

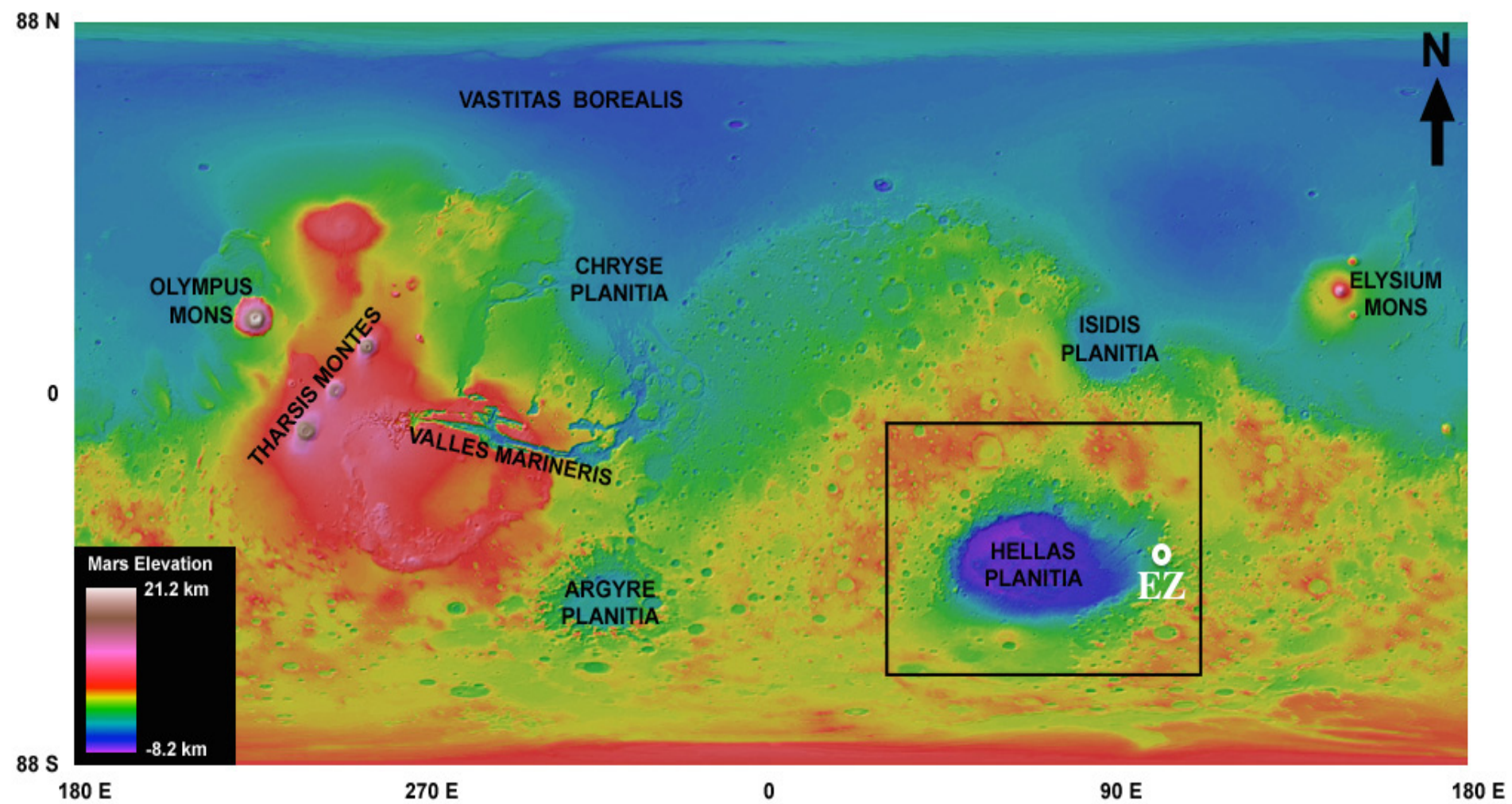
MANNED MARS MISSION EZ: EASTERN RIM OF HELLAS BASIN (PROMETHEI TERRA)

**James Rice¹, D. Crown¹, W. Feldman¹, A.
Pathare¹, A. Feustel², L. Gertsch³**

¹Planetary Science Institute

²Astronaut Office, Johnson Space Center

³Missouri Univ. of Science and Technology



Hellas Impact Basin

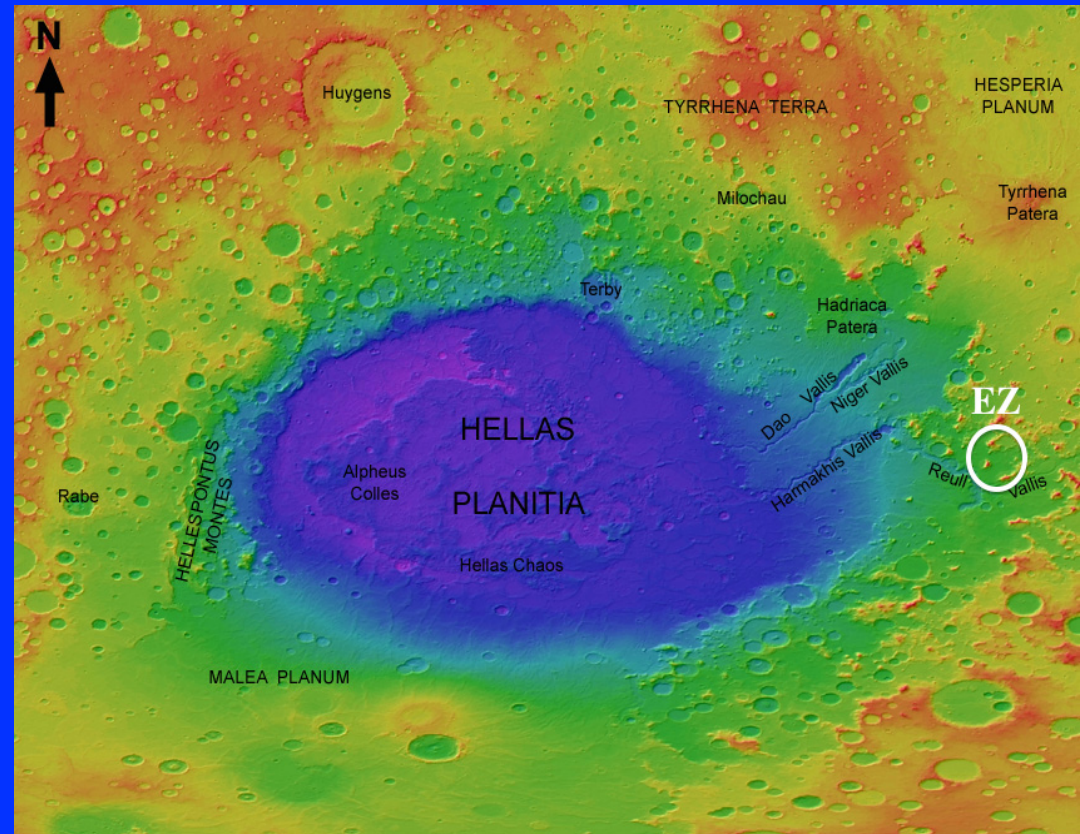
Southern cratered highlands

Formed LHB (3.9 - 4.3 Ga)

Noachian

Largest and deepest impact crater in the Solar System
(2,300 km diam; 9 km deep)

The Hellas impact event
played a major global role in
the geologic evolution of the
planet



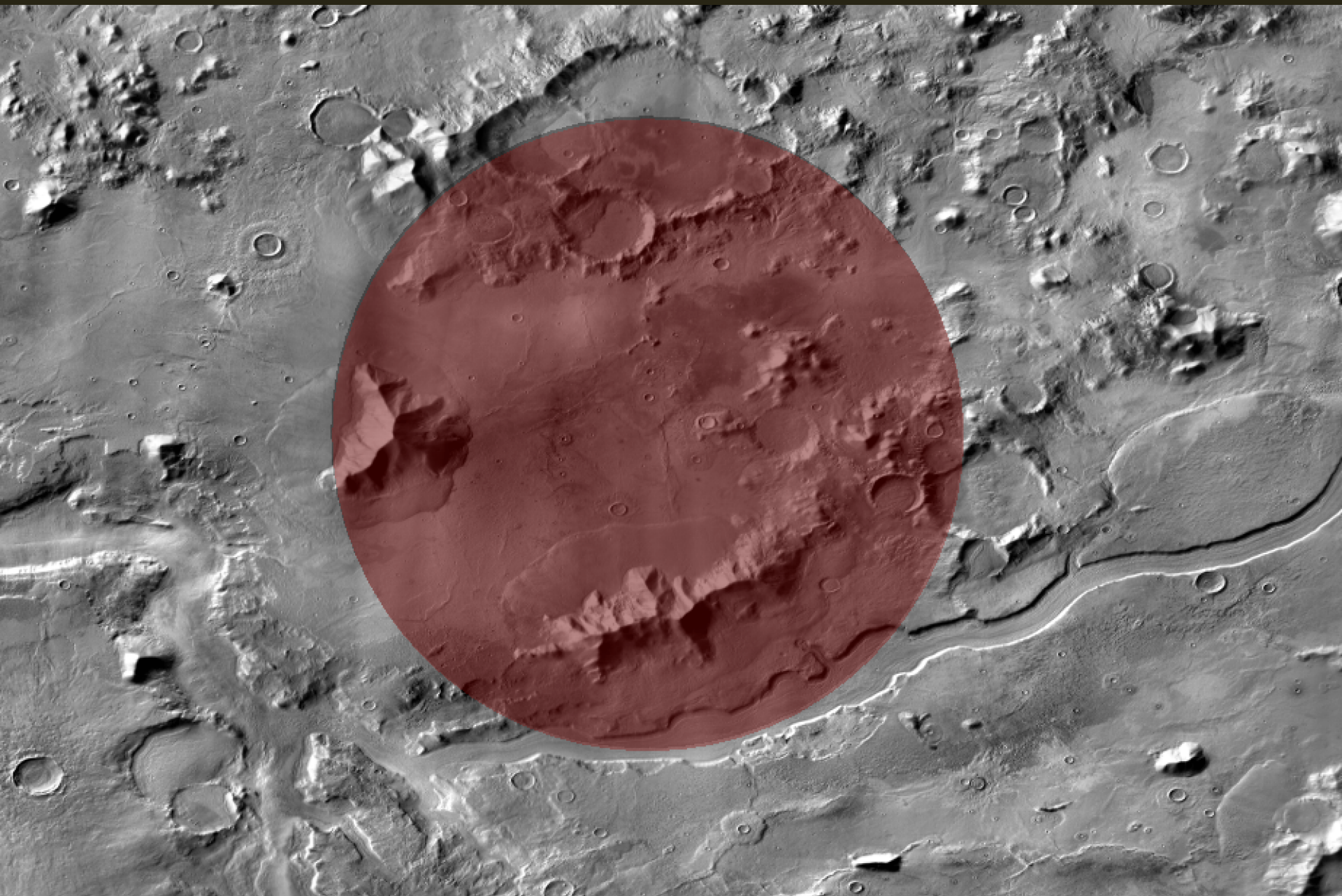
Promethei Terra

Noachian Cratered Highlands

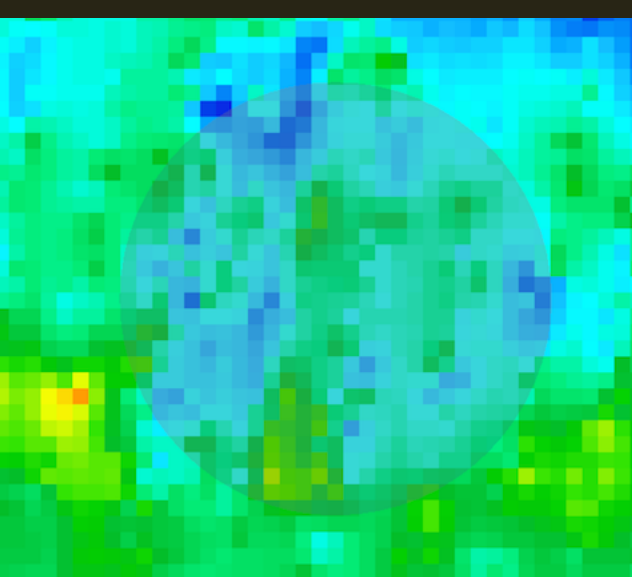
Hesperian Plains

Amazonian Ice
Rich Aprons

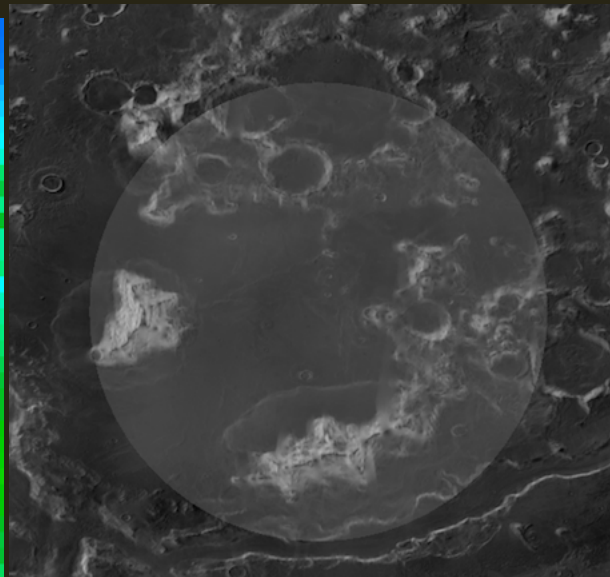
Reull Vallis



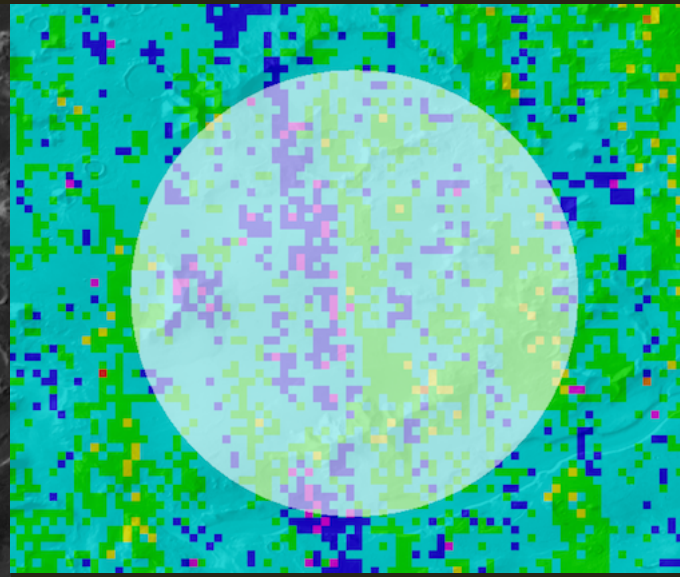
6



TI: Moderate



Slopes: flat as board

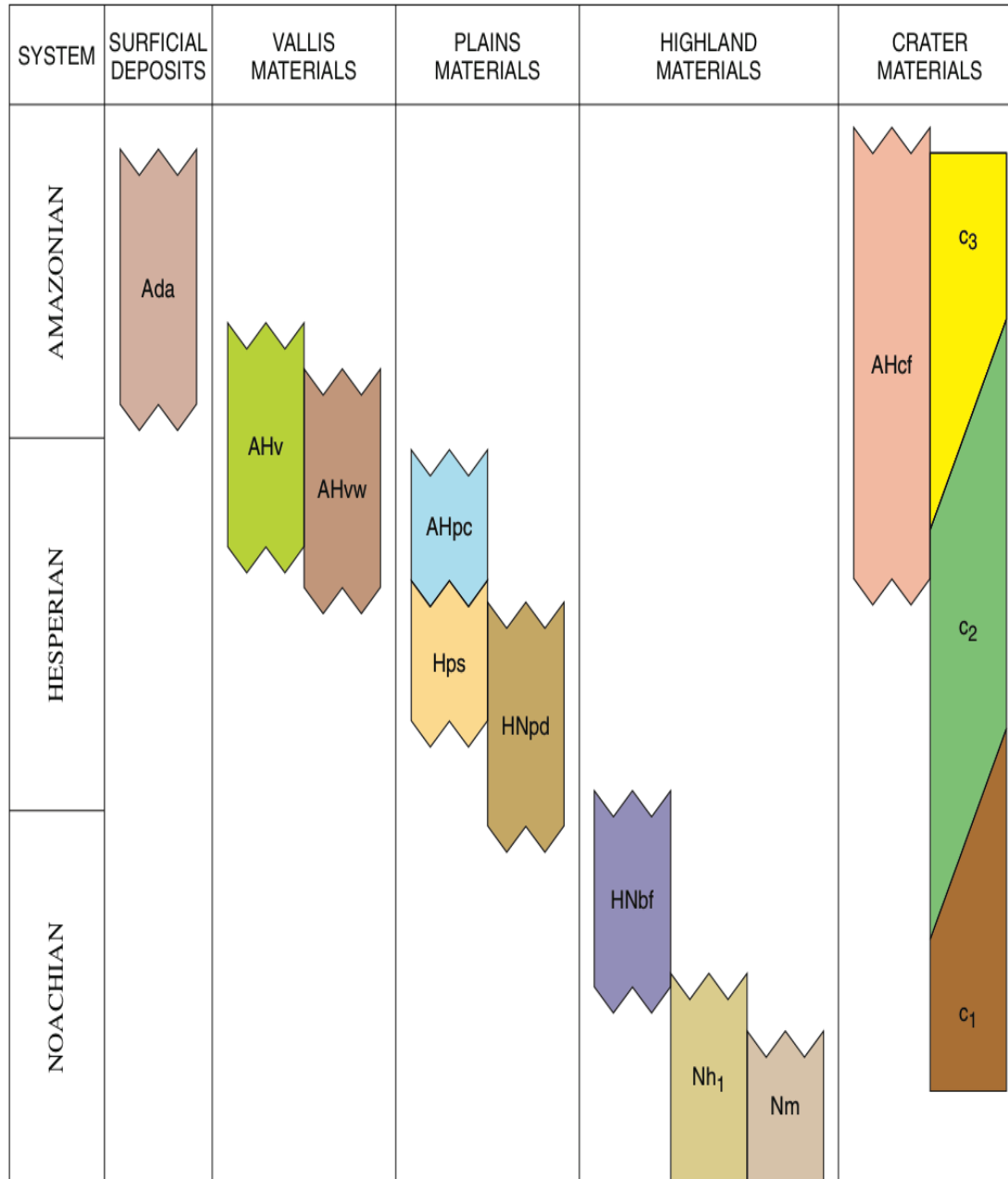


Dust Index: MER B-ish

EZ: 40°S; 104°E



Correlation of Map Units



HIGHLAND MATERIALS

HNbf

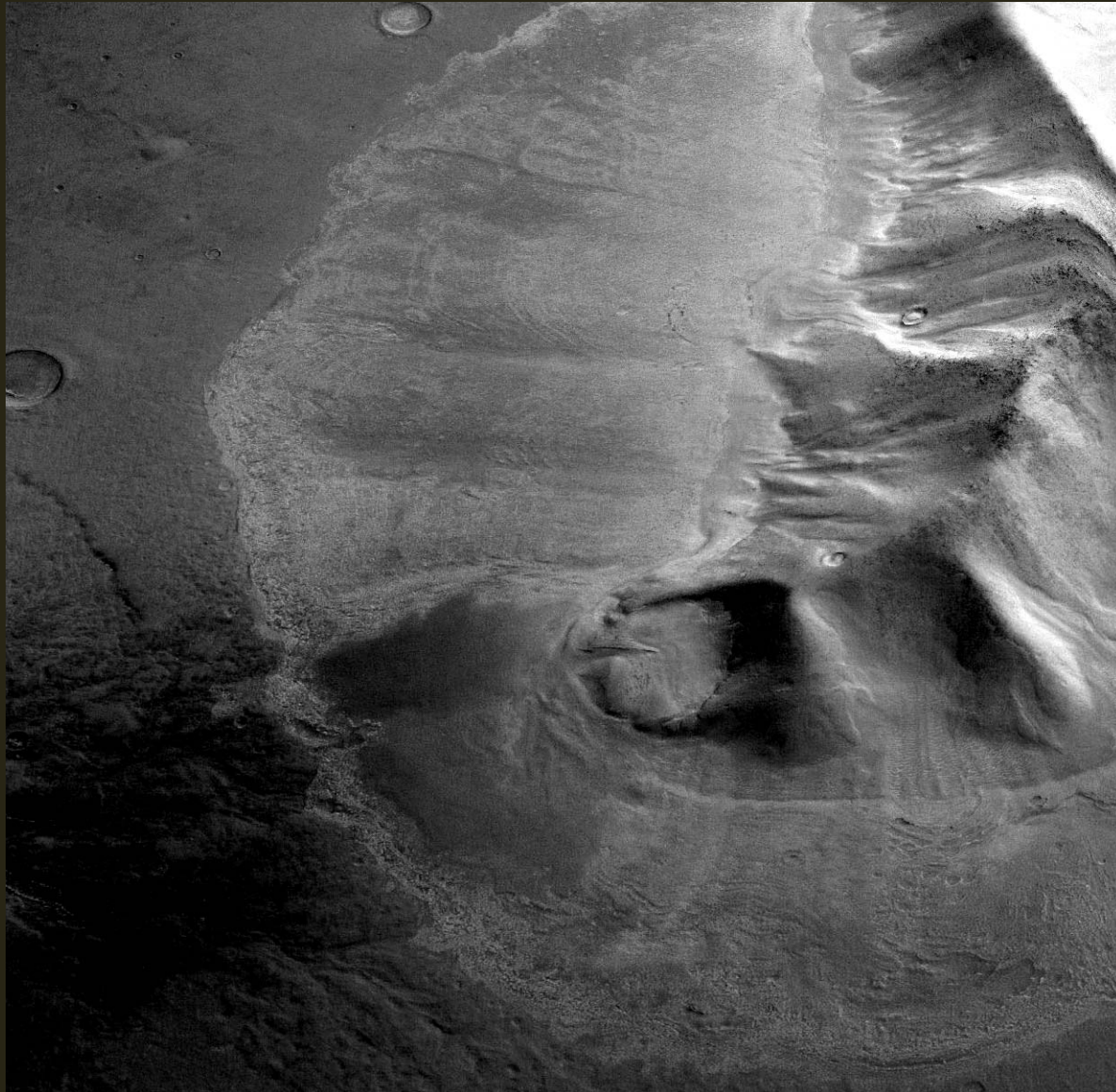
Intermontane basin fill—Smooth to slightly hummocky deposits filling low-lying regions within highlands. In map area, unit contains numerous valley networks, dendritic to rectilinear in nature; less dissected in the western part of MTM -40257. Some occurrences, especially where adjacent to smooth plains, have scarp-bounded edges. *Type area*: 38.7° S., 253° W. *Interpretation*: Sedimentary deposits derived from highland materials; may also contain eolian deposits with non-local sources; most deposits eroded by fluvial processes forming channels

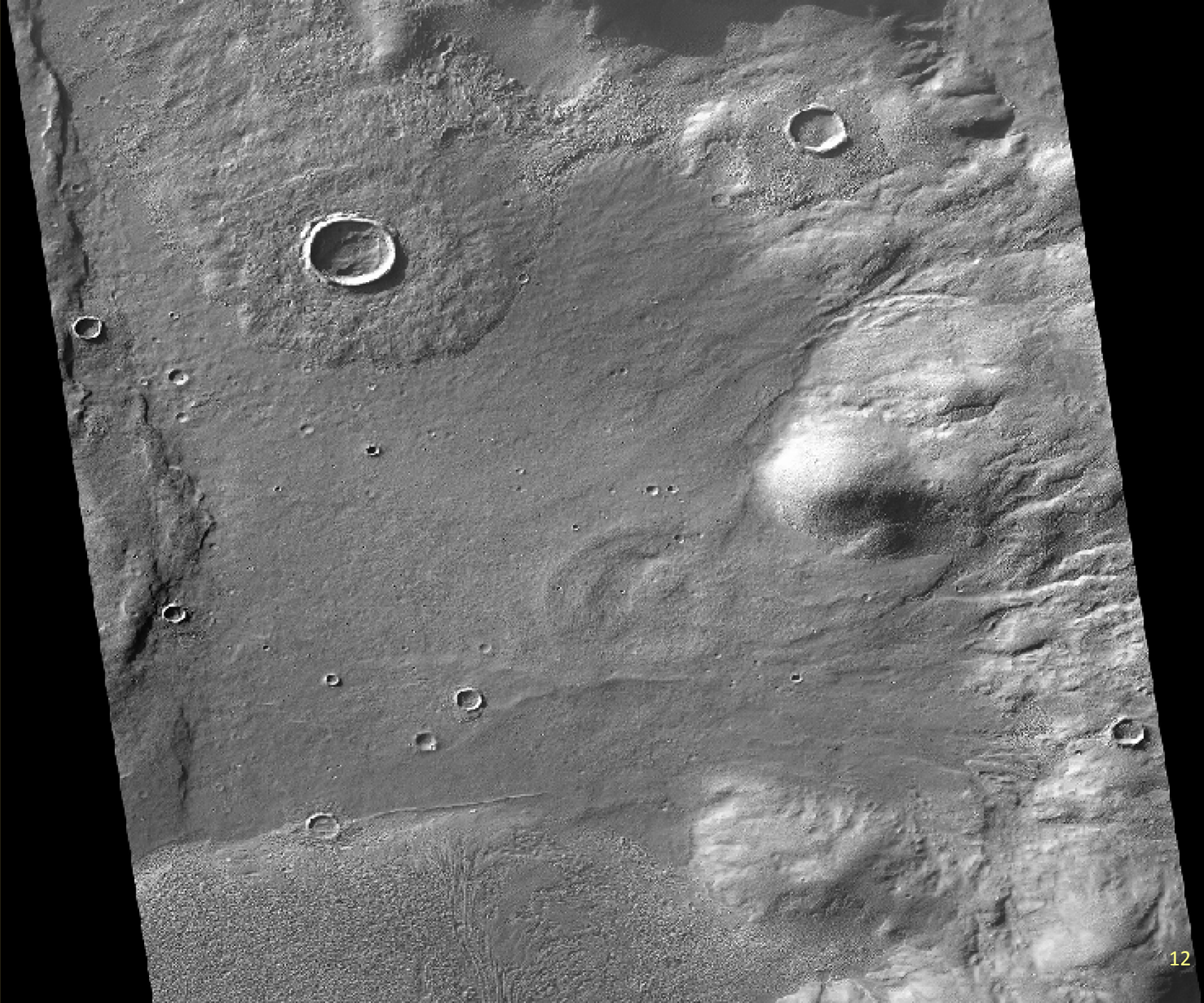
Nh₁

Basin-rim unit—Material of Hellas basin rim; consists of rugged, mountainous terrains with small sections of smooth deposits; dissected by channels which may extend onto younger materials; typically embayed by younger plains; heavily cratered. *Type area*: 39° S., 253.3° W. *Interpretation*: Impact-generated unit of ancient martian crust modified by fluvial and eolian processes [Greeley and Guest, 1987]; channel formation due to combination of ground water sapping and runoff.

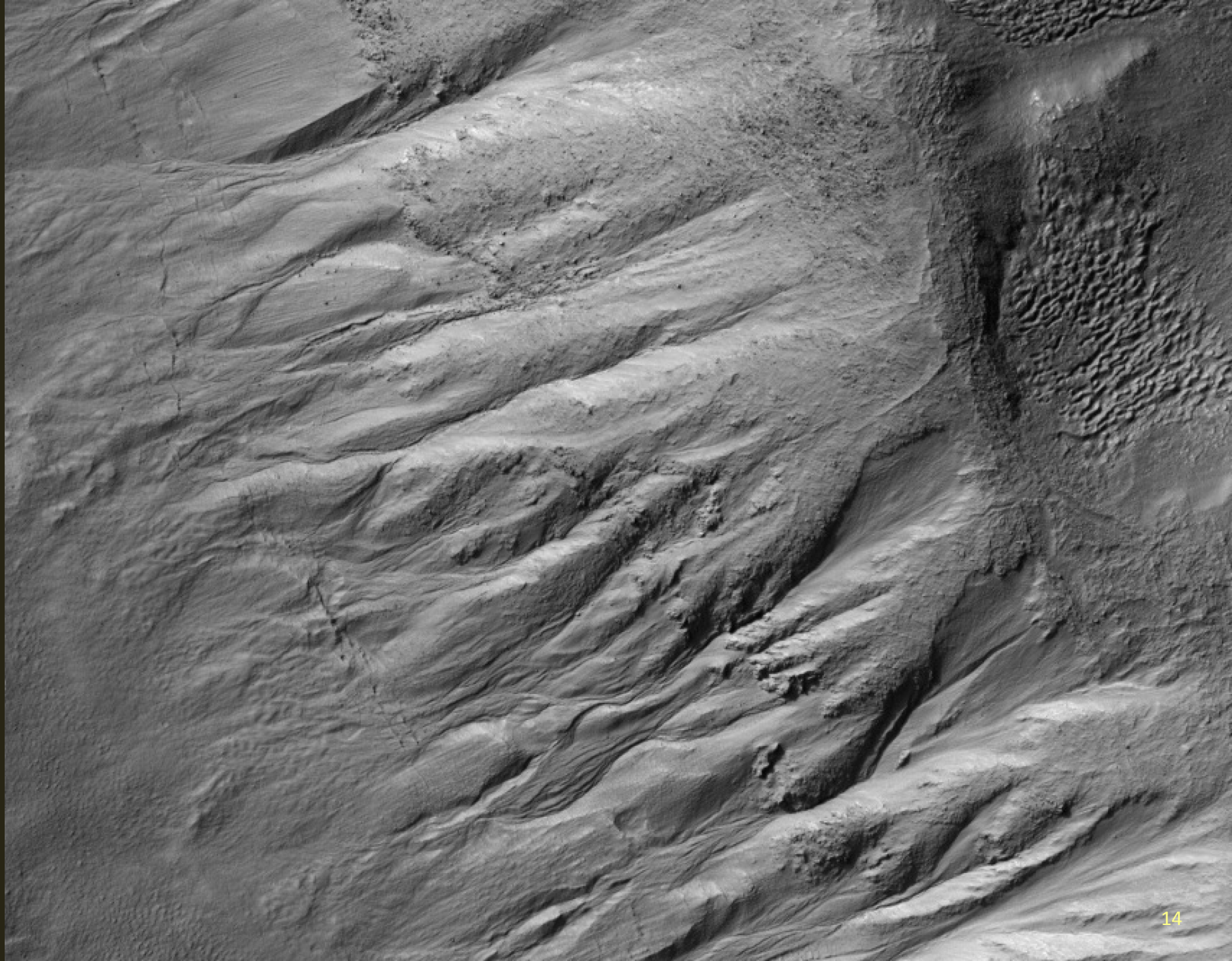
Nm

Mountainous material—Occurs throughout map area. Forms small to large, rugged, isolated massifs within basin-rim unit and younger units; typically embayed by younger plains; some surrounded by debris aprons. *Type area*: 41.4° S., 251.4° W. *Interpretation*: Ancient crustal material uplifted during formation of impact basins [Greeley and Guest, 1987]

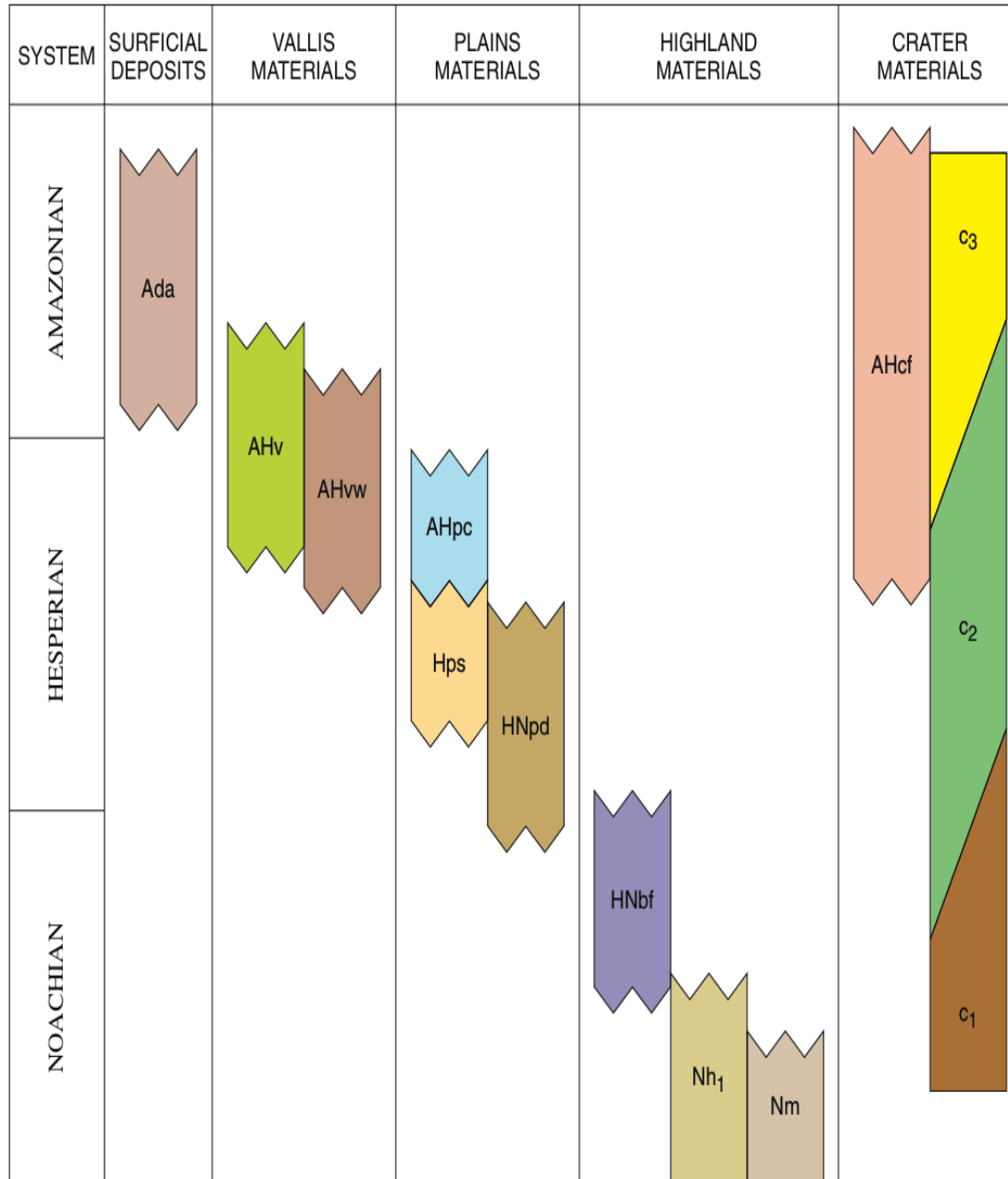








Correlation of Map Units



PLAINS MATERIALS

AHpc

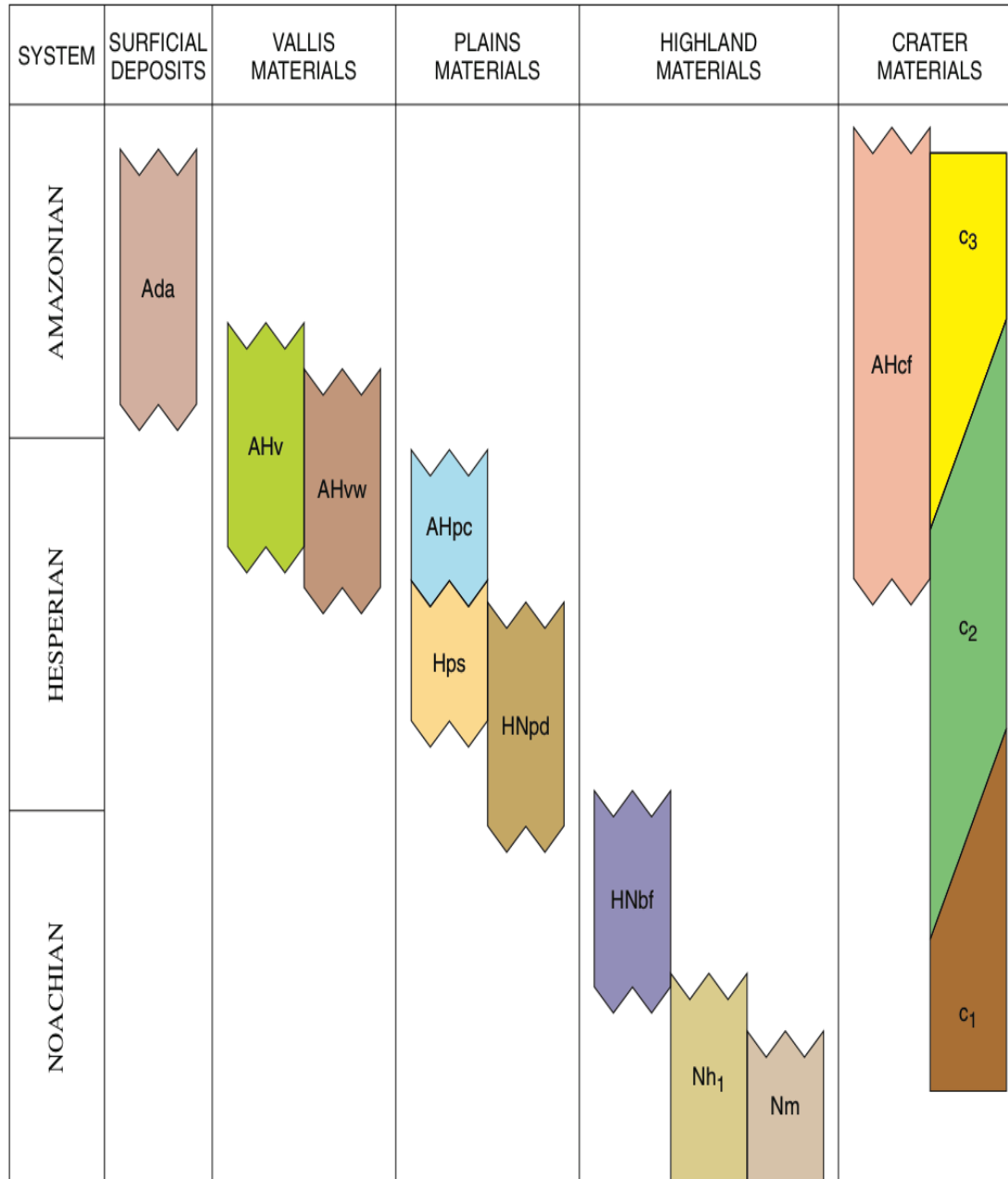
Channeled plains material—Occurs in the southwest corner of MTM –40257 and along segment 3 of Reull Vallis. Smooth to irregular surface characterized by ridges having subdued morphologies and degraded craters; dissected by channels and scarps south and west of map area; fluted where exposed along Reull Vallis and in a large side canyon south of the main canyon of Reull Vallis (south of map area). *Type area: 41.7° S., 258.5° W. Interpretation:* Material deposited following erosion of surrounding highland and plains materials Sinuous channels and scarps and degraded ridges and craters due to subsequent fluvial erosion of unit, possibly related to flooding from Reull Vallis. Mapped as smooth plains material (unit Hps) by Price [1998] and previously mapped as channeled plains rim unit (unit AHh5) by Greeley and Guest [1987], Mest [1998], and Mest and Crown 2001

Hps

Smooth plains material—Occurs adjacent to Reull Vallis and in northern part of MTM –40252. Consists of smooth, relatively featureless materials embaying highland units; some occurrences have lobate margins; appears pitted adjacent to Reull Vallis (MTM –40252). Wrinkle ridges within unit have subdued morphologies. Also occurs as flat-topped, scarp-bounded mesas south of Reull Vallis (MTM –40257) within channeled plains material. Lightly cratered. *Type area: 41° S., 256° W. Interpretation:* Sedimentary deposits resulting from overflow of water from Reull Vallis; emplaced as sediment-rich flows and (or) from transient body of water also may contain materials eroded from highland terrains [Mest and Crown, 2001]; subdued morphology of wrinkle ridges due to erosion and burial by plains material. Mapped as mesa material (unit AHm) by Price [1998] and previously included within smooth plateau unit (unit Hpl3) by Greeley and Guest [1987]



Correlation of Map Units



SURFICIAL DEPOSITS

Ada

Debris apron material—Smooth, featureless (in low- to medium-resolution images) surfaces with lobate fronts, may exhibit pits and (or) lineations (that is, longitudinal ridges and grooves); borders highland massifs, crater rims, and vallis walls. *Type areas:* 40.2° S., 251° W. (pits) and 42.3° S., 251.1° W. (lineations). *Interpretation:* Deposits of unconsolidated material resulting from mass wasting of rugged highland massifs, crater rims, and vallis walls; mobility possibly due to incorporation of water or ice [for example, Squyres and Carr, 1986; Crown and others, 1992]; pits may be from partial collapse of volatile-rich debris; longitudinal ridges and grooves may indicate sorting of material within the flow or shearing of debris as it flowed [Squyres, 1978, 1979]

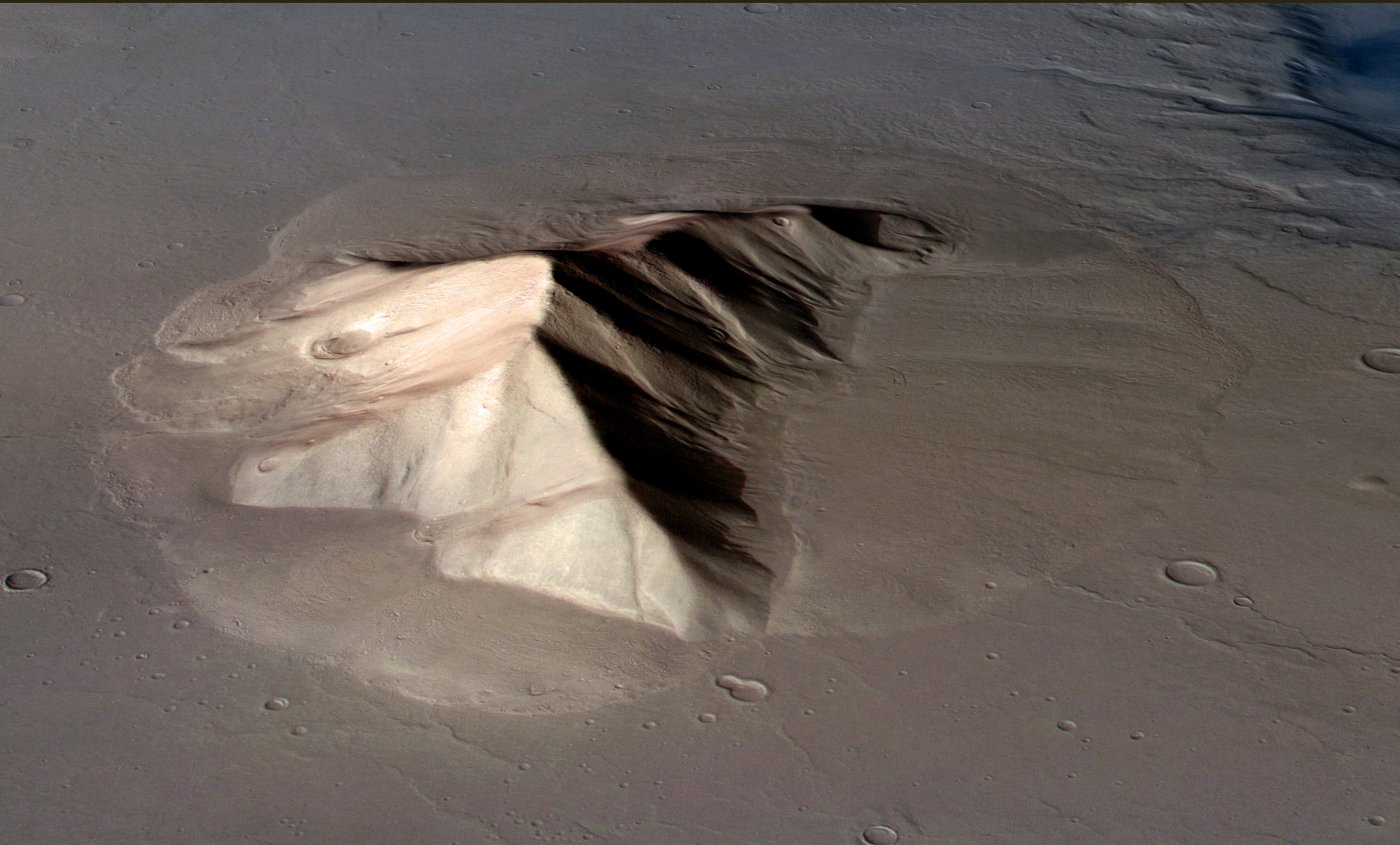
VALLIS MATERIALS

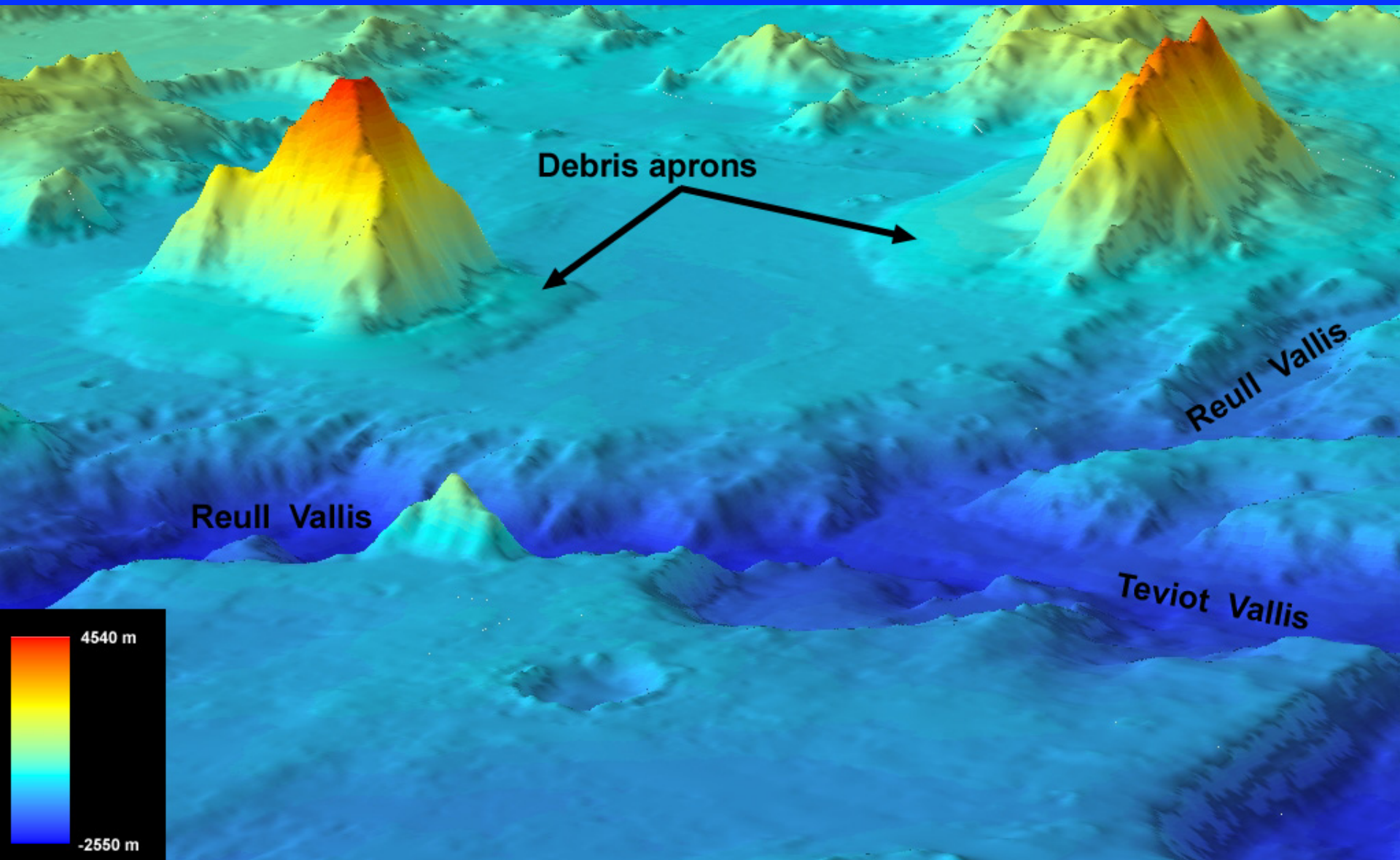
AHv

Vallis floor material—Deposits that form floor of Reull Vallis; lined parallel to vallis walls; smooth or pitted. *Type areas:* 40.2° S., 250° W. (lined), 42.4° S., 254.8° W. (smooth), and 40.7° S., 251° W. (pitted). *Interpretation:* Sedimentary material of surrounding units [Crown and others, 1992; Tanaka and Leonard, 1995] emplaced by a combination of collapse and fluid flow; modified by small-scale deflation and fluvial redistribution; pits may result from partial collapse of volatile-rich material; lineations may be related to flow of water through the canyon and/or from coalescing debris aprons [Squyres, 1978]

AHvw

Vallis wall material—Smooth deposits occurring at base of walls of Reull Vallis, typically overlain by vallis floor material. *Type area:* 40.5° S., 250.4° W. *Interpretation:* Materials eroded from highland and plains units deposited at the base of the walls of Reull Vallis, similar to talus





Lobate Debris Aprons (LDAs)

LDAs gently sloping surfaces with convex upward margins and both radial and concentric ridge-furrow lineations: indicates flow of viscous material.

- LDA morphology and structure suggest ice content > 50%
- Estimate is consistent with those based on detailed topographic profiles and rheological arguments

LDAs

Ice Volume

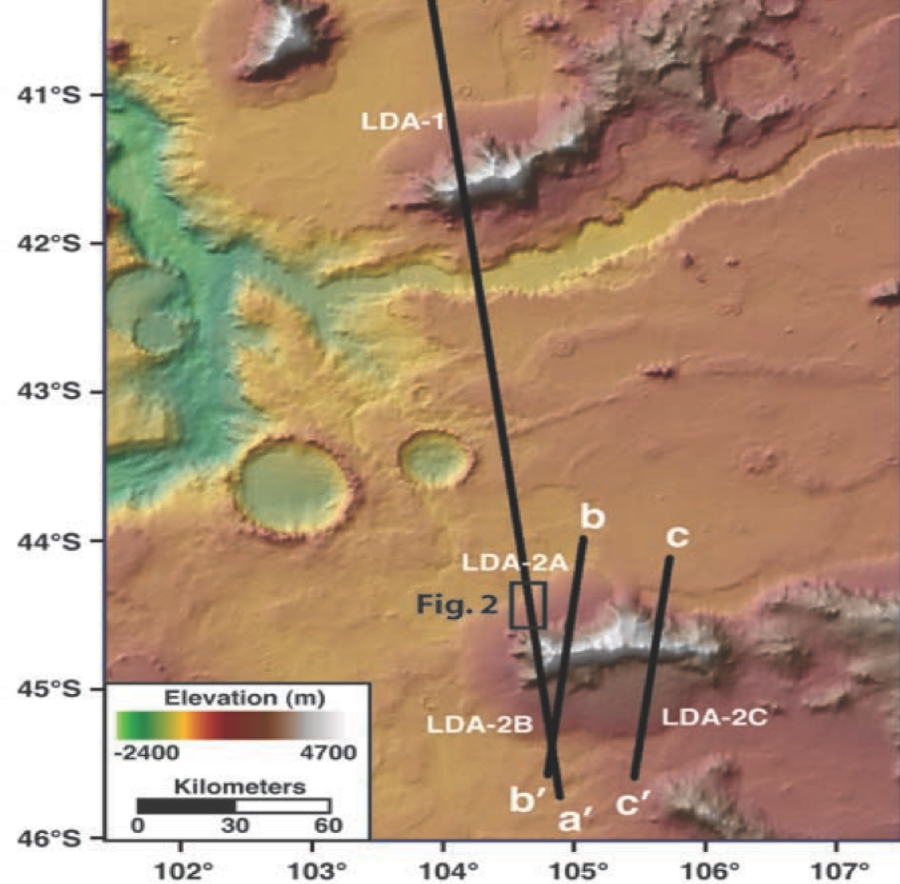
Volume estimates from surface morphology and SHARAD indicate that up to $\sim 28,000 \text{ km}^3$ of water ice sequestered in E.

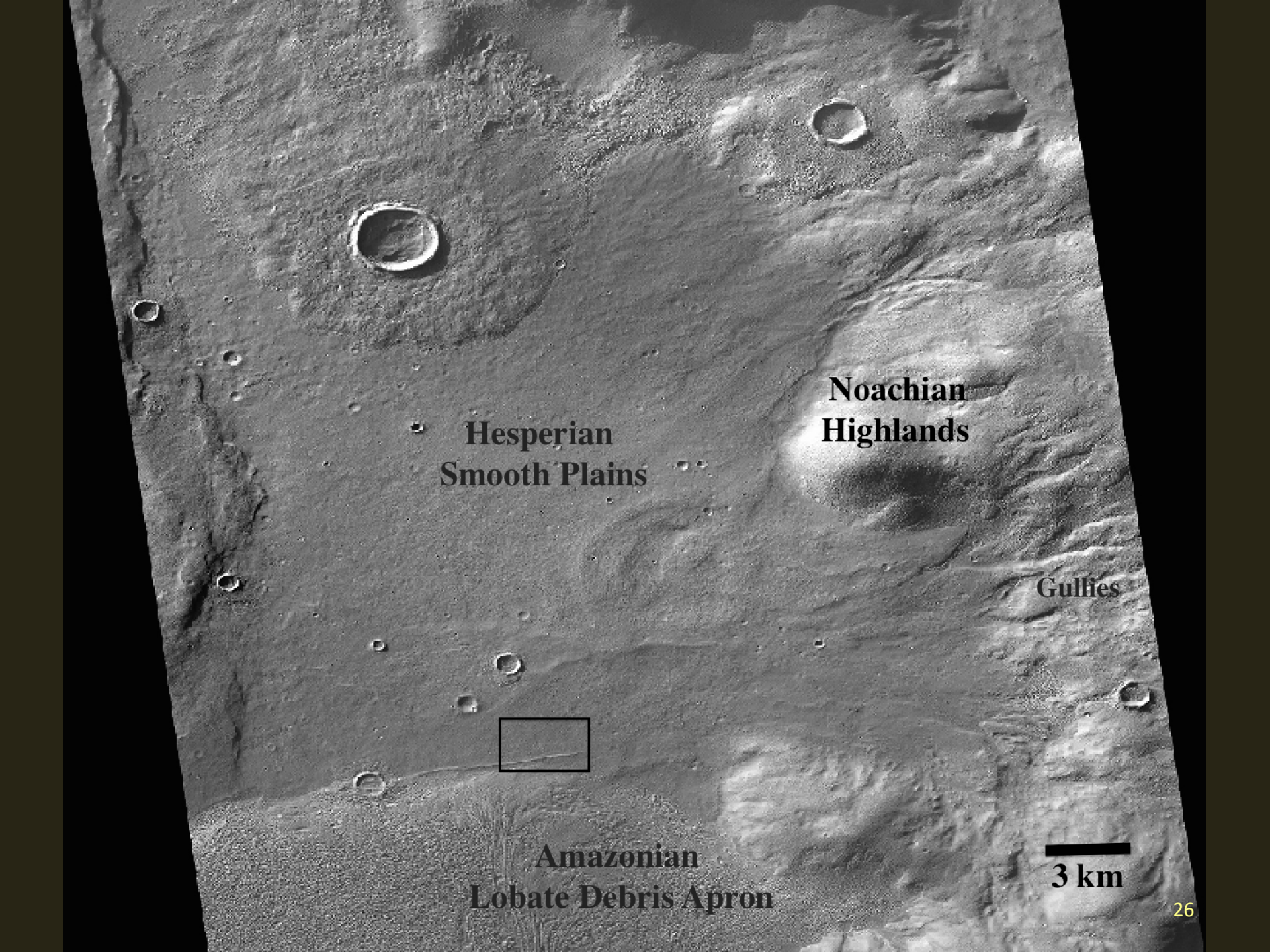
Hellas LDAs. Largest non polar ice deposit on Mars (Holt et al., 2008)

Ice Dominated Deposits

SHARAD radar data indicate that the material is largely homogeneous dominated by ice with small fraction of dust or rock and lacks significant fraction of large rock fragments.







**Hesperian
Smooth Plains**

**Noachian
Highlands**

Gullies

**Amazonian
Lobate Debris Apron**

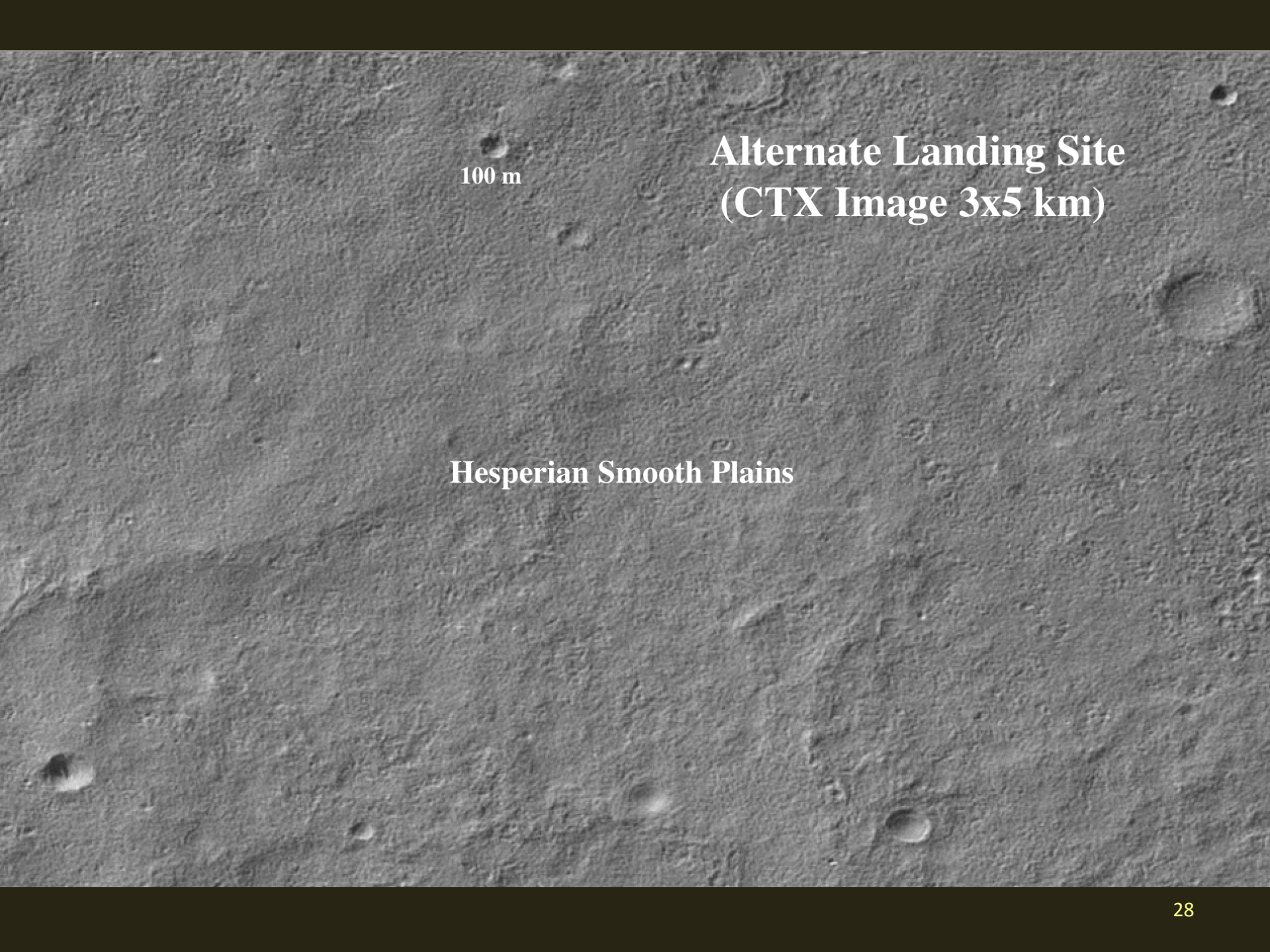
3 km

Candidate Landing Site
(CTX Image 3x5 km)

100 m

Hesperian Smooth Plains

Amazonian Lobate Debris Apron

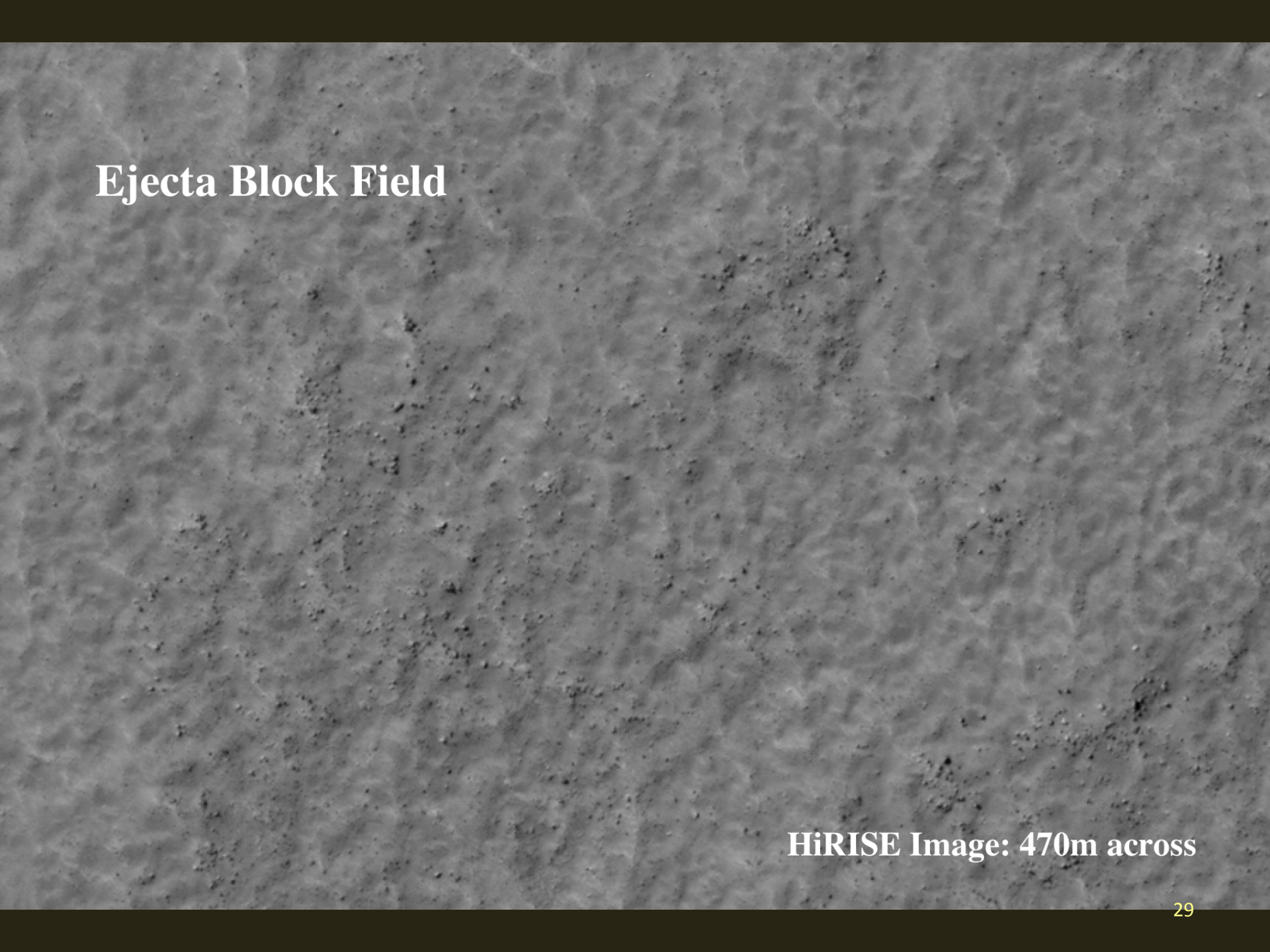


100 m

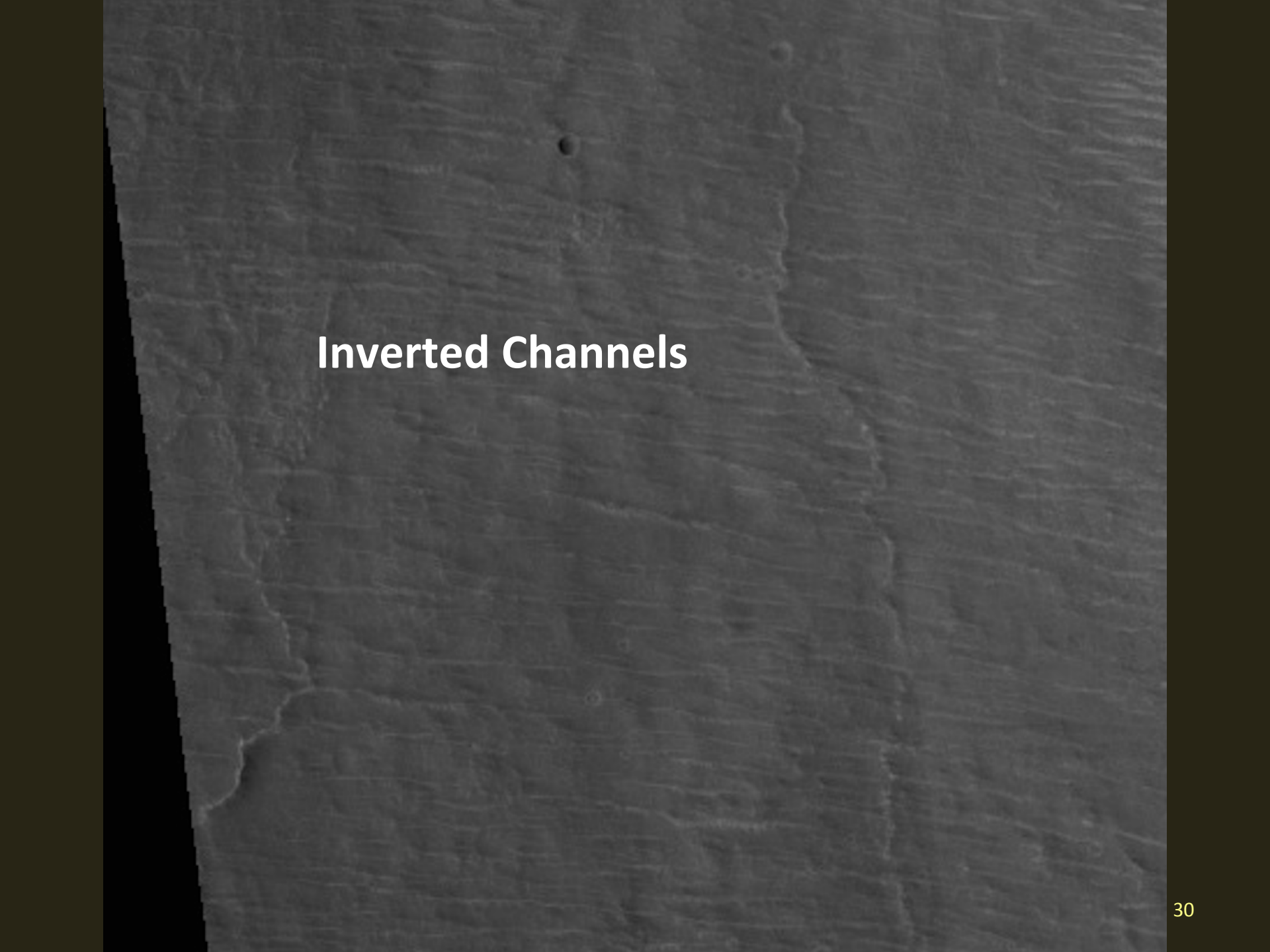
**Alternate Landing Site
(CTX Image 3x5 km)**

Hesperian Smooth Plains

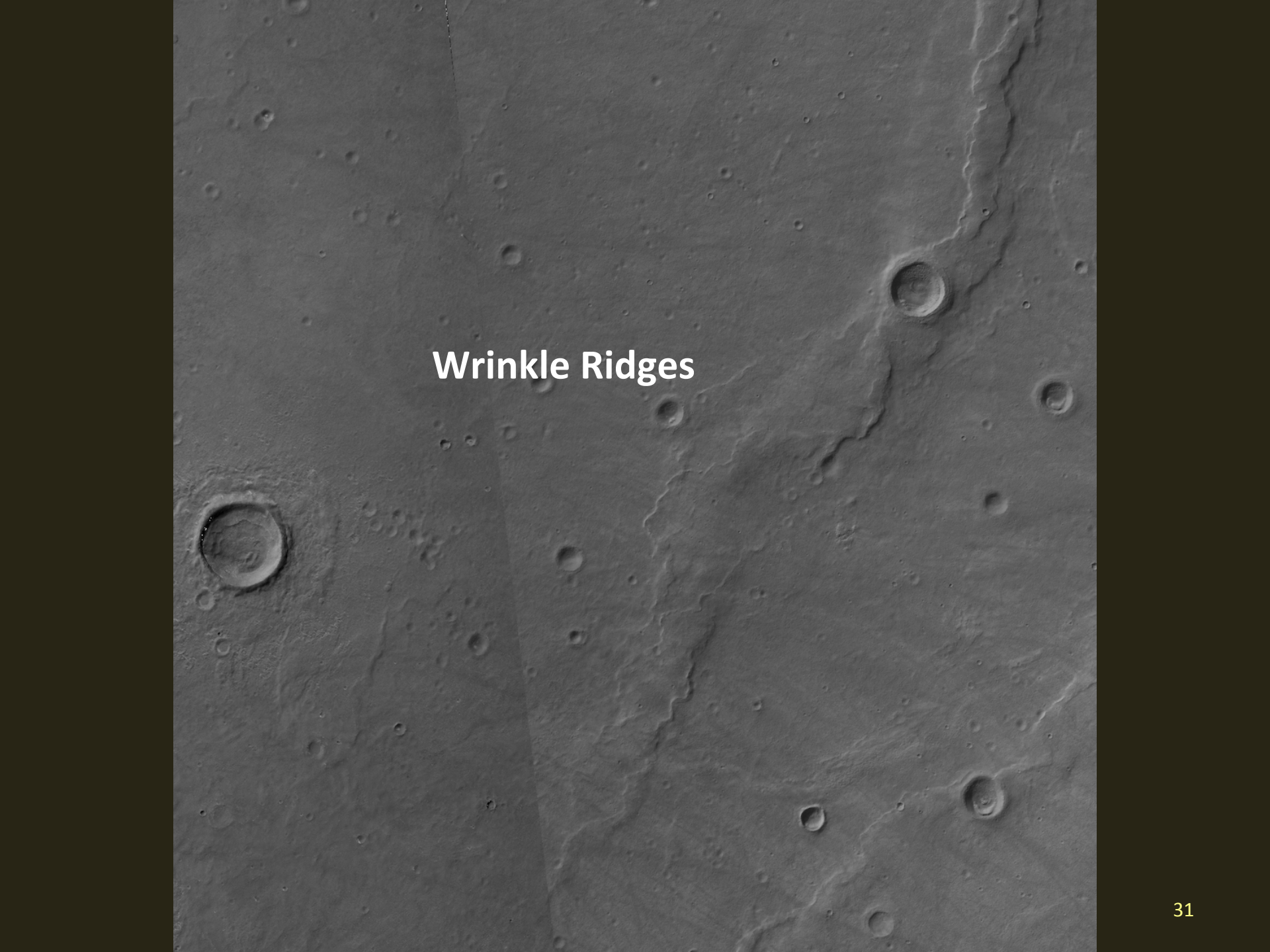
Ejecta Block Field

A grayscale HiRISE image of a planetary surface, likely Mars, showing a field of dark, irregularly shaped ejecta blocks scattered across a lighter, textured background. The blocks vary in size and are concentrated in certain areas, creating a mottled appearance. The overall texture of the surface is granular and uneven.

HiRISE Image: 470m across



Inverted Channels



Wrinkle Ridges

Site Factors				SR011	SR012	SR013	SR014	SR015	SR016	SR017	RR011	EZ SUM	
Science Site Criteria	Astrobio	Threshold	AND/OR	Potential for past habitability	●	●	●	●	●	●	●	●	8
				Potential for present habitability/refugia	●	●	●	●	●	●	●	8	
		Qualifying		Potential for organic matter, w/ surface exposure	?	?	?	?	?	?	?	8	
	Atmospheric Science	Threshold		Noachian/Hesperian rocks w/ trapped atmospheric gases	○	○	○	○	○	○	○	8	
		Qualifying		Meteorological diversity in space and time	○	○	○	○	○	○	○	8	
				High likelihood of surface-atmosphere exchange	●	●	●	●	●	●	●	8	
				Amazonian subsurface or high-latitude ice or sediment	●	●	●	●	●	●	●	8	
				High likelihood of active trace gas sources	?	?	?	?	?	?	?	8	
	Geoscience	Threshold		Range of martian geologic time; datable surfaces	●	●	●	●	●	●	●	8	
				Evidence of aqueous processes	●	●	●	●	●	●	●	8	
				Potential for interpreting relative ages	●	●	●	●	●	●	●	8	
		Qualifying		Igneous Rocks tied to 1+ provinces or different times	●	●	●	●	●	●	●	8	
				Near-surface ice, glacial or permafrost	●	●	●	●	●	●	●	8	
				Noachian or pre-Noachian bedrock units	●	●	●	●	●	●	●	8	
			Outcrops with remnant magnetization	○	○	○	○	○	○	○	8		
			Primary, secondary, and basin-forming impact deposits	●	●	●	●	●	●	●	8		
			Structural features with regional or global context	●	●	●	●	●	●	●	8		
	Diversity of aeolian sediments and/or landforms	○	○	○	○	○	○	○	8				

Key

●	Yes
○	Partial Support or Debated
	No
?	Indeterminate

ISRU and Civil Engineering Criteria					Site Factors								SRO11	SRO12	SRO13	SRO14	SRO15	SRO16	SRO17	RR011	EZ SUM
Engineering		Meets First Order Criteria (Latitude, Elevation, Thermal Inertia)																			
Water Resource	Threshold	AND/OR	Potential for ice or ice/regolith mix																		
			Potential for hydrated minerals																		
		Quantity for substantial production																			
		Potential to be minable by highly automated systems																			
		Located less than 3 km from processing equipment site																			
		Located no more than 3 meters below the surface																			
		Accessible by automated systems																			
	Qualifying	Potential for multiple sources of ice, ice/regolith mix and hydrated minerals																			
		Distance to resource location can be >5 km																			
		Route to resource location must be (plausibly) traversable																			
Civil Engineering	Threshold	~50 sq km region of flat and stable terrain with sparse rock distribution																			
		1–10 km length scale: <10°																			
		Located within 5 km of landing site location																			
	Qualifying	Located in the northern hemisphere																			
		Evidence of abundant cobble sized or smaller rocks and bulk, loose regolith																			
		Utilitarian terrain features																			
Food Production	Qualifying	Low latitude																			
		No local terrain feature(s) that could shadow light collection facilities																			
		Access to water																			
		Access to dark, minimally altered basaltic sands																			
Metal/Silicon Resource	Threshold	Potential for metal/silicon																			
		Potential to be minable by highly automated systems																			
		Located less than 3 km from processing equipment site																			
		Located no more than 3 meters below the surface																			
	Accessible by automated systems																				
	Qualifying	Potential for multiple sources of metals/silicon																			
		Distance to resource location can be >5 km																			
Route to resource location must be (plausibly) traversable																					

Key	
●	Yes
○	Partial Support or Debated
	No
?	Indeterminate

