STREAMLINED ISLANDS *of* MARS

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SESSION NO. 17 T1. Megafloods, Paleohydrology, and Fluvial Processes on Earth and Beyond: In Recognition of the Scientific Contributions of Victor R. Baker

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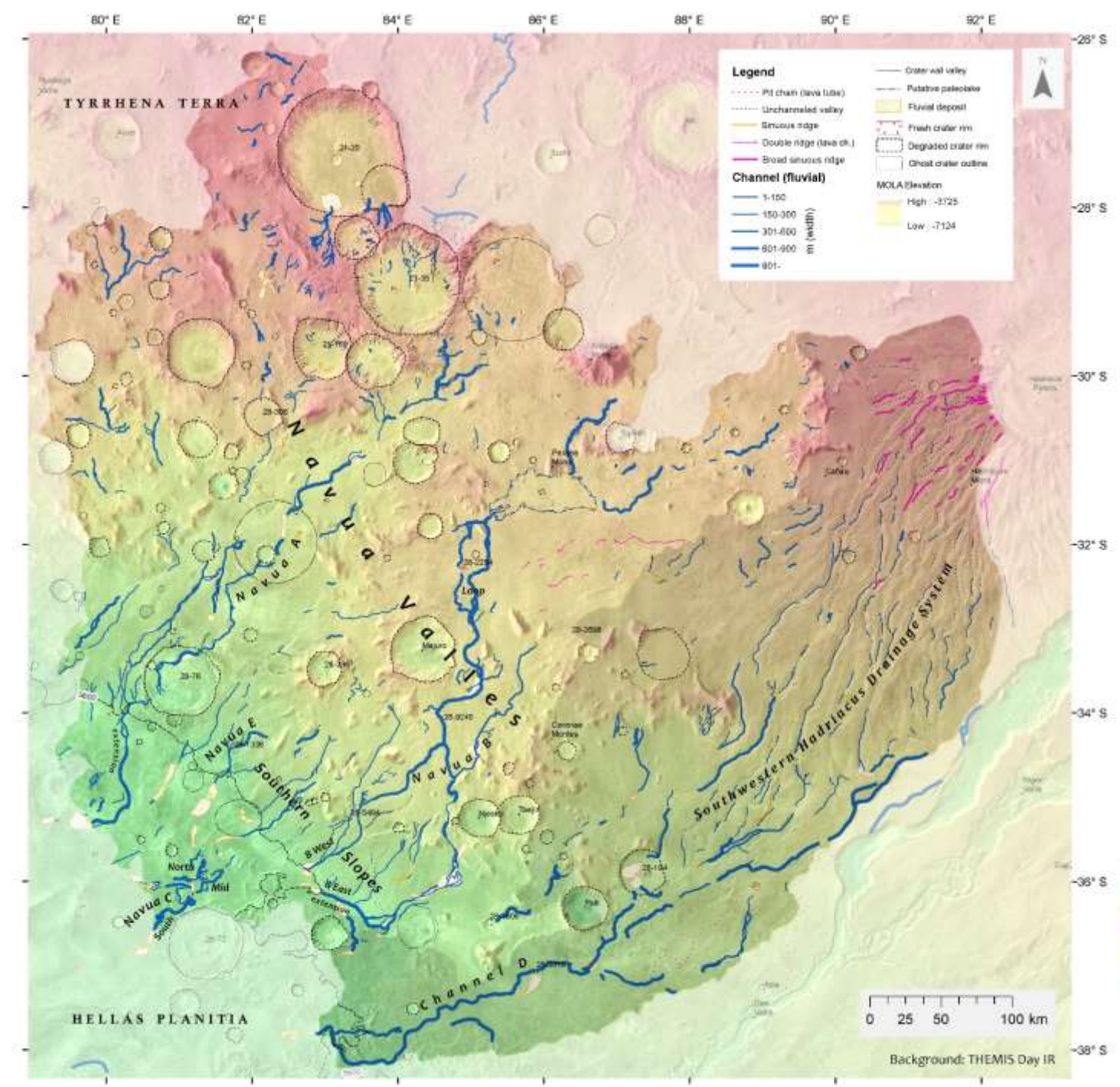
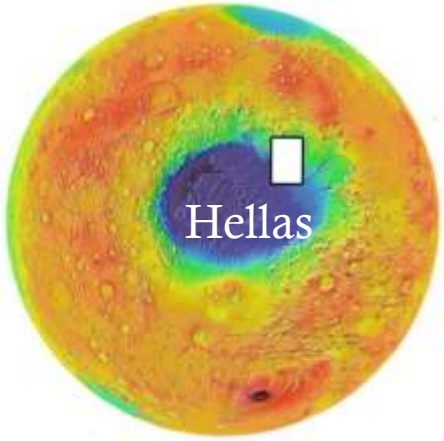
THURSDAY, 19 MAY 2016
17-7 10:20 AM

Navua Valles





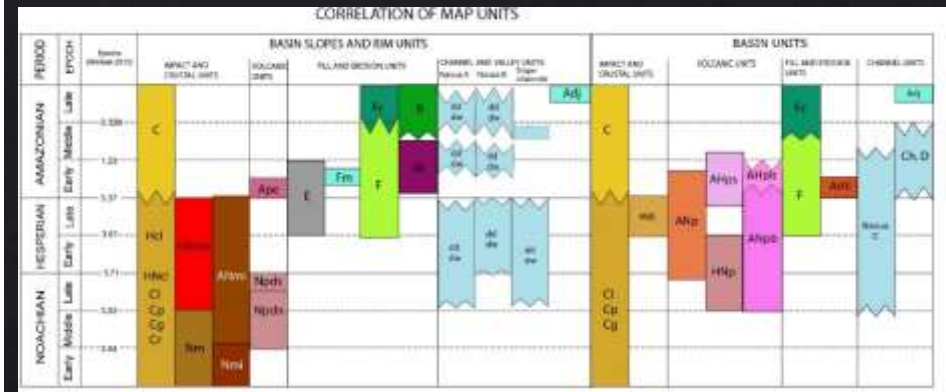
Navua Geology

Brown-Yellow: impact materials

Blue-Pink: volcanic materials

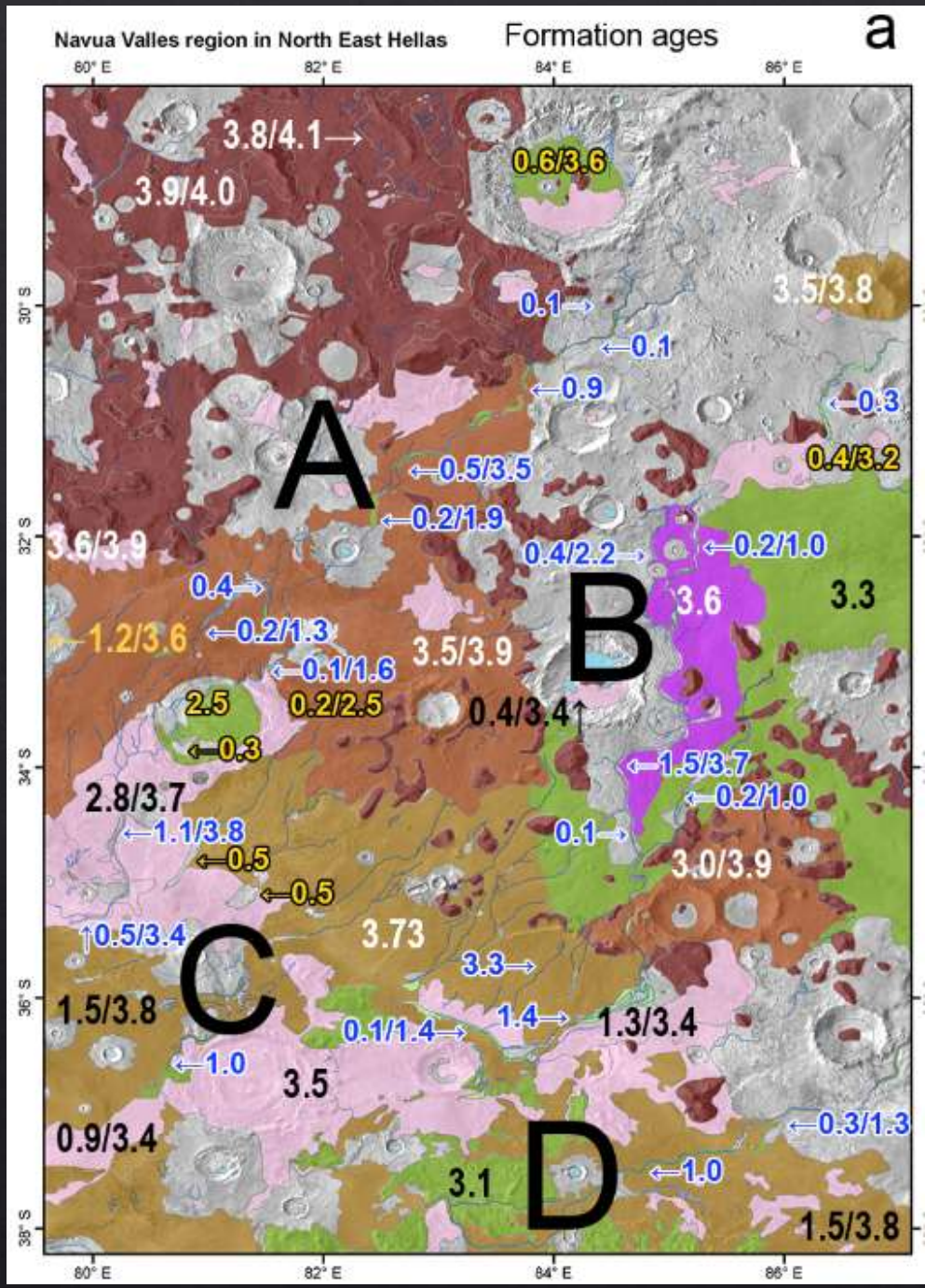
Green: fills

Blue: channel, paleolake basin (nonimpact)



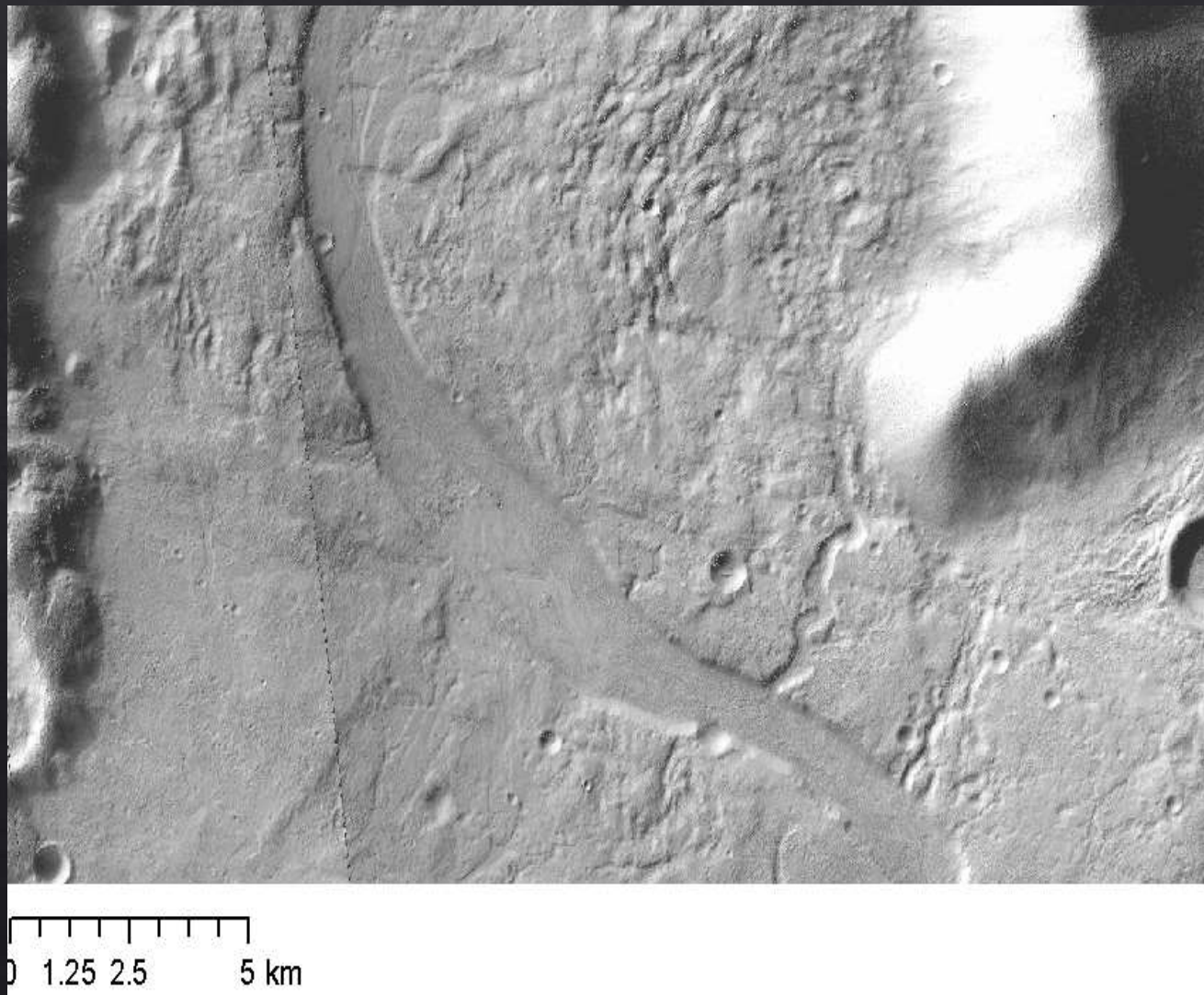
Ages

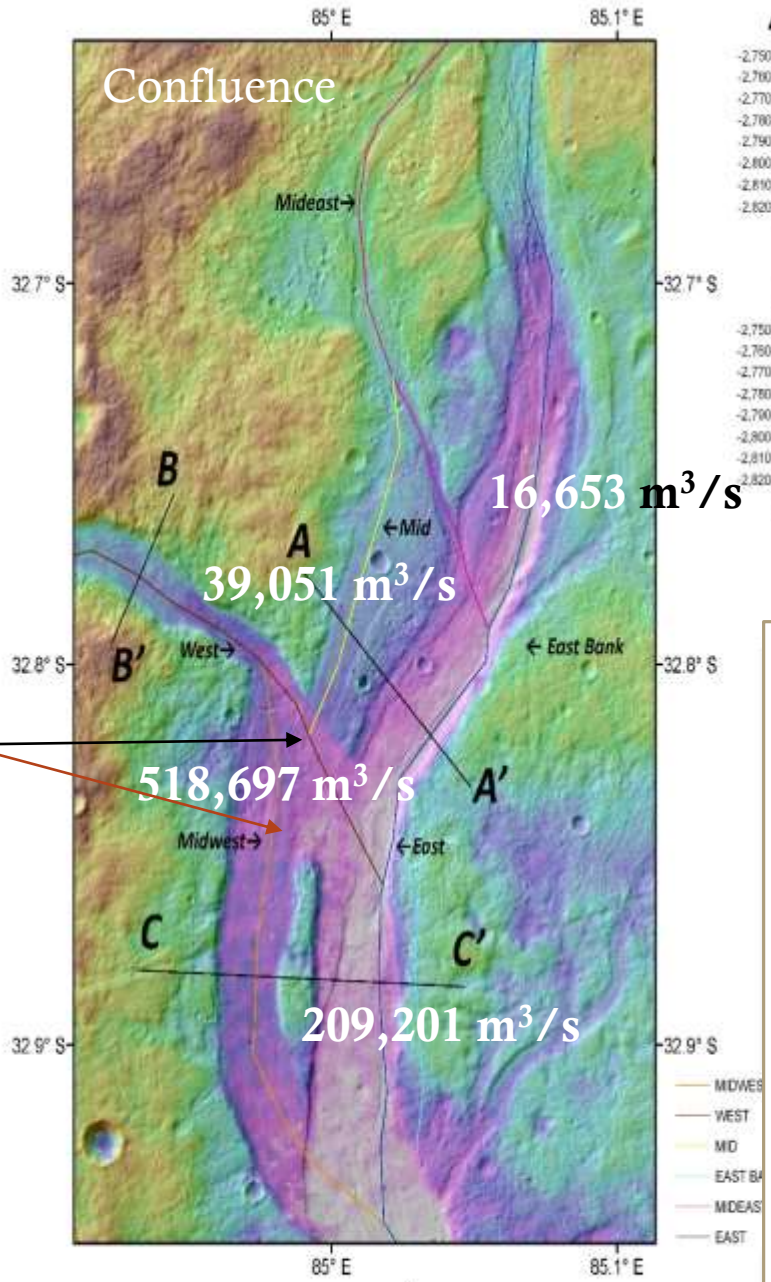
- Cratered highlands 3.8-4.1 Ga
- Ejecta 3.9-0.3
- Lava flows 3.8-3.3/0.9
- Channel surfaces 3.7-0.1
  - Channel reaches show different ages
  - Multiple events, some channels abandoned/resurfaced
- Fans 3.6/0.6
- Terminal Deposits 3.2-0.4
- Mound fields 2.5
  - Volcanic activity: 3.8-3.3 (-1.3 in basin)
  - Channel activity: 3.7-0.1
    - Not necessarily fluvial!
    - But lava and ejecta surfaces show no resurfacing after 0.9
    - Youngest resurfacing events are limited to channels: Fluvial, glacial action, wind funnel effect

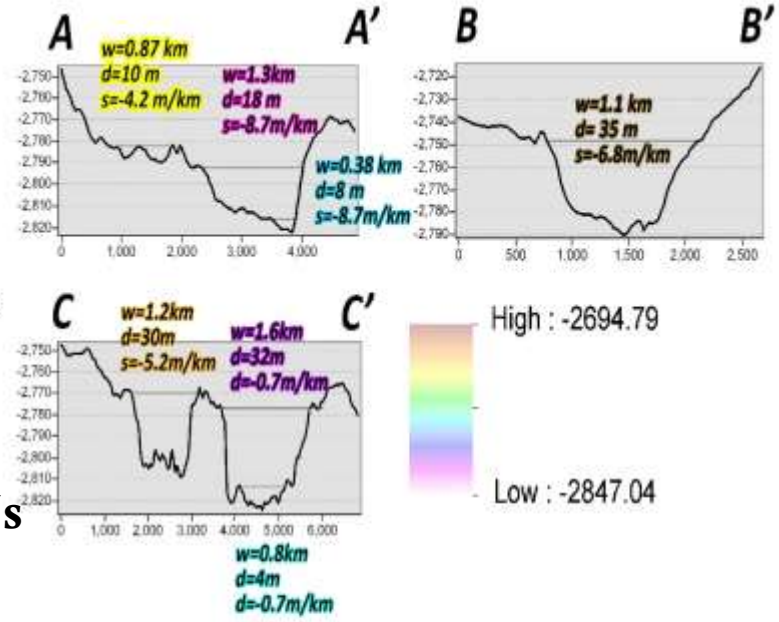


Flat floored channels

- Flood-eroded channels in lava flows and impact ejecta
- 200k-500k m3/s (not megaflood but catastrophic flood)
- 30-50 km/h
- 1-2 km width
- 20-40 m depth
- Formation: 3.4-3.7 Ga (Late Hesperian, volcanically active period)
- Hadriacus Mons formed in this period







Original topography sharply cut and eroded

Discharge rates

$$Q=udw$$

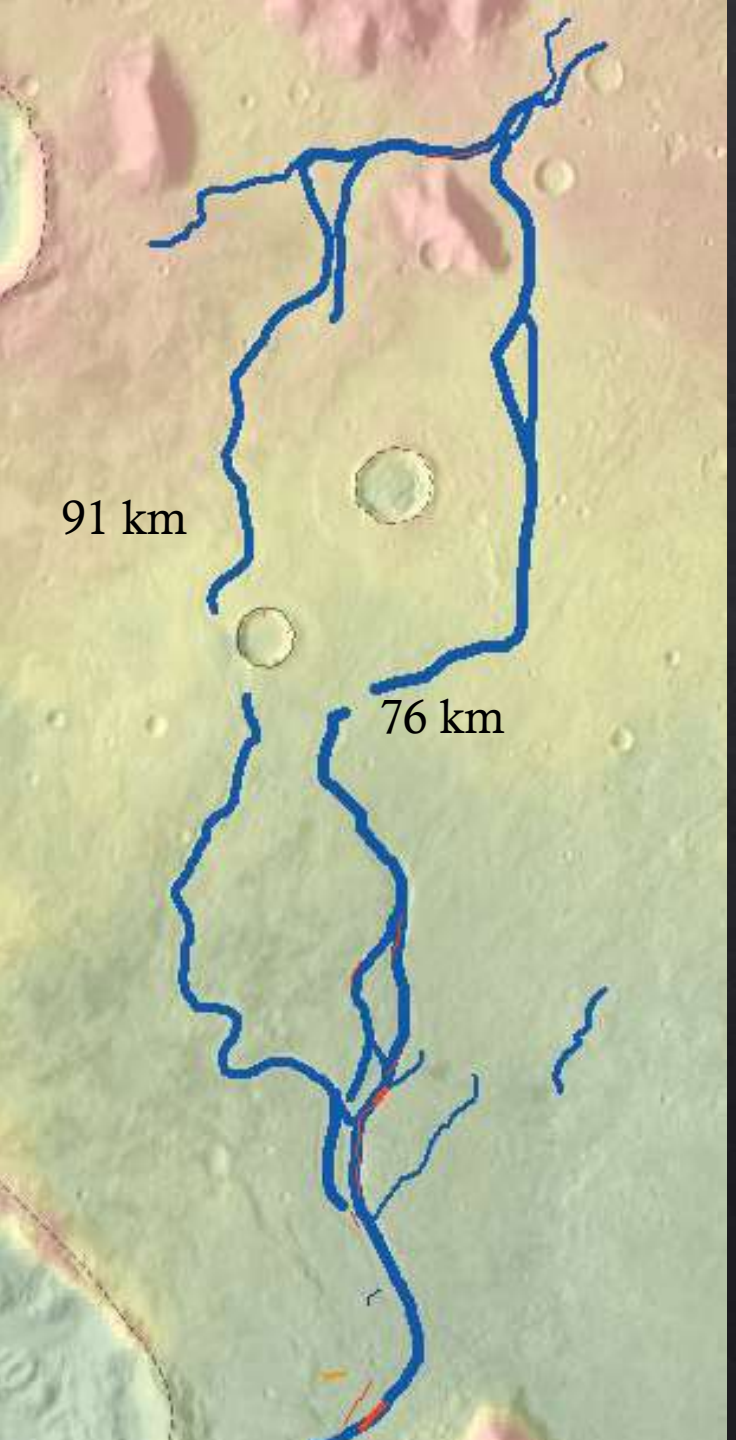
where u is the velocity of water flow in the channel, m/s
d is water depth, m
w is channel width, m

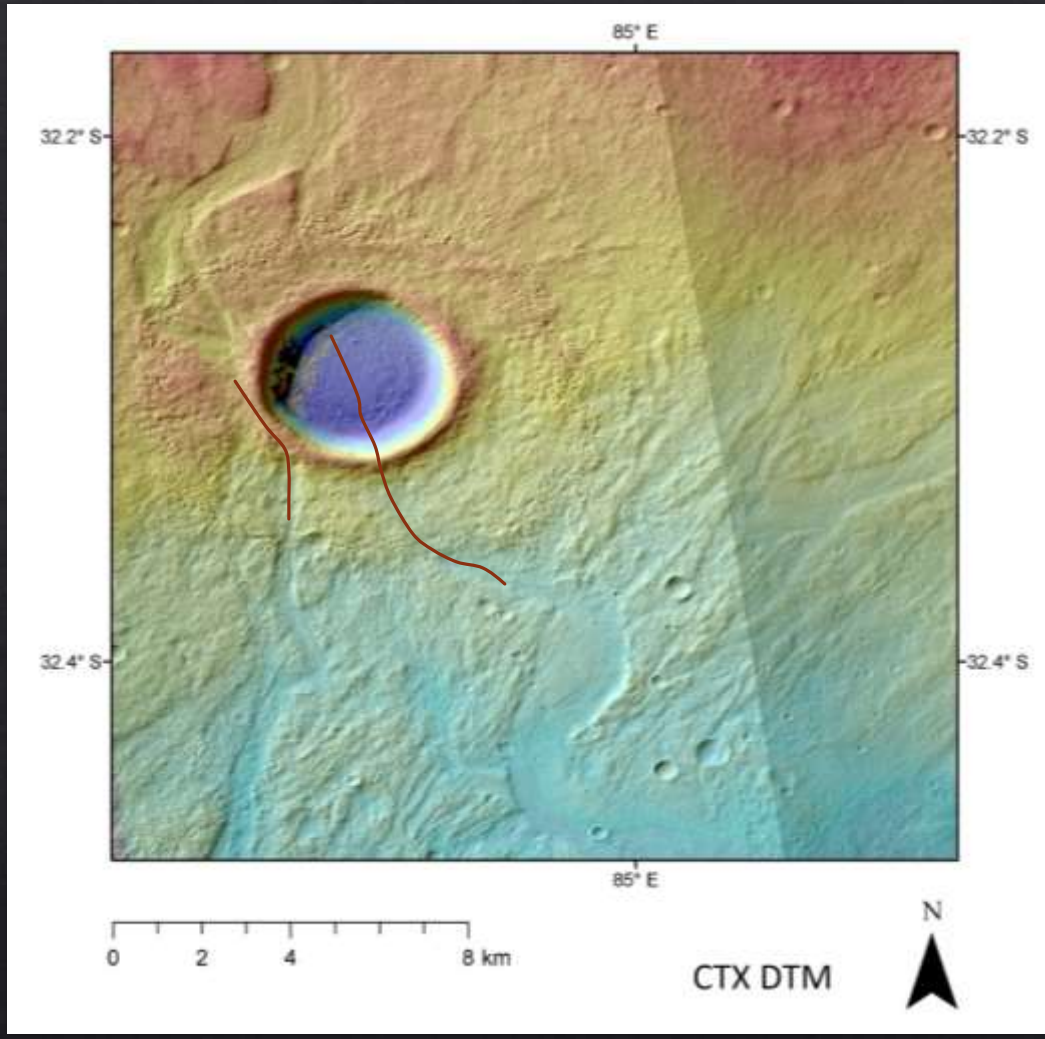
and

$$u=[(8dgsin\alpha)/f]^{1/2}$$

where g is gravitational acceleration (3.72 ms^{-2})
α is channel bed slope angle, degree
f is the dimensionless Darcy-Weisbach bed friction factor, calculated for boulder and gravel beds.

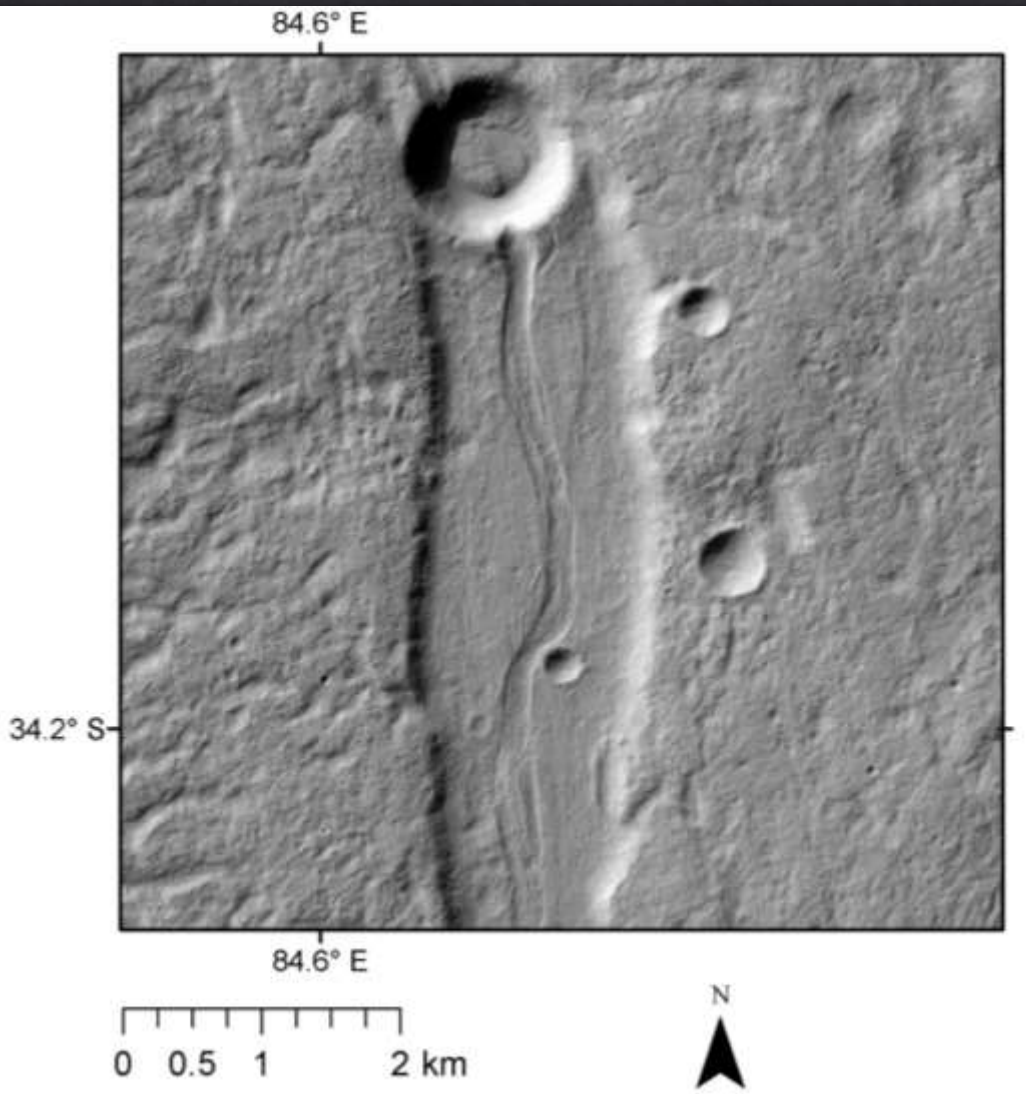
Mississippi: 8,000 - 31,000 m3/s

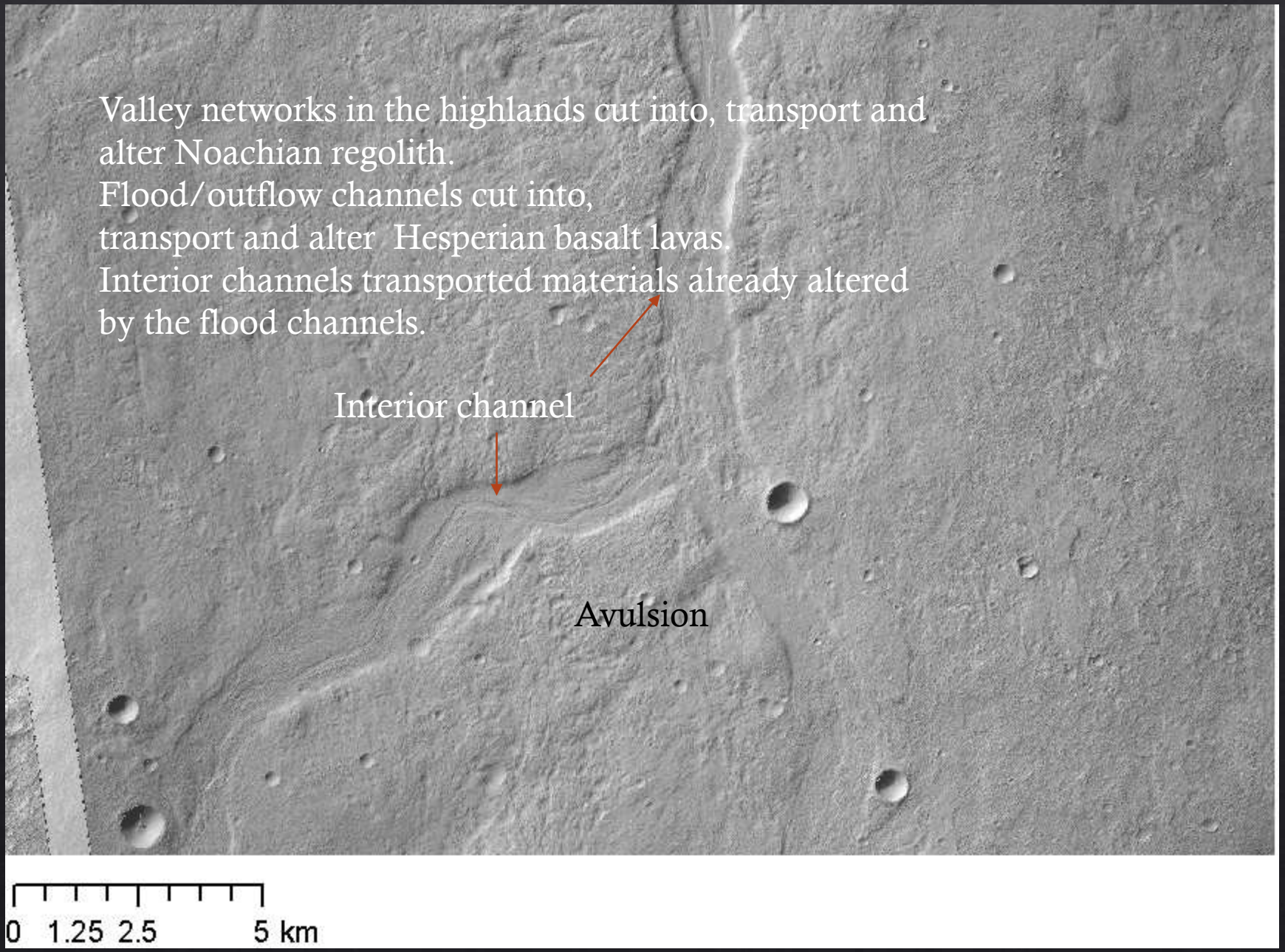

91 km
76 km


85° E
32.2° S
32.2° S
32.4° S
32.4° S
85° E
0
2
4
8 km
CTX DTM
N

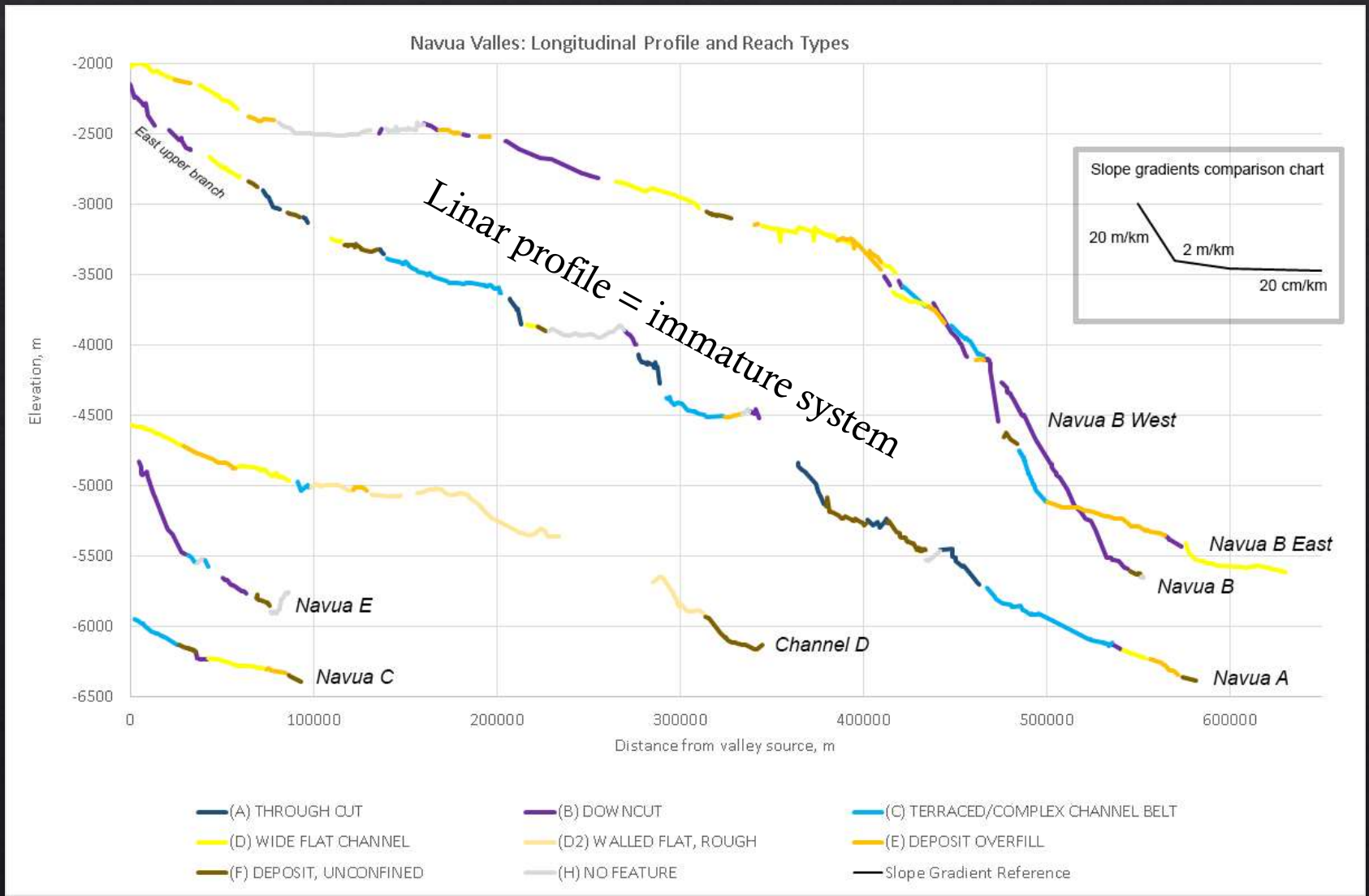
Interior channels

- Channels used repeatedly several times, the most recently by interior channels
- (smaller scale, fluvial flows)
- 10-20,000 m3/s
- >3 km/h
- Resurfacing episodes thrughout the Amazonian (2.2 to 0.2 Ga) with formation ages up to 0.2 Ga (likely new, glacial deposit)
- Latest fluvial features are these channels but they are not dated. Similar to Fresh Shallow Valleys commonly found on Mars.



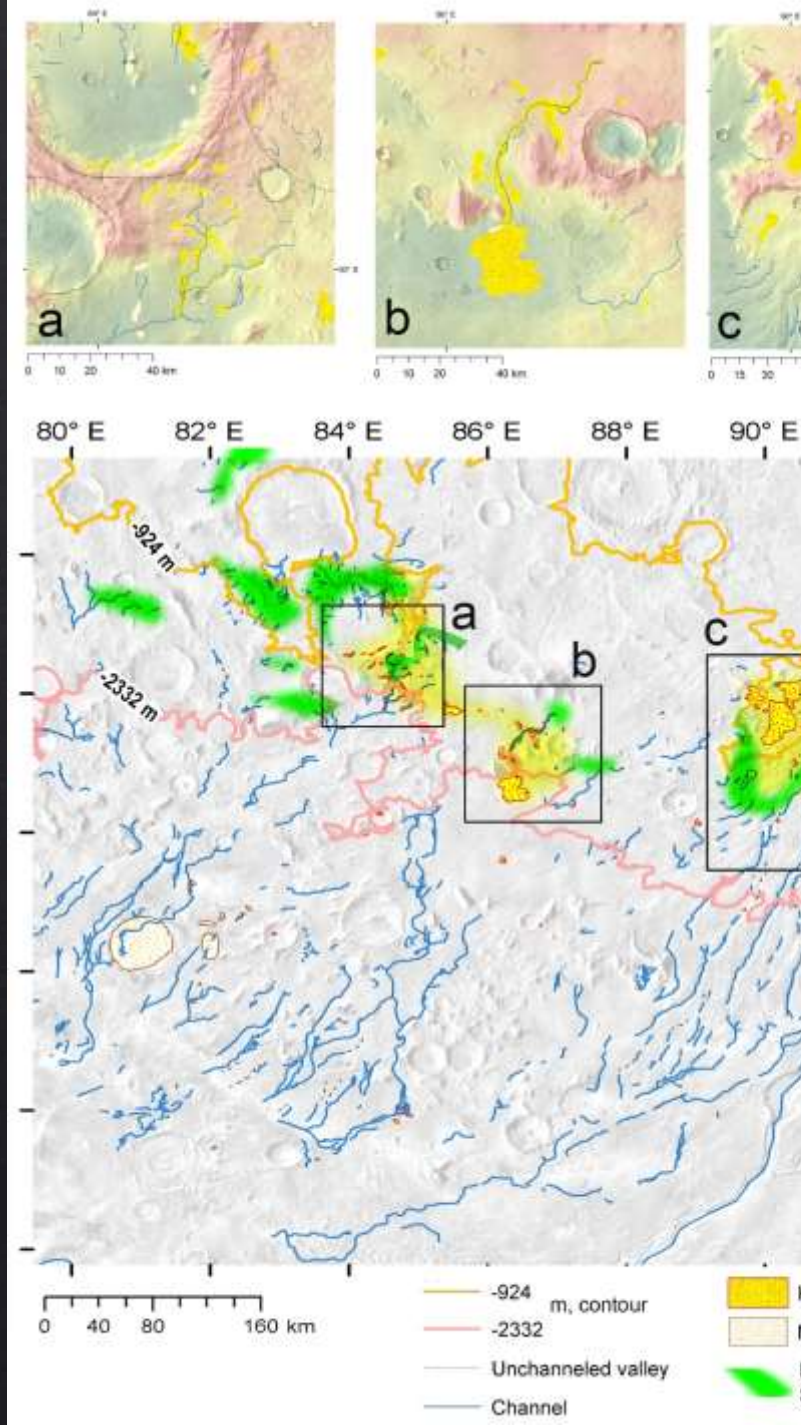

Valley networks in the highlands cut into, transport and alter Noachian regolith.
Flood/outflow channels cut into, transport and alter Hesperian basalt lavas.
Interior channels transported materials already altered by the flood channels.
Interior channel
Avulsion
0 1.25 2.5 5 km

Longitudinal profiles



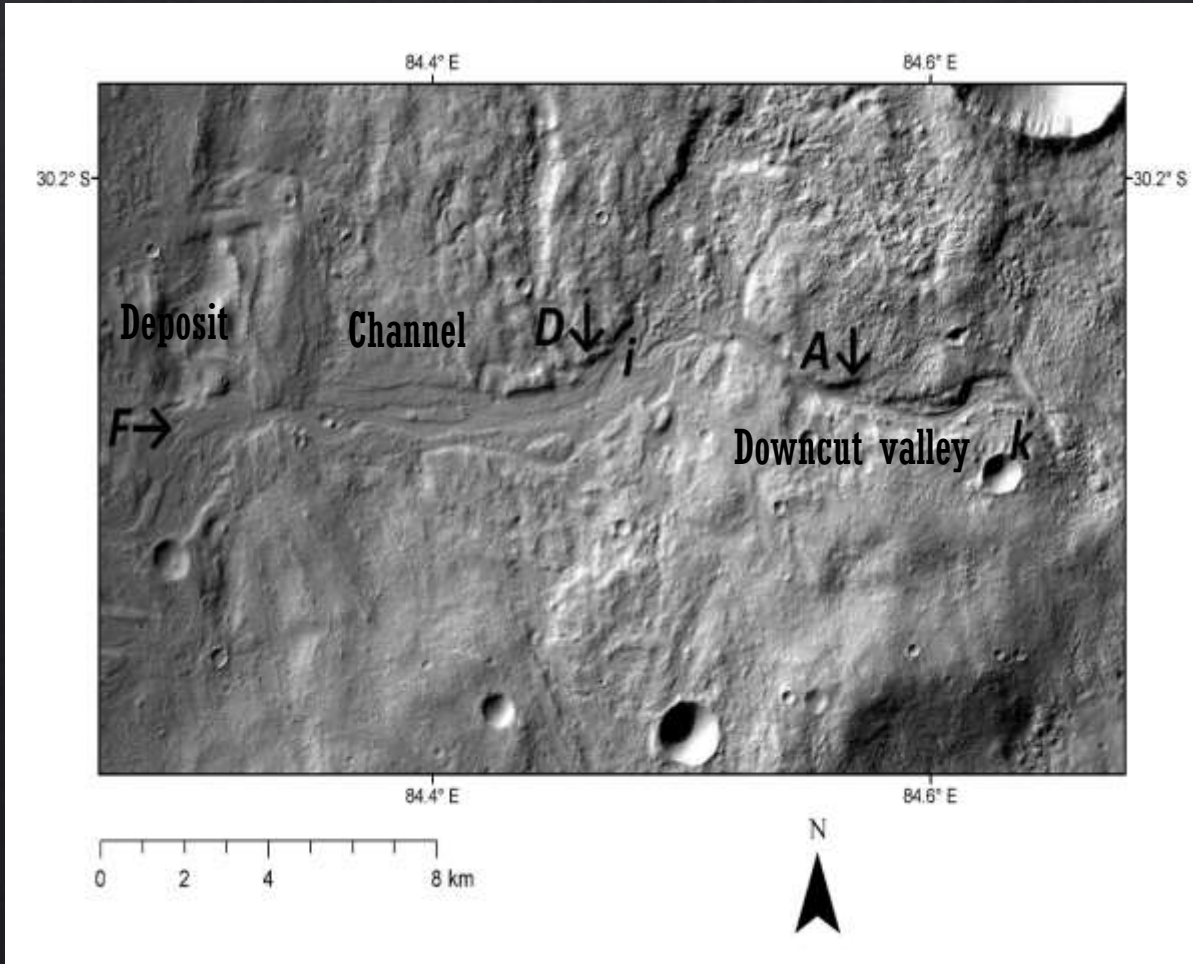
Source of water

- Green: source valley reaches (mountaintops)
- Yellow: knobby terrain (pingos?)
- Source is likely snowmelt at high elevations related to volcanic activity
- Groundwater present for lower reaches
- Similar setting is common on Mars but not close to volcanic centers
- Precipitation, volcanism and groundwater and altered materials likely formed a hydrothermal system which may have provided habitable zones. Its materials are preserved in the terminal deposits.



A channel sequence in Navua

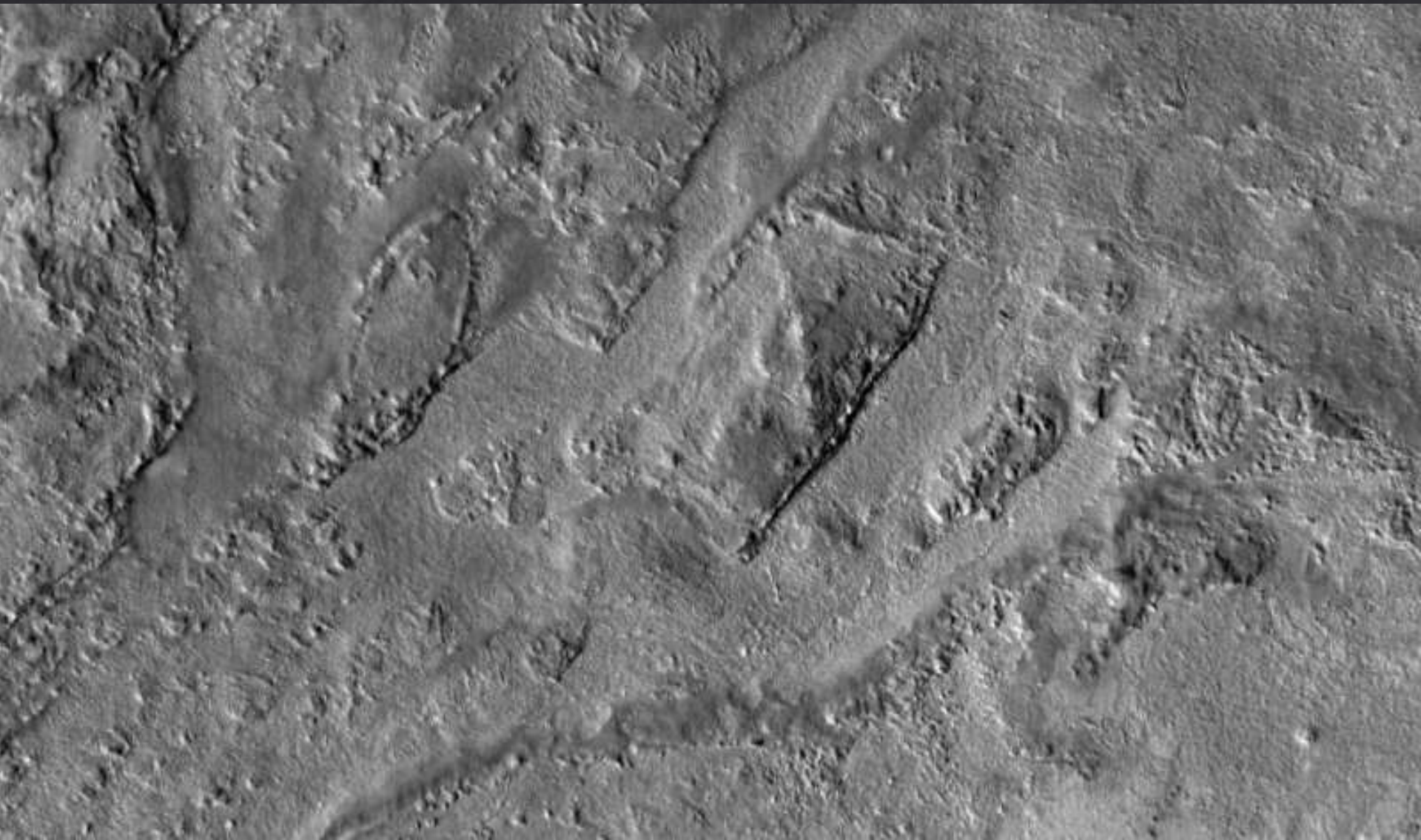
- Outflow channels normally have no terminal deposits.
- These channels have several sections with terminal deposit.



Channels / conclusion

- Fluvial and catastrophic-flood (outflow?) channels have:
  - Different origins
  - Different ages
  - Different discharges
  - **Mars had a large variety of environments that produced fluvial channels**
    - They formed throughout Mars history from Noachian to Amazonian times
    - Source was pluvial / snow / runoff, groundwater, subglacial
    - Termini show deposits
    - Some likely co-evolved with lava flows
    - Impact and volcanic materials were altered and reworked several times. The most complex alteration is expected at the interior channels' deposits, if any.

ISLANDS



Bar vs Island - Definitions

- Earth: bar: usually submerged / unvegetated
  island: usually emerged / vegetated

- Streamlined erosional islands with lee side depositional extensions (pendant bars)

Bar vs Island: Mars

- No water
- No vegetation

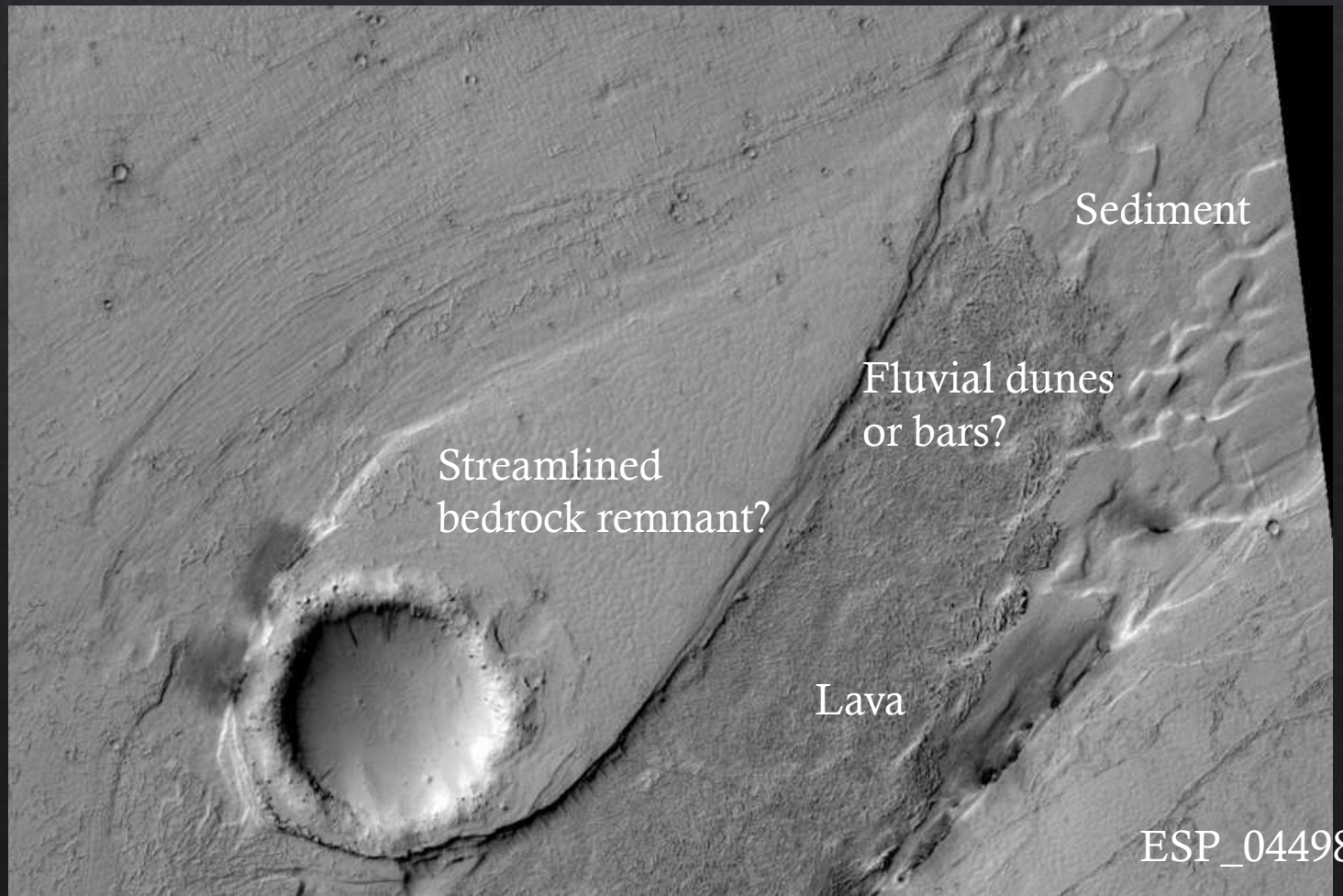
- Geological definition:
- Bar: depositional
- Island: erosional bedrock remnant
- Eroded alluvium: mixed
- or ← Composit forms?

Island origins

- 1. Depositional bars -> fluvial origin, availability of transportable material. – *low height (scales with channel width)*
  - Braided channels
- Fluvial dunes (smaller, repeated forms) – *(scales with channel depth)*
- Complex: Dissected alluvium (erosional islands in alluvial plains or channel fill deposit) -> fluvial origin, multiple modes of stream activity (depositional-erosional)
- 2. Erosional remnants - > no deposition, catastrophic floods, or avulsion – *steep walled, same level as overbank*
  - Anastomosing channels (islands wider than channel width)
- 3. Composite: Lee deposits / Pendant bar

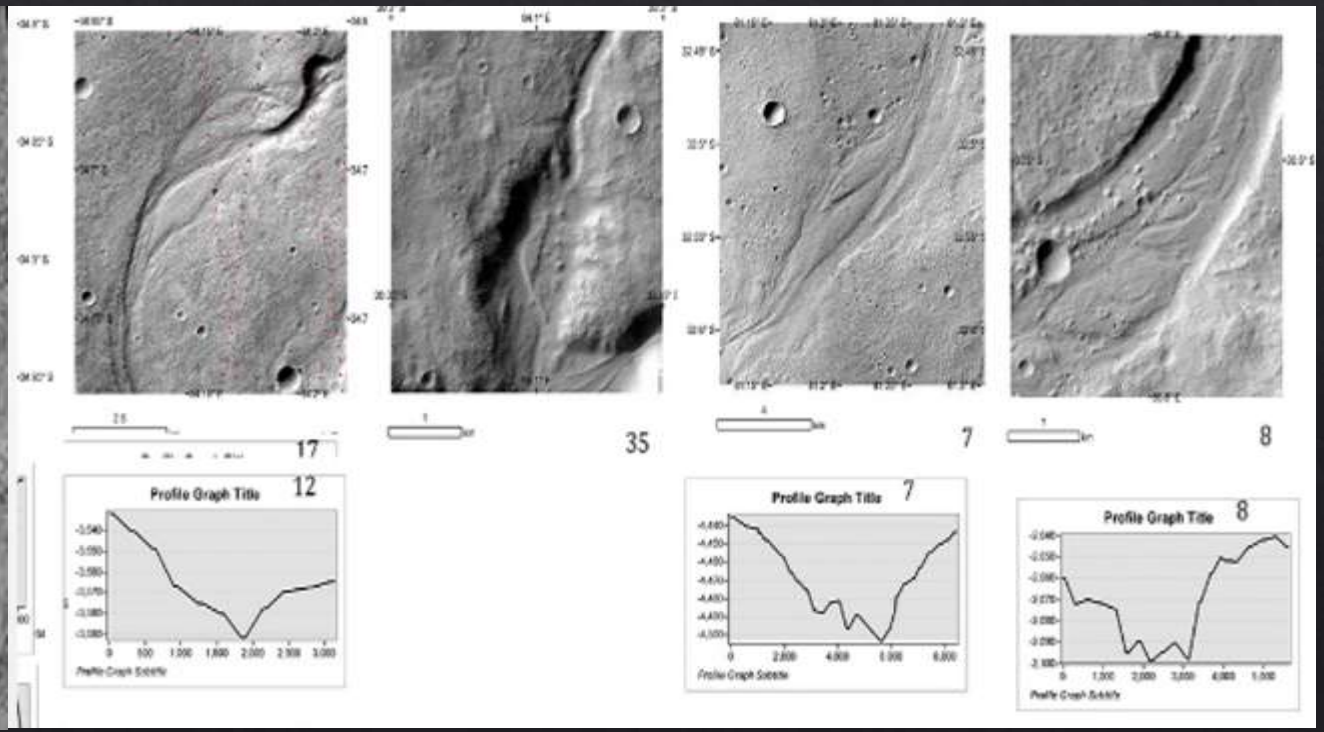
Linguoid/diagonal deposits in Lethe Valles. Mars and Sabie River, South Africa.

- (crater cored) island vs. fluvial dunes



Bars or islands?

- Low streamlined hills are classified as depositional bars or dissected alluvium (alluvial plain with interior channels)



Fluvial channels cutting into alluvium or channel fill / expansion bars?

Alluvial Erosional Bar?

Streamlined islands

Typical catastrophically formed
Streamlined forms

Simud-Tiu Valles

Streamlined islands

- Teardrop- shaped islands: the blunter ends point upstream and long tails point downstream.

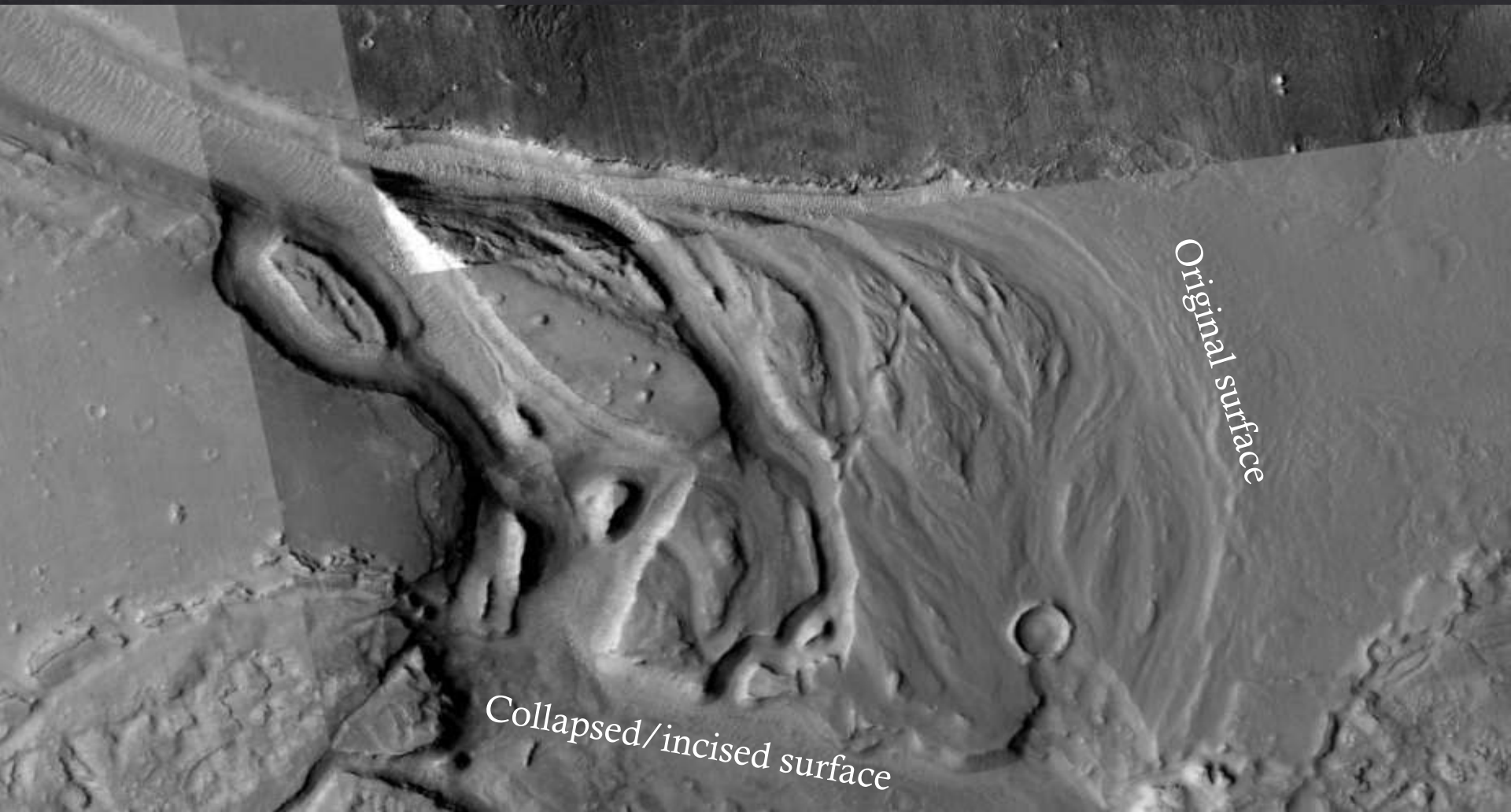
Not here: remnant islands

↑ Palos flow

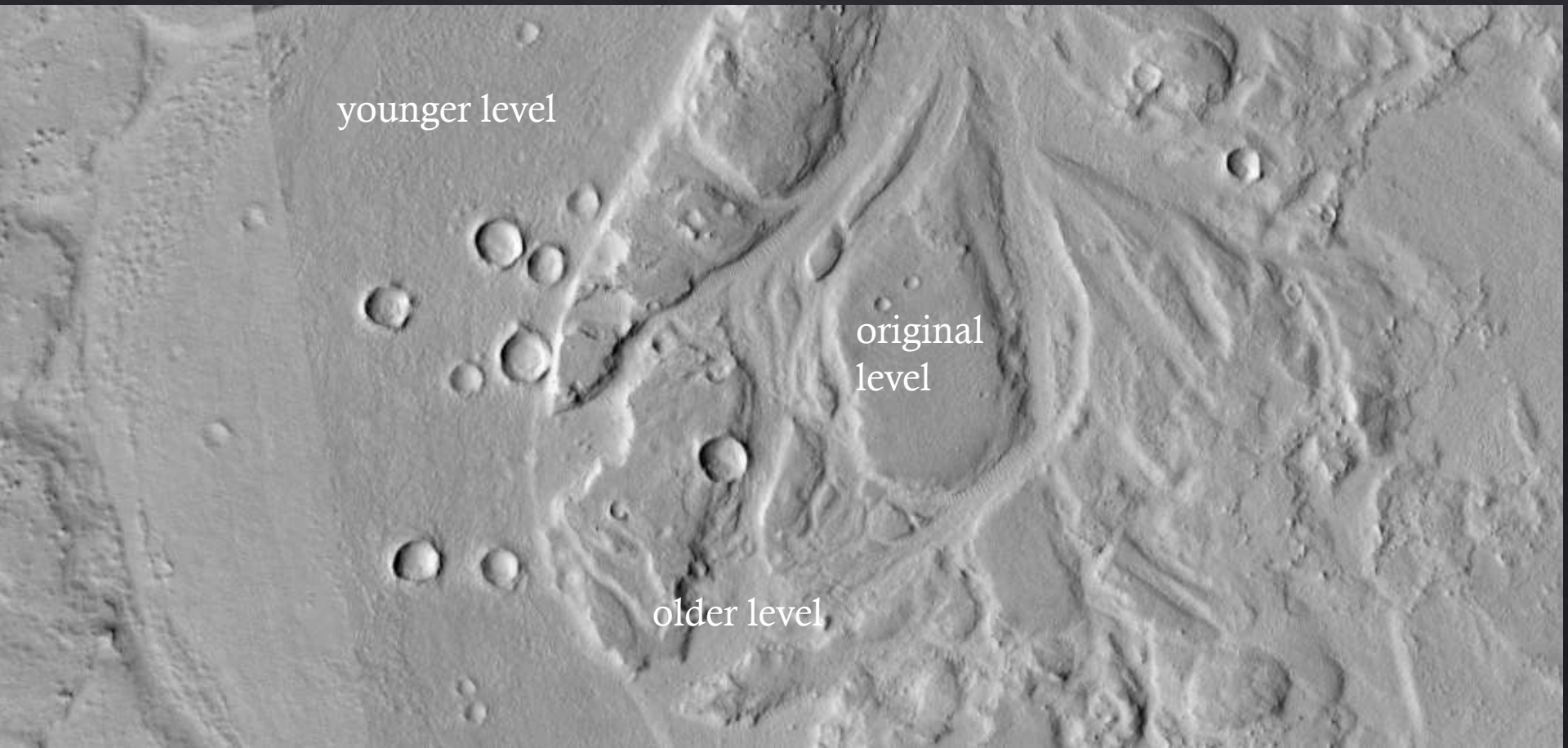
Fluvial? Aeolian? Sedimentary? Remnant?

Yardangs-in-islands?

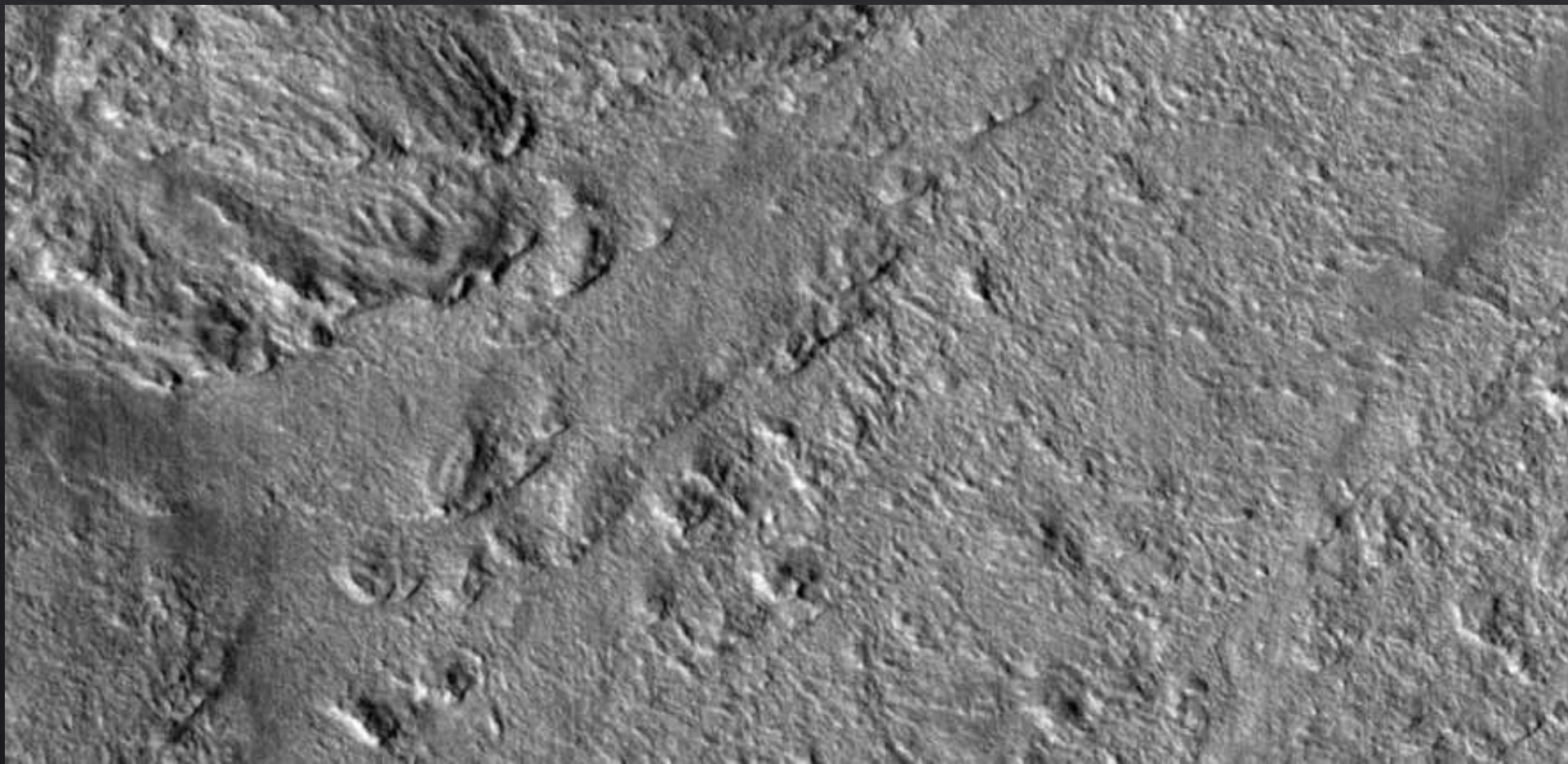
Generations of island erosion

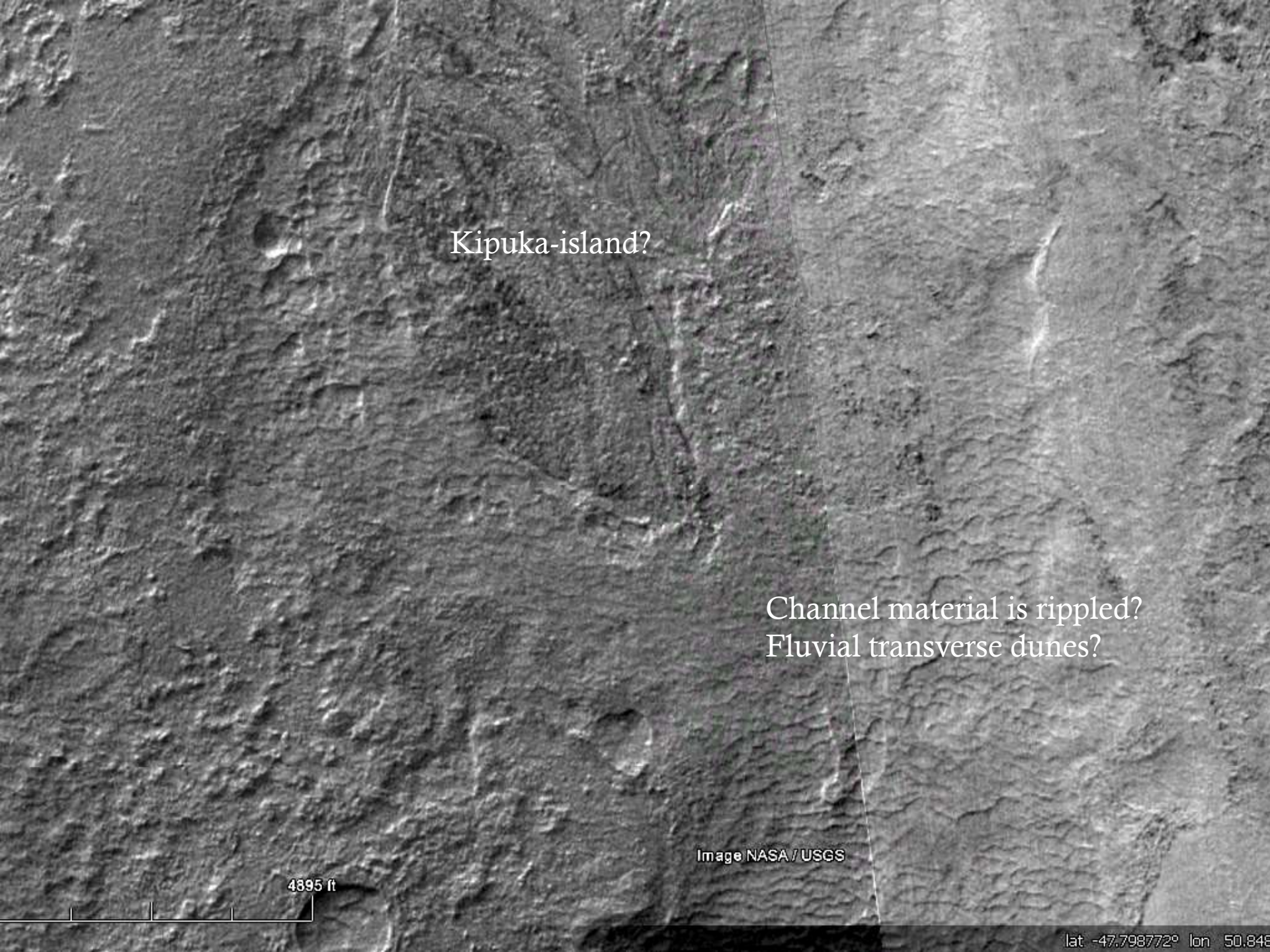


Generations of channels

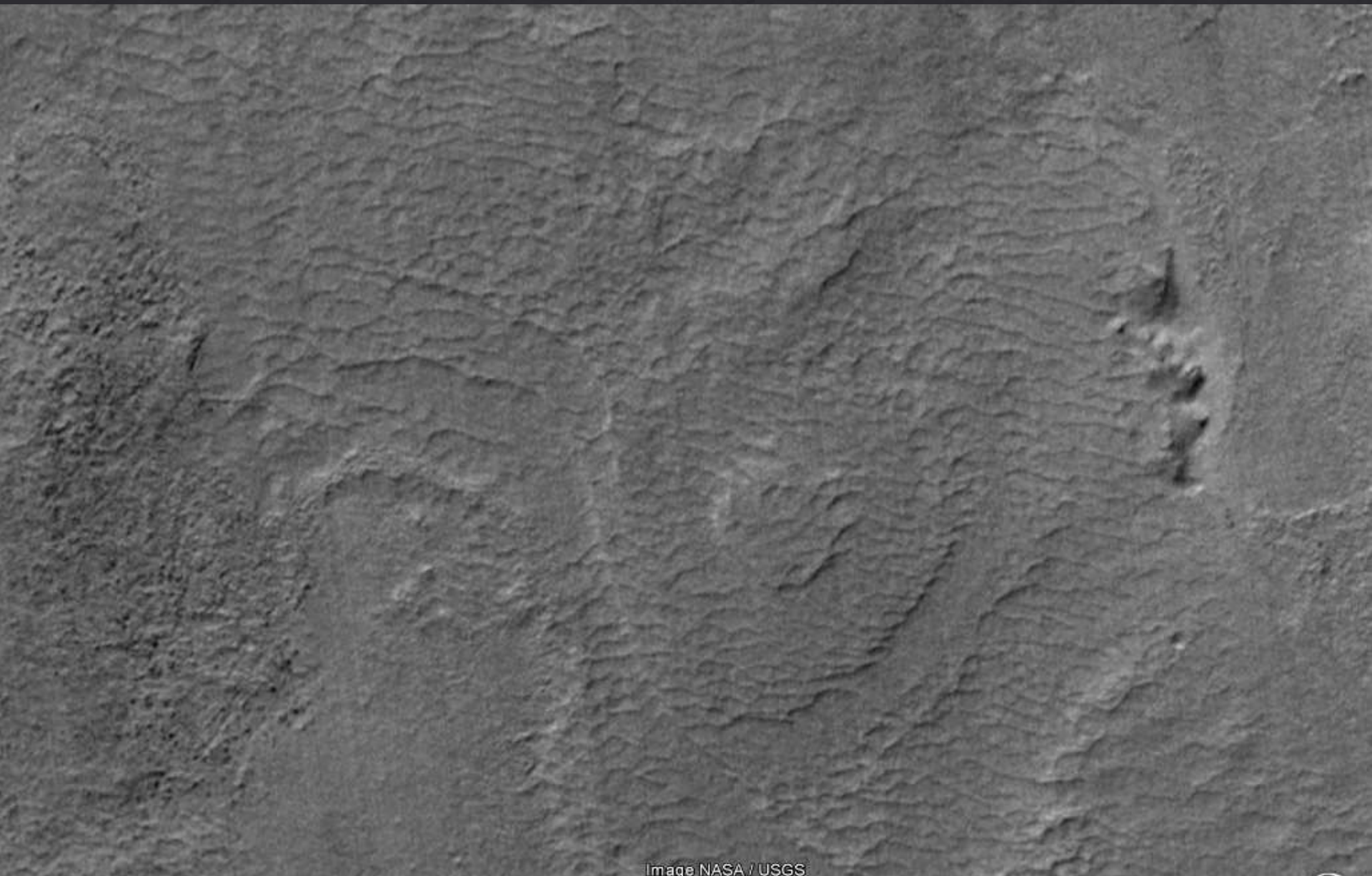


Bars? Fluvial dunes? Aeolian forms?

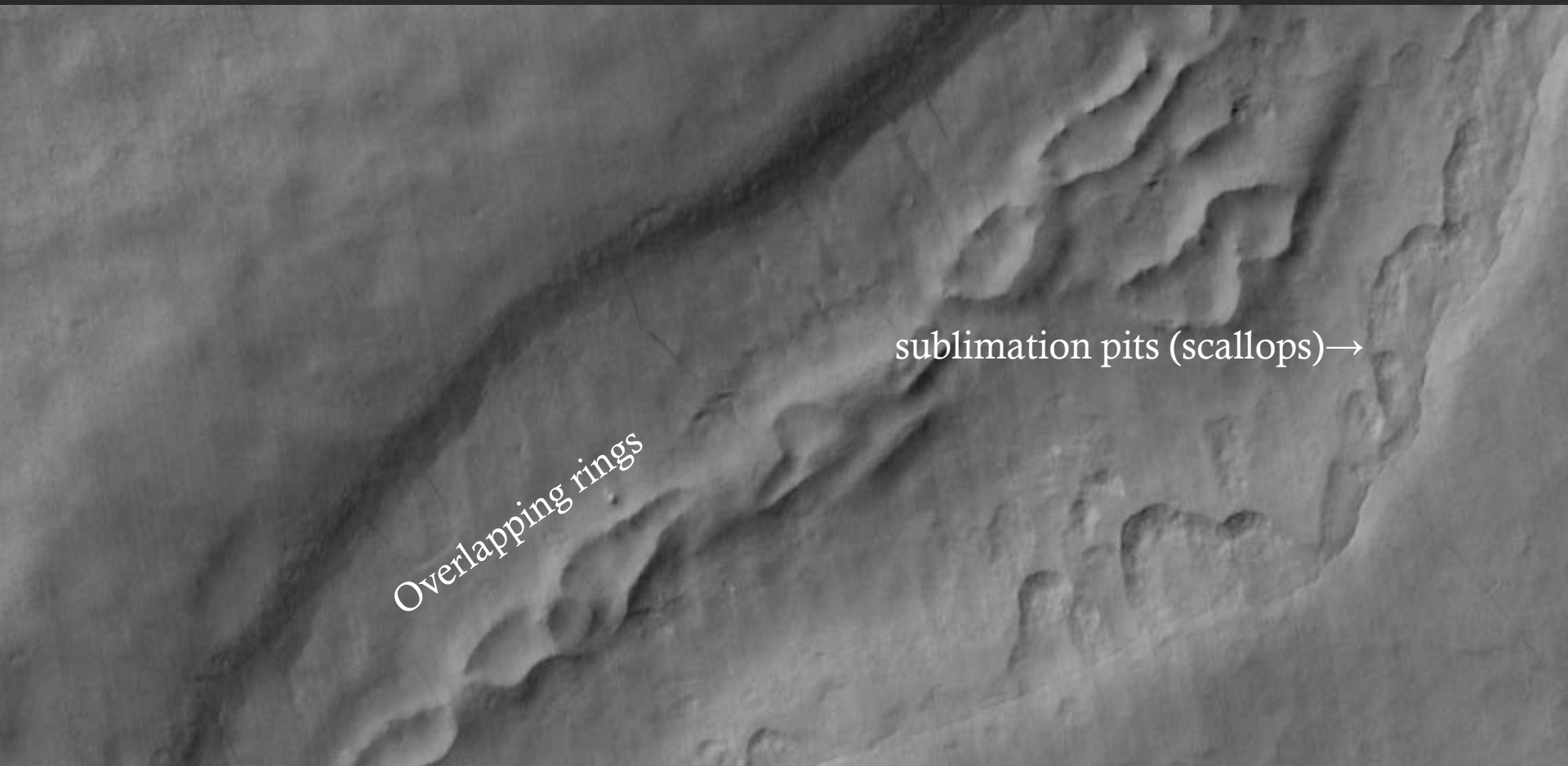



Kipuka-island?
Channel material is rippled?
Fluvial transverse dunes?
Image NASA / USGS
4895 ft
lat -47.798772° lon 50.848

Ripples not fluvial: it occurs on top of layered channel filling material
Indurated aeolian forms?

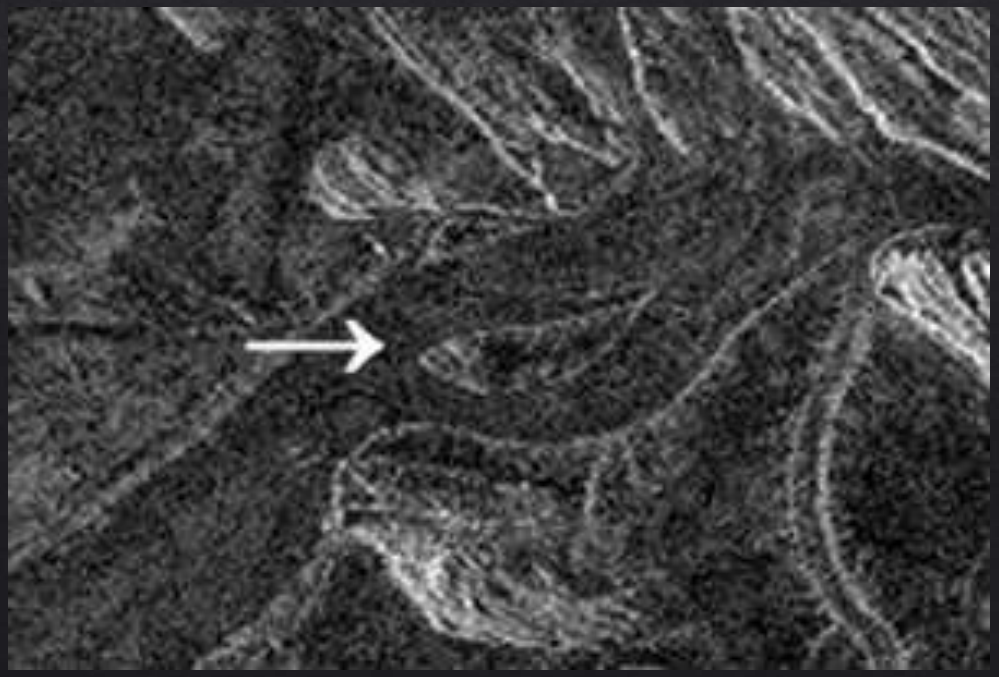


- Enigmatic forms



Questions:

- Are islands different in different channels?
- How can we distinguish bars and islands? (depositional/erosional or submerged/emerged) and fluvial dunes?
- Can islands help determine the origin of the channel?



Lava channel on Venus

More questions?

- hhargitai@gmail.com
- Channel database: planetarydatabase.wordpress.com

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