The Geomorphology of the Proposed MSL Field Site in Gale Crater

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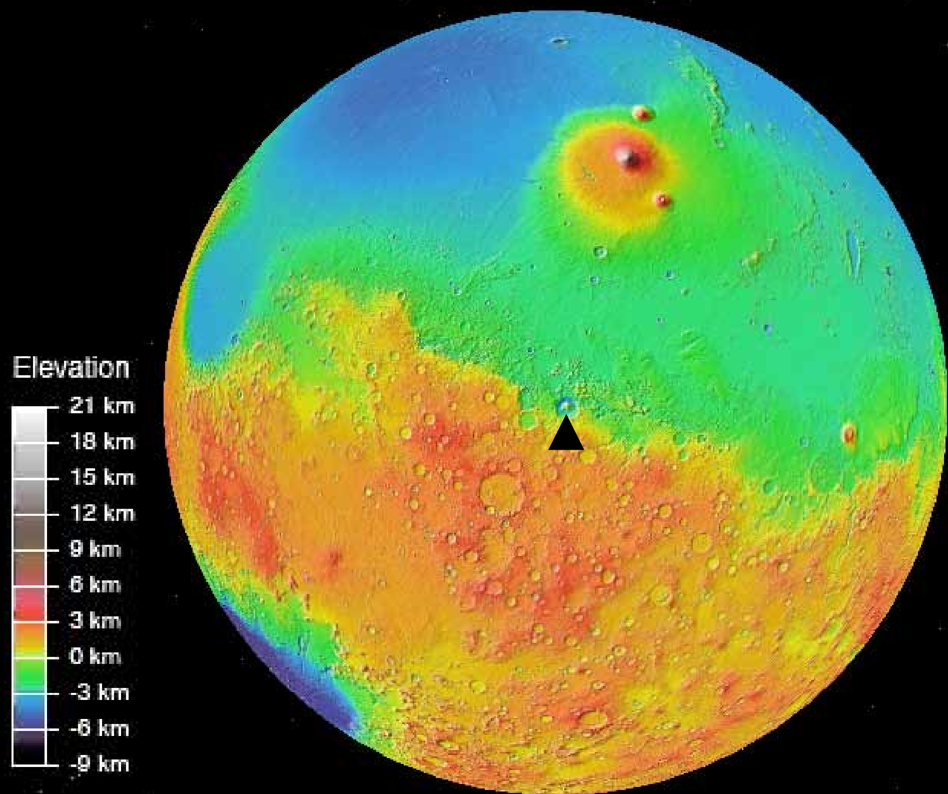
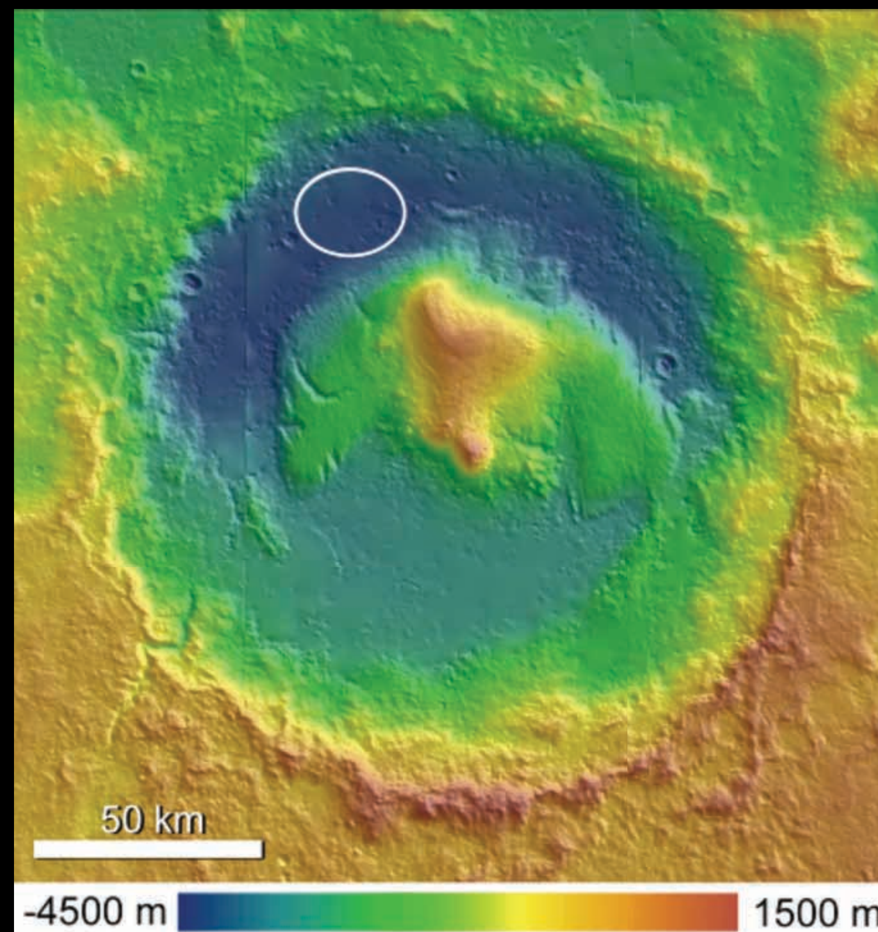
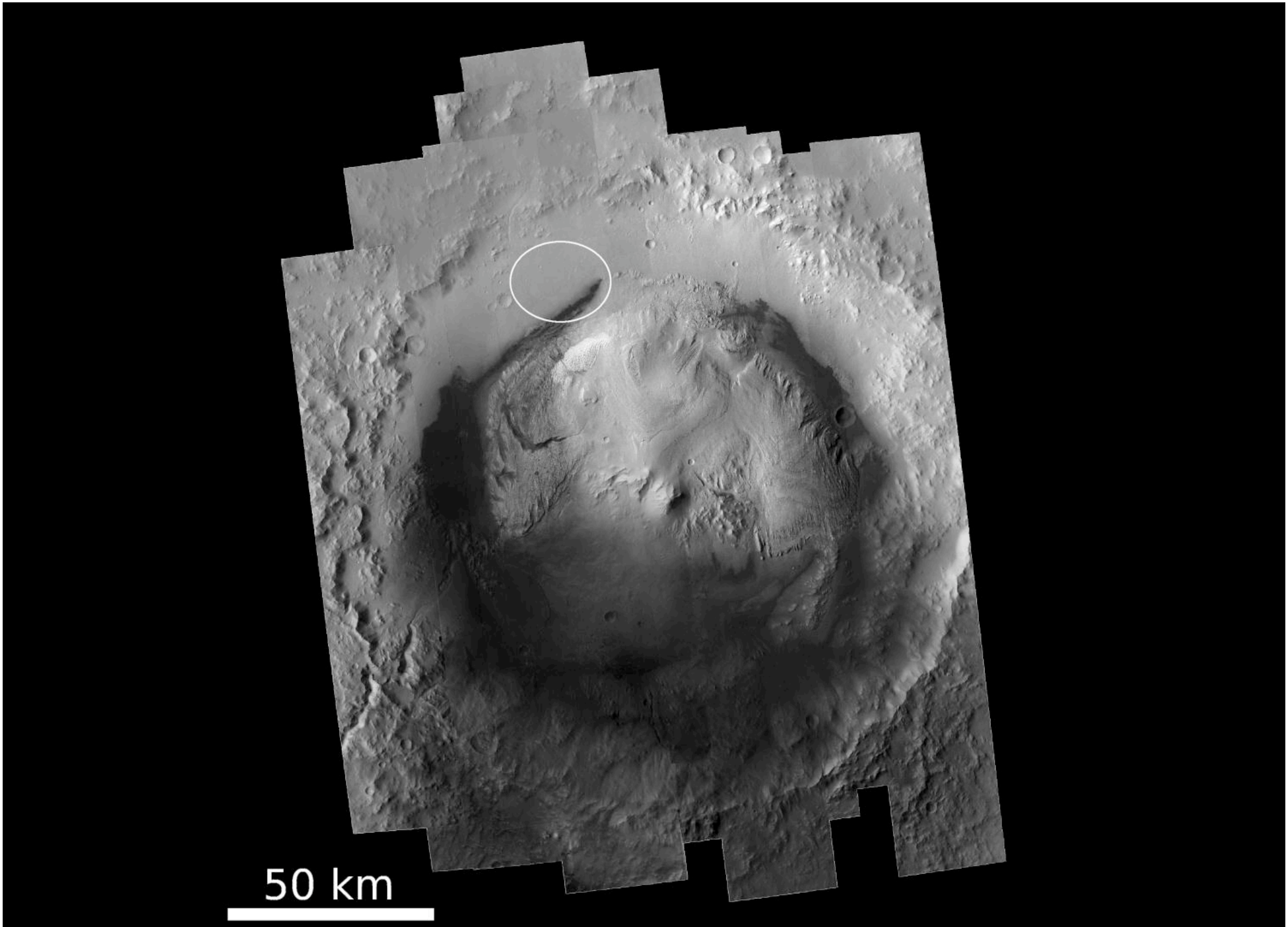


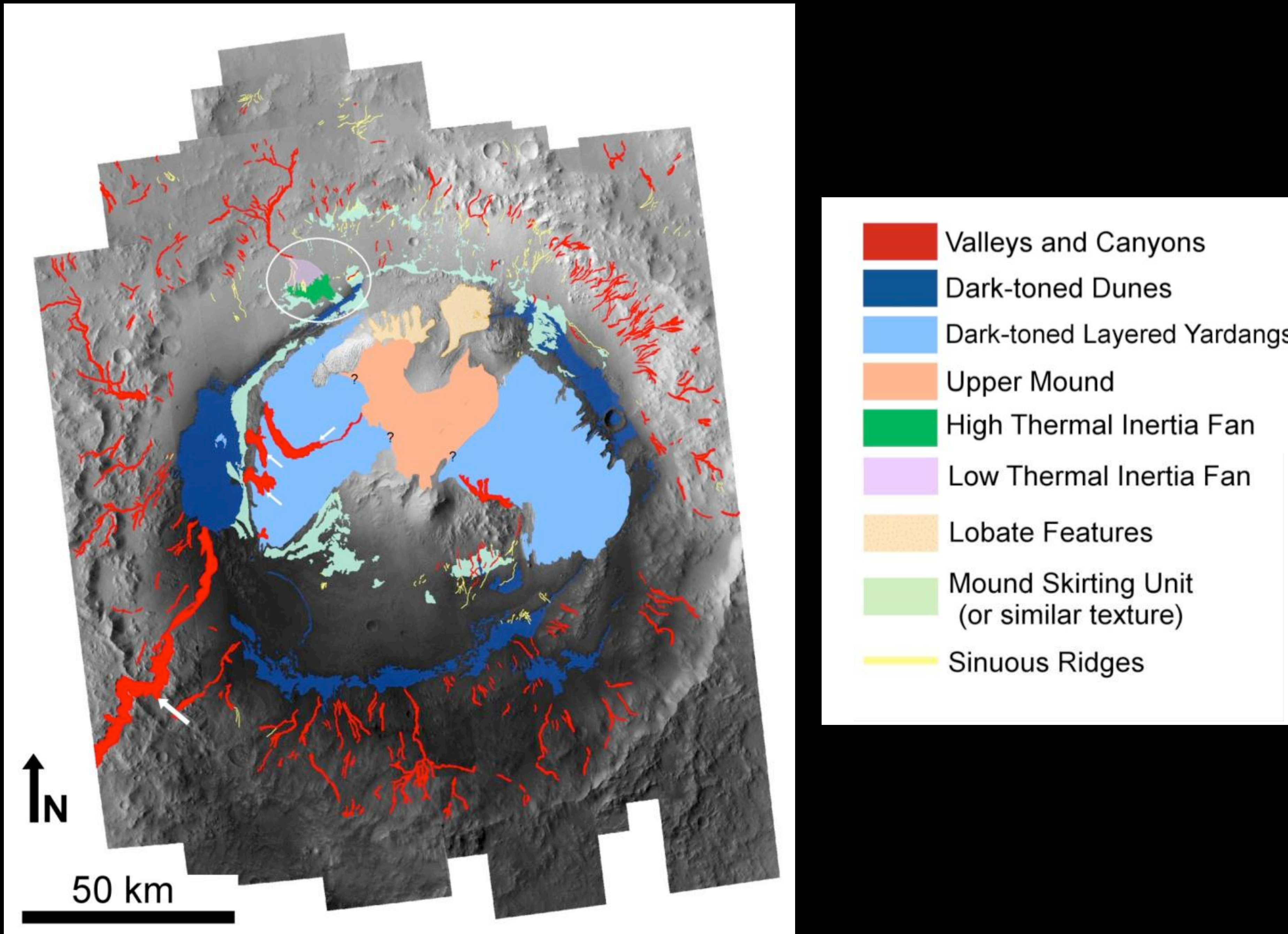
MOLA Team/NASA/GSFC/Google



Anderson & Bell (2010)



Anderson & Bell (2010)

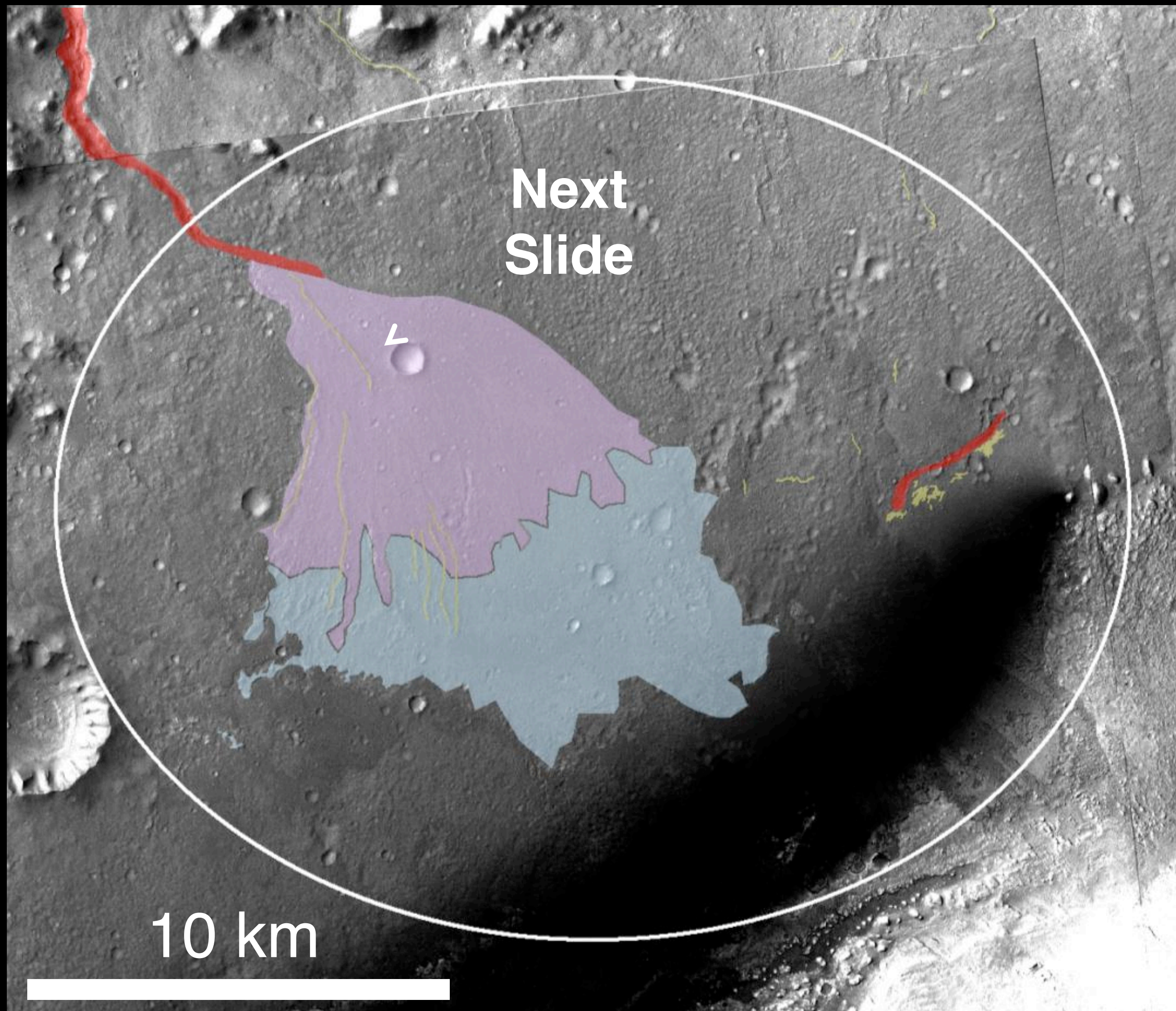


Anderson & Bell (2010)

Ellipse Science: Alluvial Fan

- Branching channels on the crater wall end in a fan-shaped feature.
- The fan can be divided into two units, distinguished by texture and thermal inertia (TI).

NASA/JPL/ASU/Fergason et al. (2006)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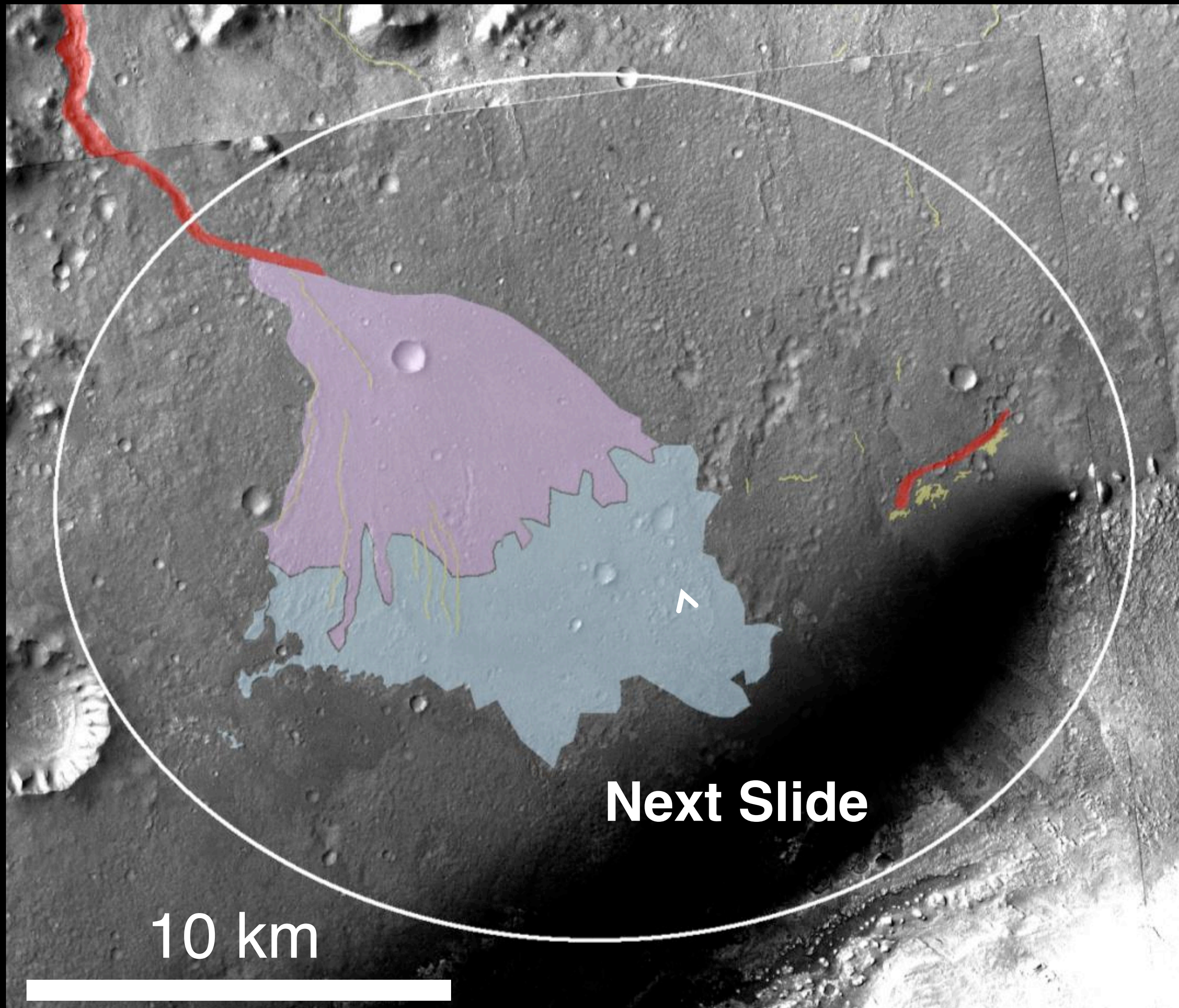
Slide
10 km

Low TI Fan

- Smooth surface with occasional ridges (inverted channels)
- Many craters appear filled or mantled
- May be a thin layer over High TI Fan

HiRISE Image: PSP_009716_1755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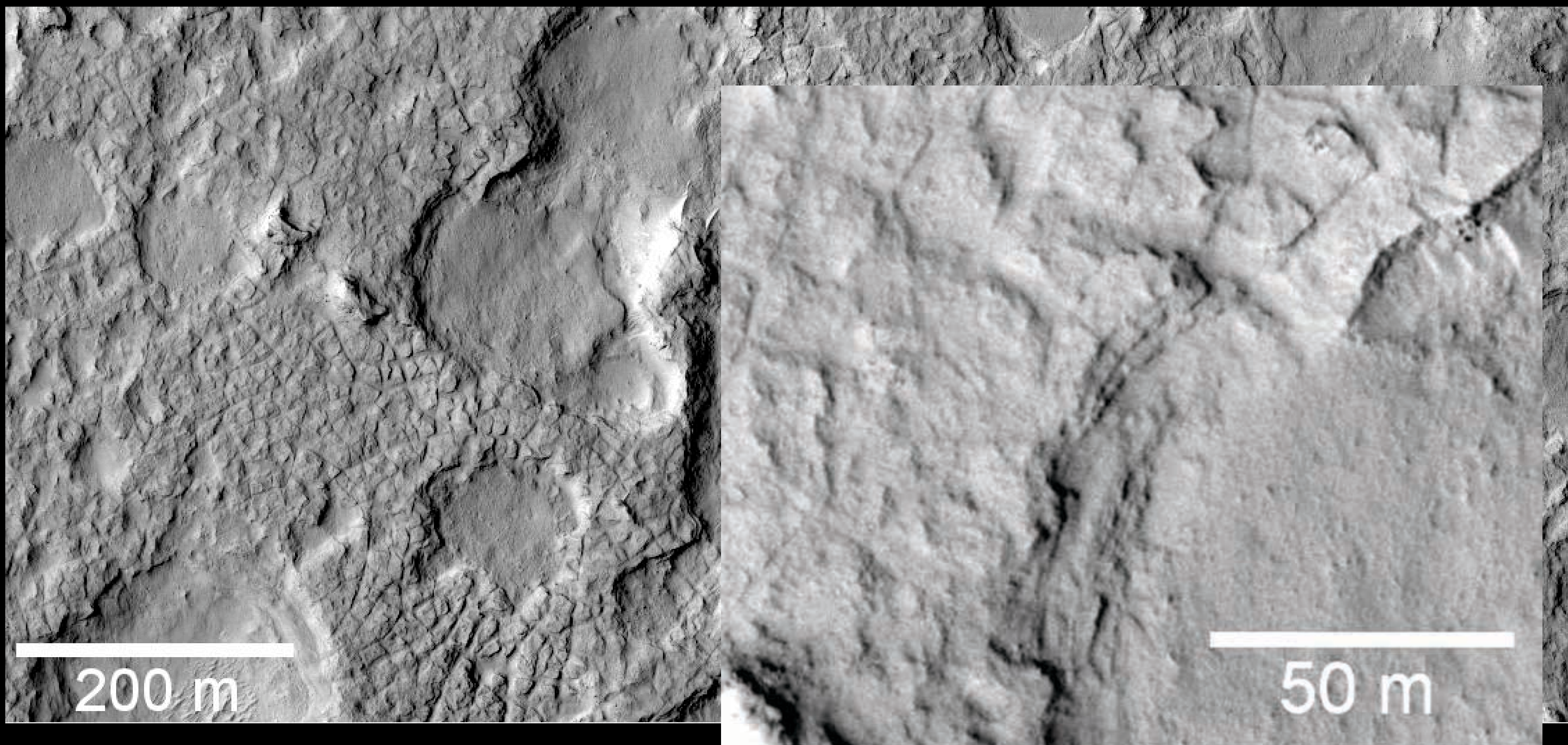
10 km

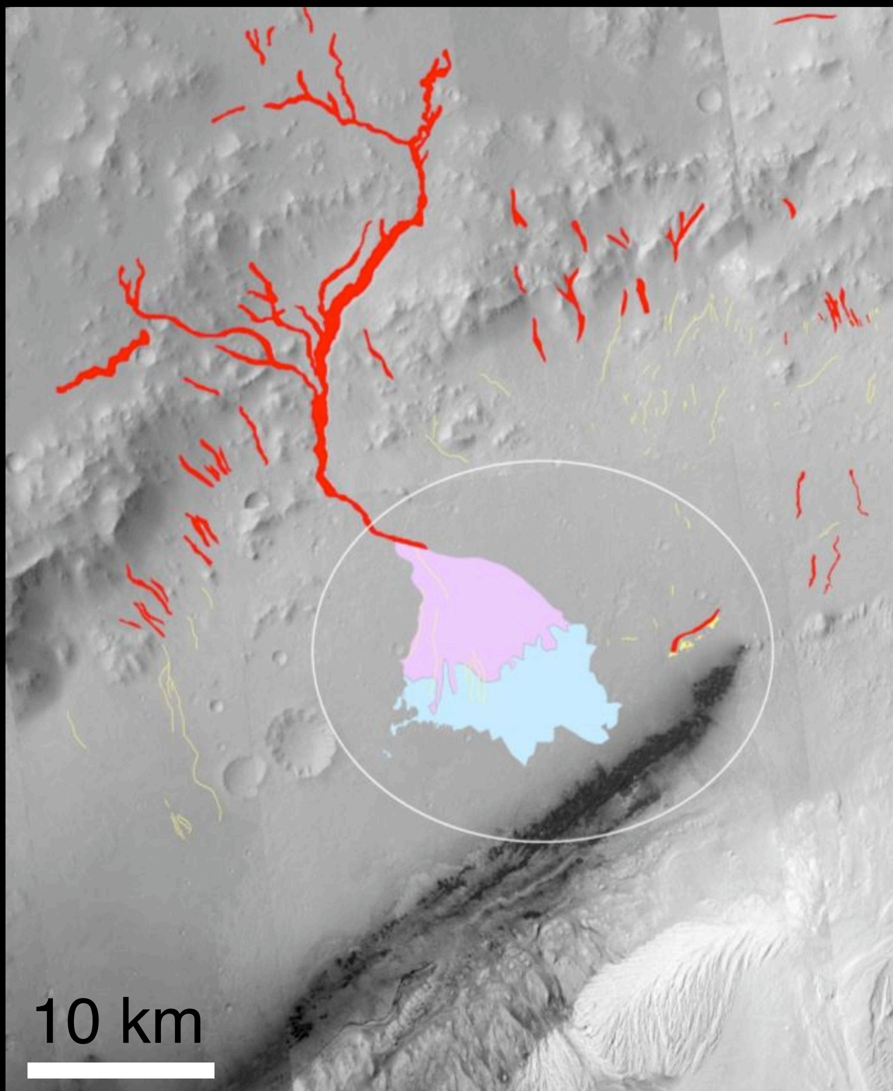
High TI Fan



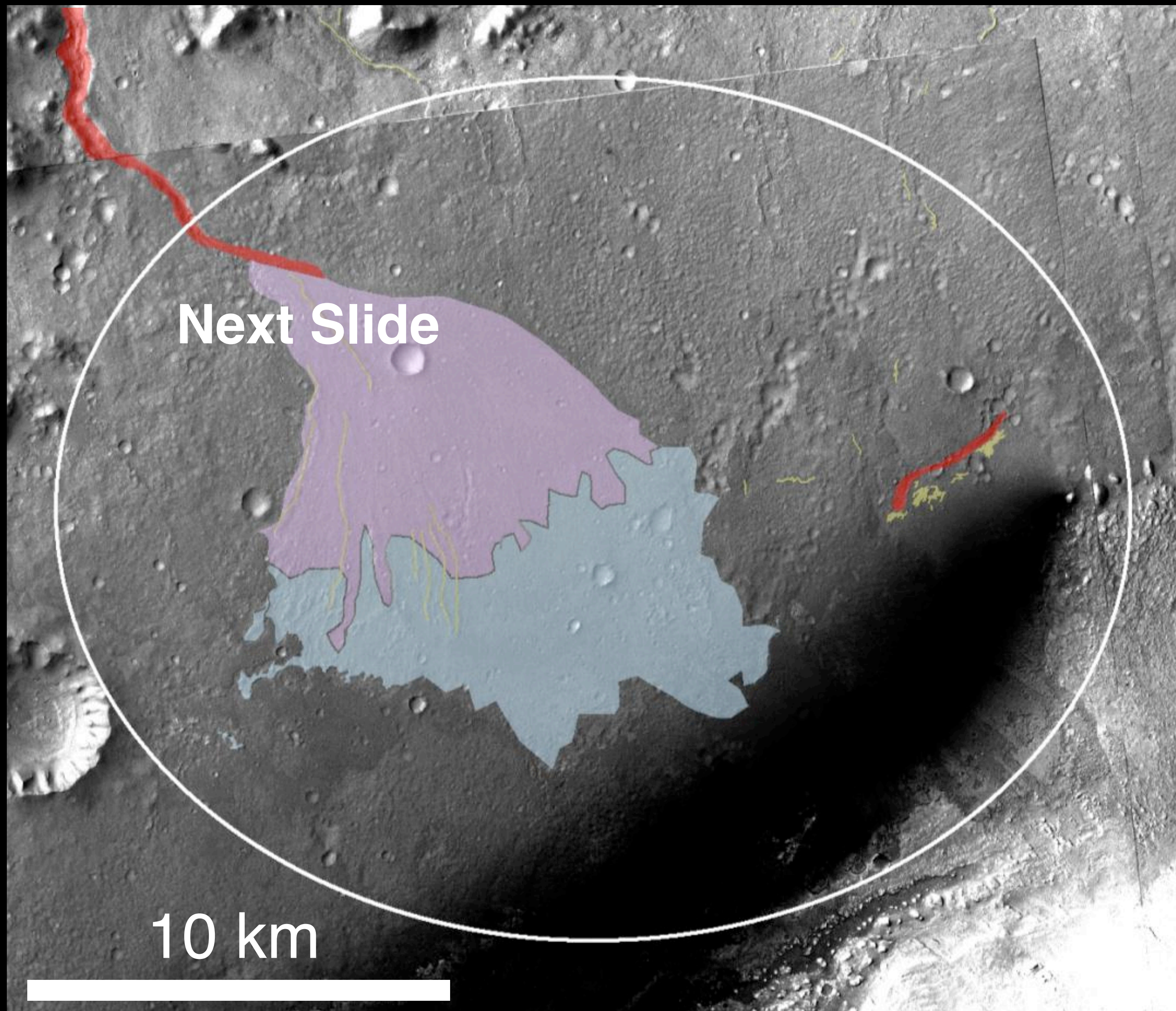
- Underlies the Low TI fan.
- High TI fan is made of fractured, layered rock.
- Many craters are sharply defined, some are partially filled.

HiRISE Image: PSP_010639_1755

Ellipse Science: Alluvial Fan



- Fan sediment, inverted channels
  - Infer depositional process and duration
- Fan stratigraphy
  - Erosional and depositional history
- Samples of Gale crater wall (noachian crust)
  - Composition and alteration history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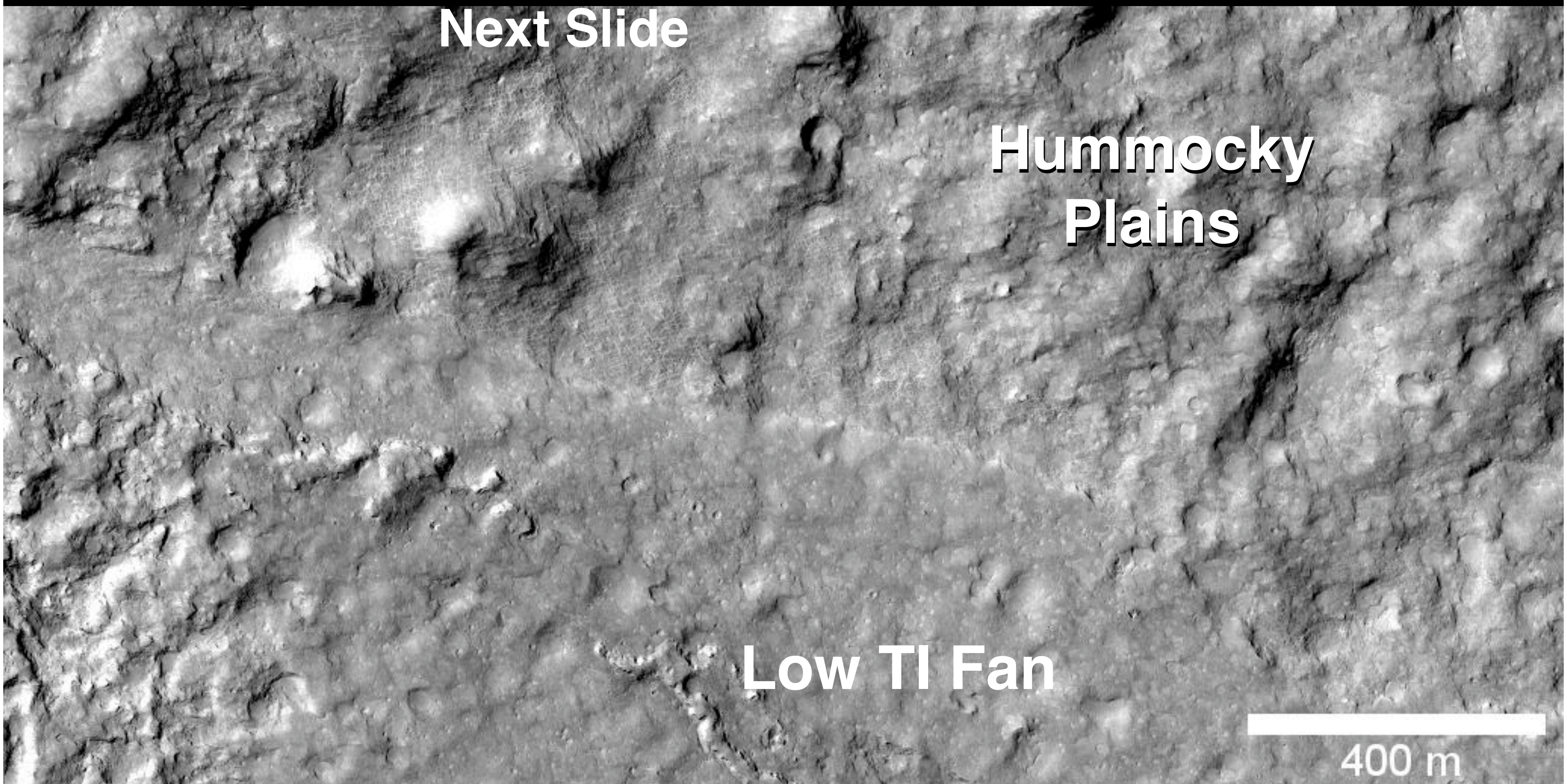
10 km

Hummocky Plains

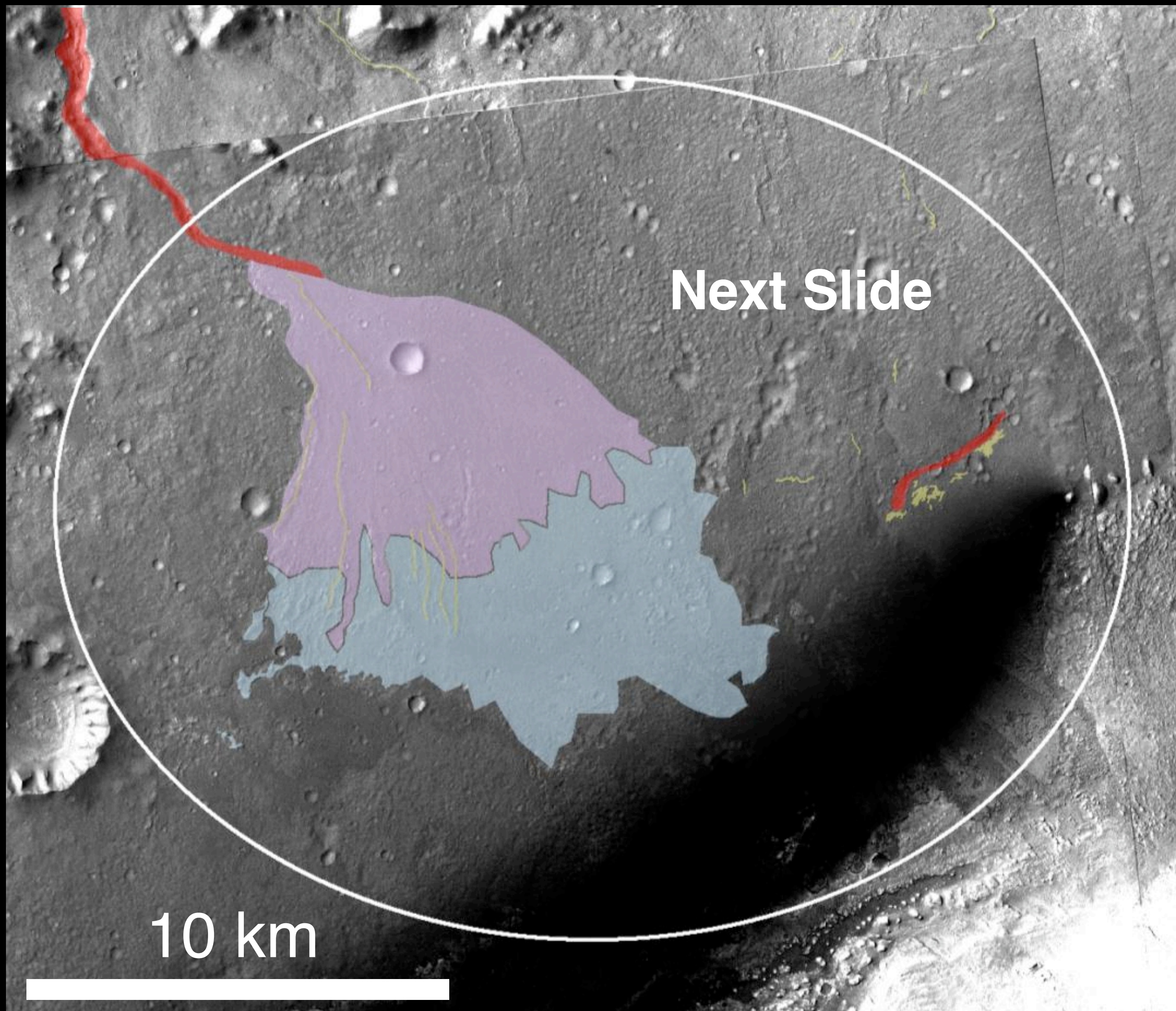


- Much of the crater floor has a hummocky appearance.

Cemented Fractures

- North and west of the alluvial fan the hummocky plains unit is rugged, with many erosion-resistant ridges (likely cemented fractures).

HiRISE Image: PSP_009650_1755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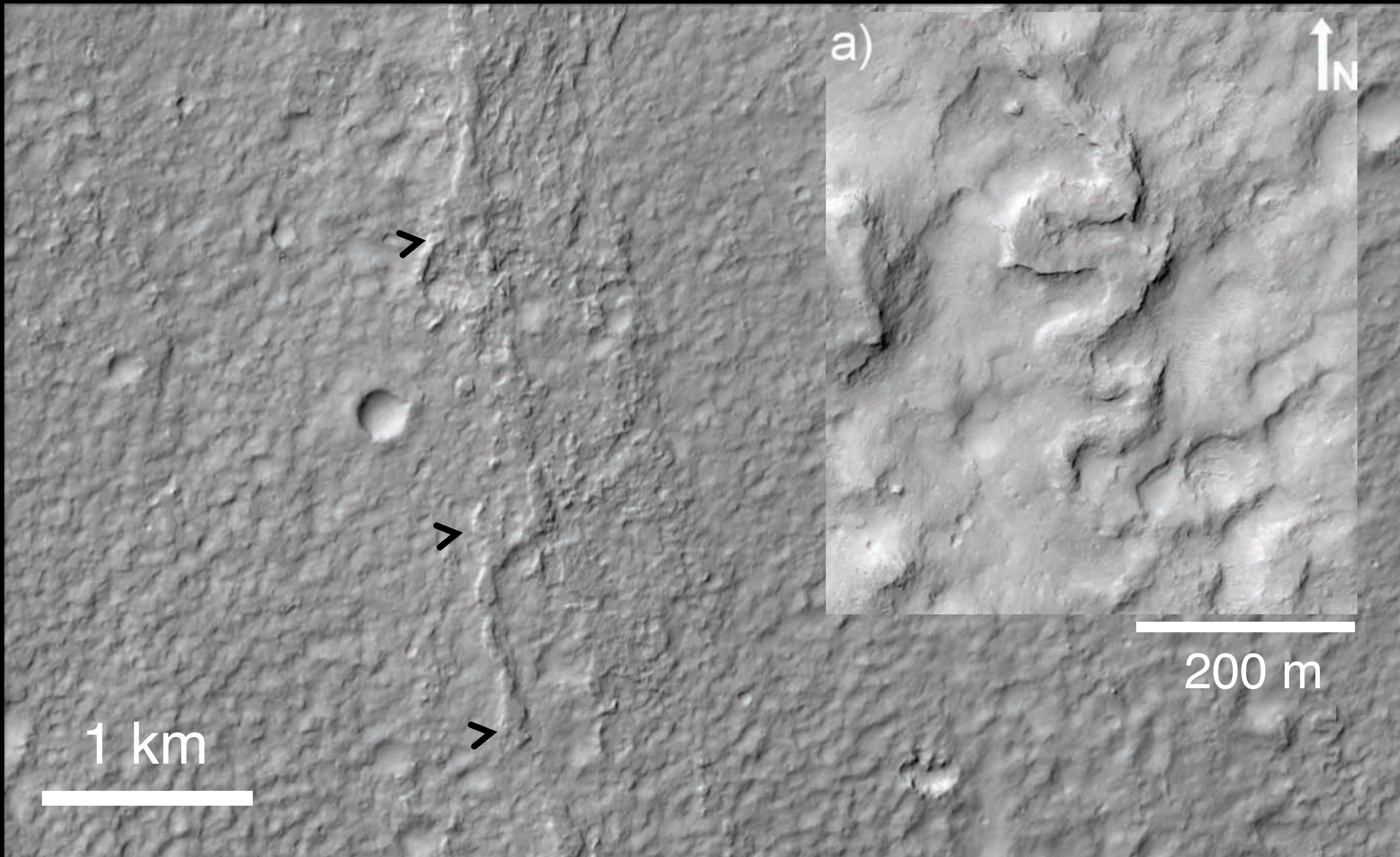
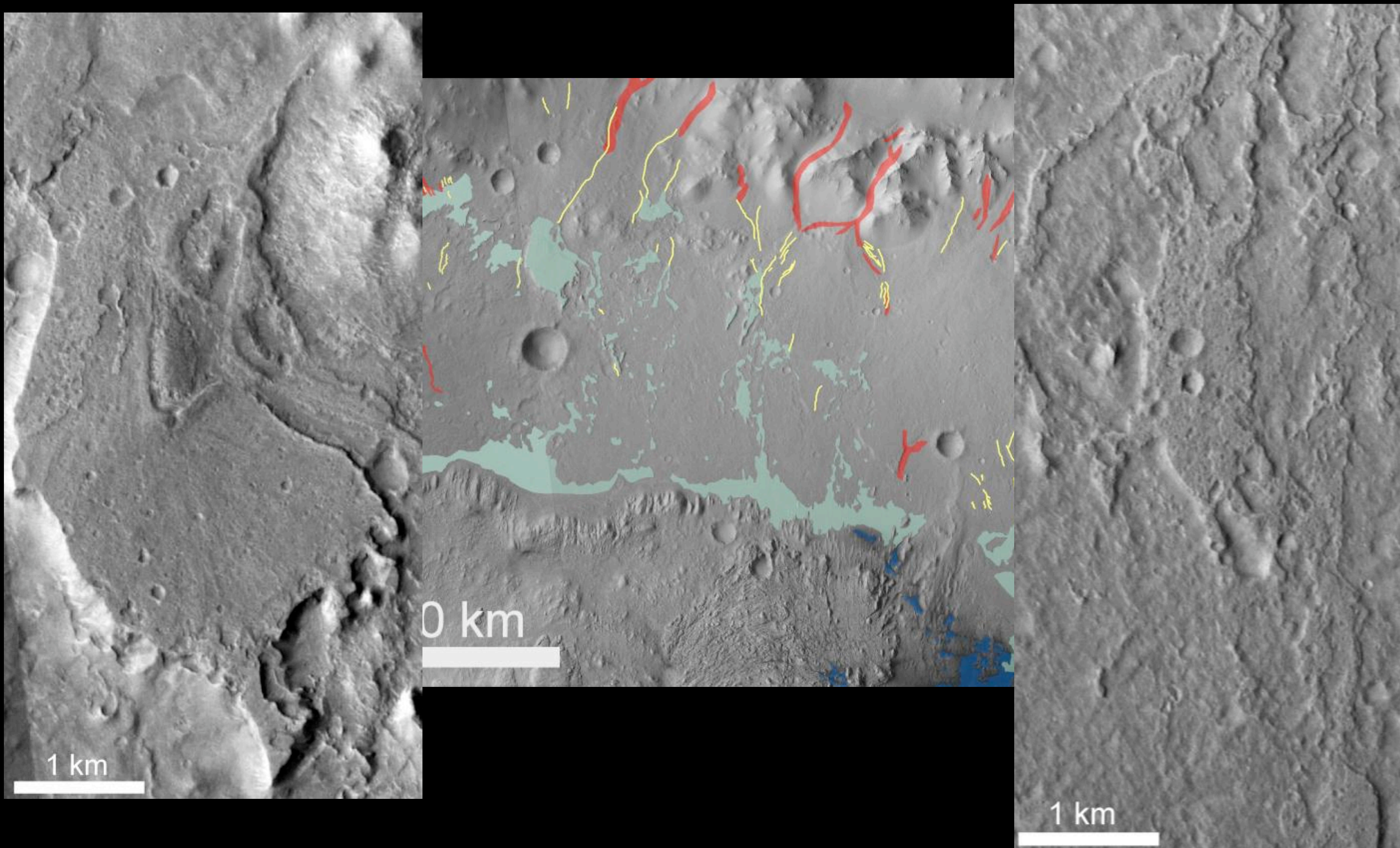


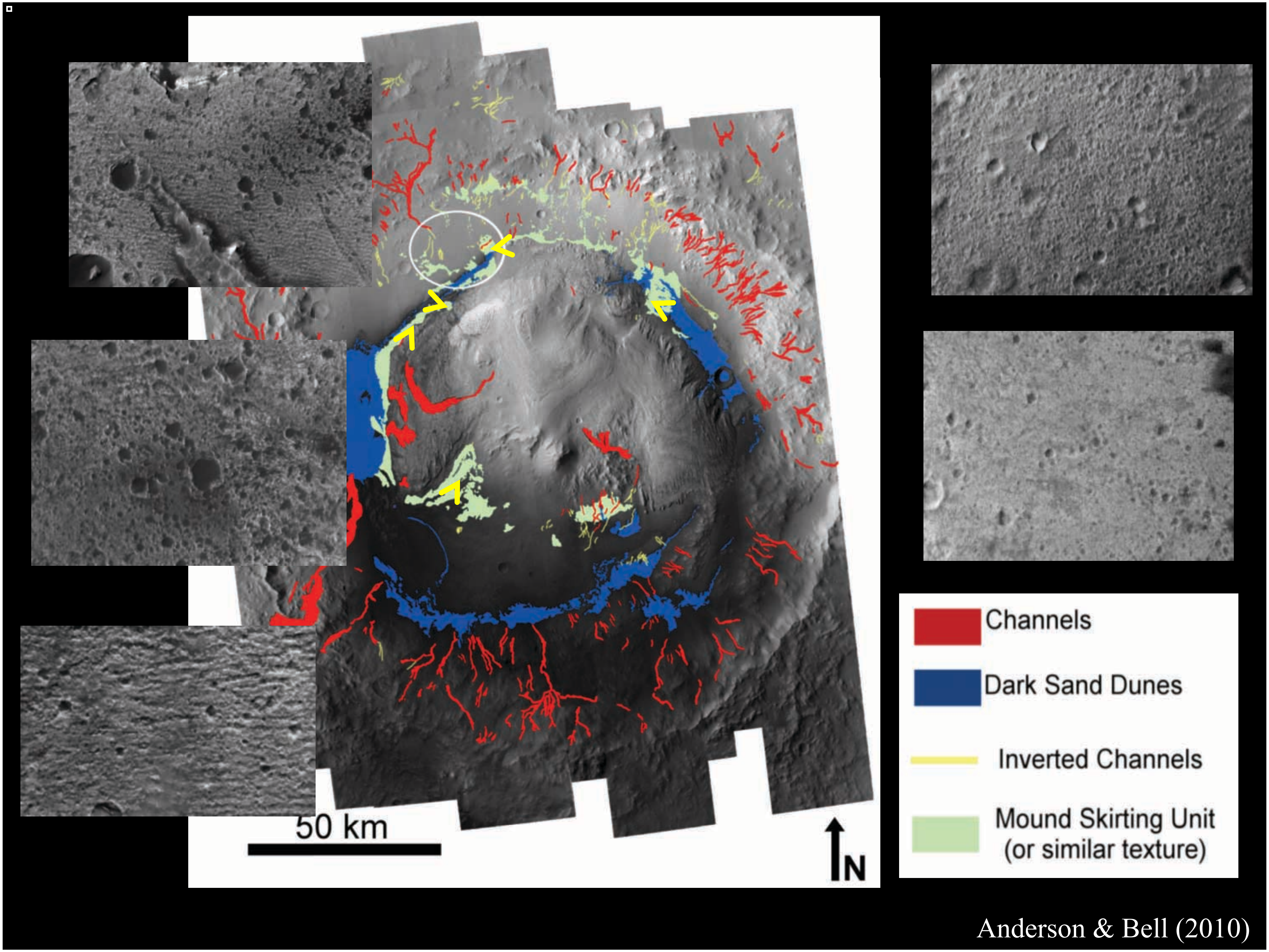
- The hummocky plains preserves sinuous ridges likely to be inverted channels.
- Chains of mesas extend from the wall to the mound.

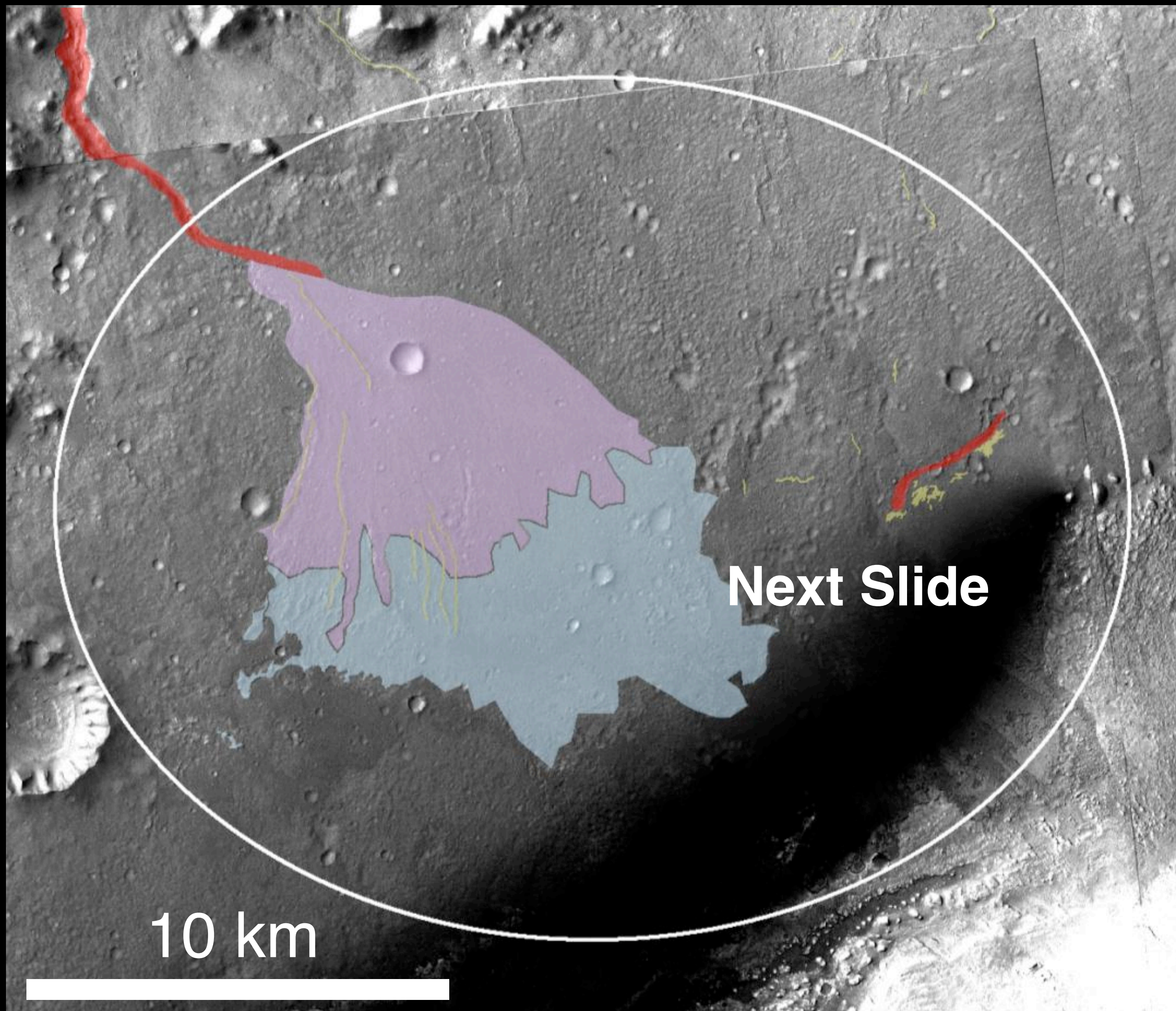
HiRISE Image: PSP_009571_1755



- The mesas appear to be associated with fans along the northern wall, and extend across the crater floor to merge with the mound-skirting unit at the base of the mound.

Anderson & Bell (2010)


50 km
N
Channels
Dark Sand Dunes
Inverted Channels
Mound Skirting Unit
(or similar texture)
Anderson & Bell (2010)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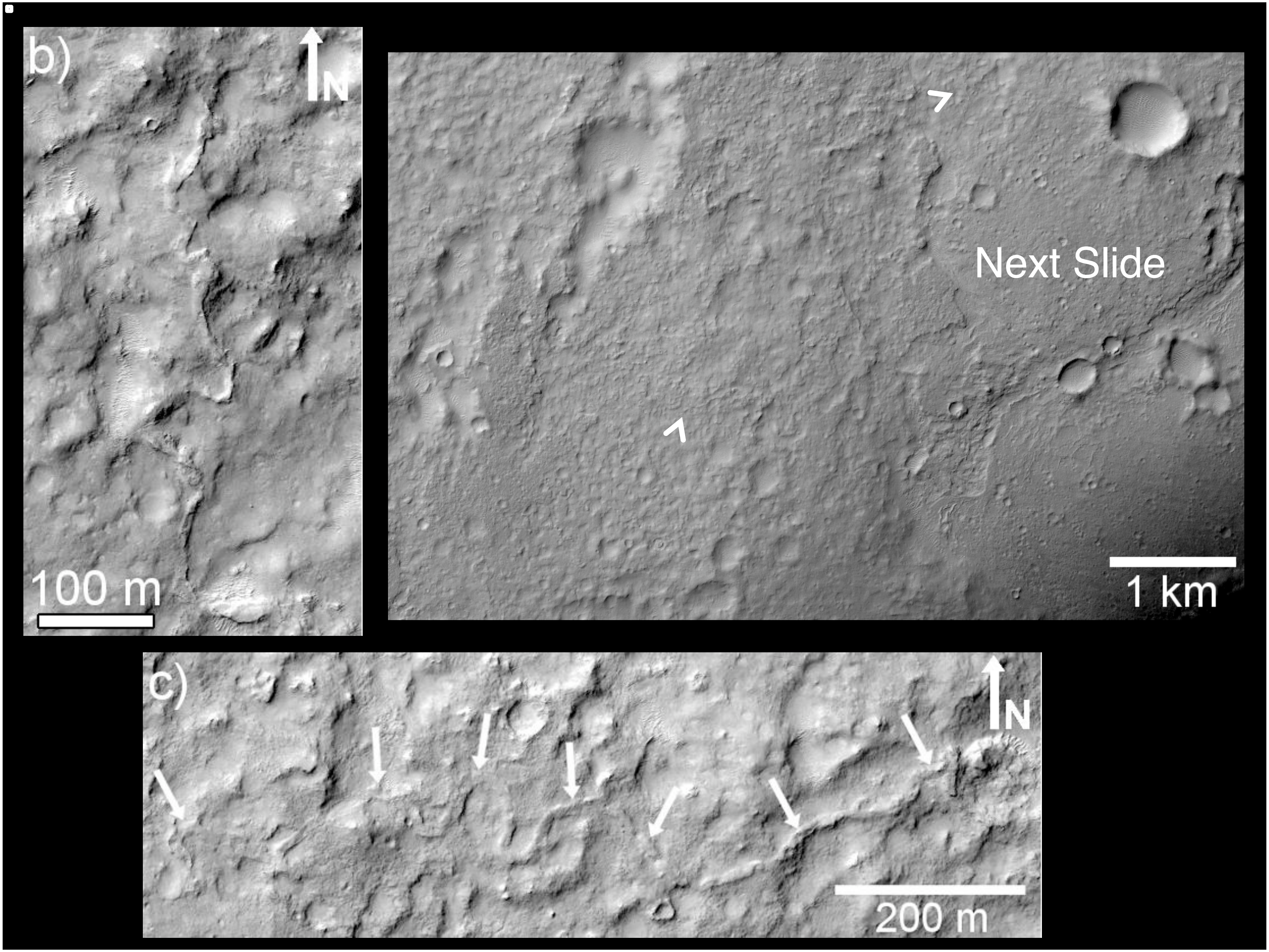
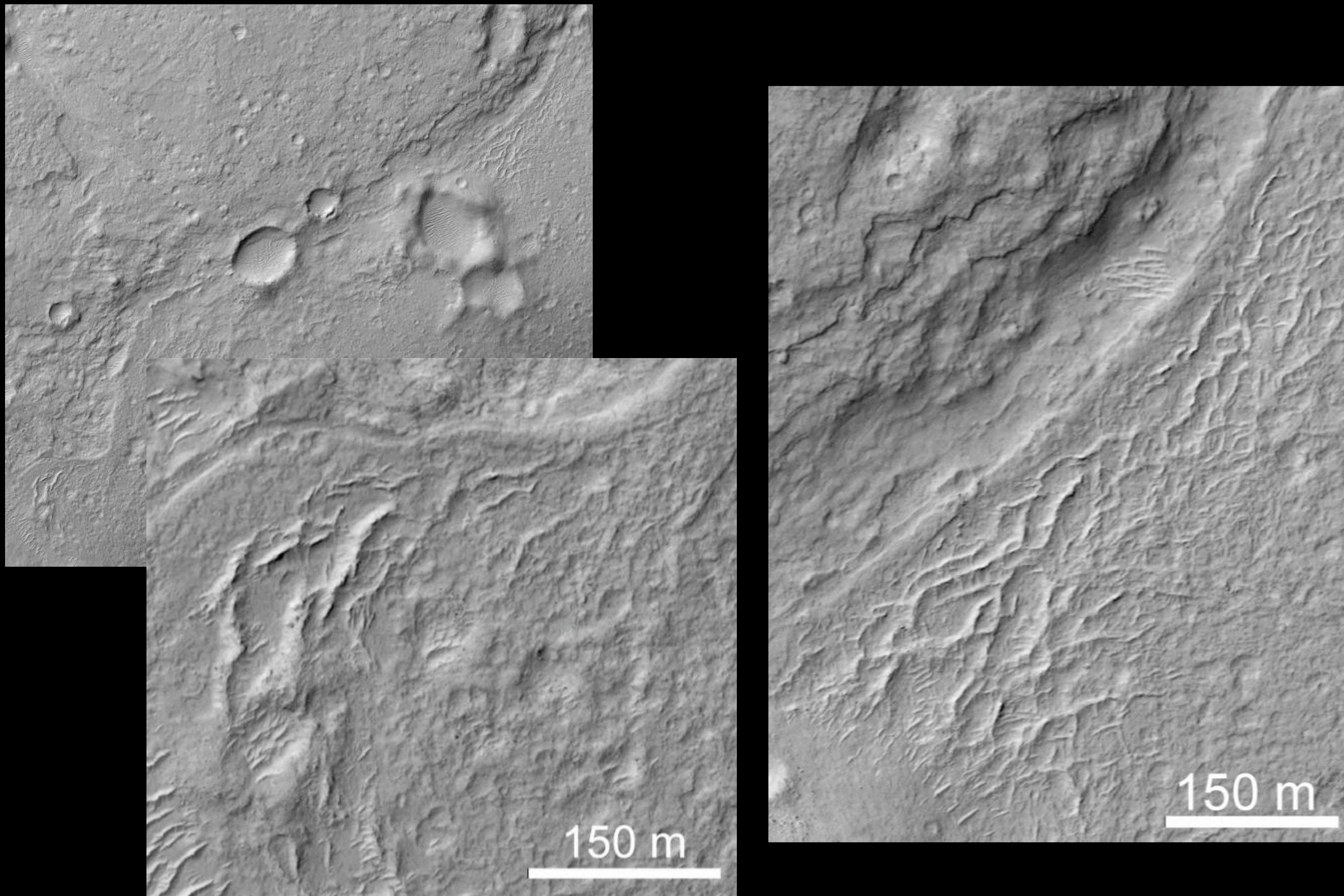
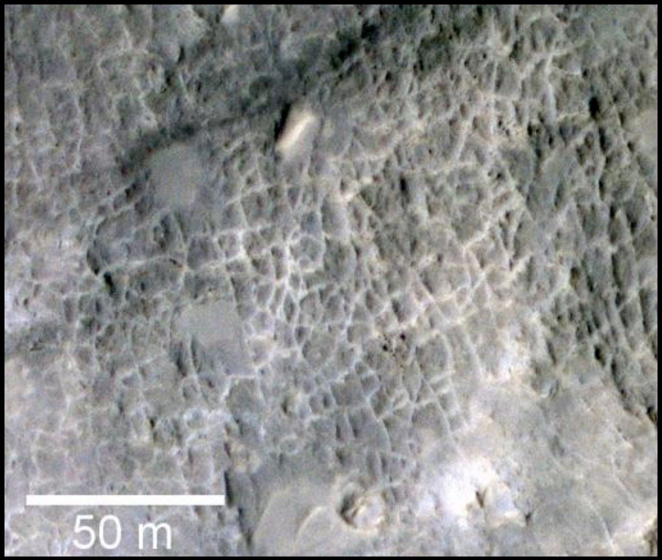
10 km


b)
N
100 m
Next Slide
1 km
c)
N
200 m



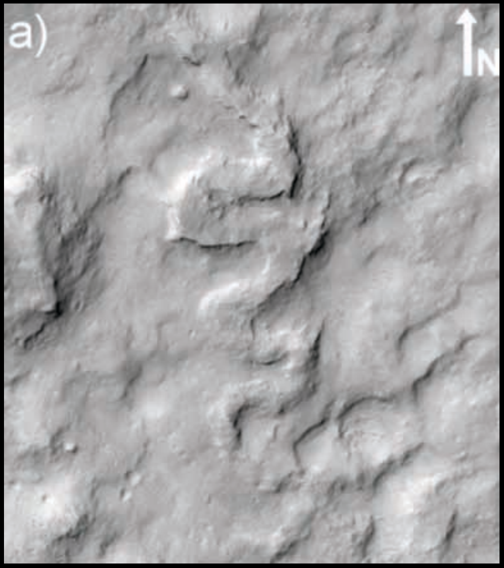
- Are these features inverted channels or bedforms?

Science in the Ellipse: Inverted Features



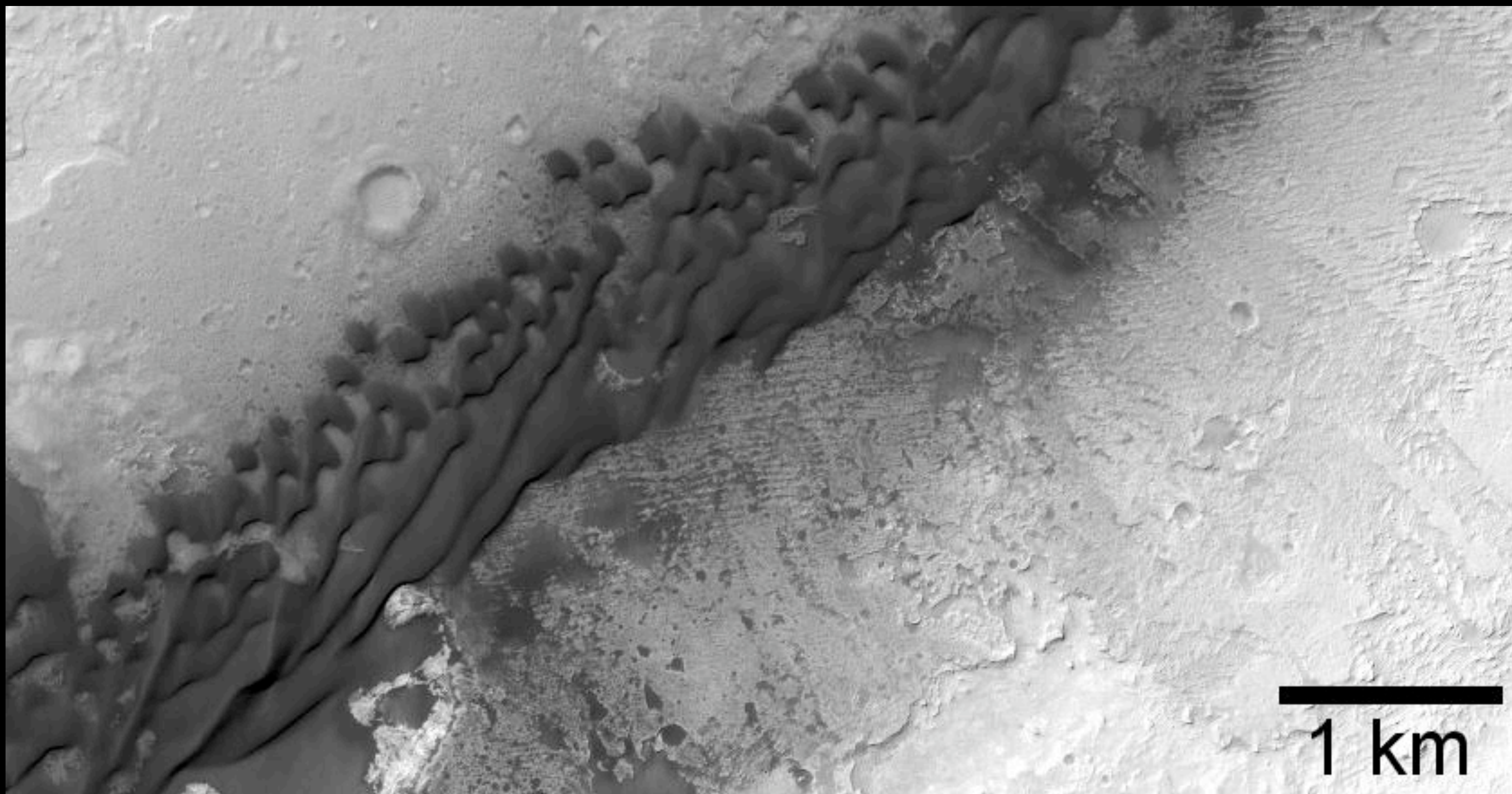
- Cemented Fractures
  - How did the fractures form?
  - What is the composition and alteration history?

- Inverted channels
  - Determine depositional environment and flow characteristics.
  - Are the dense, branching features inverted channels or aeolian bedforms?

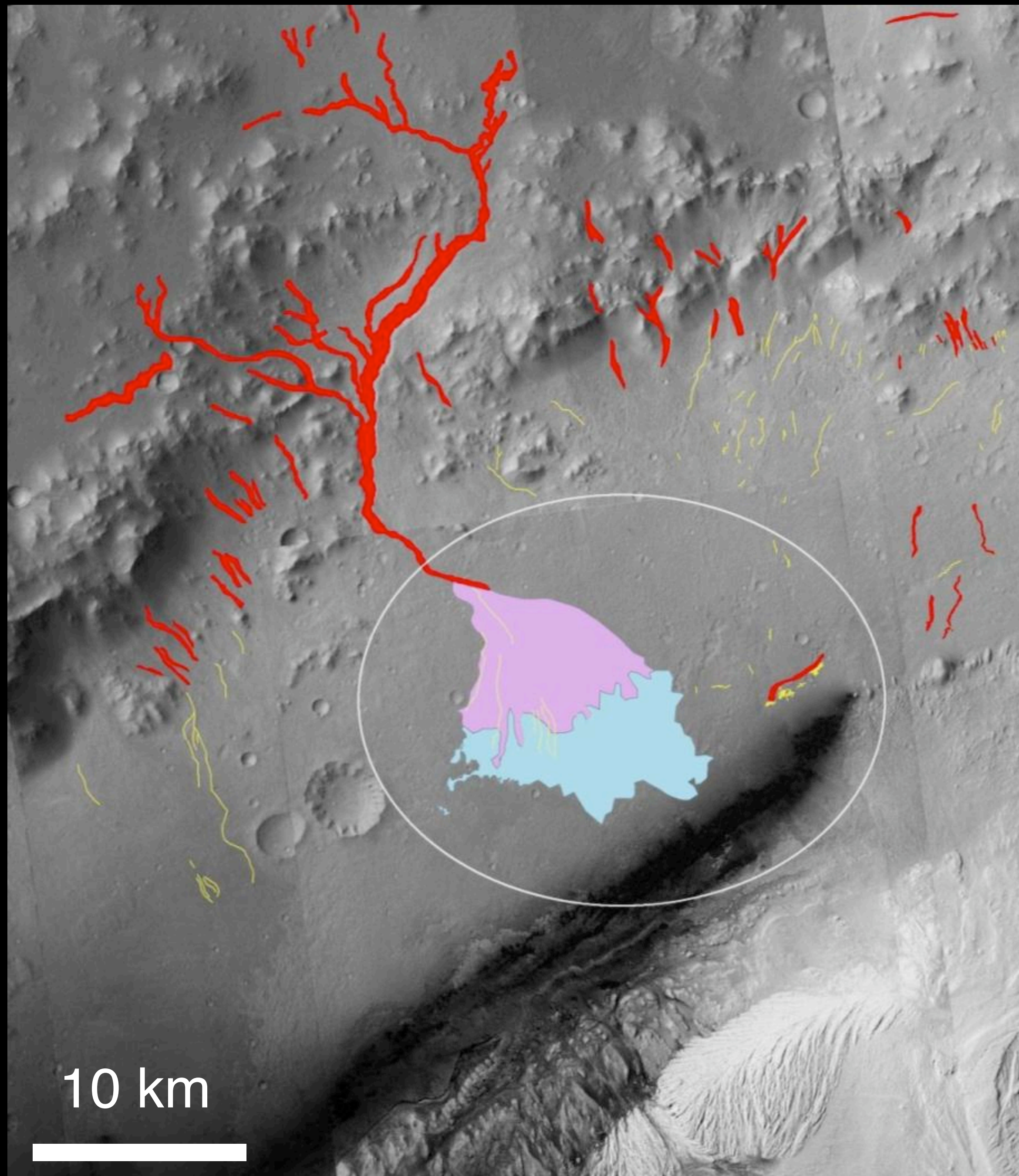


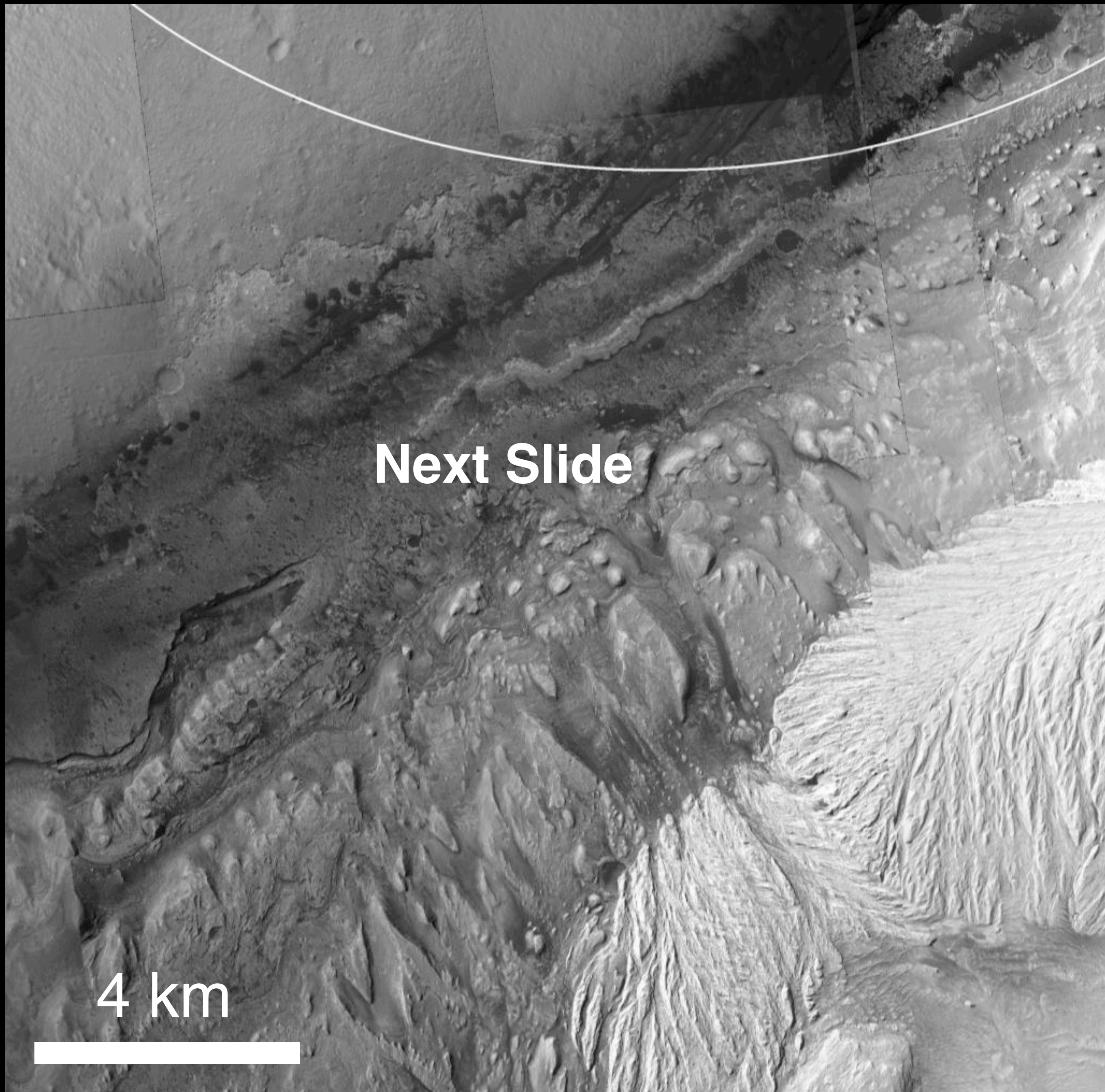
- Chains of mesas
  - What is their relation to fluvial processes?
  - Are they actually the same as the mound-skirting unit?

Science in the Ellipse: Old and Young Bedforms



- Study large “young” dunes - how active are they?
- Characterize lithified bedforms in the mound-skirting unit


10 km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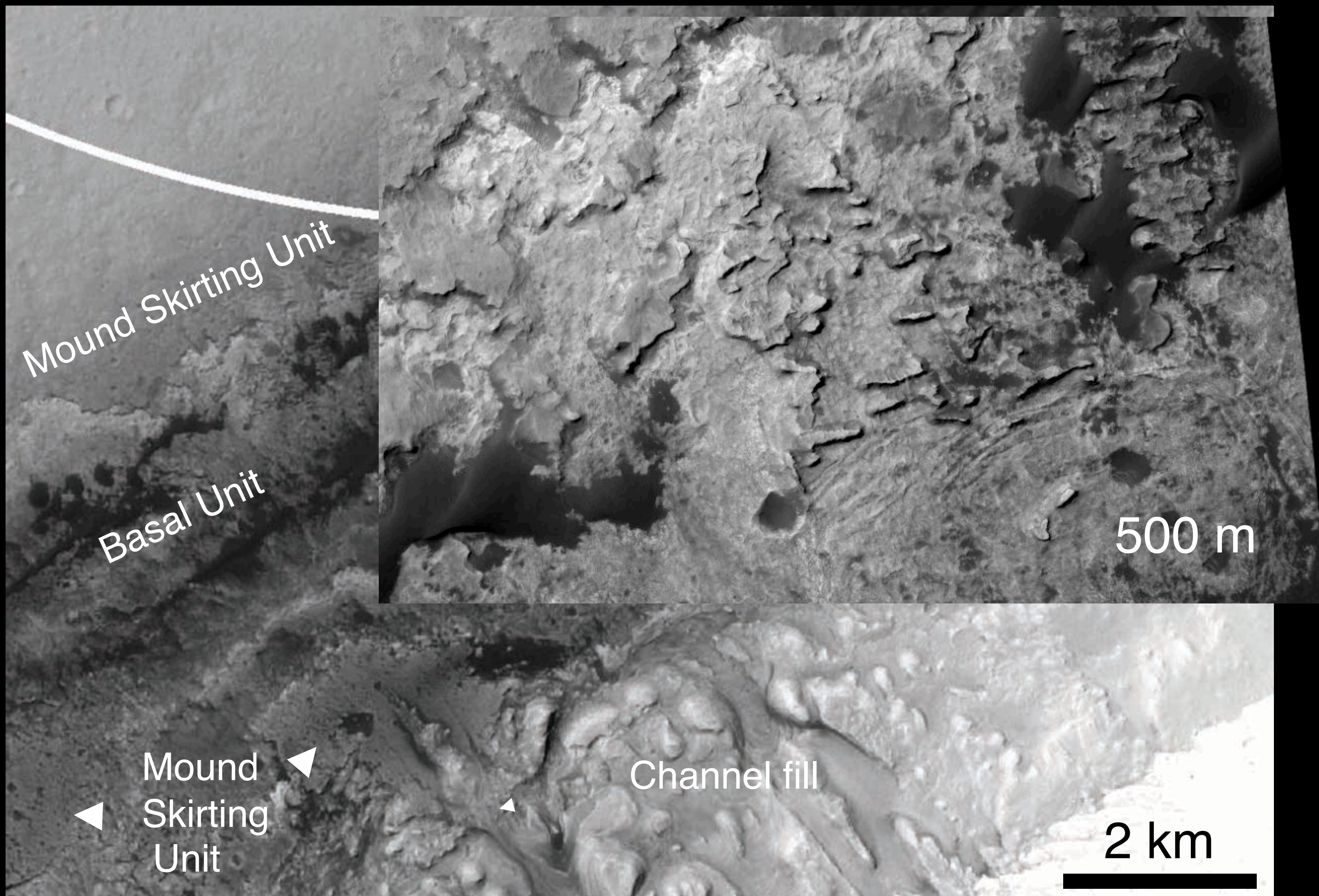
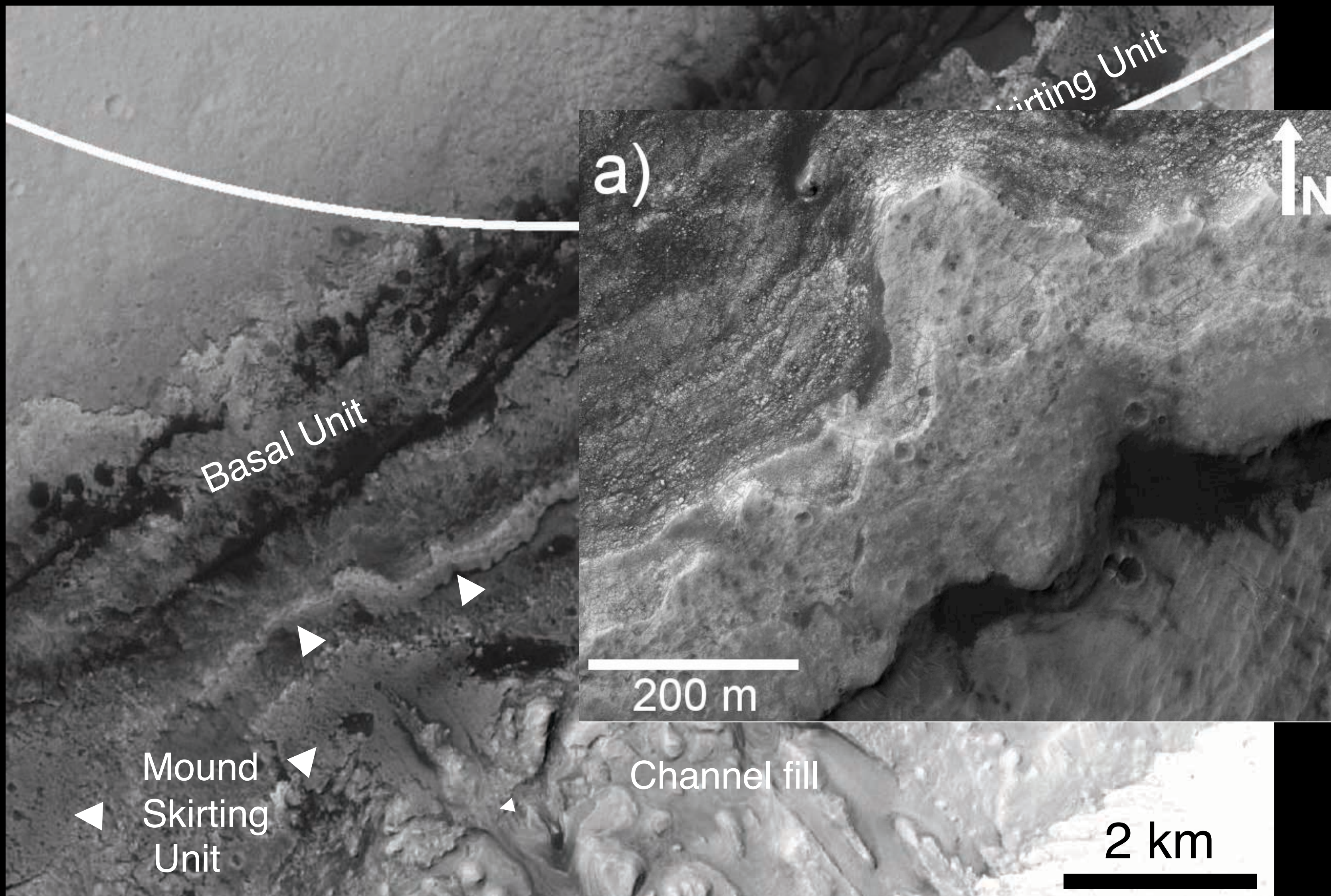
4 km



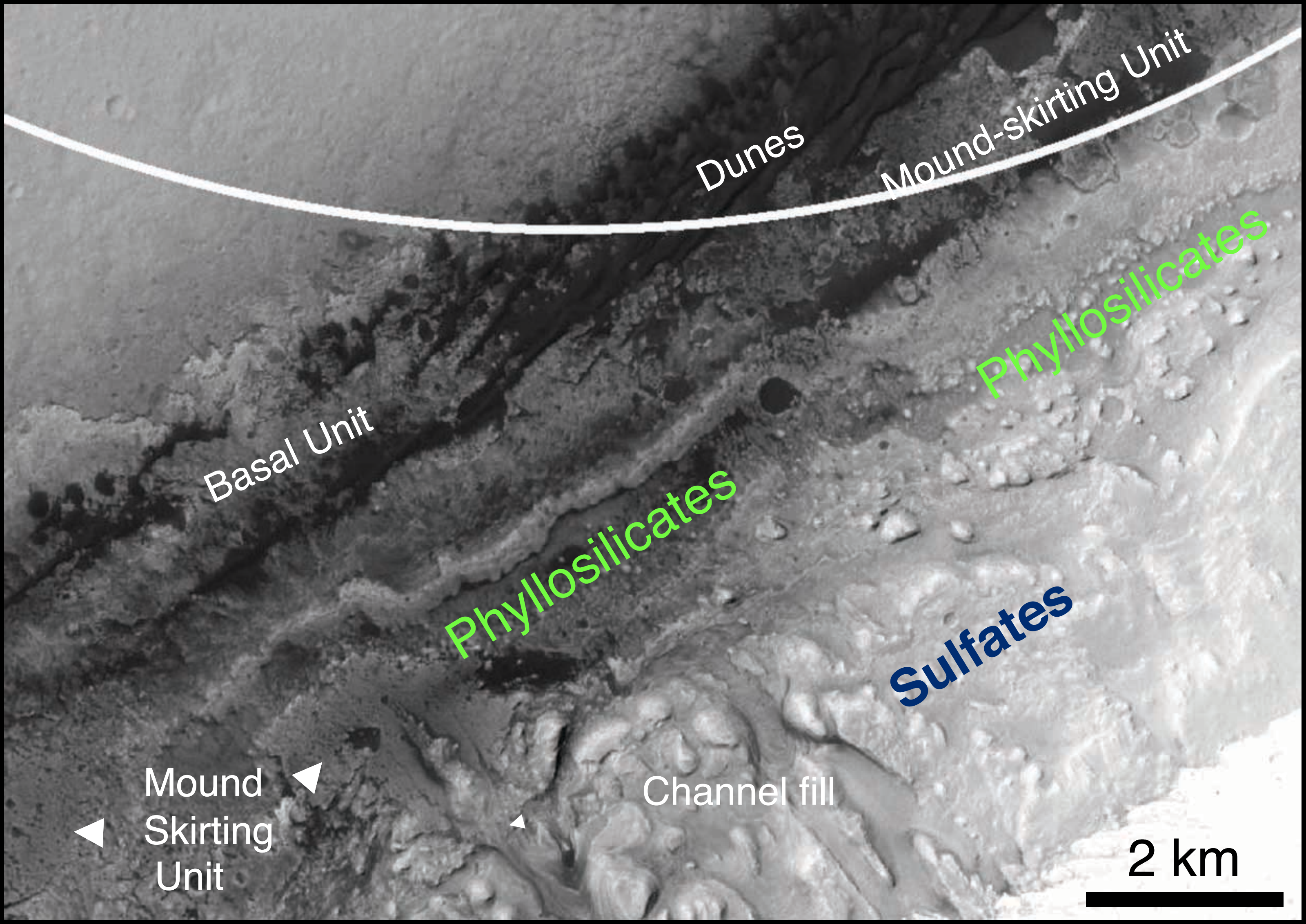
- The mound-skirting unit overlies the mound's basal unit, forming scarps and mesas.

CTX: MSSS/JPL/NASA



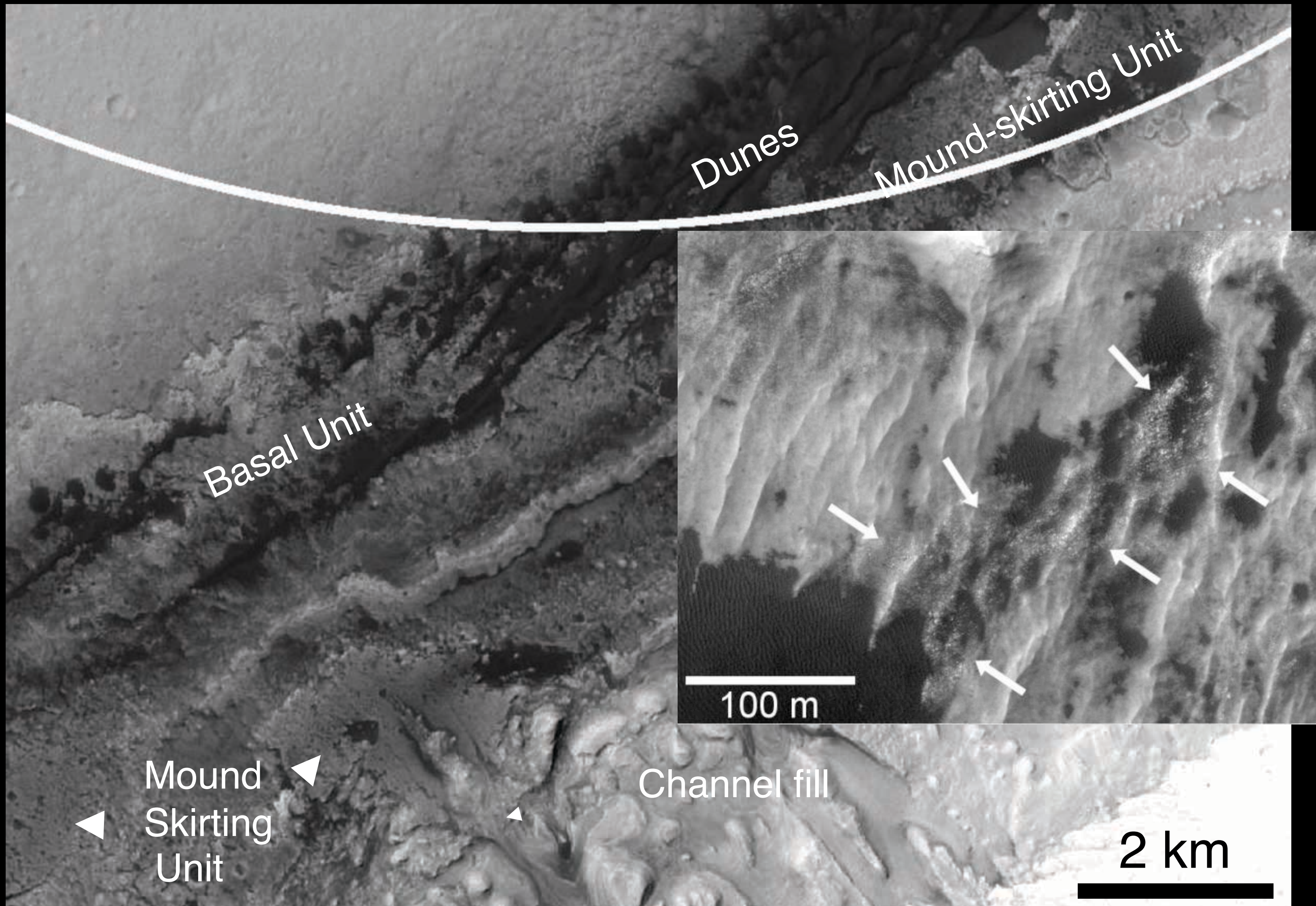
- This light-toned, fractured, layered material is a ridge that broadens to the northeast.

CTX: MSSS/JPL/NASA



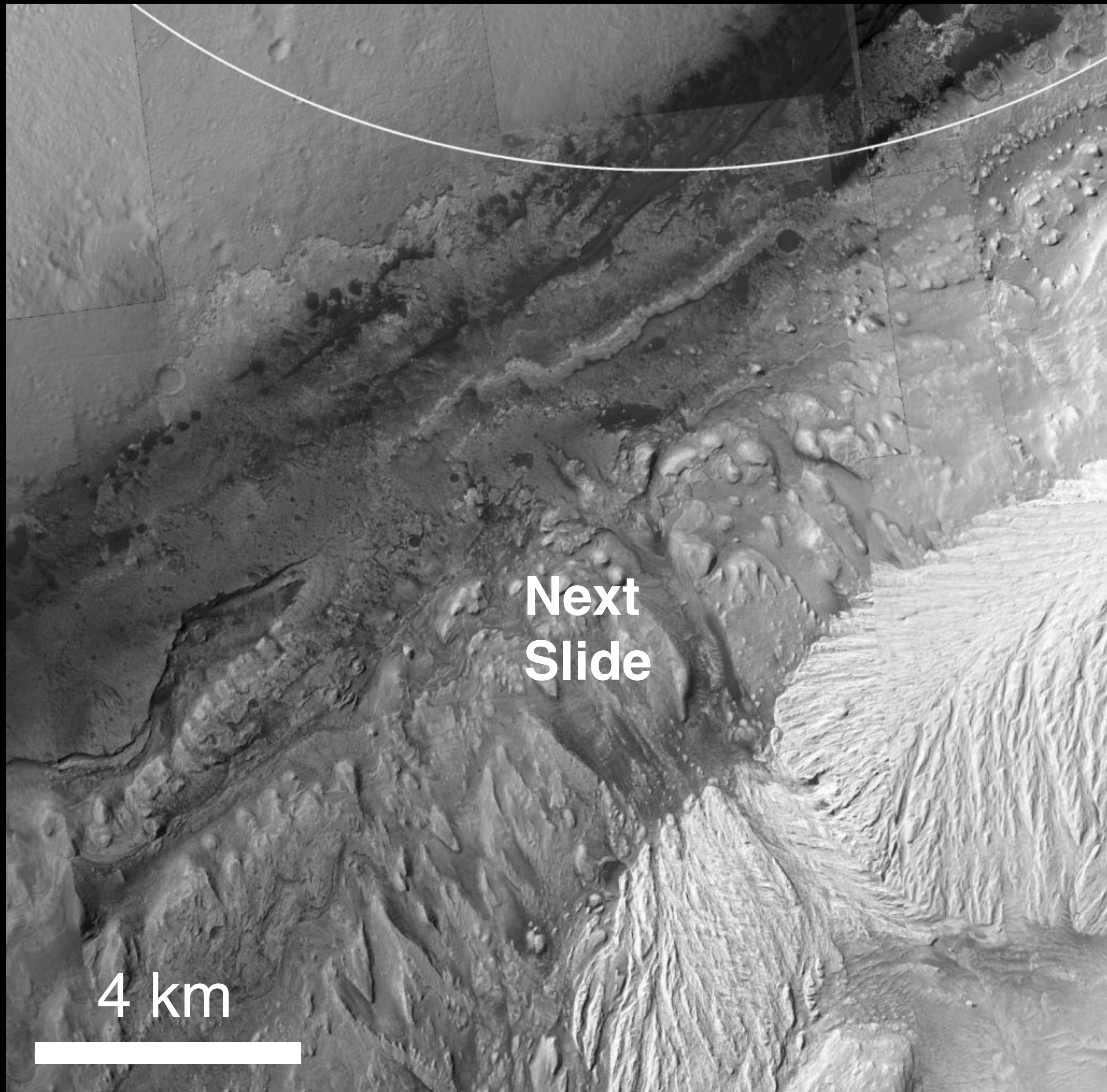
- The trough between the light-toned ridge and the rest of the mound shows the strongest CRISM phyllosilicate signature in Gale. (Milliken *et al.* 2010)

CTX: MSSS/JPL/NASA



- The rippled surface of the phyllosilicate-bearing trough appears to be hard: it is fractured, and dark dunes on it do not blend with their substrate.

CTX: MSSS/JPL/NASA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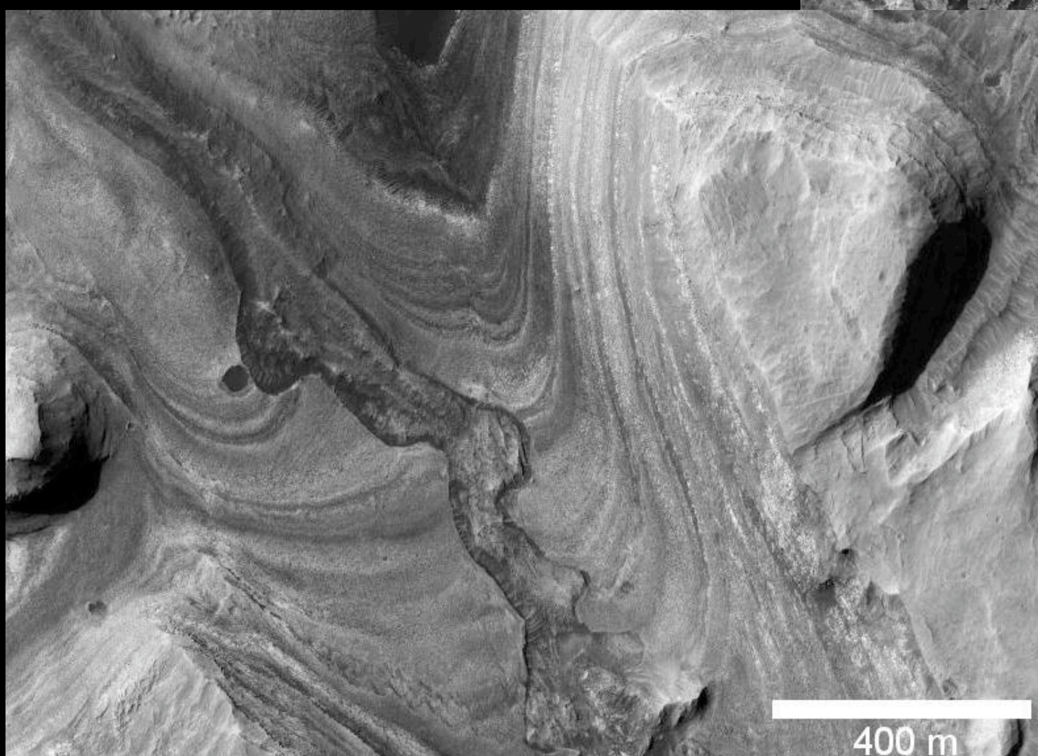
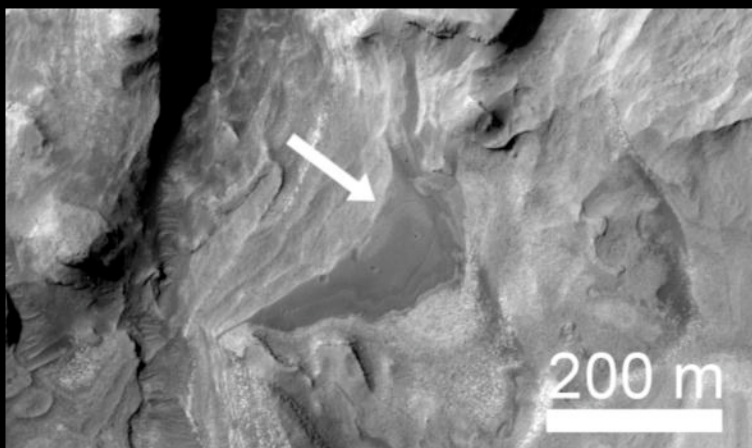
4 km

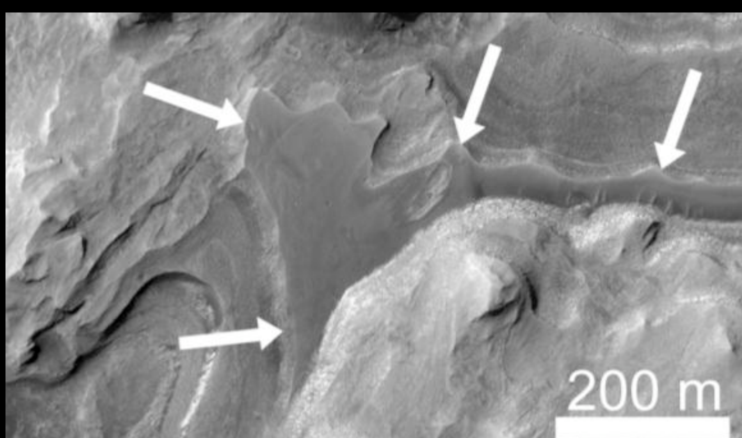
- A filled channel is carved into the layered rocks of the lower mound.
- Channel fill material extends onto a patch of the mound-skirting unit.



HiRISE Image: PSP_009149_1750

- MSL would be able to access a distinct marker bed that is traceable around much of the mound.

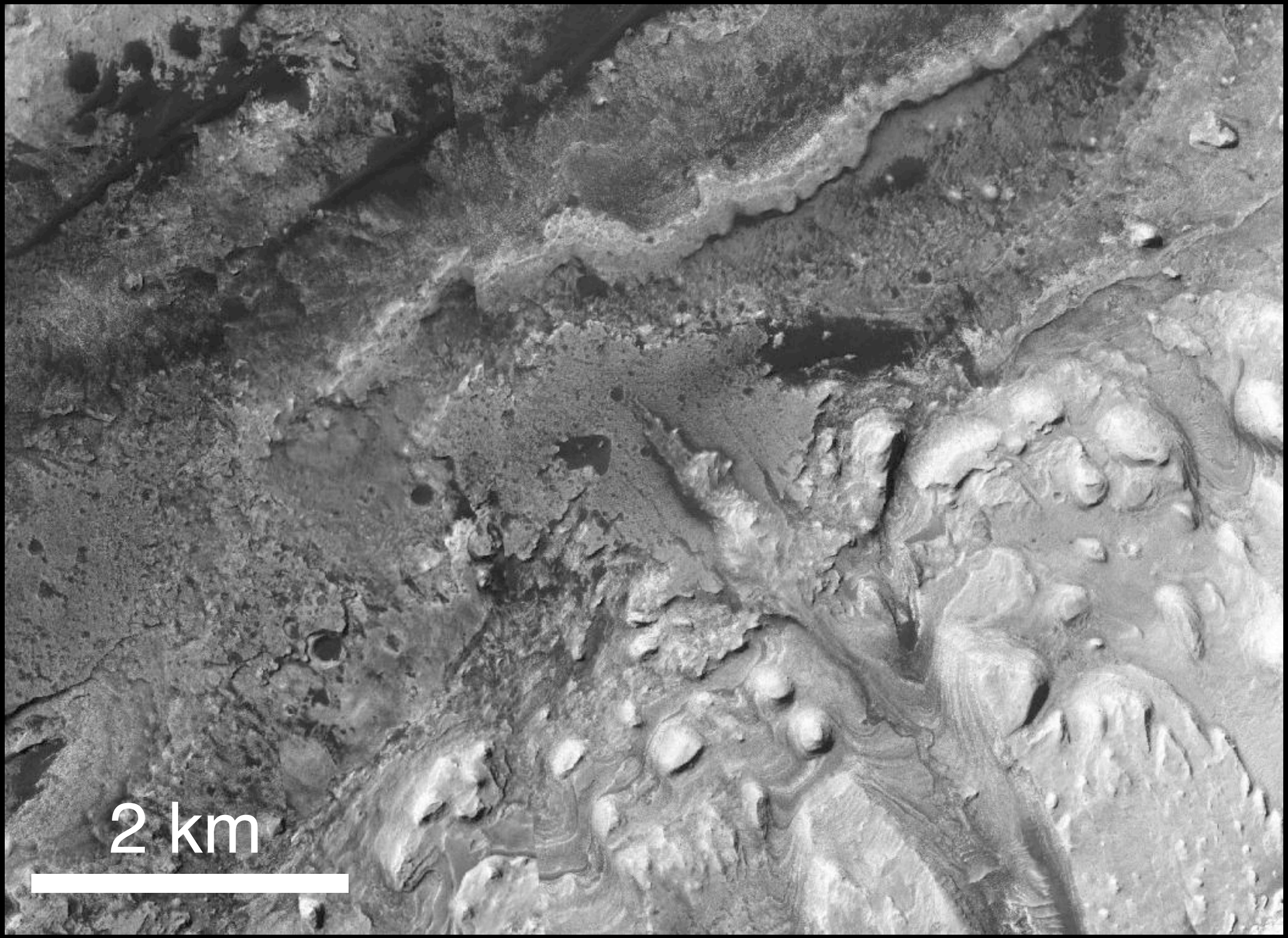




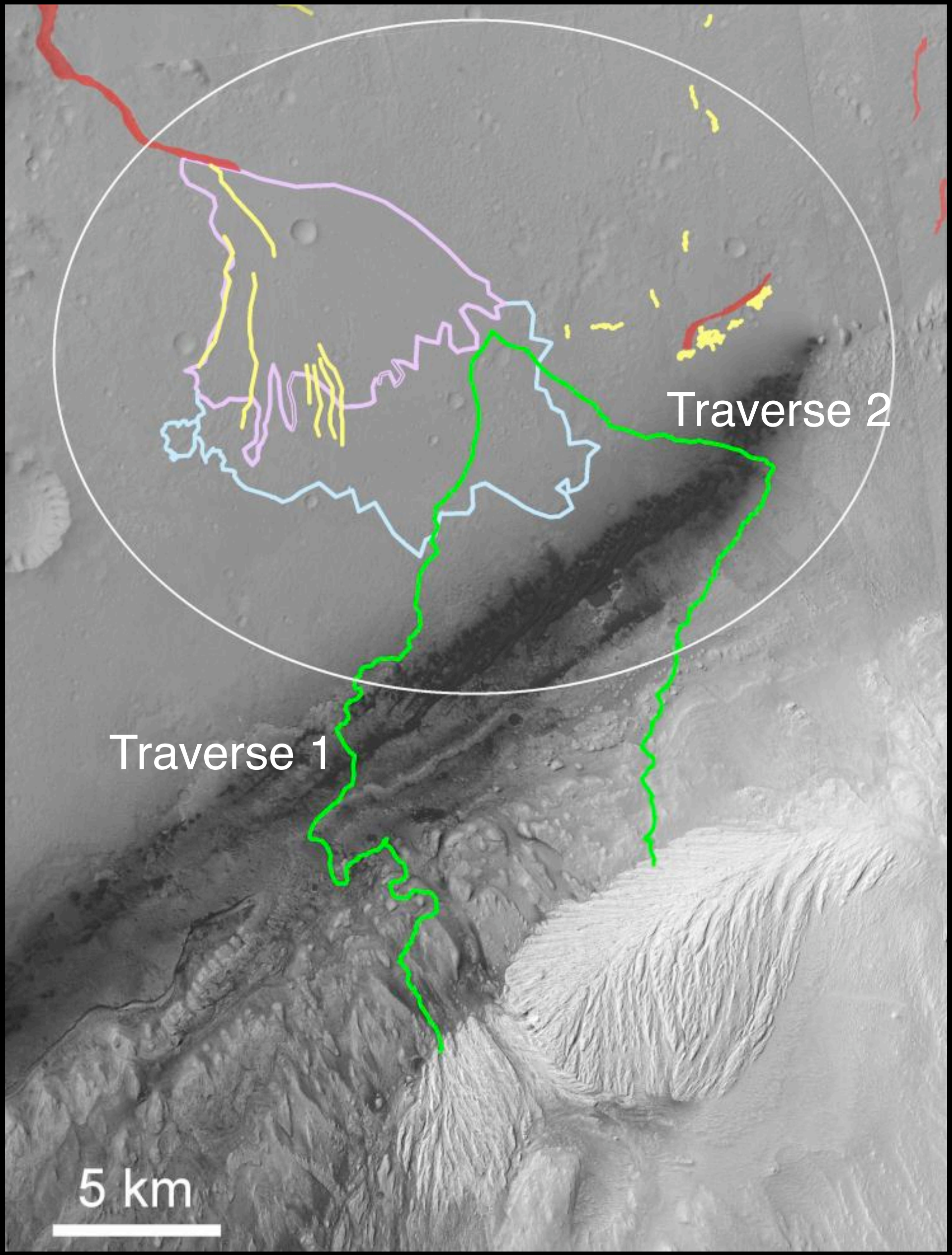
HiRISE Image: PSP_009149_1750

Cemented Fractures on the Mound

- Erosion-resistant ridges are common in Gale, including on the mound near the MSL traverse.



- This area is the primary target for MSL
  - Study interbedded phyllosilicate and sulfate-bearing strata, including marker bed
  - Characterize channel fill and the outcrop of mound-skirting unit
  - Work upwards through the lower mound stratigraphy
  - Study erosion-resistant fractures



- Left: Two possible traverses starting at the center of the ellipse.
- Traverse 1 is preferred: mound strata are better-exposed.
- Traverse 2 comes closer to inverted channels in the ellipse and spends more time on the mound-skirting unit.

Anderson & Bell (2010)

Conclusions

- Science targets in the ellipse:
  - Alluvial fan with exposed stratigraphy
    - Determine frequency and nature of deposition
    - Sample noachian crust
    - Study examples of subsequent burial and erosion
  - Inverted channels (on and off the fan)
    - Determine depositional environment, flow characteristics and duration
  - Cemented fractures
    - Characterize their composition and alteration history
  - Mound-skirting unit
    - Investigate relationship with fluvial processes (chains of mesas) and aeolian processes (lithified bedforms)
  - "Young" mafic dunes
    - Characterize modern aeolian transport parameters, soil mechanics, induration rates, etc.

- These are all targets of opportunity that MSL could study on the way to the mound.

Conclusions

- Science targets on the mound:
  - Basal unit and light-toned ridge
    - Determine composition, depositional setting, etc.
  - Interbedded phyllosilicates and sulfates
    - Alteration and depositional environment
    - Biomarker preservation
    - Do these reflect a global change?
  - Filled channel and fan-shaped outcrop of mound-skirting unit
    - Channel fill may provide samples from higher on the mound
    - Outcrop places the mound-skirting unit into stratigraphic context
  - Large cemented fractures
    - Characterize the post-depositional alteration of mound materials
  - Kilometers of stratigraphy!
    - Construct a detailed picture of ancient Mars.

- Gale Crater is a diverse landing site, with many science targets inside and outside of the ellipse!
  - MSL would be able to access materials from many different environments, maximizing knowledge gained about martian habitability.