

# New Results from Geologic Mapping of Gusev Crater: Implications for Extended Mission Targets

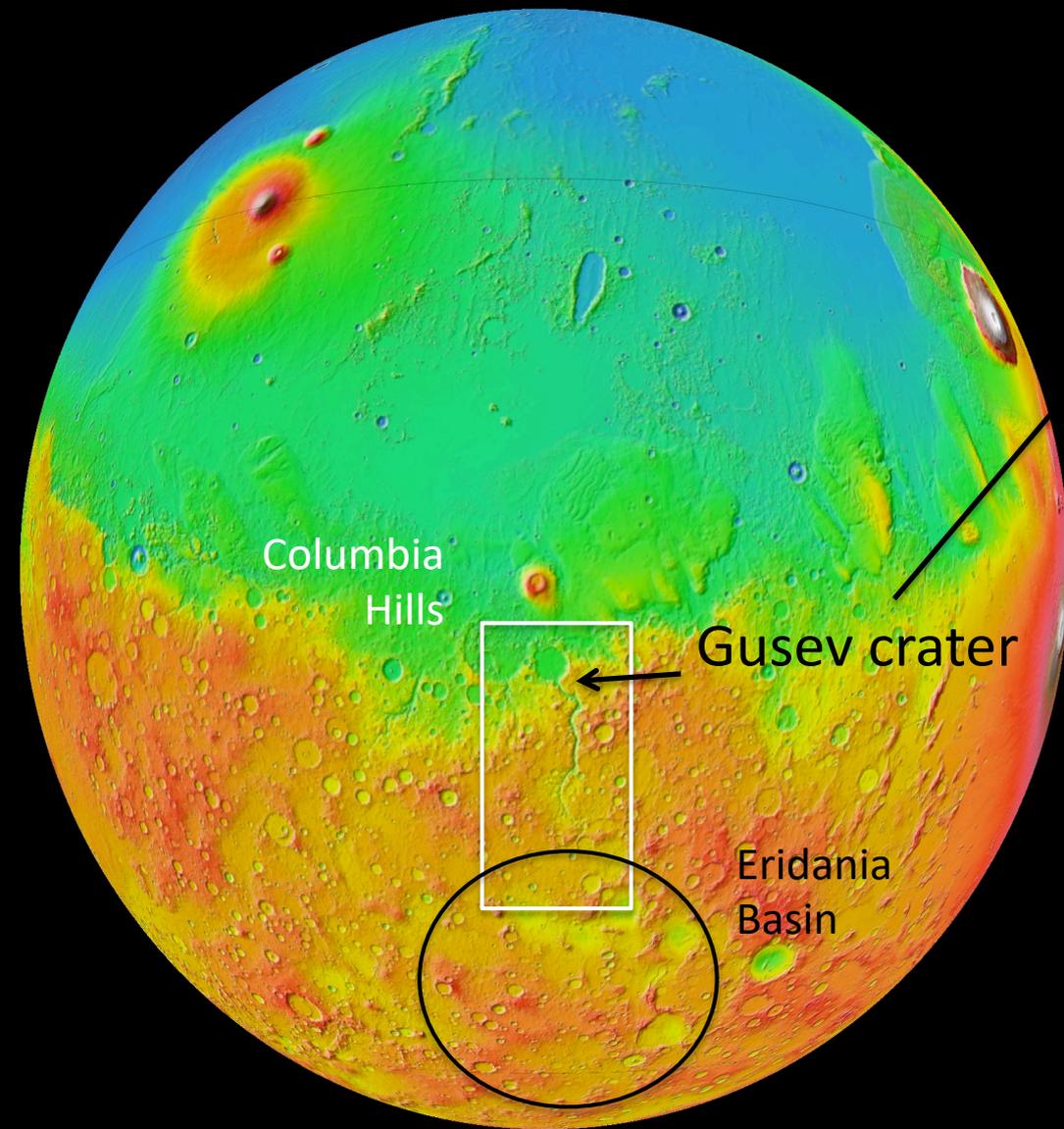
A high-angle photograph of a Mars rover, likely Curiosity, positioned on a rocky, reddish-brown terrain. The rover is white and black, with six large, treaded wheels. It is facing towards the right of the frame. In the background, a large, dark, circular crater is visible, surrounded by a low ridge. The sky is a hazy, orange-brown color, typical of the Martian atmosphere.

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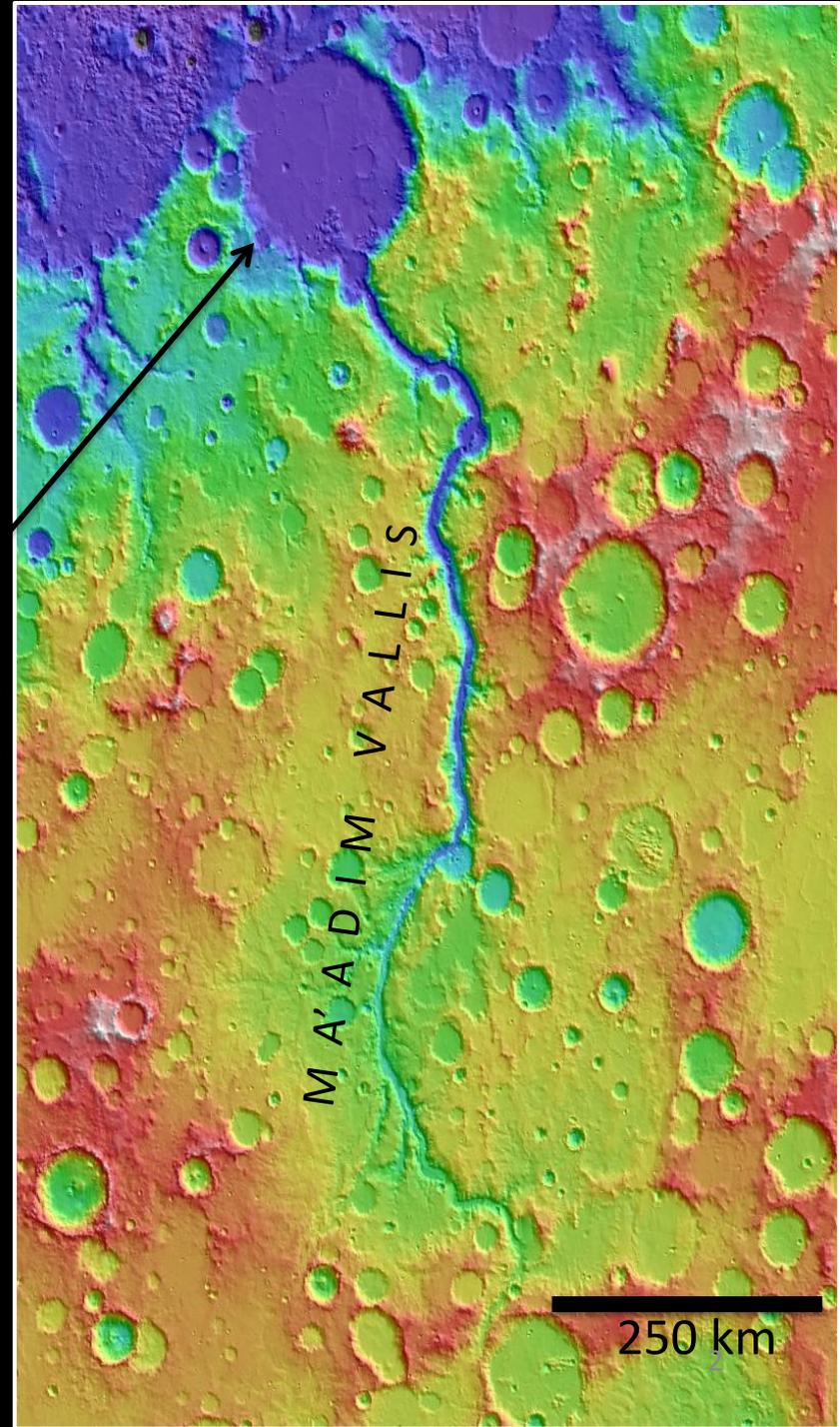
# Context



Columbia  
Hills

Gusev crater

Eridania  
Basin



M A' A D I M V A L L I S

250 km

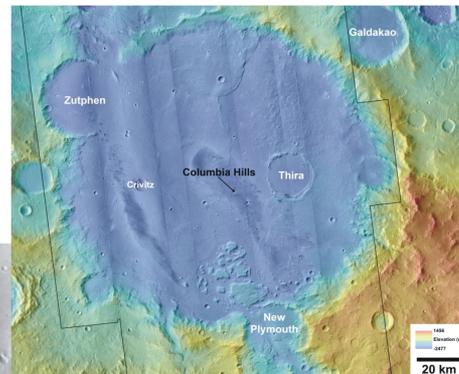
MOLA elevation



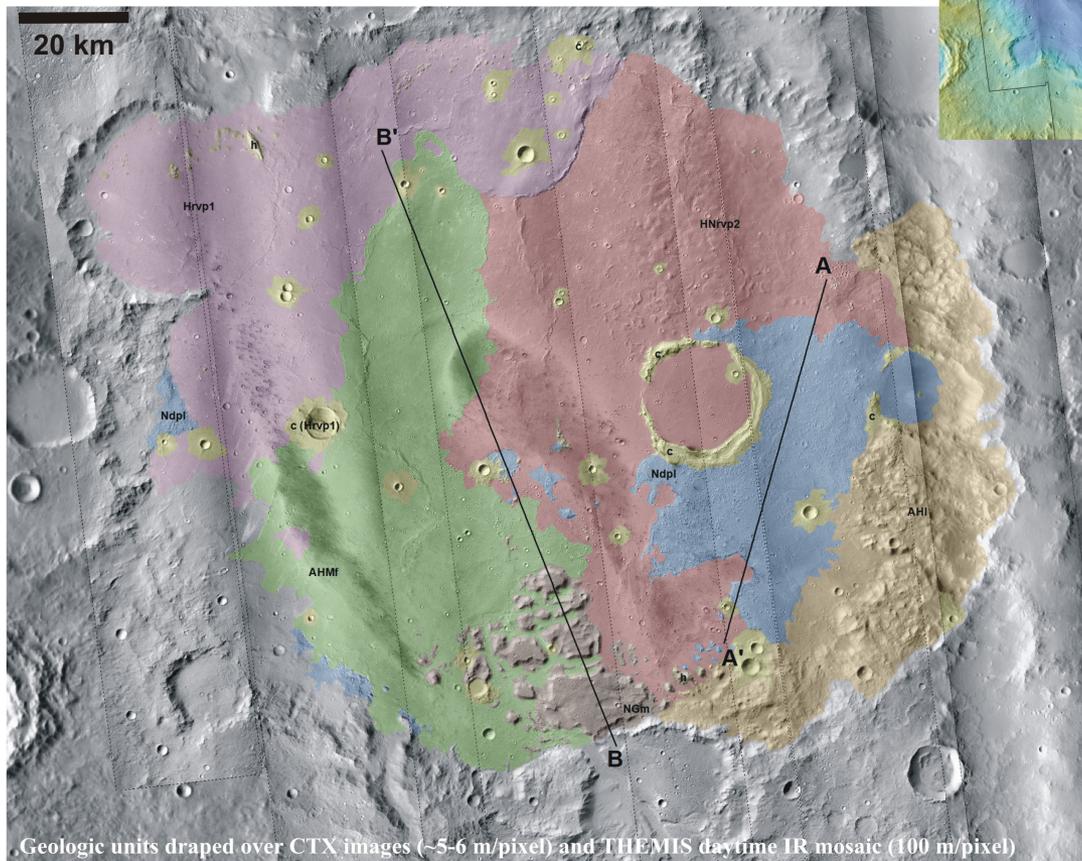
# New Results From Geologic Mapping of Gusev Crater: Implications for Extended Mission Targets

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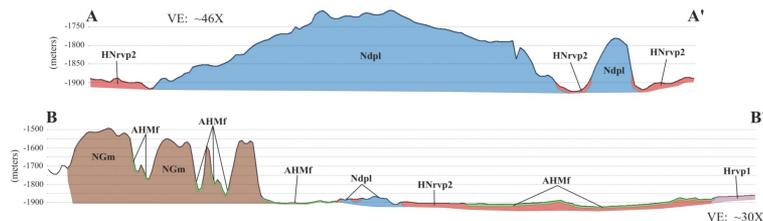
Above: MOLA DEM draped over CTX images (~5-6 m/pixel) and THEMIS daytime IR mosaic (100 m/pixel)



Geologic units draped over CTX images (~5-6 m/pixel) and THEMIS daytime IR mosaic (100 m/pixel)

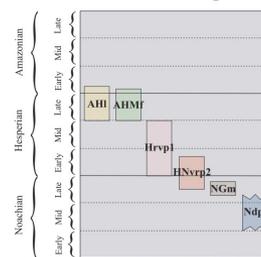
## GEOLOGIC UNITS

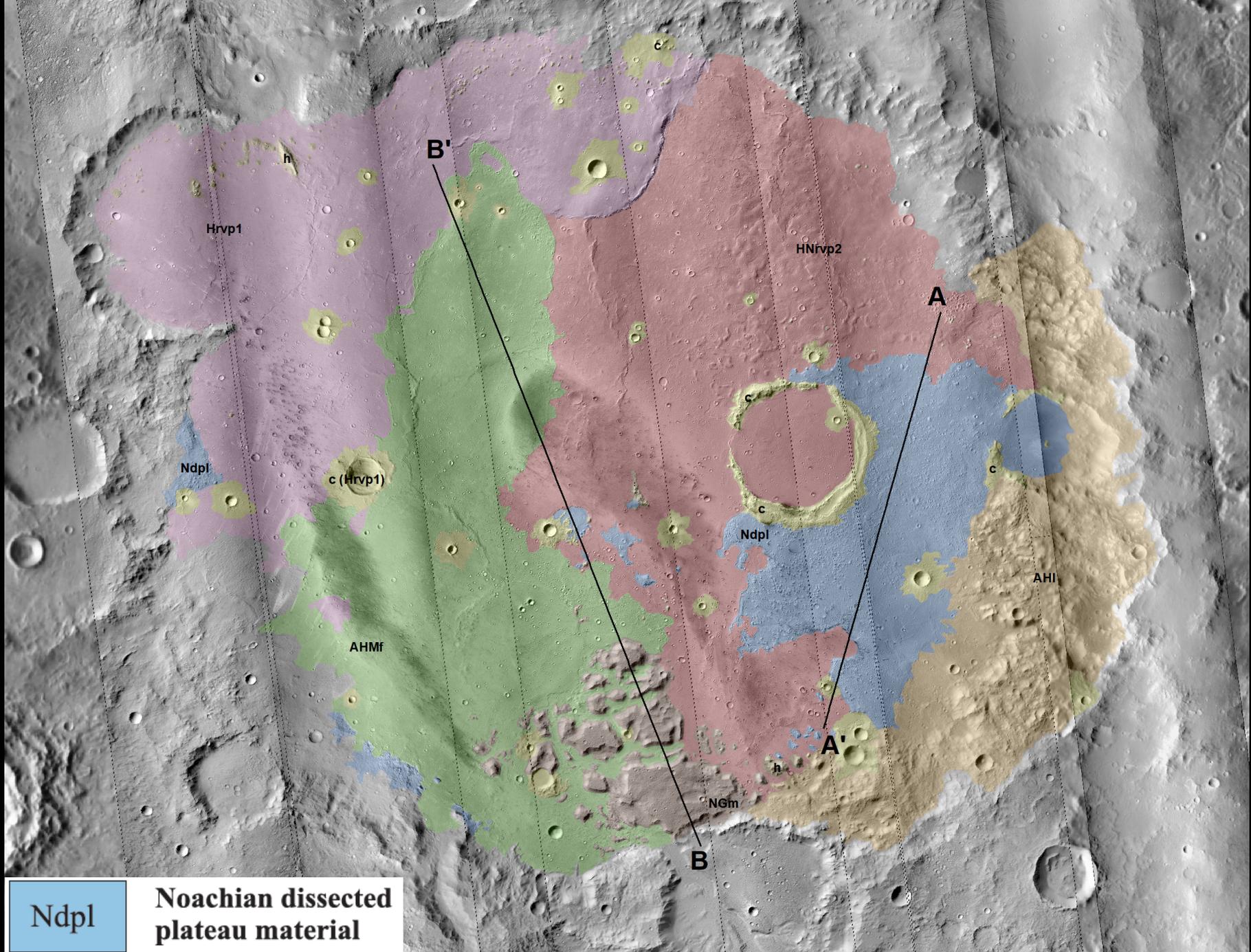
- h Hill material
- c Crater material
- AHl Amazonian-Hesperian landslide material
- AHMf Amazonian-Hesperian Ma'adim debris flow
- Hrvp1 Hesperian ridged volcanic plains 1
- HNrvp2 Hesperian-Noachian ridged volcanic plains 2
- NGm Noachian Gusev mesa material
- Ndpi Noachian dissected plateau material



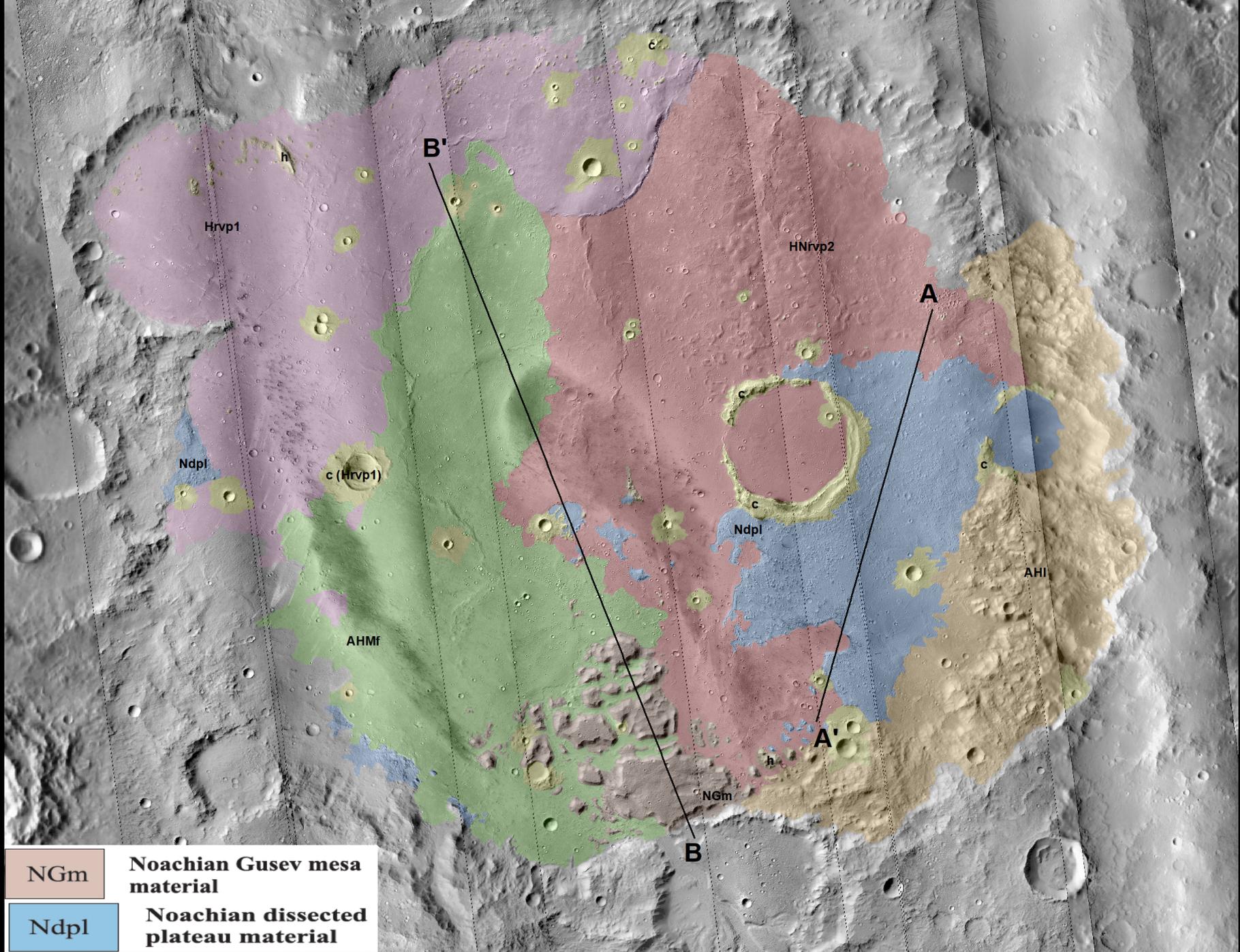
MOLA Topographic Profiles A-A' and B-B' (~463 m/pixel resolution)

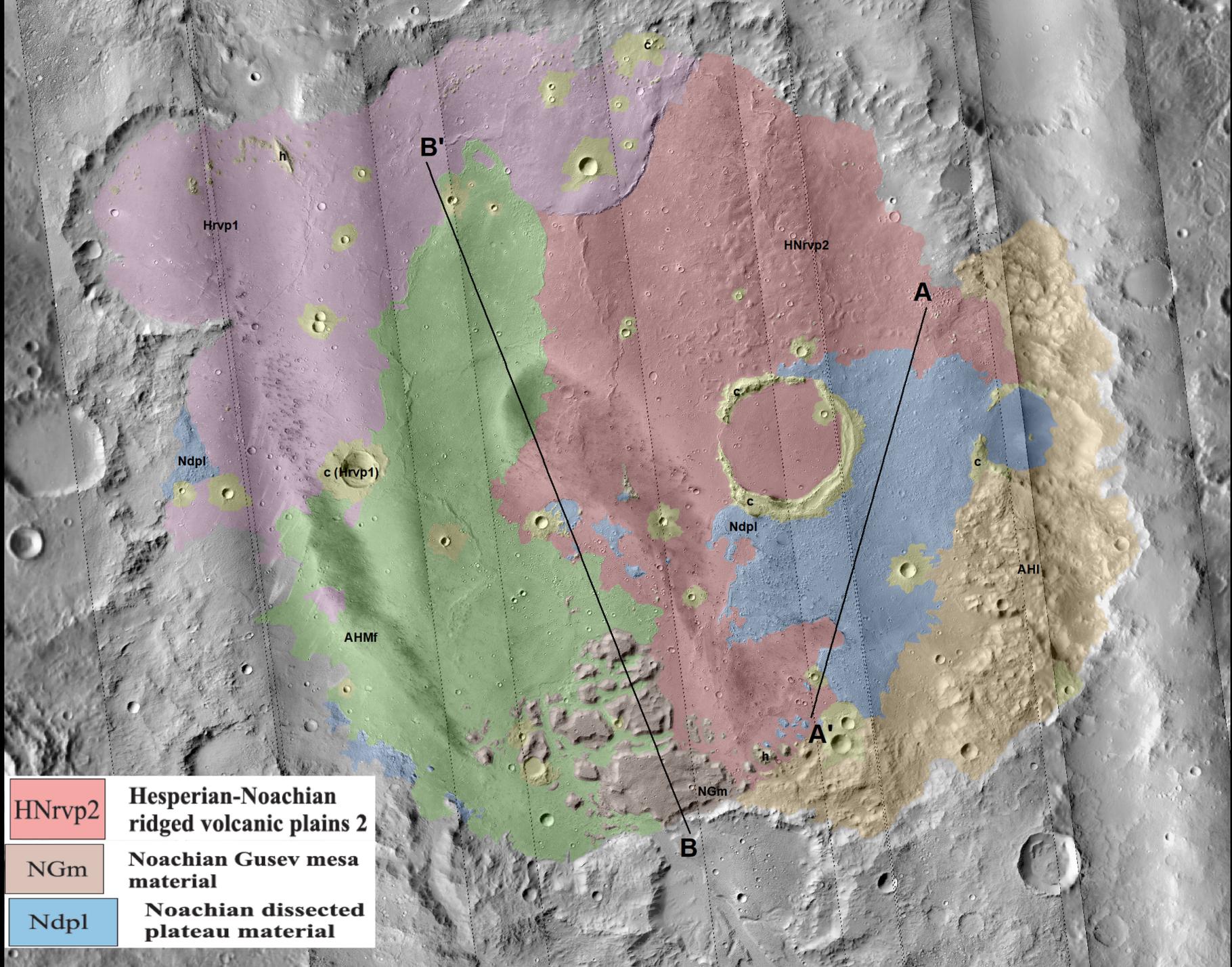
## Correlation of Map Units





**Ndpl** Noachian dissected plateau material





HNrvp2

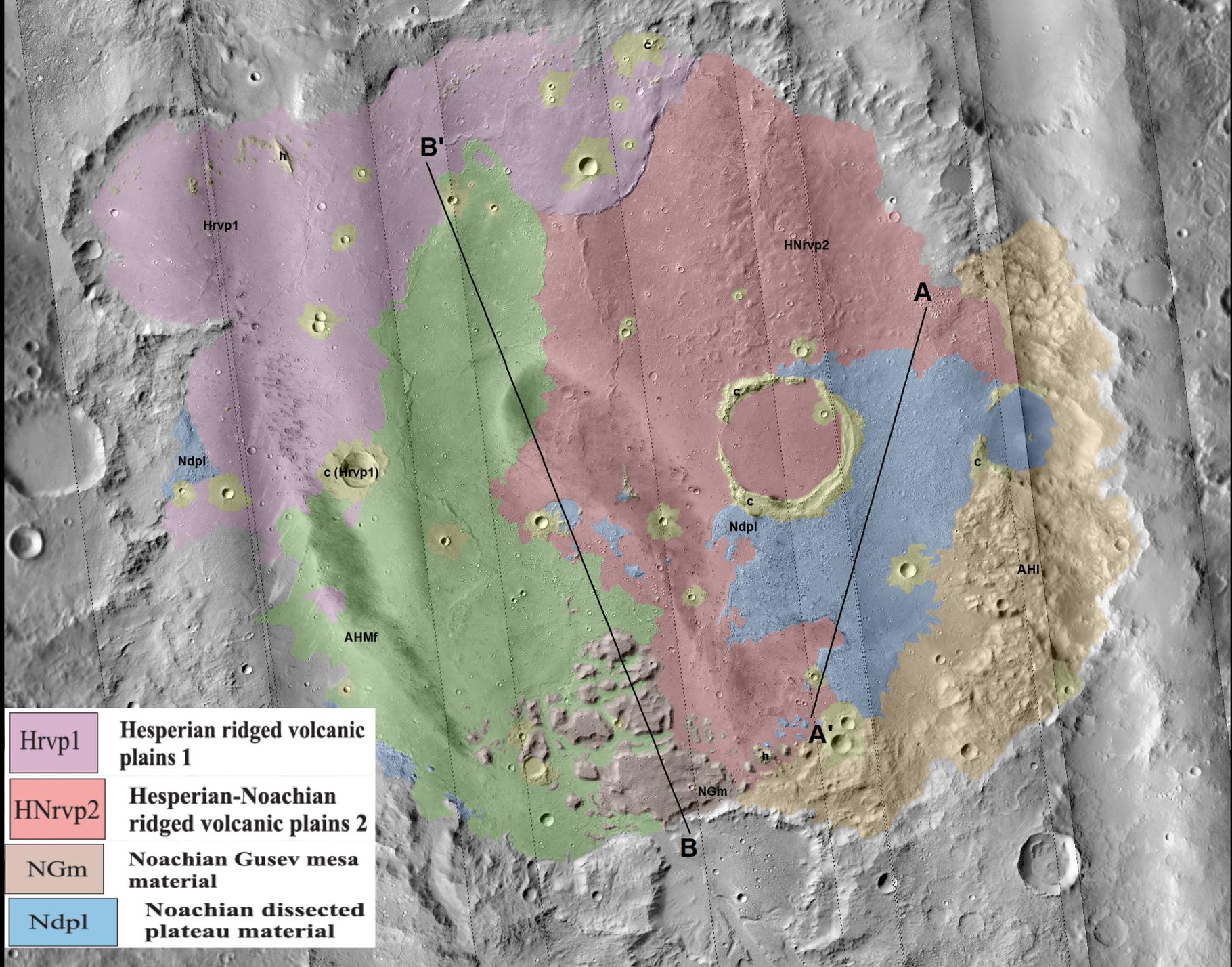
**Hesperian-Noachian  
ridged volcanic plains 2**

NGm

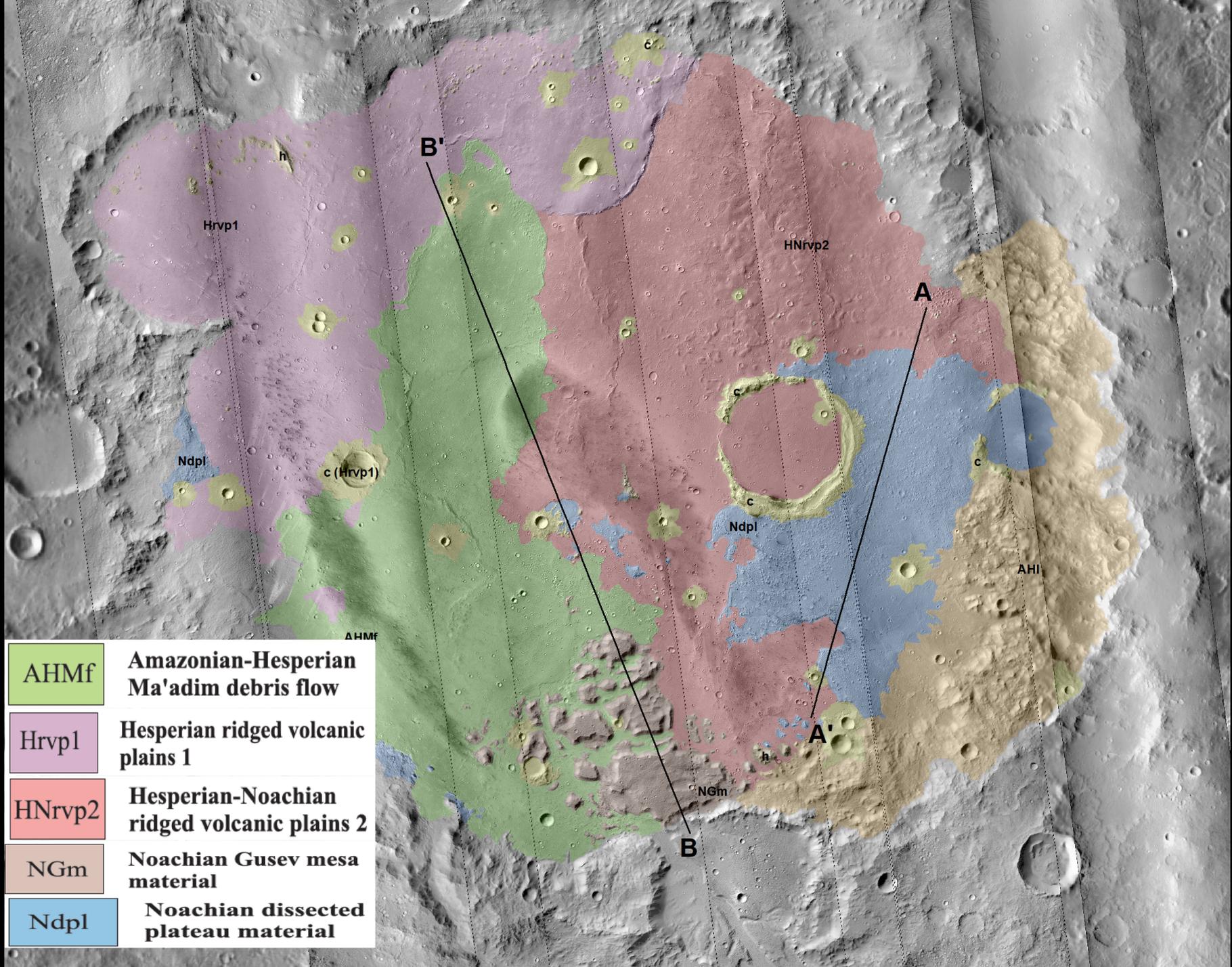
**Noachian Gusev mesa  
material**

Ndpl

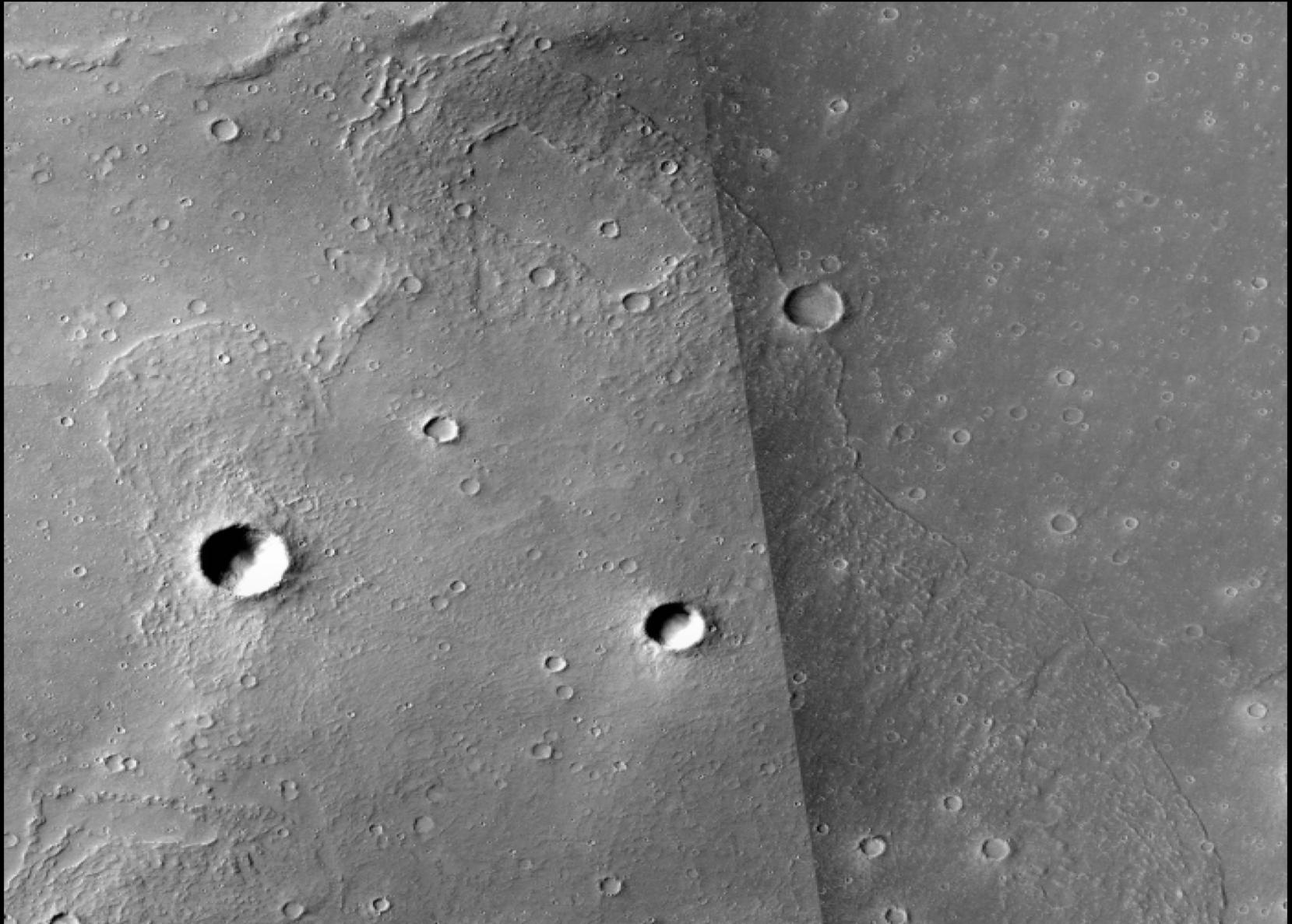
**Noachian dissected  
plateau material**

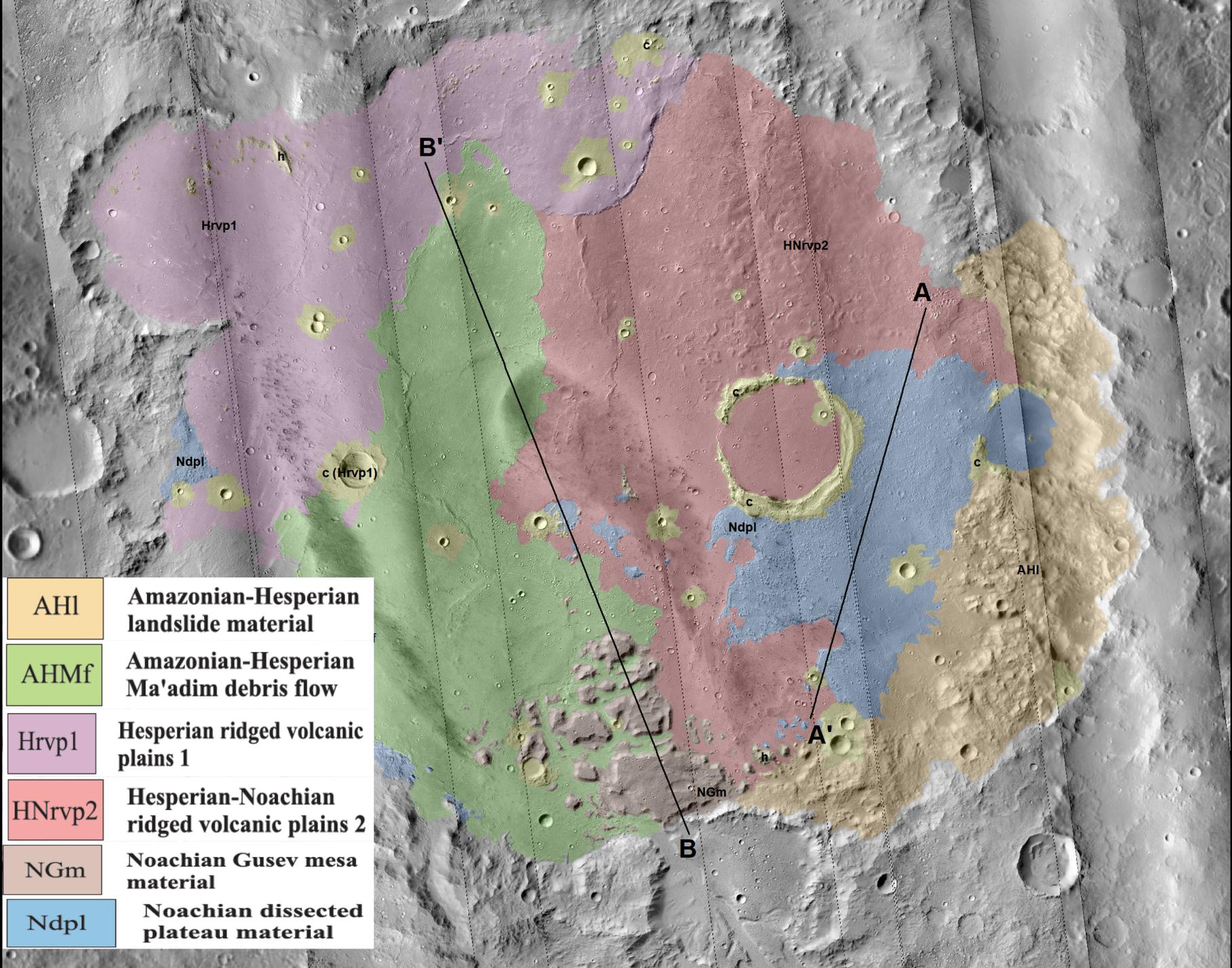


Hrvp1	Hesperian ridged volcanic plains 1
HNrvp2	Hesperian-Noachian ridged volcanic plains 2
NGm	Noachian Gusev mesa material
Ndpl	Noachian dissected plateau material



# Ma'adim Vallis Debris Flow





AHI	Amazonian-Hesperian landslide material
AHMf	Amazonian-Hesperian Ma'adim debris flow
Hrvp1	Hesperian ridged volcanic plains 1
HNrvp2	Hesperian-Noachian ridged volcanic plains 2
NGm	Noachian Gusev mesa material
Ndpl	Noachian dissected plateau material

Hrvp1

Ndpl

c (Hrvp1)

HNrvp2

NGm

B'

B

A

A'

AHI

h

c

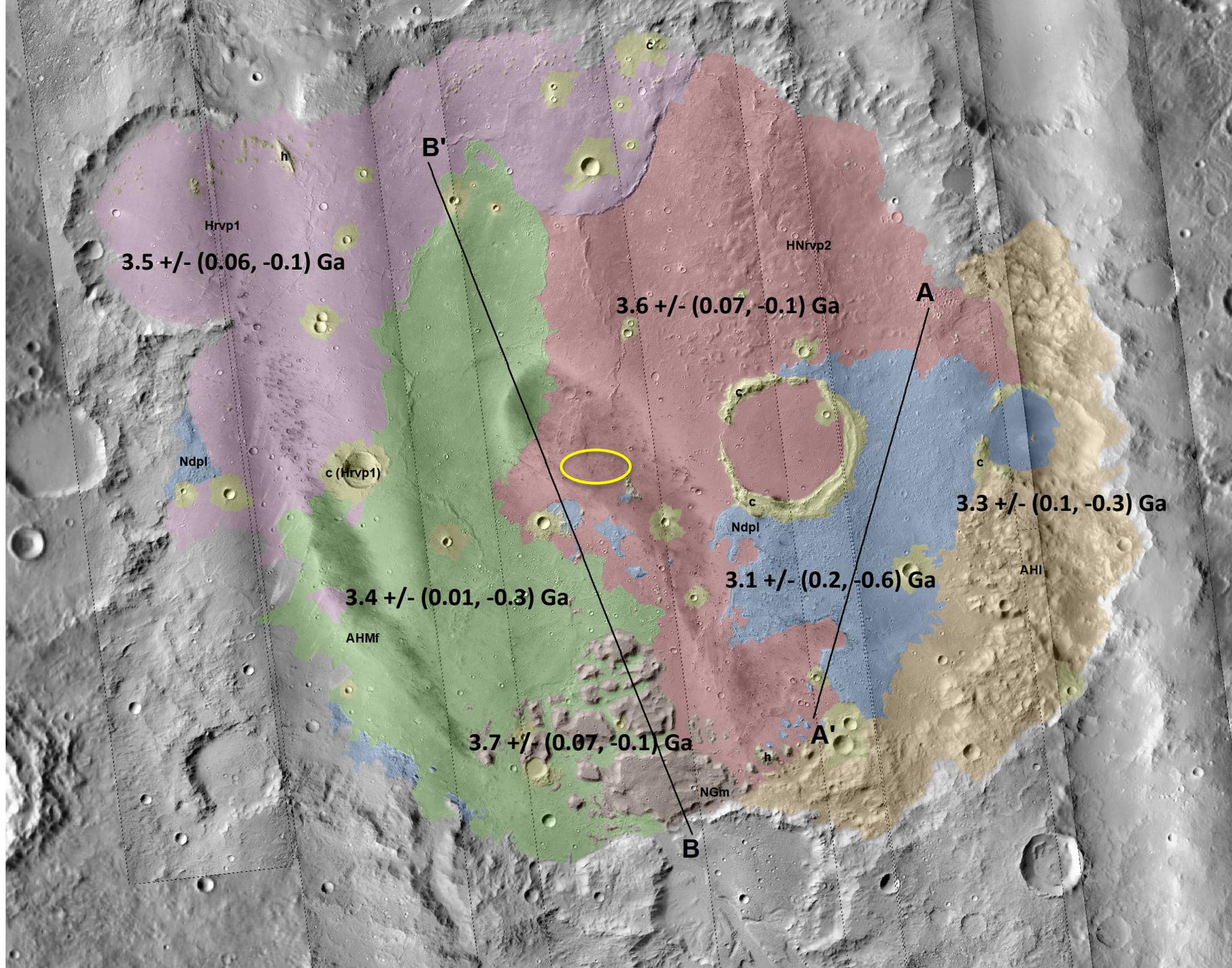
c

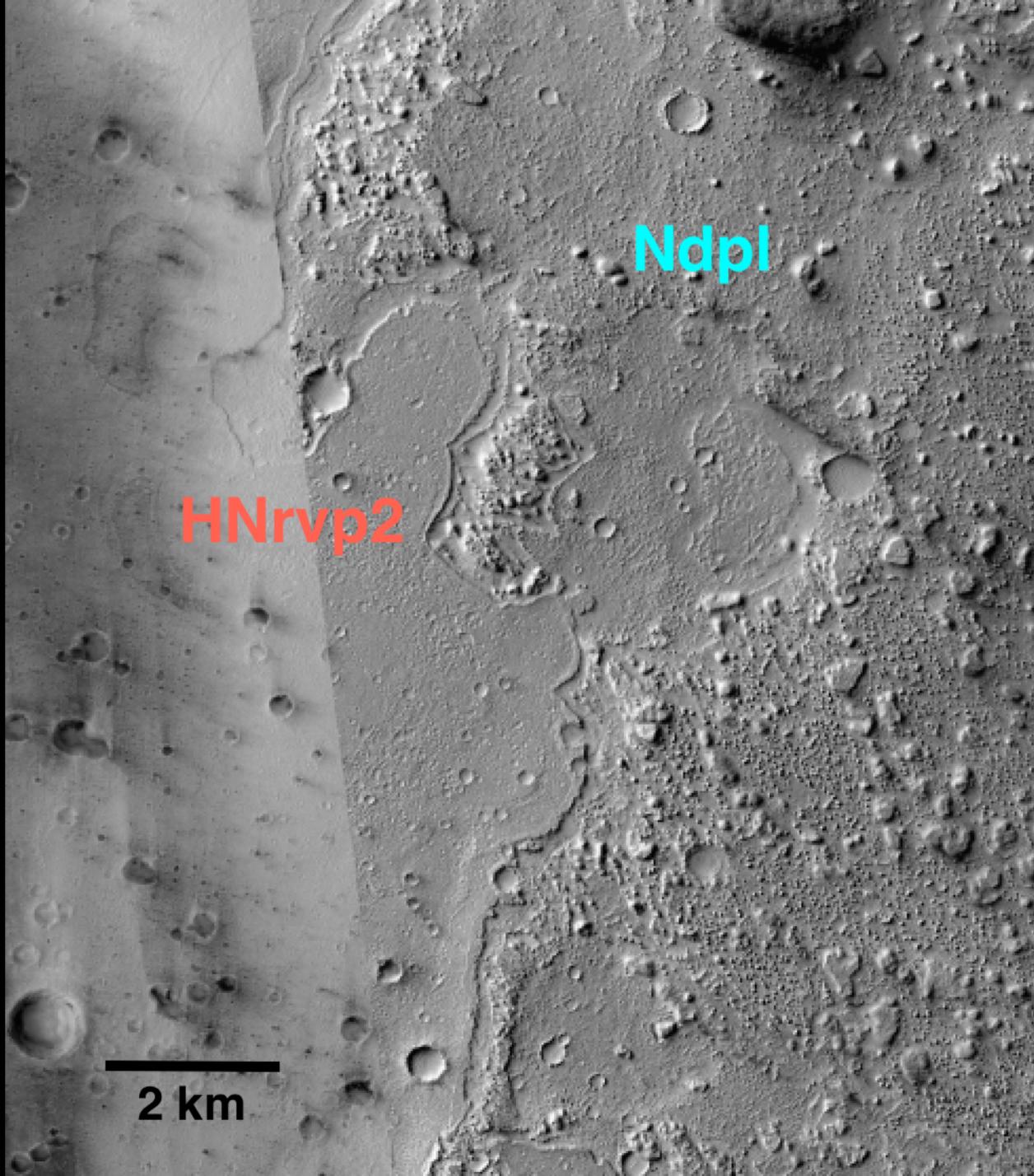
c

Ndpl

c

h

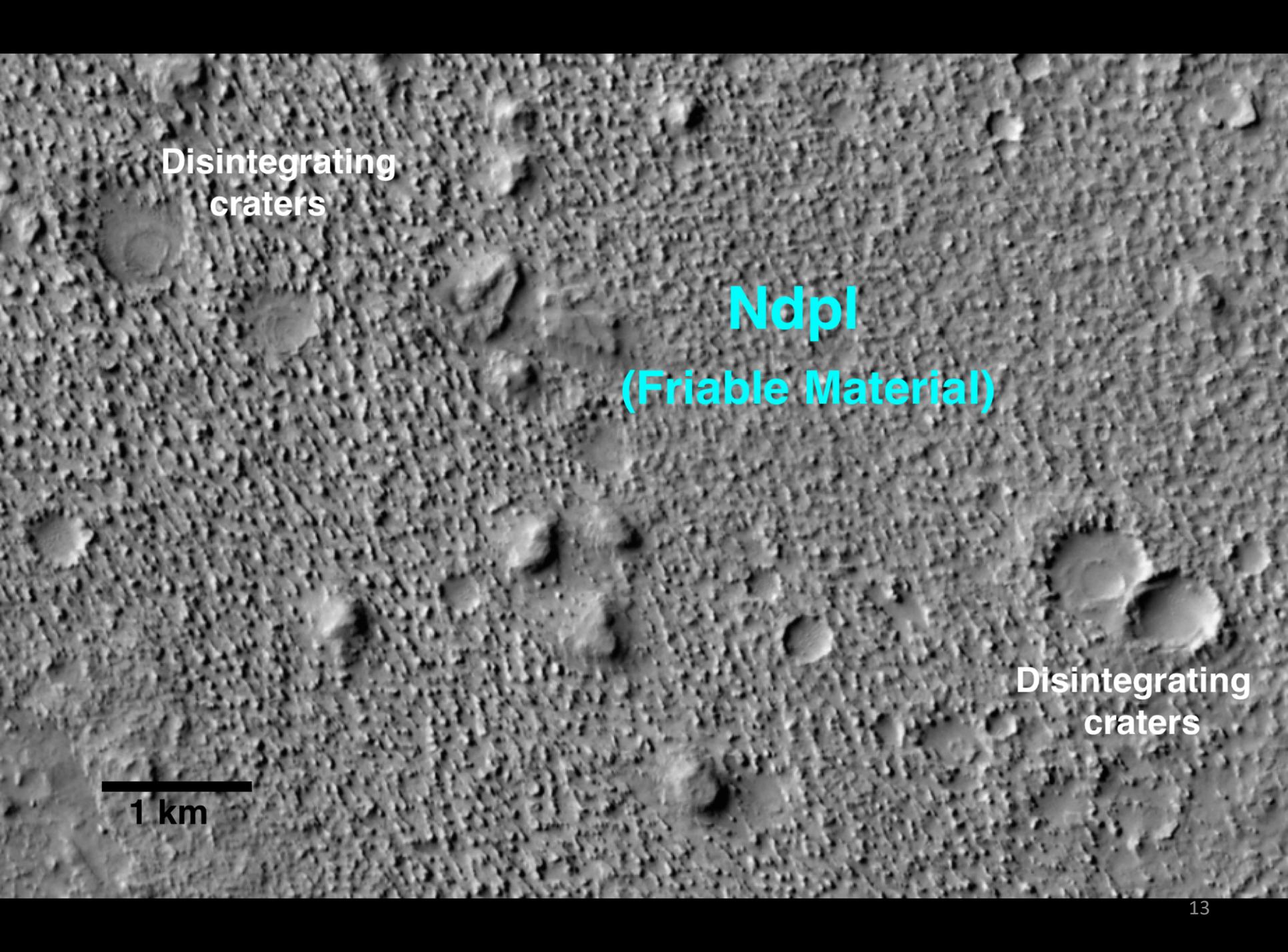




HNrvp2

Ndpl

2 km

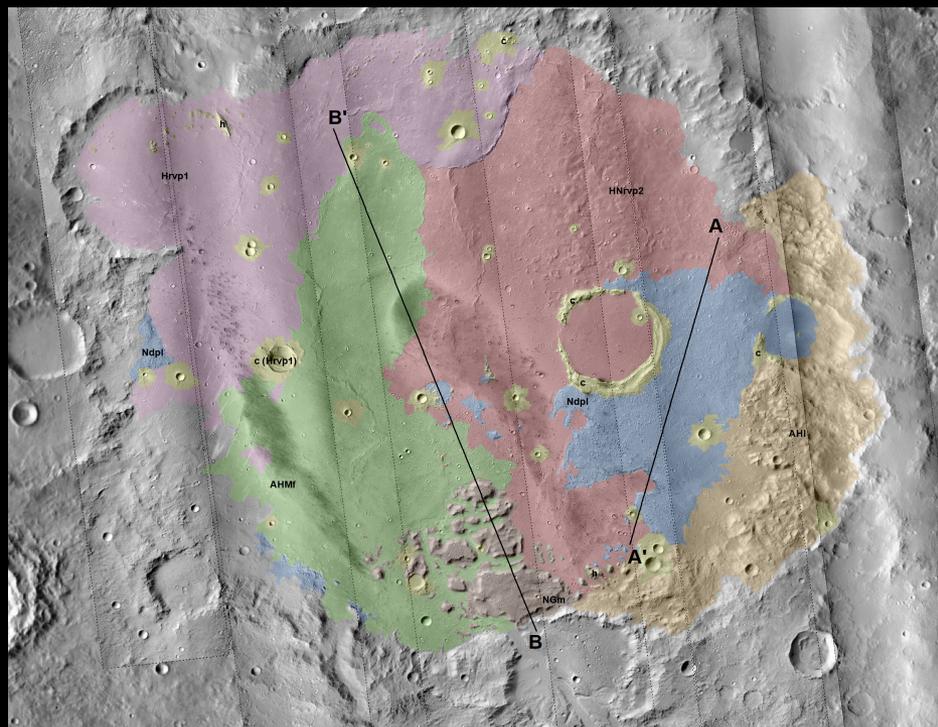
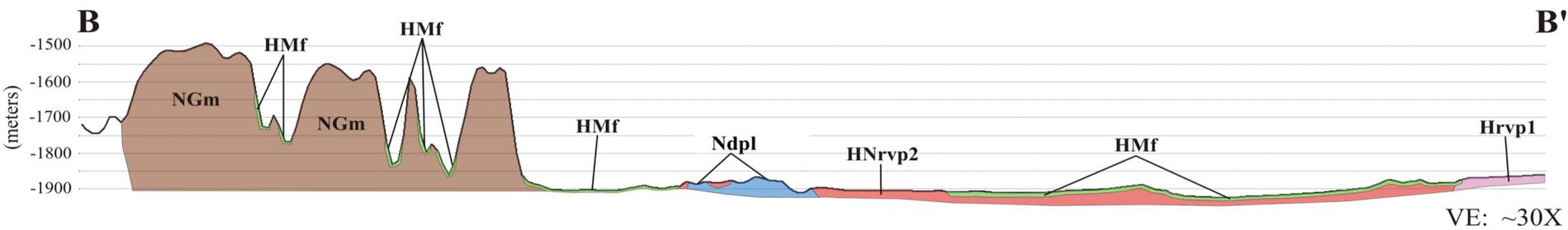
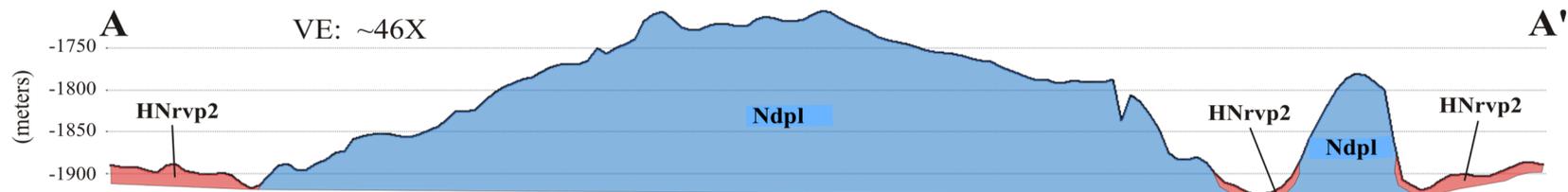


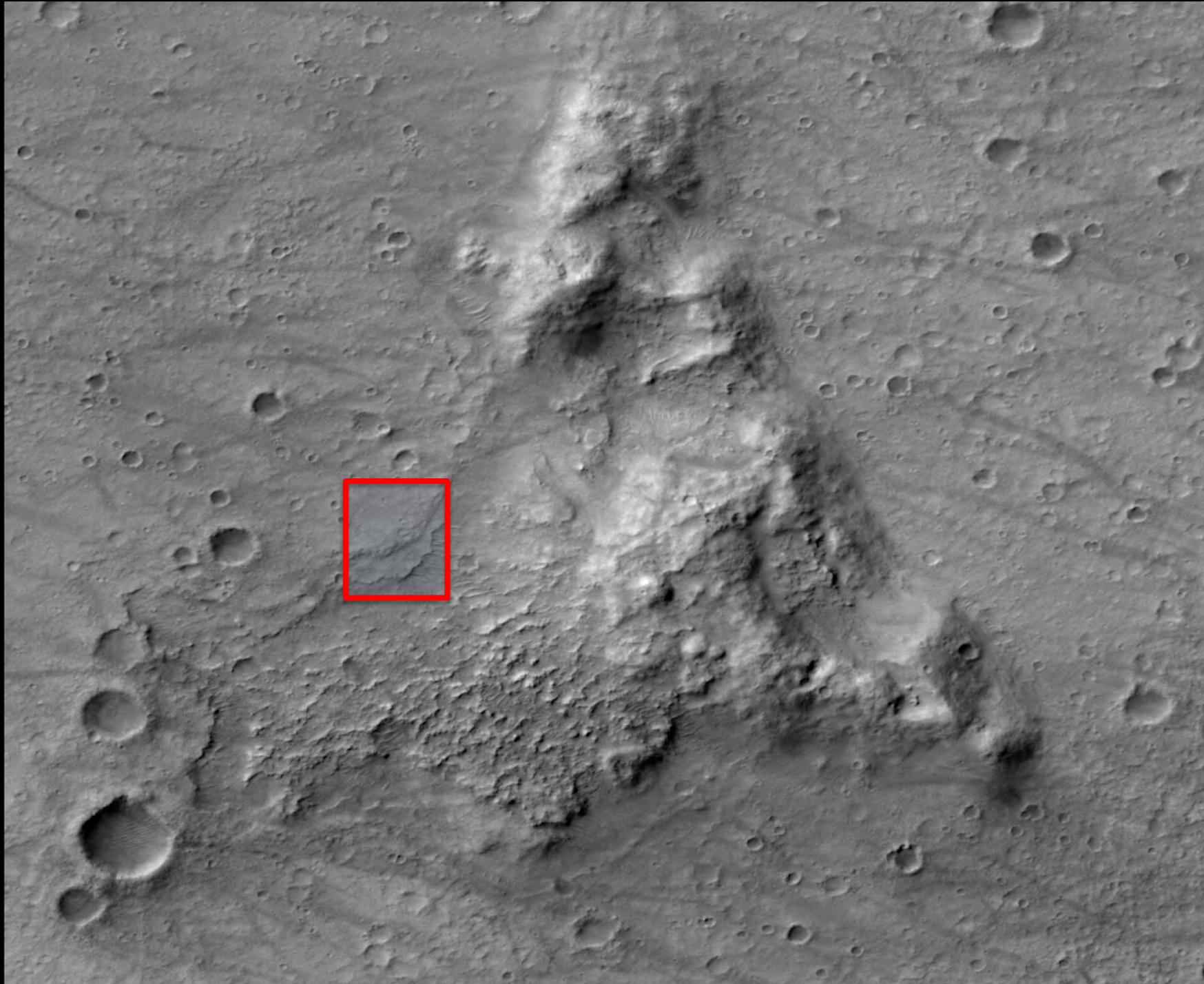
Disintegrating  
craters

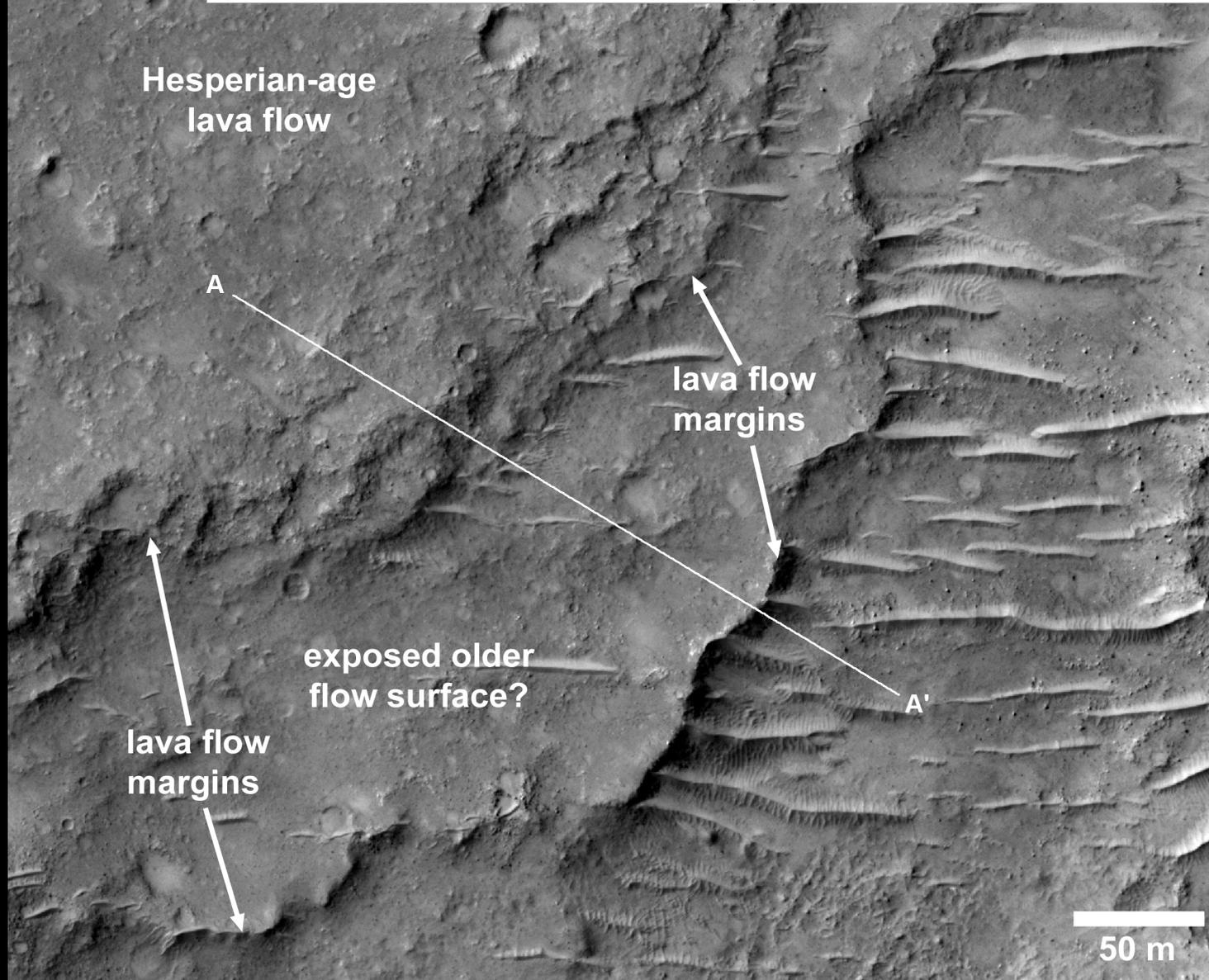
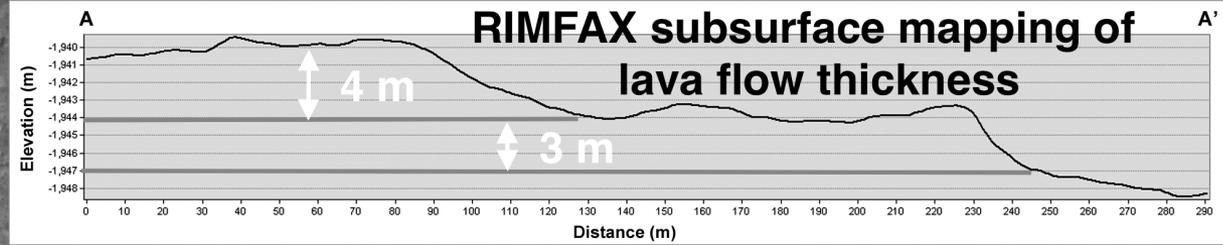
**Ndpl**  
**(Friable Material)**

Disintegrating  
craters

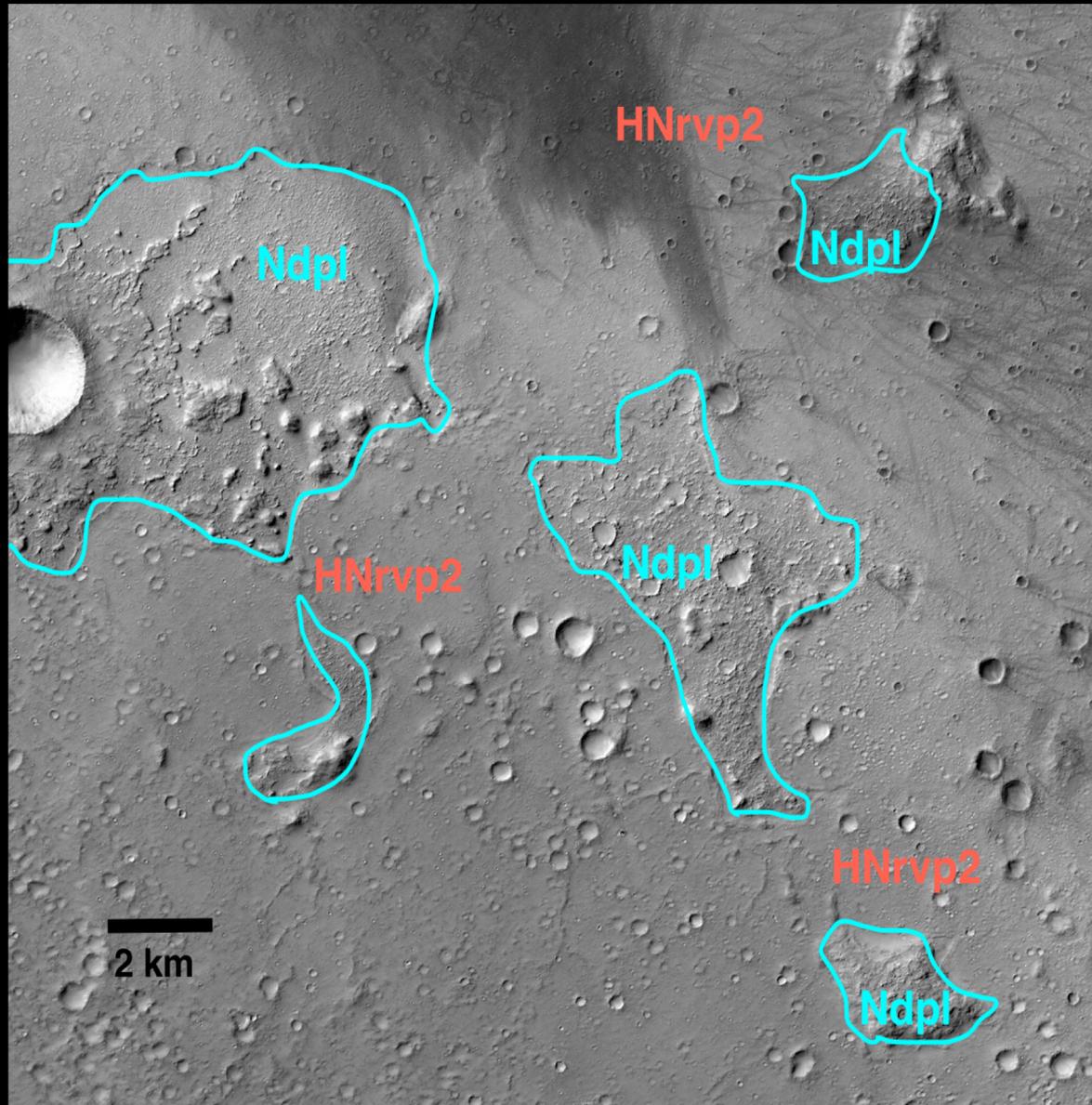
1 km



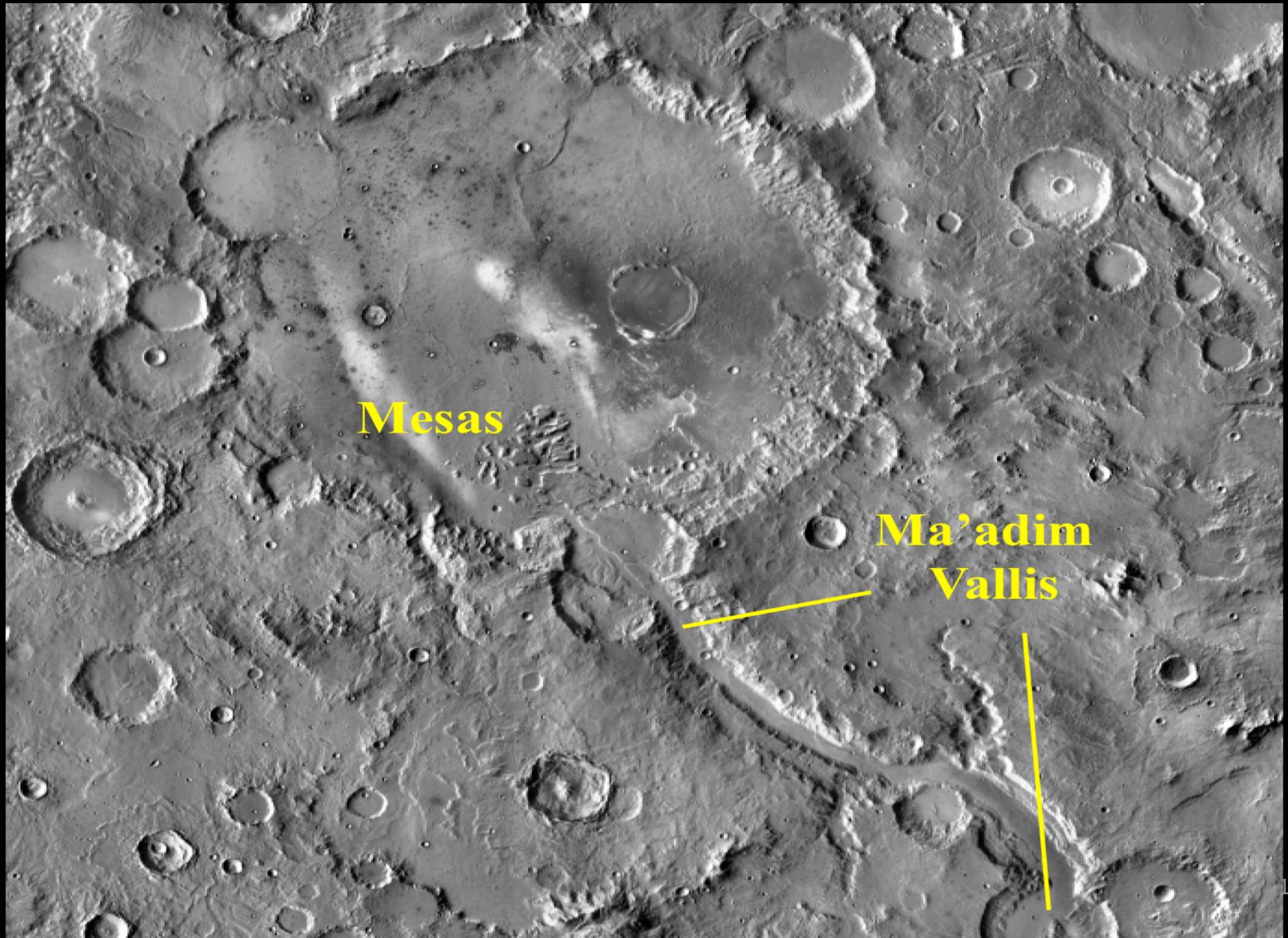


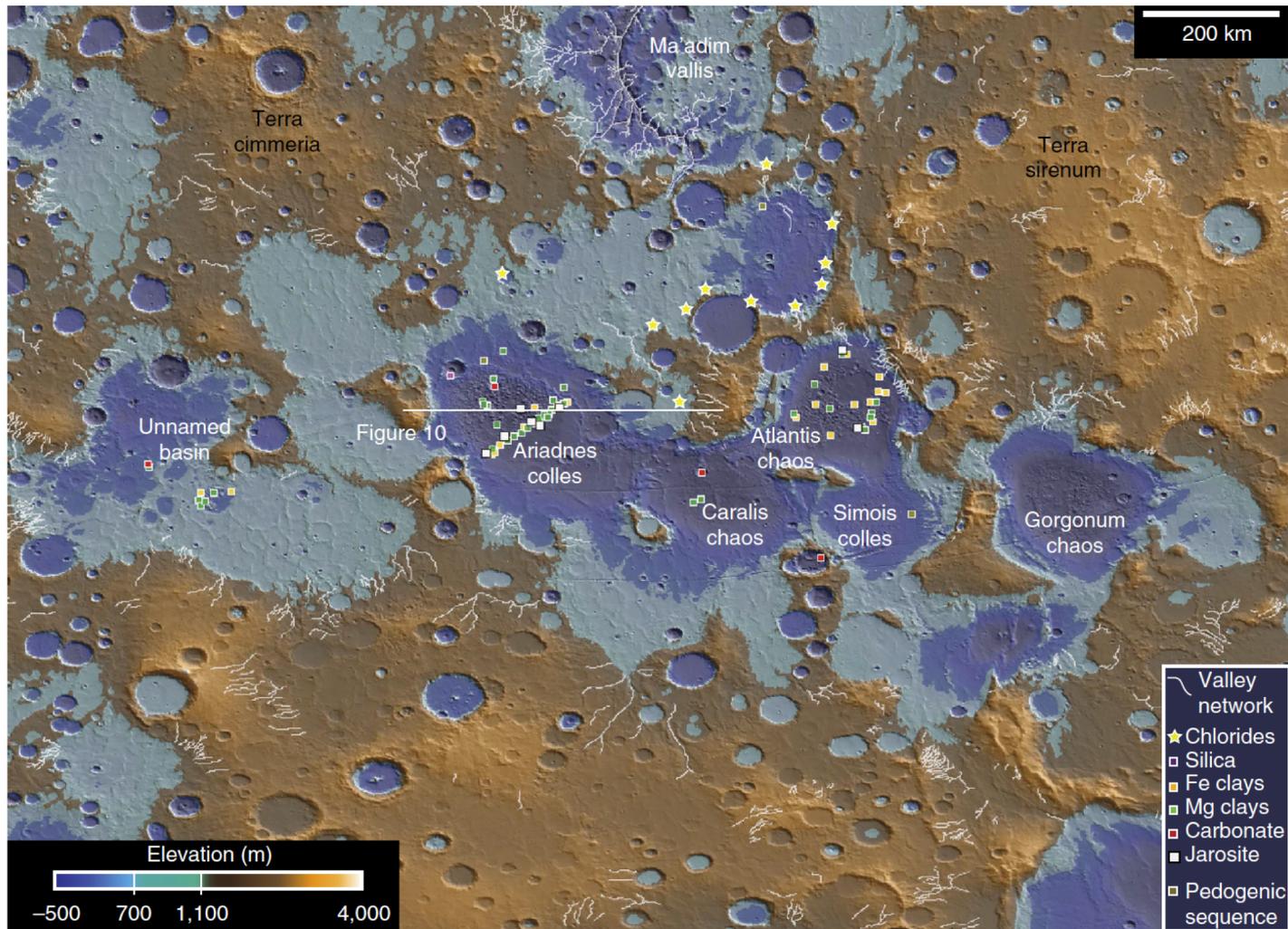


Dissected Plateau Material (Ndpl): windows into once extensive unit that predates the Gusev plains basalts (HNrvp2)



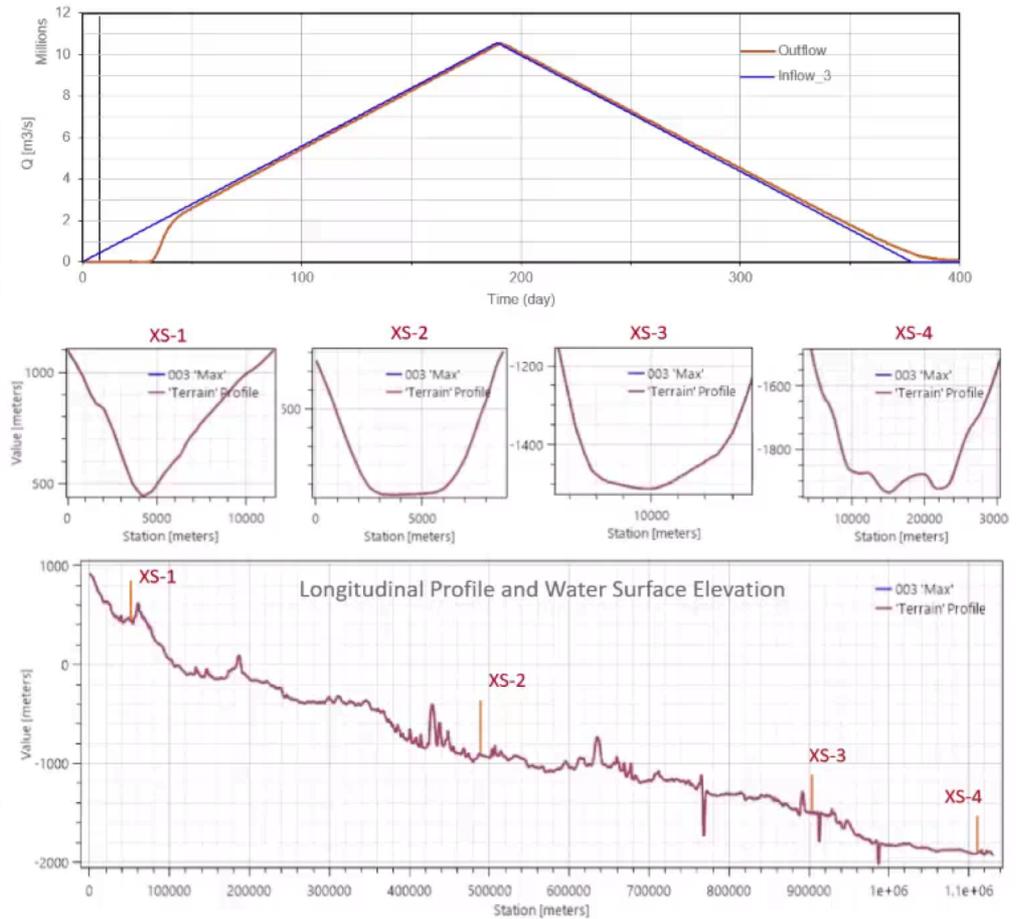
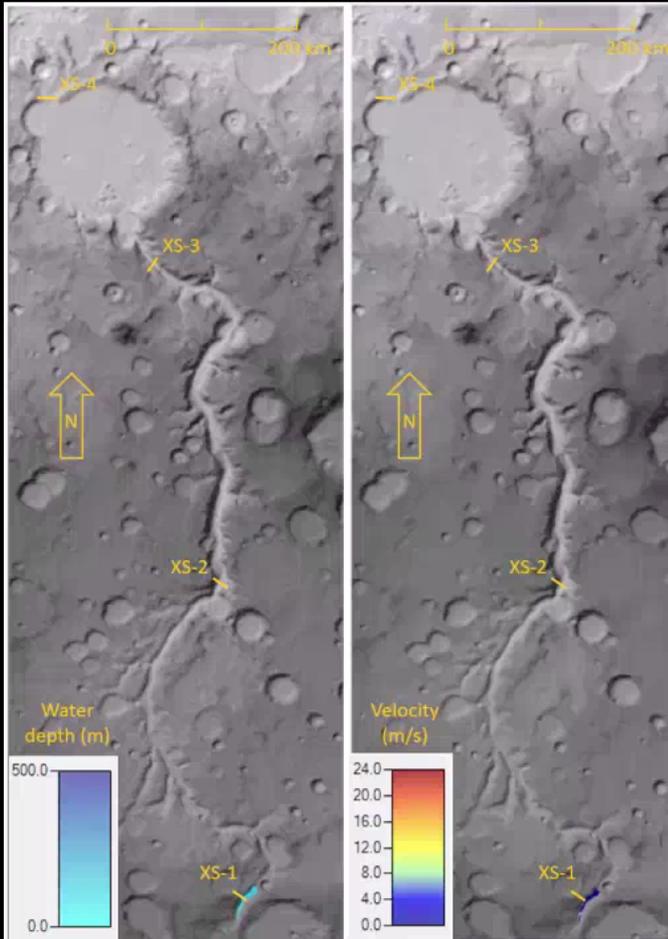
# Gusev Lake and Delta Hypothesis





**Figure 5 | Topography and mineralogy of Eridania basin.** MOLA topographic data are colorized to show the maximum (1,100 m) and minimum (700 m) level of an ancient sea. Alteration minerals represent phases detected in this study using CRISM data with the exception of 'chlorides,' which were detected previously using THEMIS data. Deep basin units are pervasively altered to Fe- and Mg-rich clay minerals, and likely sulphides, which are traced by the occurrence of jarosite.

# Ma'adim Vallis Flooding and Gusev Lake Formation Hydraulic Model



Mesa

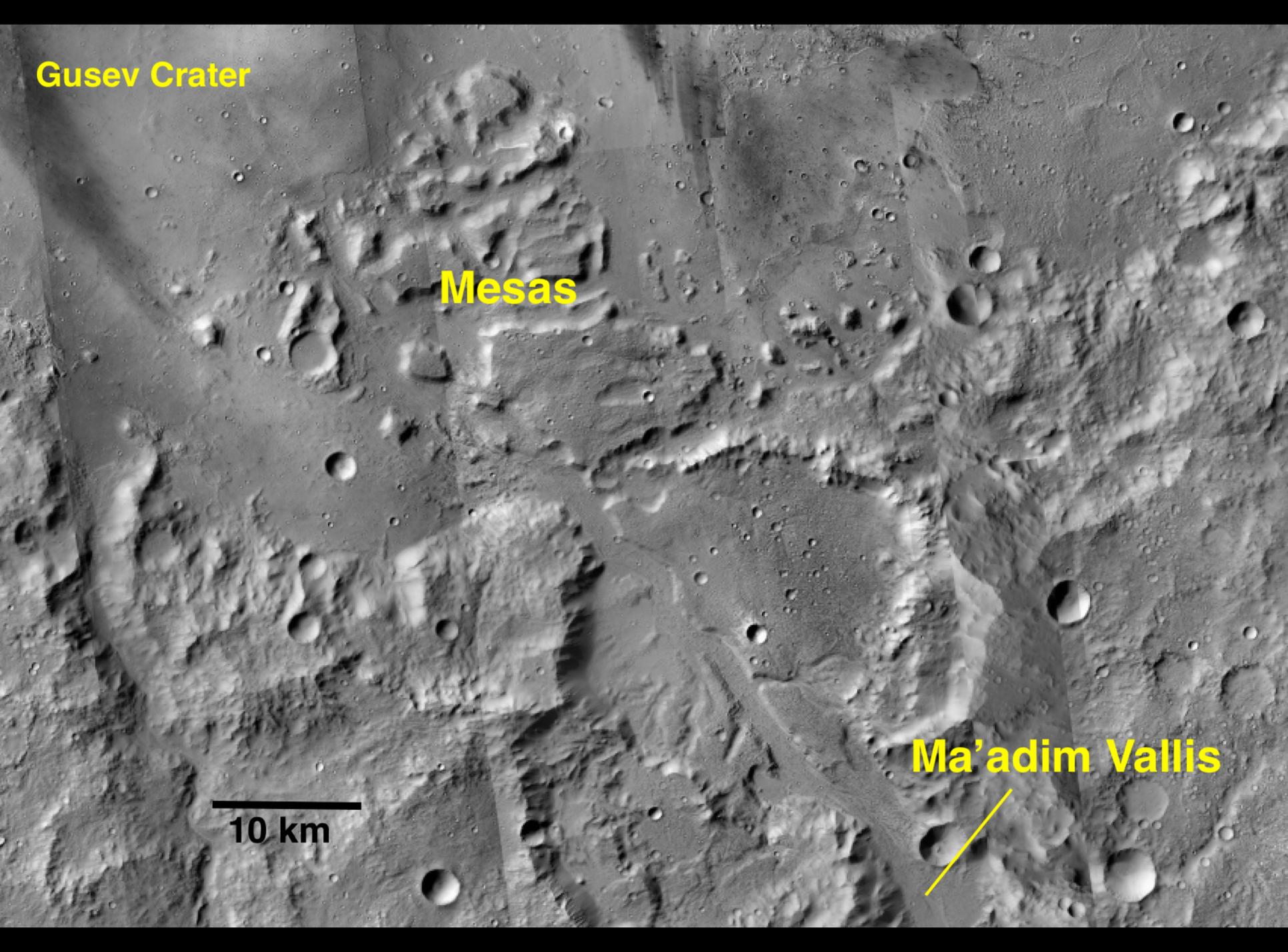


**Gusev Crater**

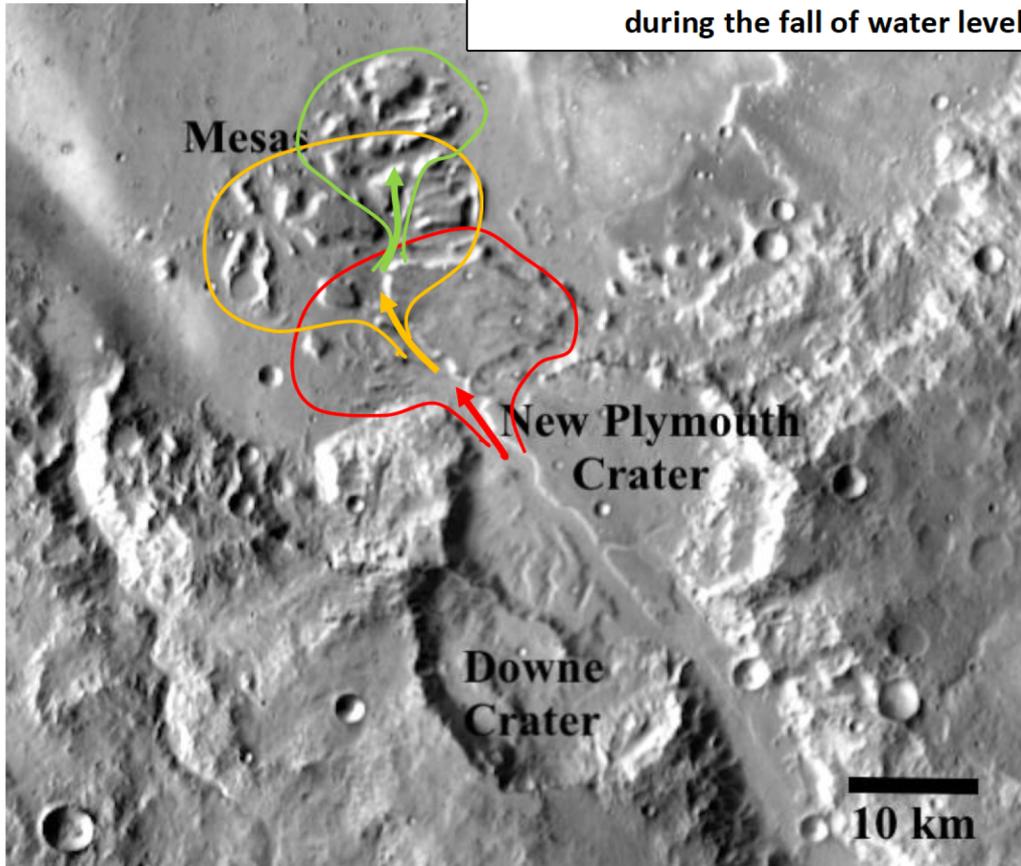
**Mesas**

**Ma'adim Vallis**

**10 km**

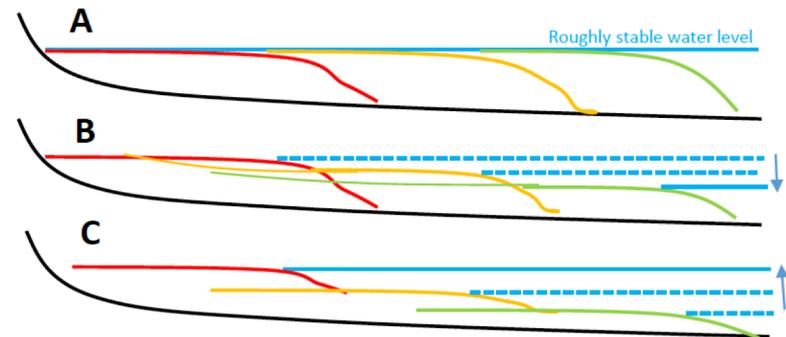


May be a telescoping delta complex, eventually dissected into mesas by down-cutting rivers during the fall of water level.

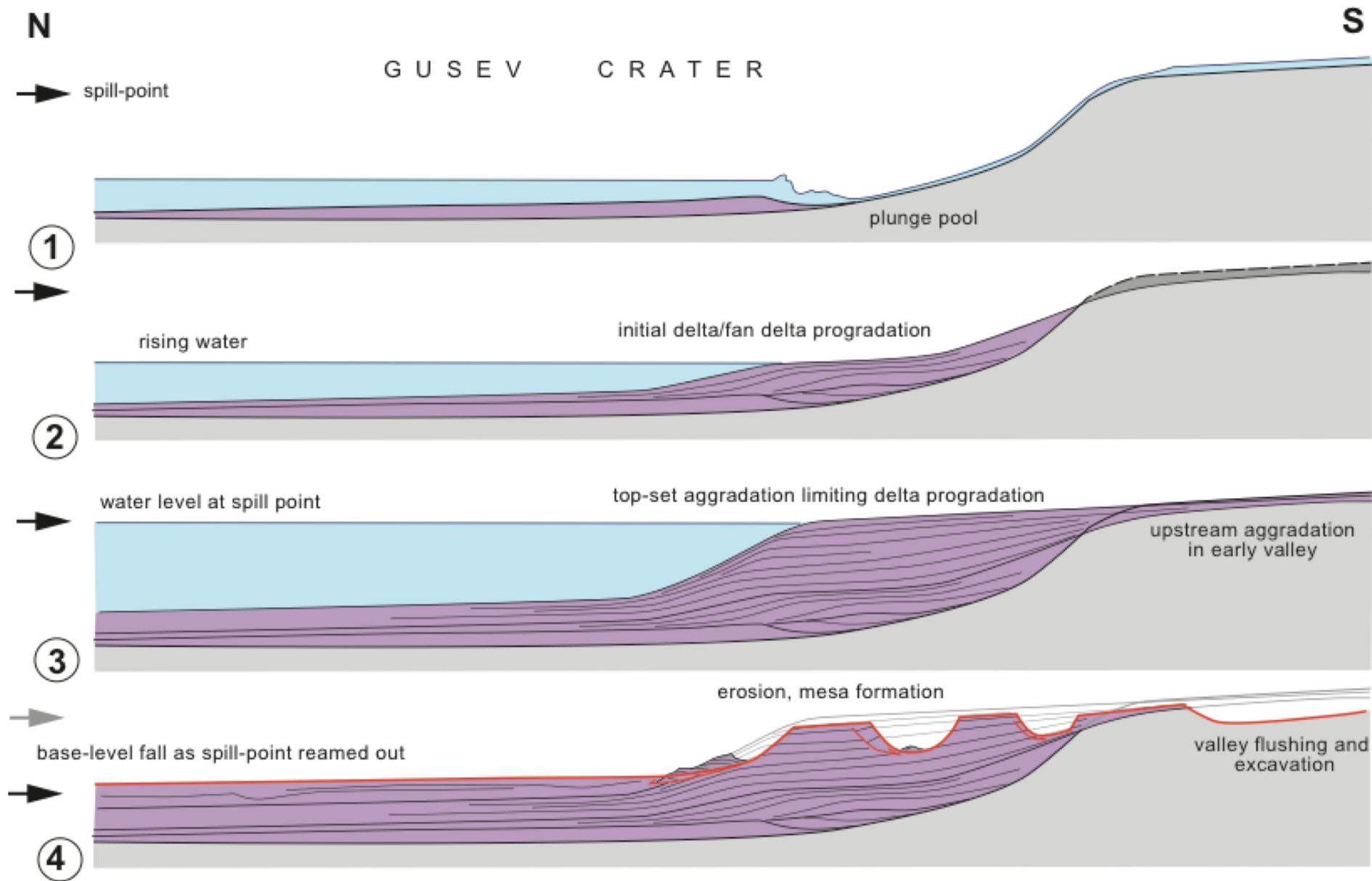


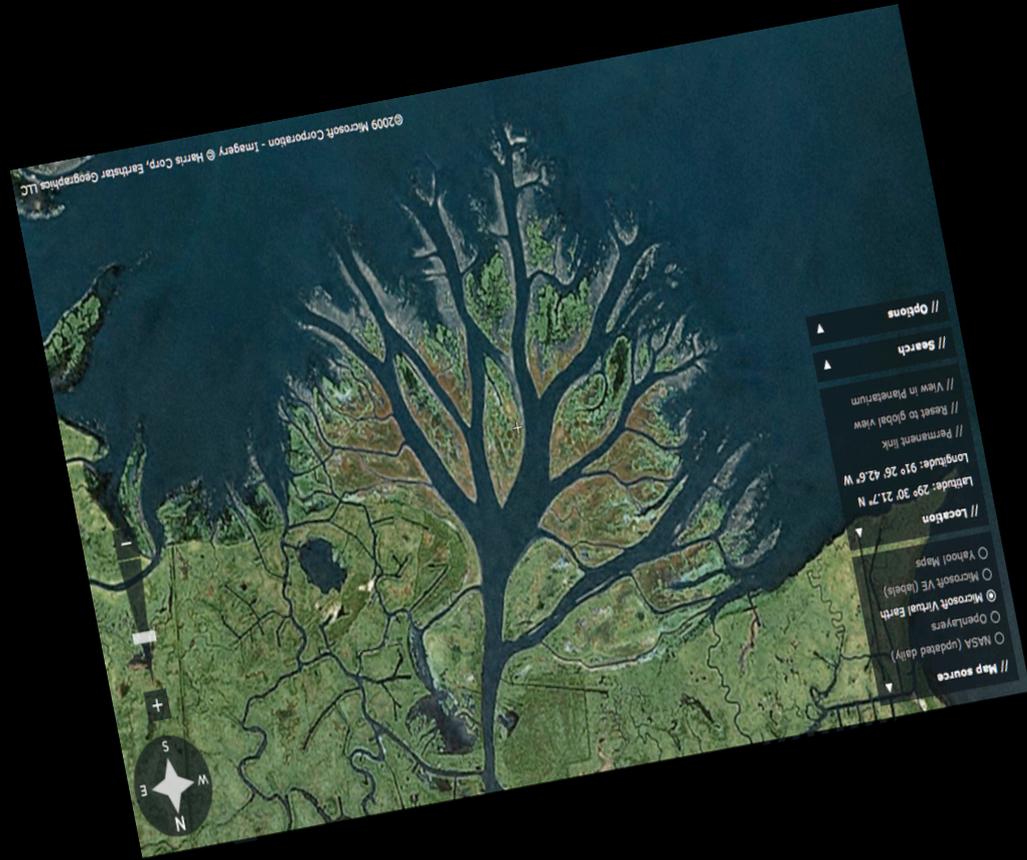
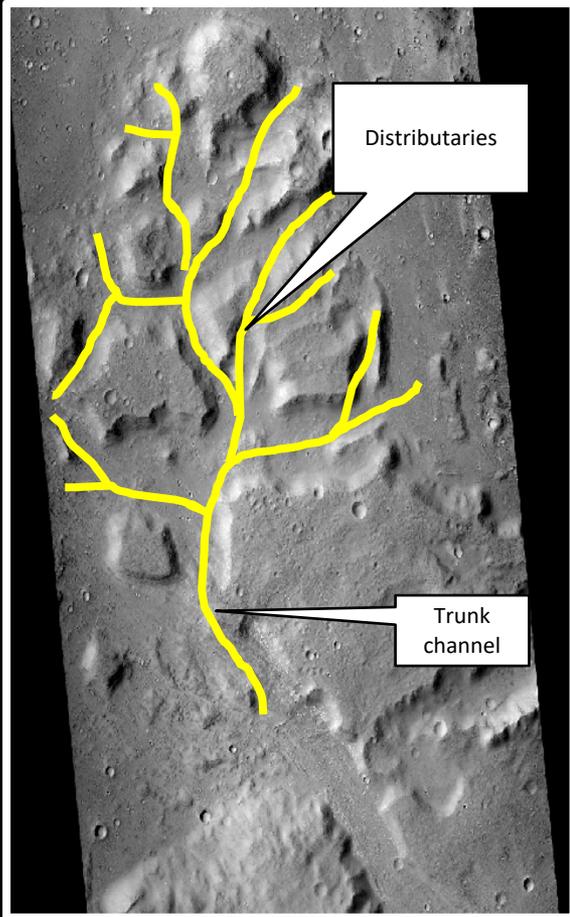
It's difficult to say if the apparent telescoping of successive delta lobes was due to (see diagrams below):

- (A) Exhaustion of delta-plain accommodation space (at a roughly stable water level), which forced the distributary system to seek accommodation at the front (= delta progradation),
- (B) Gradual decrease of bulk accommodation by falling water level, which caused headward incision and frontal progradation of the distributary system.
- (C) Delta back-stepping due to rising water level (which would mean not true telescoping, but backward stacking of retreating delta lobes).

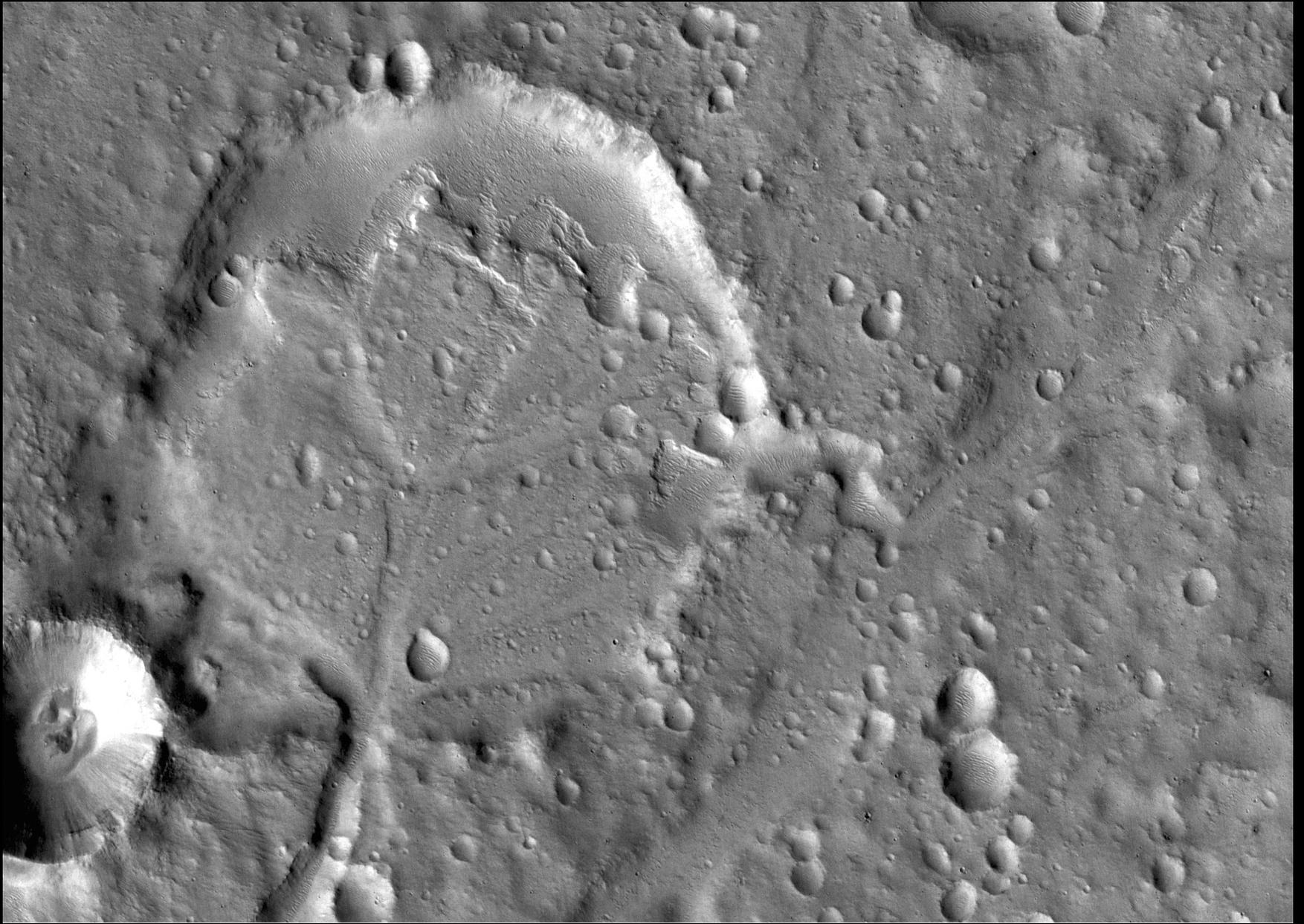


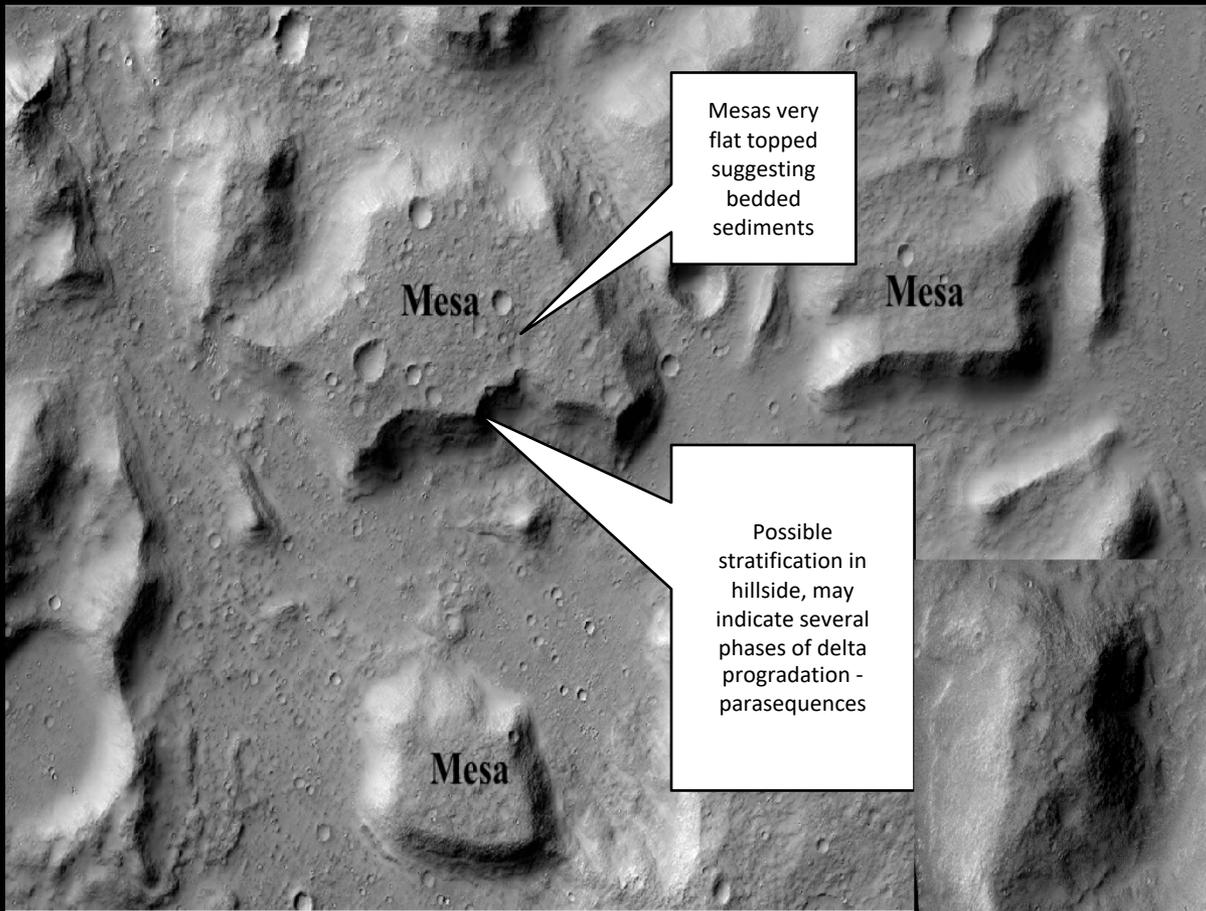
The height (altitude) of the mesas may be a clue, as it may help distinguish case **A** from cases **B/C**. Cases **B** and **C** will be difficult to distinguish on this basis, but the former would be more likely since the system's development ends up with river incision, which suggests a net fall of water level.





Possible network of distributary channels compared to the modern day Wax Lake delta





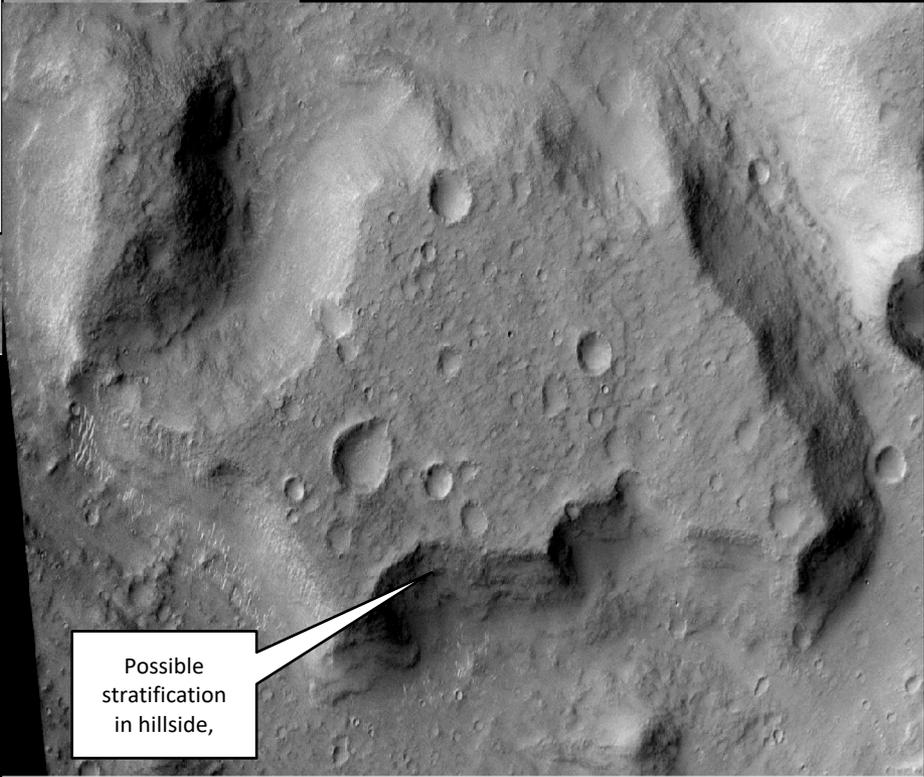
Mesas very flat topped suggesting bedded sediments

Mesa

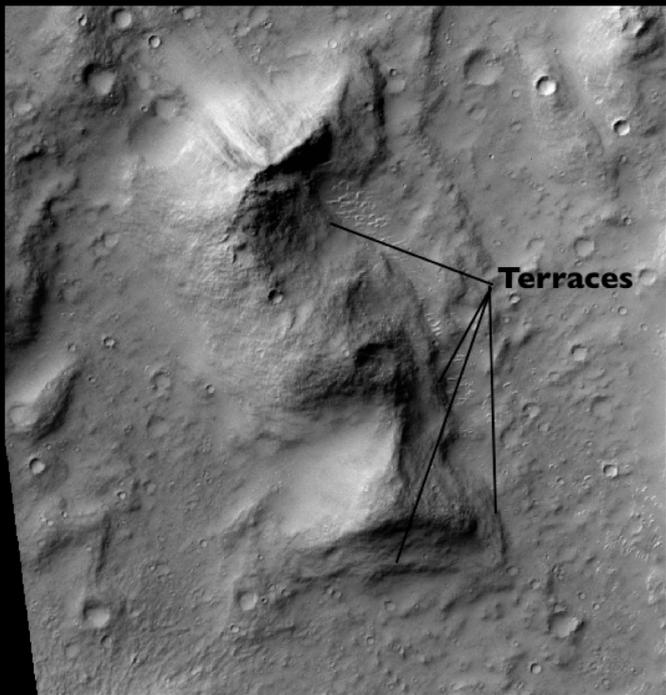
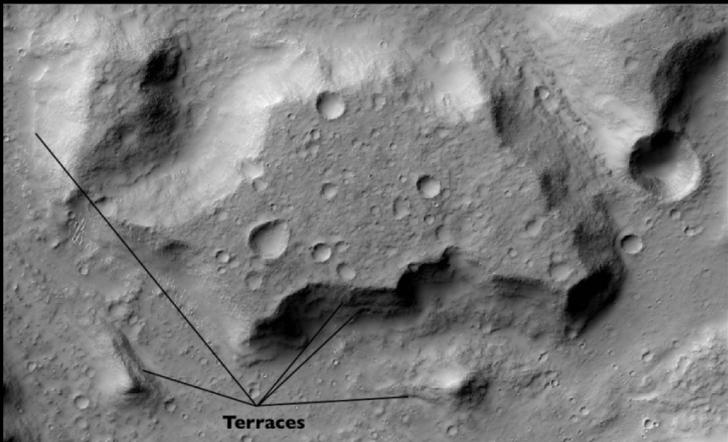
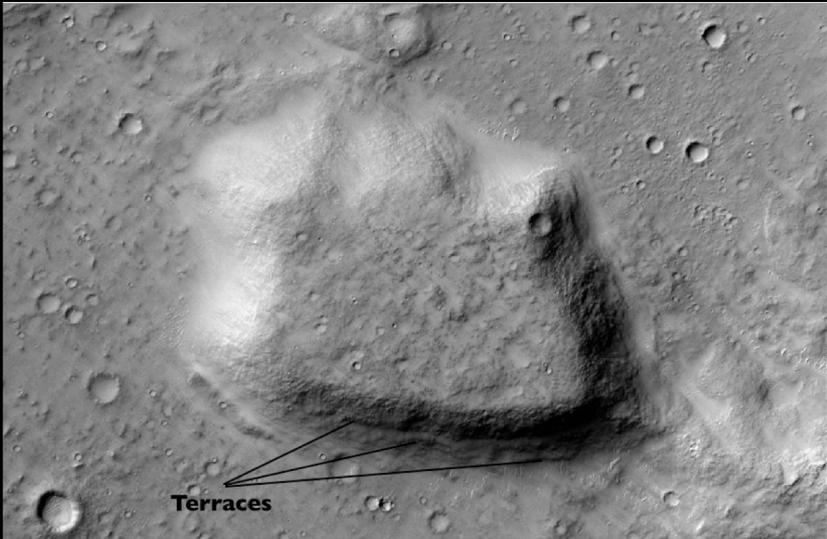
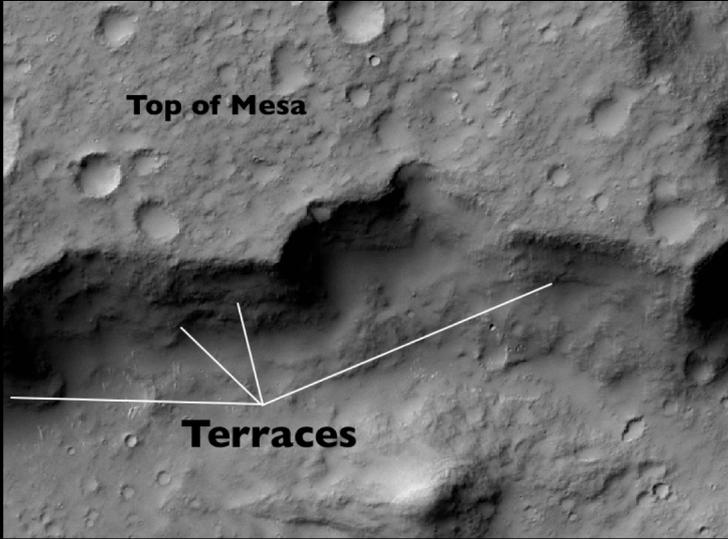
Mesa

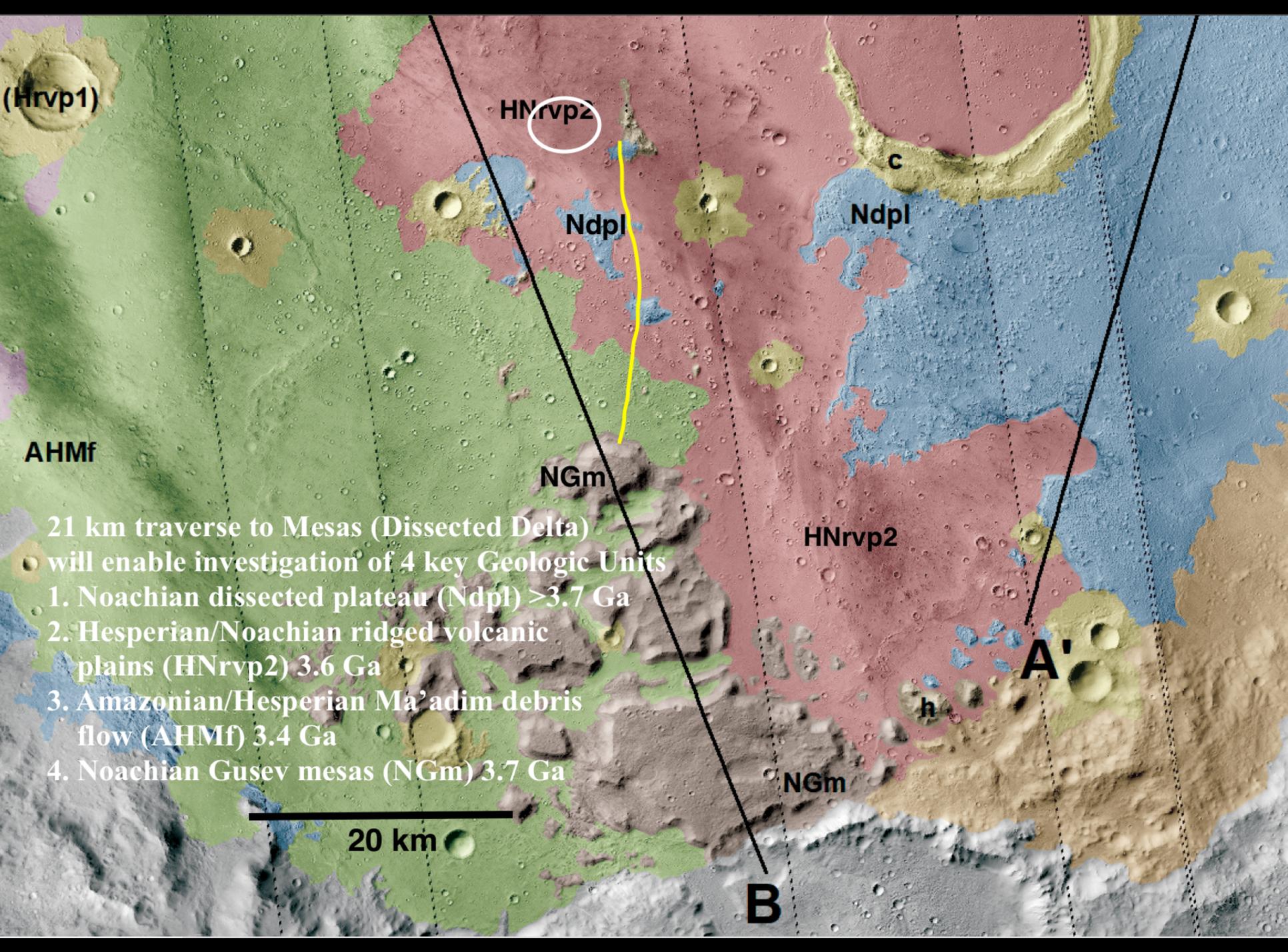
Possible stratification in hillside, may indicate several phases of delta progradation - parasequences

Mesa



Possible stratification in hillside,





(Hrvp1)

HNrvp2

Ndpl

Ndpl

AHMf

NGm

HNrvp2

A'

h

NGm

20 km

B

- 21 km traverse to Mesas (Dissected Delta)  
will enable investigation of 4 key Geologic Units
1. Noachian dissected plateau (Ndpl) >3.7 Ga
  2. Hesperian/Noachian ridged volcanic plains (HNrvp2) 3.6 Ga
  3. Amazonian/Hesperian Ma'adim debris flow (AHMf) 3.4 Ga
  4. Noachian Gusev mesas (NGm) 3.7 Ga