A LARGE LAKE BASIN AT THE HEAD OF MA'ADIM VALLIS, MARS

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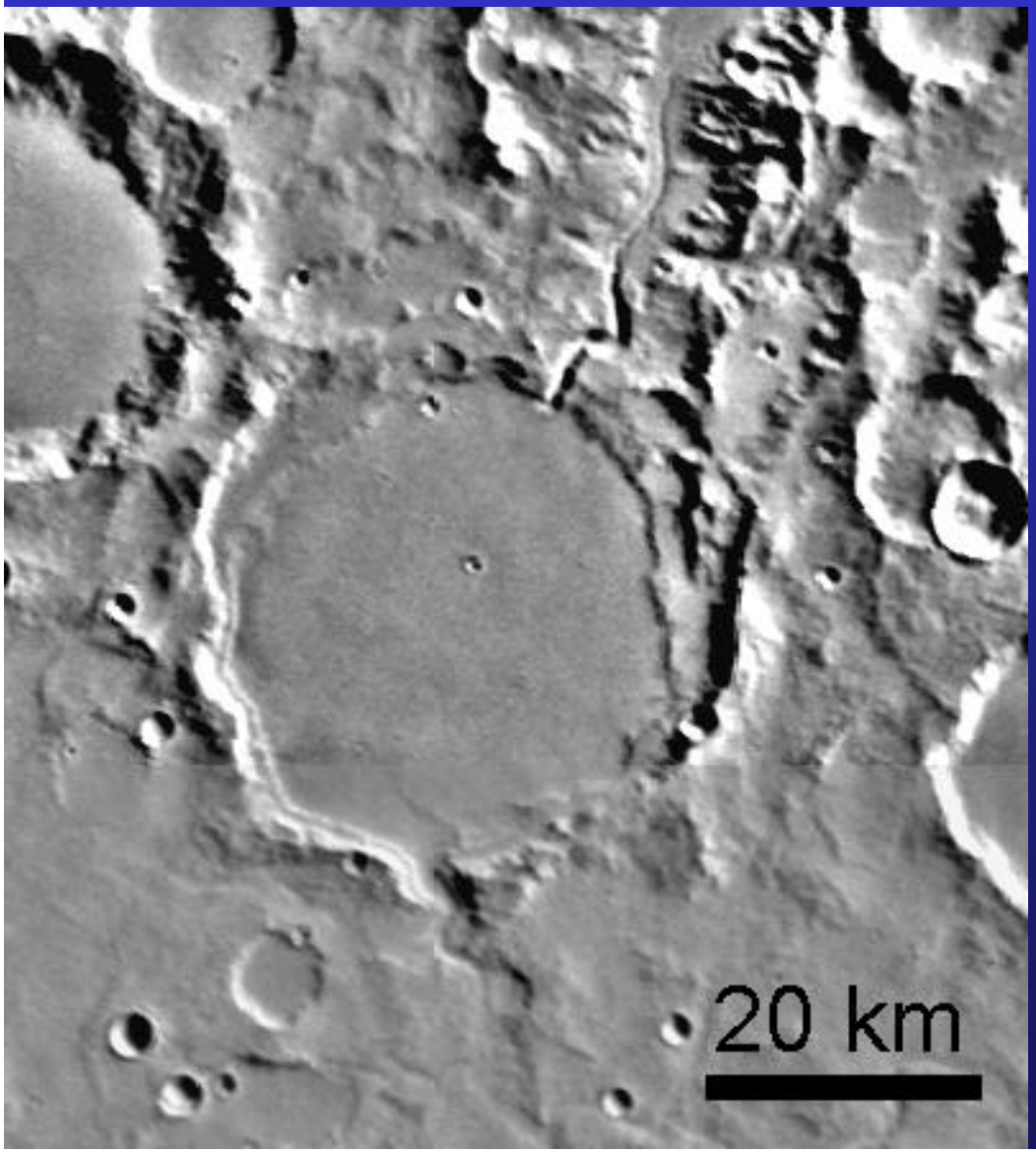
FEATURES OF LAKES

- Closed basin
- Single or multiple inflowing valleys
- Usually a single outflowing valley, crosscutting one or more drainage divides
- Interior depositional terracing, deltas, or erosional benches
- Interior plains deposit
- Long-lived lakes require stable water table

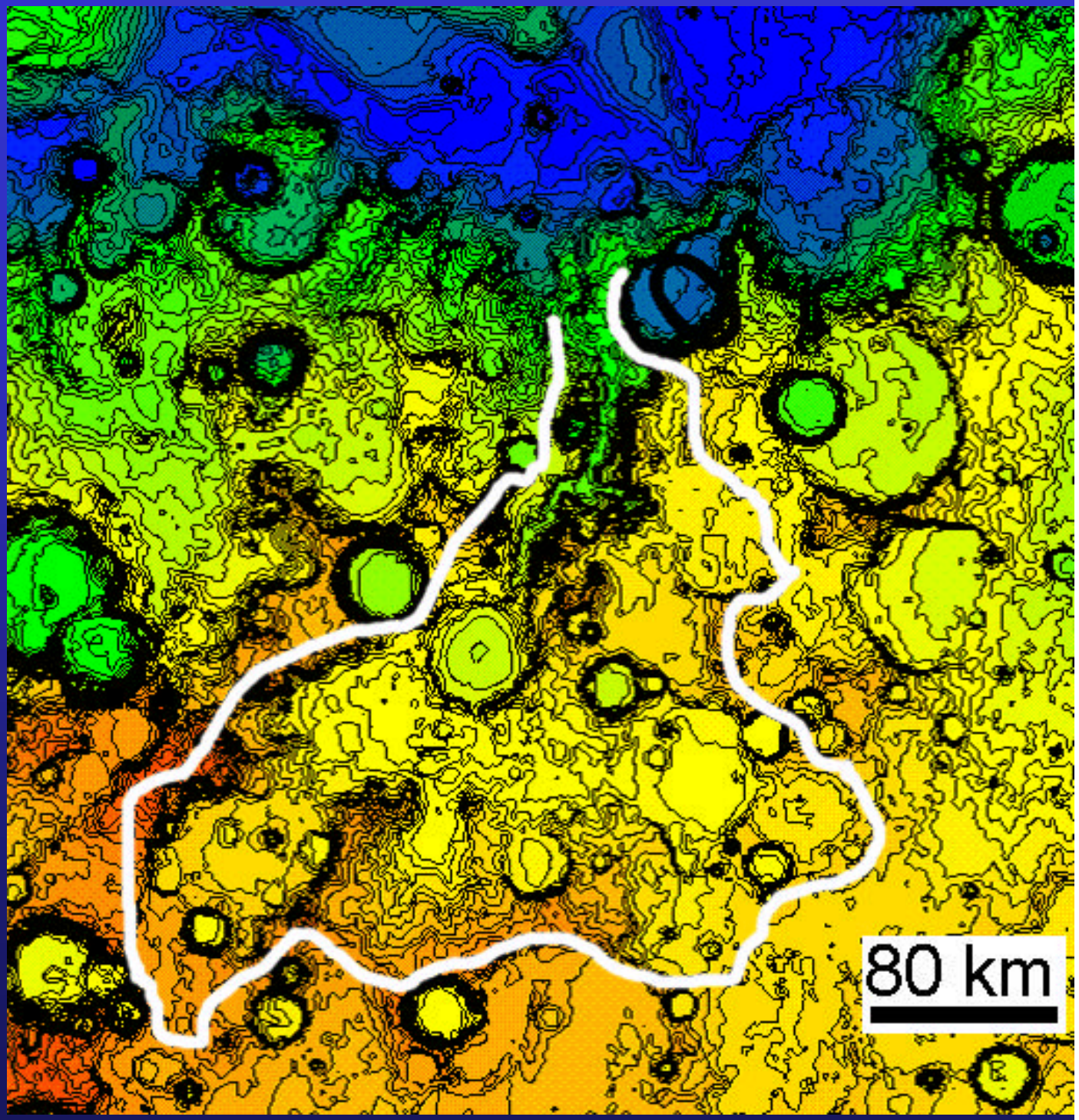
(Precipitation + inflow) = (evaporation + outflow)

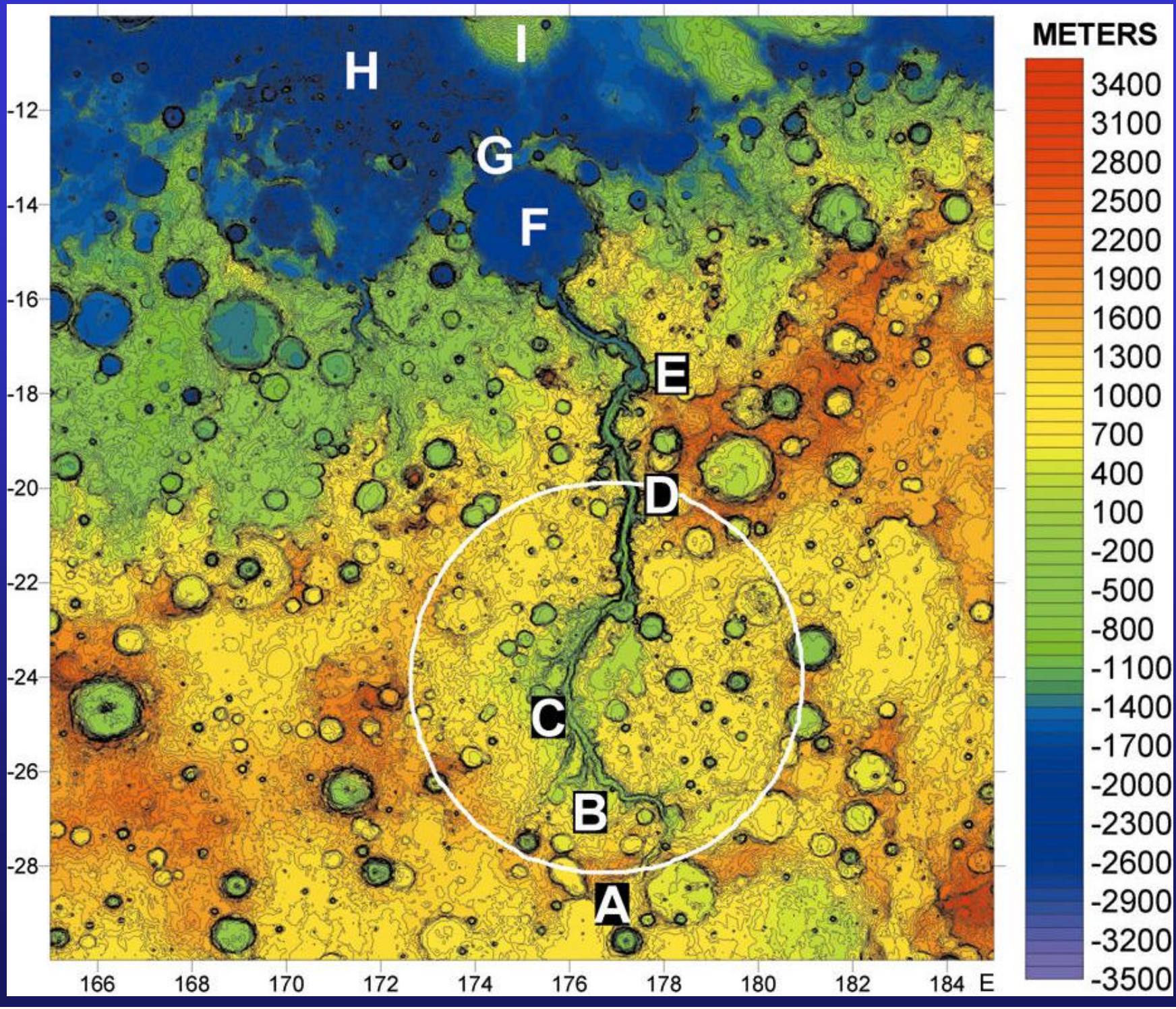
Crosscut impact crater lake in Memnonia quad.



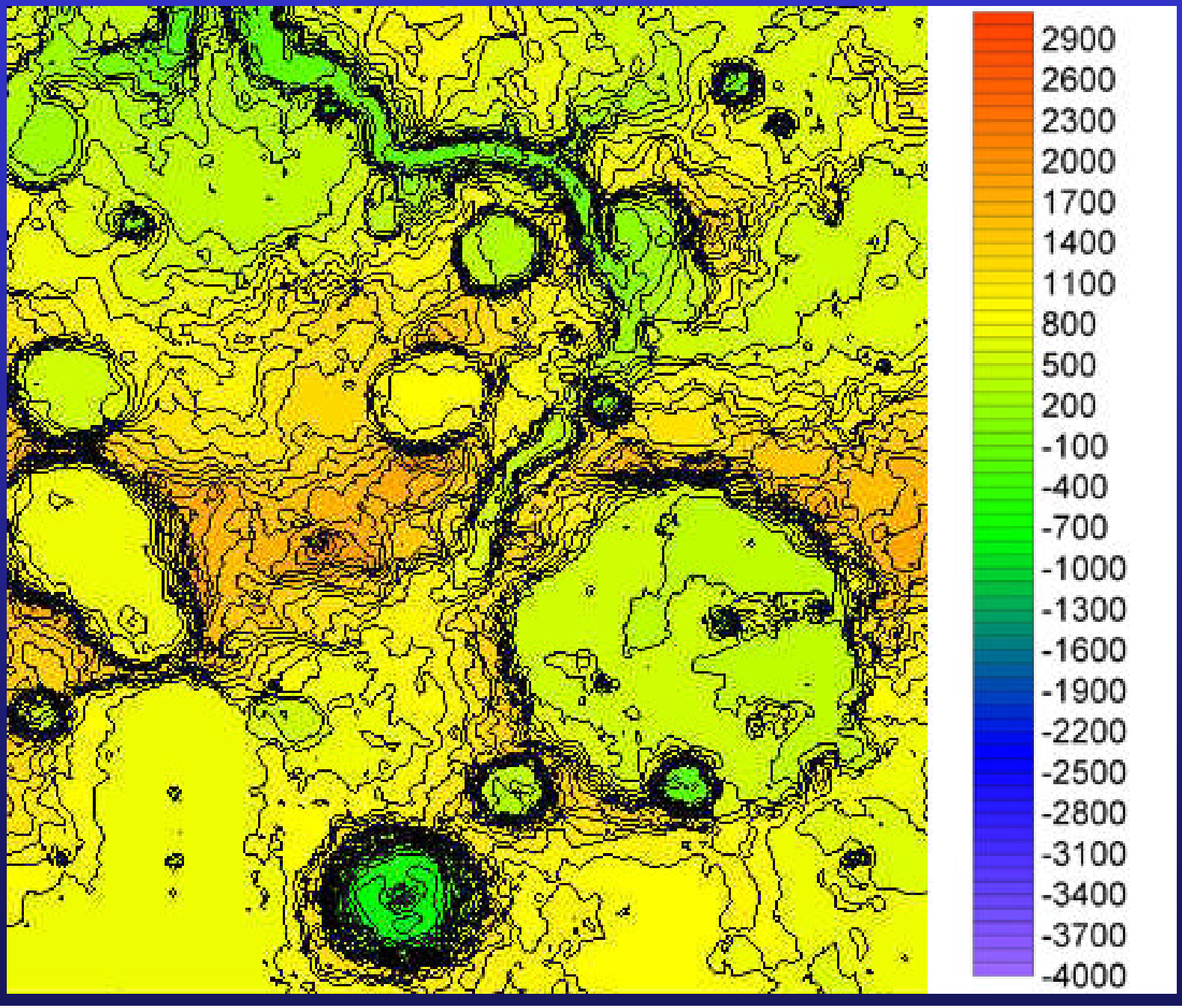
Memnonia crater lake, MOLA grid

1 km/cell
100 m interval
14.5° S, 185° E

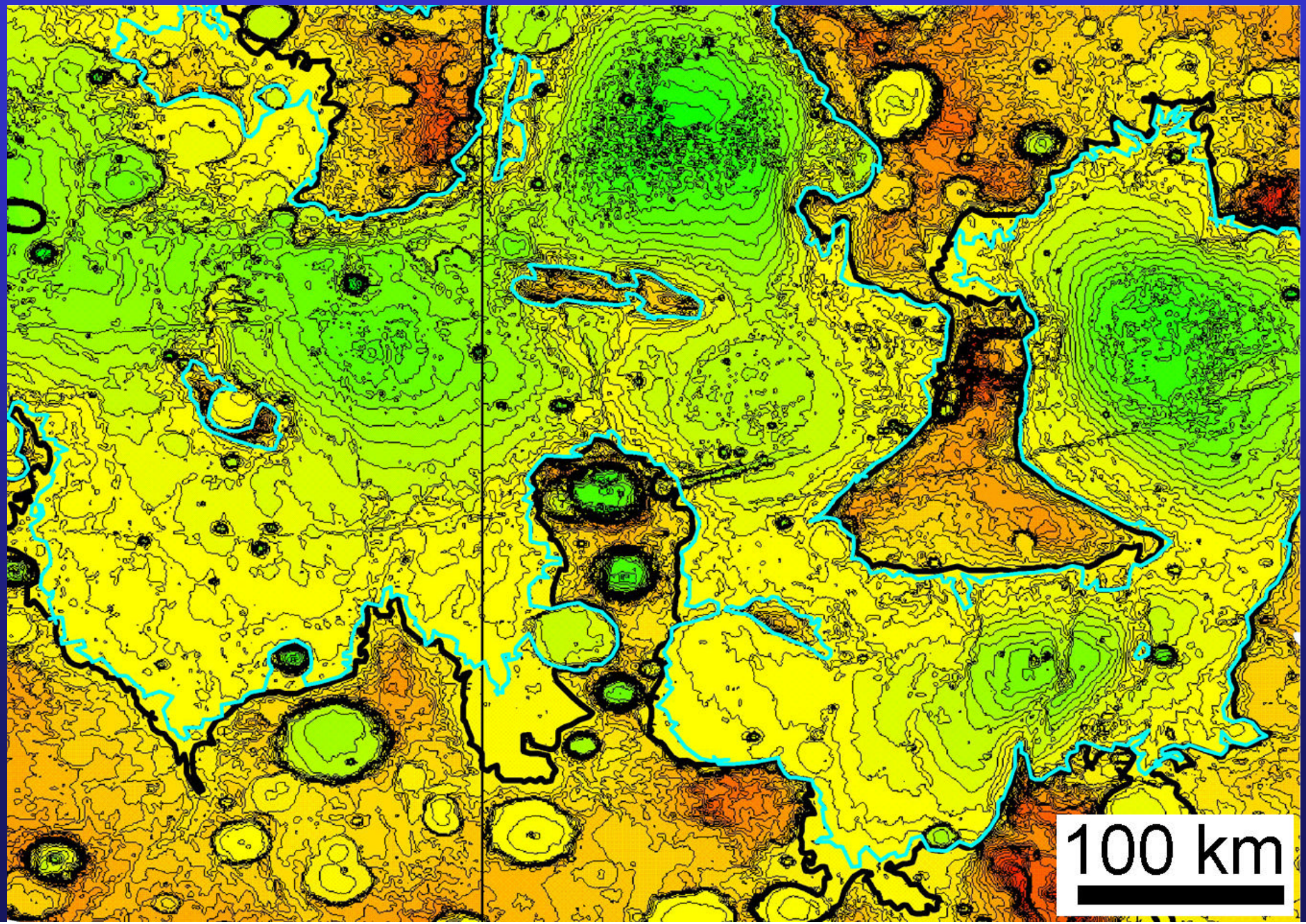



METERS
3400
3100
2800
2500
2200
1900
1600
1300
1000
700
400
100
-200
-500
-800
-1100
-1400
-1700
-2000
-2300
-2600
-2900
-3200
-3500
-12
-14
-16
-18
-20
-22
-24
-26
-28
166
168
170
172
174
176
178
180
182
184 E
H
I
G
F
E
D
C
B
A

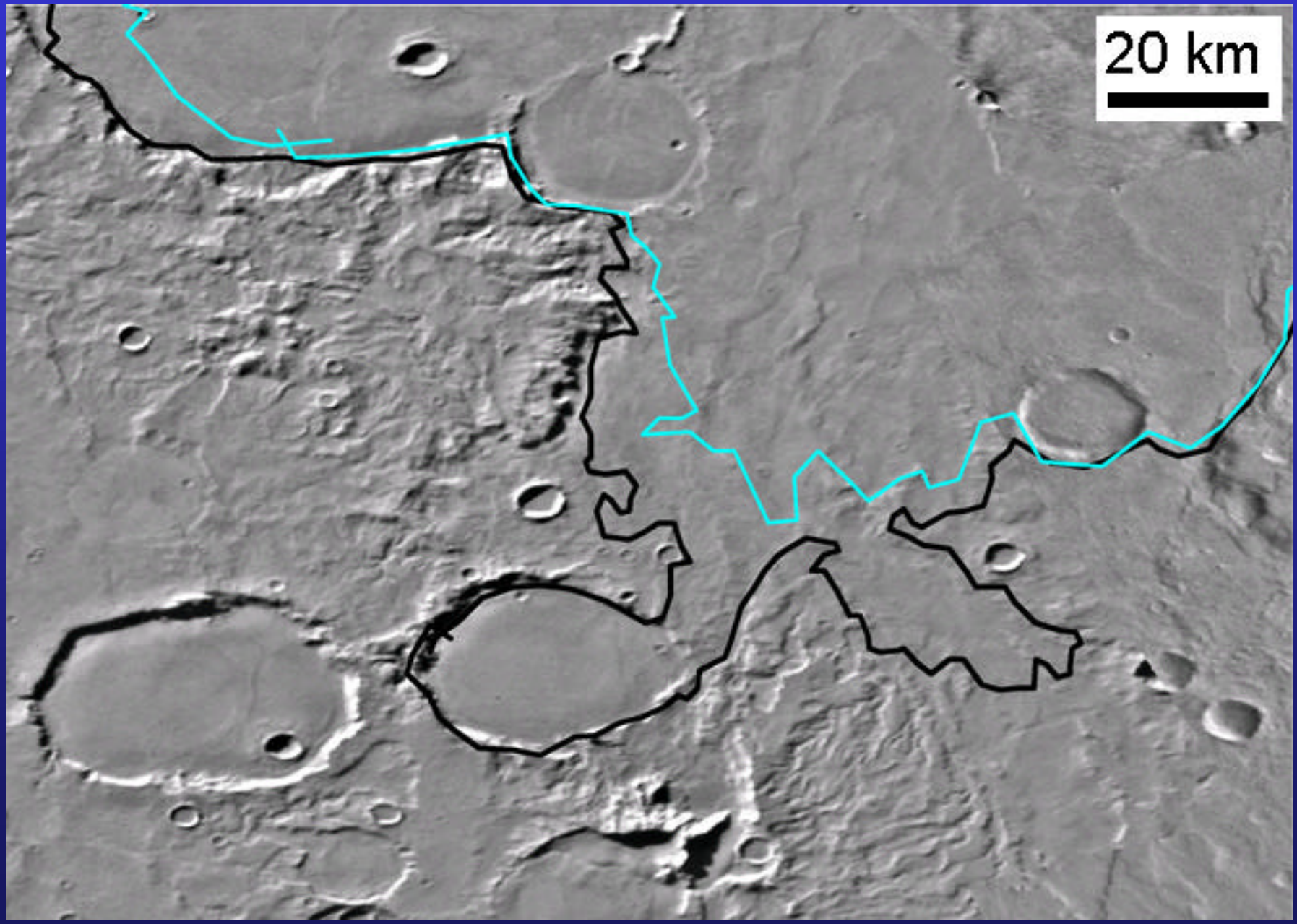
Head of Ma’adim Vallis crosscuts divide



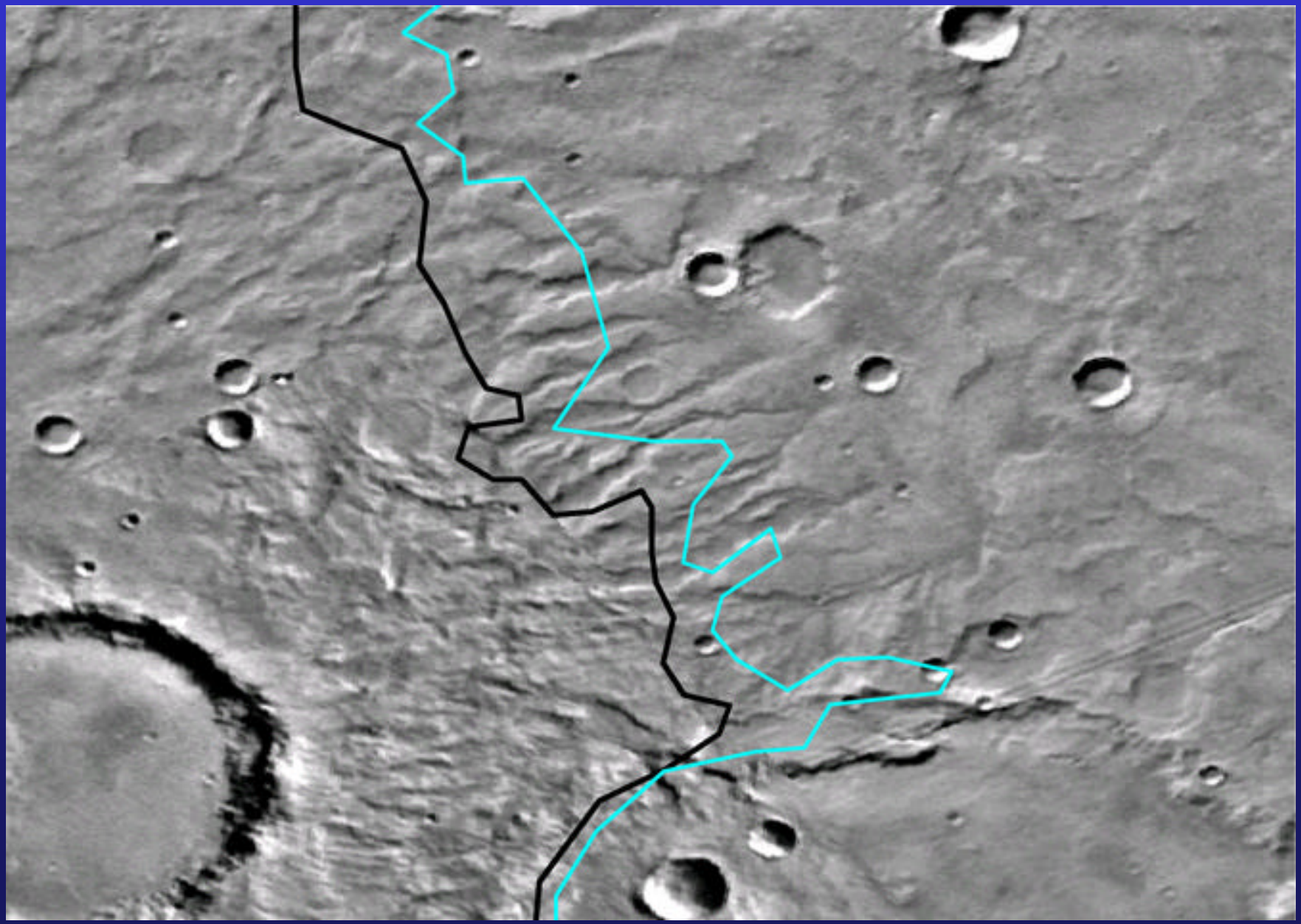
Shoreline break in slope, deep basins



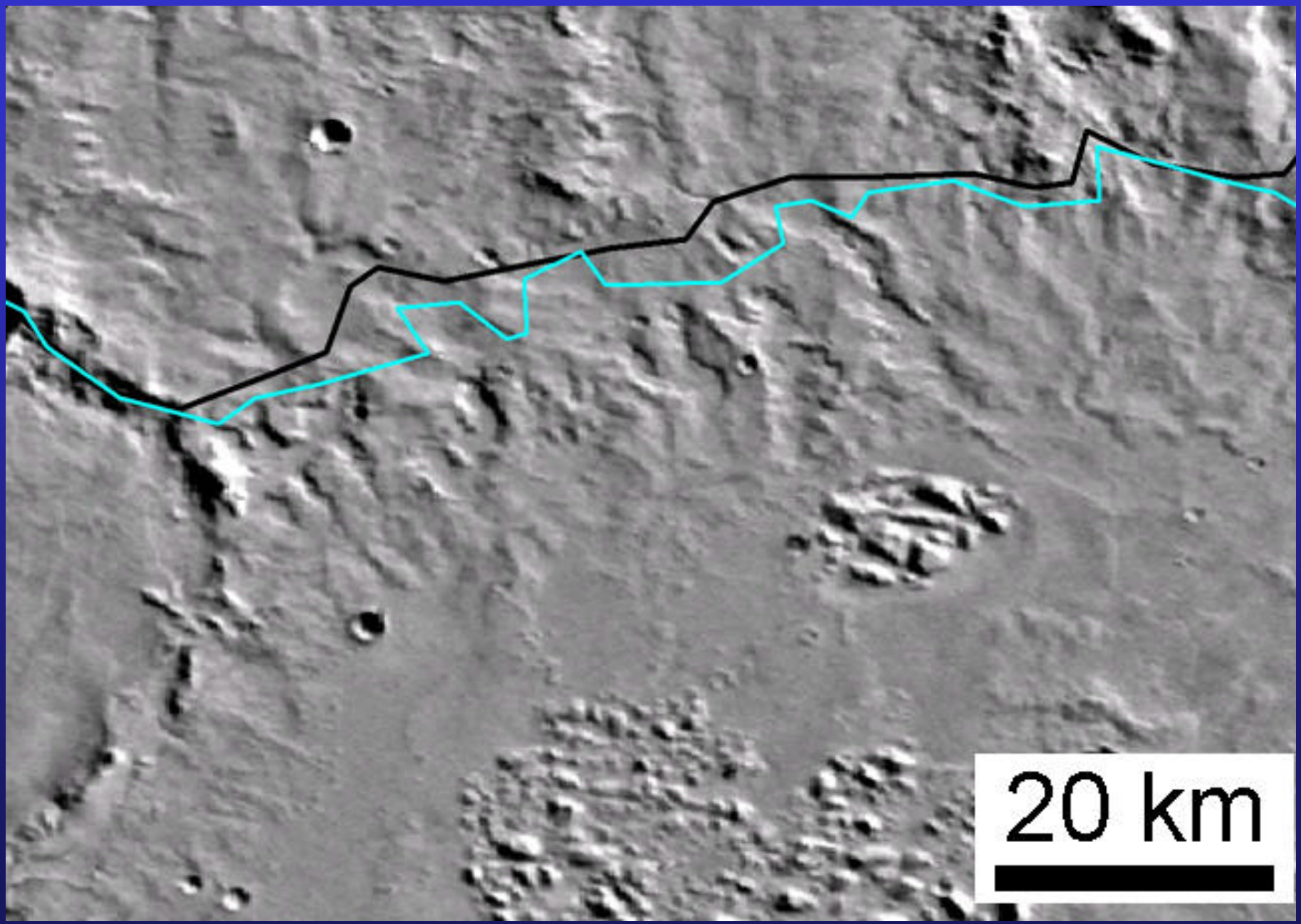
Abrupt termination of valleys at transition



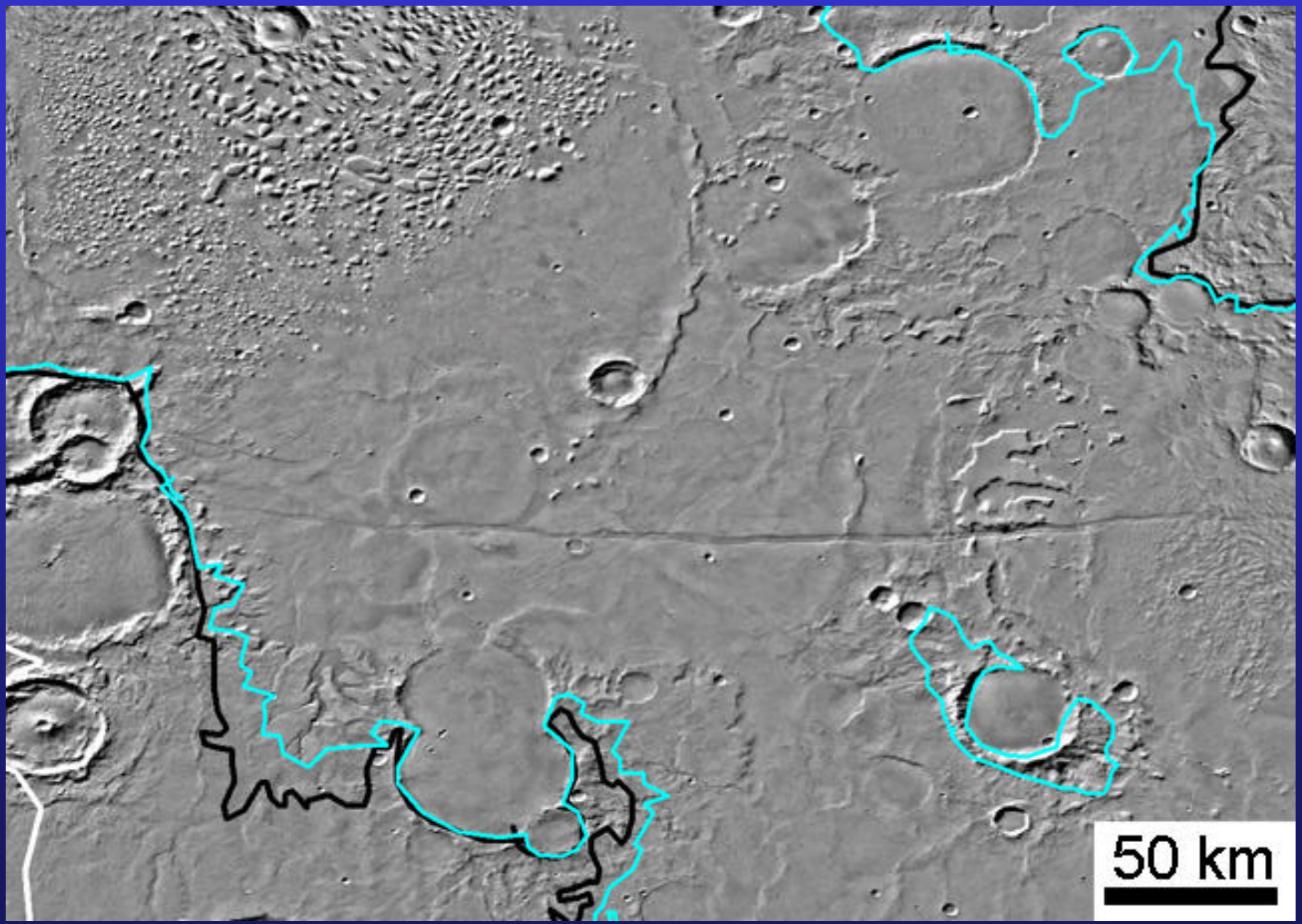
Transitional valley network morphology 1



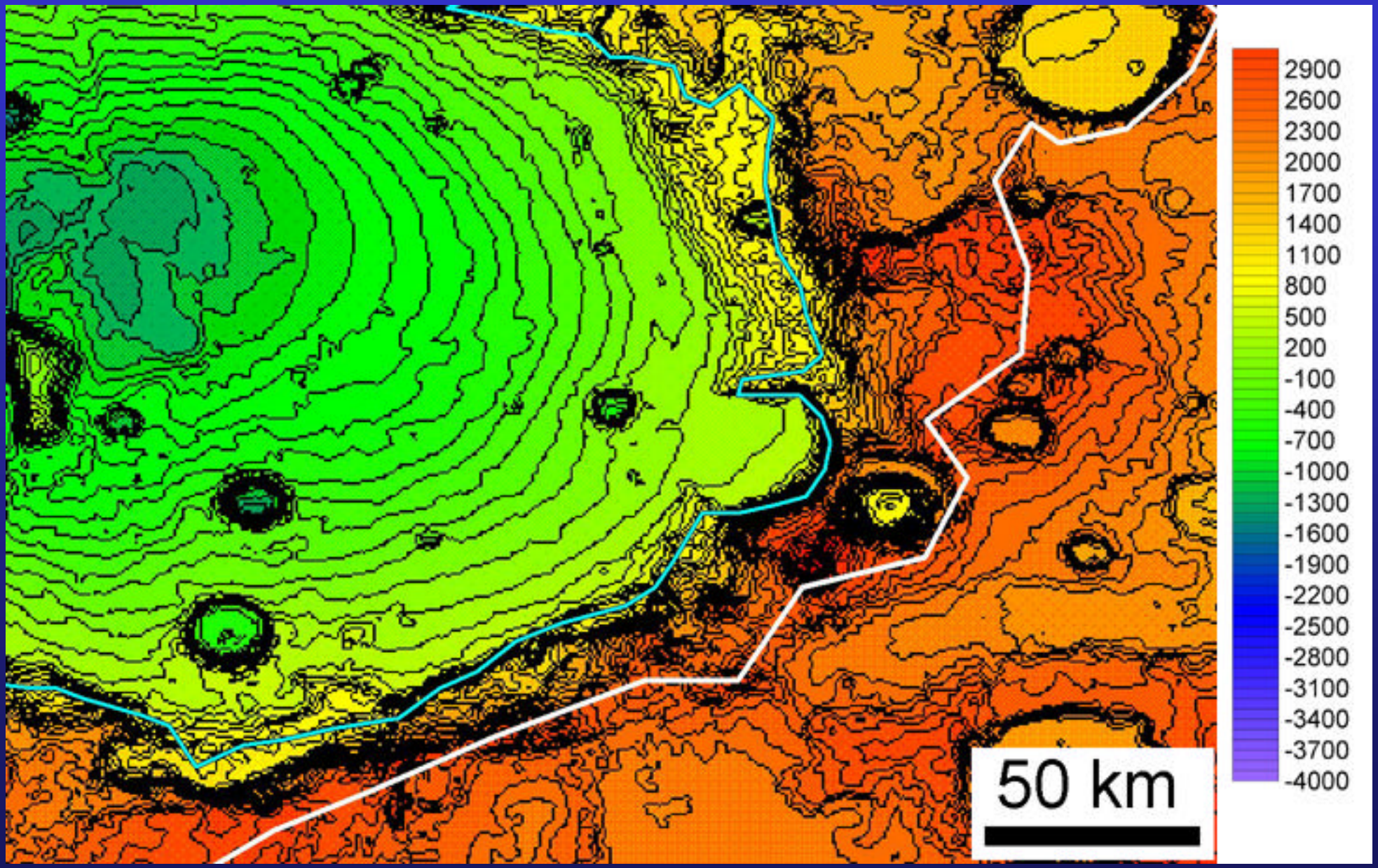
Transitional valley network morphology 2

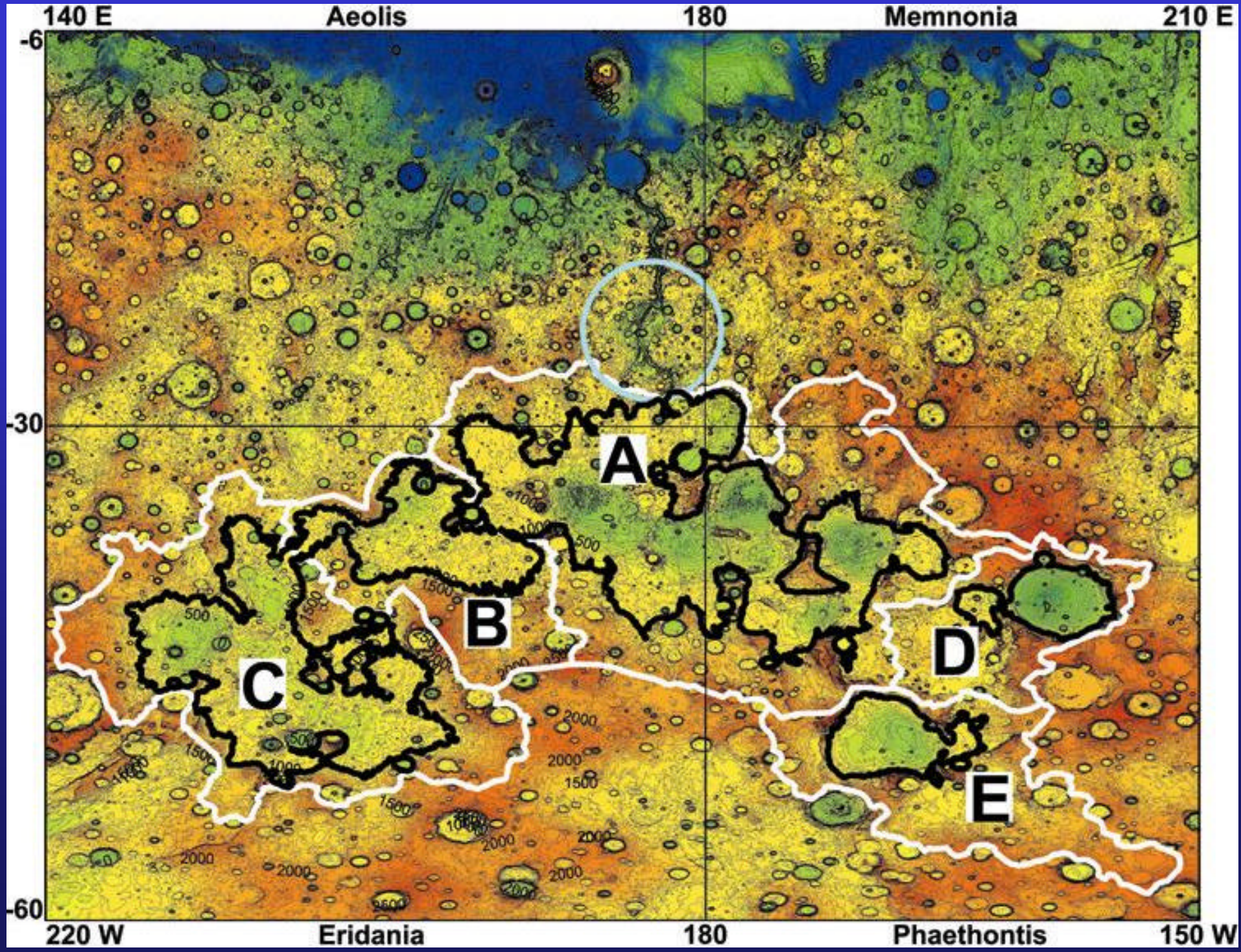


Eroded floor materials and buried craters



Bench at same level in nearby Newton Cr.




140 E
Aeolis
180
Memnonia
210 E
-6
-30
-60
220 W
Eridania
180
Phaethontis
150 W
A
B
C
D
E

LAKE SUB-BASIN DATA

SUB-BASIN	Area at 1100 m level (km^2)	Volume at 1100 m level (km^3)	Area at 950 m level (km^2)	Volume at 950 m level (km^3)
A			509,000	218,000
B			116,000	24,000
C			257,000	81,000
TOTALS	**1,100,000**	**487,000**	**882,000**	**323,000**

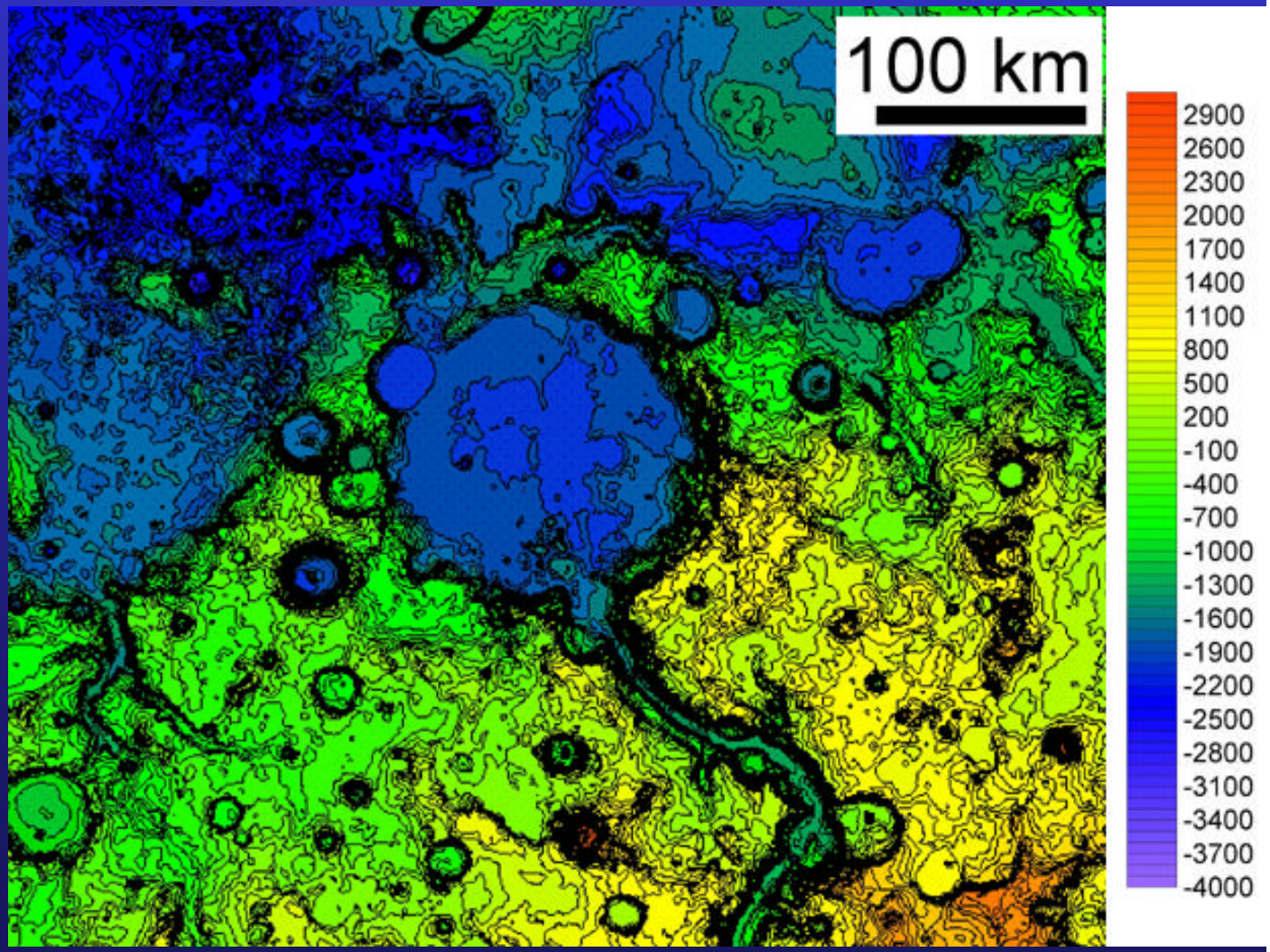
Surface water available for discharge	**164,000 km^3**
Surface water available for direct runoff	**97,000 km^3**
Volume of Ma'adim Vallis	**14,000 km^3**
Water/sediment ratio for a single flood of surface water	**7:1**
Water/sediment ratio assuming equalized aquifer	**12:1**

CRATER STATISTICS

	n	N(2)	N(5)	Age
LAKE FLOOR	732	633 ± 27	204 ± 15	Late Noachian near Hesperian boundary
GUSEV FLOOR*	24	541 ± 221	None	
MA'ADIM FLOOR*	5	708 ± 306	None	
MA'ADIM DELTA*	10	619 ± 206	None	
* data from Cabrol et al., *Icarus*, 133, 98-108 (1998).				

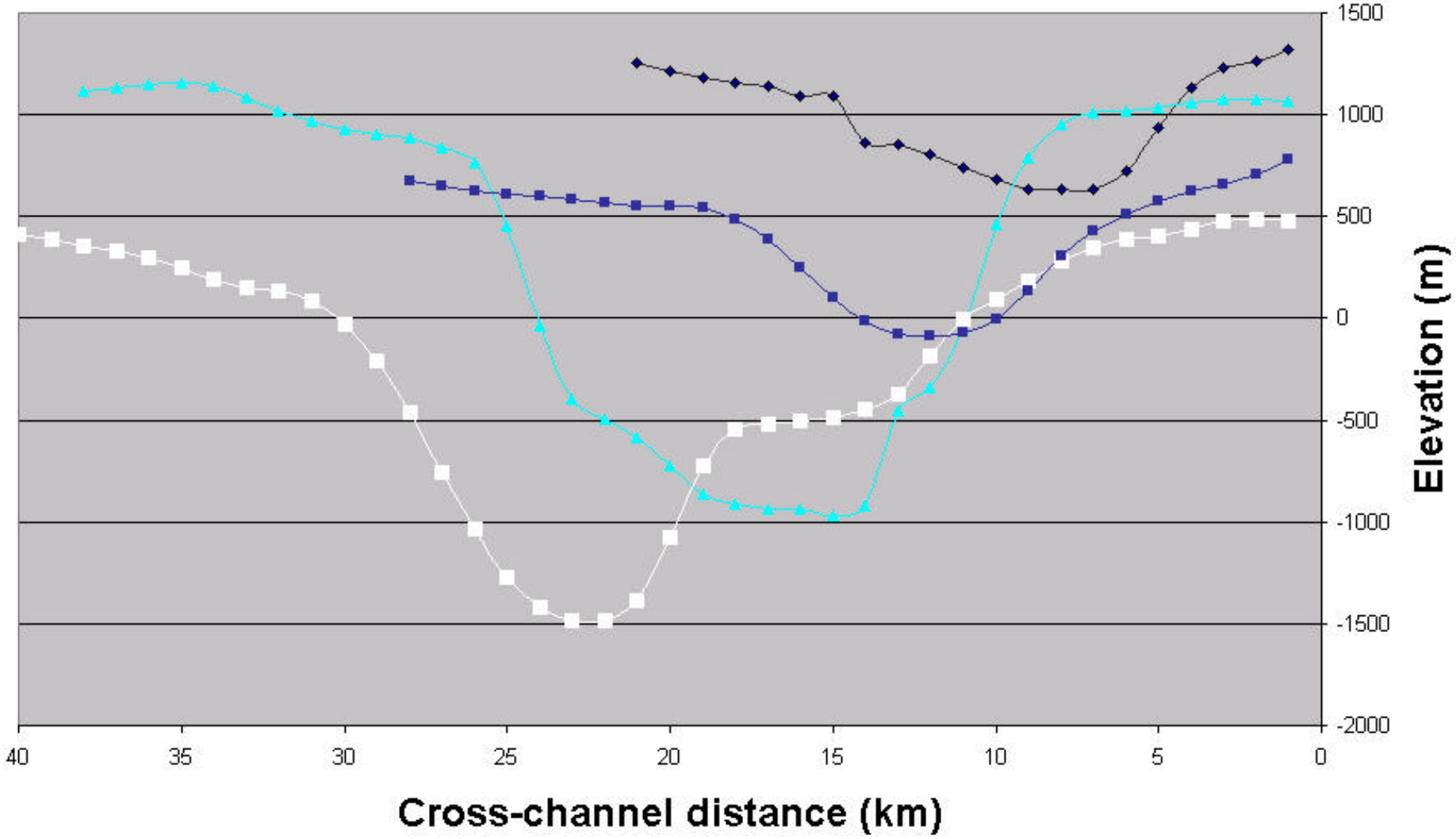
No significant differences in crater age of source basin and Gusev Crater, both date to near the Noachian/Hesperian boundary

Volume eroded from Ma'adim Vallis is ~14,000 km^3, and fill within Gusev crater estimated at 15,100 km^3*



* Estimate by Carter et al, 2001, LPSC 32, 2404

Cross-Sections of Ma'adim Vallis

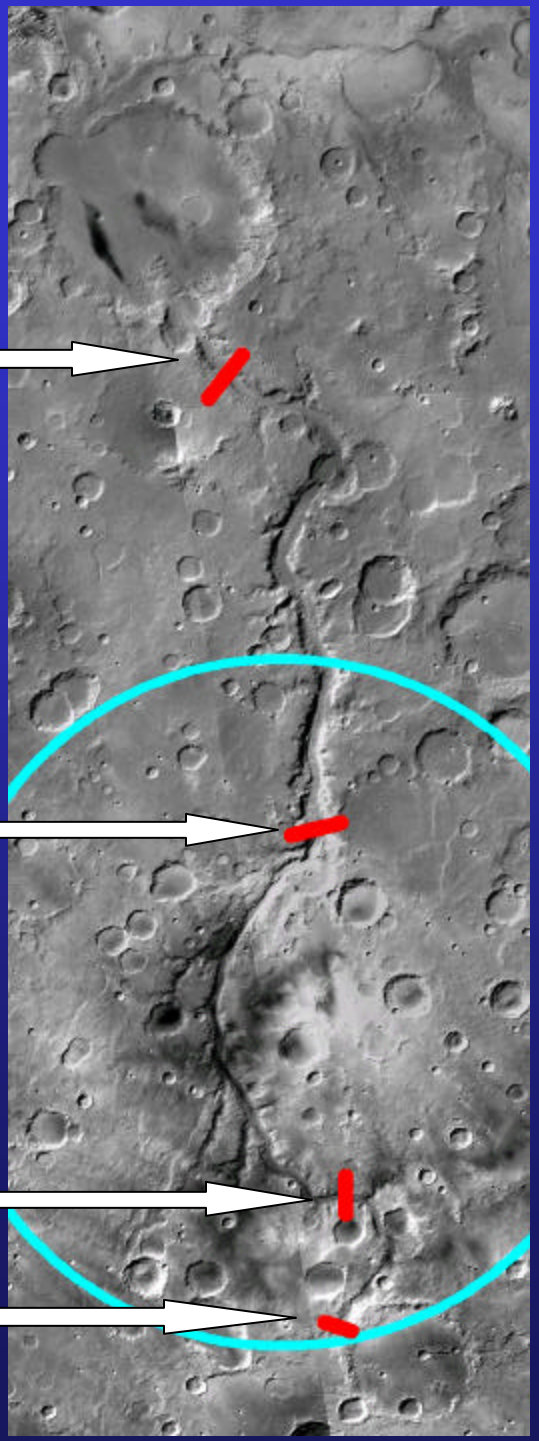


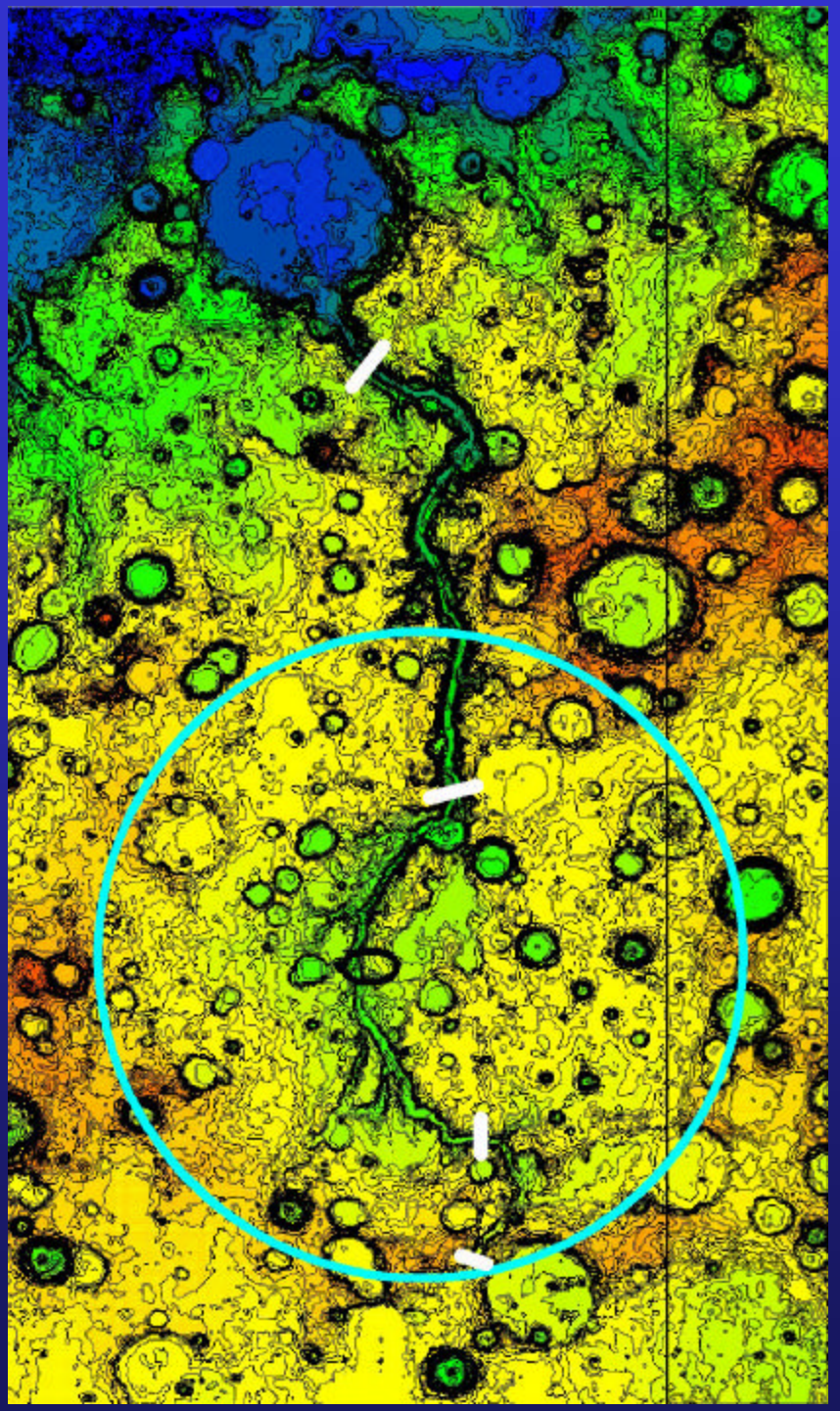
White

Light blue

Dark blue

Black





SUMMARY OF EVIDENCE

- Channel head crosscuts drainage divide @ 1,100 m
- Constant elevation of plains/upland transition
- Deep basins in lake floor rule out plains volcanism
- Regional consistency of lake levels (benches, scarps)
- Abrupt widening of valleys crossing transition
- Similar age of basin floor deposits and Gusev floor
- Appropriate available discharge to carve Ma'adim Vallis and crosscut ~1,050 m mid-channel divide

IMPLICATIONS

- **Regional groundwater table in this area at ~1,100 m**
- **Water table likely declined approaching dichotomy**
- **Elevation of all regional valley base levels at the dichotomy, Ma'adim base level, and Gusev exit breach, are at -1,500 m. Gusev crater, at -1,900 m, may have contained a long-lived lake**
- **Multiple outflows in main channel necessary to remove sediment delivered by tributaries**
- **Ma'adim longevity probably in the 10^4 to 10^7 year range, with lakes extant for longer time**