



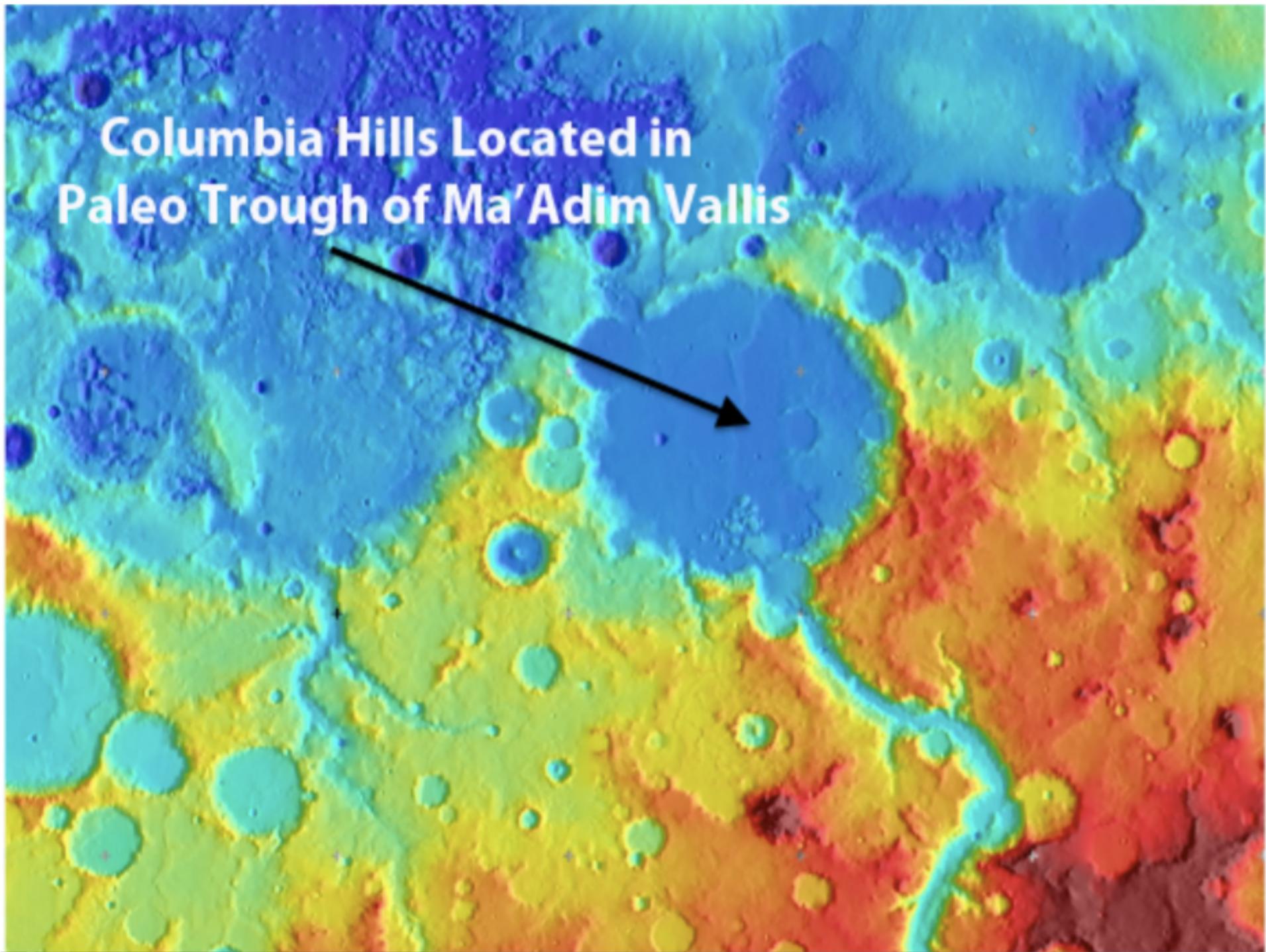
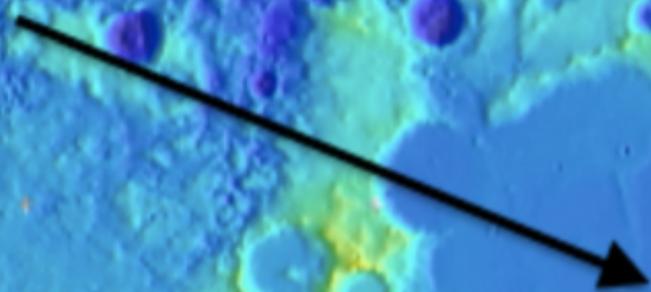
*New Destinations in the Columbia Hills and
Extended Mission Science in Gusev Crater*

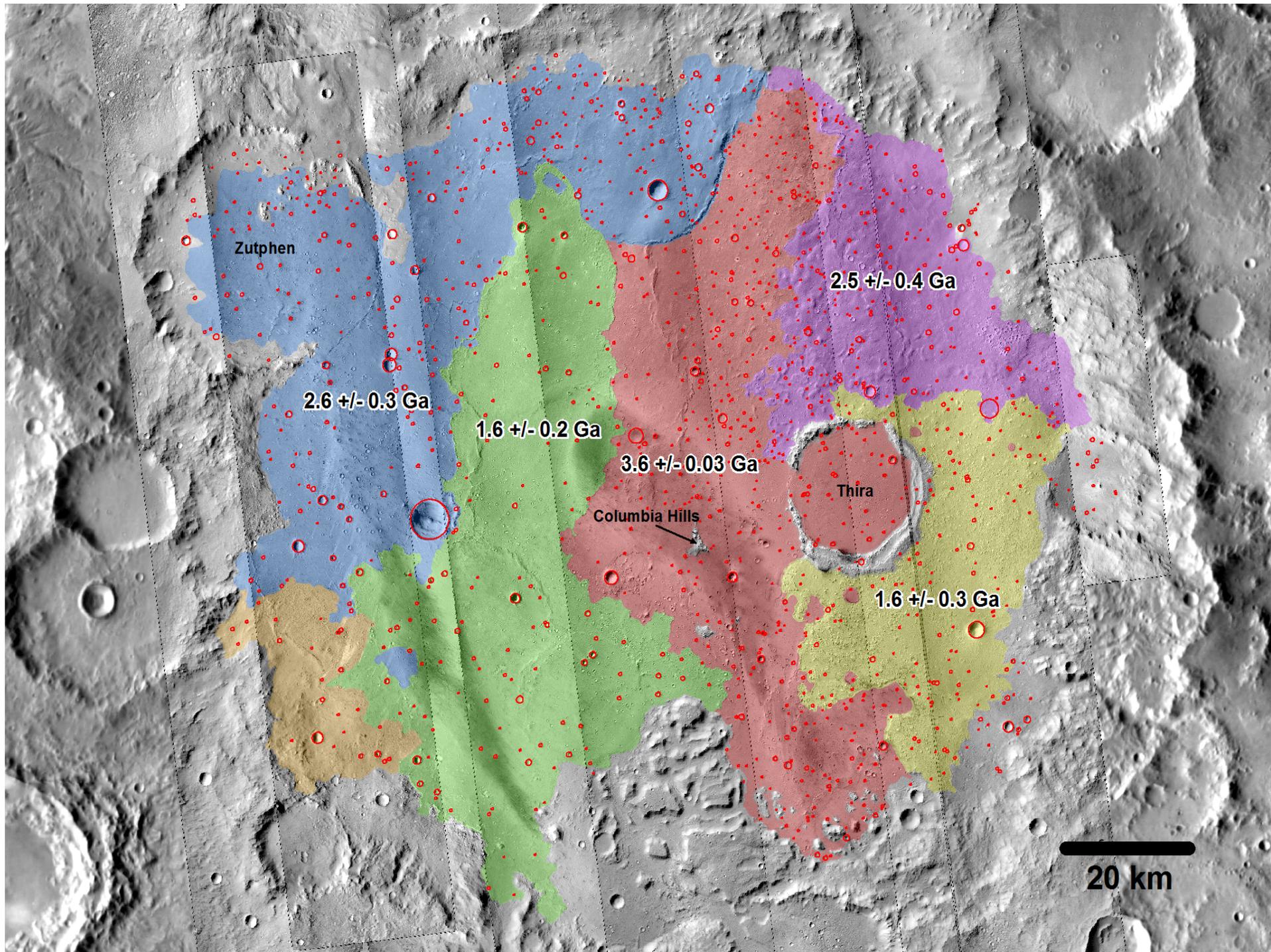
Jim Rice, Steve Ruff, and Alex Longo

*Mars 2020 3rd Landing Site Workshop
February 9, 2017*

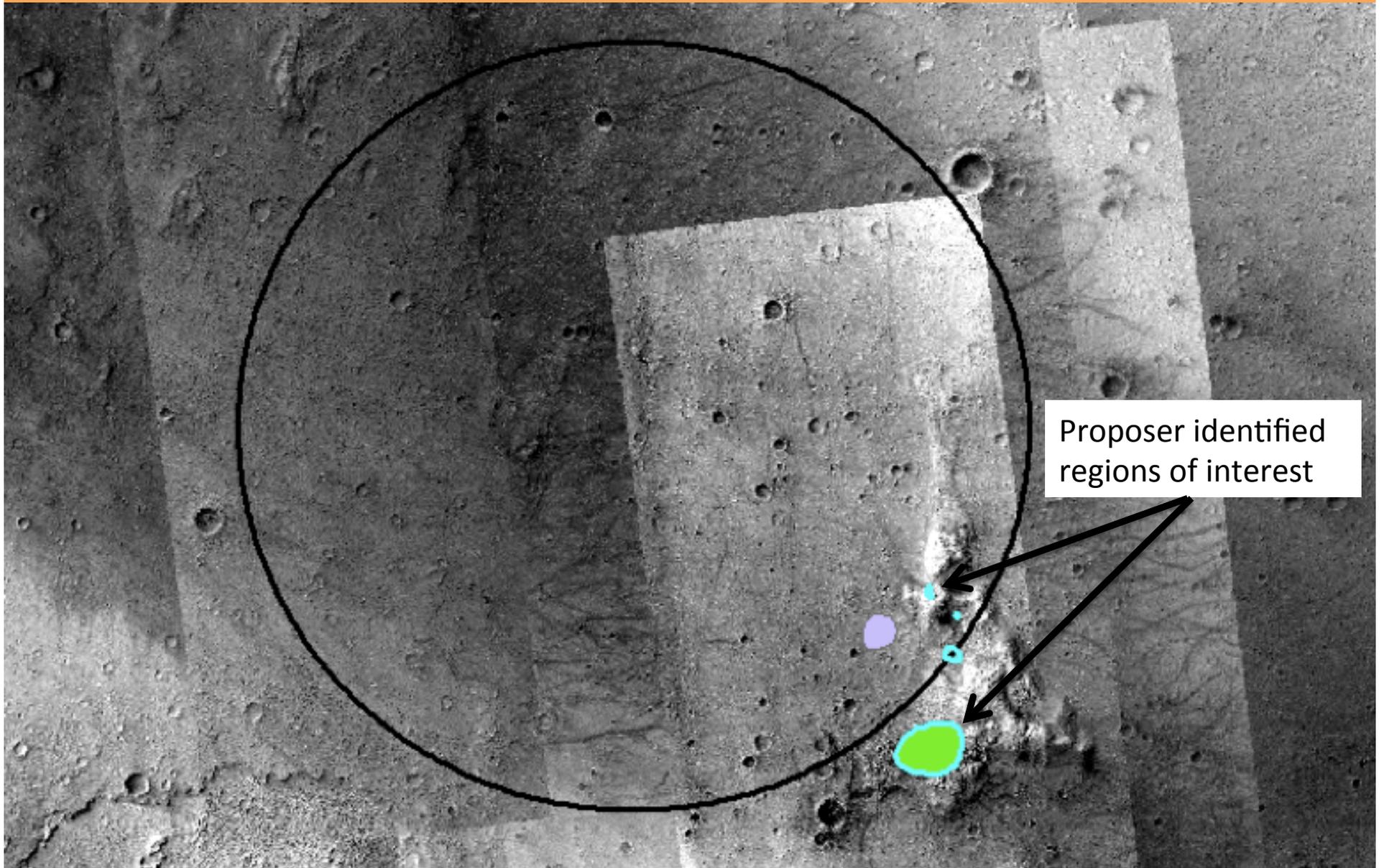


**Columbia Hills Located in
Paleo Trough of Ma'Adim Vallis**





Columbia Hills Ellipse Placement



Explore important new regions that Spirit didn't:

Spirit LDEF

Crossfield (buried Home Plate like structure?)

von Braun Butte (former Inner Basin fill?)

Goddard Crater (volcanic source vent?)

Promised Land (volcaniclastic tephra? Fluvio-lacustrine? Other?)

Etched Terrain (volcaniclastic tephra? Fluvio-lacustrine? Other?)

Crossfield (buried Home Plate like structure?)

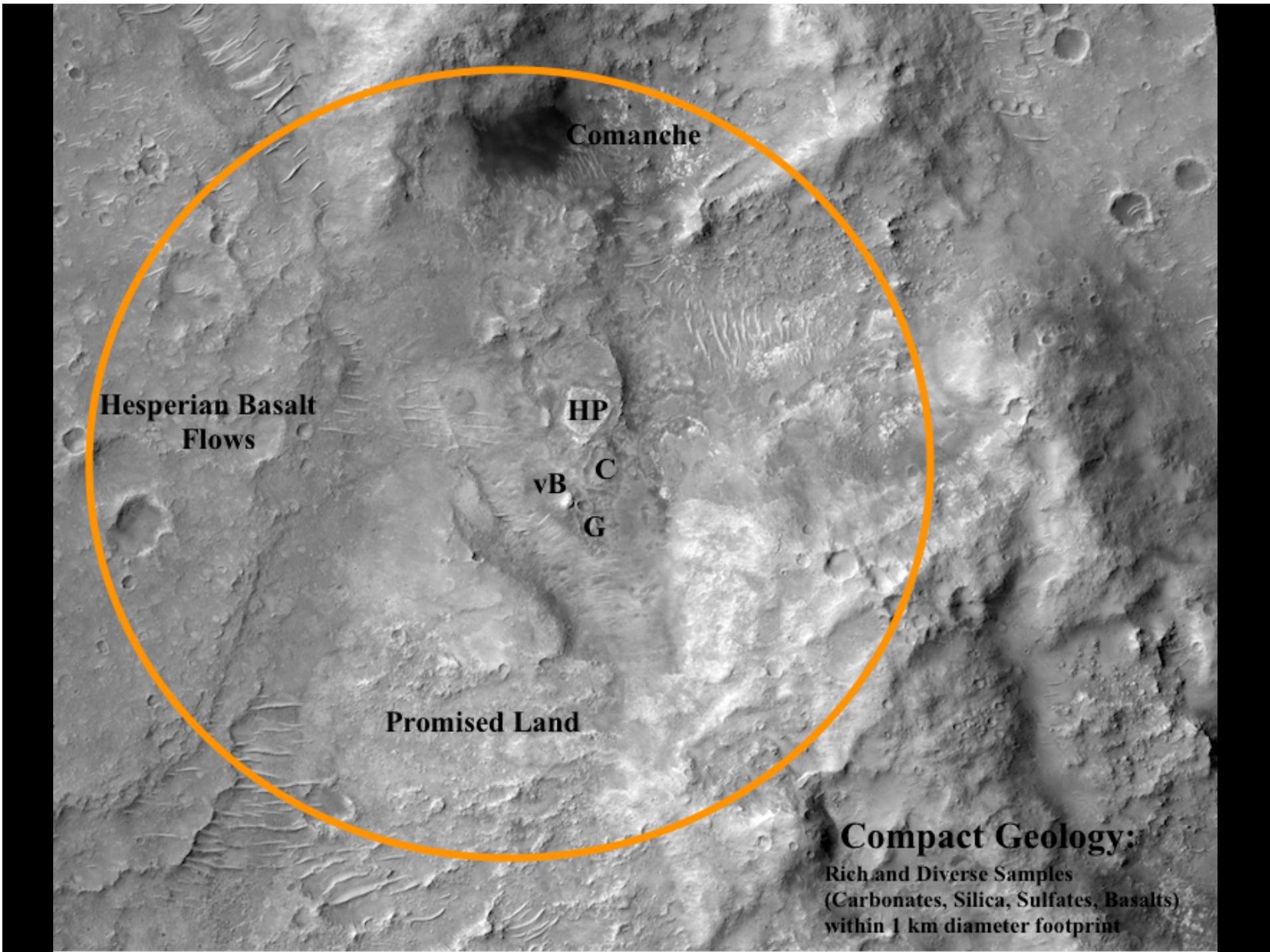
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- Mastcam-Z, WATSON, SuperCam RMI imaging to document m-scale context to sub-mm morphology. Attempt to distinguish weathering textures from primary textures
- SuperCam to determine igneous mineralogy
- SuperCam LIBS and PIXL morphology and mapping for mm- to sub-mm scale elemental composition
- SHERLOC mapping to seek organics and or alteration minerals
- RIMFAX to assess subsurface expression and structural relations



Comanche

Hesperian Basalt
Flows

HP

vB

C

G

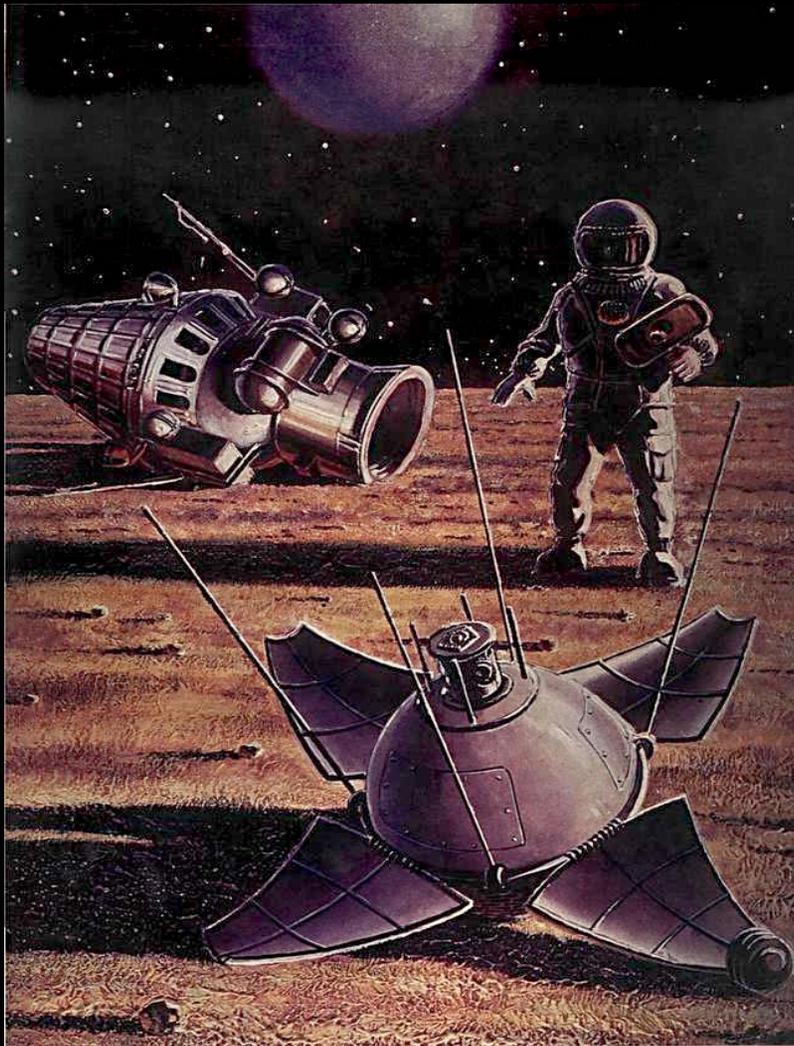
Promised Land

Compact Geology:

Rich and Diverse Samples
(Carbonates, Silica, Sulfates, Basalts)
within 1 km diameter footprint

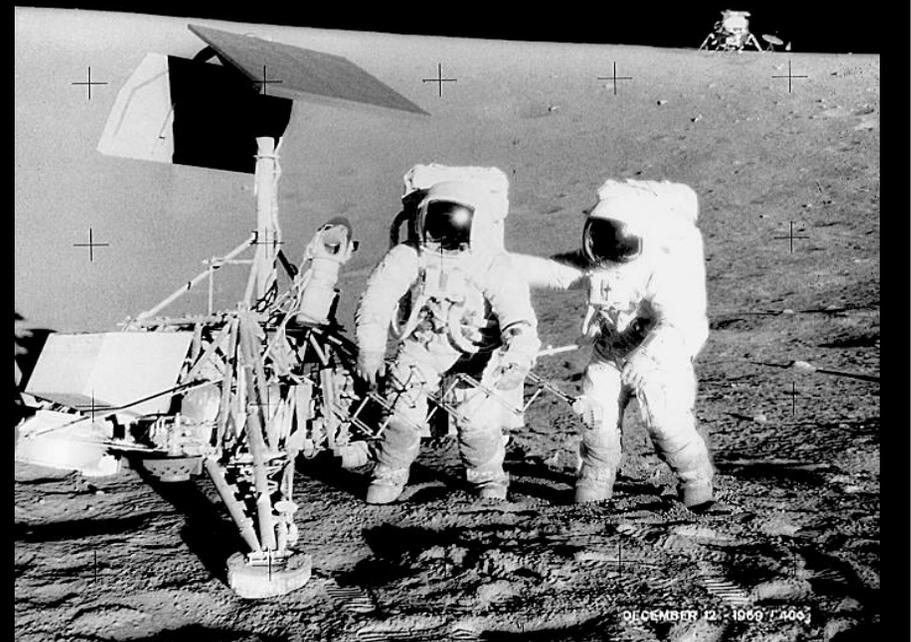


Previous attempts to visit precursor spacecraft for analysis



LIFE

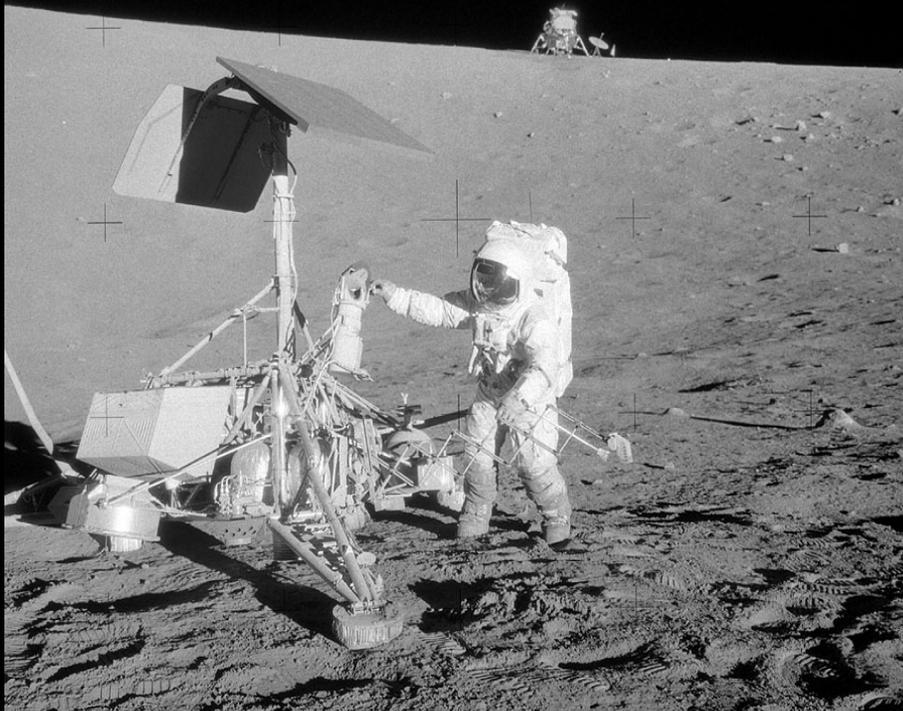
**APOLLO 12
ON THE MOON**



Heritage of Long Duration Exposure Experiments

Apollo 12 retrieved components from S-III exposed 2.5 years

LDEF: materials, coatings, electronics, optics, thermal systems exposed 5.7 years

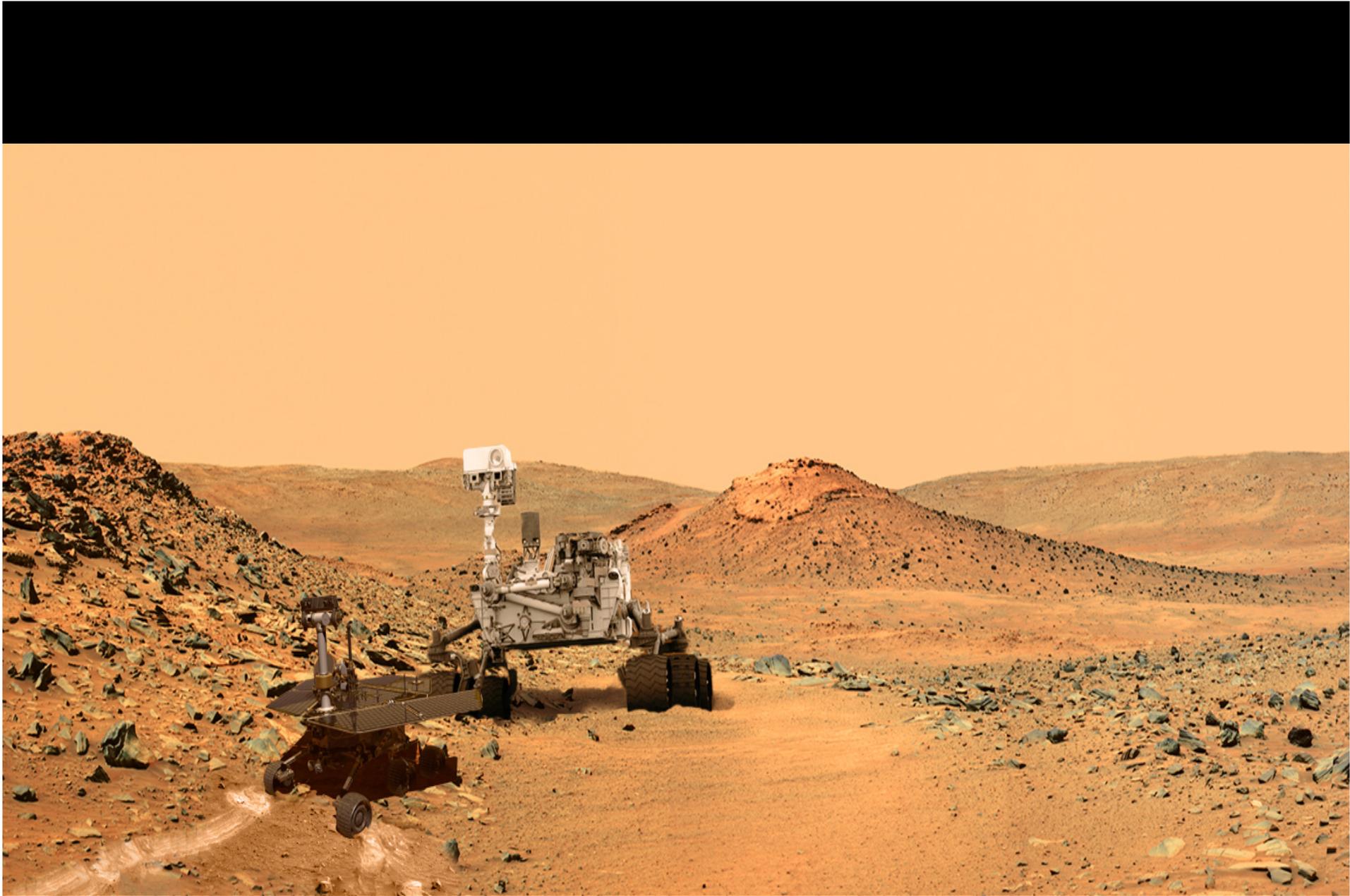


Mars 2020 Science Objective D: Prepare for Human Exploration

Extra incentive for revisiting Columbia Hills is that Spirit can be located and inspected (Mastcam, SHERLOC, PIXL, and SuperCam)

By this time Spirit will have been exposed to the Martian environment for 17 years. Thereby making it an excellent long duration exposure experiment. This will provide long-term data on the Martian environment (weathering, micrometeorites) and its effects on material degradation (SA, coatings, optics, actuators, cabling etc). Are any terrestrial organics on Spirit?

This data will aid in design of future surface systems, equipment and structures for both manned and robotic exploration of Mars.



ROI A

Spirit

Home Plate

Silica

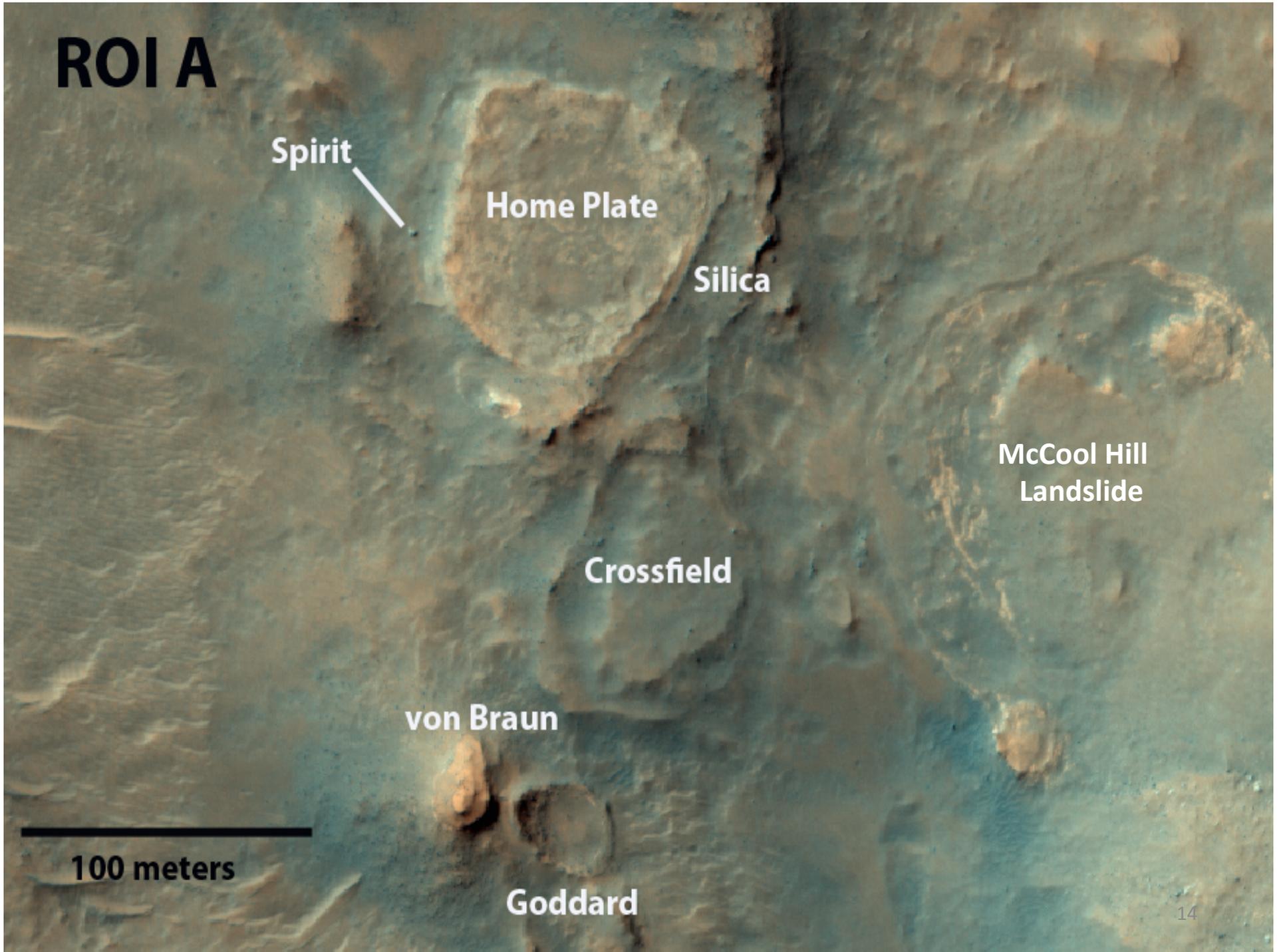
McCool Hill
Landslide

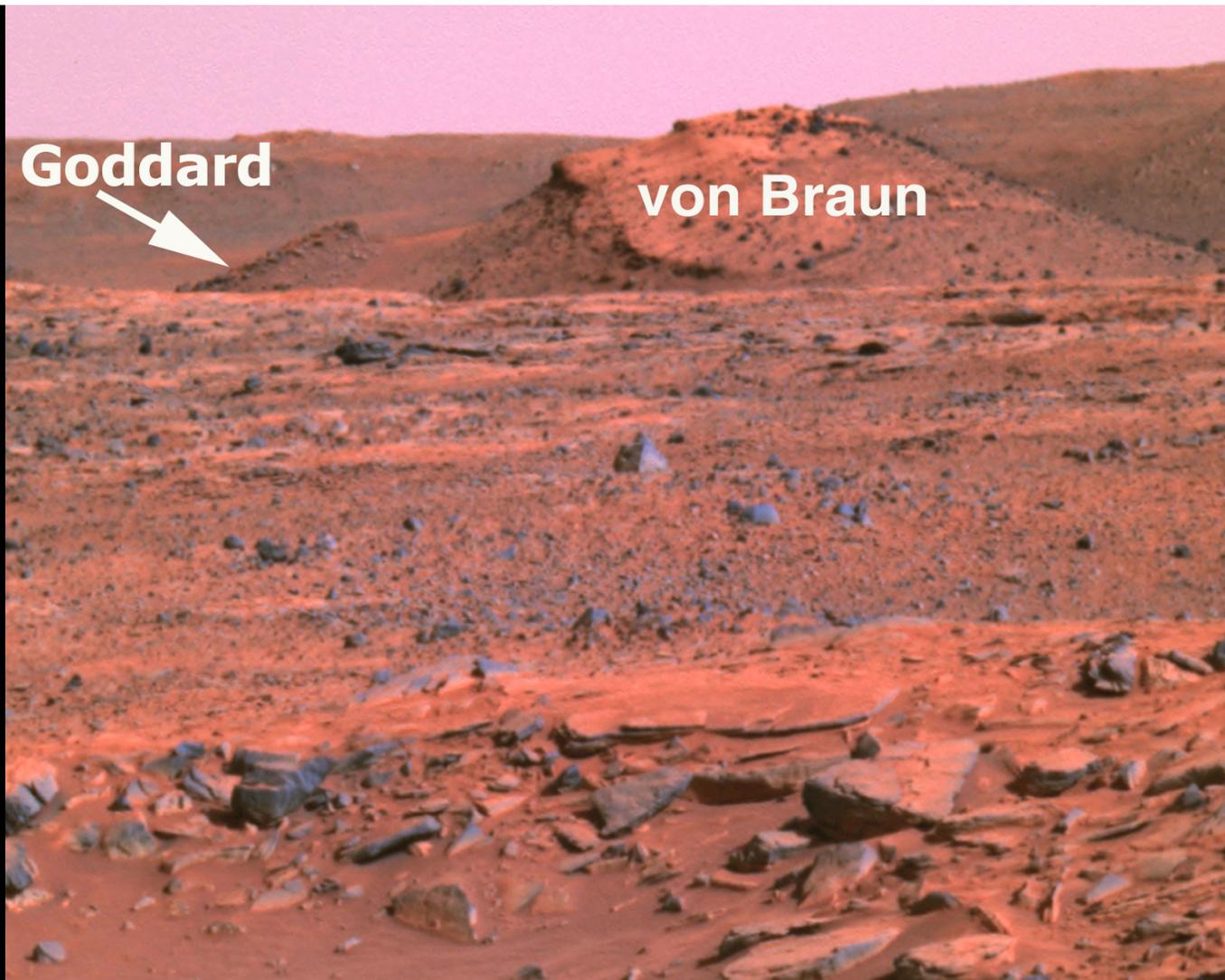
Crossfield

von Braun

100 meters

Goddard

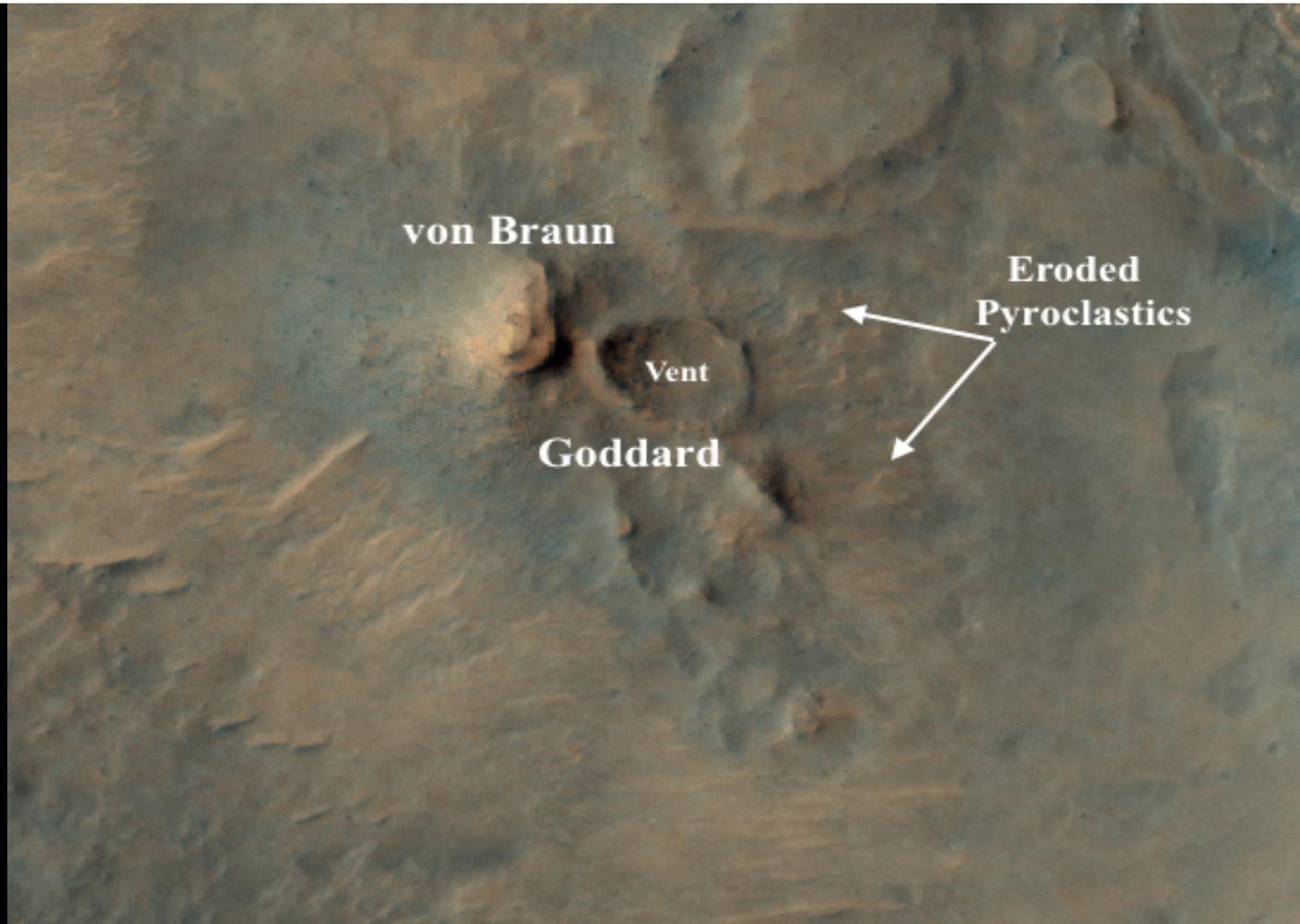




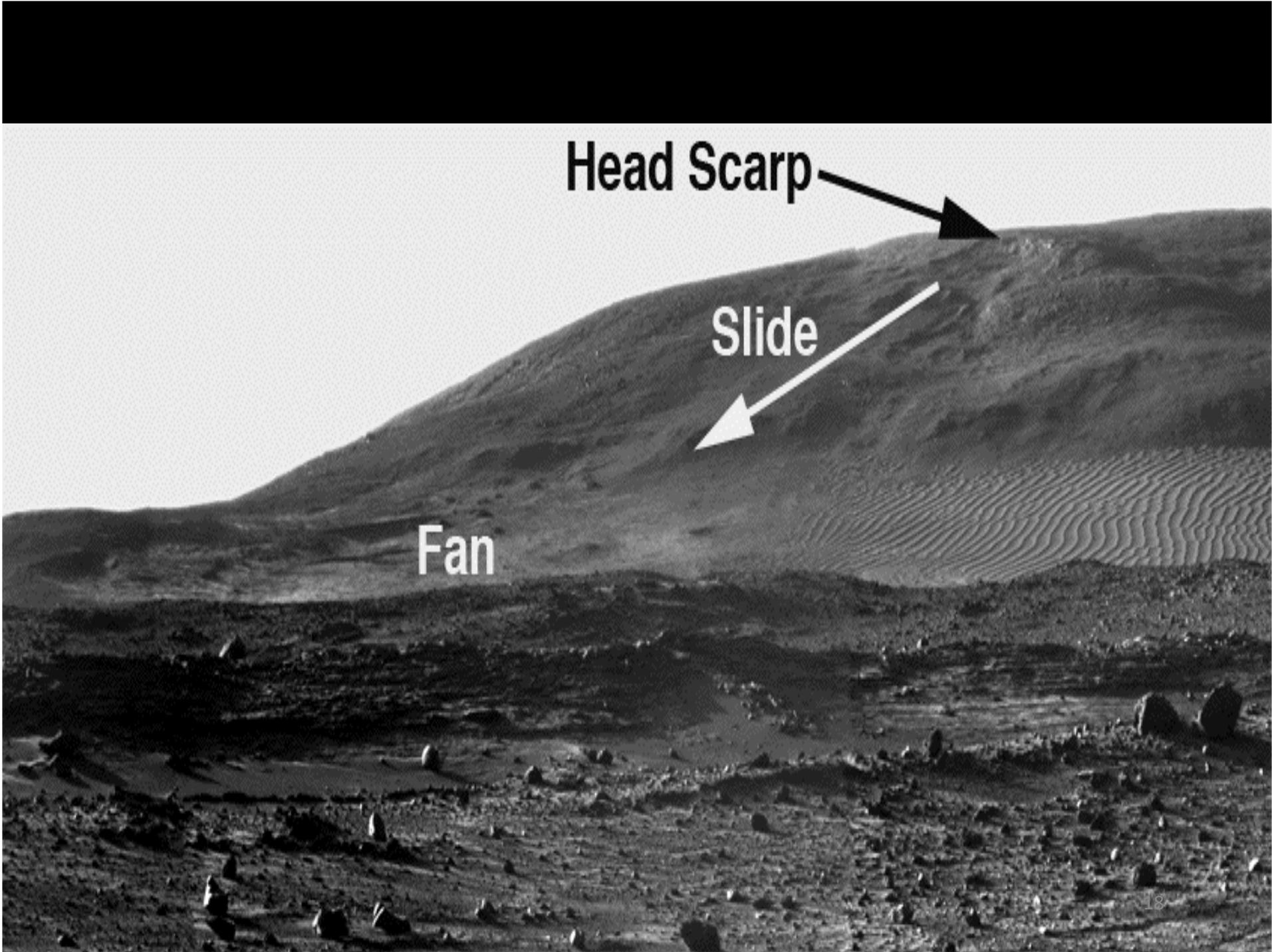
von Braun Butte: 7 meter high layered butte (cliff and ledge forming members) appears to be capped with Home Plate-like material. von Braun interpreted to be an erosional remnant of a once more extensive unit that covered the Inner Basin.

**von Braun Butte
(130 m away)**





Goddard Crater: Elliptical depression 35 m x 25 m, ranging in depth from 2.6 to 3.5 m. Crater appears to be a volcanic vent and not an impact crater based on its morphology, context, and associated eroded materials interpreted to be pyroclastics.

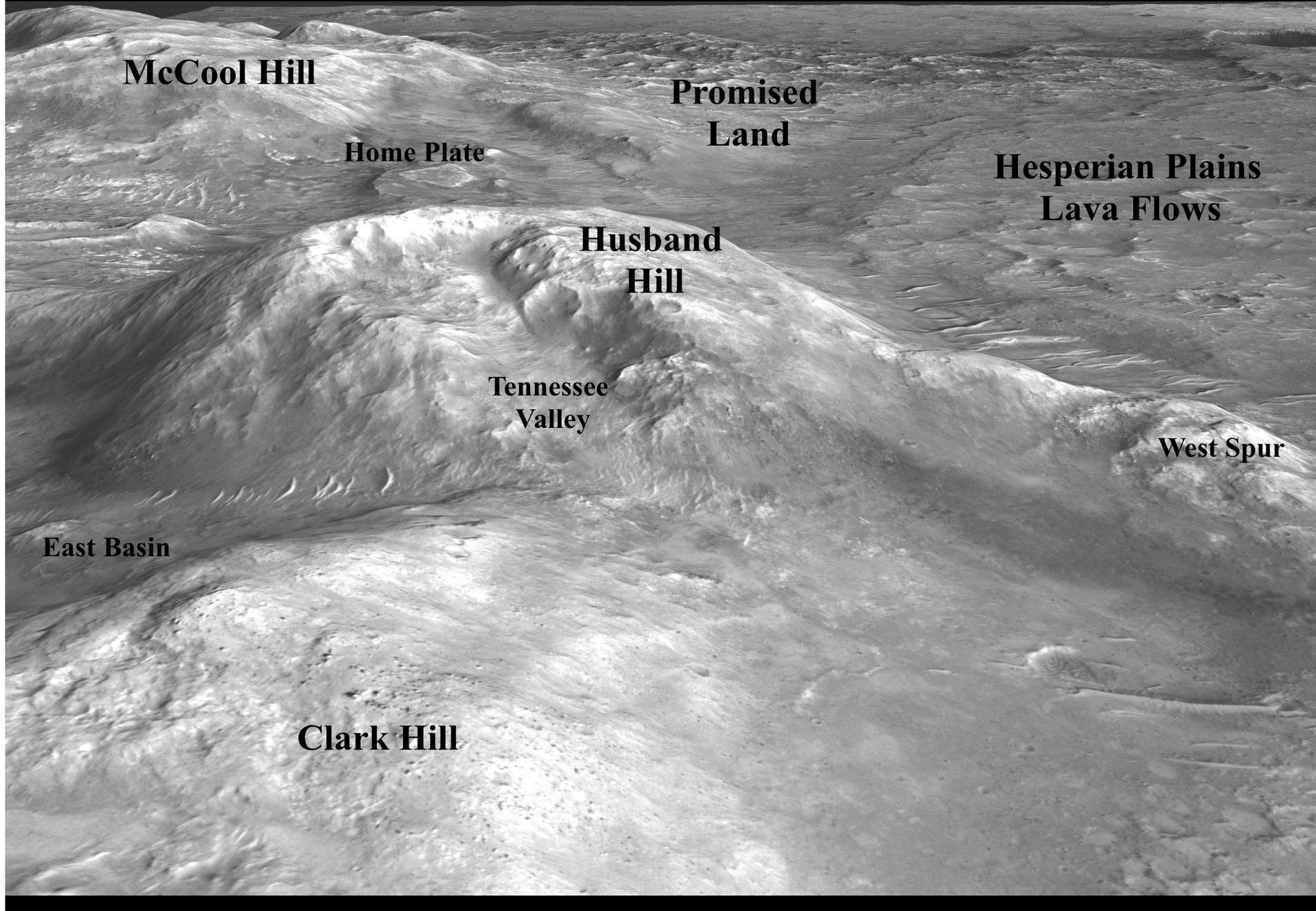


Head Scarp

Slide

Fan

View to South



McCool Hill

Home Plate

**Promised
Land**

**Hesperian Plains
Lava Flows**

**Husband
Hill**

**Tennessee
Valley**

West Spur

East Basin

Clark Hill

Home Plate to Promised Land: 700 m

Promised Land to Italy: 4.2 km

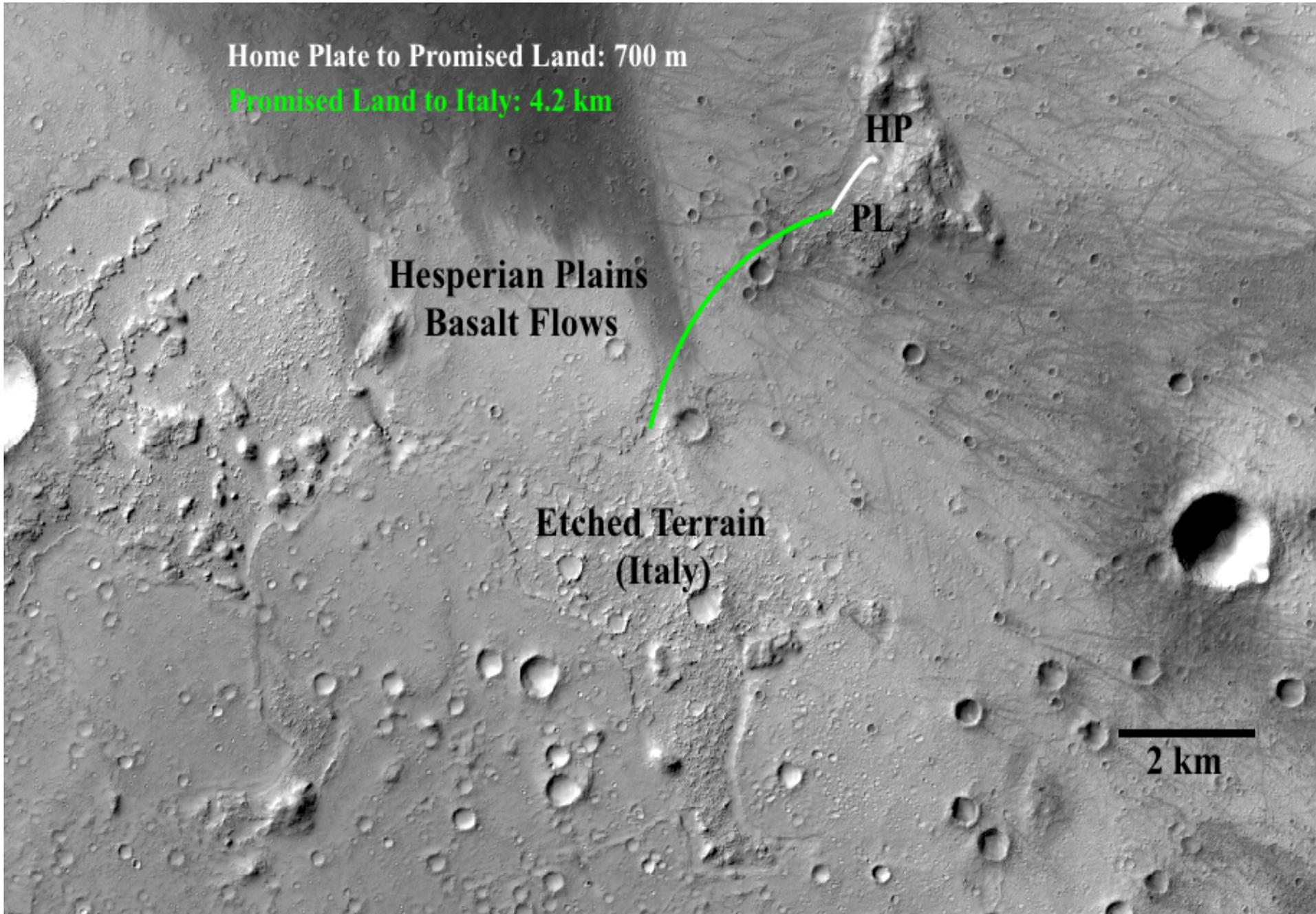
HP

PL

Hesperian Plains
Basalt Flows

Etched Terrain
(Italy)

2 km



**Home
Plate**



**Promised
Land**

*Basaltic Plains
Lava Flows:
Hesperian Age
(3.6 Ga)*

Promised Land

Promised Land: Hi thermal inertia, NE-SW trending bouldery ridges, light toned polygonal ground unit sandwiched between the Hesperian plains lava flows and Noachian Columbia Hills.

Testable hypothesis: Is this a former now mostly buried extensive unit similar to other 'window' areas of terrain seen on Gusev floor? Is it Volcanic (tephra)? Fluvio-lacustrine?

Promised
Land

Promised Land

Home Plate to Promised Land: 700 m

Promised Land to Italy: 4.2 km

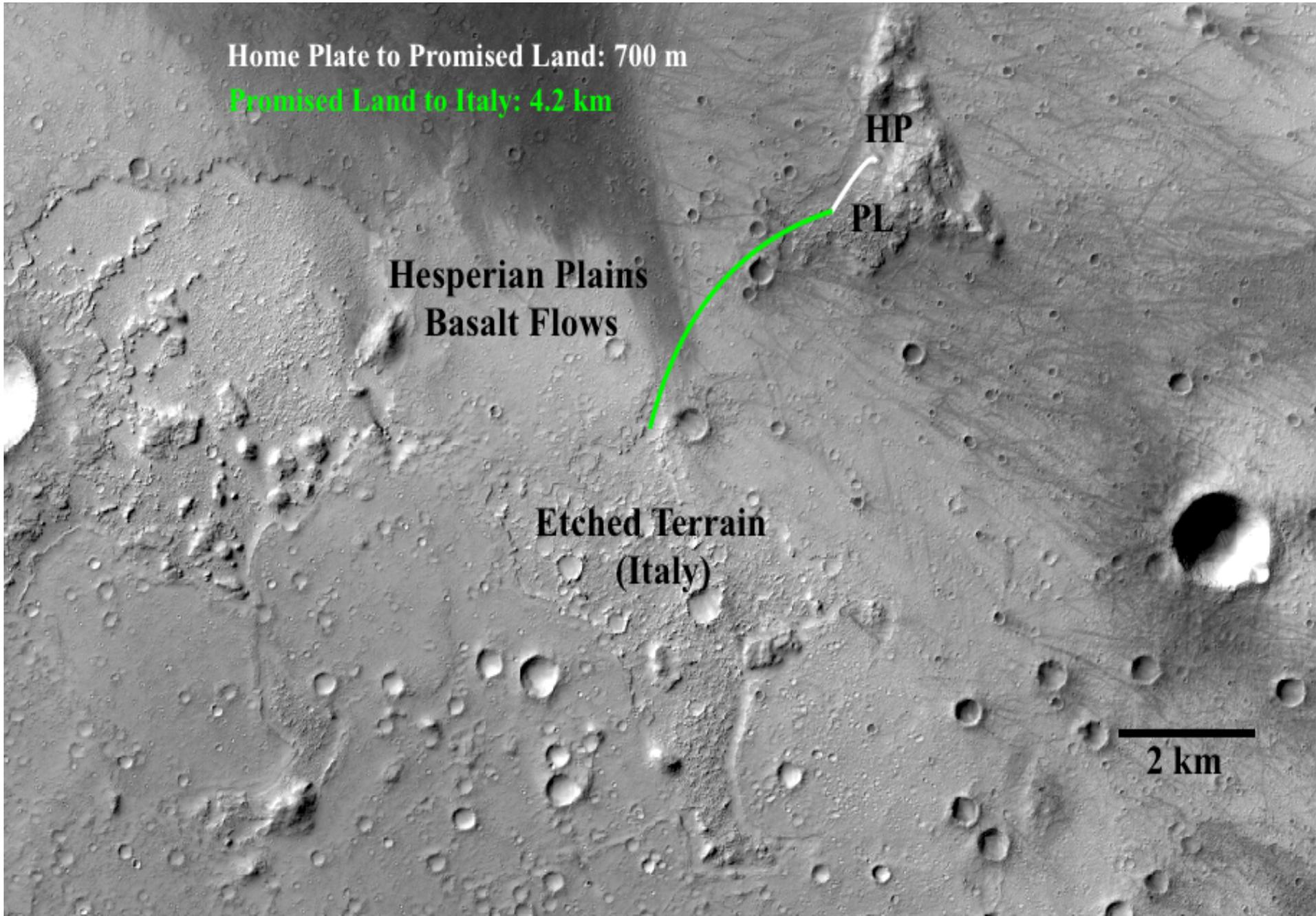
HP

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Hesperian Plains
Basalt Flows

Etched Terrain
(Italy)

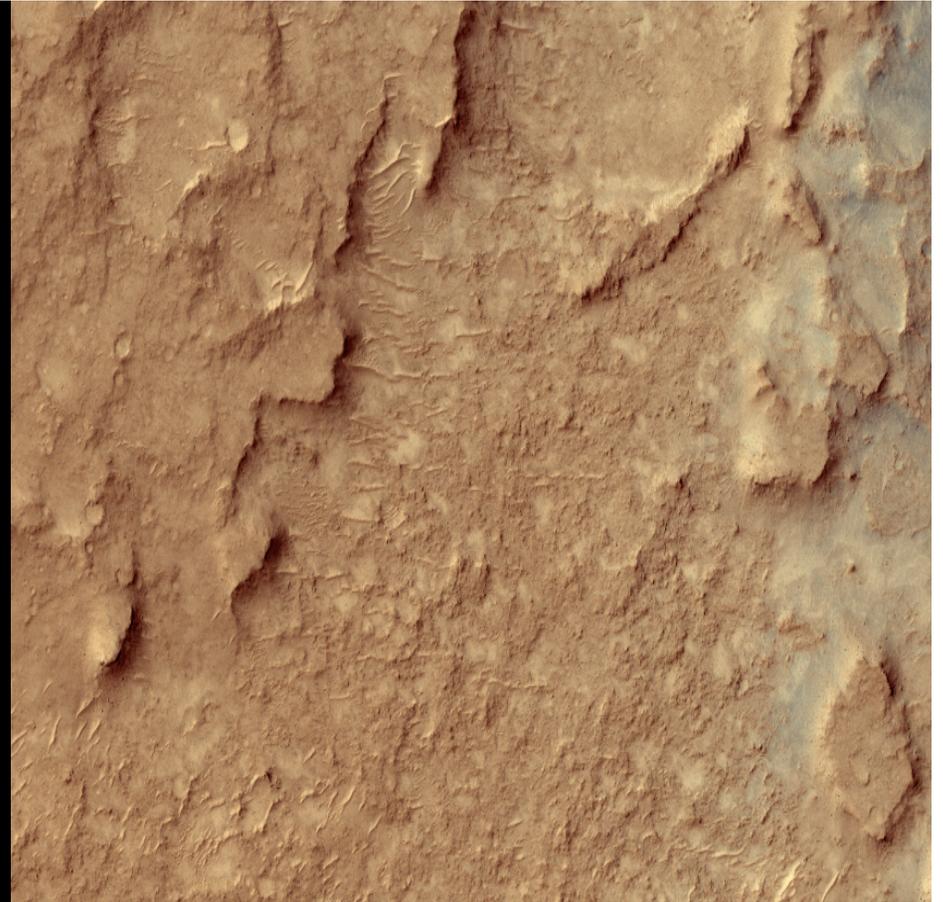
2 km



Reasons to Return to the Columbia Hills

Gusev Plains are Hesperian olivine rich basalt (3.6 Ga).

These rock samples would permit radiometric dating of an areally extensive Hesperian age lava flow surface which can then be used to calibrate Martian crater curves.



Testable hypothesis: Is 'Italy' a window to a former now mostly buried extensive unit similar to areas of terrain seen in the Promised Land and other 'windows' scattered across the floor of Gusev Crater? Is it Volcanic (tephra)? Fluvio-lacustrine?

**Columbia
Hills**

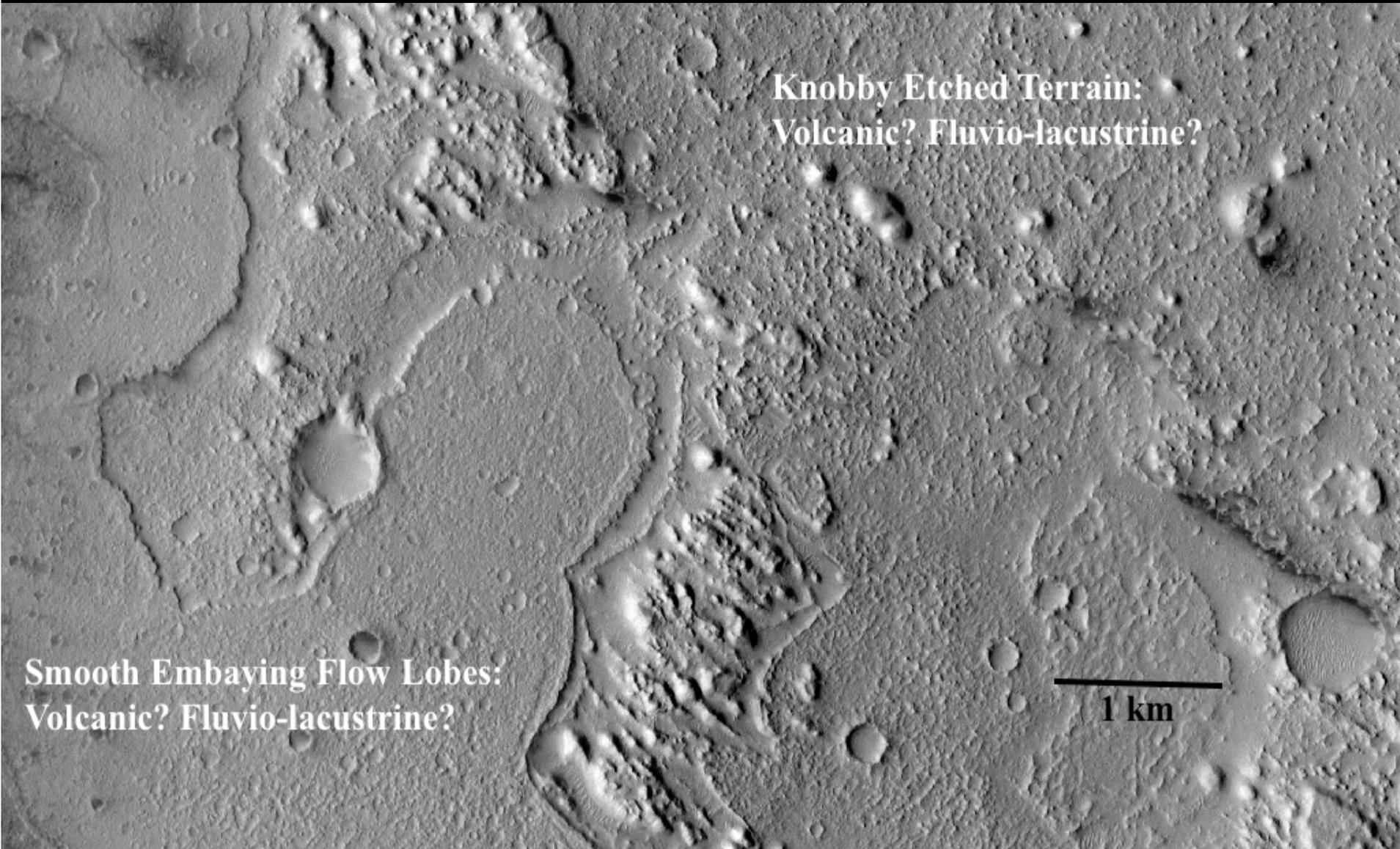
**Thira
Crater**

Italy

**Etched
Terrain**

Italy to SE Etched Terrain: 16.4 km

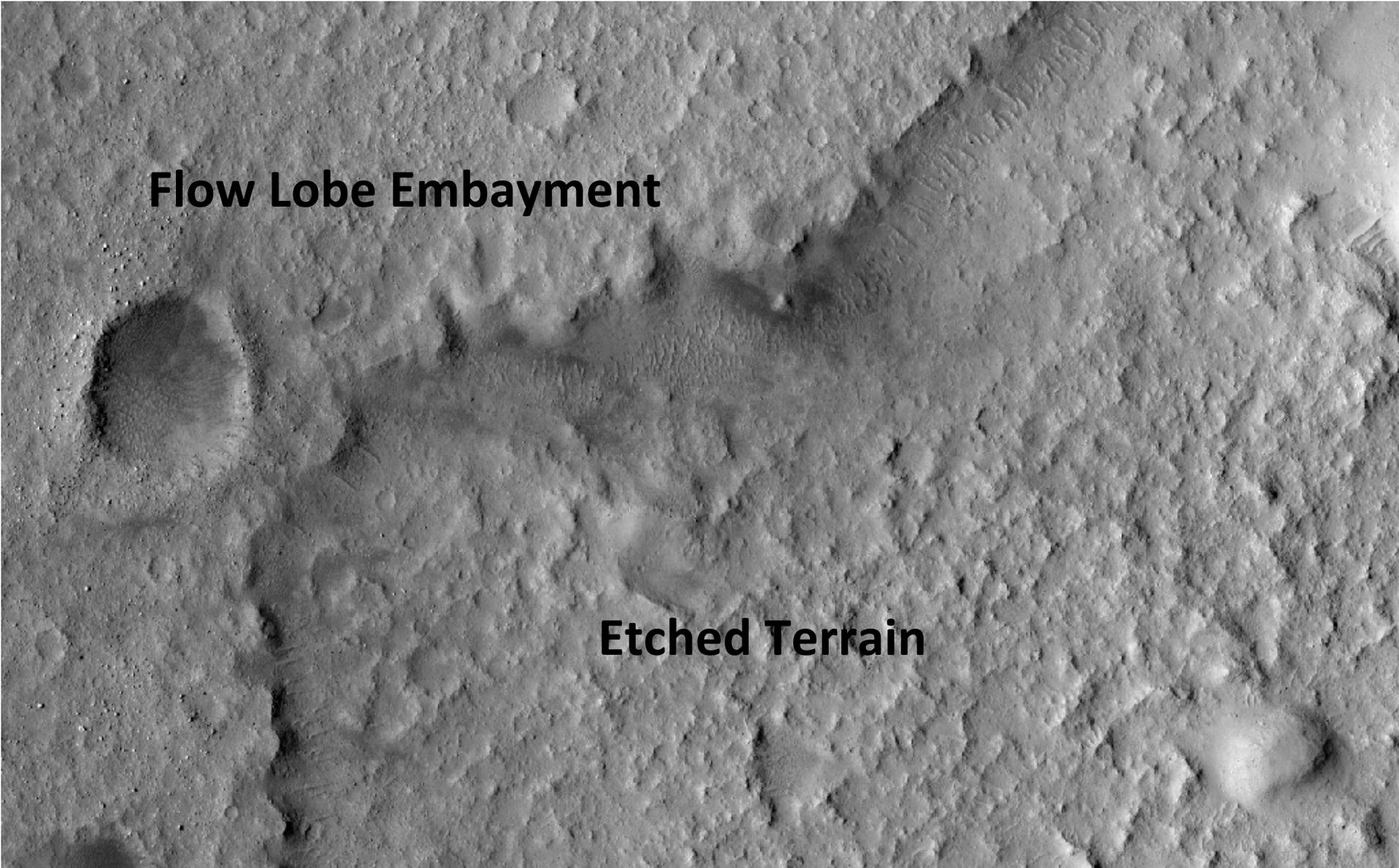
1.5 km



**Knobby Etched Terrain:
Volcanic? Fluvio-lacustrine?**

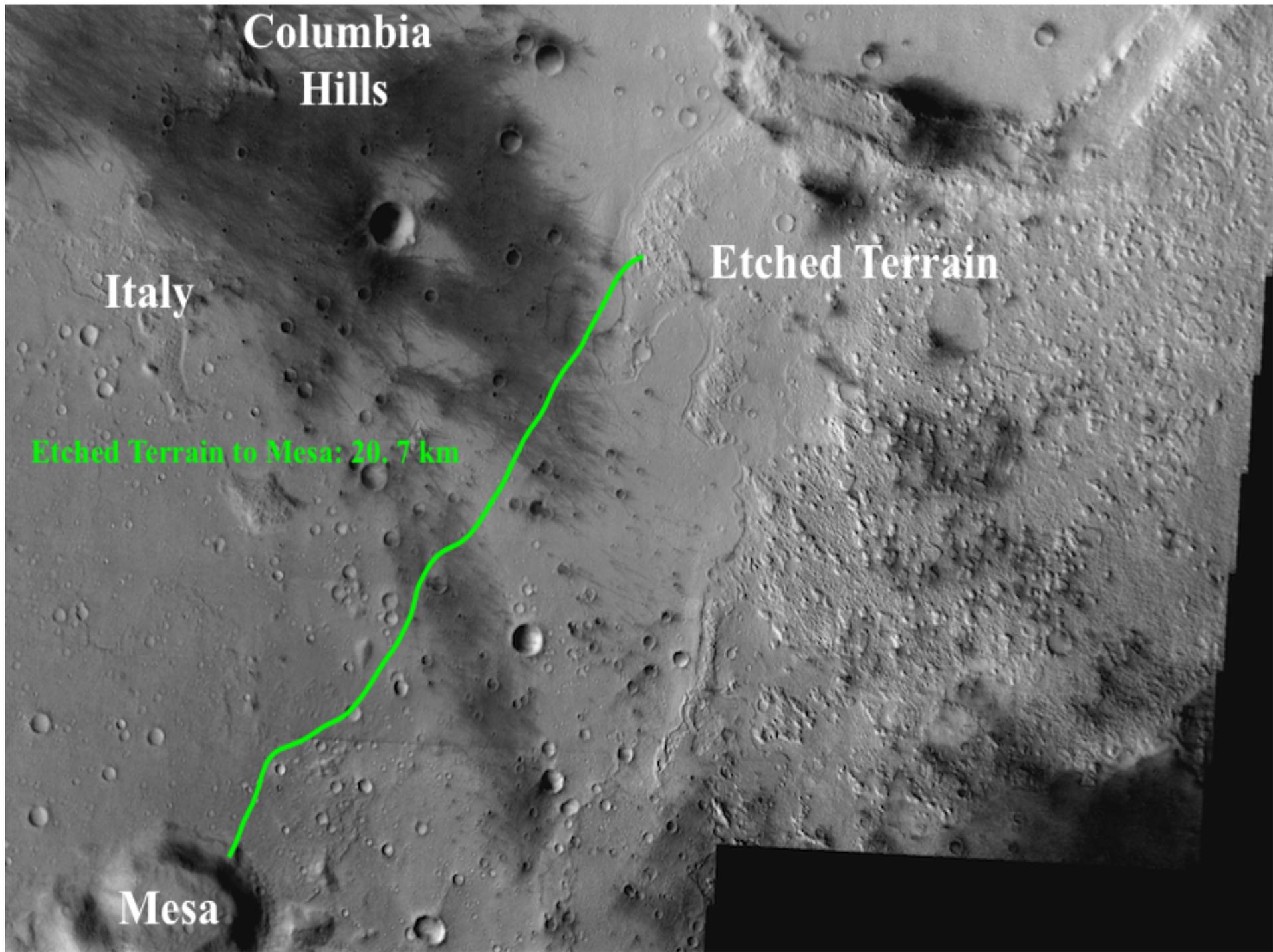
**Smooth Embaying Flow Lobes:
Volcanic? Fluvio-lacustrine?**

1 km



Flow Lobe Embayment

Etched Terrain



Columbia
Hills

Italy

Etched Terrain

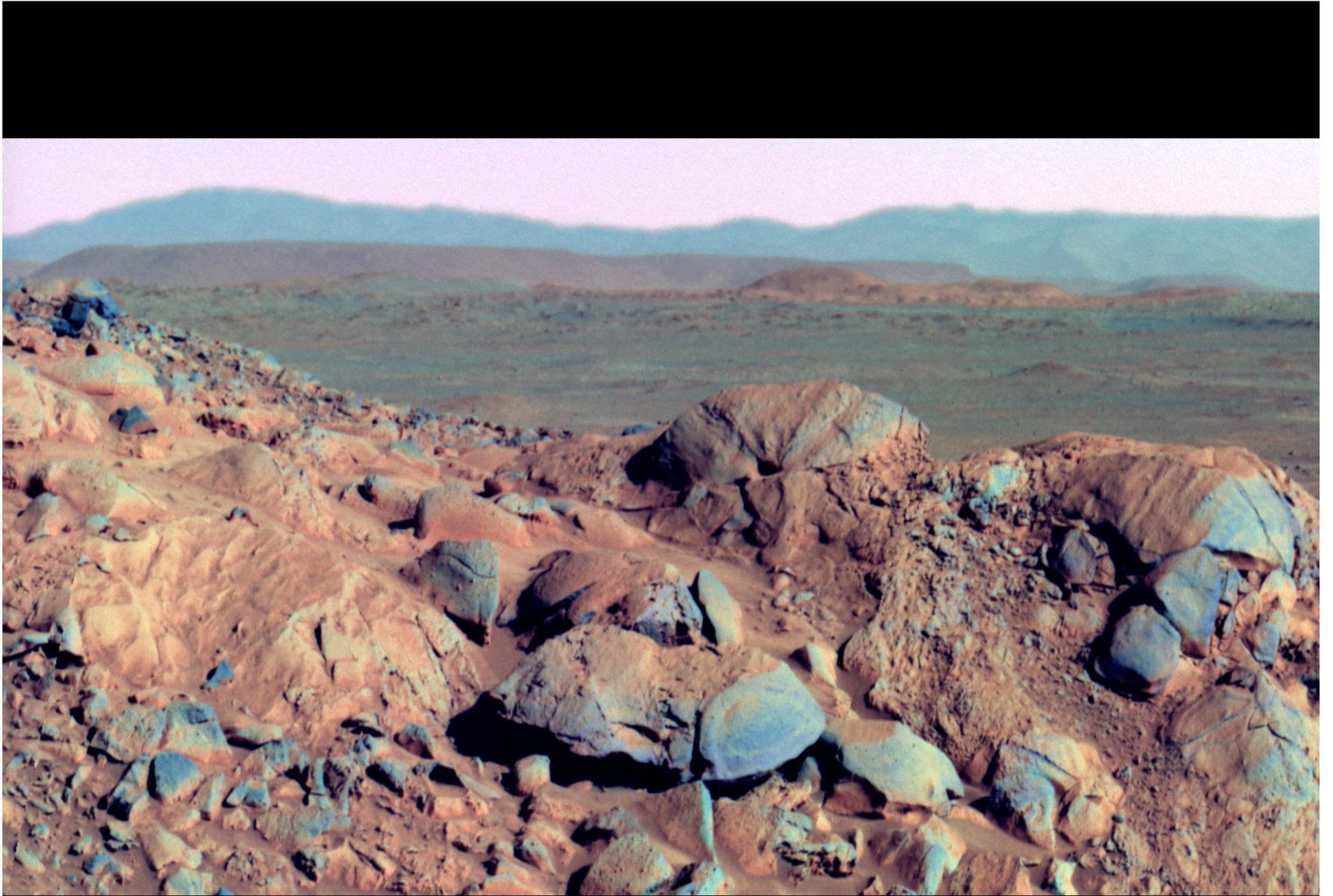
Etched Terrain to Mesa: 20.7 km

Mesa

Reasons to Return to the Columbia Hills

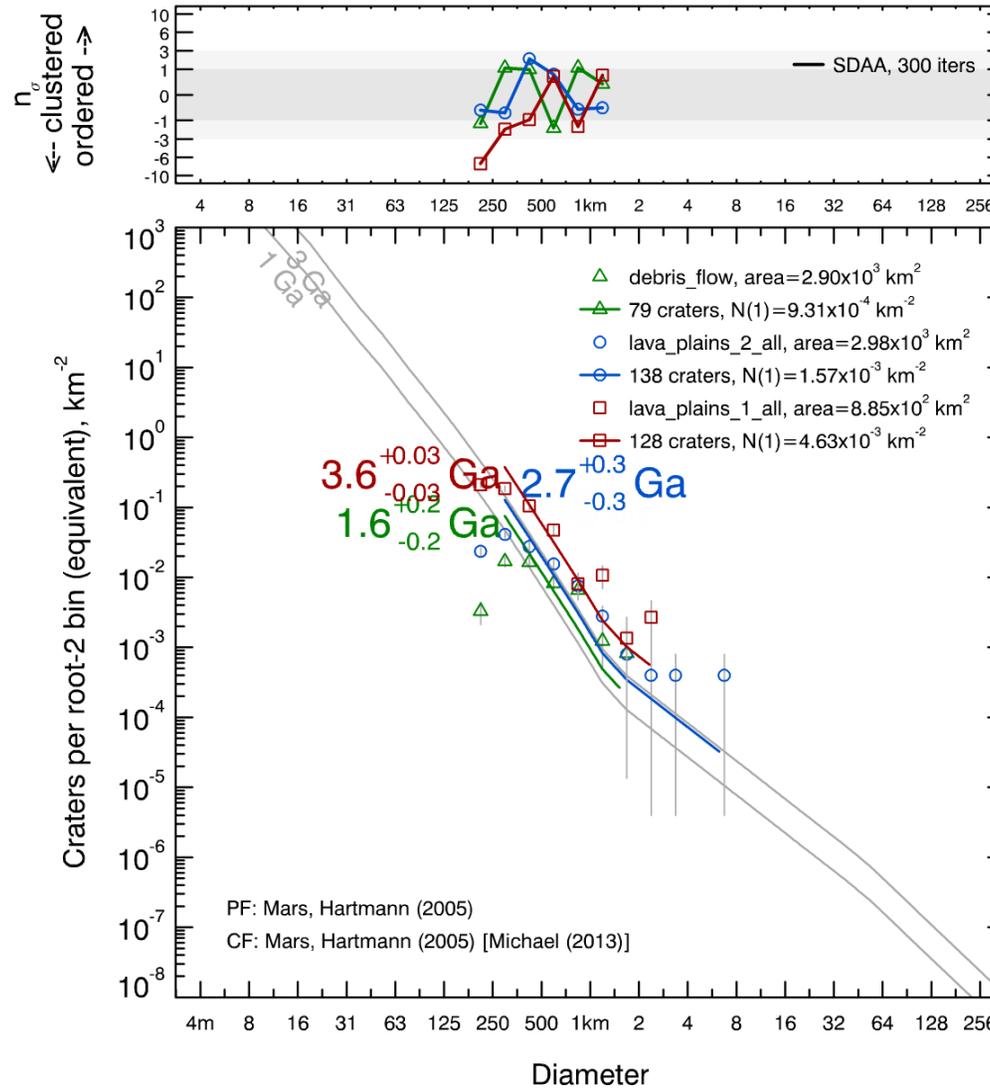
Landing Site with Ultimate Ground Truth

- *Key advantage and unique aspect of this landing site is that we already know exactly where we need to go and have already found significant astrobiologic and geologic samples to be collected, complements of Spirit.
- *Extra incentive for revisiting Columbia Hills is that Spirit can be located, inspected and provide data to help Prepare for Human Exploration.
- *Explore important new regions that Spirit did not.



Gusev Crater Floor Terrains

Fit Range: Lava Plains 1 (0.3-2.3 km), Lava Plains 2 (0.3-6.2 km), Debris Flow (0.3-1.5 km)



Gusev Crater Floor Terrains

Fit Range: Hummocky Plains (0.3-2.9 km), Blocky Plains (0.3-2.5 km)

