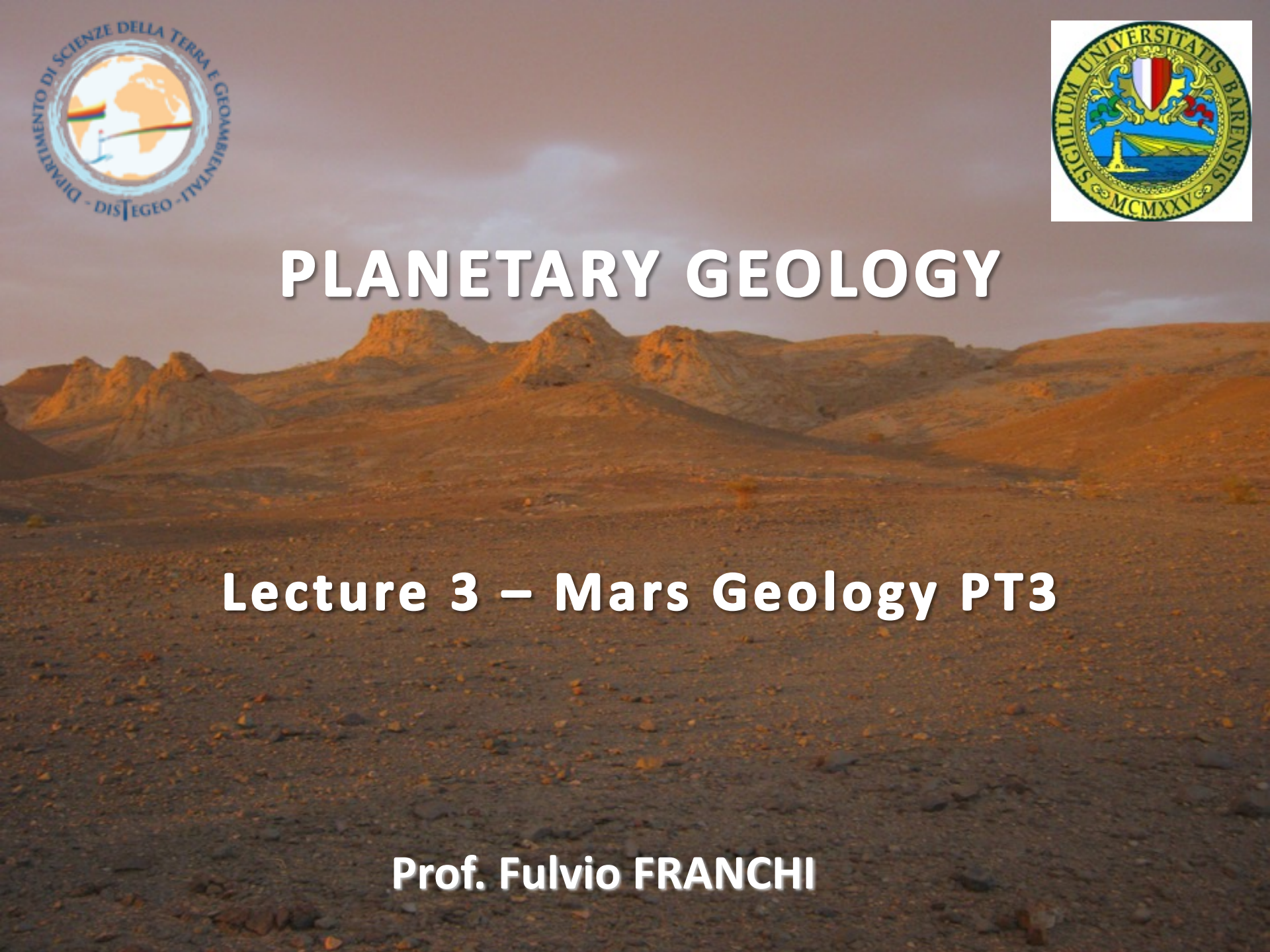


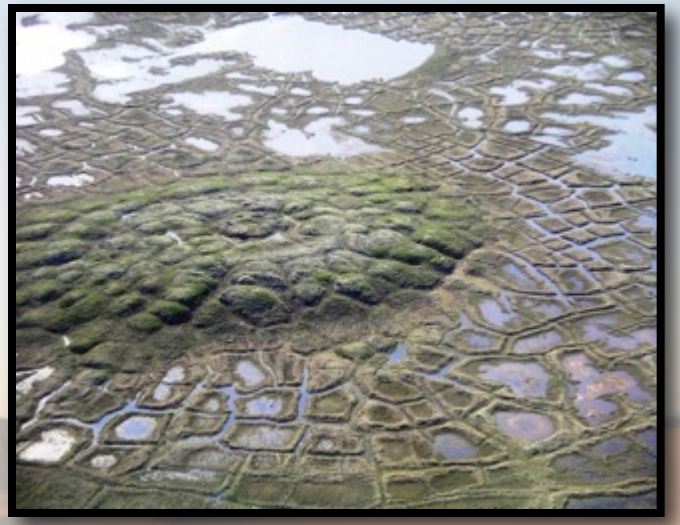
PLANETARY GEOLOGY

Lecture 3 – Mars Geology PT3

Prof. Fulvio FRANCHI

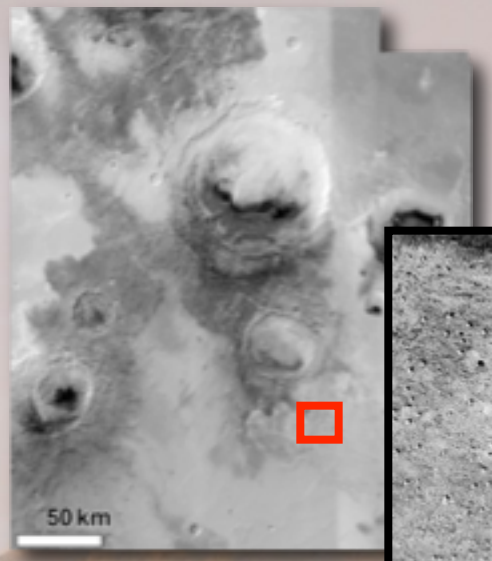
Mars Geology

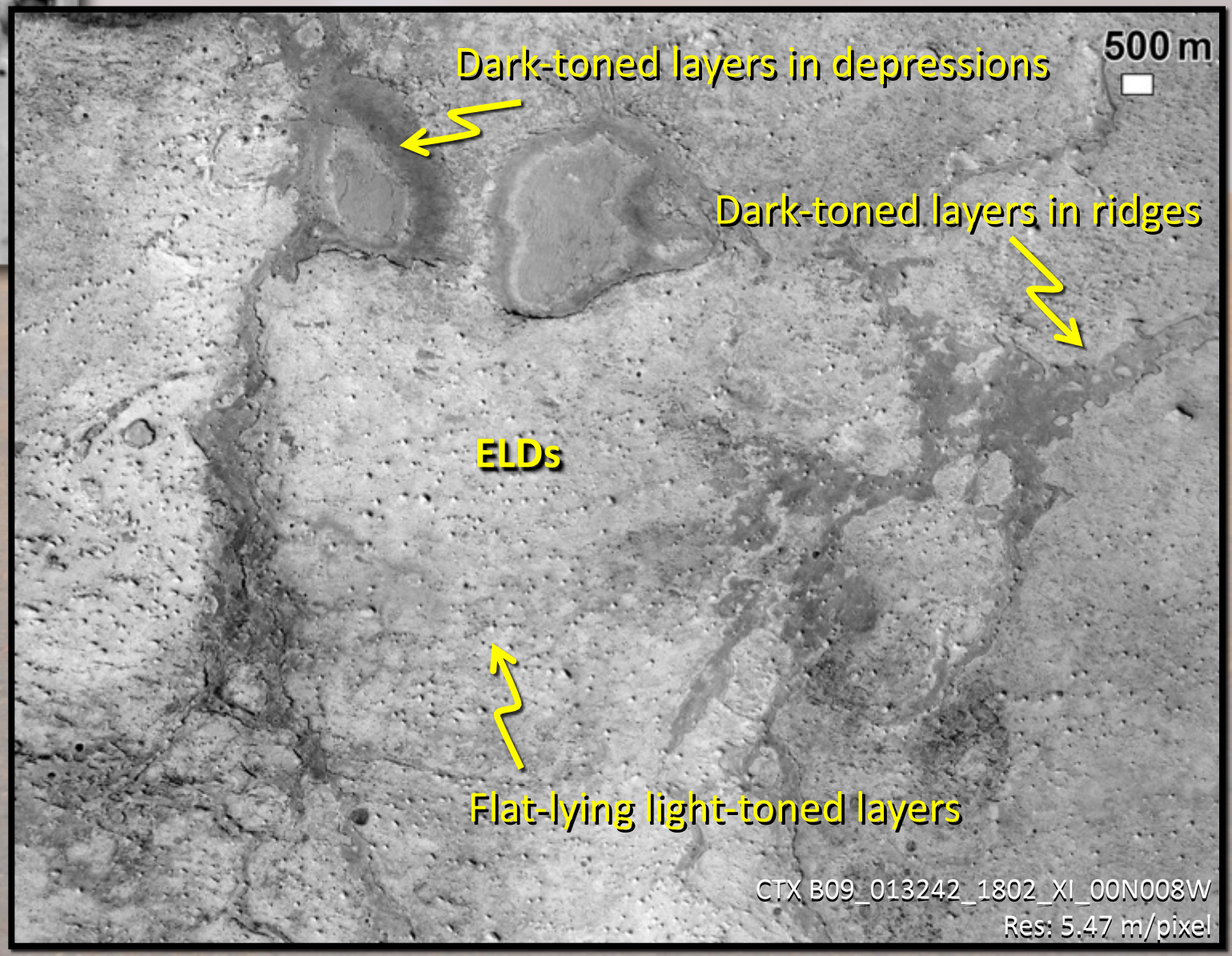
TOPICS TO BE COVERED:

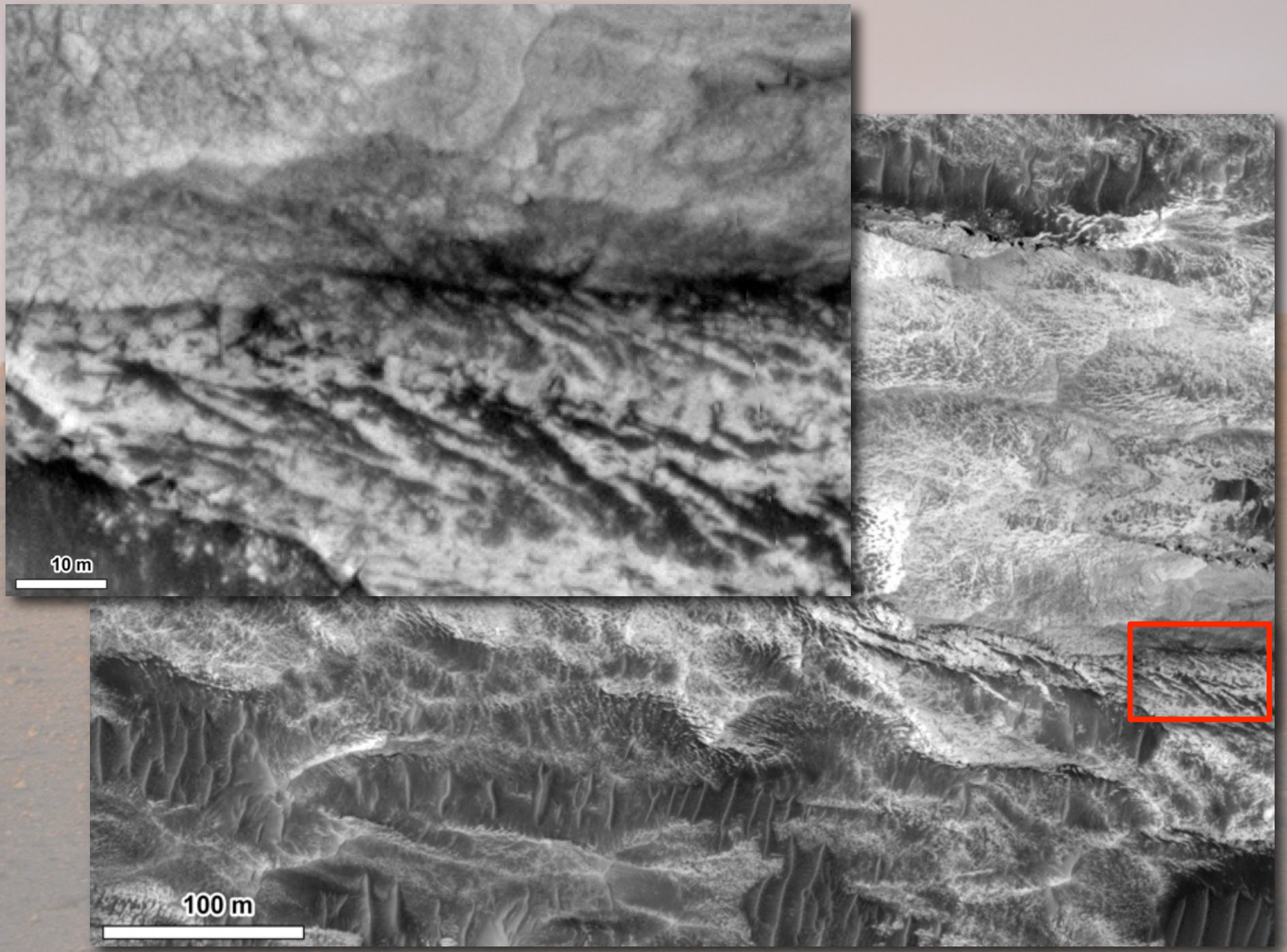


- **Mars Geology (Pt. 3):**
  - **Aeolian deposits**
  - **Glacial and periglacial deposits**
  - **Mars evolution**

Plateau


50 km


Dark-toned layers in depressions
500 m
Dark-toned layers in ridges
ELDs
Flat-lying light-toned layers
CTX B09_013242_1802_XI_00N008W
Res: 5.47 m/pixel

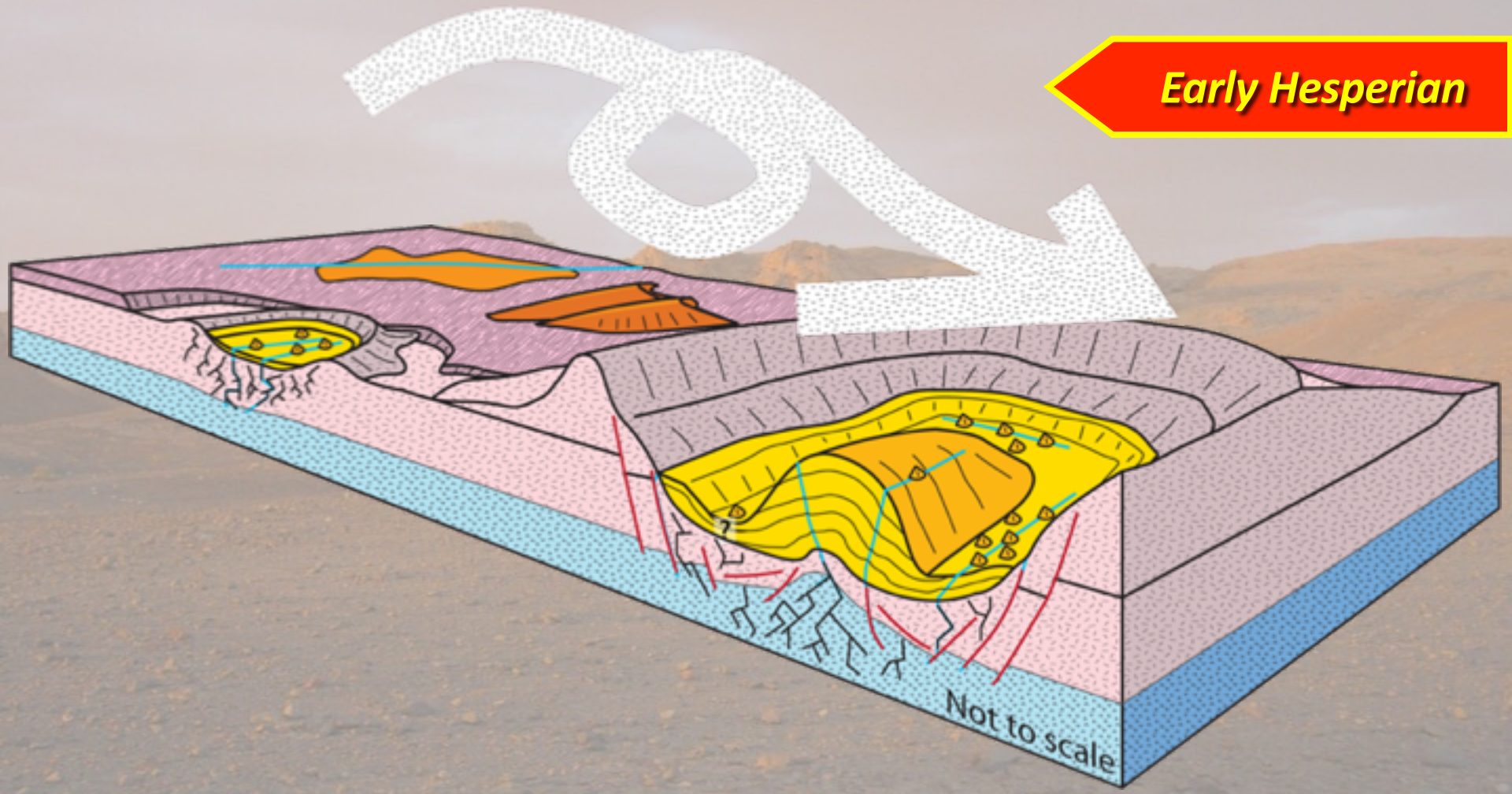

10 m
100 m

Plateau

- ✓ The scale of the cross stratification, their association to dune-forms and the general morphological setting (absence/paucity of morphologies such as channels) suggest an aeolian depositional environment for at least part of the ELDs located outside of the craters.
- ✓ Flat-bedded deposits possibly onlapping other ELDs suggest a formation as playa deposits.
- ✓ Fissure ridges suggest limited sources of fluid upwelling.

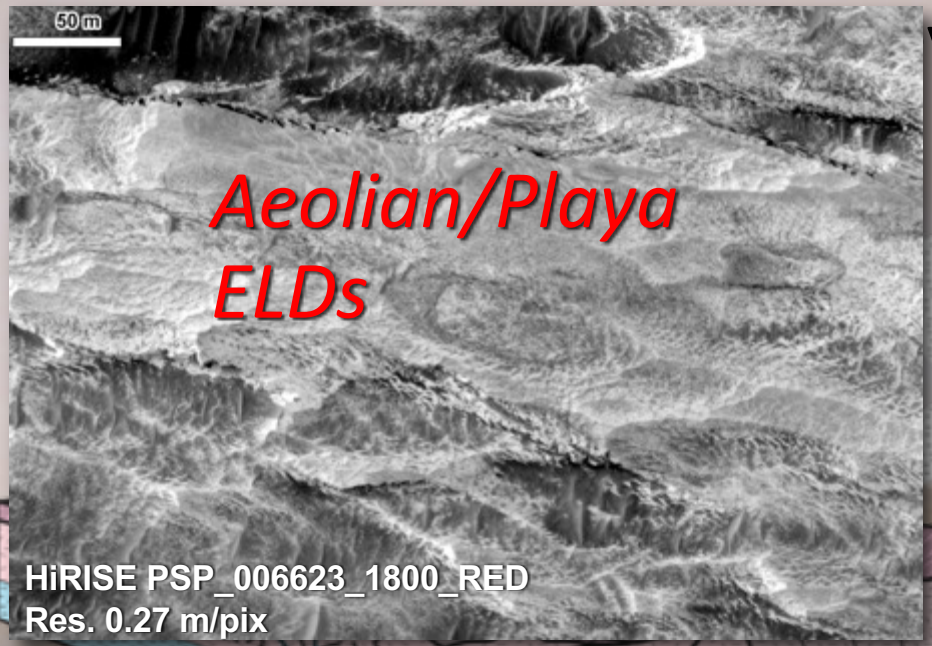
→ 'Meridiani like'

Basin evolution

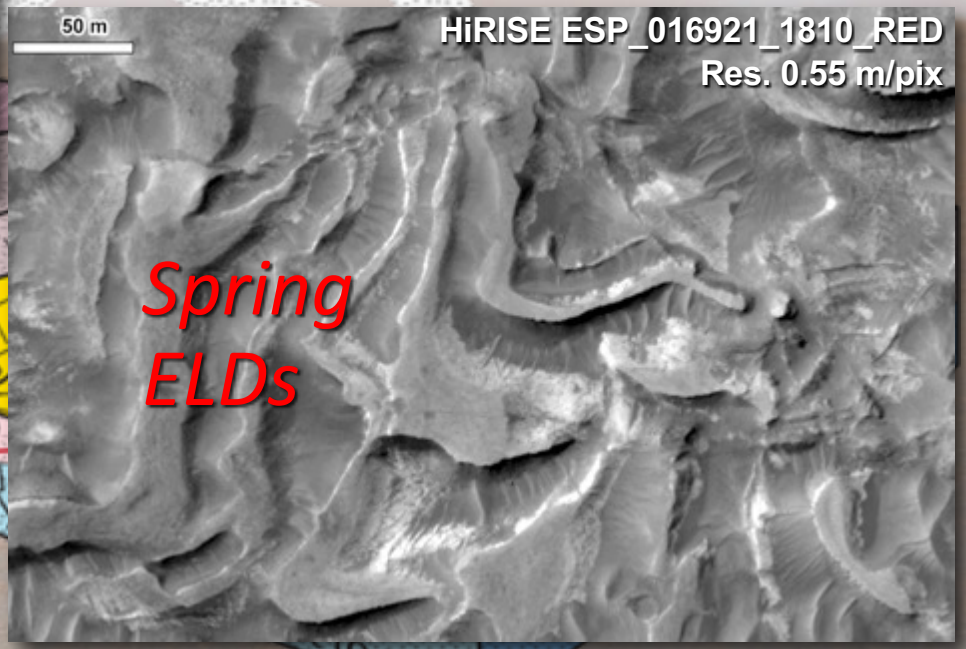


Spring deposits form in the craters, while in the plateau they are associated to playa deposition and aeolian reworking and re-deposition.

volution

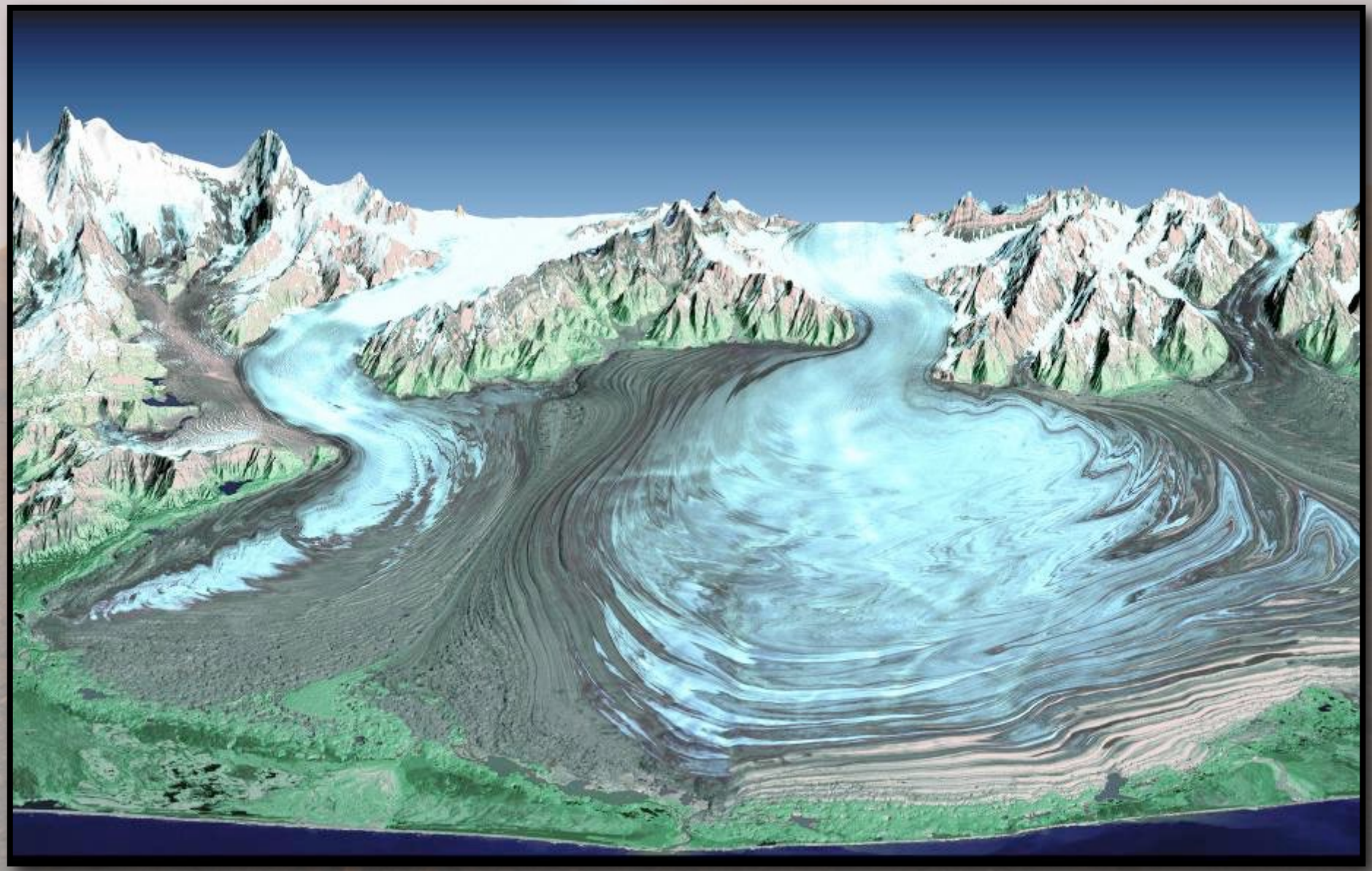


Early Hesperian

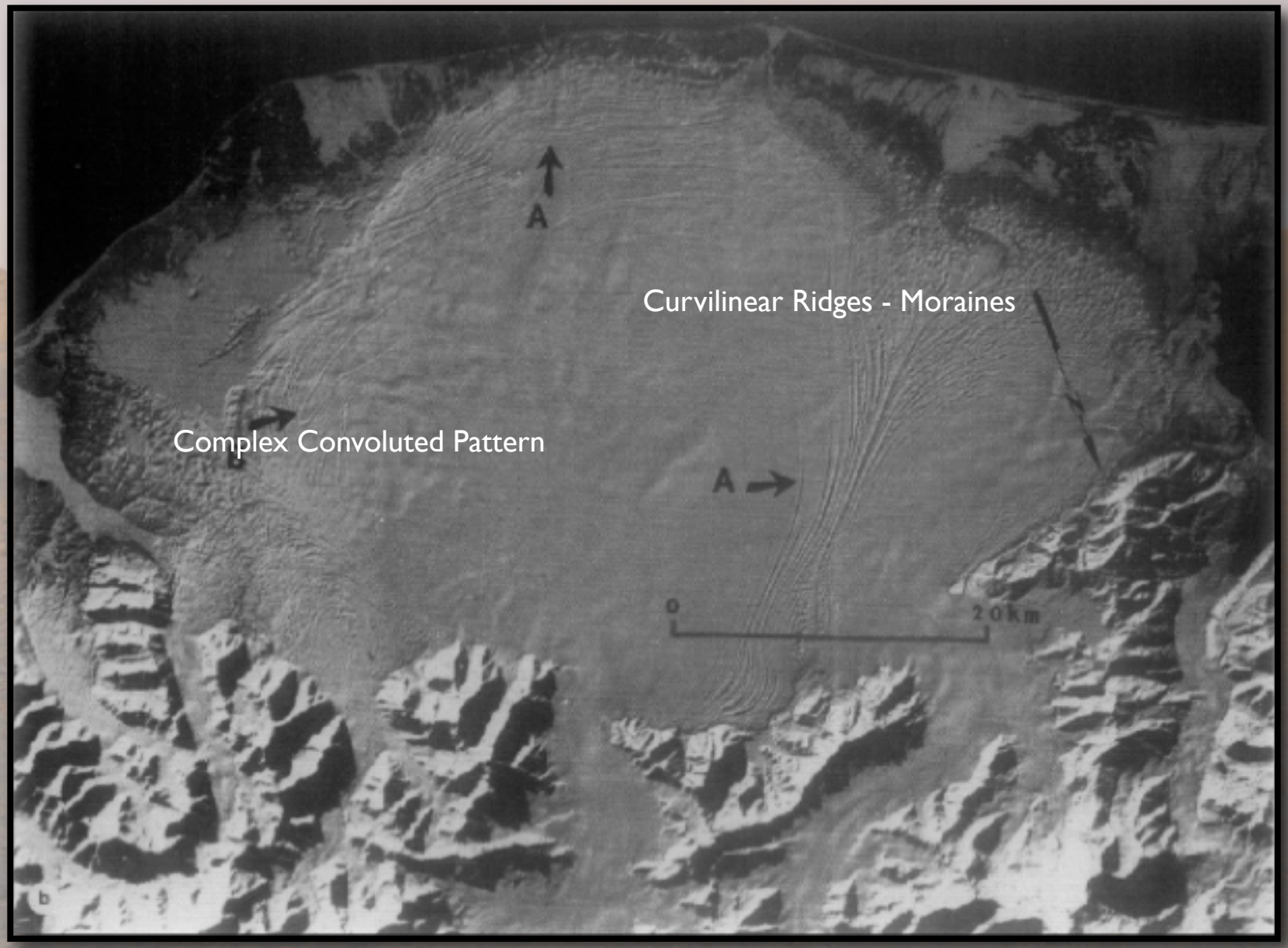


Spring deposits form in the craters, while in the plateau they are associated to playa deposition and aeolian reworking and re-deposition.

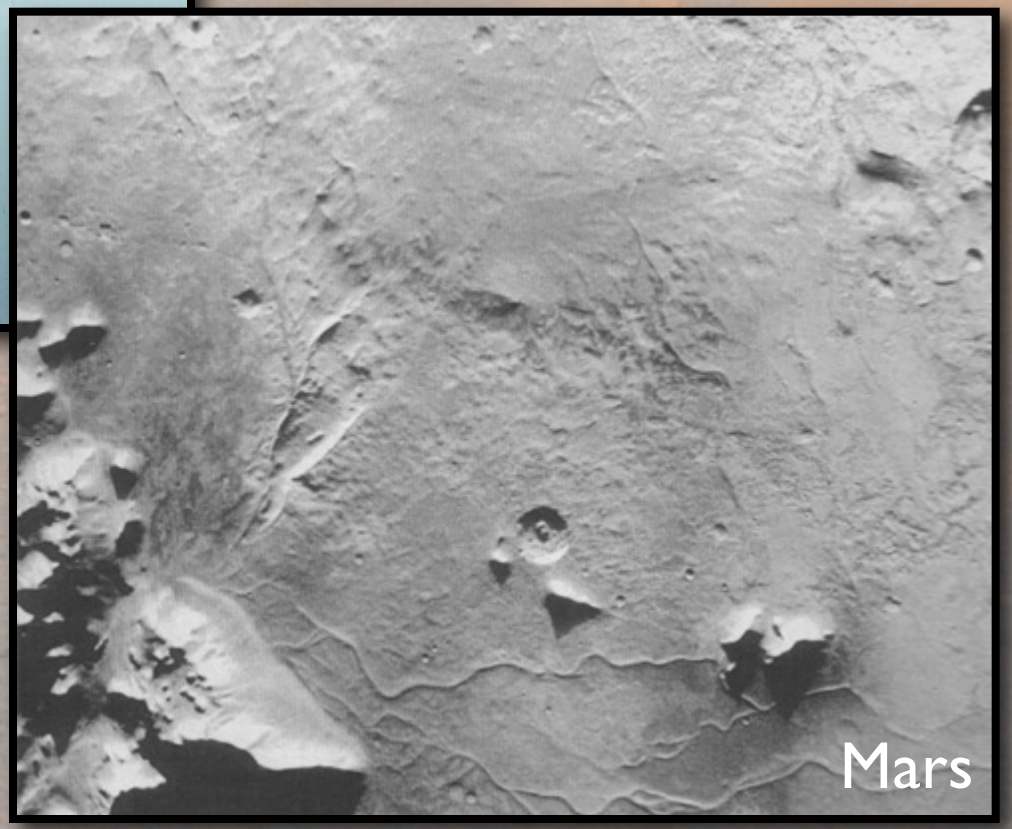
Glacial systems on Mars?
Earth (Malaspina glacier, Alaska)



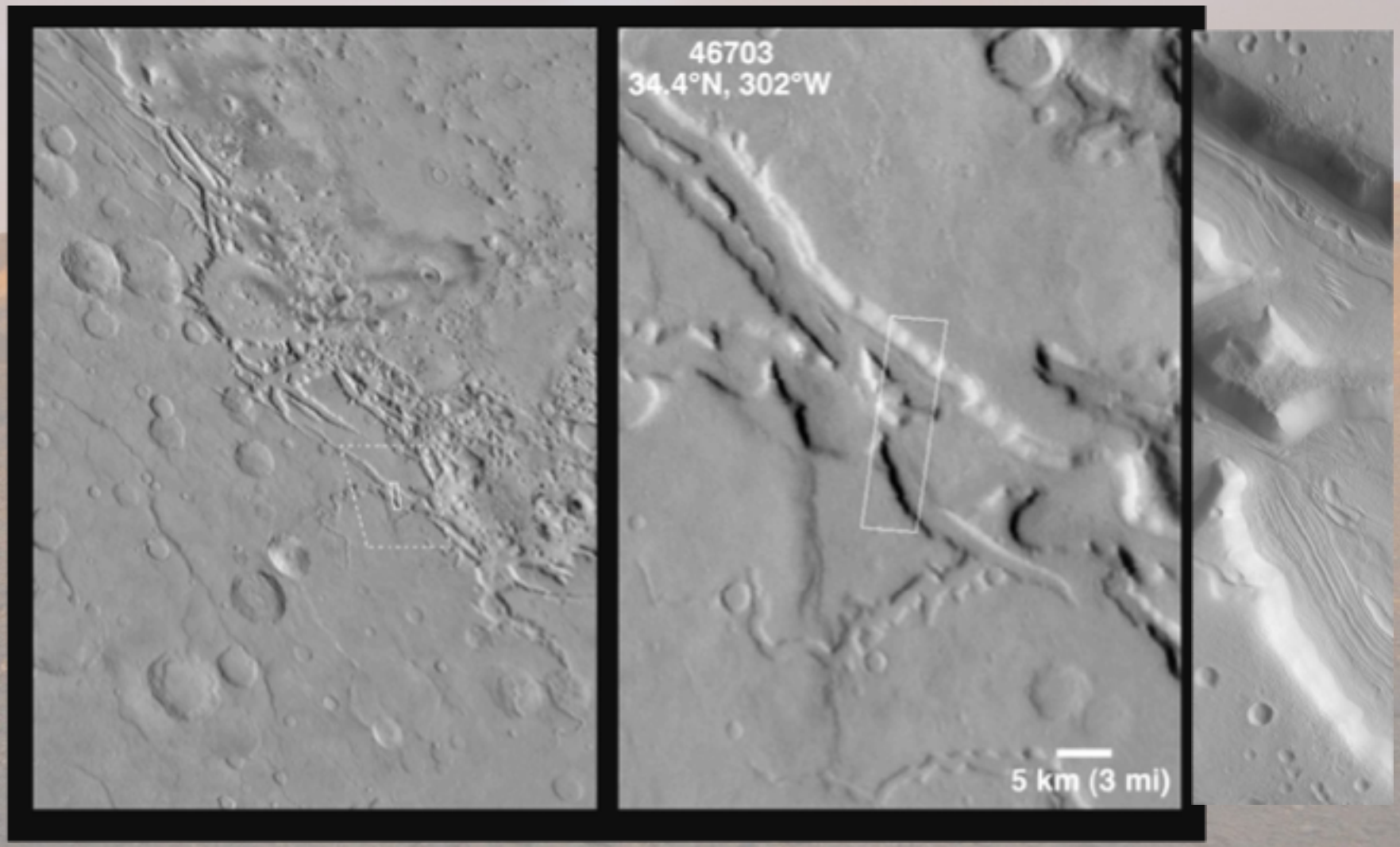
Glacial systems: Mars



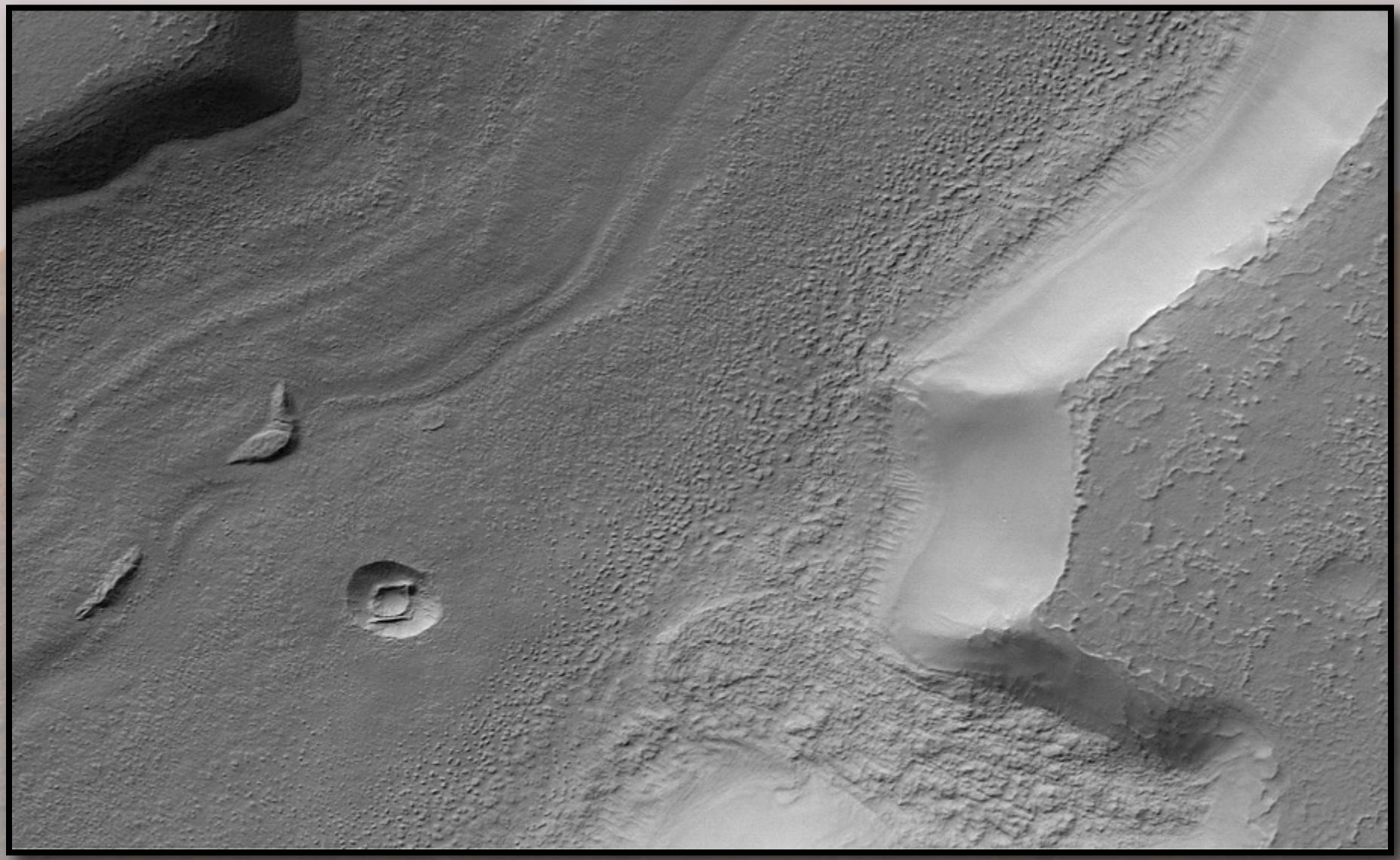
Glacial Systems
Subglacial zone: eskers

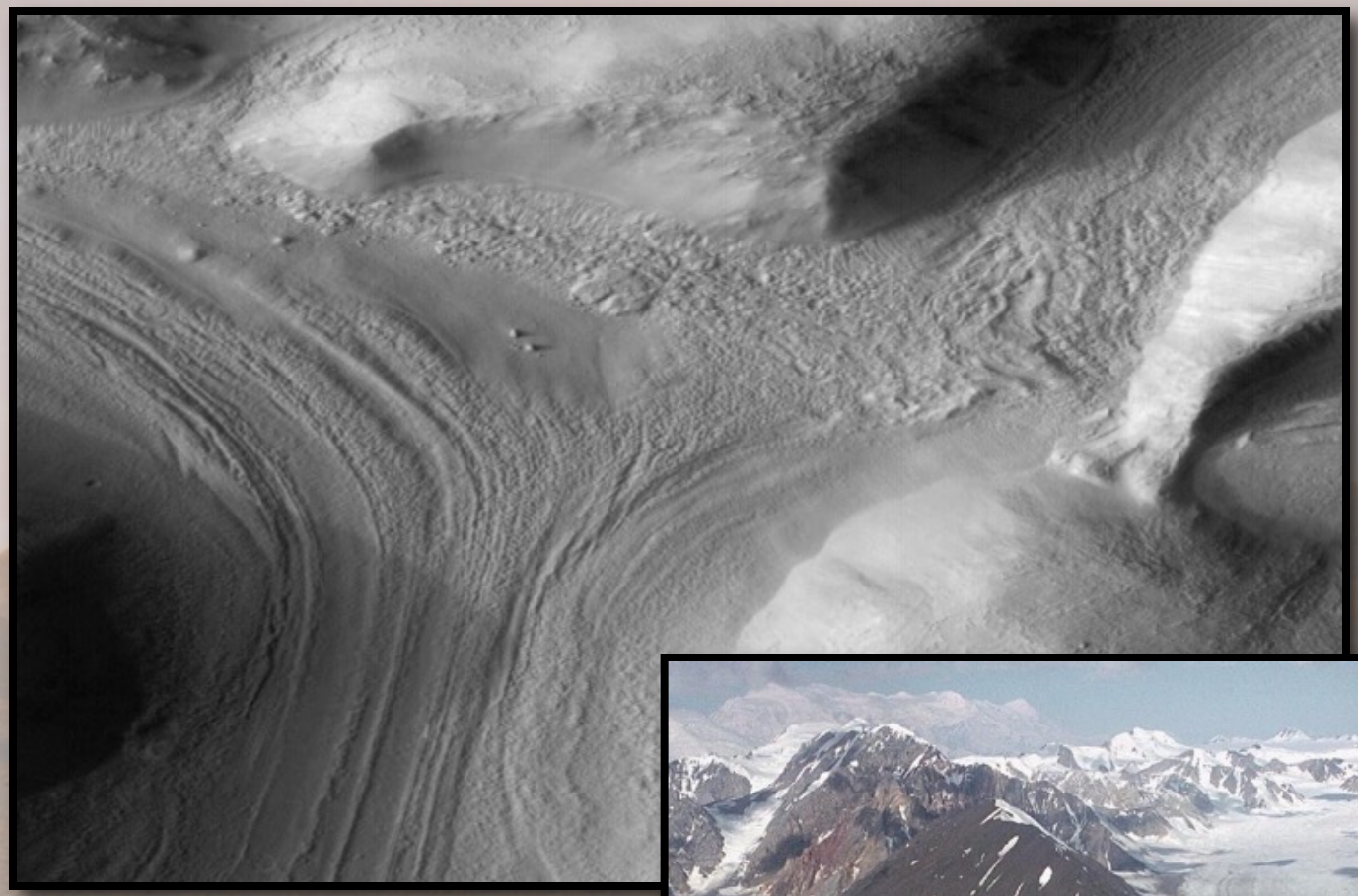


Glacial Systems:
Lineated valley fills



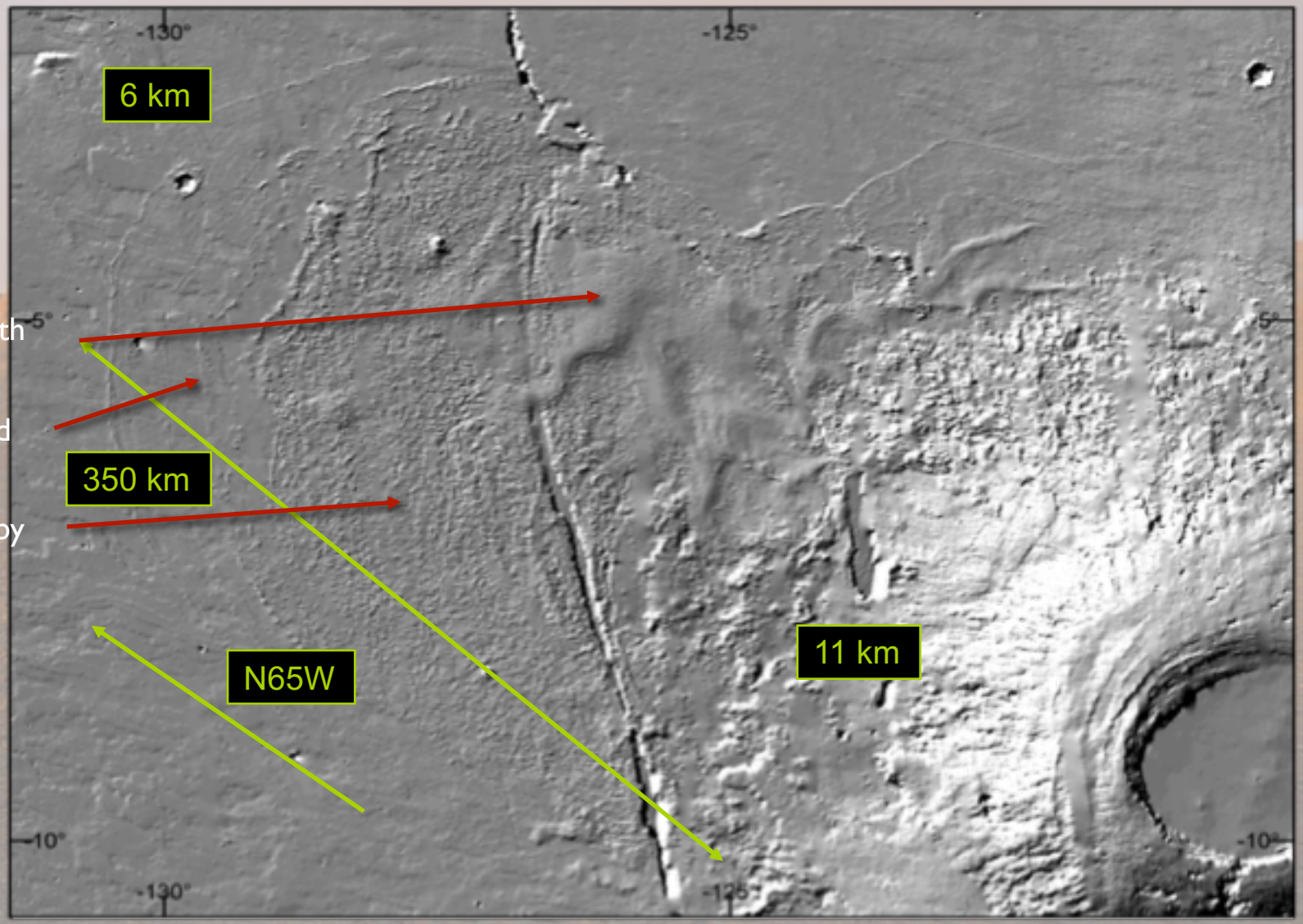
Glacial Systems:
Lineated valley fills





Yukon Glacier

Glacial Systems: Arsia Mons



Glacial Systems: Arsia Mons

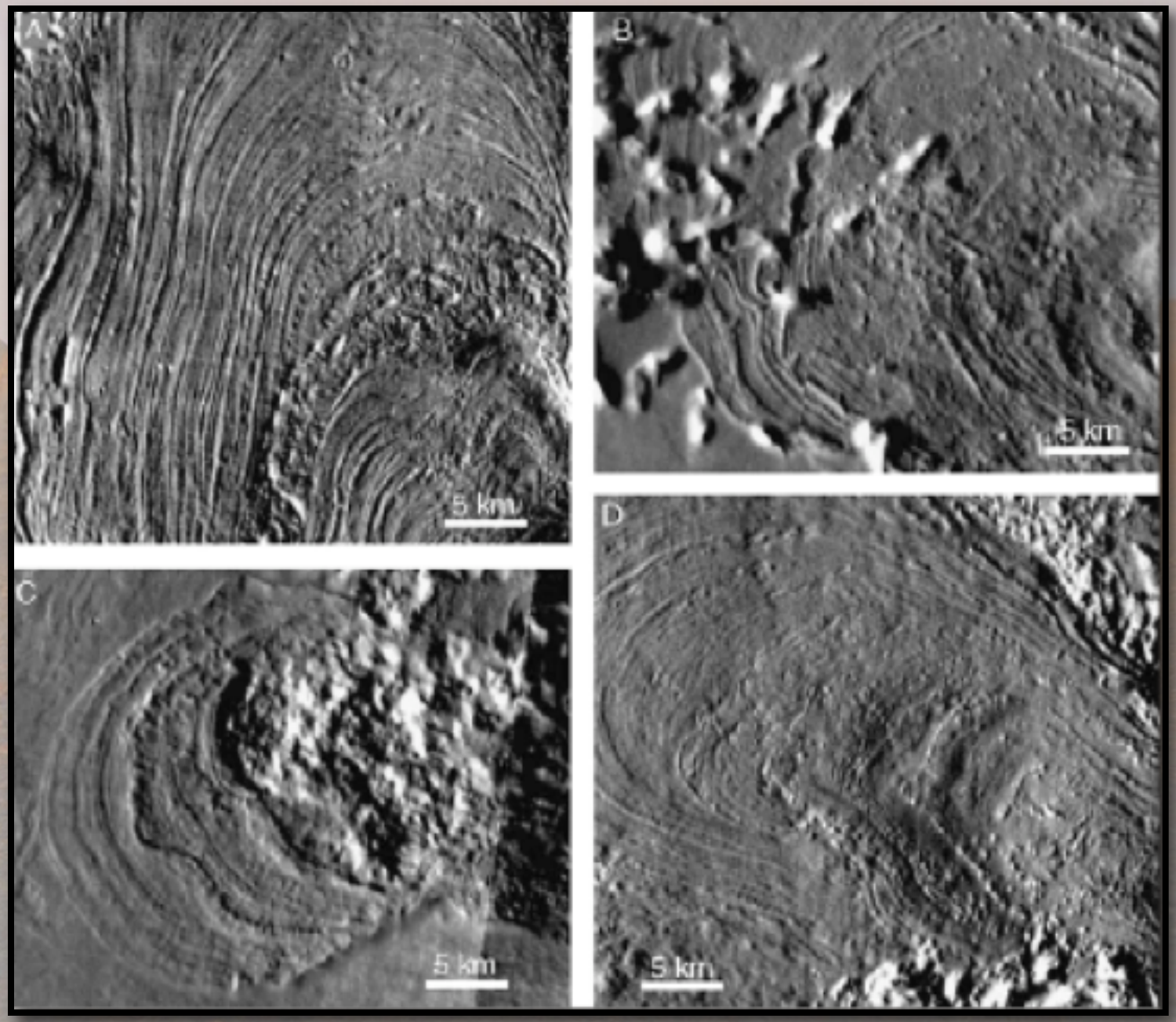
An **outer ridged facies:** interpreted as drop moraines formed at the margin of an ablating and predominantly receding cold-based glacier.

A **knobby facies:** interpreted as a sublimation till derived from in situ downwasting of ash rich glacier ice.

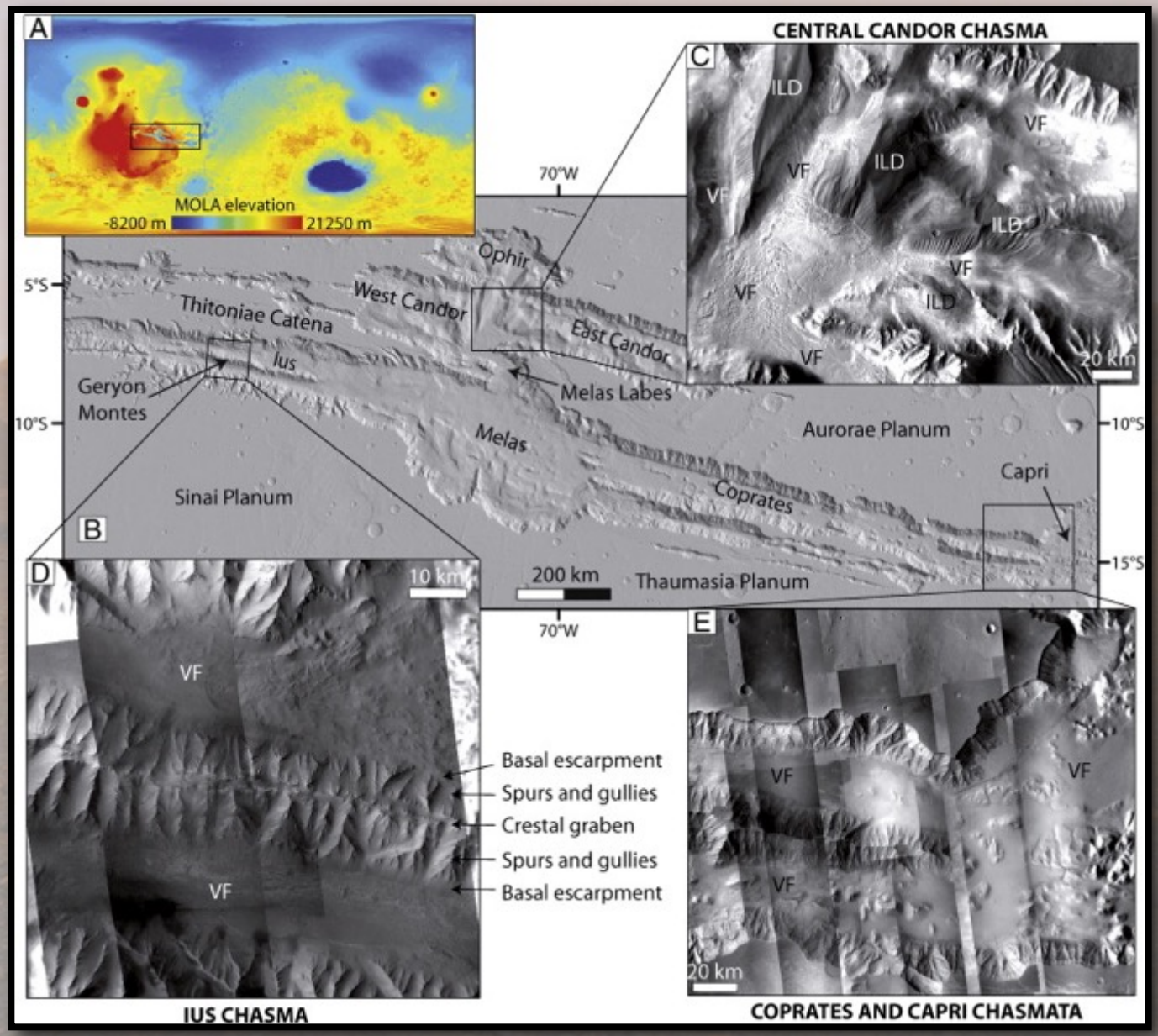
Convex-outward lobes with concentric parallel ridges: interpreted as rock-glacier deposits,
some of which may still be underlain by a core of glacier ice.

The western flank of Arsia Mons was occupied by an extensive mountain glacial system accumulating on, and emerging from, the upper slopes of the volcano and spreading downslope to form a piedmont-like fan.

Glacial Systems: Olympus Mons

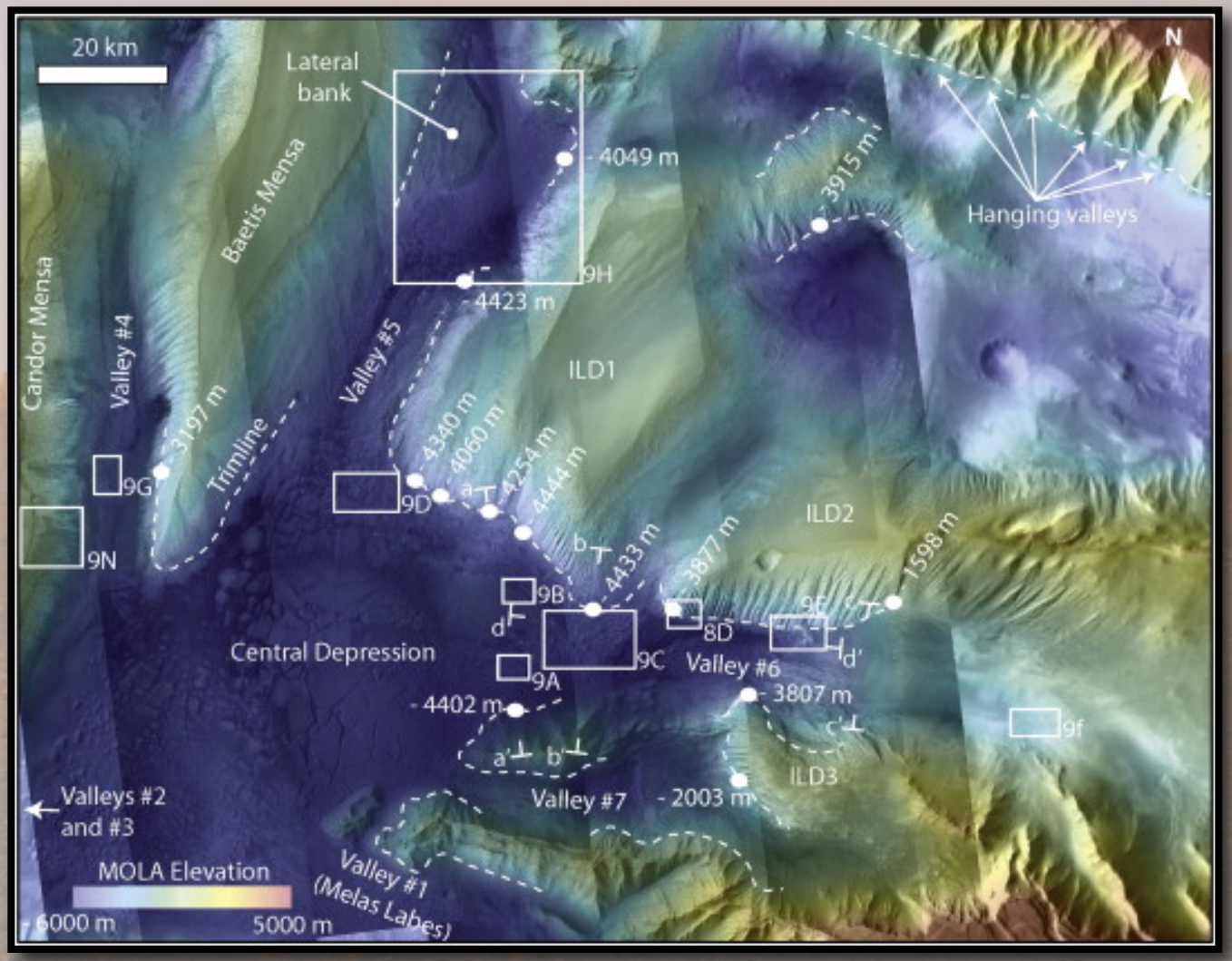


Glacial Systems: Fossil ice in Valles Marineris?



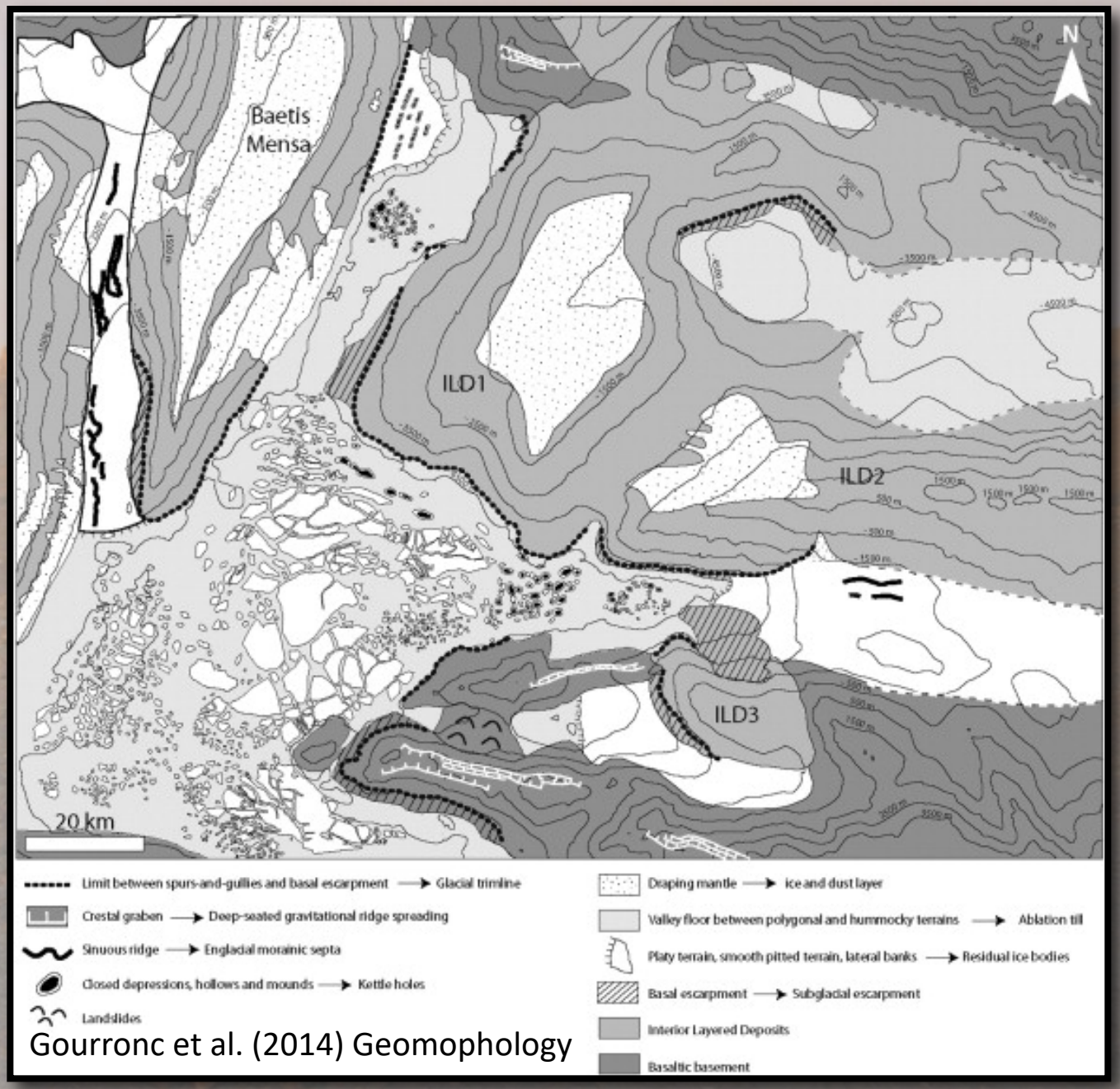
Gourronc et al. (2014) Geomophology

Glacial Systems: Central Candor Chasma



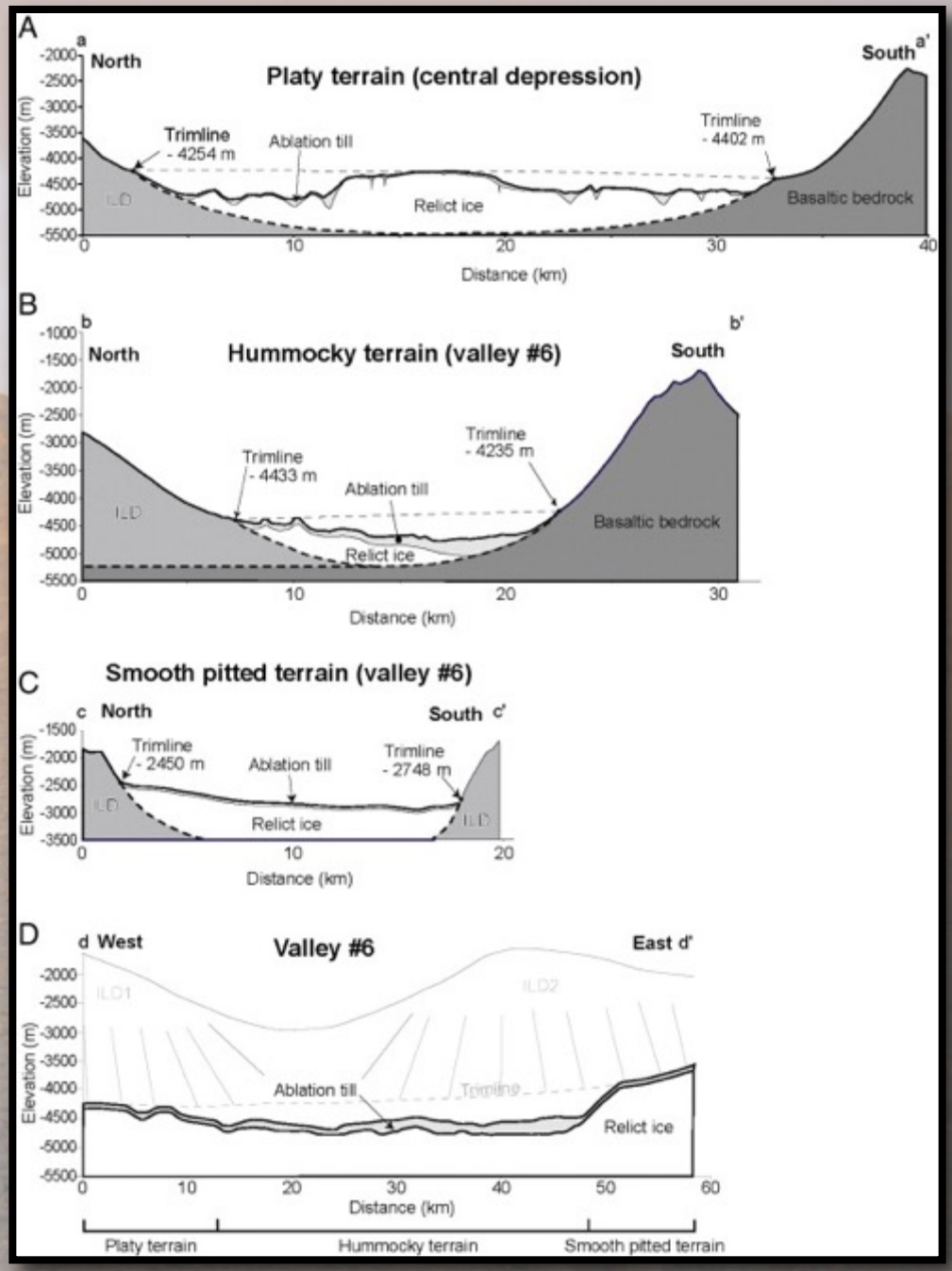
Gourronc et al. (2014) Geomophology

Glacial Systems: Central Candor Chasma



Gourronc et al. (2014) Geomophology

Glacial Systems: Central Candor Chasma



Gourronc et al. (2014) Geomophology

Mars Periglacial Features

- The term periglacial was first introduced to describe the climatic and geomorphic conditions peripheral to the late Pleistocene ice sheets (on Earth!)
- The term has been generalized to include those environments where climatic conditions result in severe frost action that dominates geomorphic processes
- Permafrost is not a prerequisite, but it is practically ubiquitous in the periglacial environment
- Glacial vs. Periglacial
  - Several landforms suggesting of presence of ground ice at various levels
  - Controversy over a variety of landforms, either interpreted as glacial in origin or periglacial
  - Main point of difference: glacier vs. rock glacier

Mars Periglacial Features: Contraction cracks

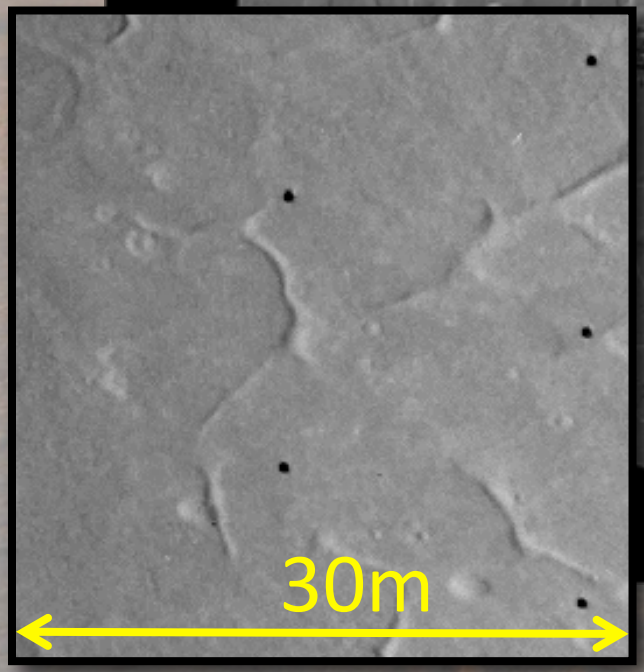
- A tensile fracture resulting from thermal stresses in frozen ground.

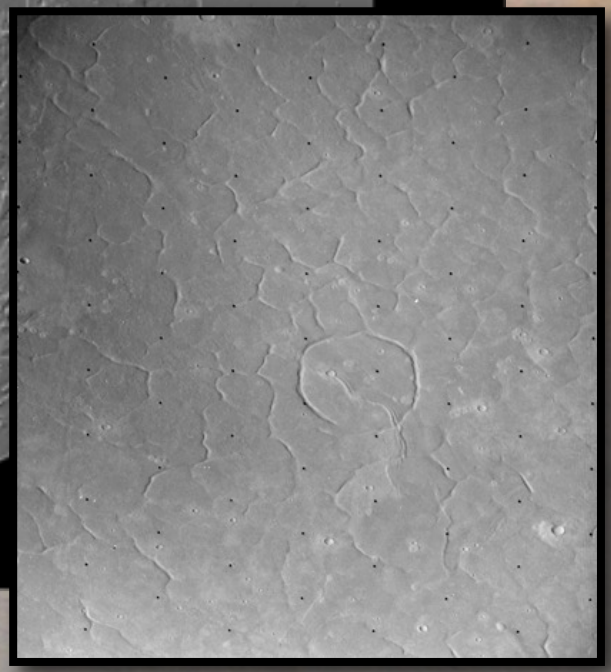
- COMMENT: Tensile stresses caused by a reduction in ground temperature are probably a major factor in thermal contraction cracking, but it is usually difficult to prove that desiccation is not also involved. Ice wedges, sand wedges, soil wedges and ice veins form in thermal contraction cracks.

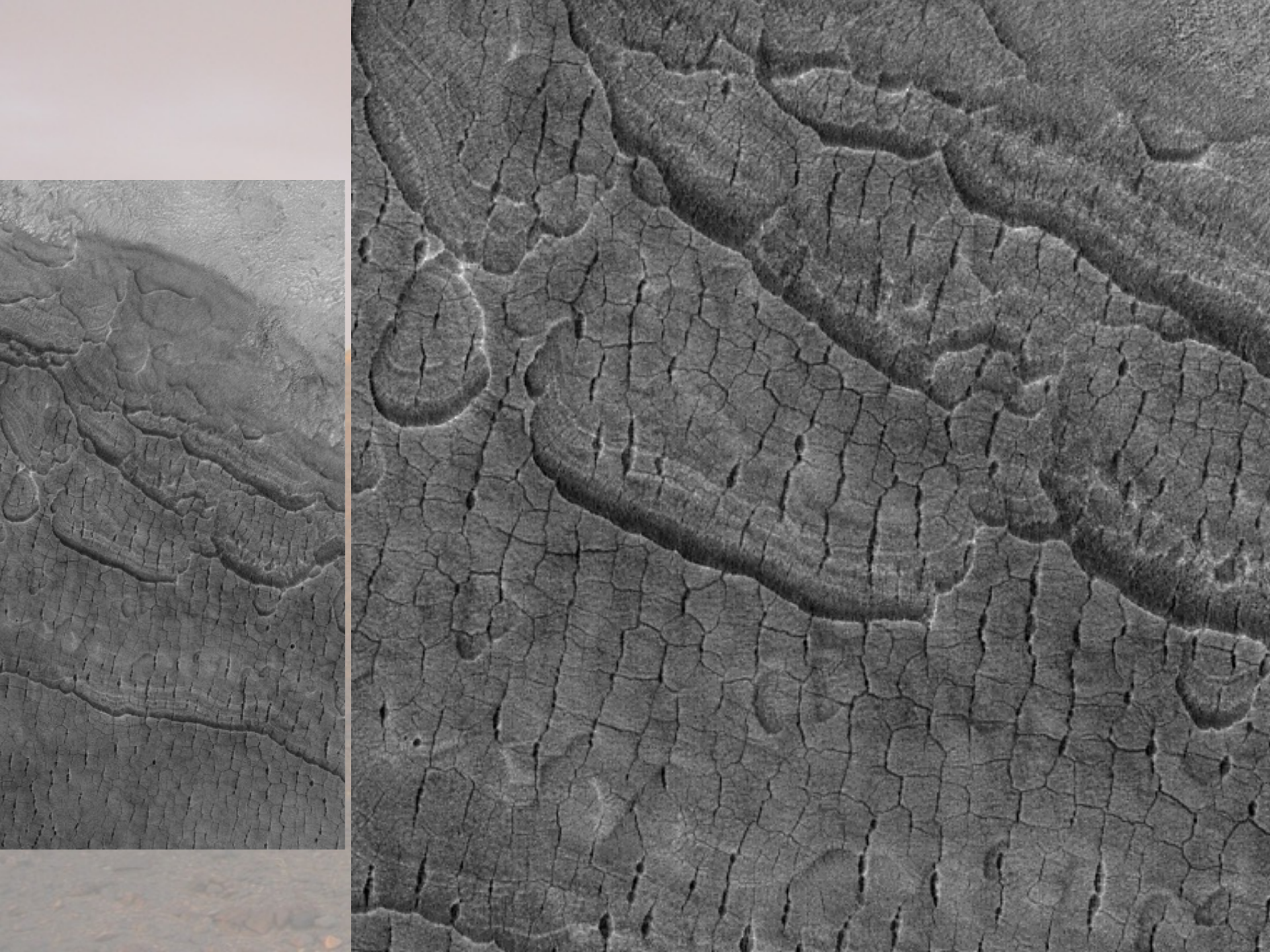
- SYNONYMS: frost crack, frost fissure, and (not recommended) frost wedge, contraction crack.

Mars Periglacial Features: Contraction cracks

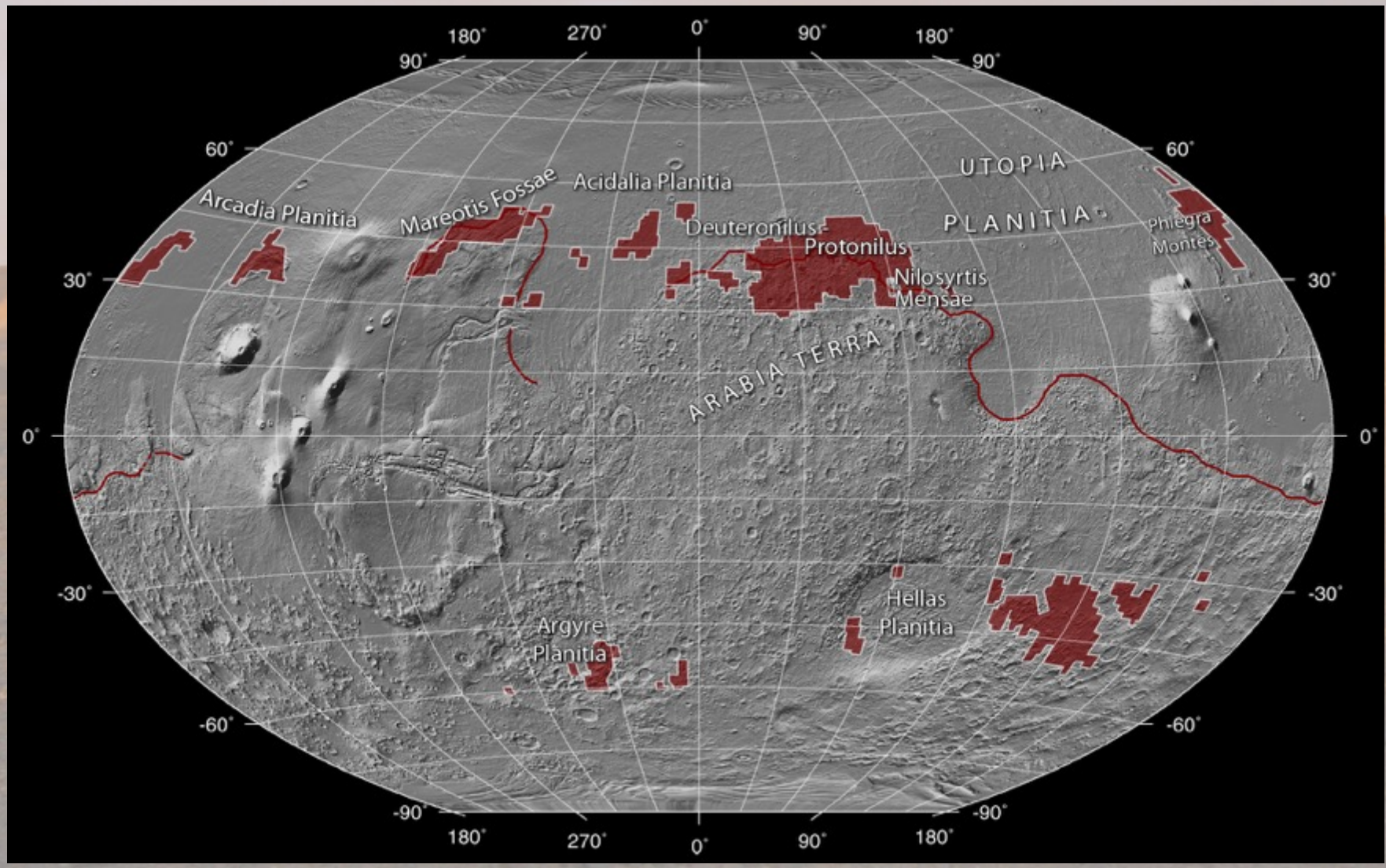
Mars Periglacial Features:
Giant Polygons on Mars







Mars Periglacial Features:
Rock Glaciers



Mars Periglacial Features: Rock Glaciers

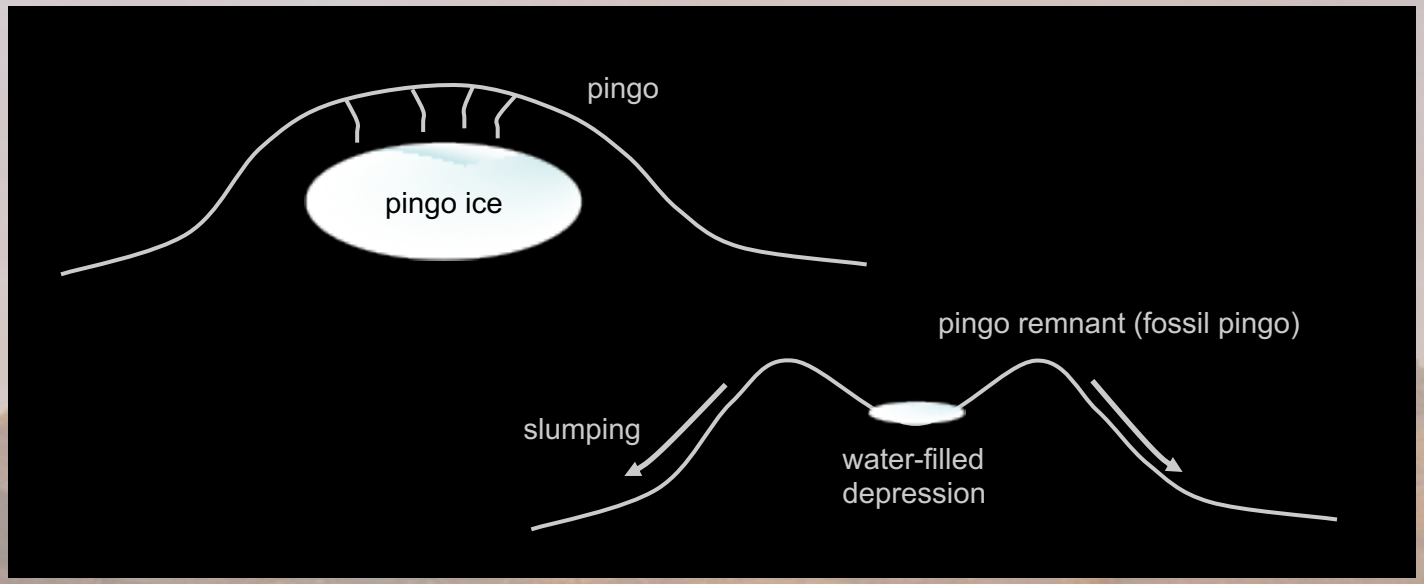
Rock glaciers are landforms of blocky detritus which may extend outward and downslope from talus cones or from glaciers or the terminal moraines of glaciers. Their growth and formation is subject to some debate, with three main theories:

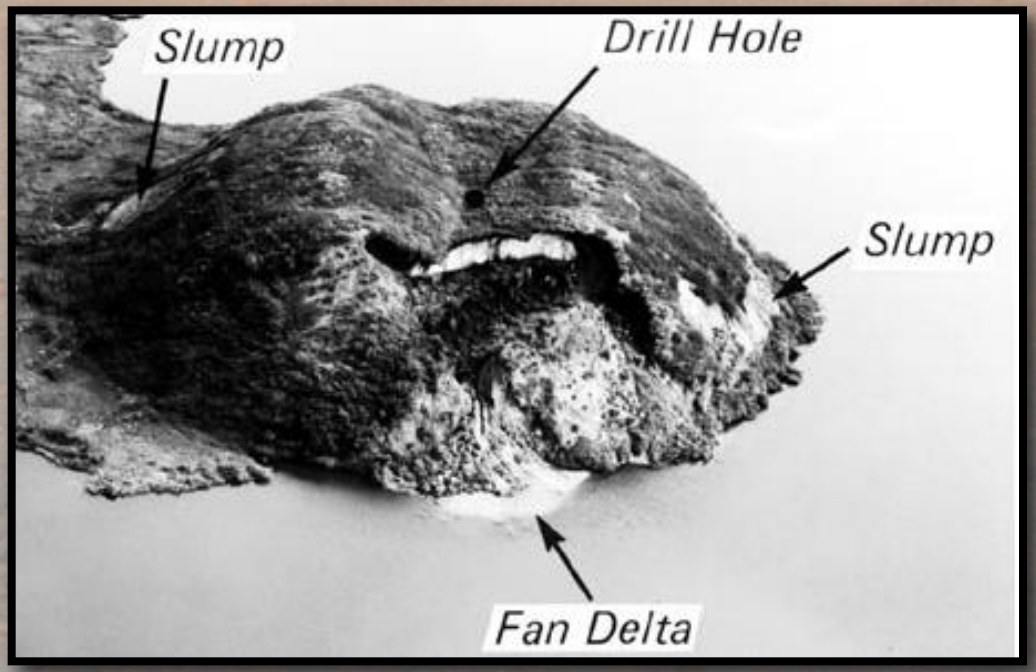
- They originated from cirque glaciers and contain a glacial ice core or interstitial ice between the rocks which causes the formation to move downslope;
- A permafrost origin, which implies that the features are related to permafrost action rather than glacial action;
- A mass wasting or landslide origin which does not require the presence of ice and suggests a sudden catastrophic origin with little subsequent movement.

Mars Periglacial Features:
Rock Glaciers

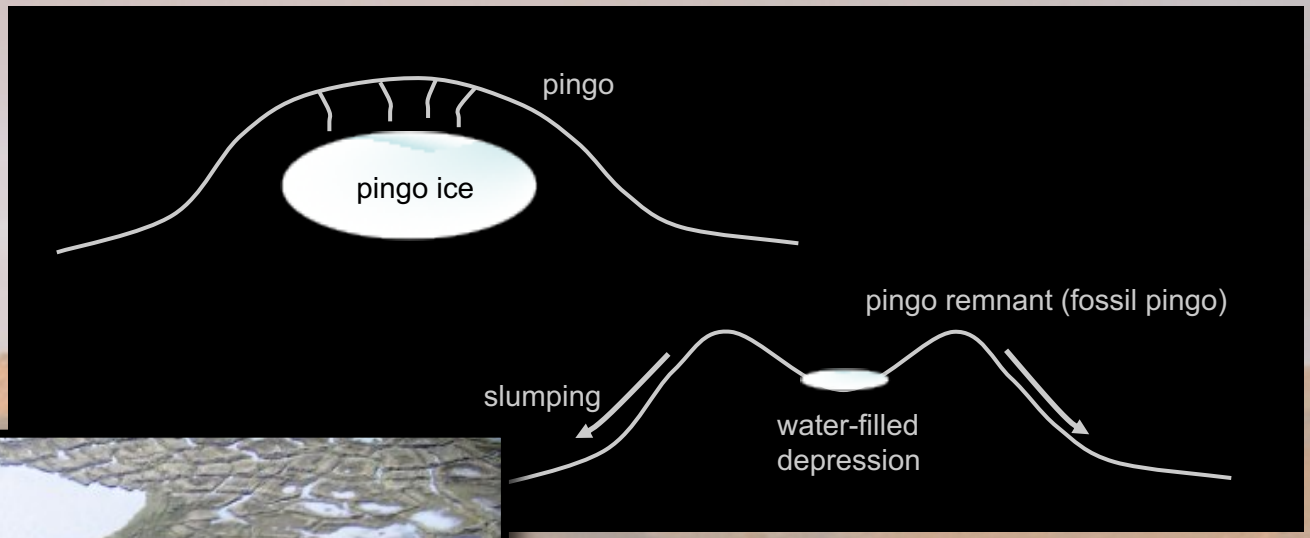
Mars Periglacial Features: Pingos & Mounds

Mars Periglacial Features: Pingo & fossil pingos

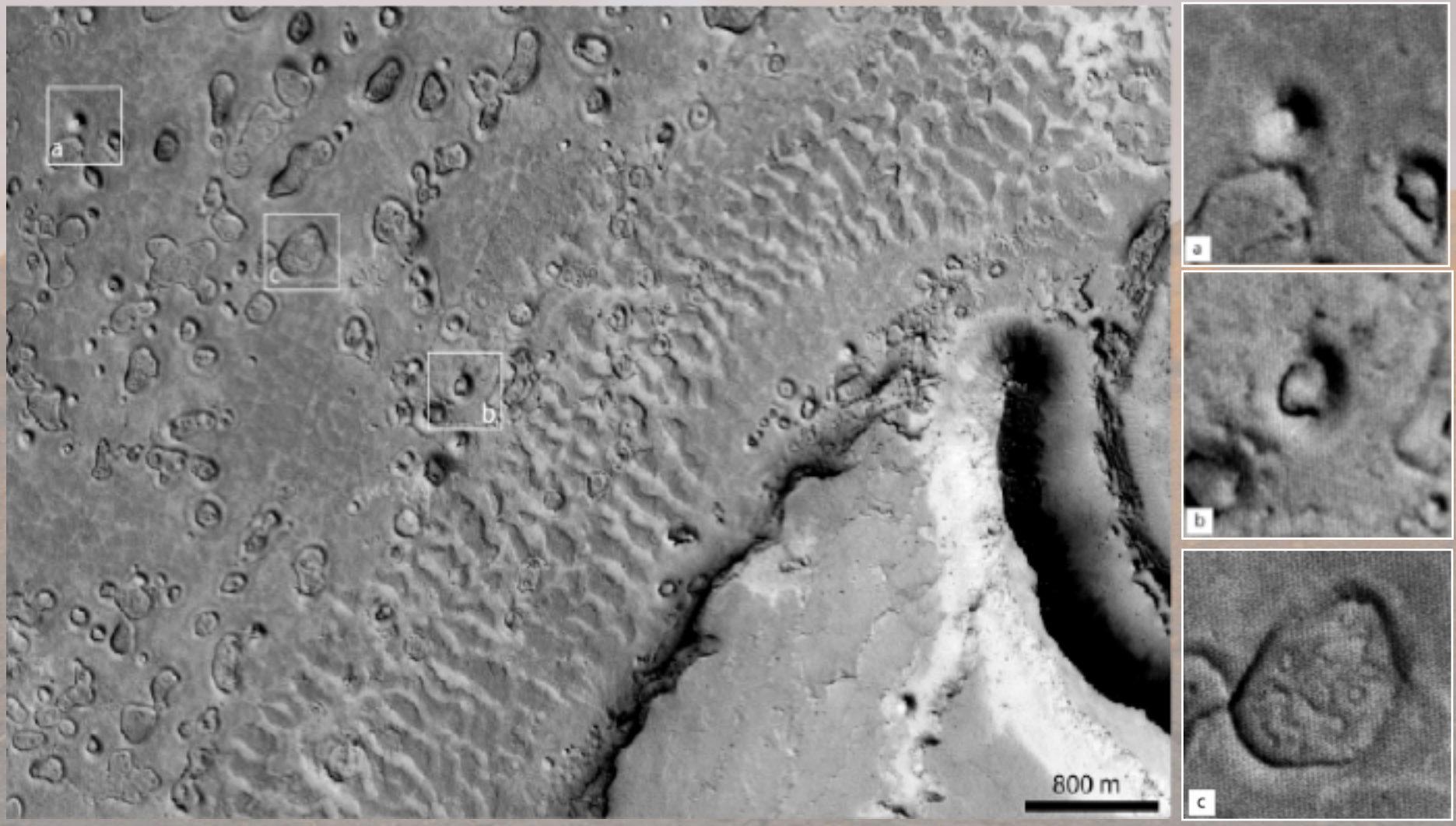




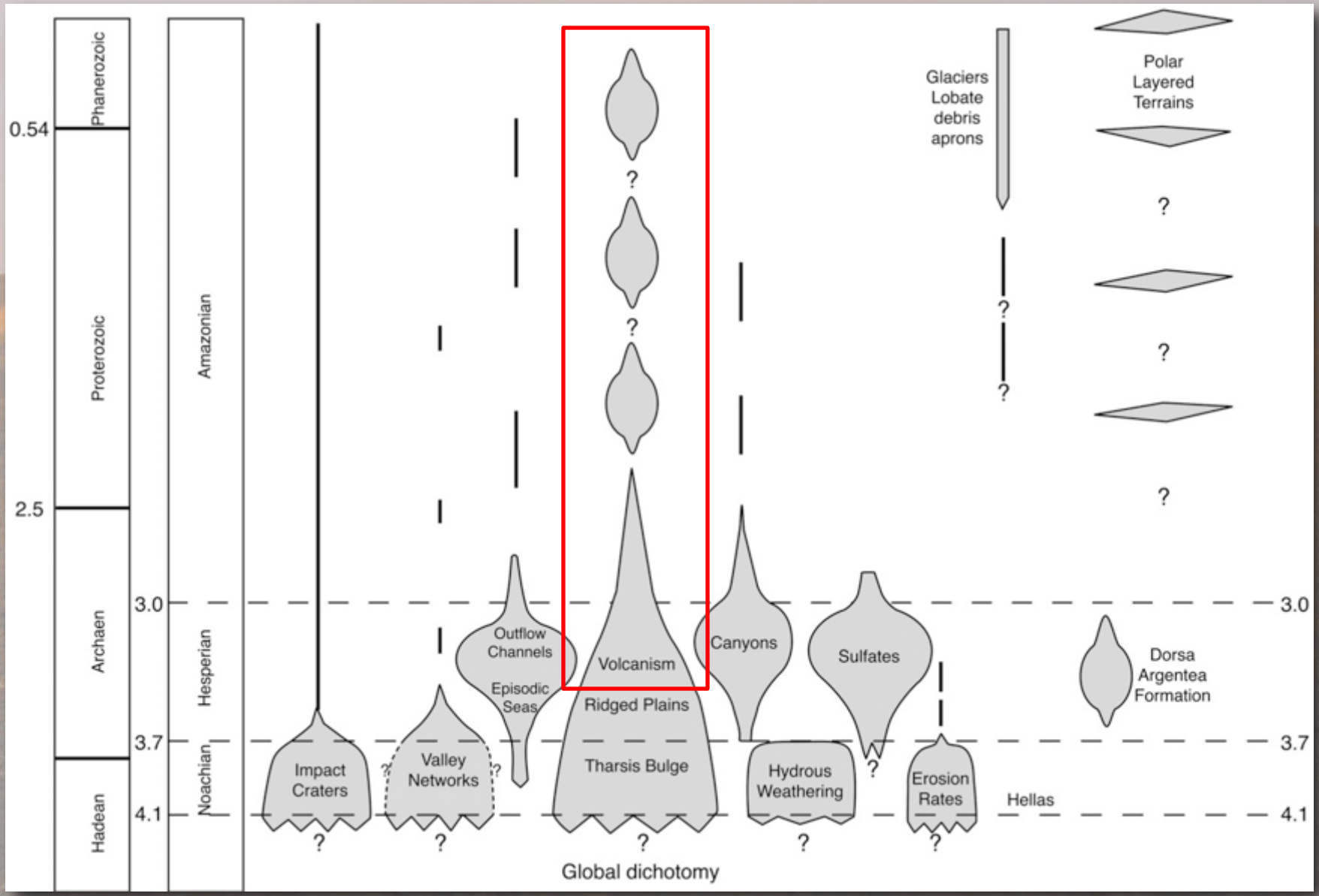
Mars Periglacial Features: Pingo & fossil pingos



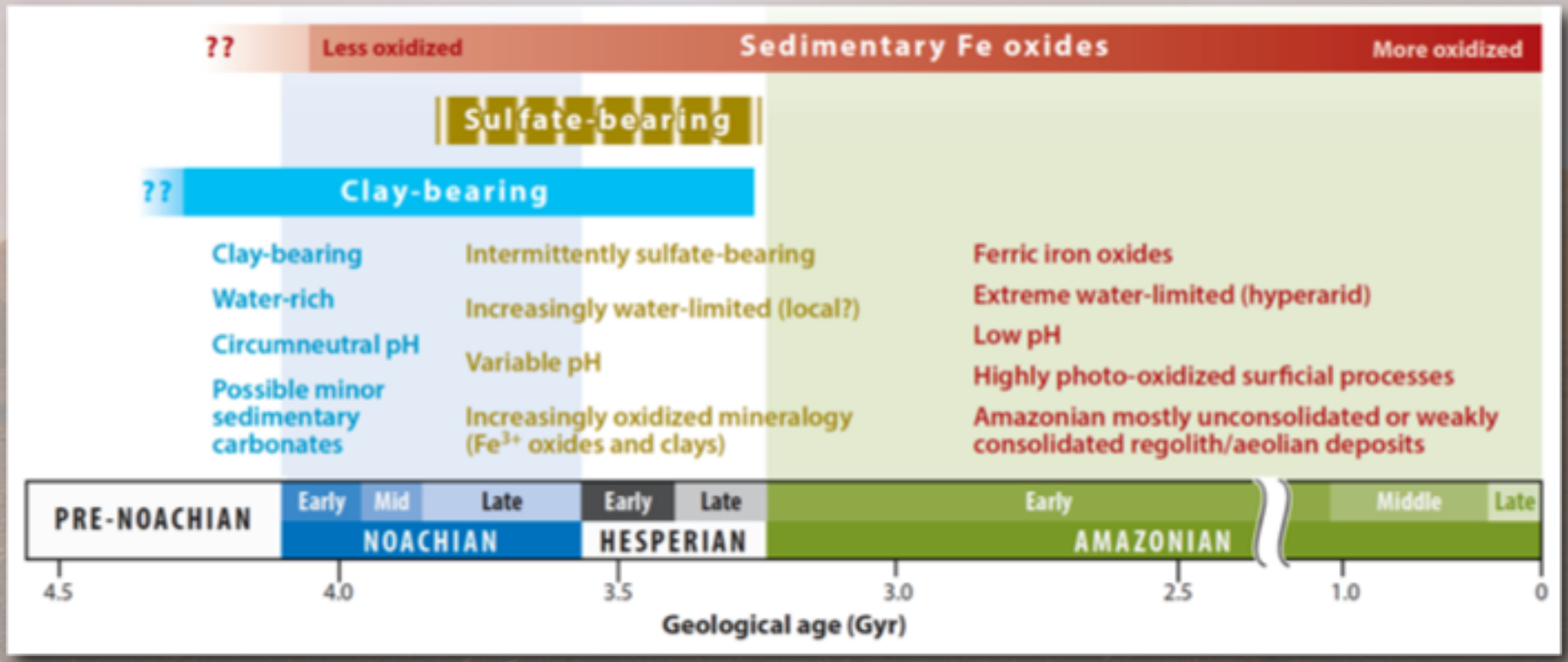
Mars Periglacial Features: Pingos on Mars?



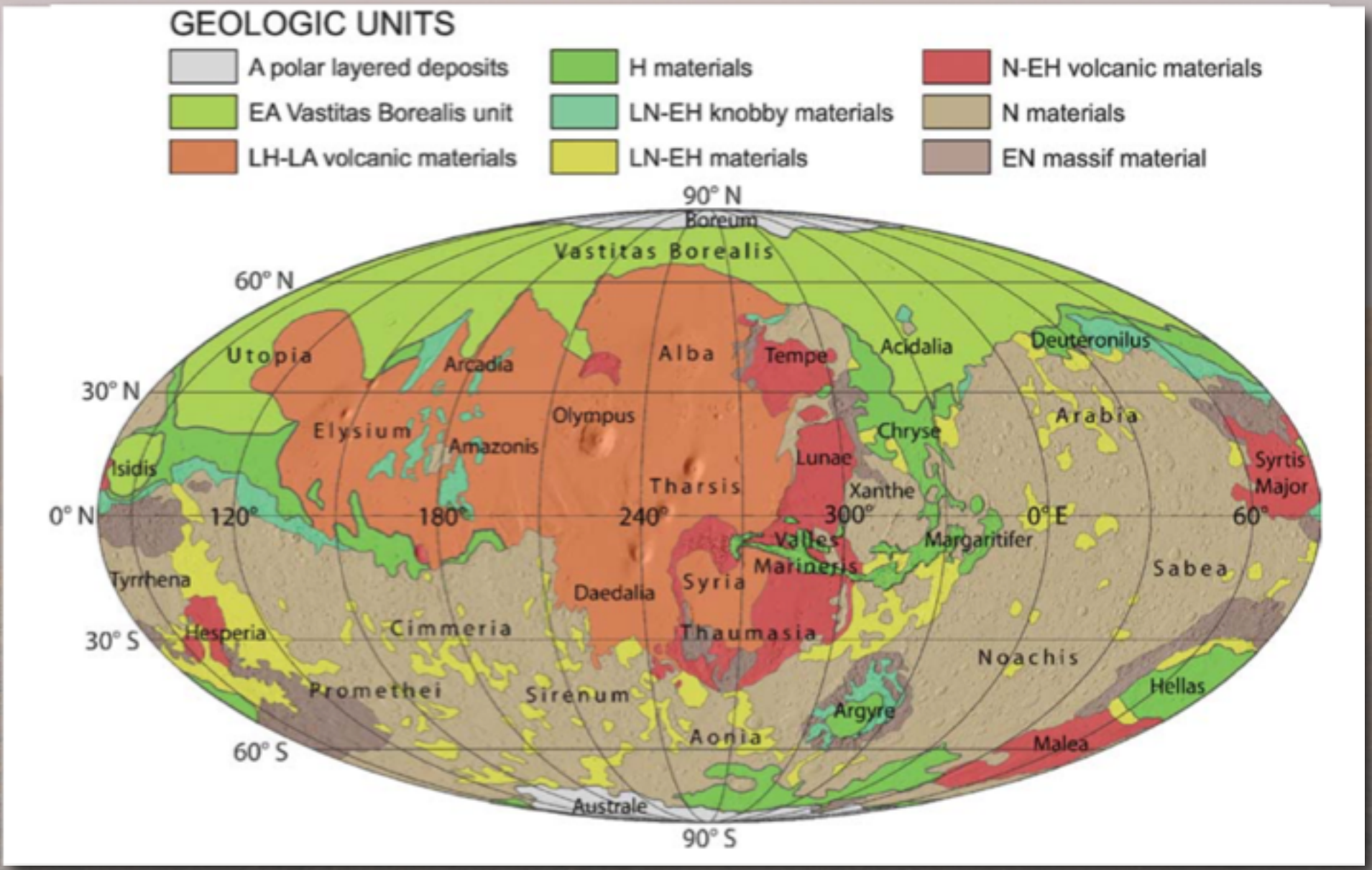
Geological History of Mars



Sedimentary mineralogical evolution



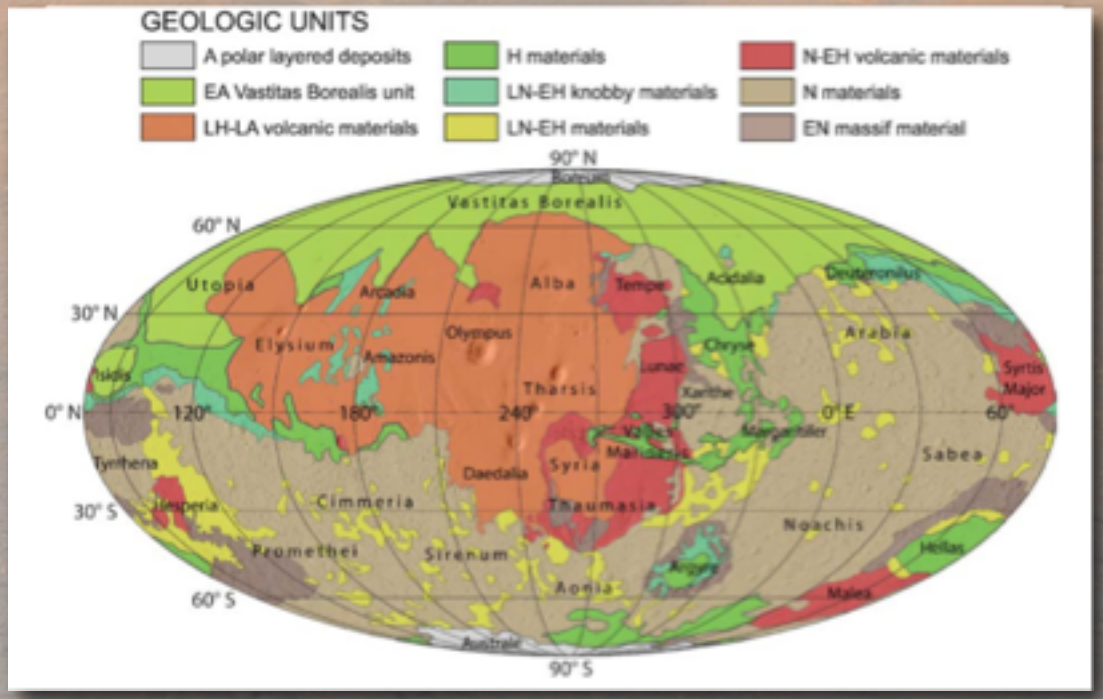
Mc Lennan et al., 2019 - Annu. Rev. Earth Planet. Sci. 2019. 47:91–118



Source: *Nimmo and Tanaka (2005), Annu. Rev. Earth Planet. Sci.. 33:133–6*

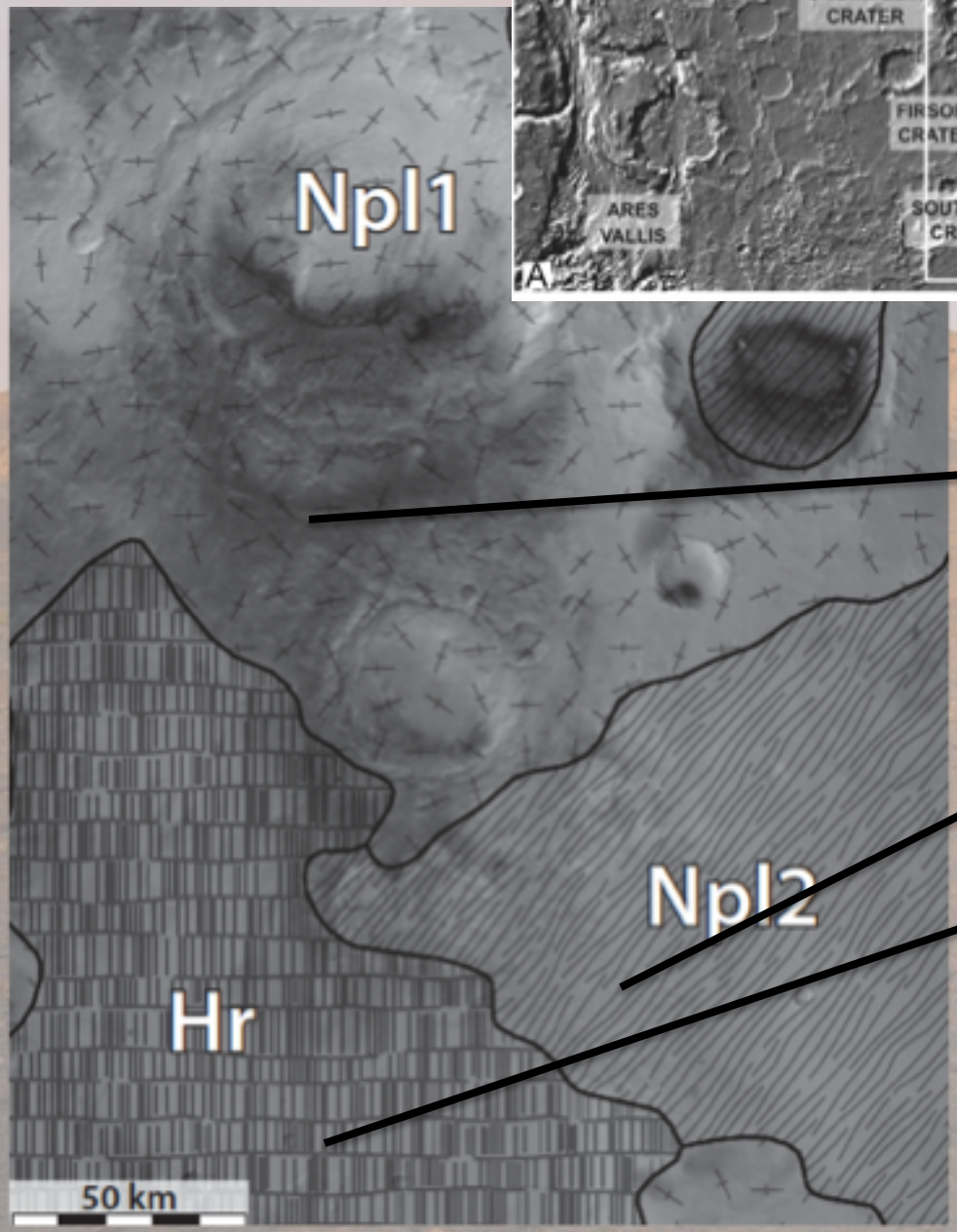
Practical exercise: starting from the global geological map of Mars prepare a detailed geological map of a region (100km x 100km) of your choice using HiRISE images downloadable from Google Earth:

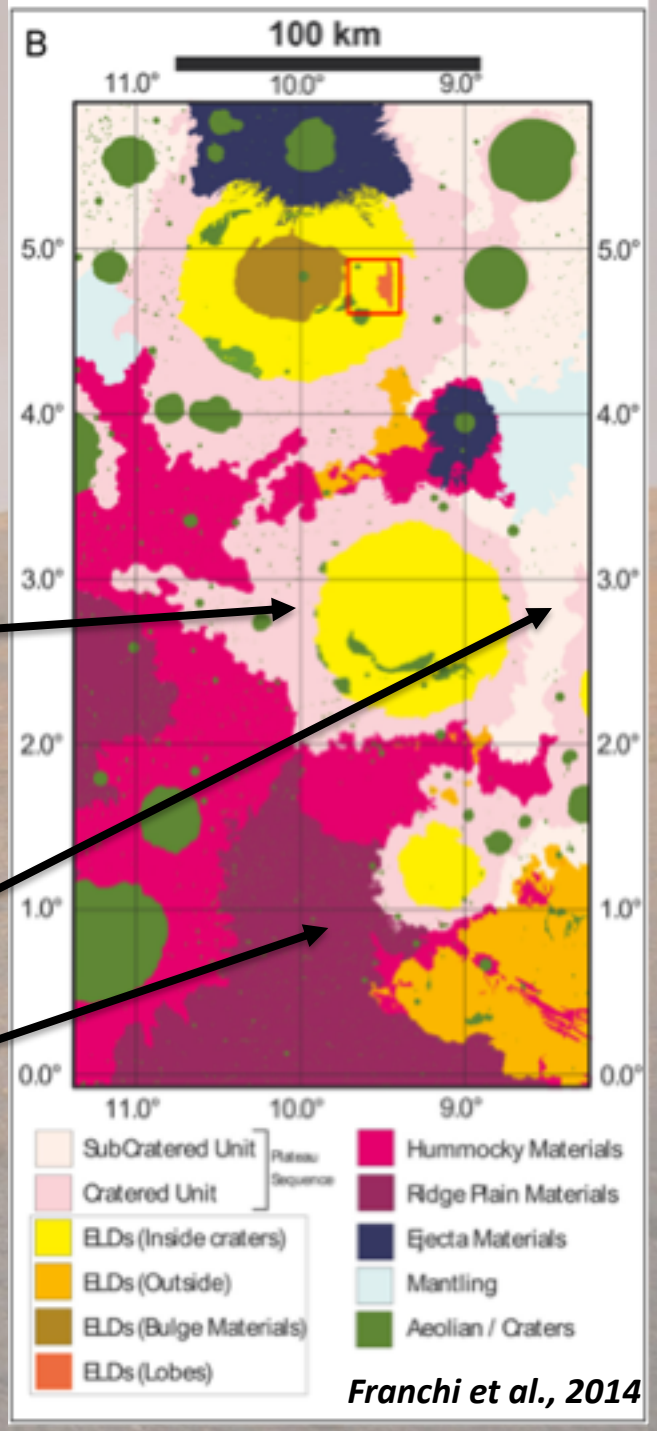
- Import the Geological Map of Mars in QGIS
- Overlap georeferenced HiRISE images
- Follow unit boundaries and re-draw YOUR map at high resolution.
- Highlight ineteresting morphological and sedimentary features.



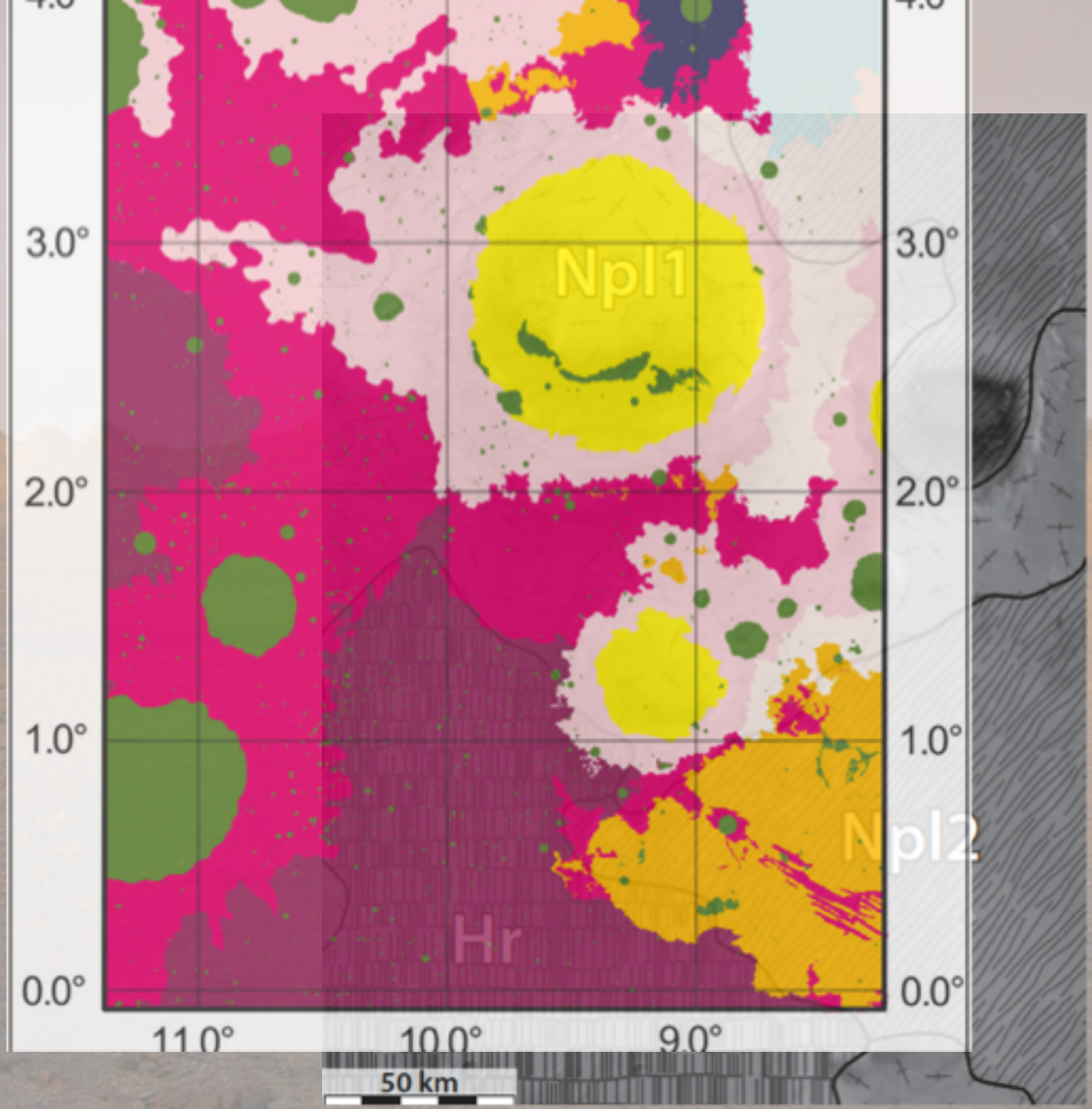
Source: *Nimmo and Tanaka (2005), Annu. Rev. Earth Planet. Sci.. 33:133–6*

Pondrelli et al., 2015





Franchi et al., 2014


4.0°
3.0°
2.0°
1.0°
0.0°
11.0°
10.0°
9.0°
Npl1
Npl2
Hr
50 km


THANK YOU