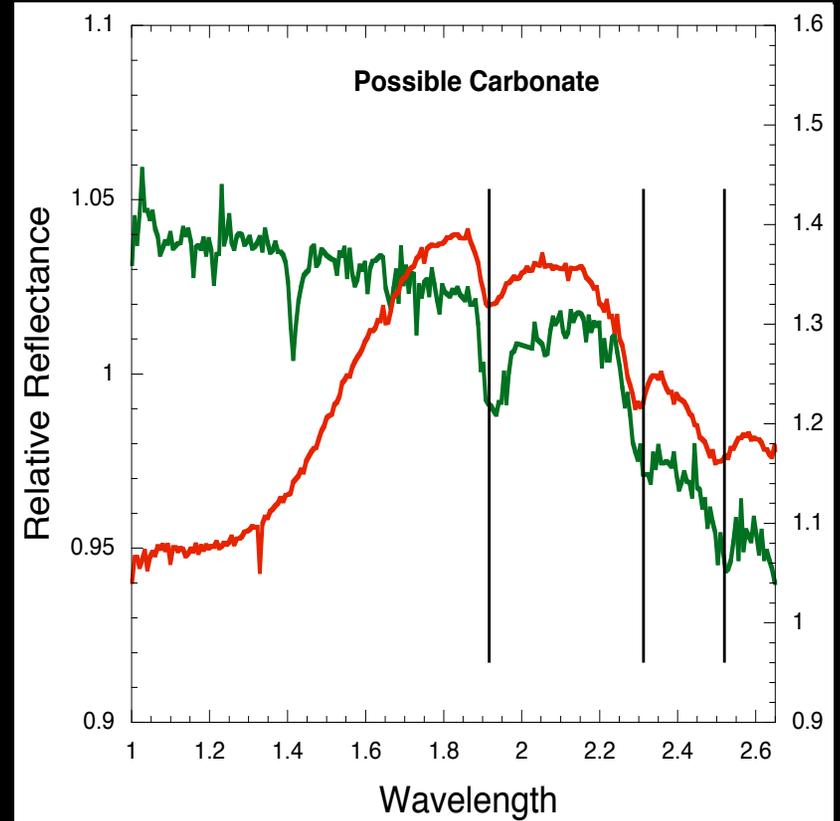
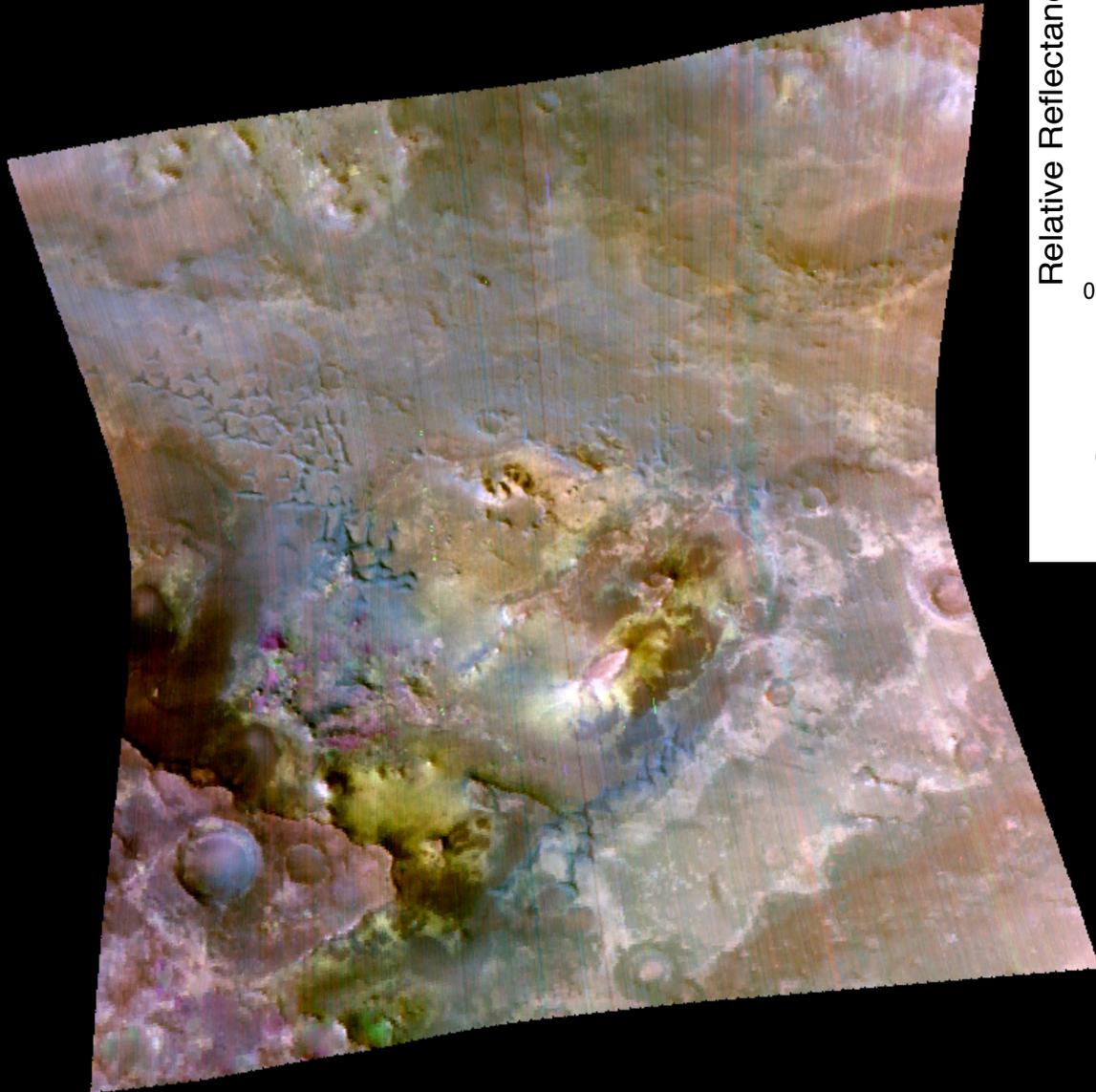
Nili Fossae Trough

- 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

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

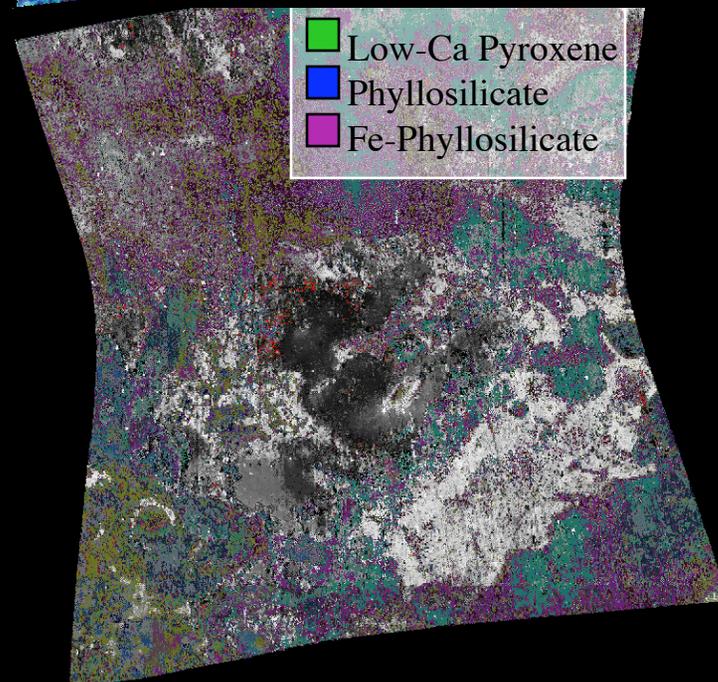
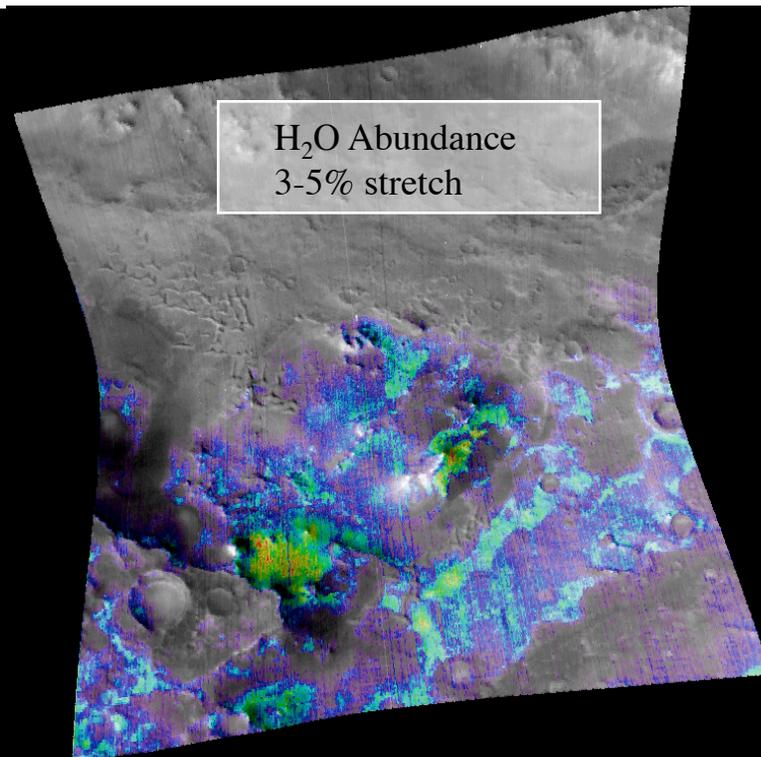
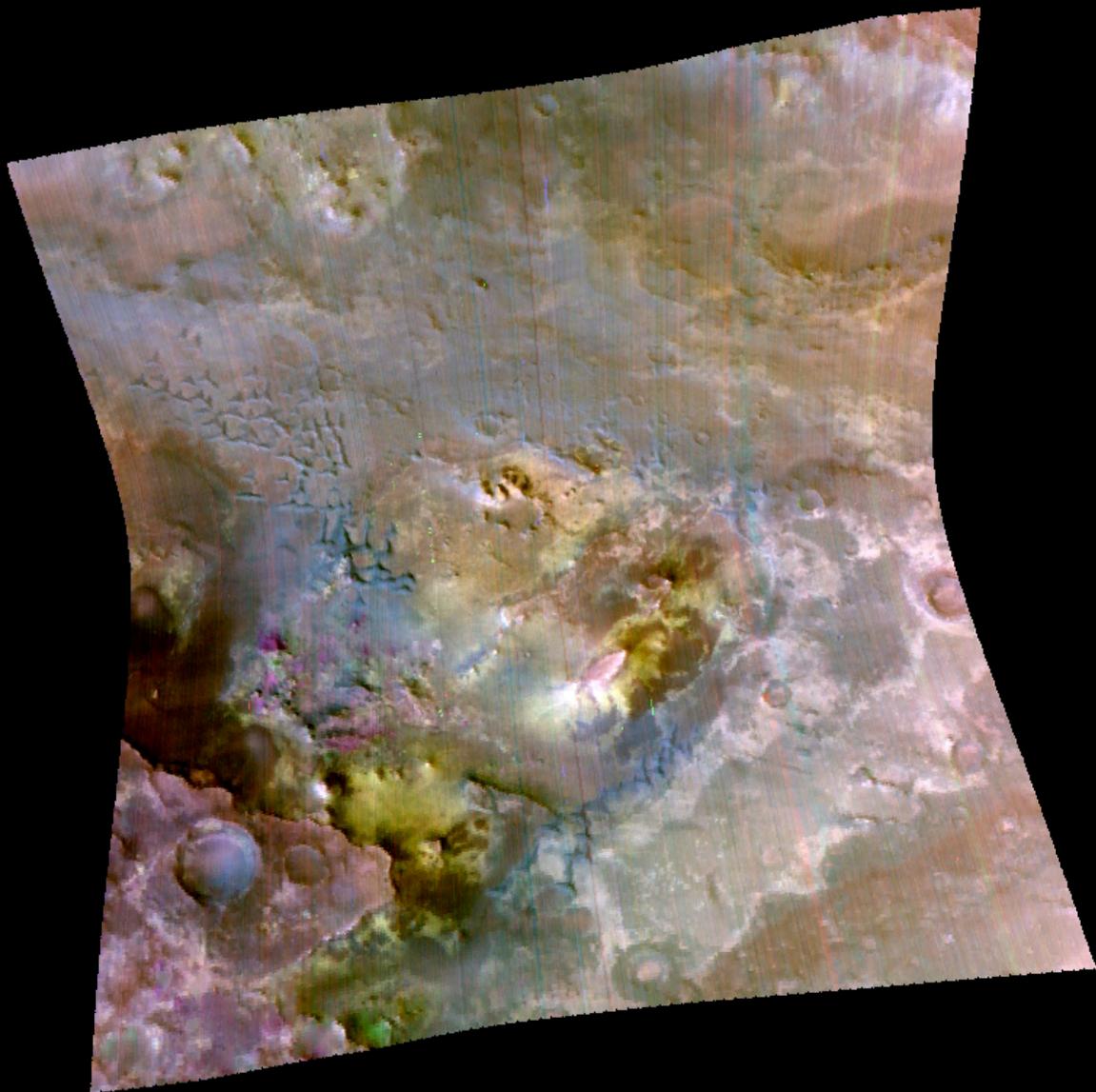


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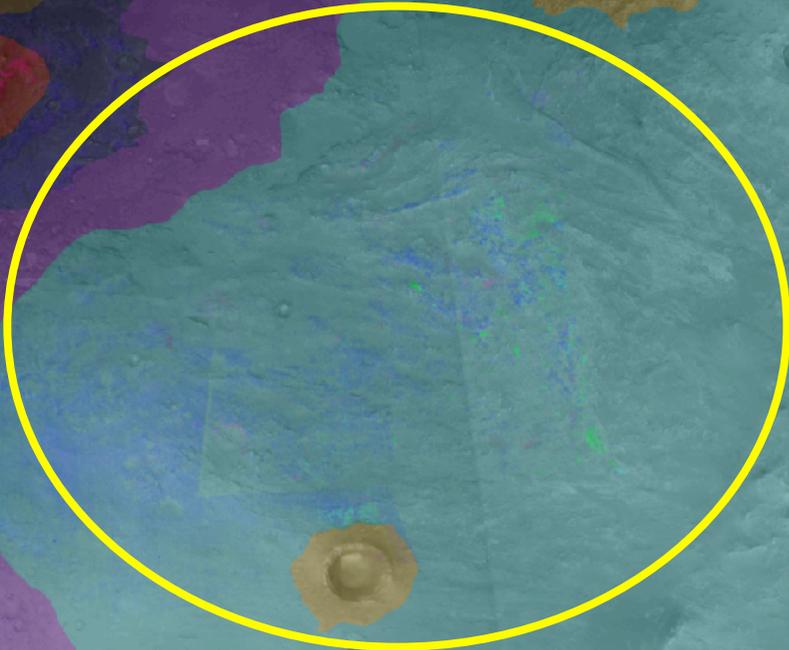


Mineralogy identified
Fe-oxide and crystalline hematite
Fe/Mg Smectite with variety of
band positions, H₂O content
Kaolinite
Carbonate
Pyroxene (Low and High Ca)
Olivine

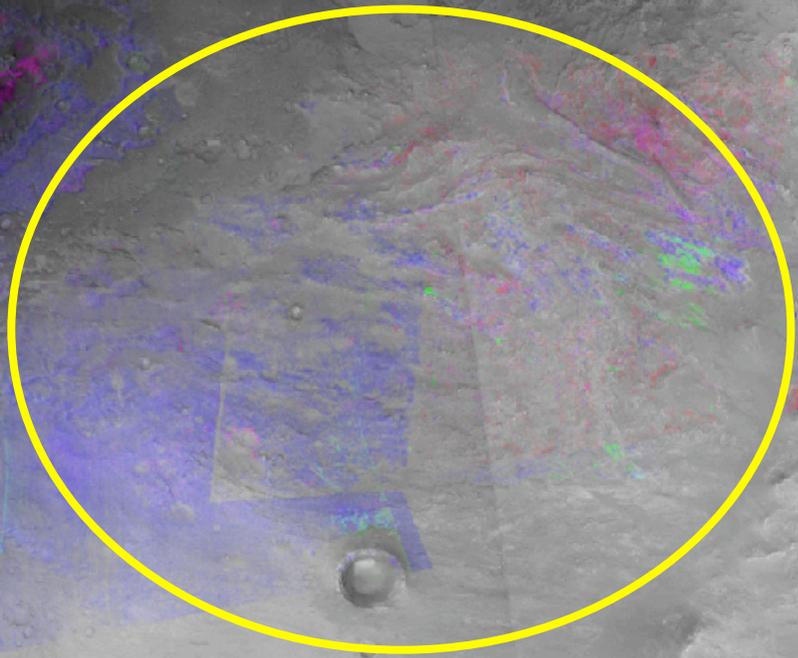
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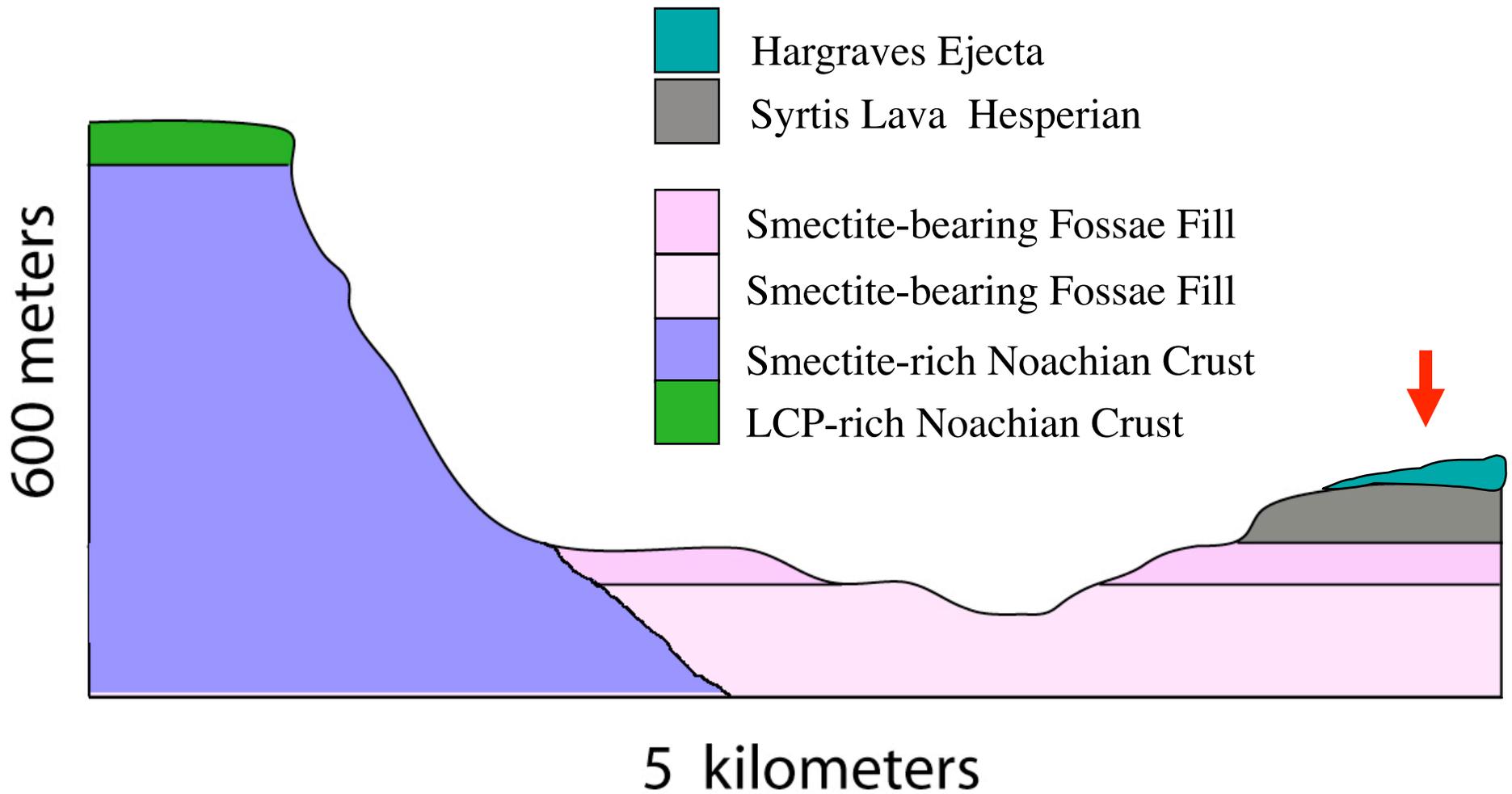


- Scarp walls
- Noachian crust
- Channel floor
- Trough fill
- Hesperian lava
- Hargraves Ejecta
- Fresh Craters

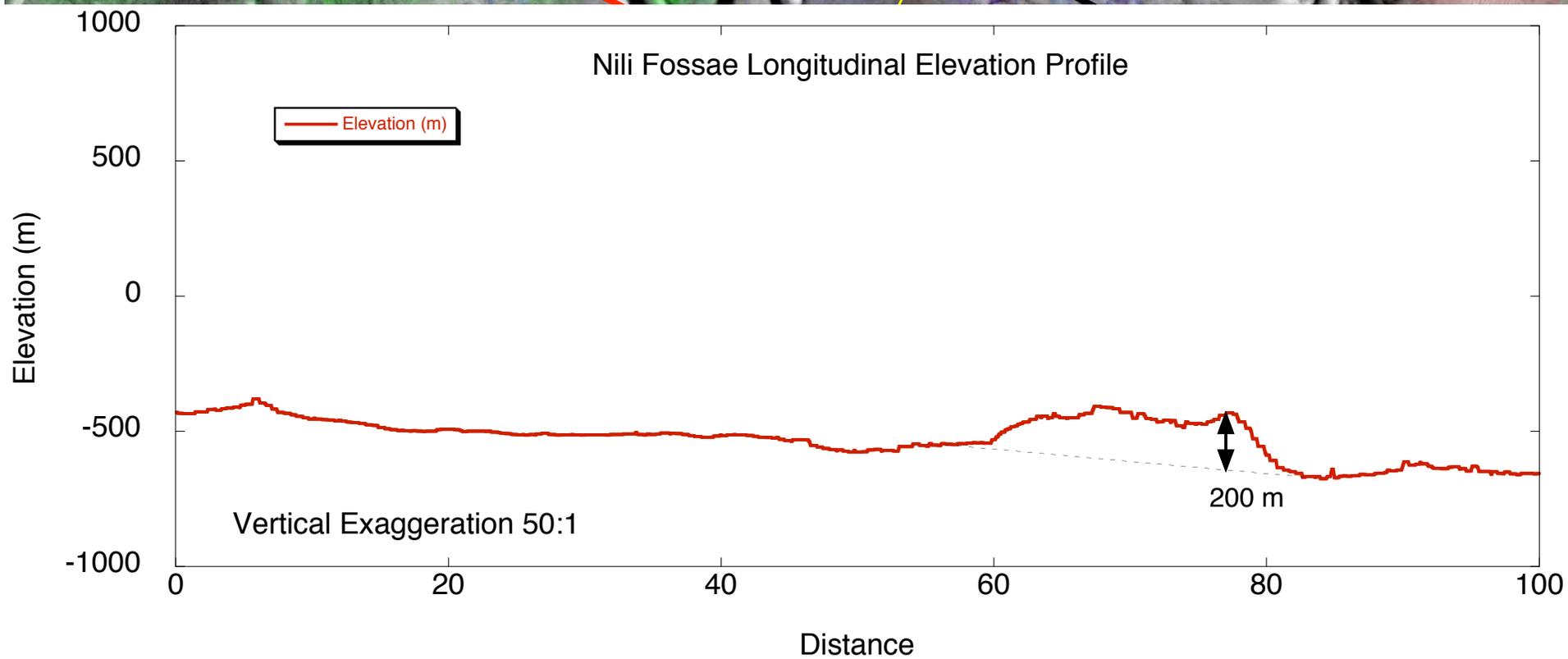
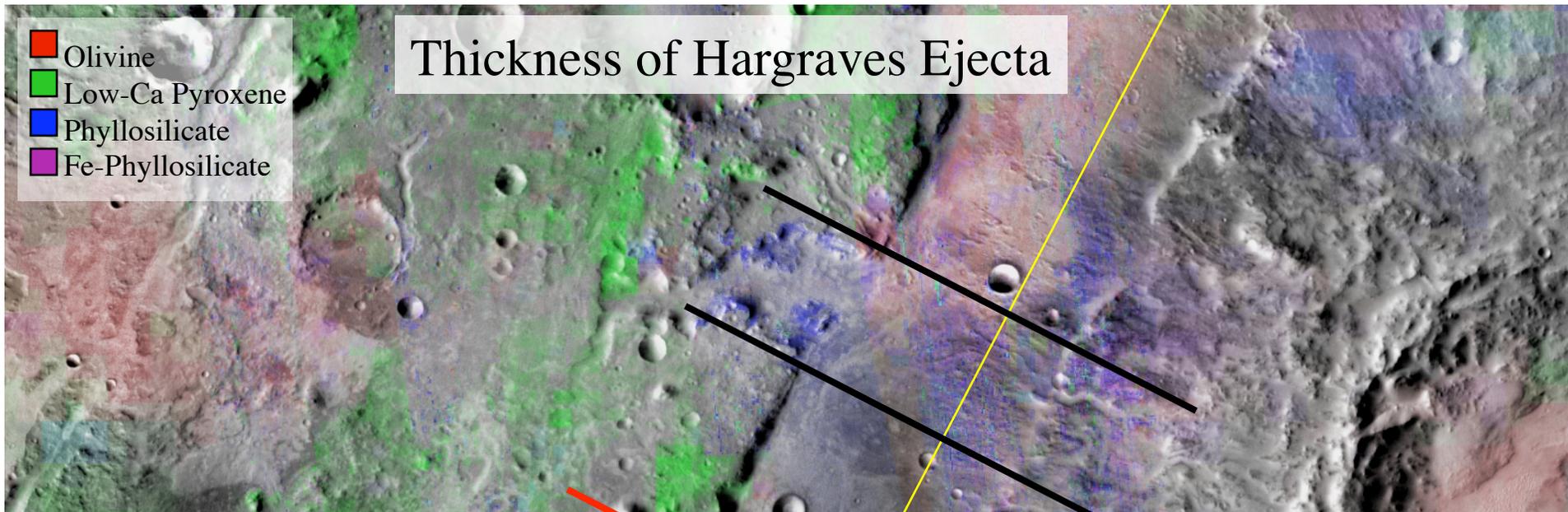


-  Olivine
-  Low-Ca Pyroxene
-  Phyllosilicate
-  Fe-Phyllosilicate

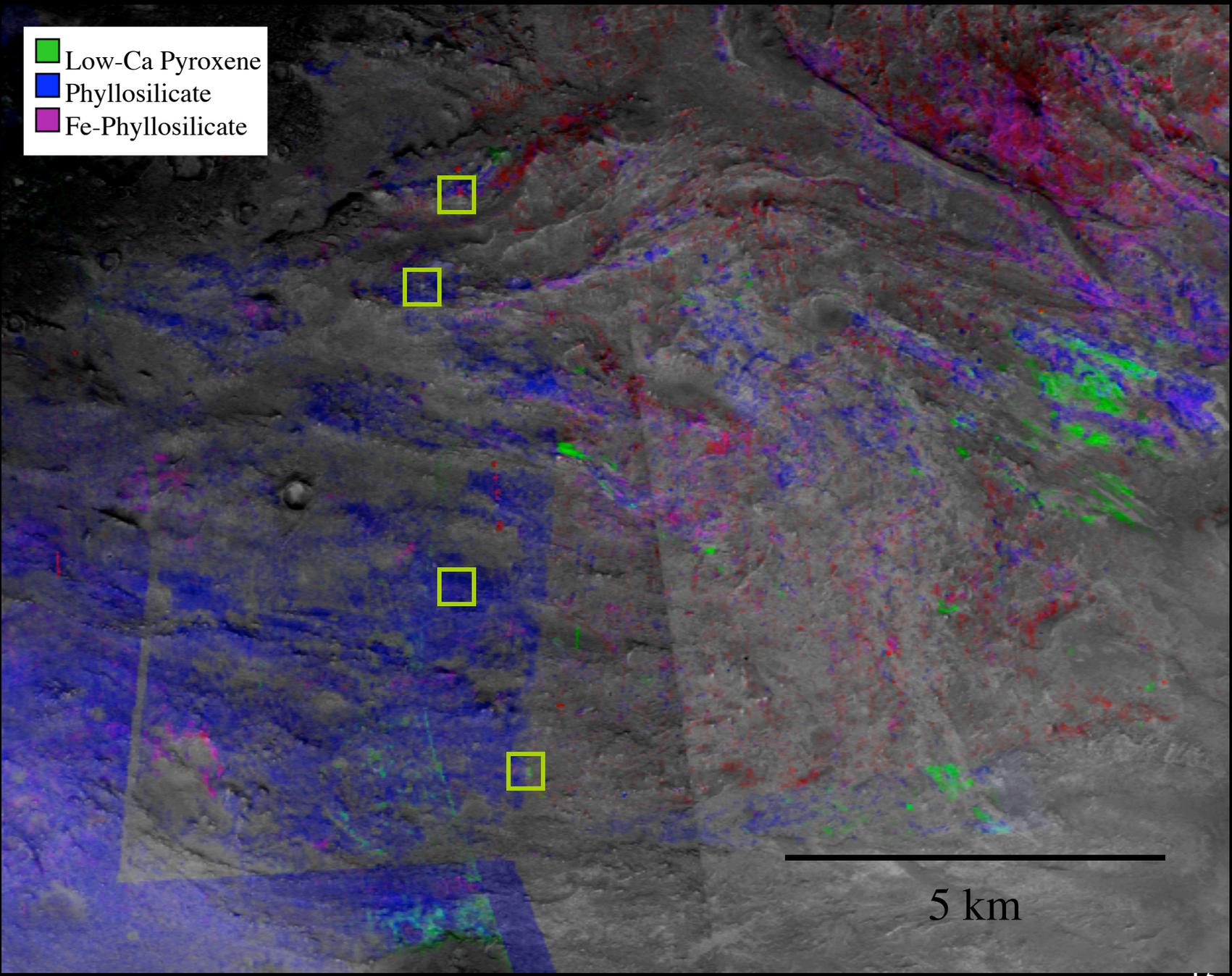




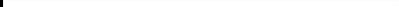
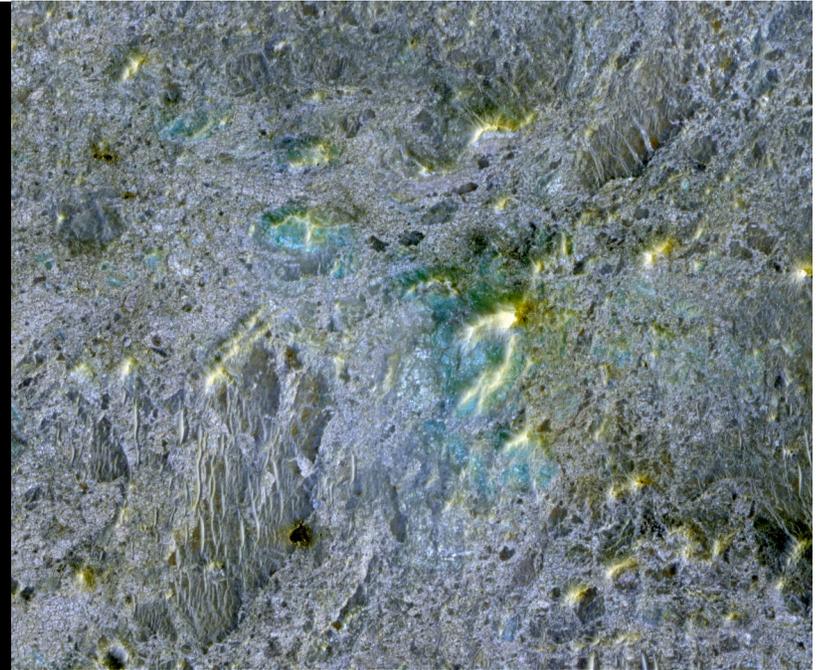
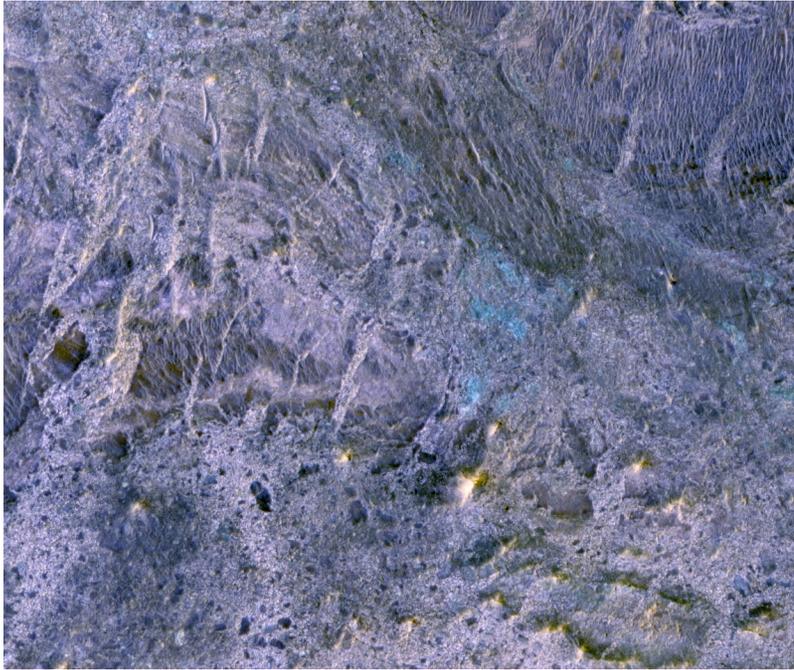
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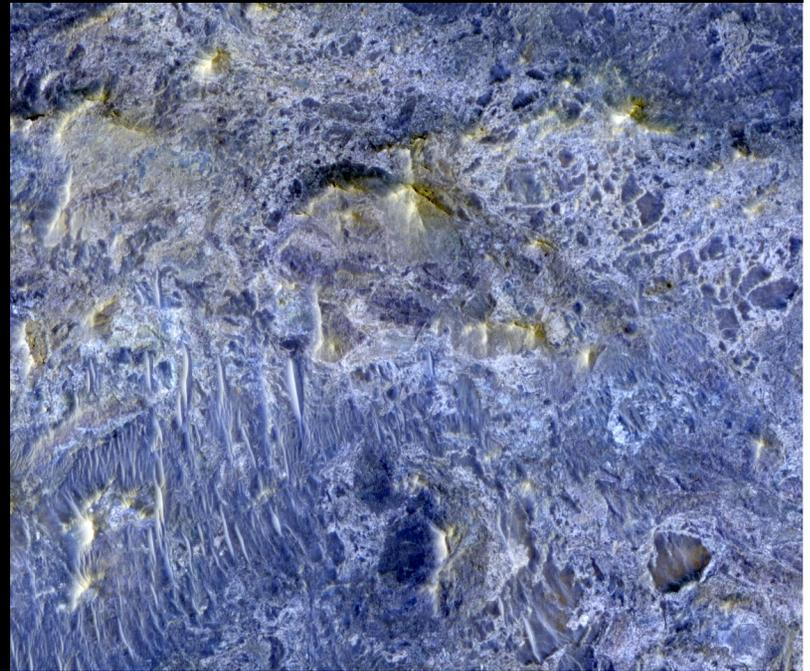
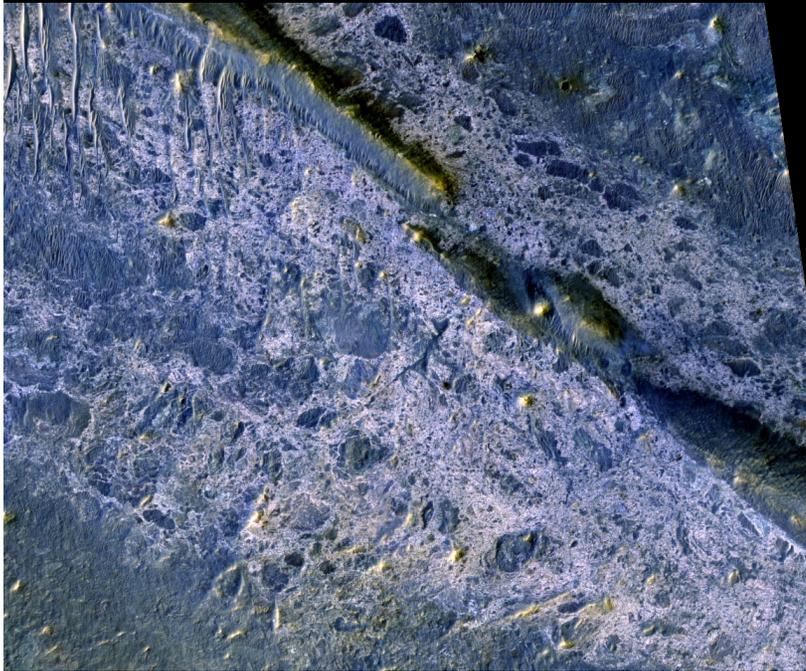
- Low-Ca Pyroxene
- Phyllosilicate
- Fe-Phyllosilicate

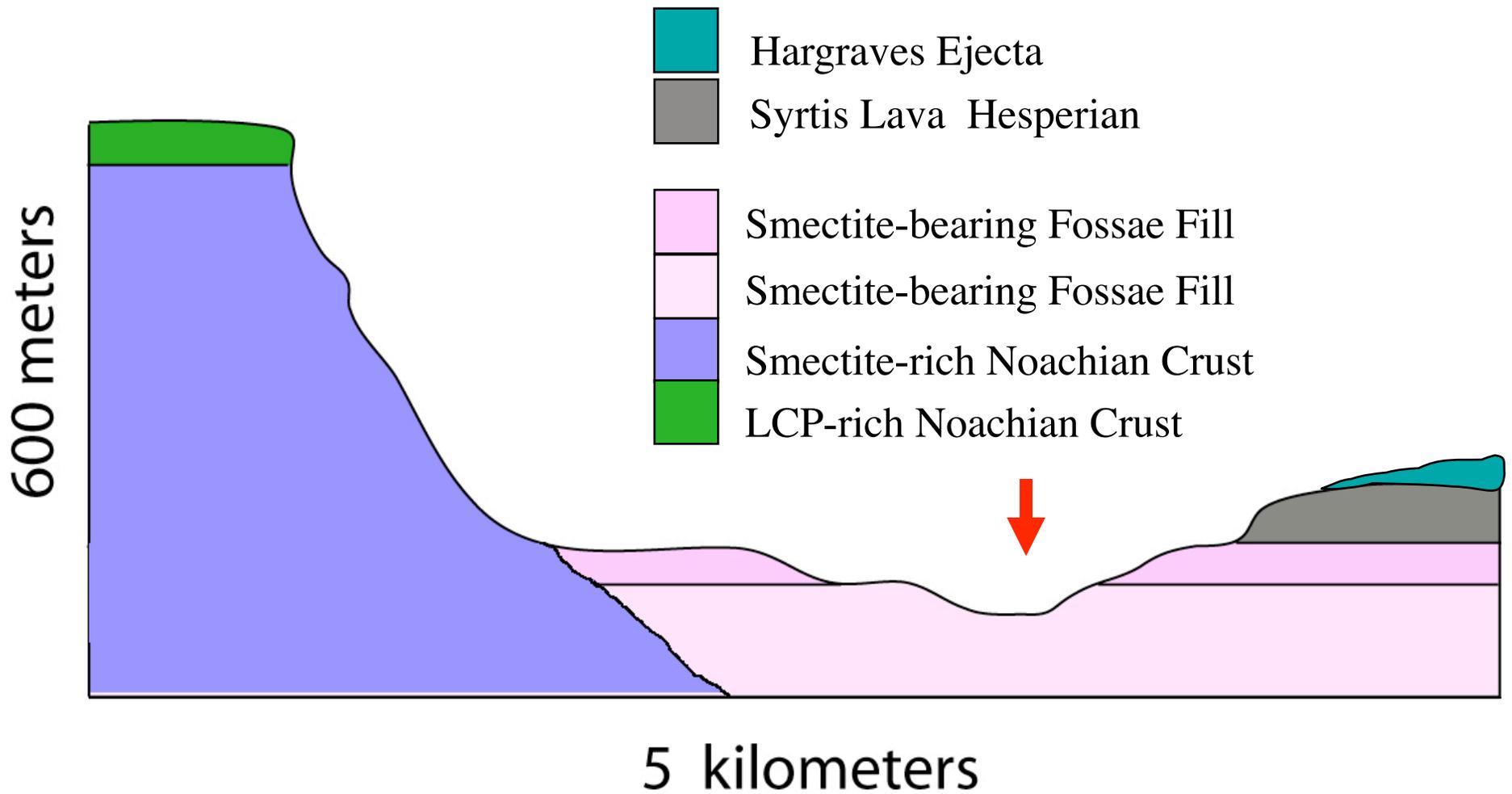


5 km



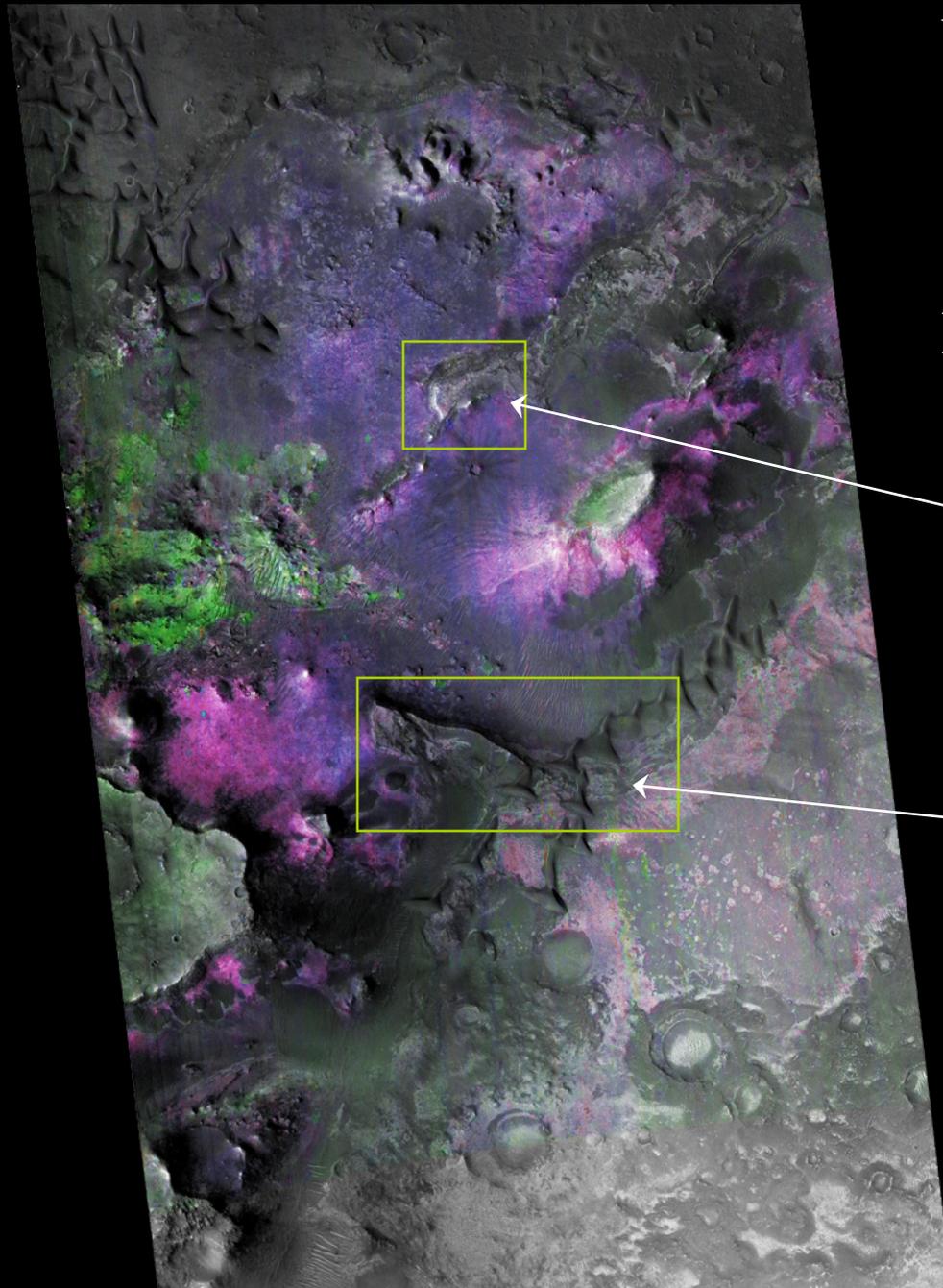
250 m





(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

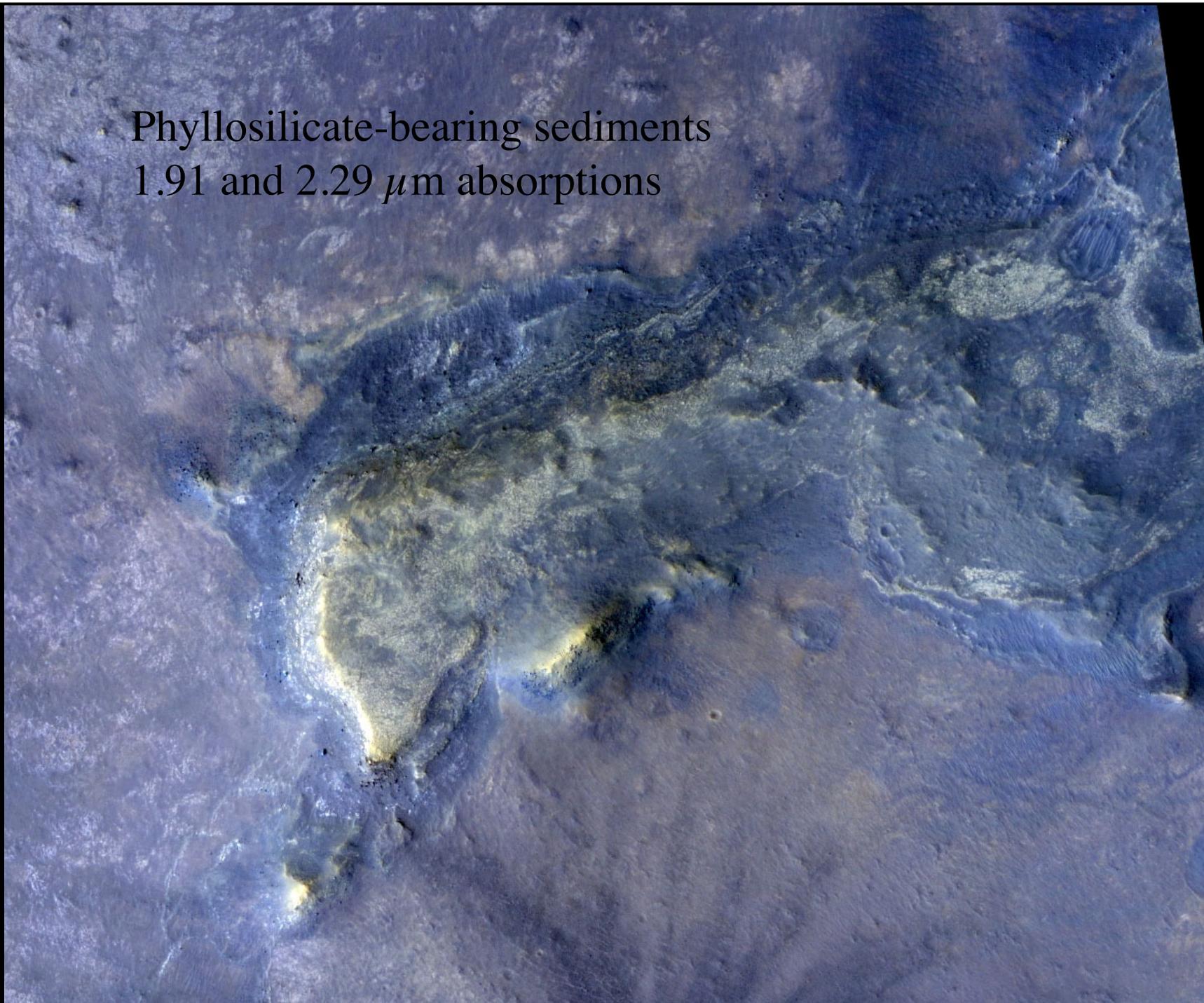


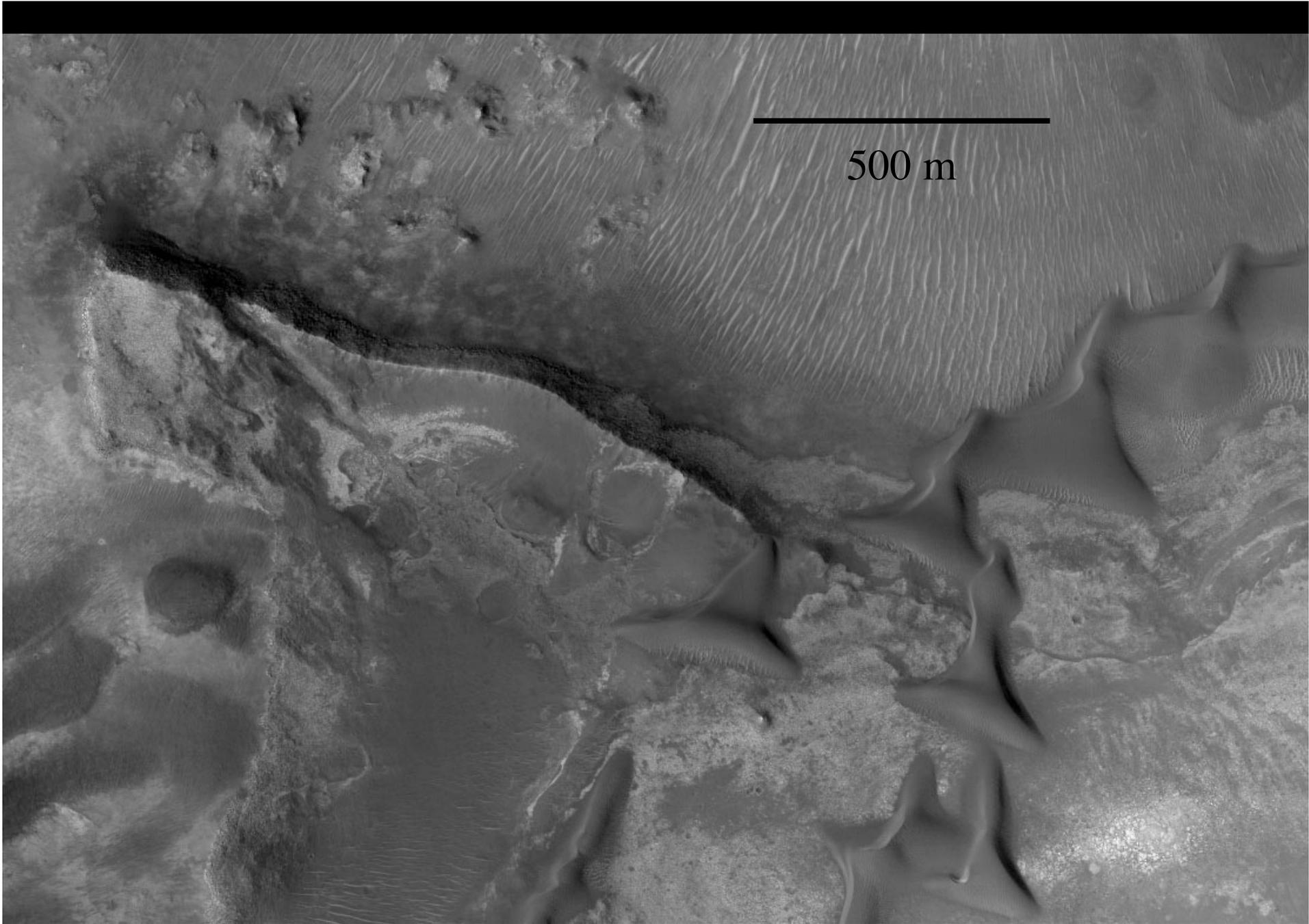
Layered material on the
floor of the sapping
channel

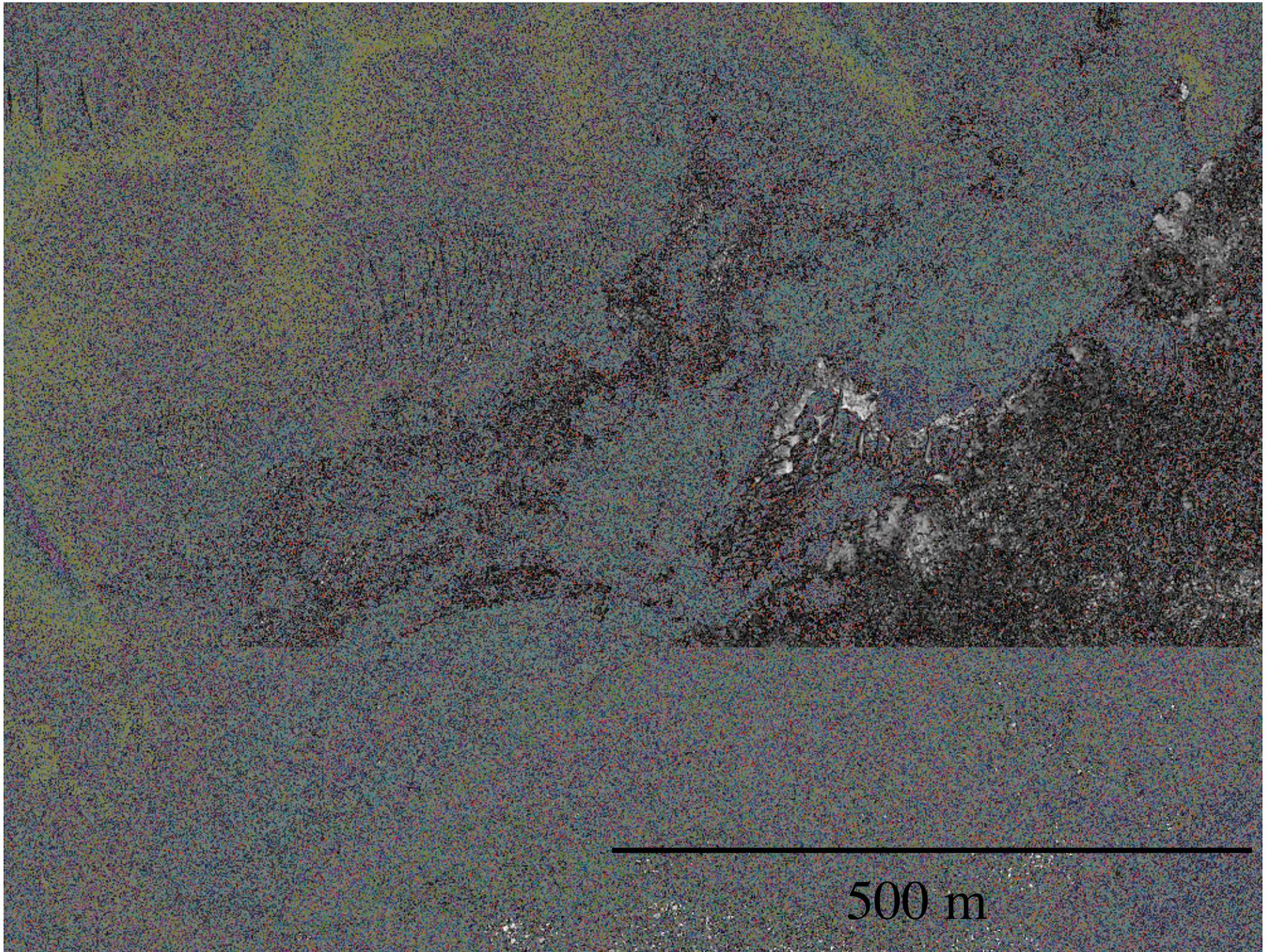
Trough fill

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

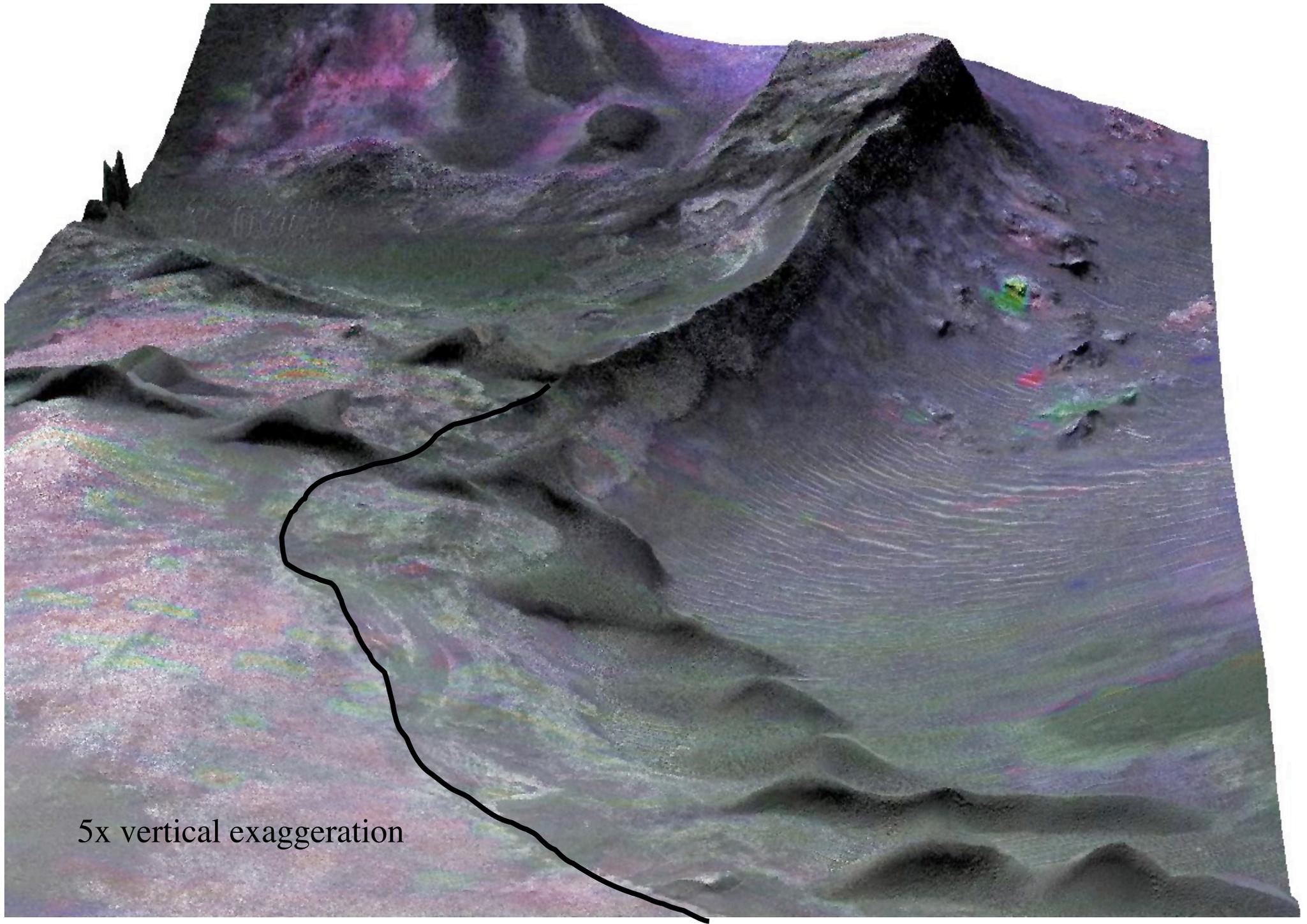
Phyllosilicate-bearing sediments
1.91 and 2.29 μm absorptions



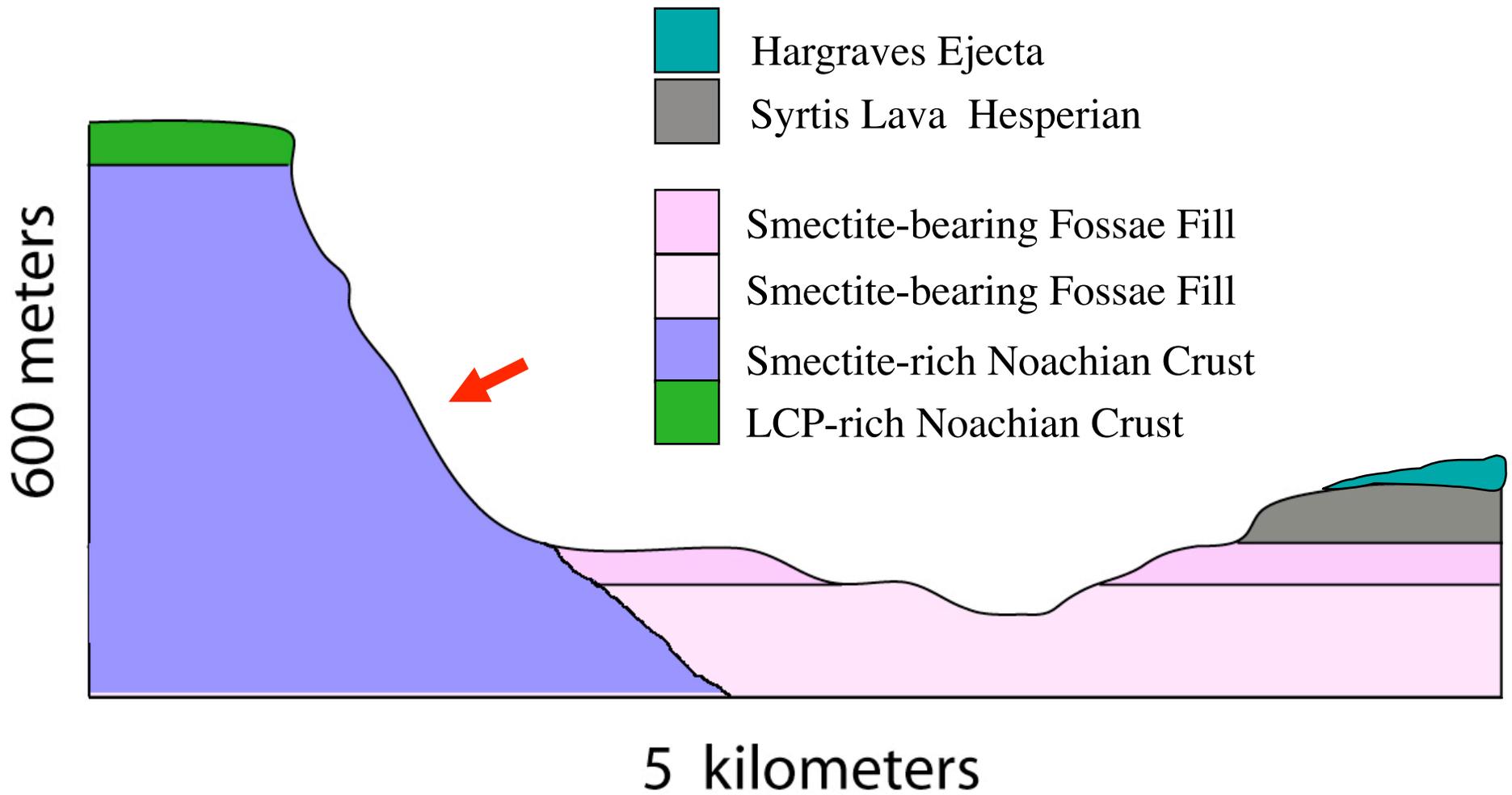




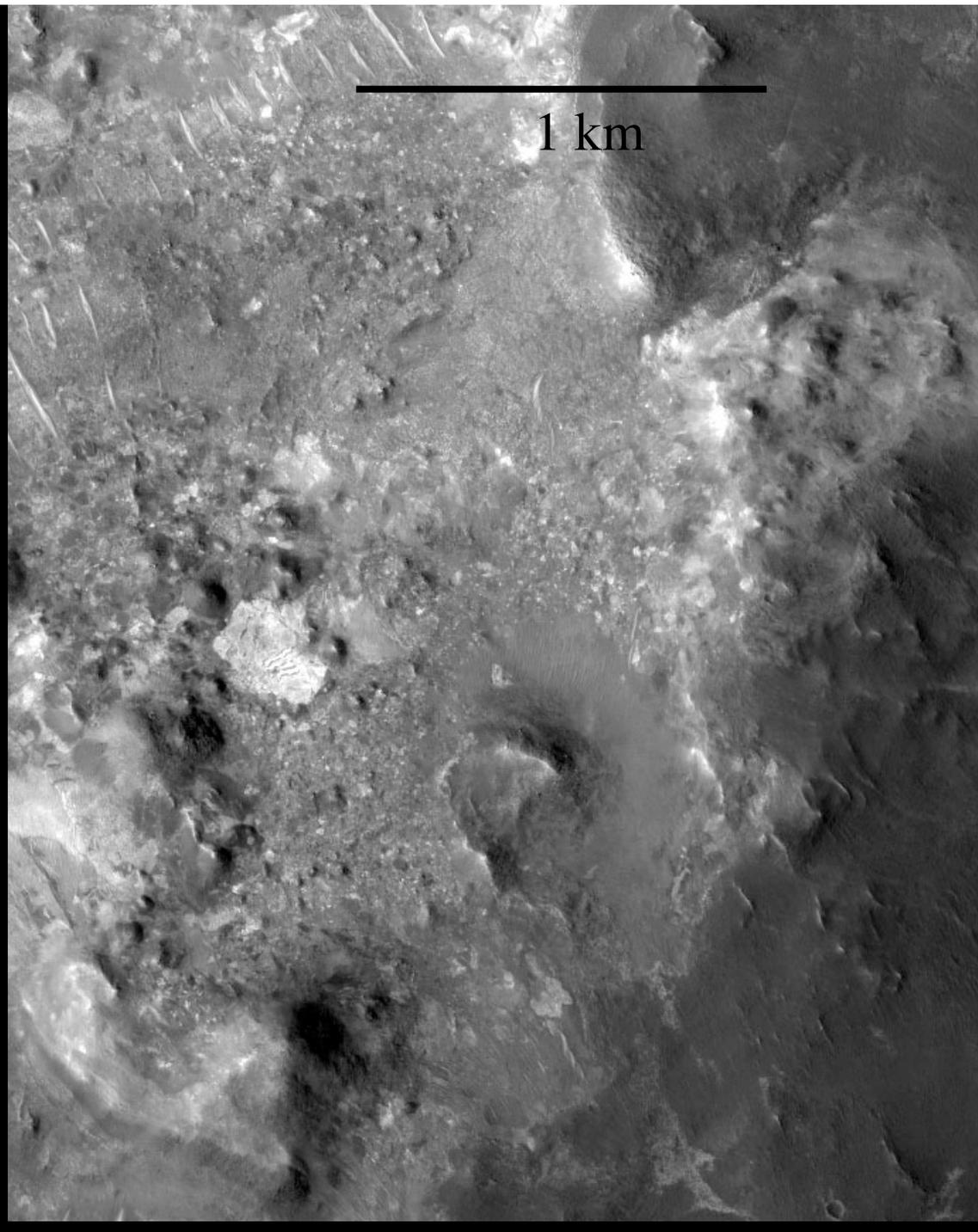
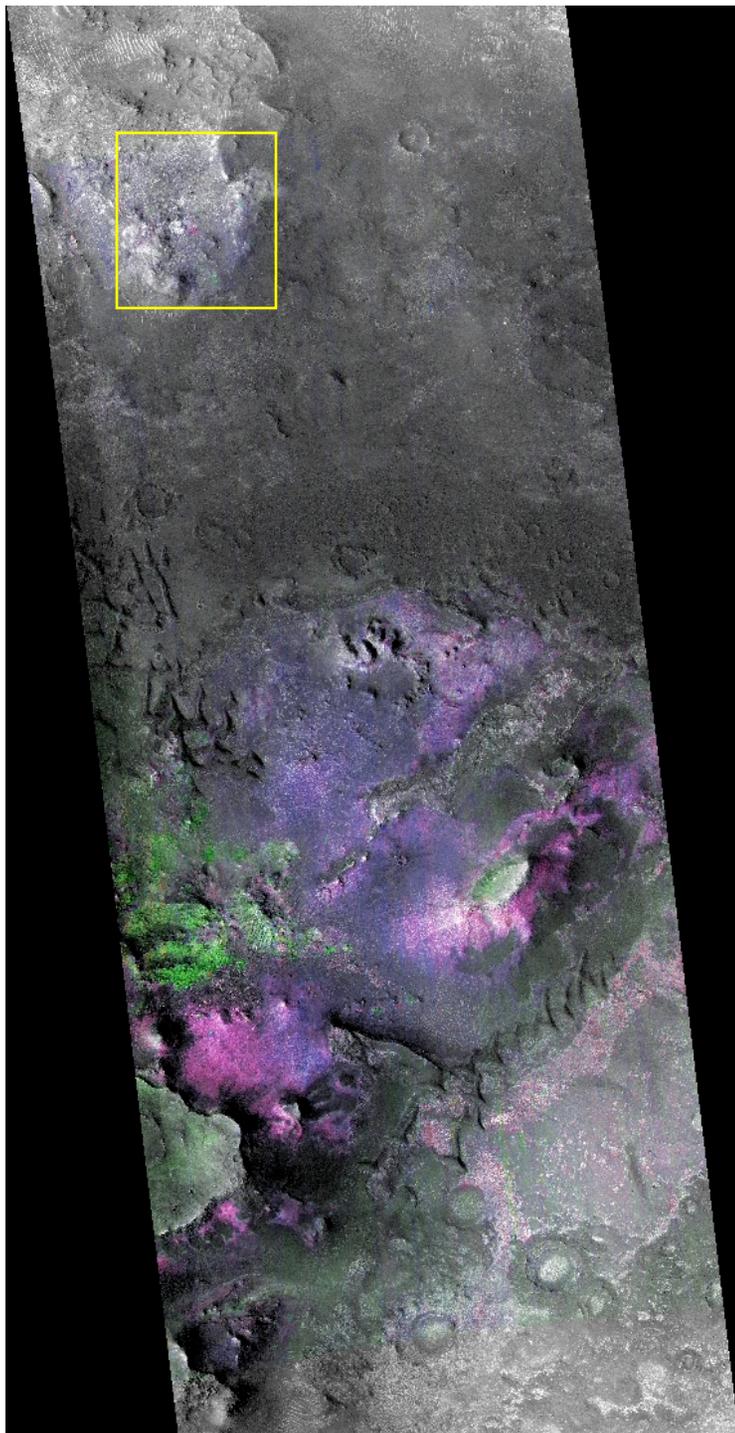
500 m

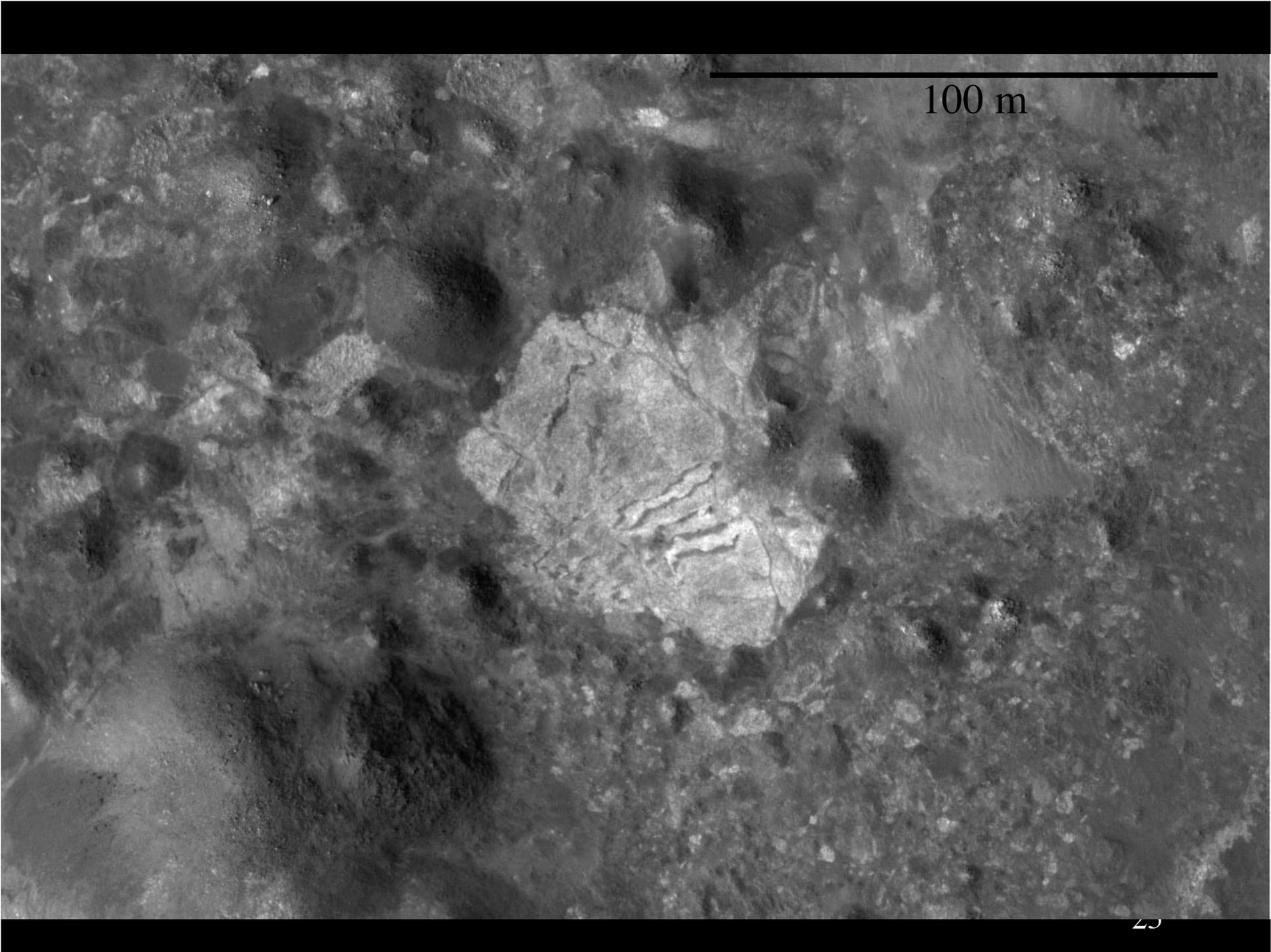


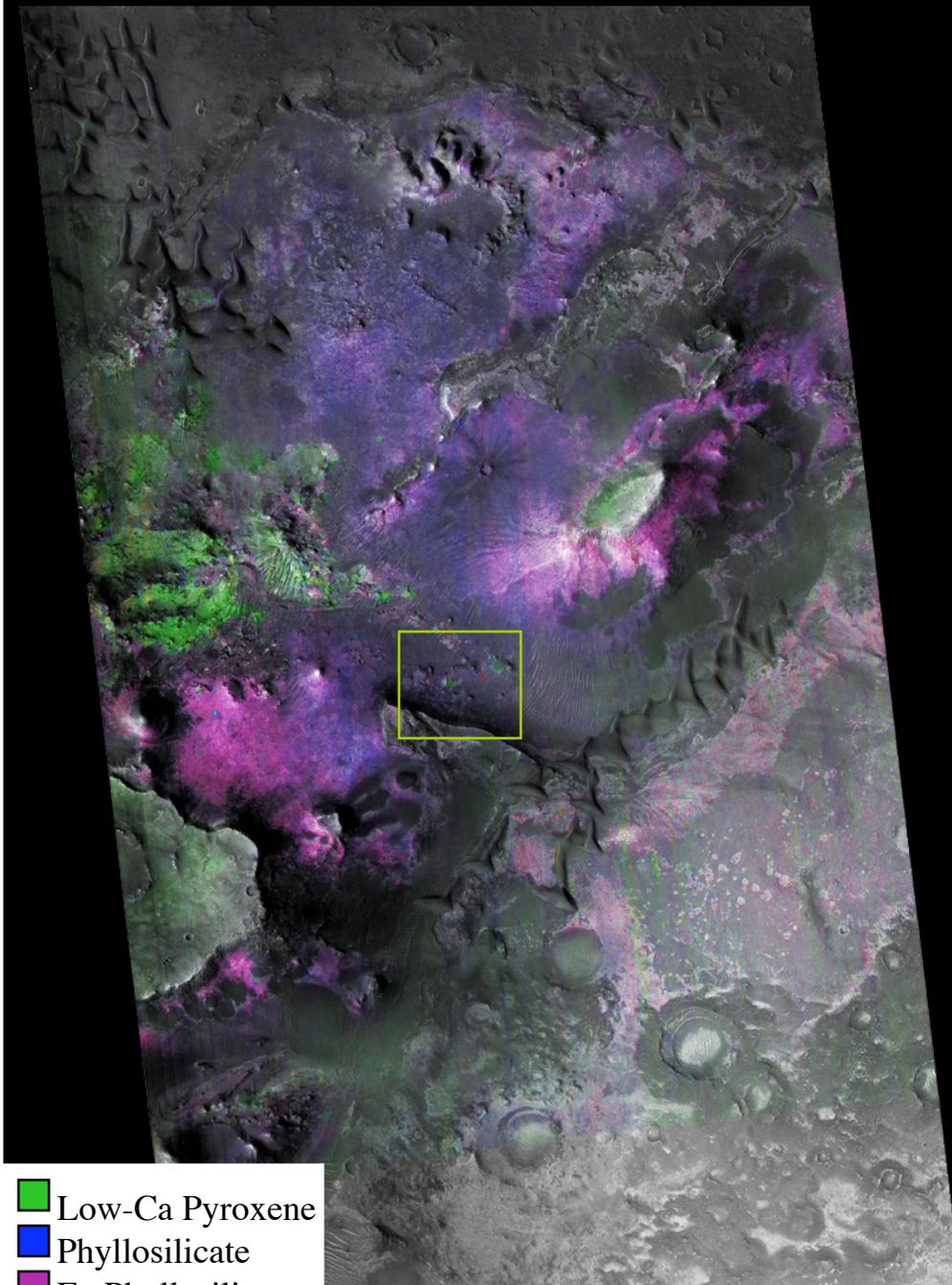
5x vertical exaggeration



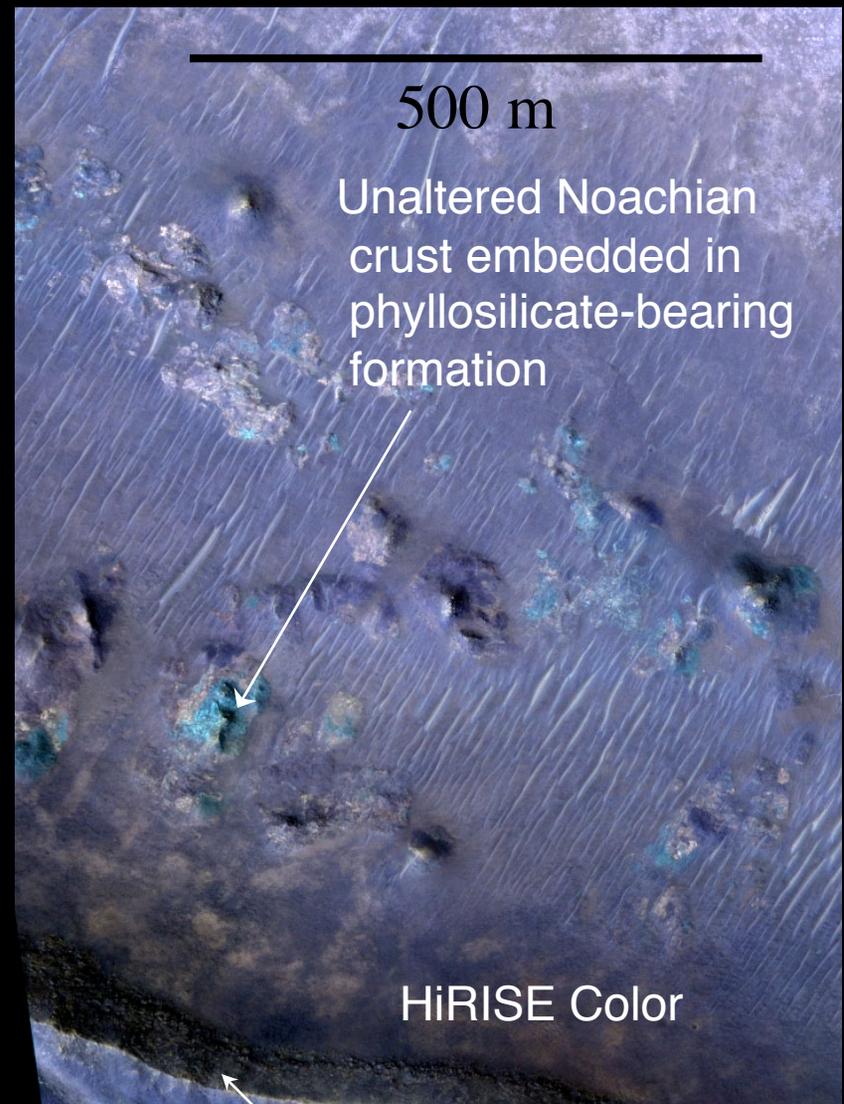
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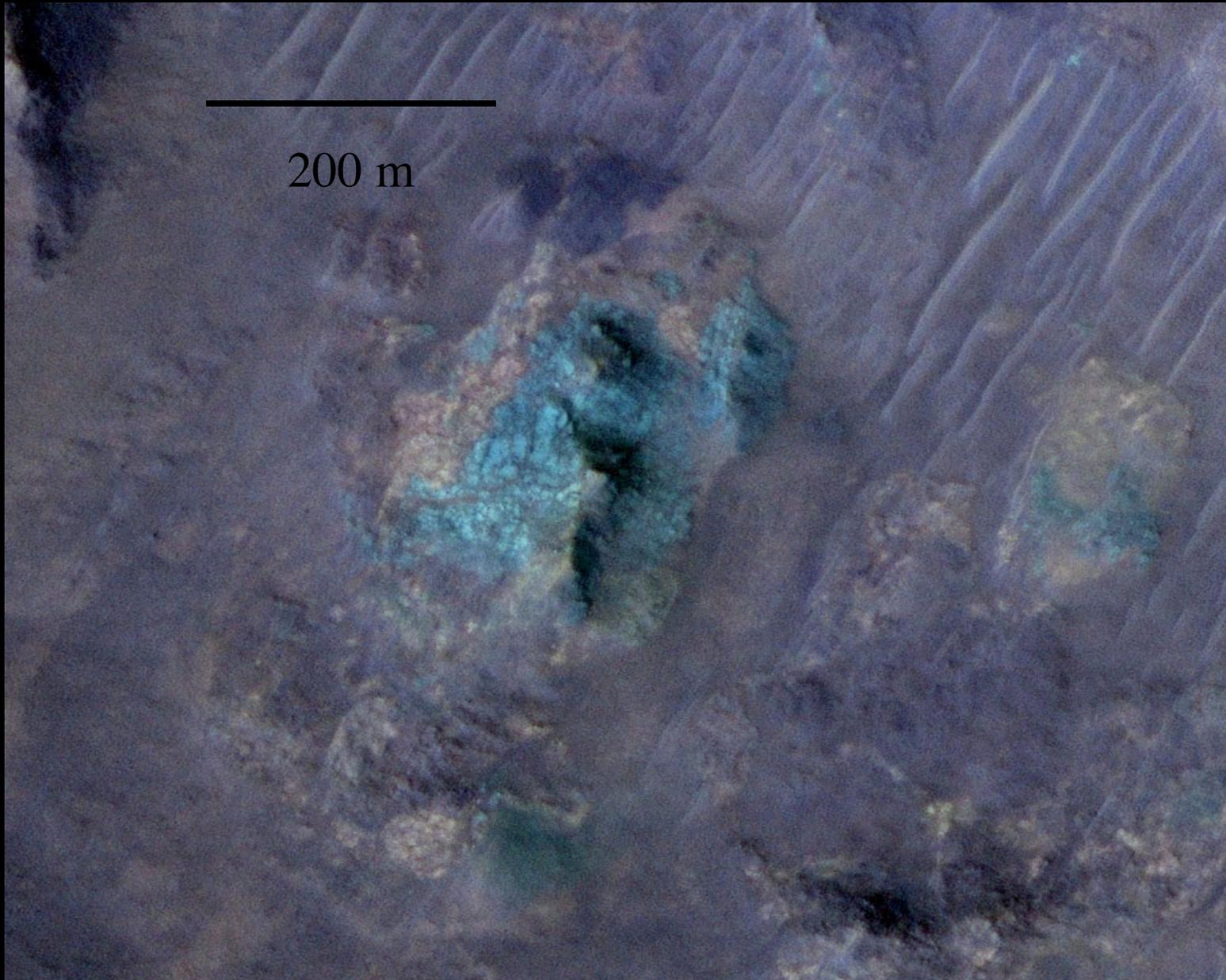
- Low-Ca Pyroxene
- Phyllosilicate
- Fe-Phyllosilicate



500 m
Unaltered Noachian
crust embedded in
phyllosilicate-bearing
formation

HiRISE Color

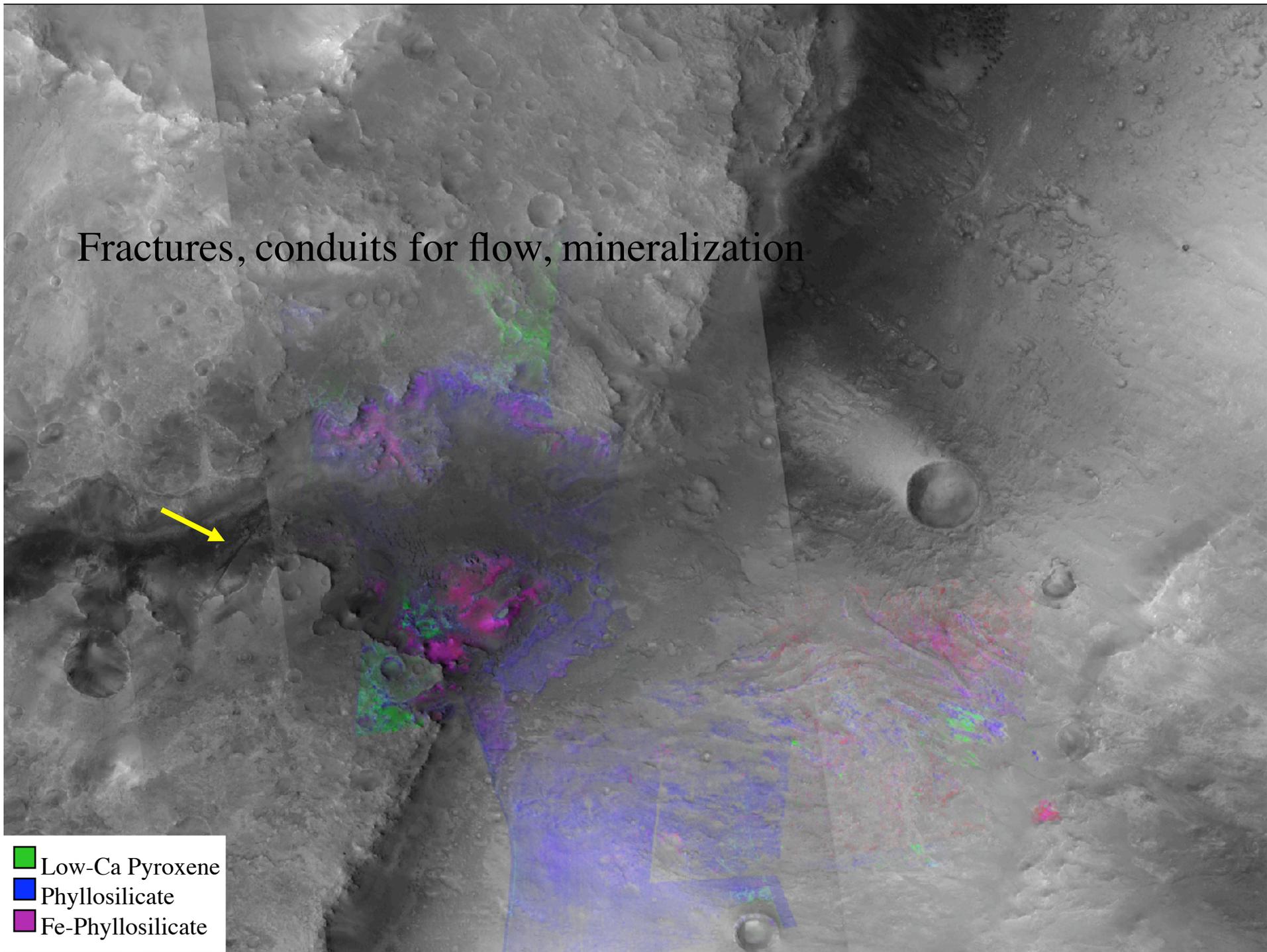
Layered
Sediments

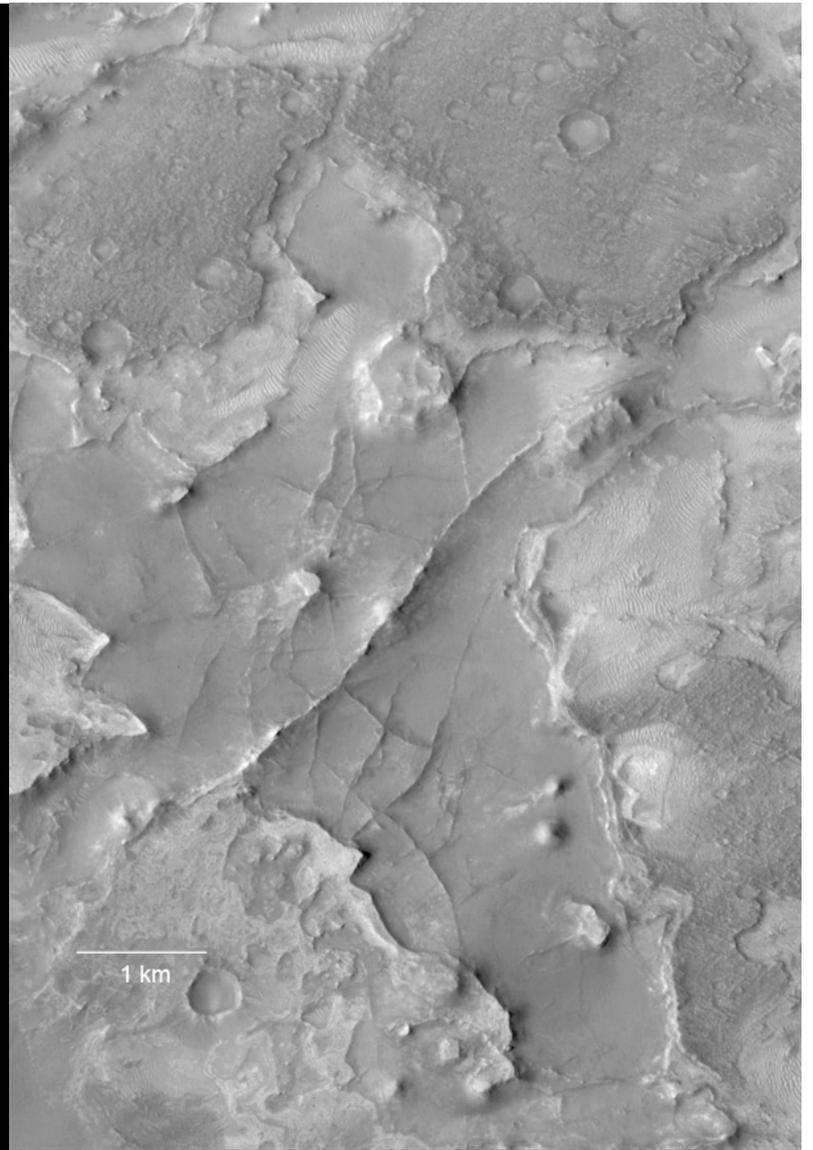
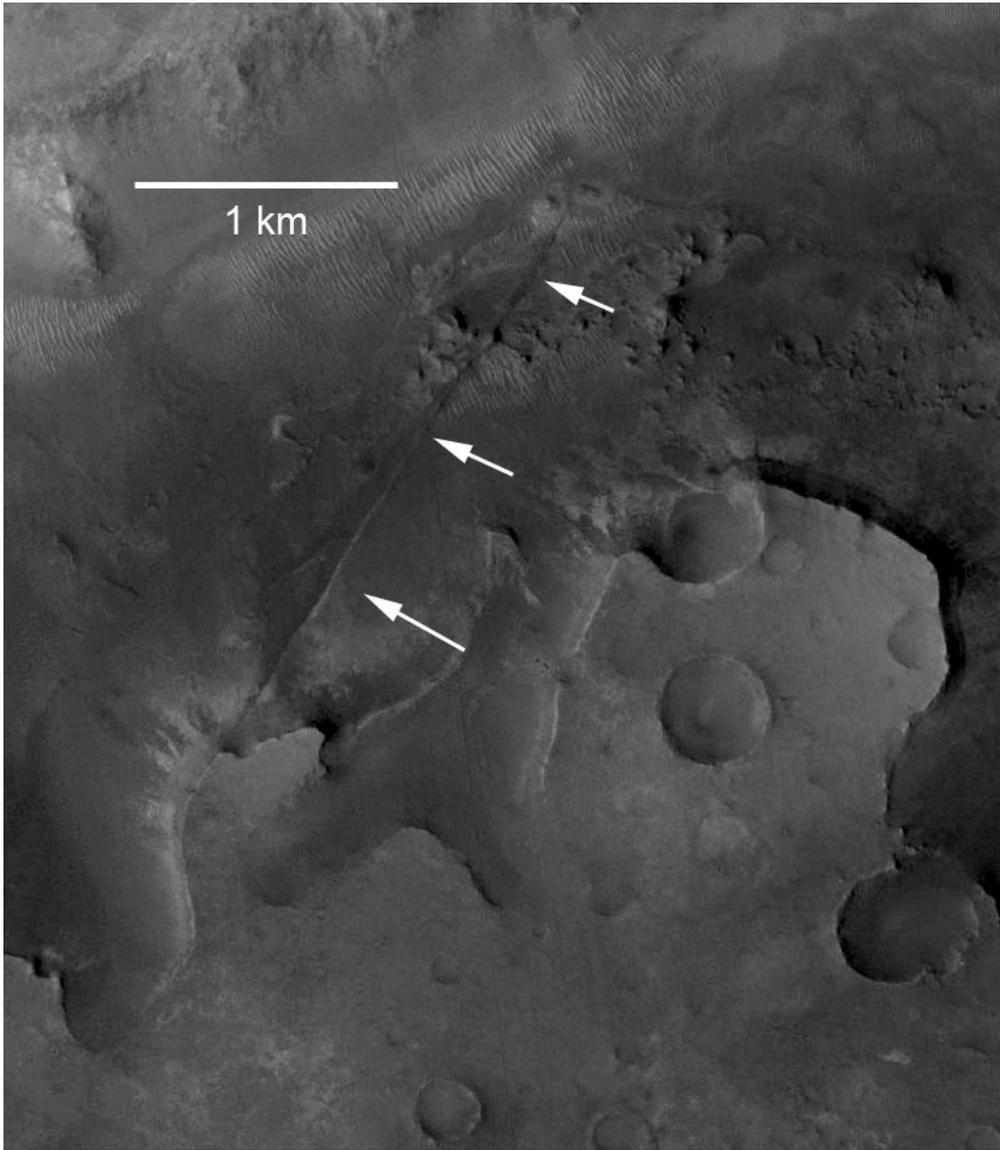


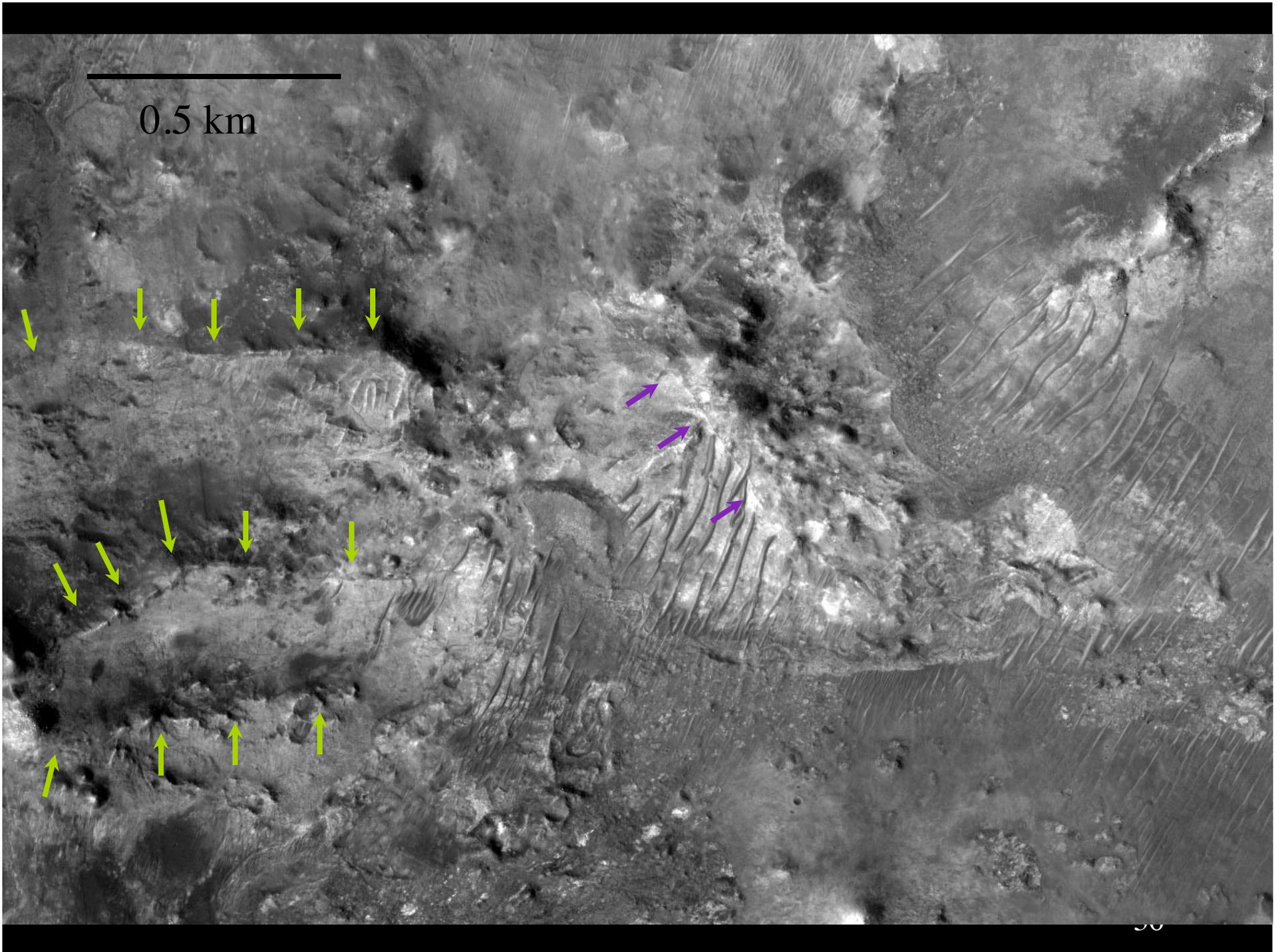
Fractures, conduits for flow, mineralization



- Low-Ca Pyroxene
- Phyllosilicate
- Fe-Phyllosilicate

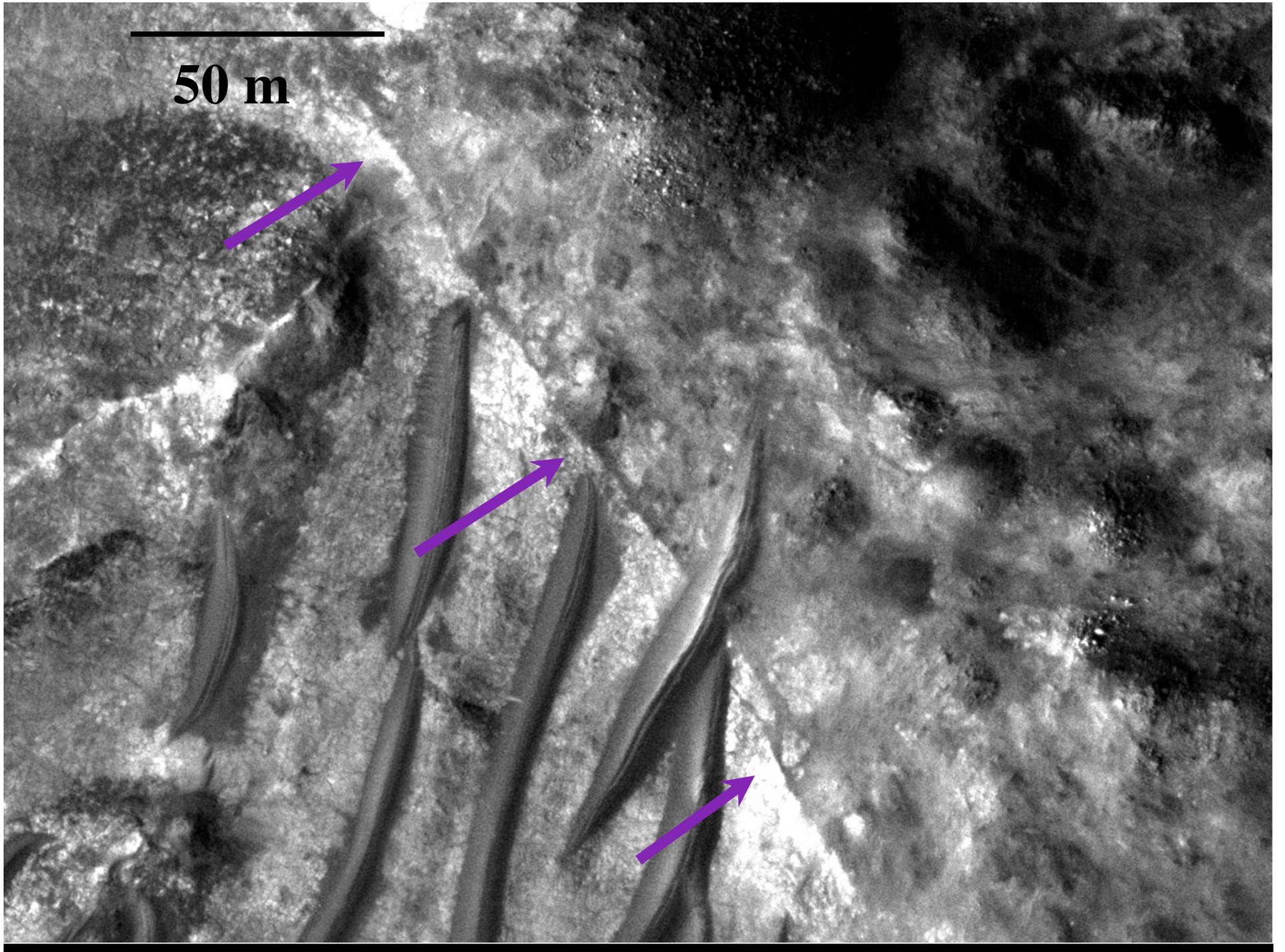






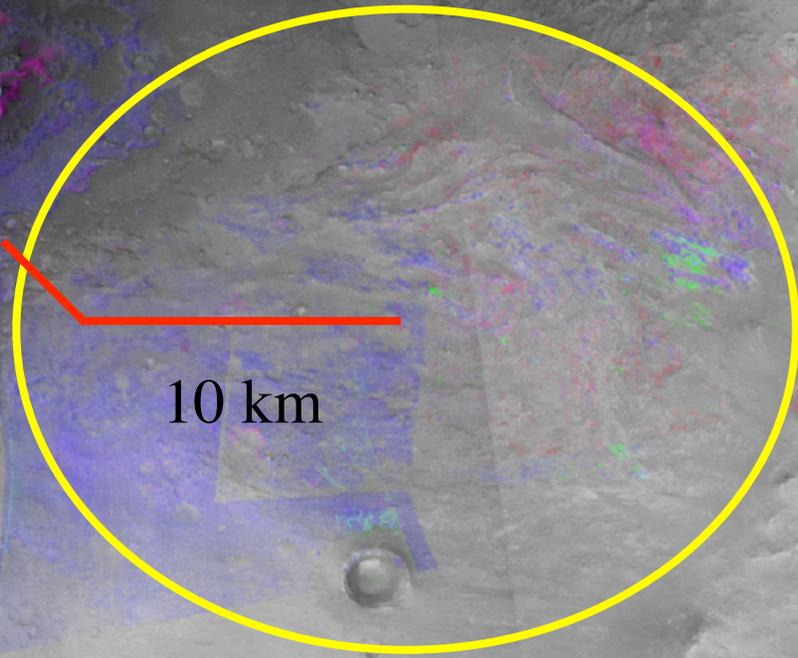
0.5 km

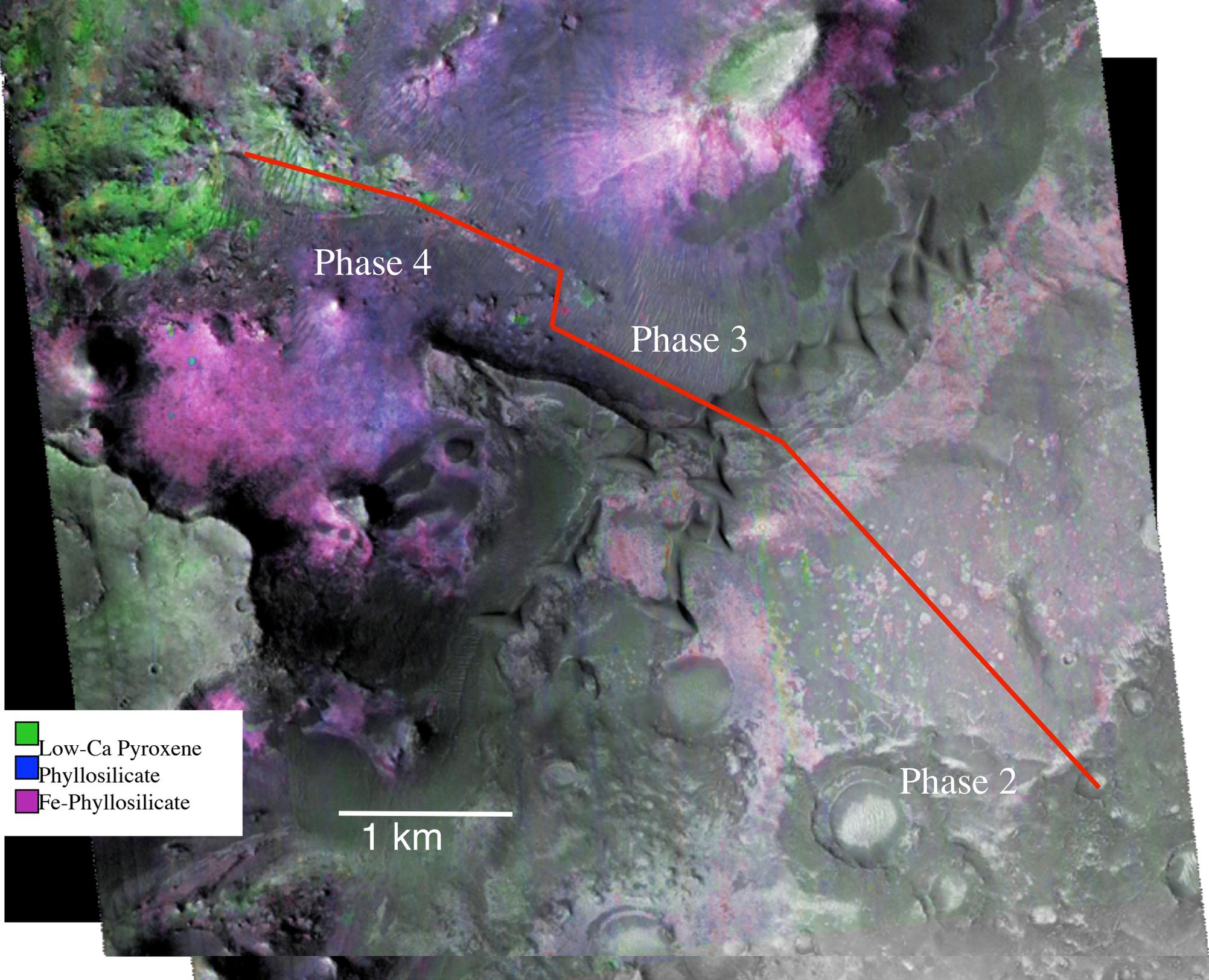
50 m



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

Phase 1: Ellipse Science
Fluidized ejecta from Hargraves
Diverse lithologies (unaltered, altered, kaolinite)
Hesperian lavas of Syrtis Major





Nili Fossae Trough

- Diverse habitable environments mitigates the risk of disappointment
- Broader science goals advance understanding of Mars as a planet
- Diverse Noachian environments present throughout the landing site
- Regional geologic context, 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
- 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

Discussion Points

- Diversity
 - Number of rock types, stratigraphic and/or cross-cutting relationships, mineralogic and geomorphic diversity, evidence for interaction with water
 - Multiple working hypotheses
- Context
 - How much can be placed in a geologic framework? Can local observations be placed in a regional context? How can MSL payload resolve alternative interpretations?
- Habitability
 - How well do mineralogy and geomorphology indicate a particular habitable environment?
- Fossil/Biosignature Preservation
 - Are minerals contemporaneous with sedimentation/rock alteration? What mech/process is involved in fossilization?

Critical Questions Directed to the Nili Fossae Trough

- The Noachian crust is megabreccia from Isidis and will be too complicated to understand
- The go-to site is only penetratively altered megabreccia and we've seen this at Columbian Hills
- The Noachian-Hesperian transition has been crossed by Spirit, and not much will be learned here
- Preservation potential of fossils/biosignatures is weak