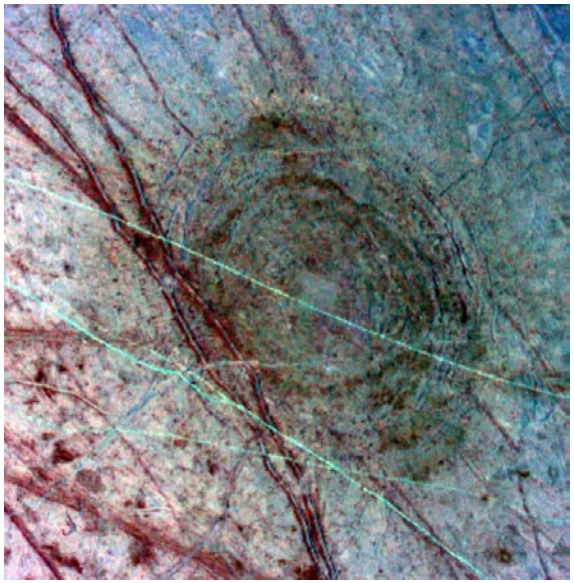
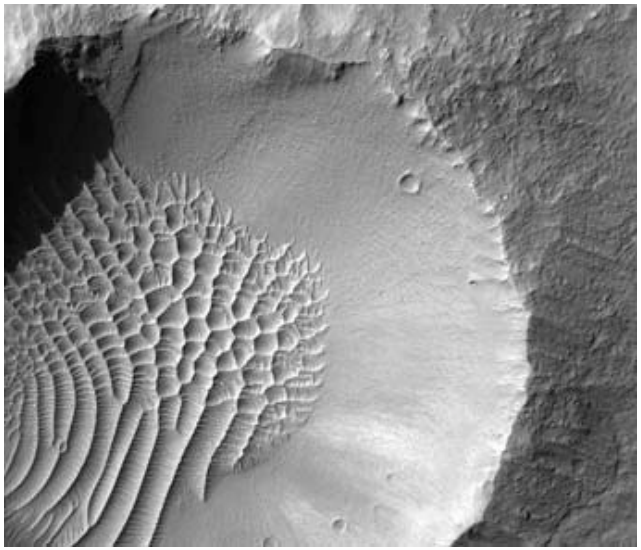
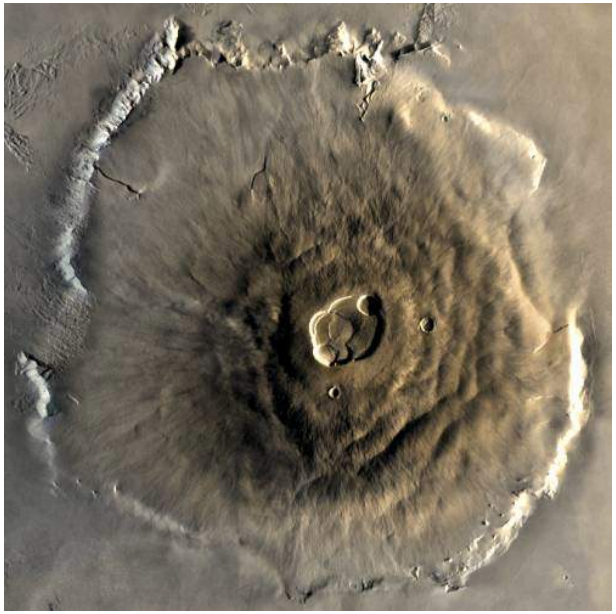
Planetary Surface Processes

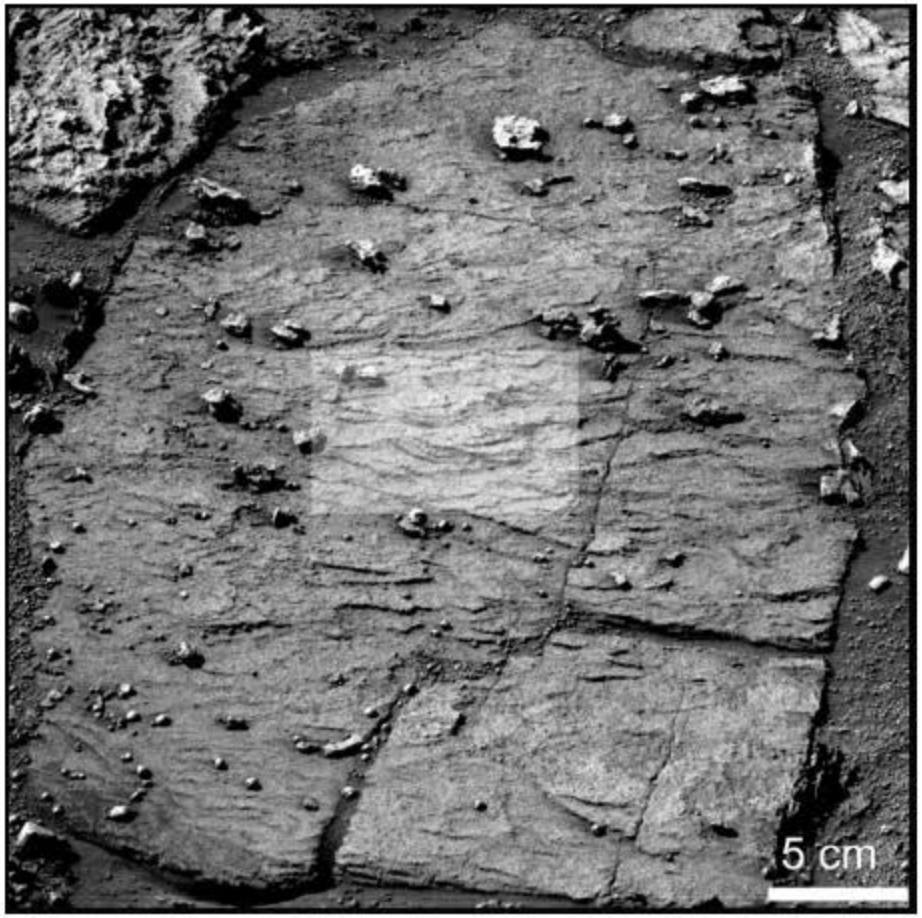
Cratering
Gravity
Tectonics
Volcanism
Winds
Fluvial
Glacial
Chemical weathering



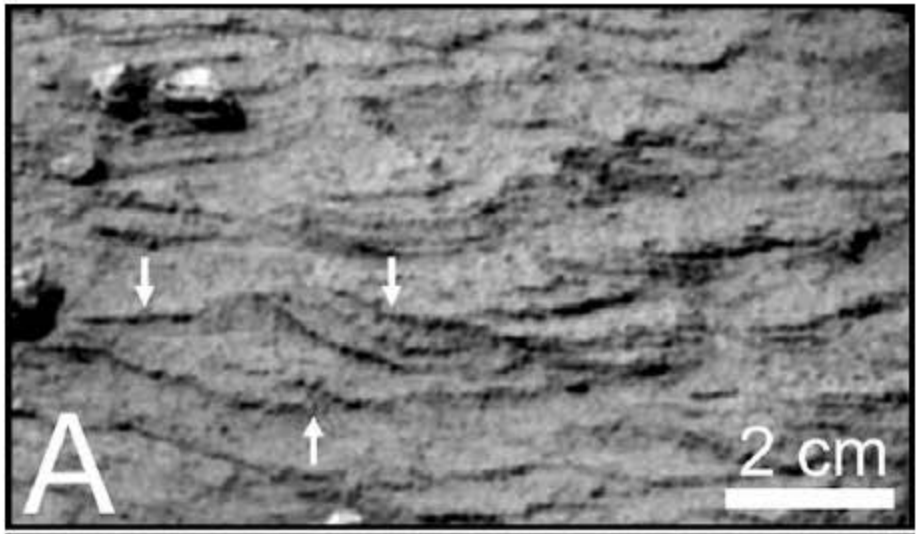


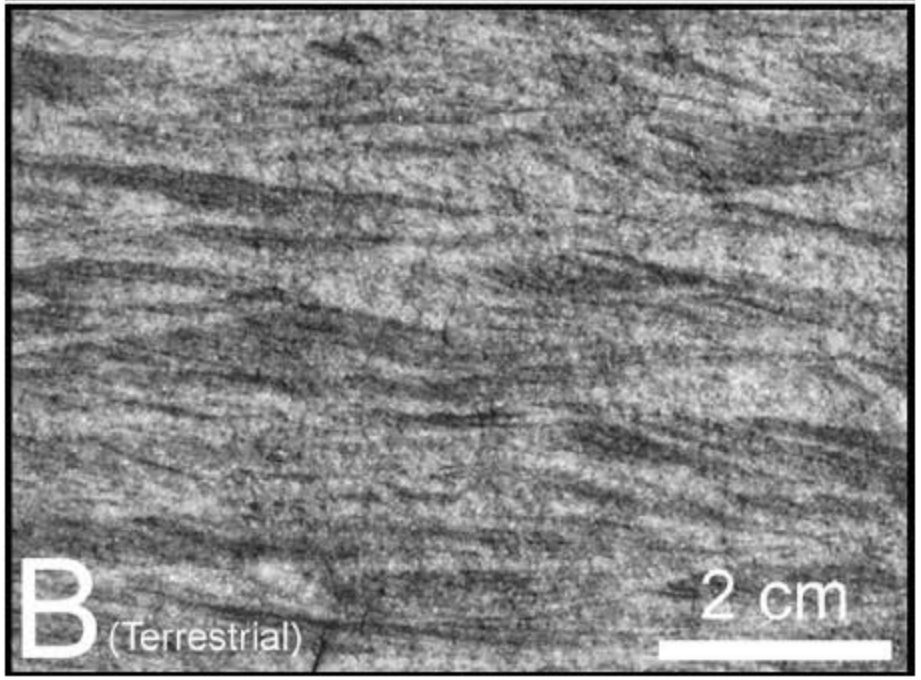


Shallow ponds at Meridiani Planum

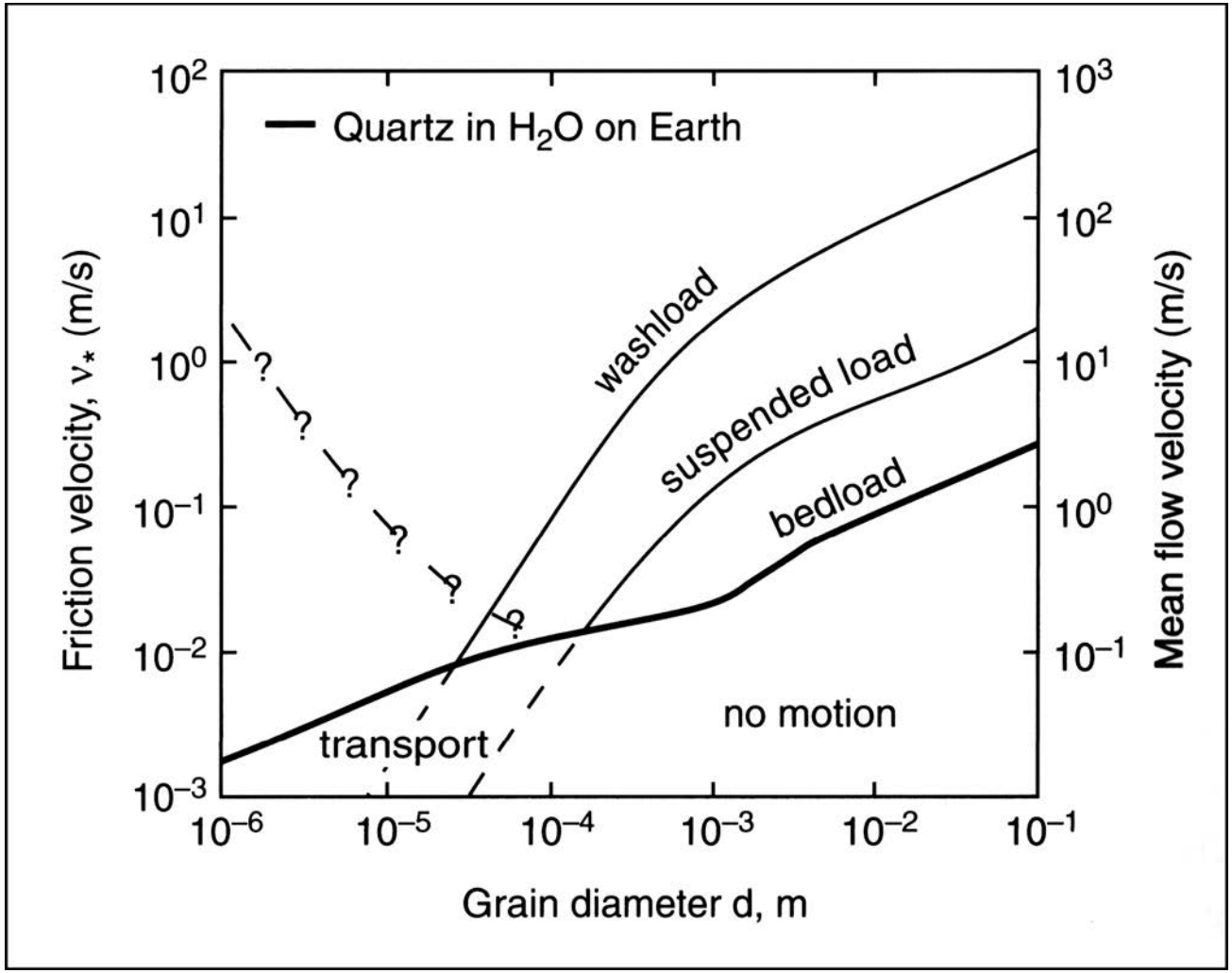


Grotzinger et al. (2006)



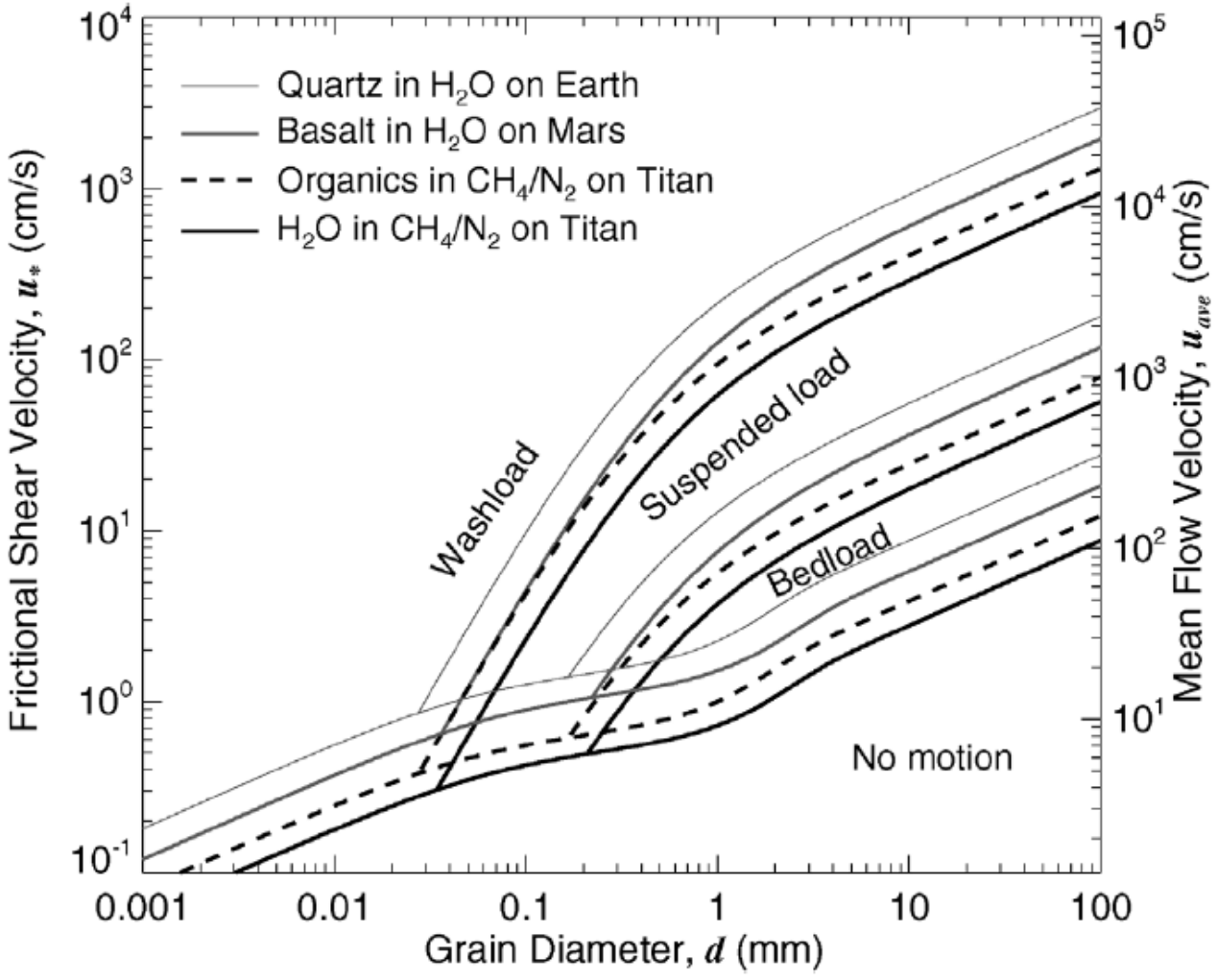


Fluvial sediment transport



Melosh (2011)

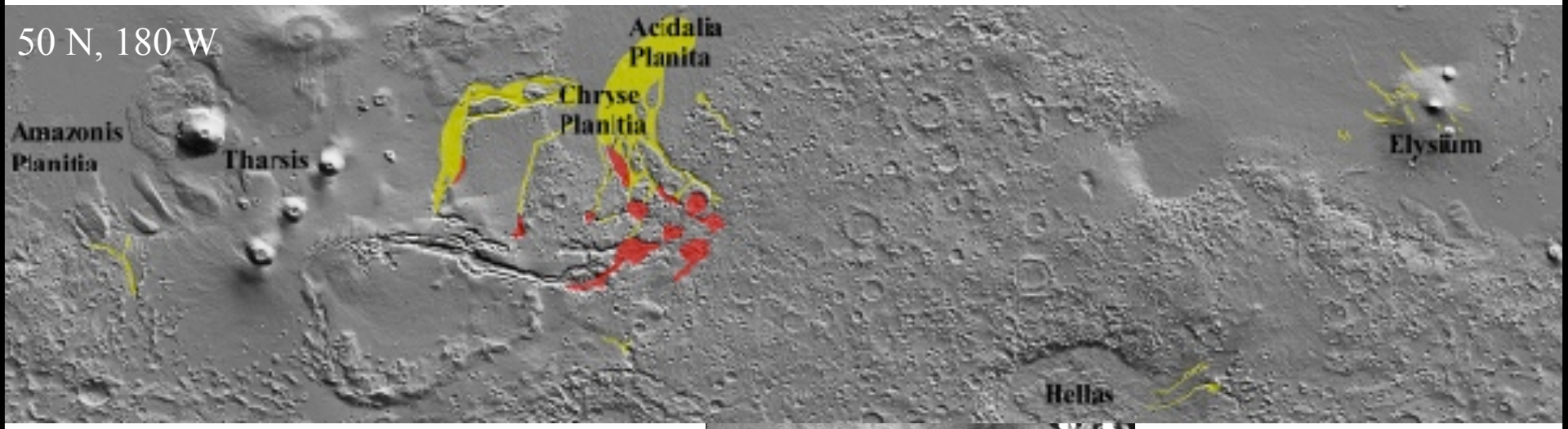
Fluvial sediment transport

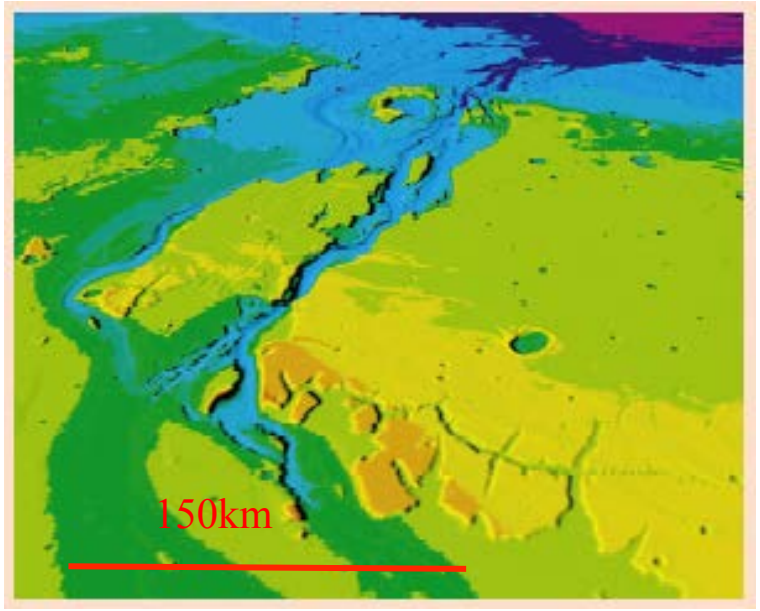


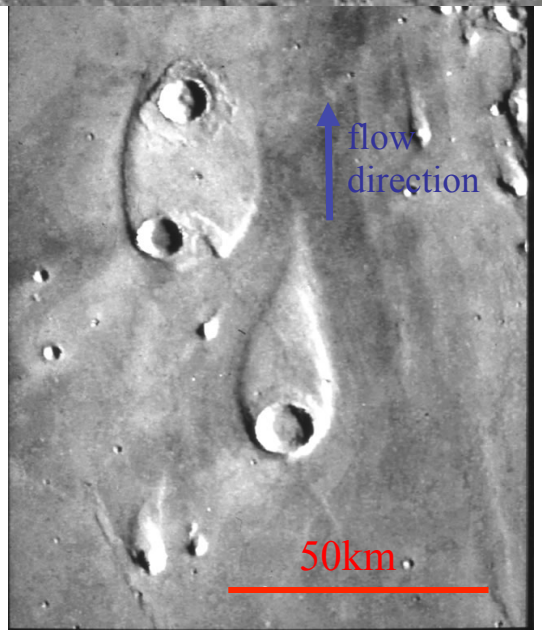
Burr et al. (2006)

Map of Mars Outflow Channels

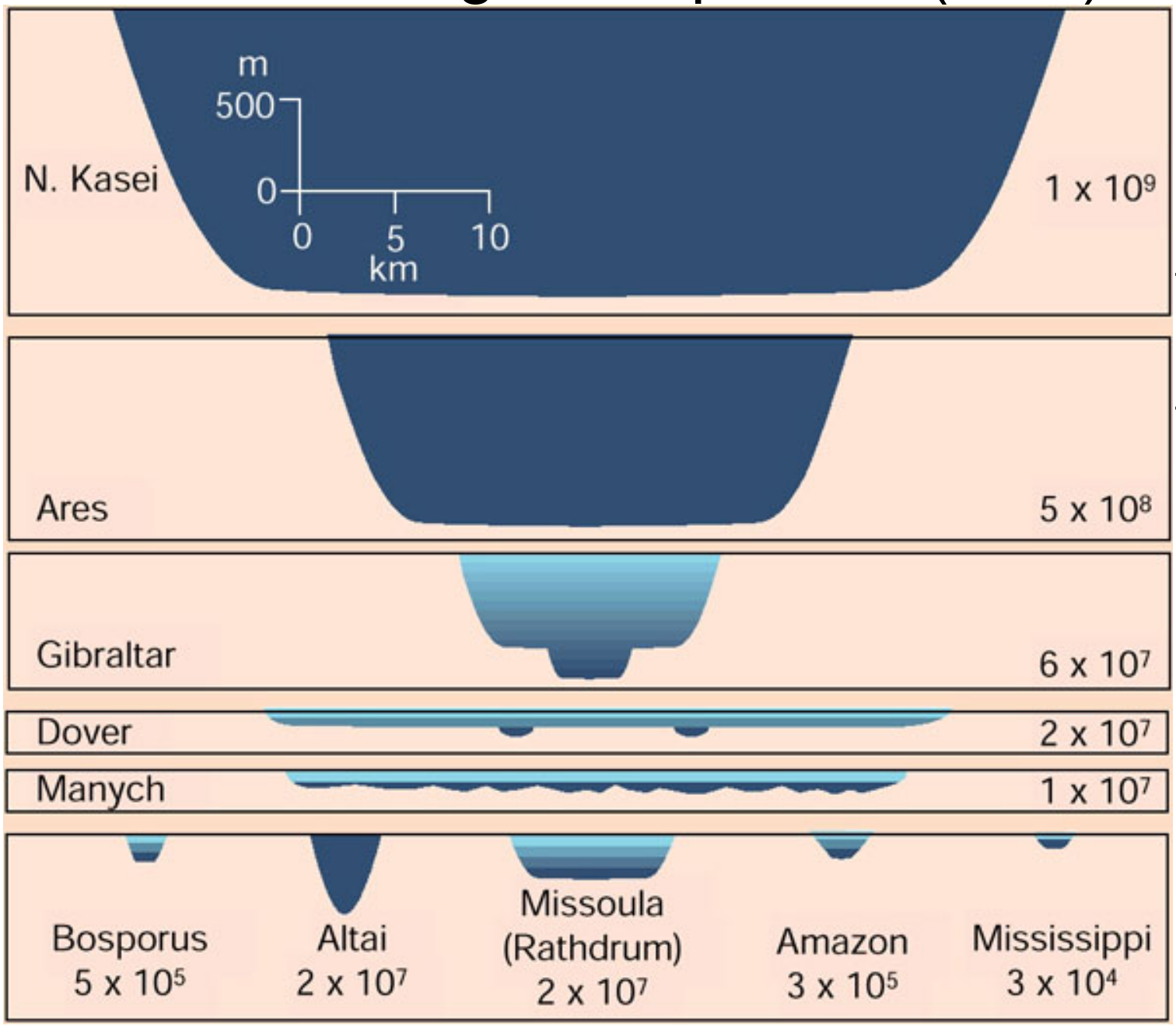
Concentrated east of Tharsis in topographic trough





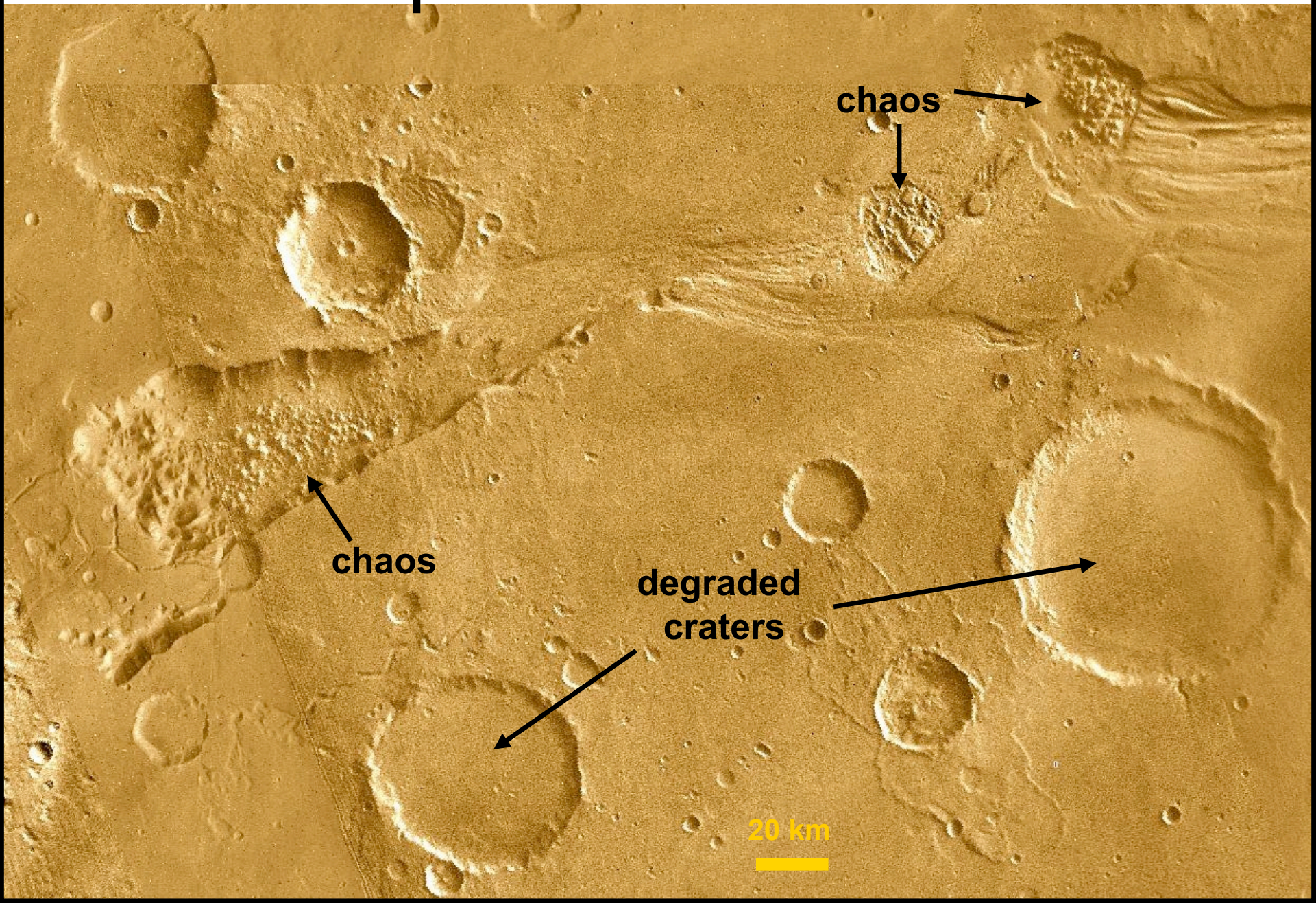


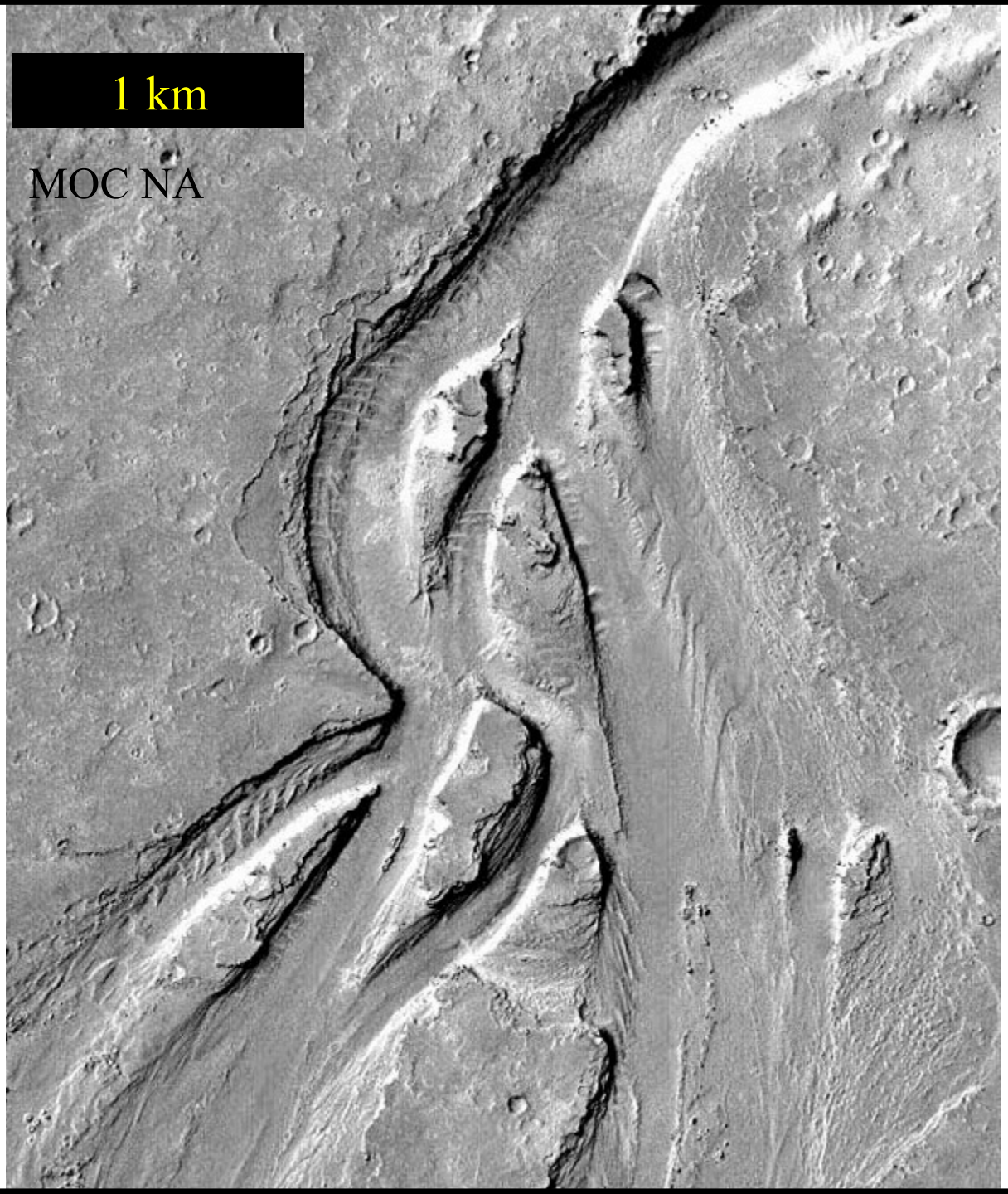
Flood Discharge Comparison (m^3/s)



Baker, 2001

Catastrophic Outflow Channels




1 km
MOC NA

Mars/Earth Flood Comparison

Similarities

- Morphological Features
  - terraces, streamlined hills, bars, inner channel cataracts, scour marks, longitudinal grooves, megaripples, low sinuosity
- Duration (?)
- Multiple Events

Differences

- Origination
  - Earth → glacial breakout
  - Mars → subsurface breakout
- Scale
- Discharge

Martian Gullies

- A very unexpected discovery (Malin & Edgett, *Science* 283, 2330-2335, 2000)
- Found predominantly at high latitudes (>30^{o}), on pole-facing slopes
- Inferred to be young < 10 MA – cover young features like dunes and polygons
- Snowmelt? Melting of ground ice?
  Groundwater aquifers?!?
  Or not related to water at all?

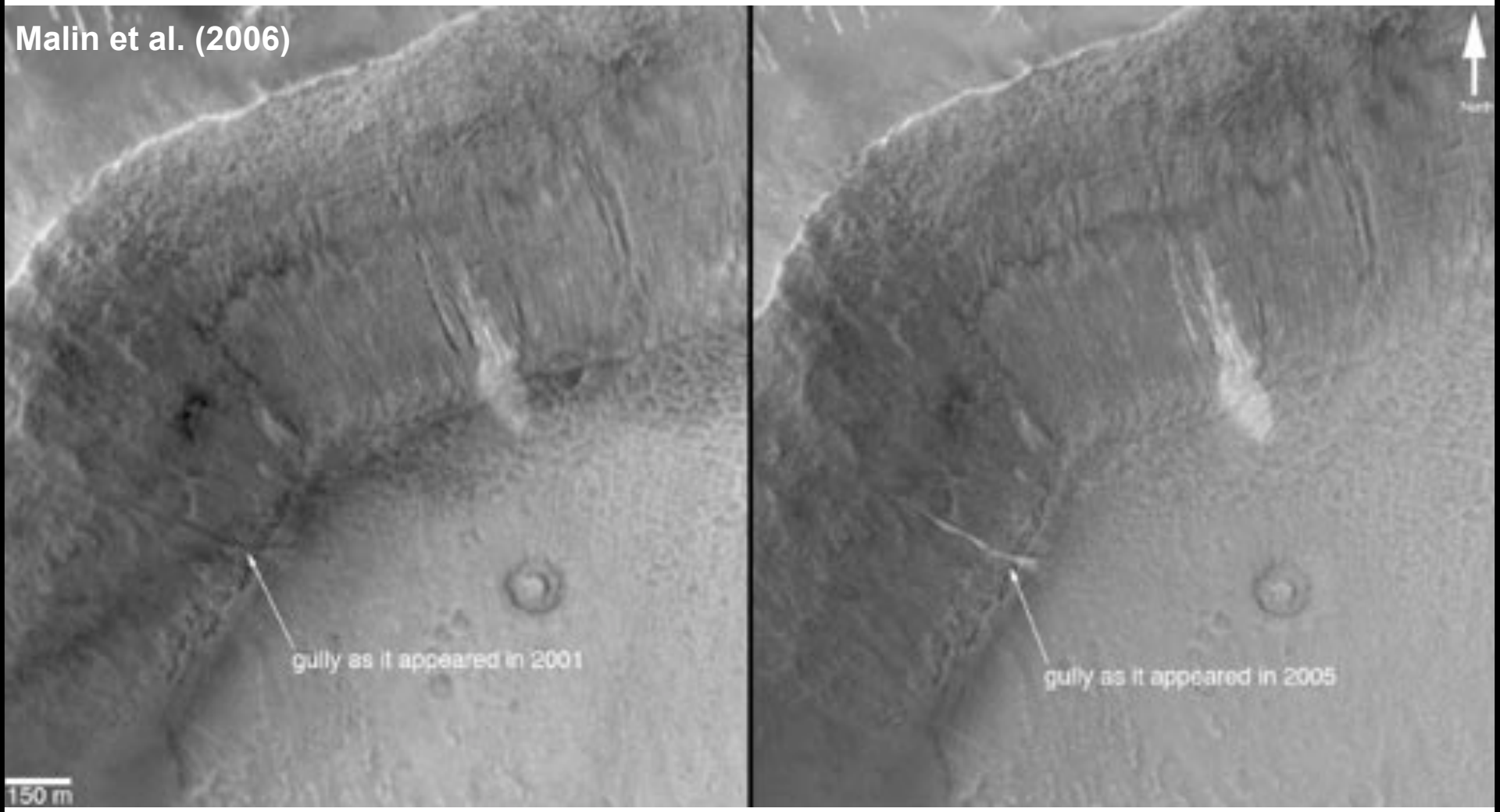
Gullies in the northern wall of a crater at 39.1 °S, 166.1 °W
Subframe of MOC image E11-04033

NASA/JPL/Malin Space Science Systems

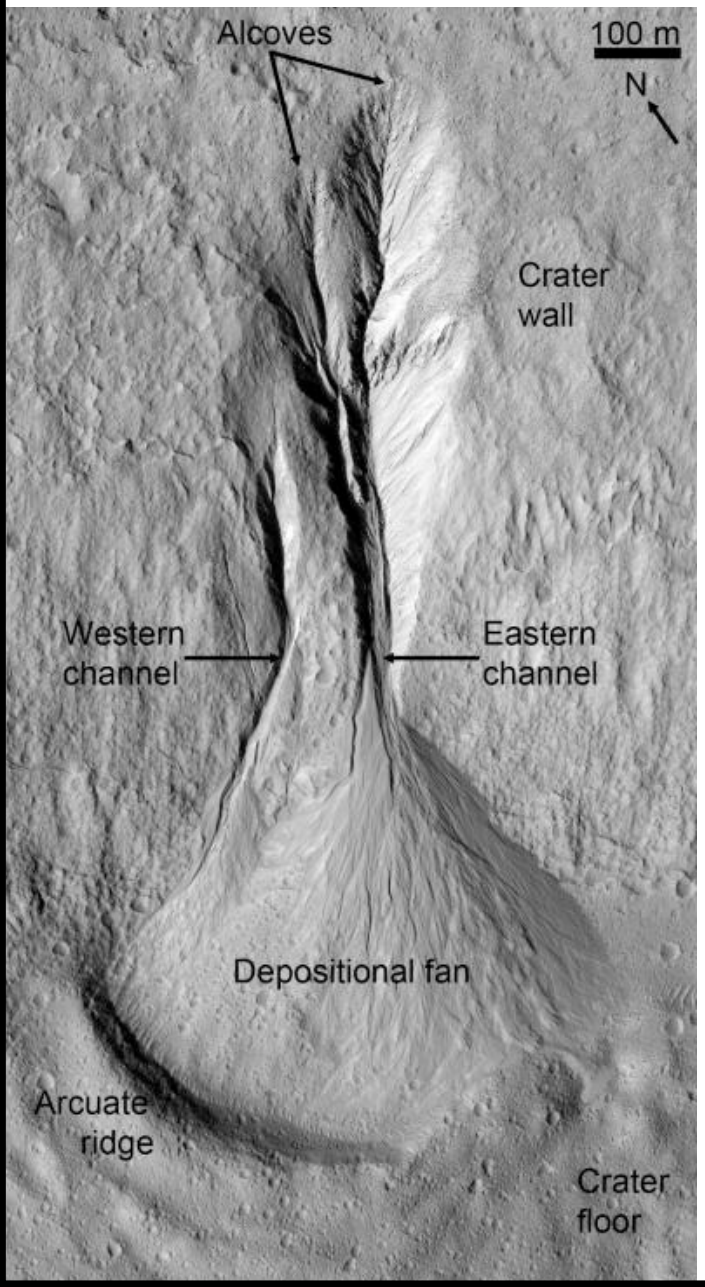
Gullies in crater near 39°S, 200°W

MOC2-388/PIA04570 NASA/JPL/MSSS

Gullies are active today!

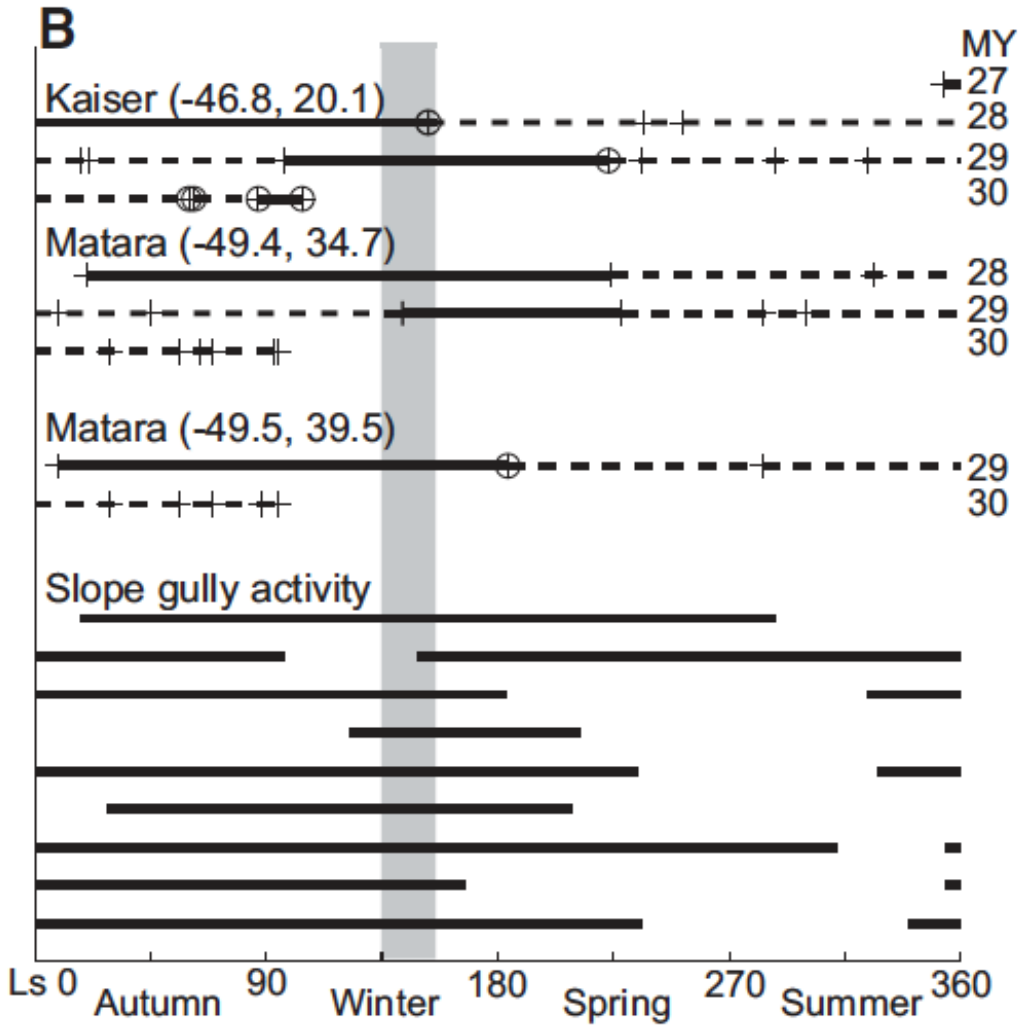


Gullies look like water-carved features…



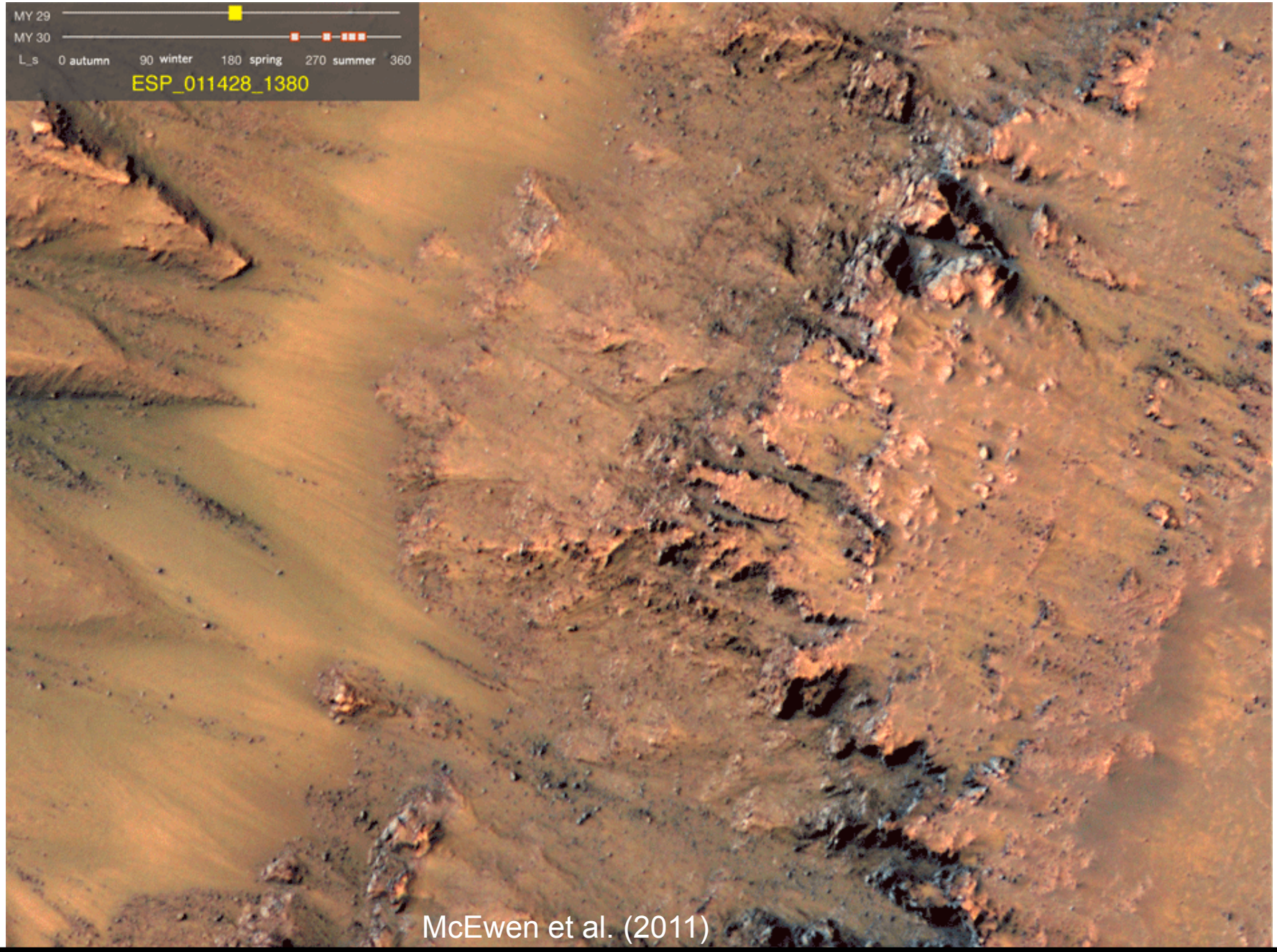
…but they're active in the winter time!

➔ related to CO_2 frost?



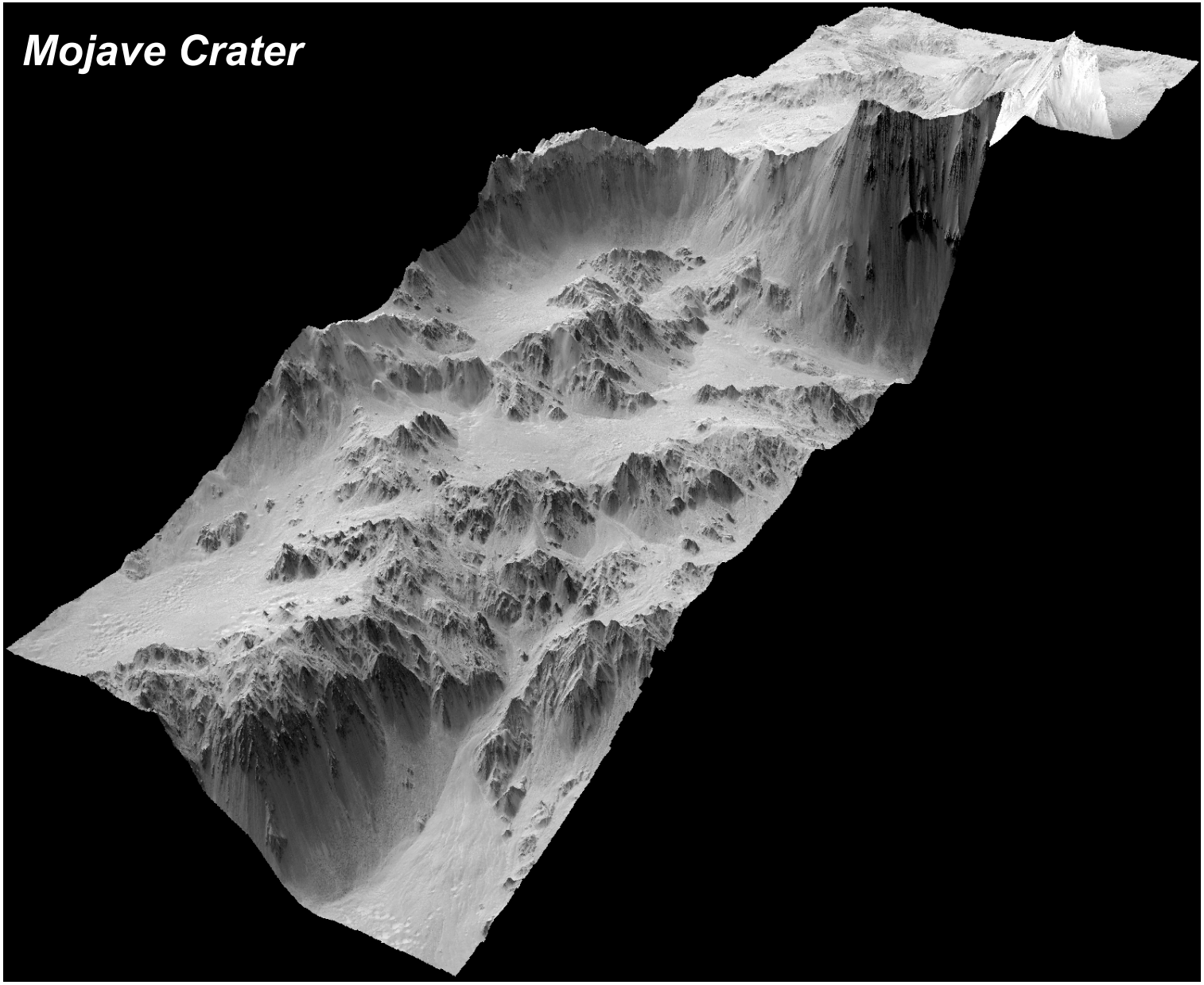
Diniega et al. (2010)

Recurring slope lineae: active in summer

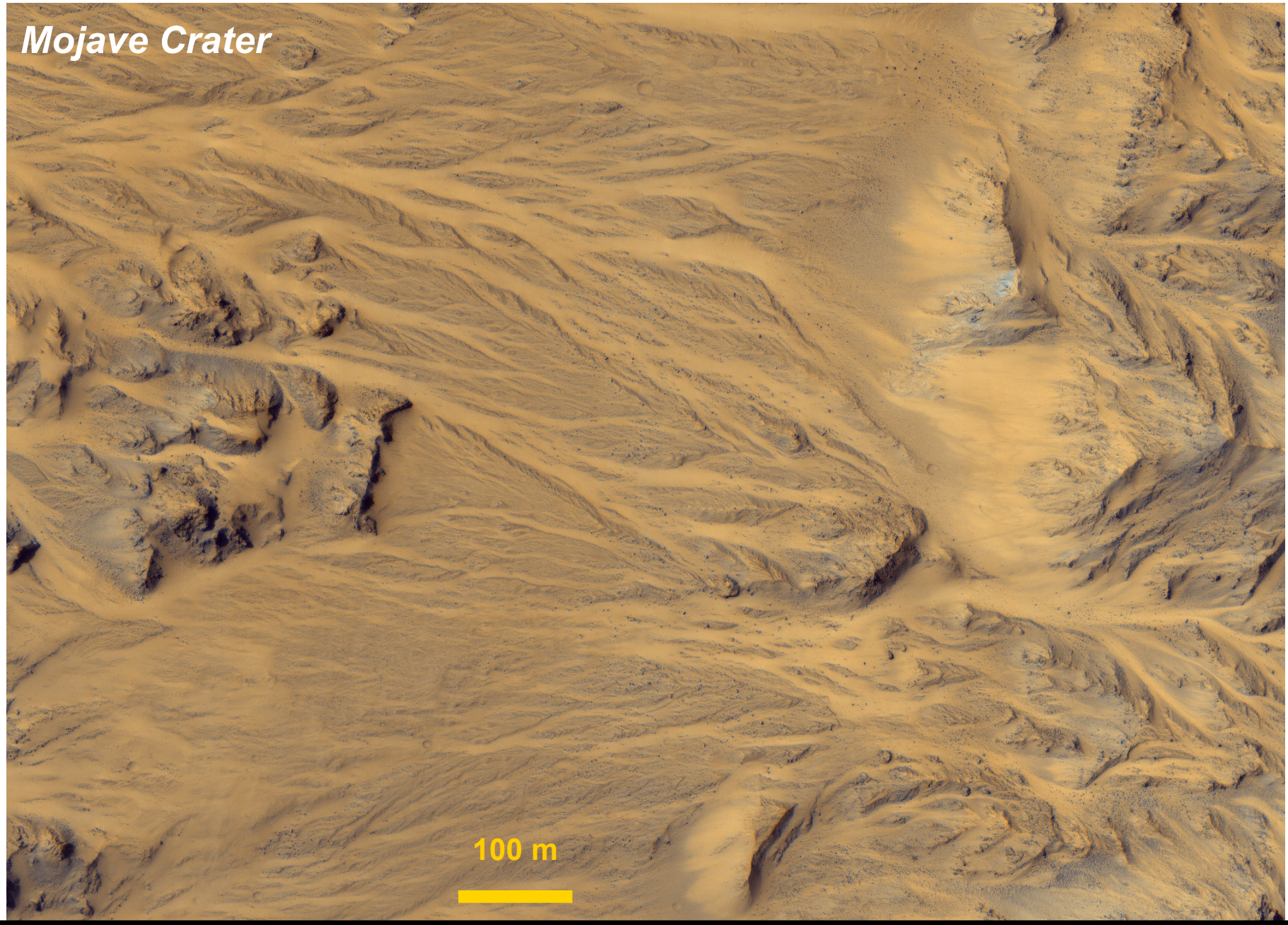


McEwen et al. (2011)

“Recent” fluvial activity driven by impact melting?



“Recent” fluvial activity driven by impact melting?



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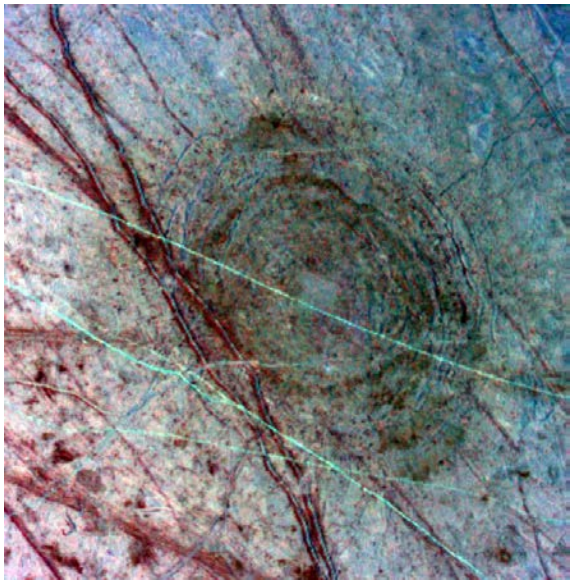
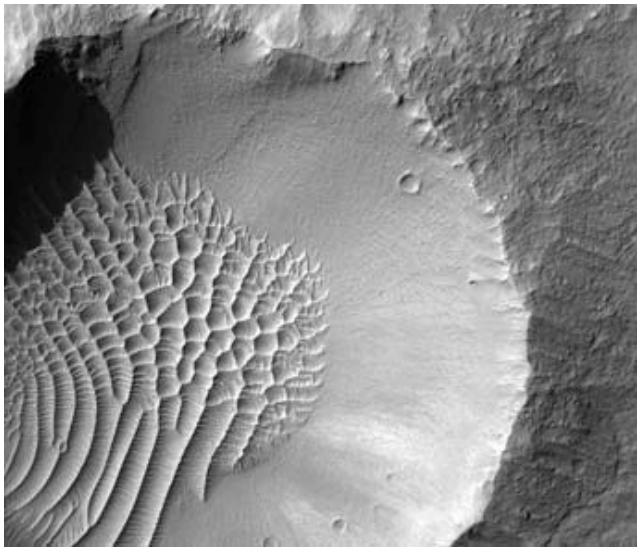
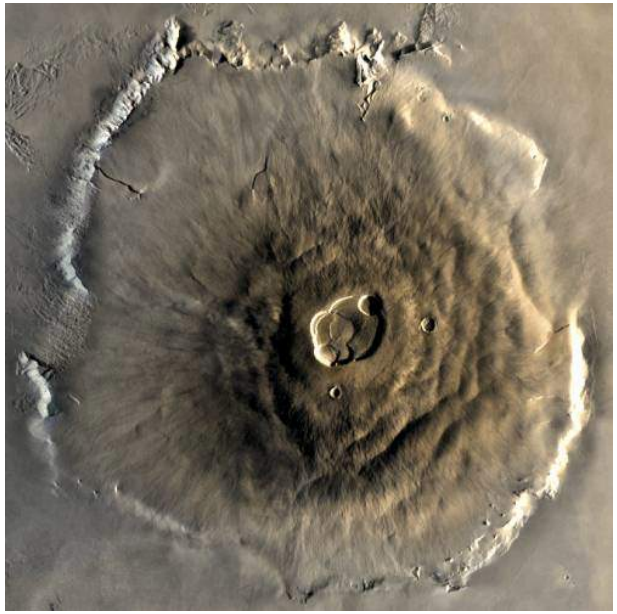
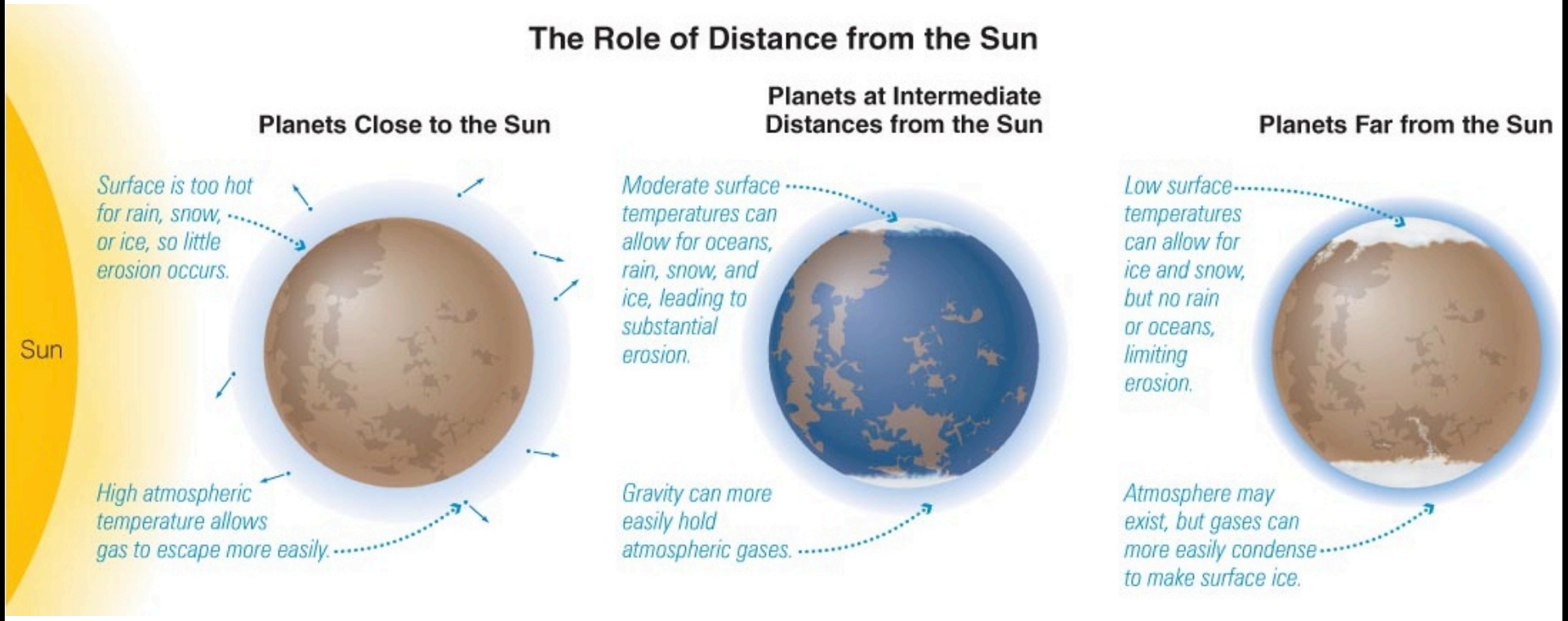






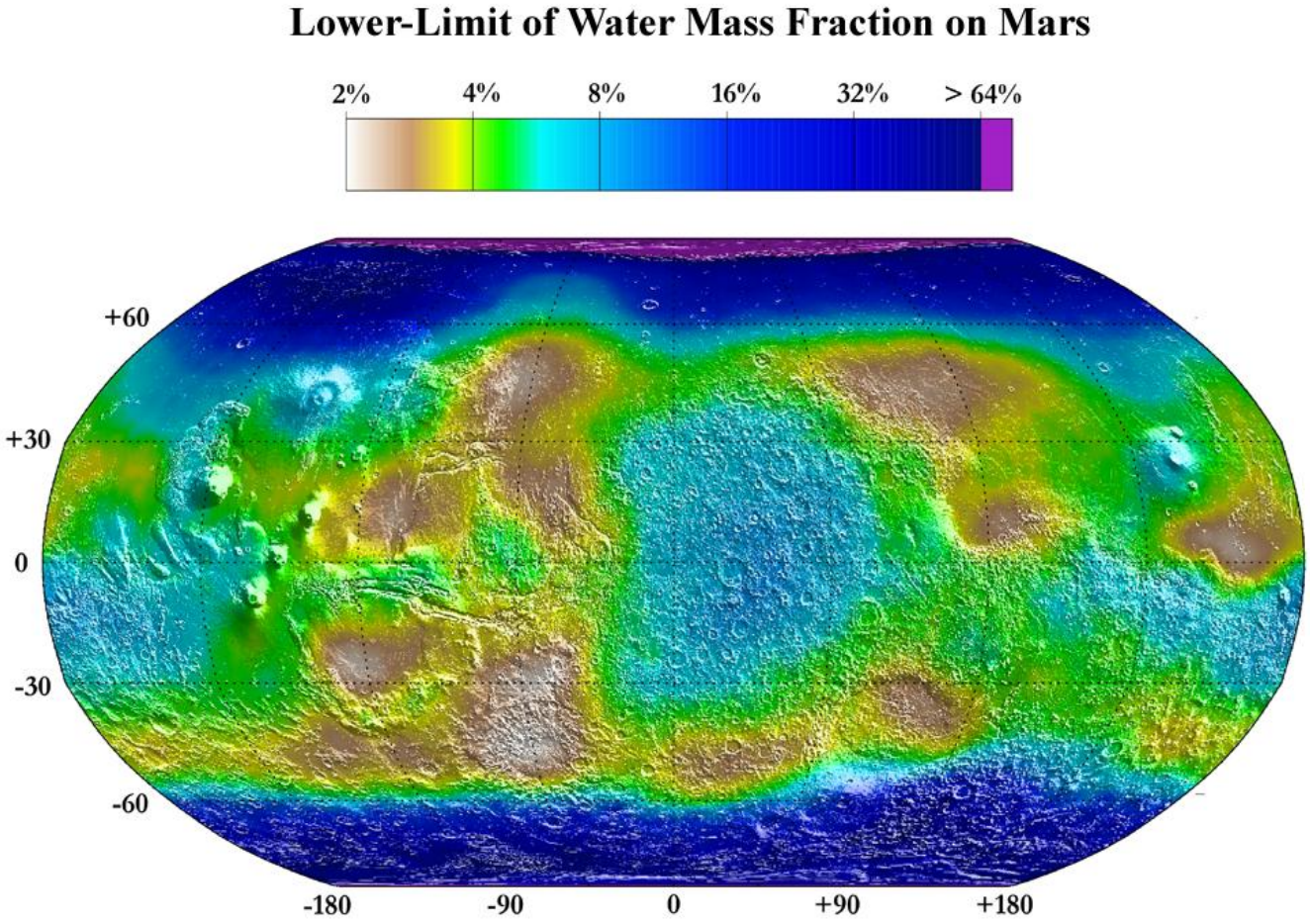
Mars is the outermost terrestrial planet.



Where is Mars's water now?

- Lost to space
- In atmosphere
- Trapped in
  - Polar caps (at surface)
  - Ground ice
  - Mineral structures in rocks

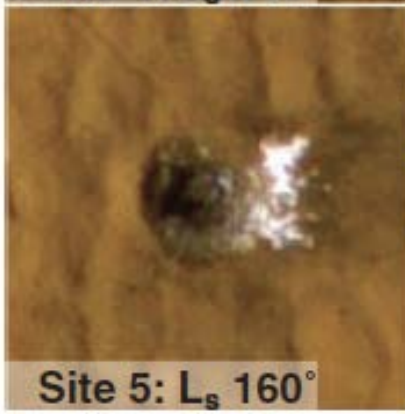
Ground Ice (and hydrated minerals): Evidence from Neutron Spectroscopy

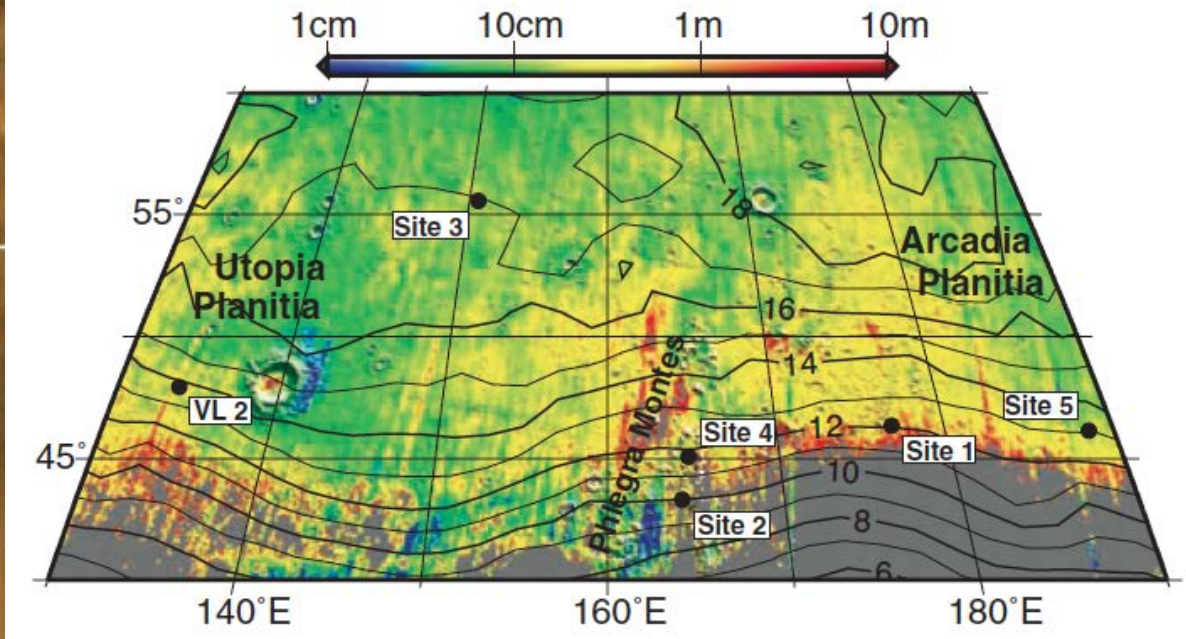


Data from Mars Odyssey Gamma Ray Spectrometer, see for example Feldman et al. 2002

Ice revealed by impacts

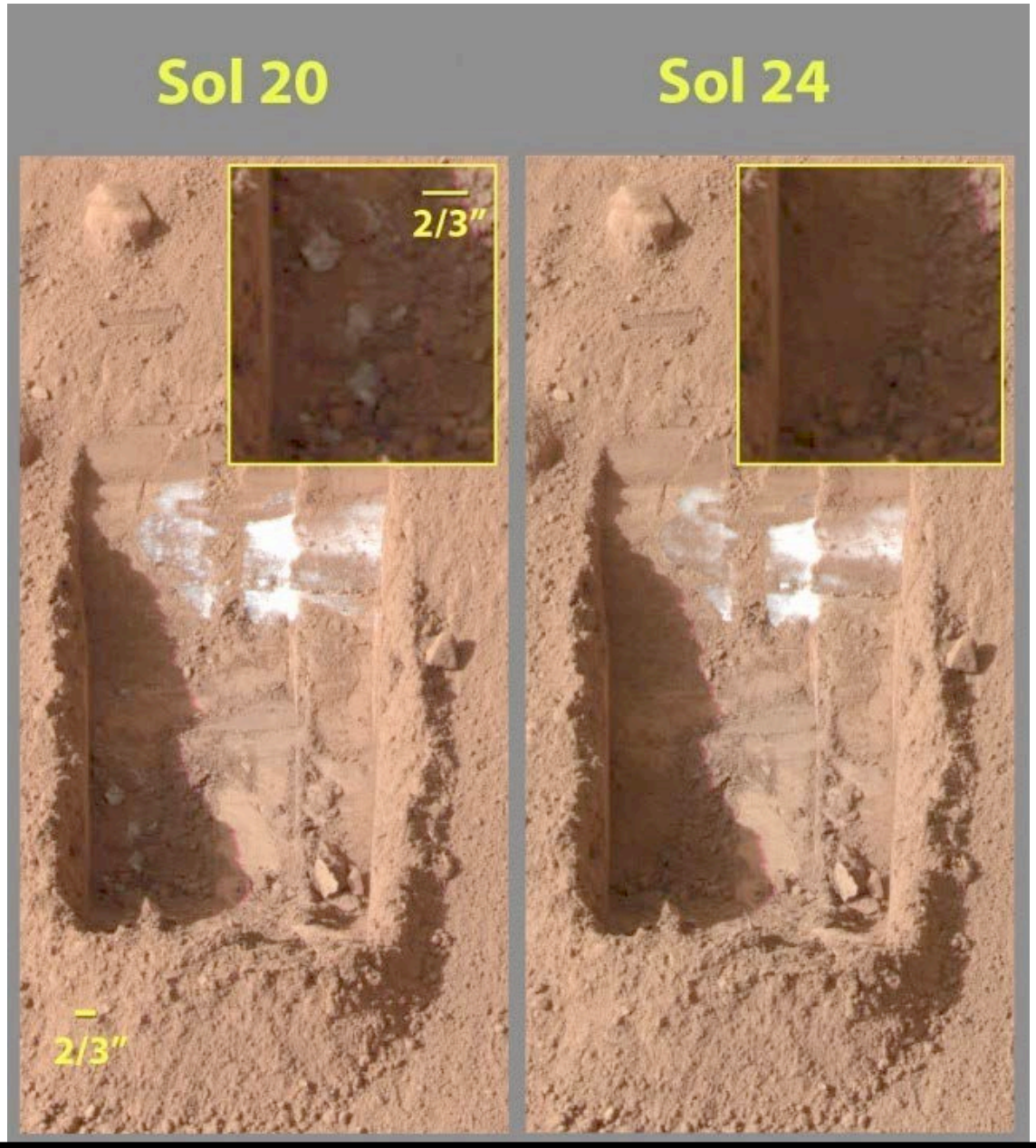
Observed to fade over time



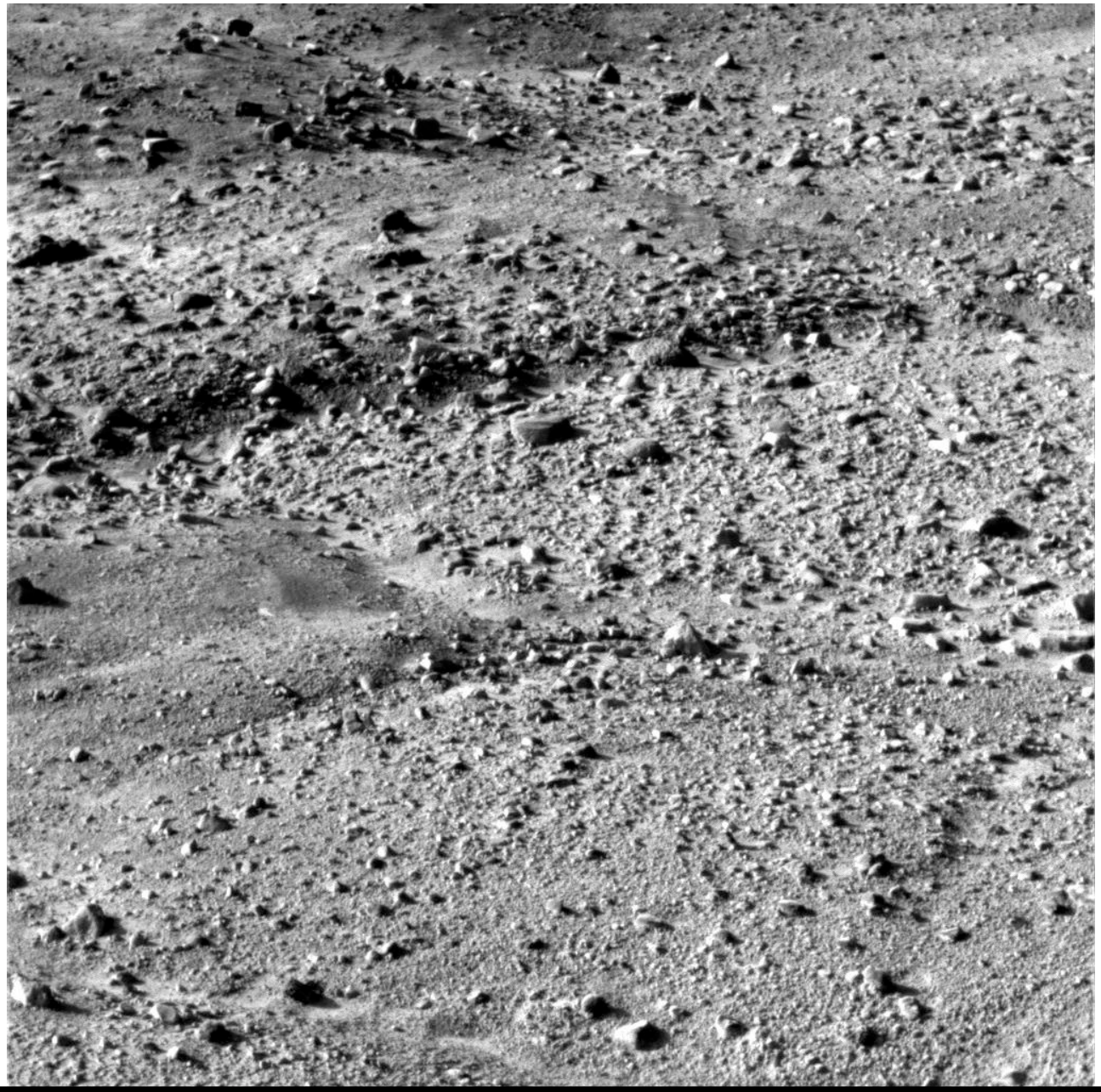


Byrne et al. (2009)

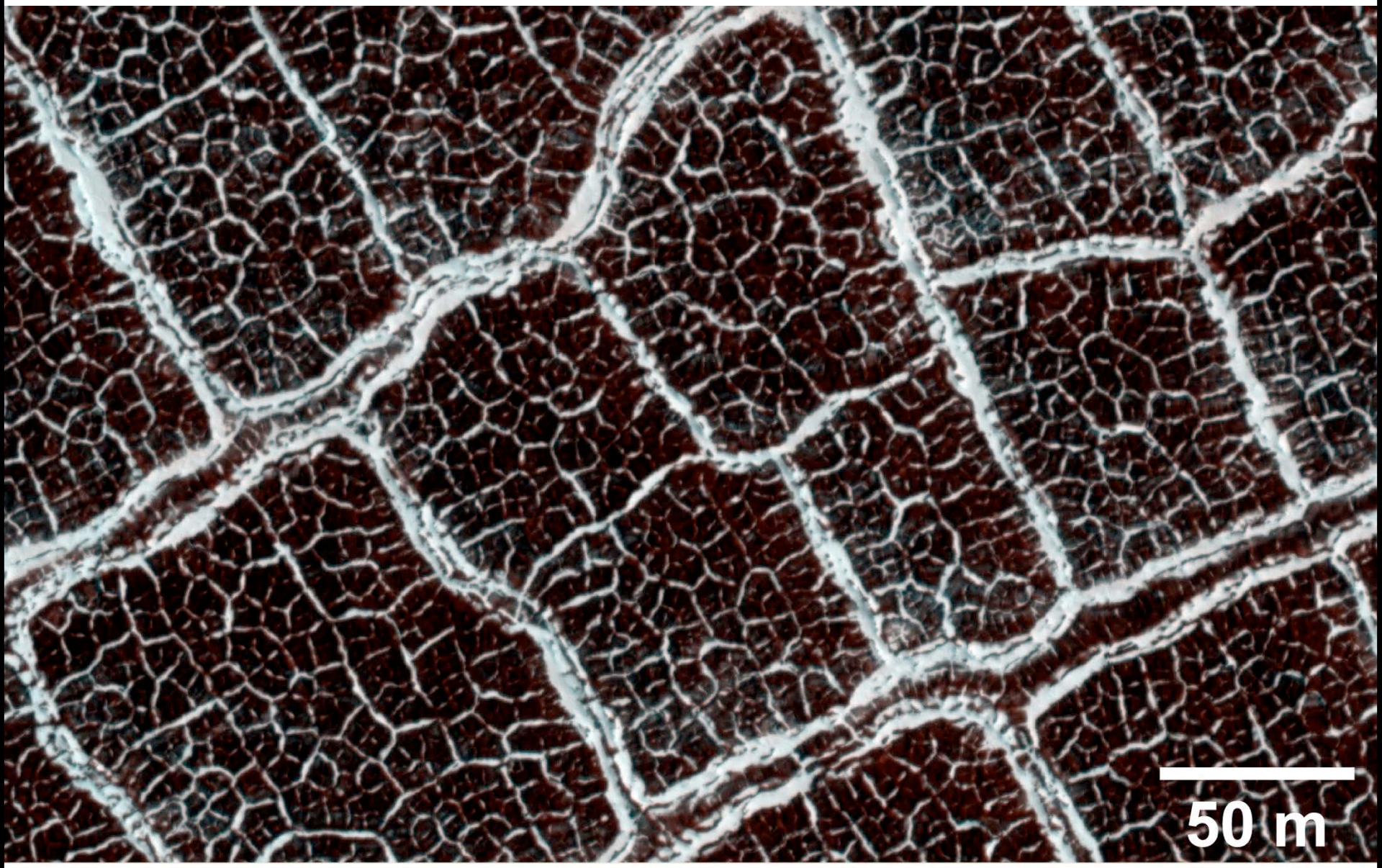
Phoenix observed ice directly



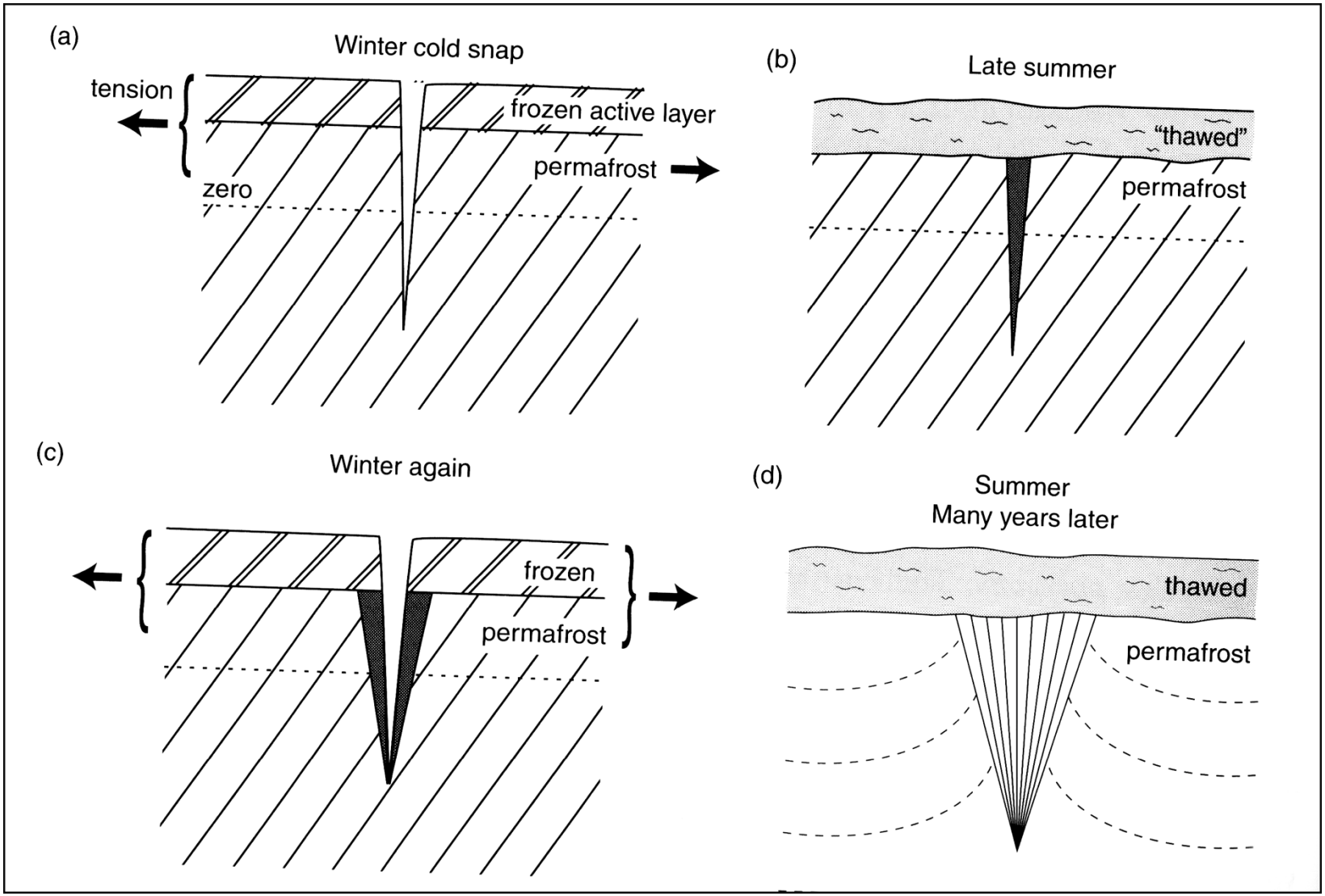
Polygonal patterned ground - Phoenix



Polygonal patterned ground - HiRISE



Contraction crack formation



Melosh (2011)