Geographical Distribution of Crater Depths on Mars

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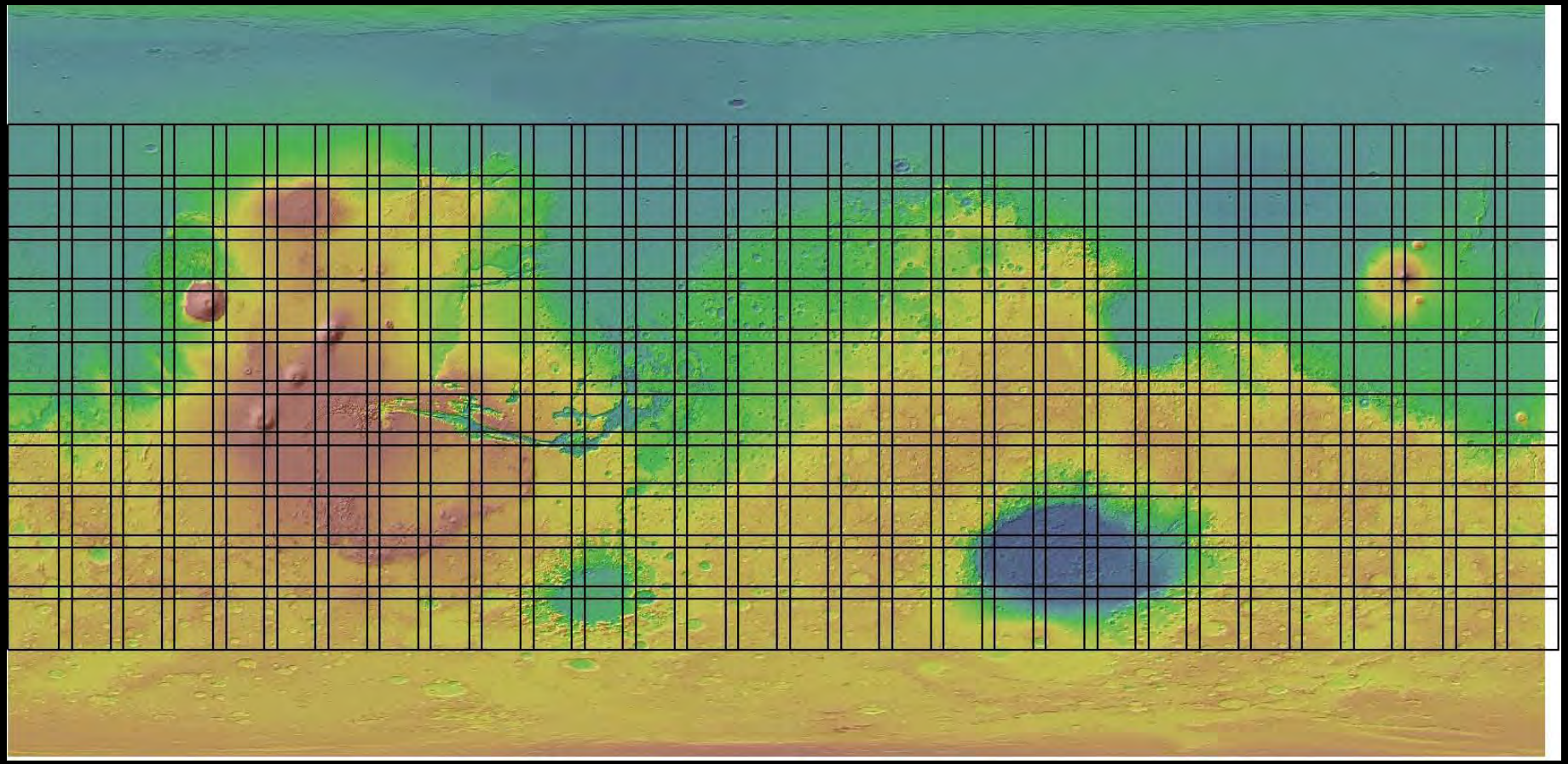
Content

- Global auto-detection of craters from MOLA topography
- Comparison to “standard” Barlow global catalog of craters
- Implication for extent of cryosphere
- Where are the deepest craters on Mars?
- Where are the shallowest craters on Mars?

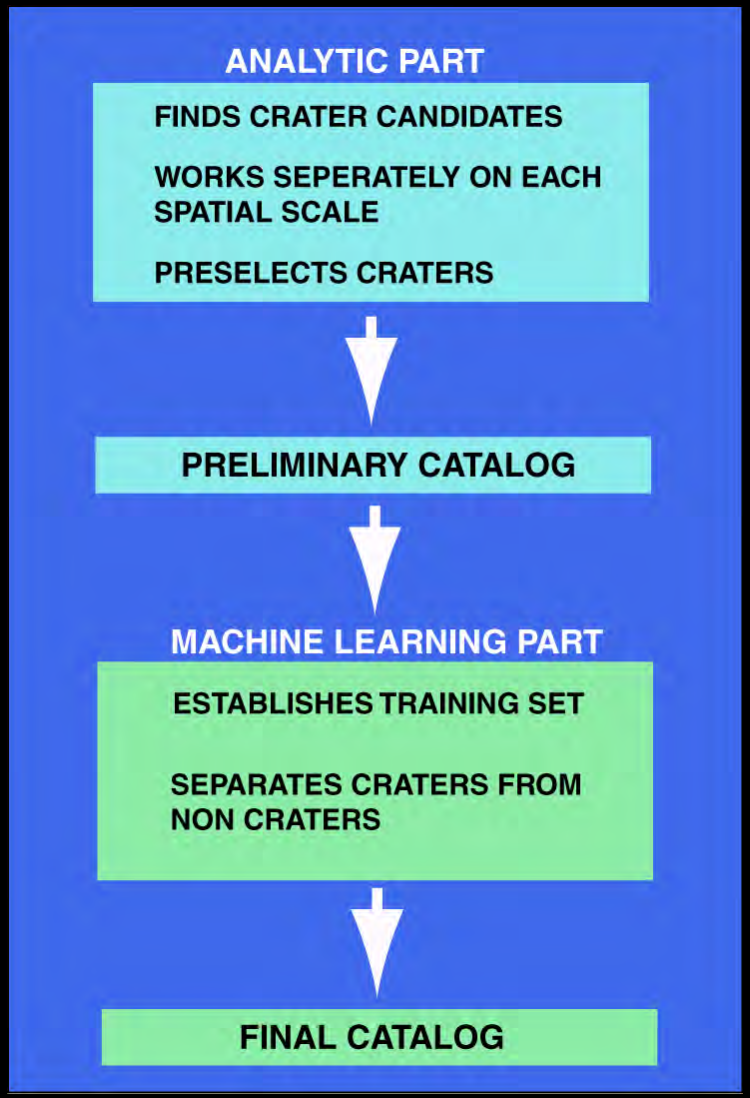
Global Auto-Survey of Martian Craters from Topography

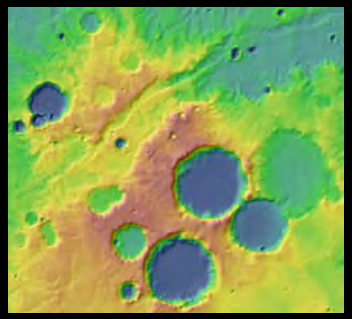


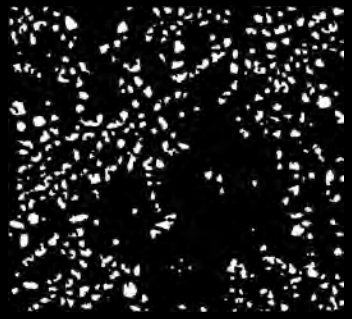
300 overlapping “equatorial tiles

Additional 56 “polar” tiles

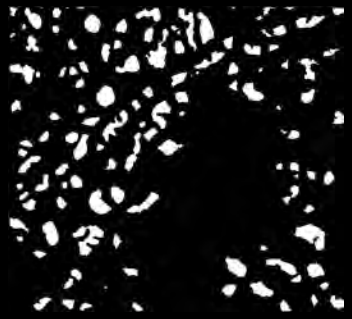
Detecting Craters in a Single Tile





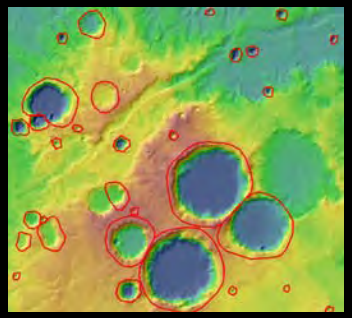


small



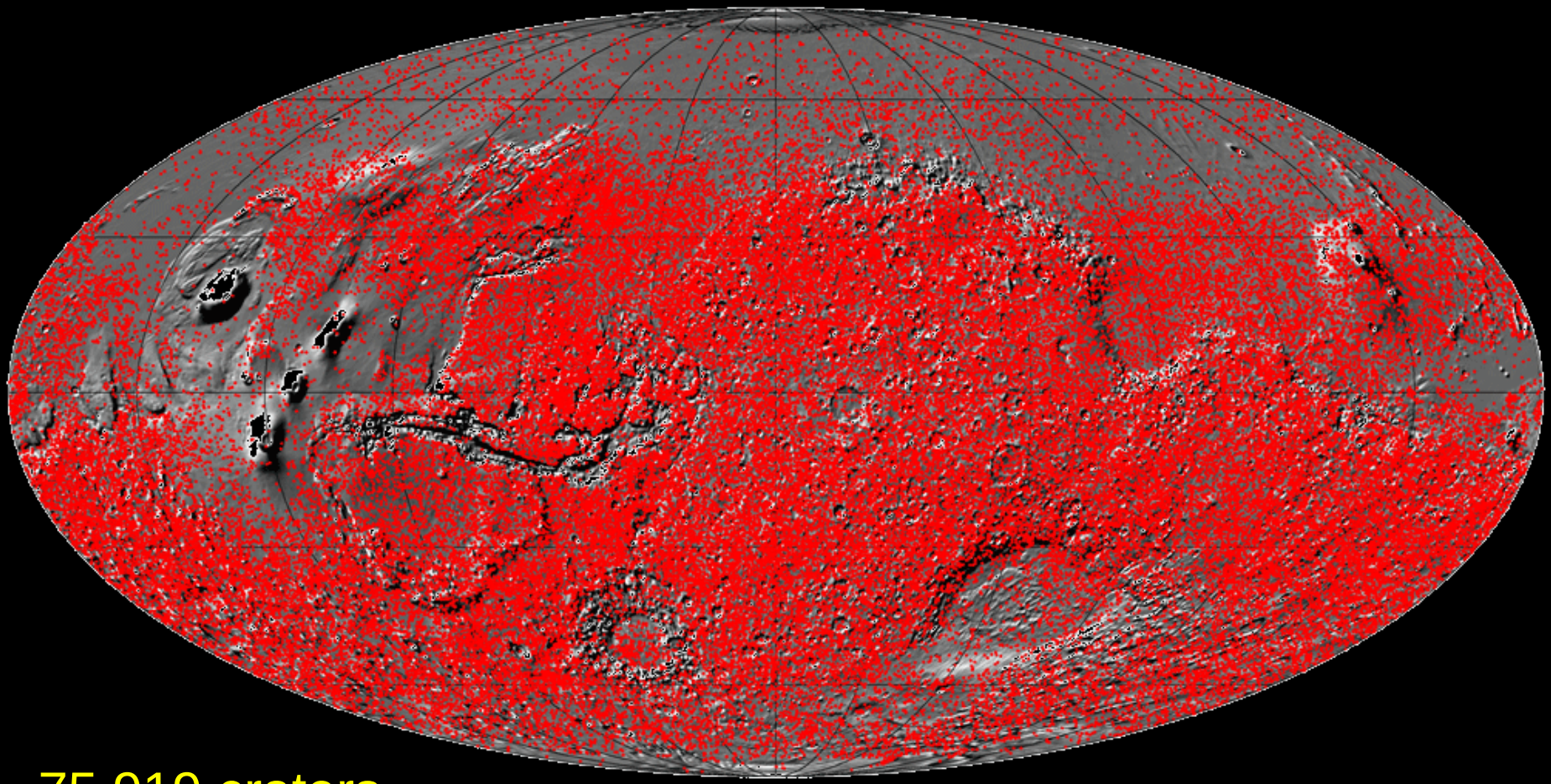
medium

large



T. F. Stepinski et al., (2009) Machine Cataloging of Impact Craters on Mars. Icarus, 203, p.77-87.

Detected craters



- 75,919 craters
- diameter
- depth

Results of Crater Auto-Detection

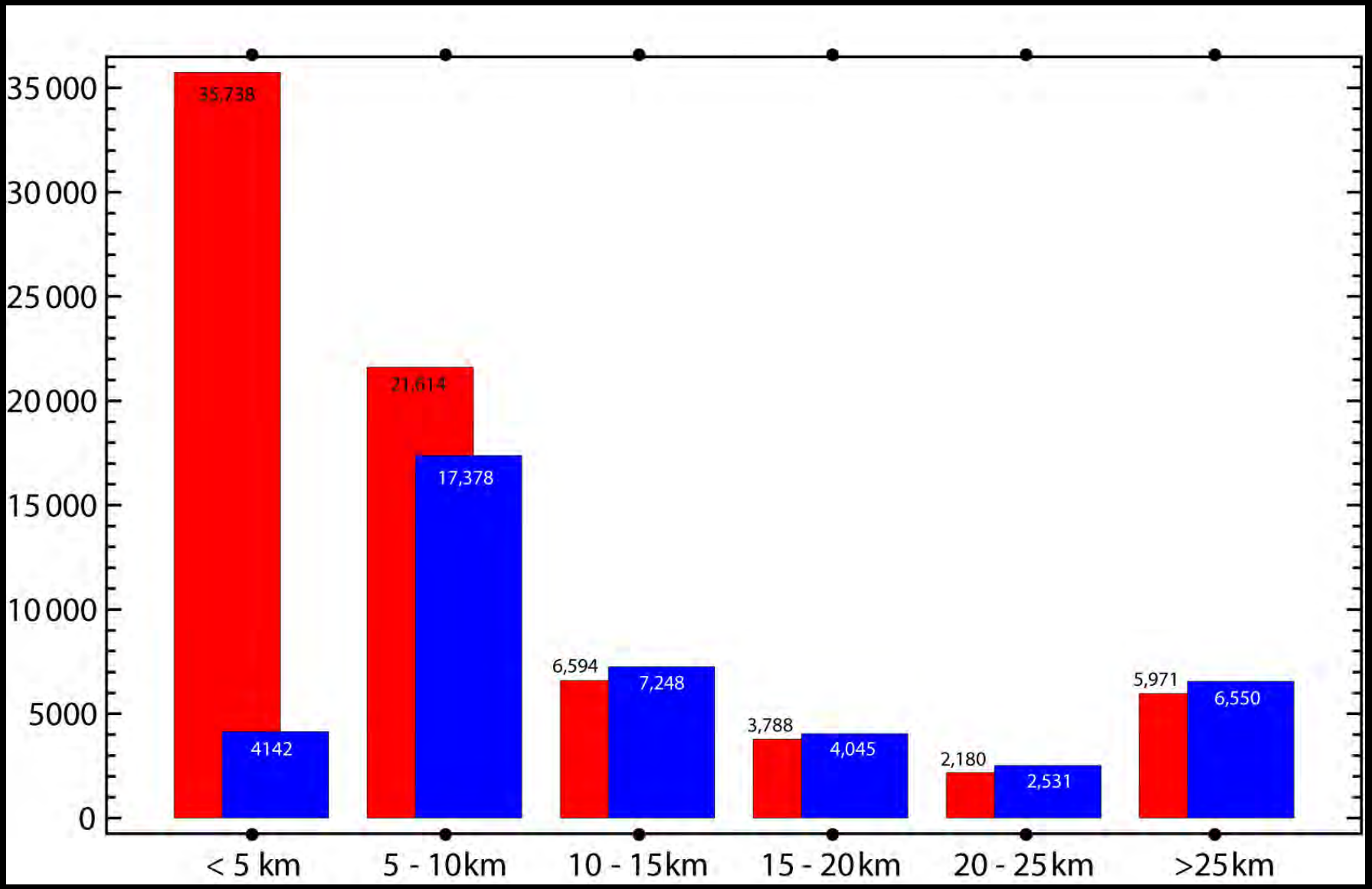
Completeness

- The survey makes no claim of completeness.
- Accuracy at different surfaces is different.
- False positives and false negatives are present.

Measurements

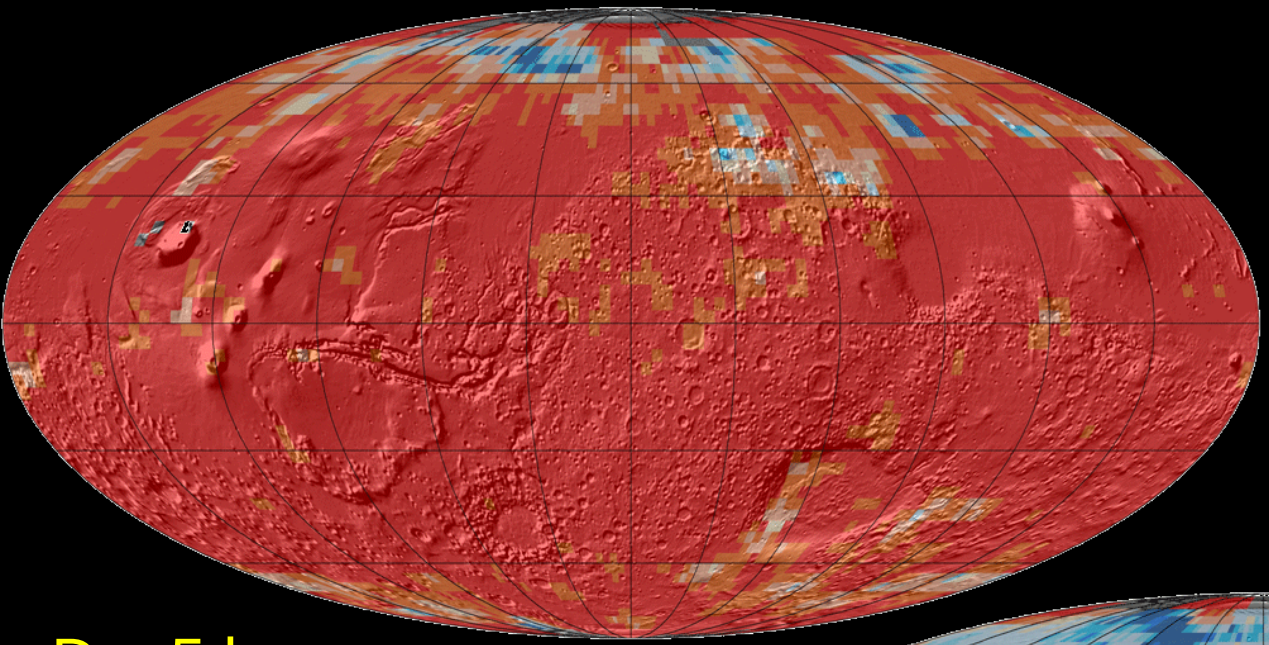
- All measurements are approximate.
- Crater size is a diameter of a circle having area equal to the area of identified depression.
- Crater depth is a largest elevation difference within a depression.

Comparison to Barlow Catalog



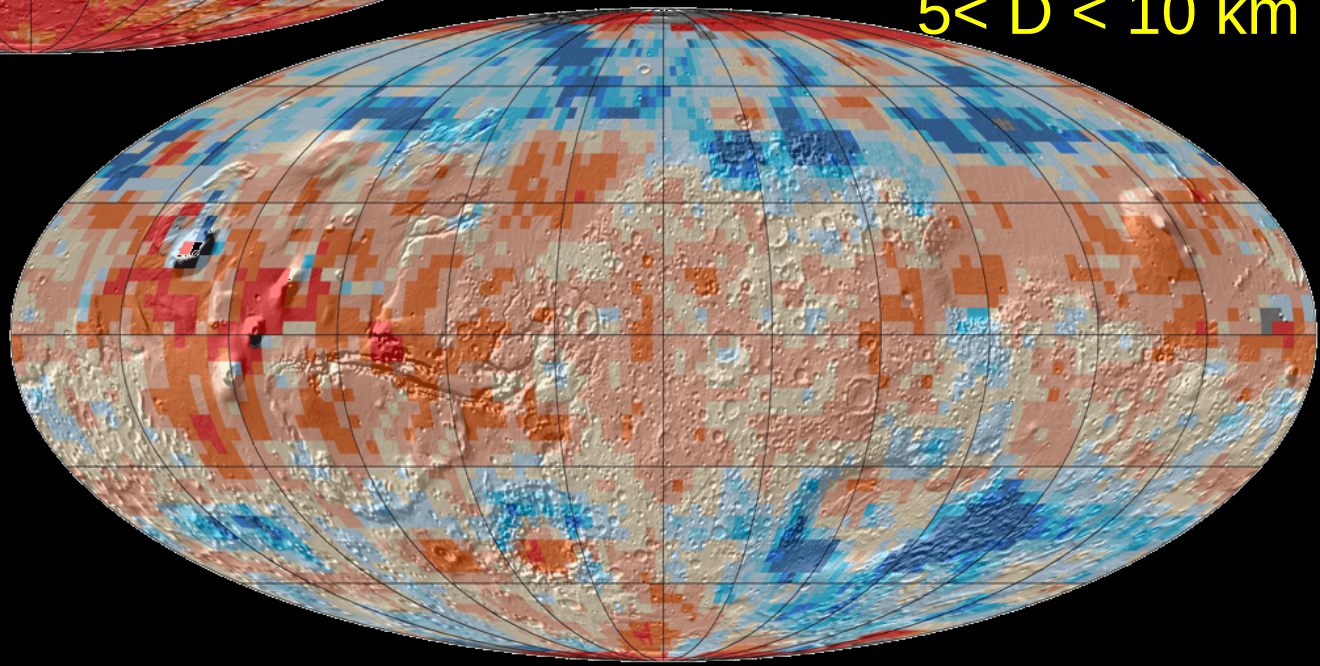
Barlow, N.G., 1988. Crater size-distributions and a revised martian relative chronology. Icarus 75, 285–305.

Comparison to Barlow Catalog



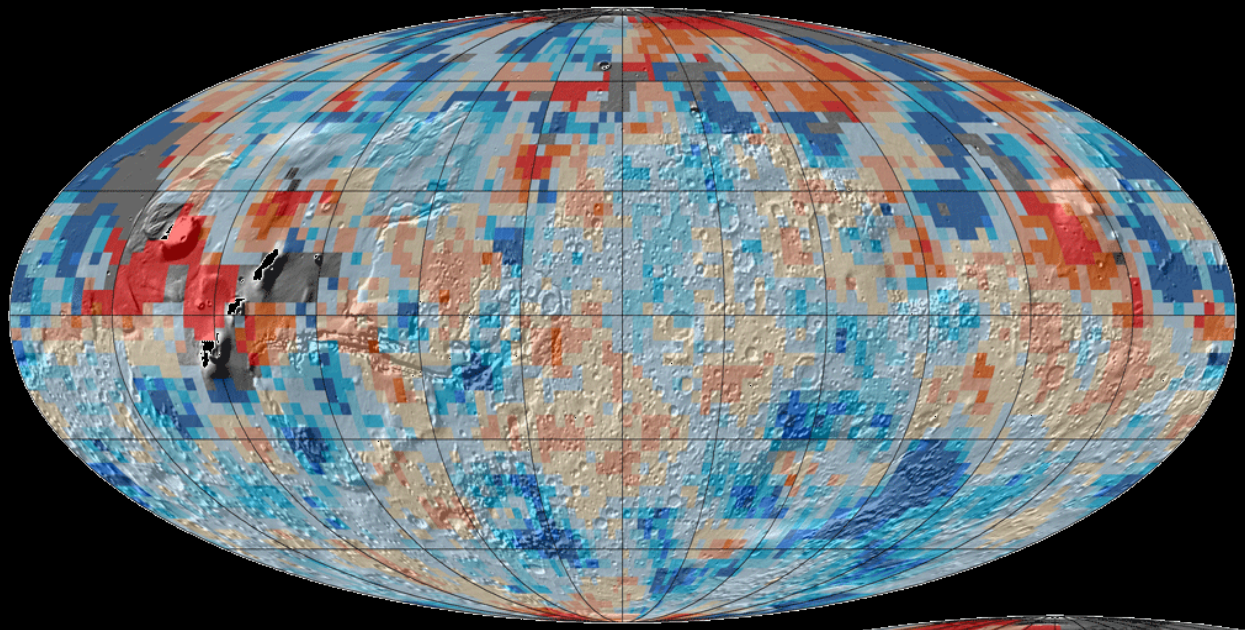
D < 5 km

5< D < 10 km

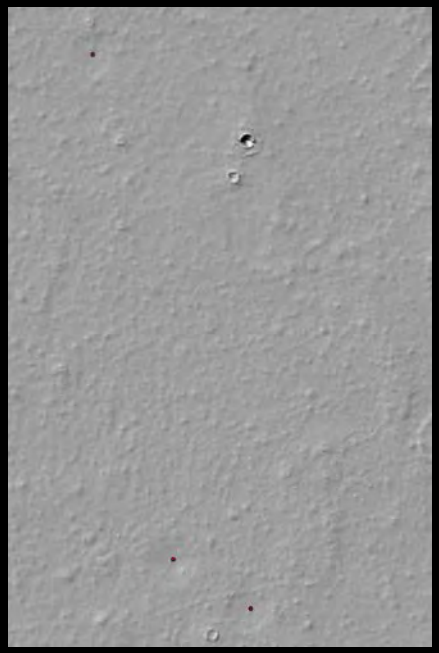


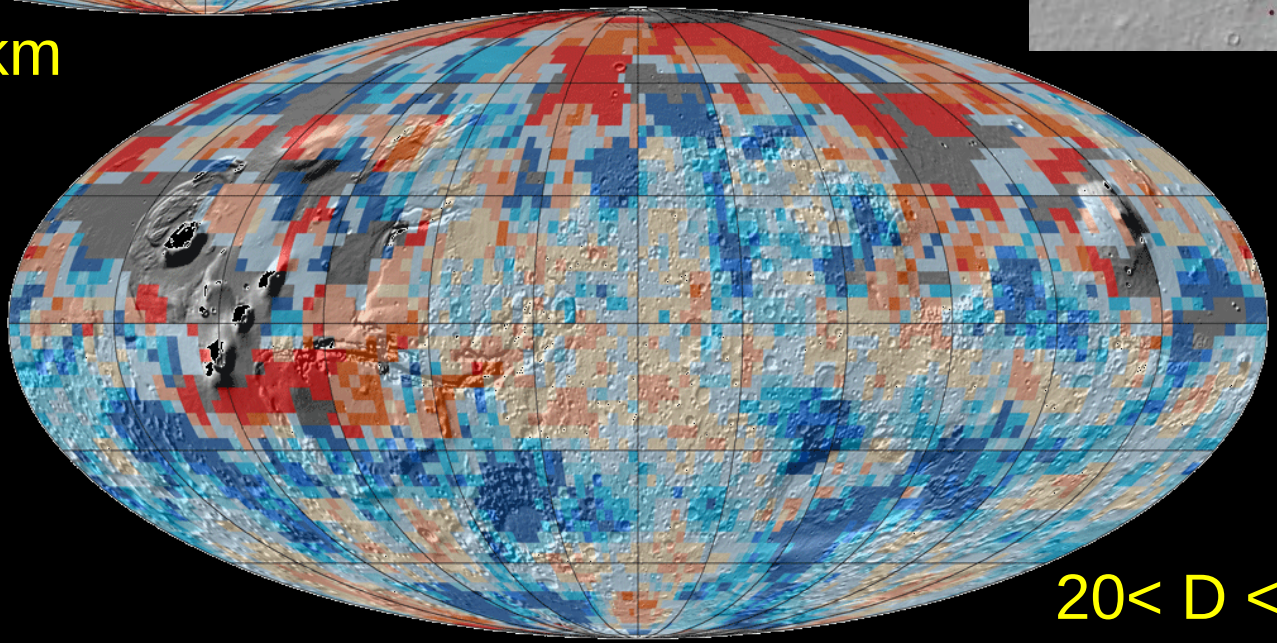
-4 - 1
-1 - -0.75
-0.75 - -0.5
-0.5 - -0.25
-0.25 - 0
0 - 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1

Comparison to Barlow Catalog



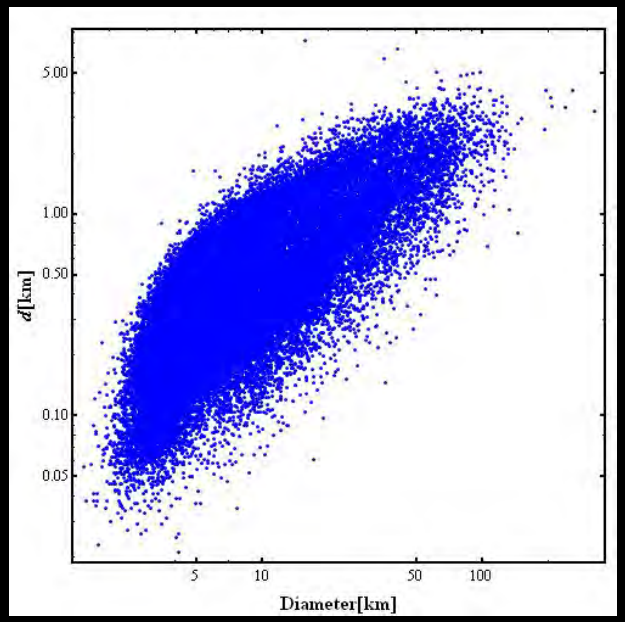
15 < D < 20 km



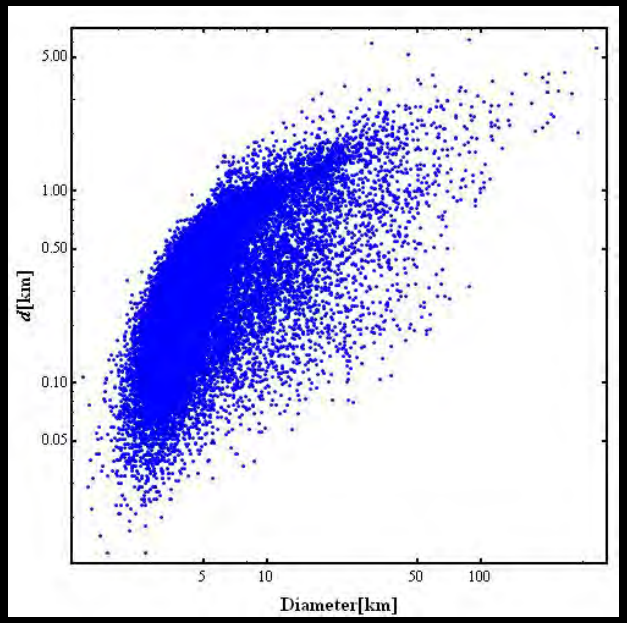


20< D < 25 km

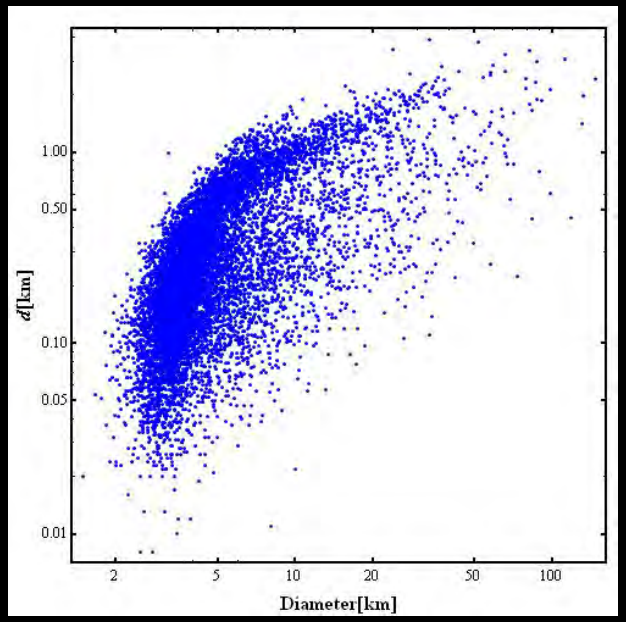
Depth-Diameter Relation



Noachian

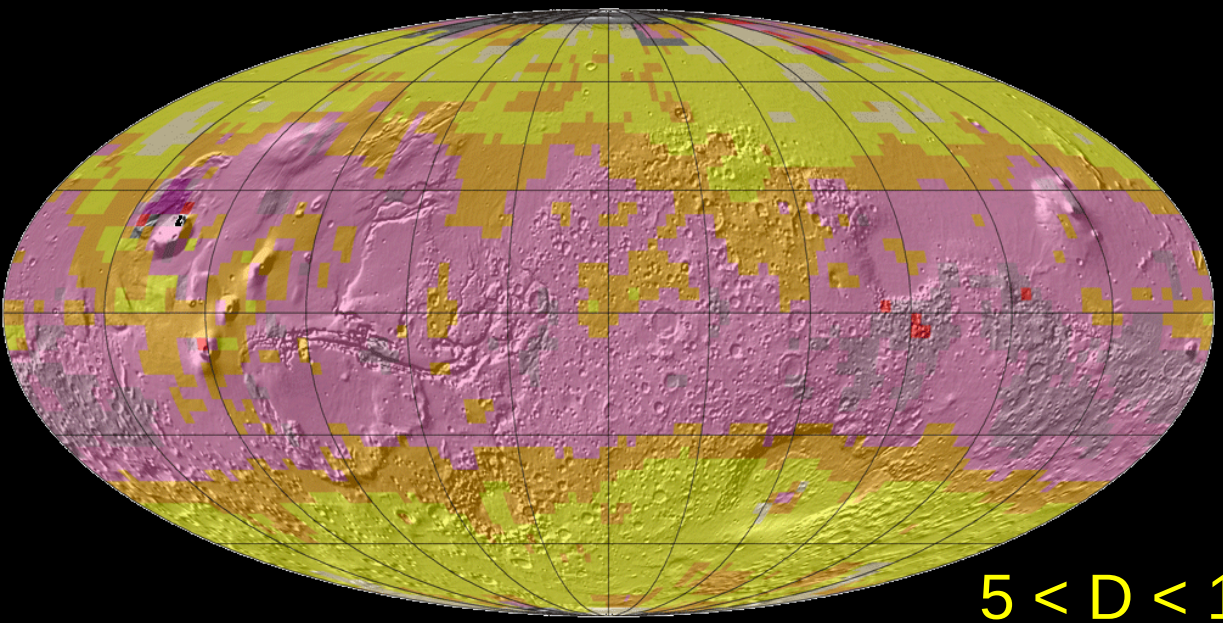


Hesperian



Amazonian

Geographical Distribution of d/D

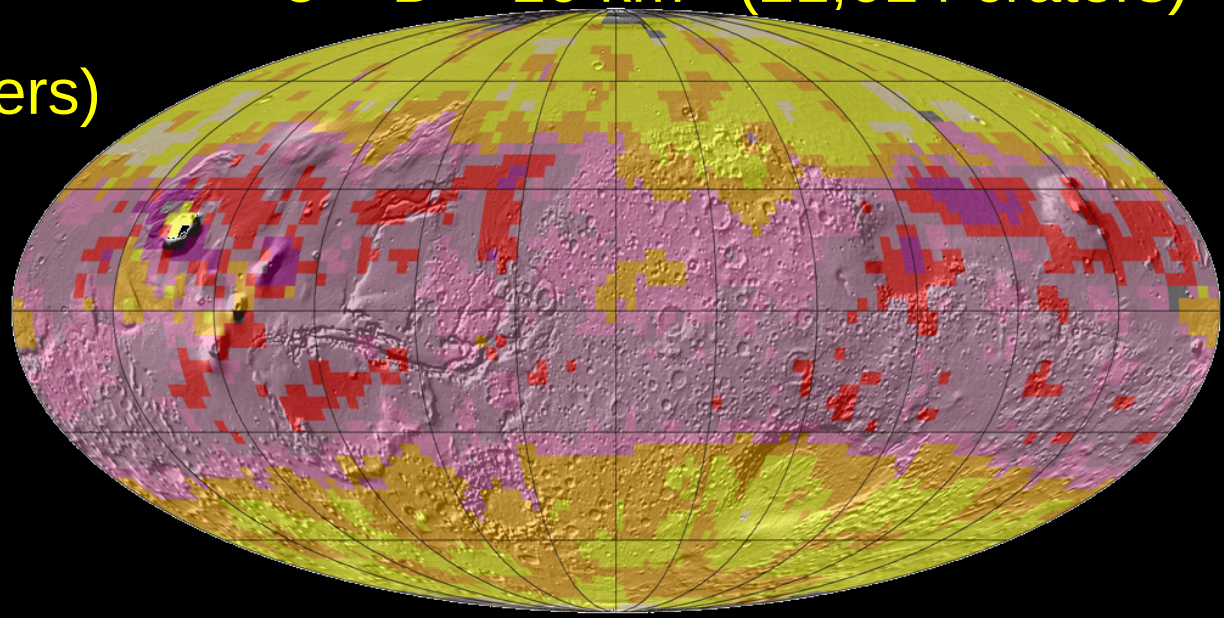


smaller craters are
relatively deeper
in equatorial regions

!

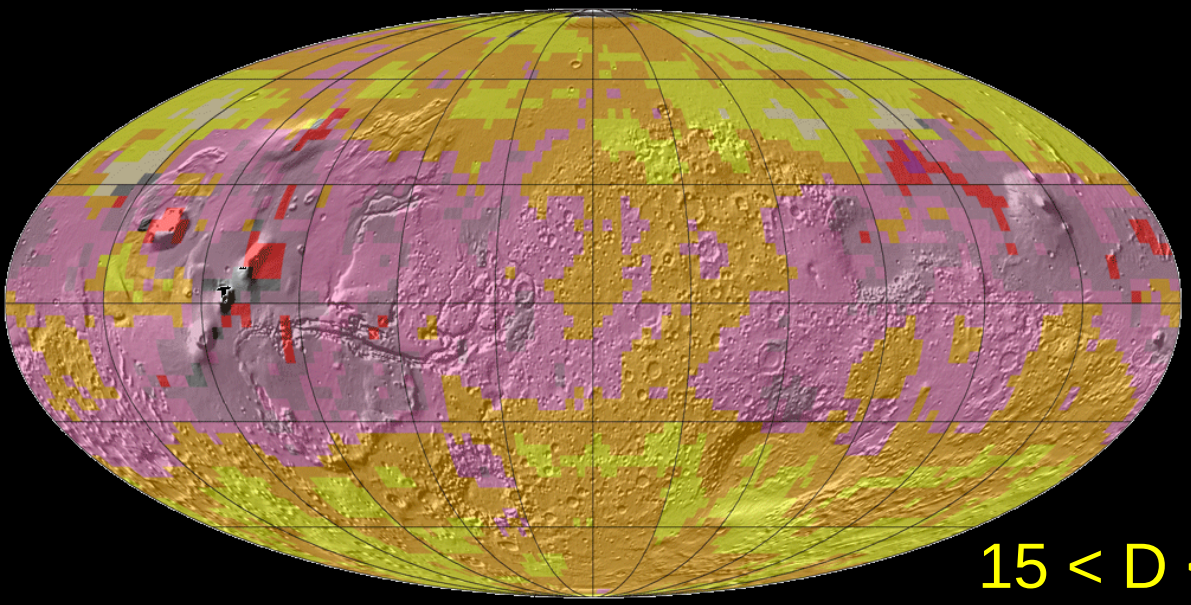
5 < D < 10 km (21,614 craters)

D < 5 km (35,738 craters)



- 0.00784 - 0.02
- 0.02 - 0.04
- 0.04 - 0.06
- 0.06 - 0.08
- 0.08 - 0.1
- 0.1 - 0.12
- 0.12 - 0.166

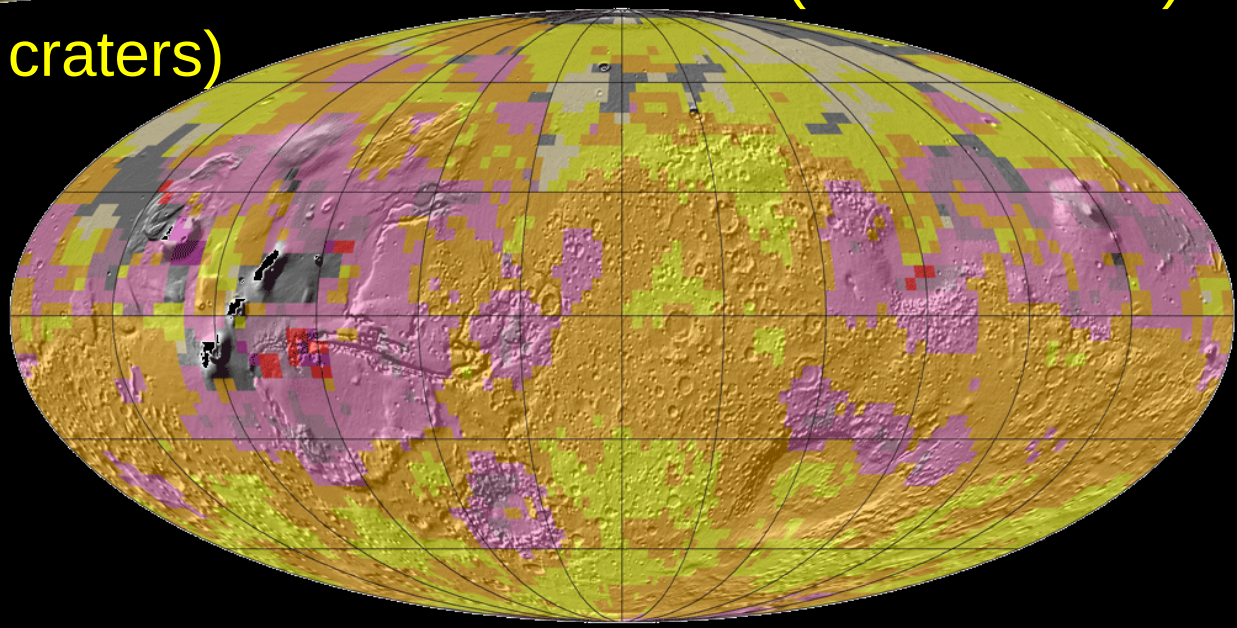
Geographical Distribution of d/D



correlation between latitude and d/D starts to break down for larger craters

10 < D < 15 km (6594 craters)

15 < D < 20 km (3788 craters)



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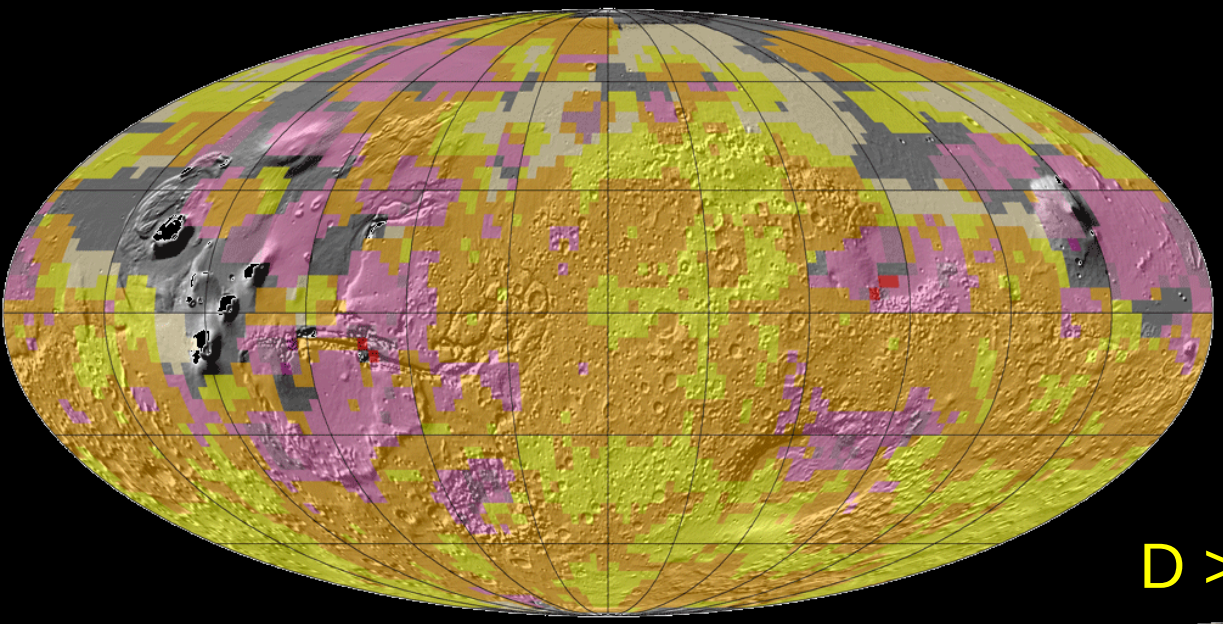
- 0.02 - 0.04
- 0.04 - 0.06
- 0.06 - 0.08
- 0.08 - 0.1
- 0.1 - 0.12
- 0.12 - 0.166

Geographical Distribution of d/D

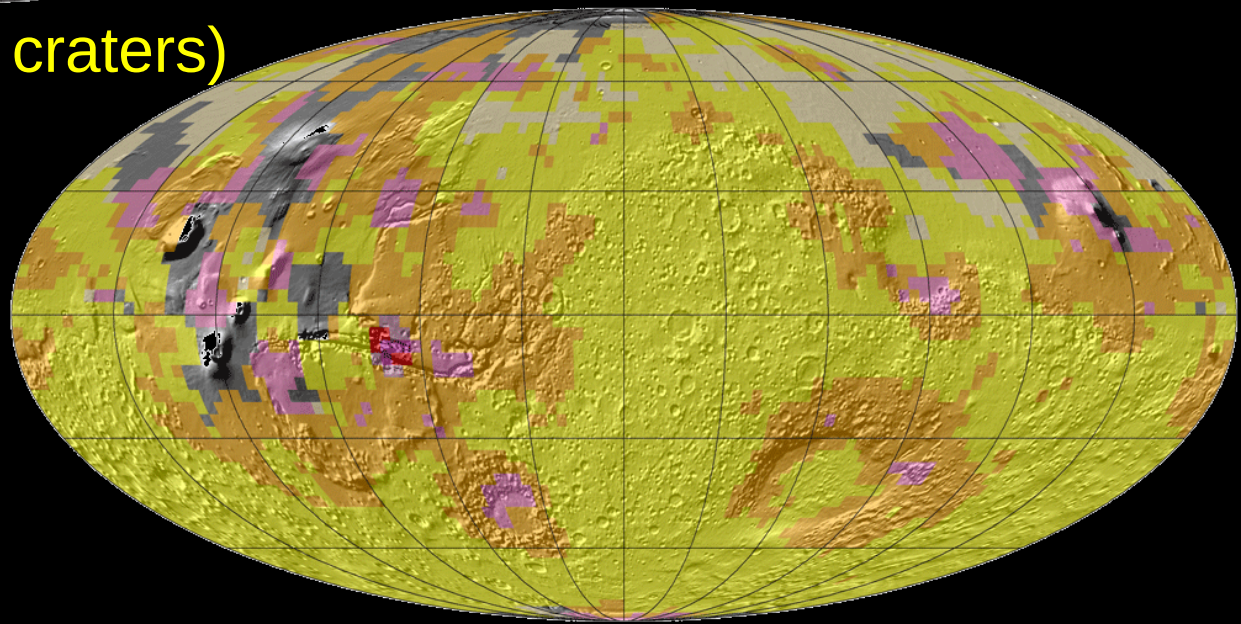


no correlation between
Latitude and d/D
for large craters

!

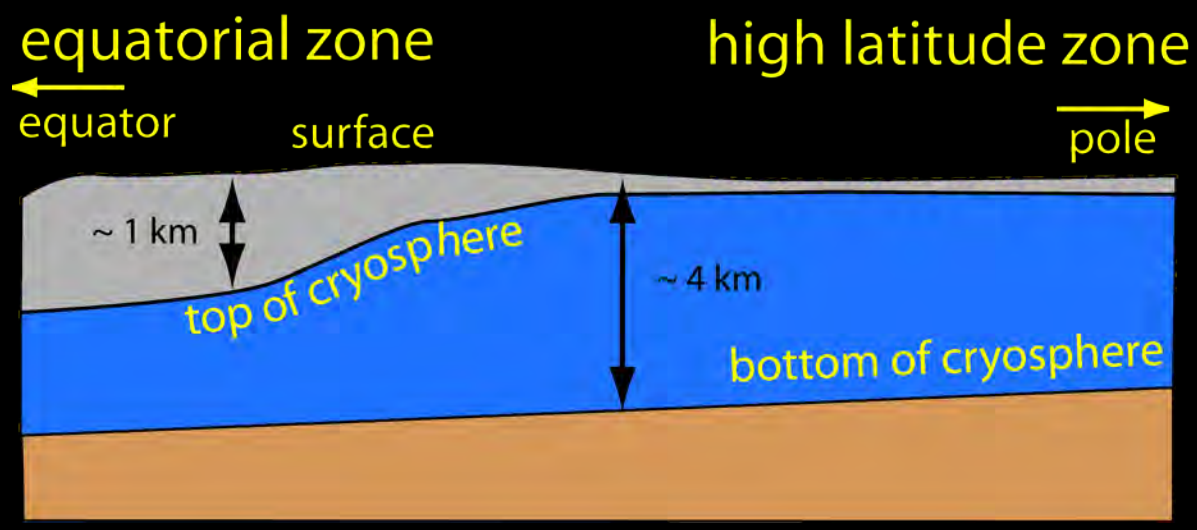
D > 25 km (5971 craters)

20 < D < 25 km (2180 craters)



- 0.00784 - 0.02
- 0.02 - 0.04
- 0.04 - 0.06
- 0.06 - 0.08
- 0.08 - 0.1
- 0.1 - 0.12
- 0.12 - 0.166

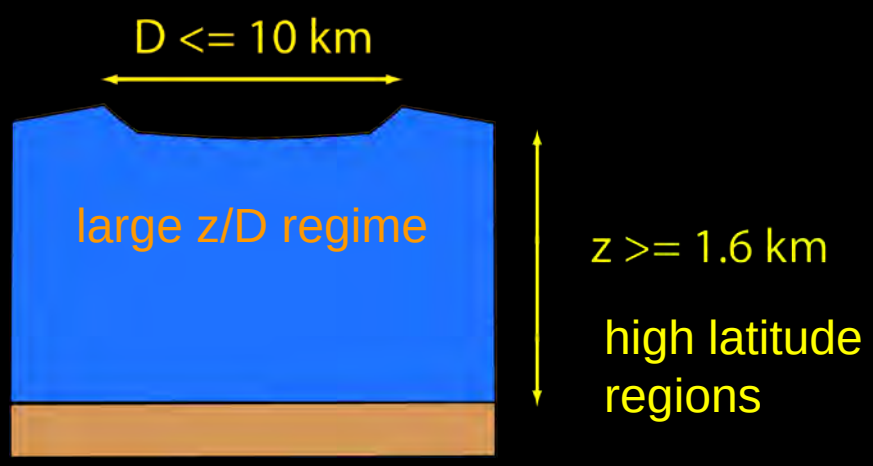
Implications for Cryosphere



Global distribution of d/D provides “observational” support for existence of cryosphere with varying depth of upper boundary.

How so?

Viscous relaxation – Small Craters



Style of crater modification depends on the z/D ratio:

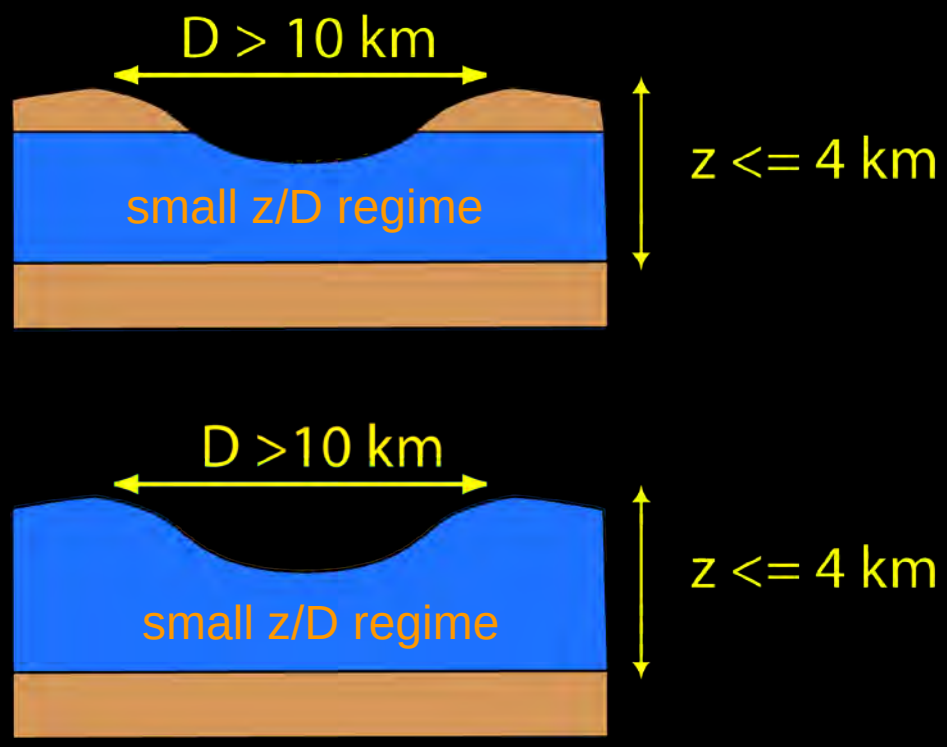
- no ice – no shallowing
- z/D large – shallowing
- z/D small – no shallowing

Parmentier, E. M. and Head, J. W. (1981) Icarus, 47, 100-111.

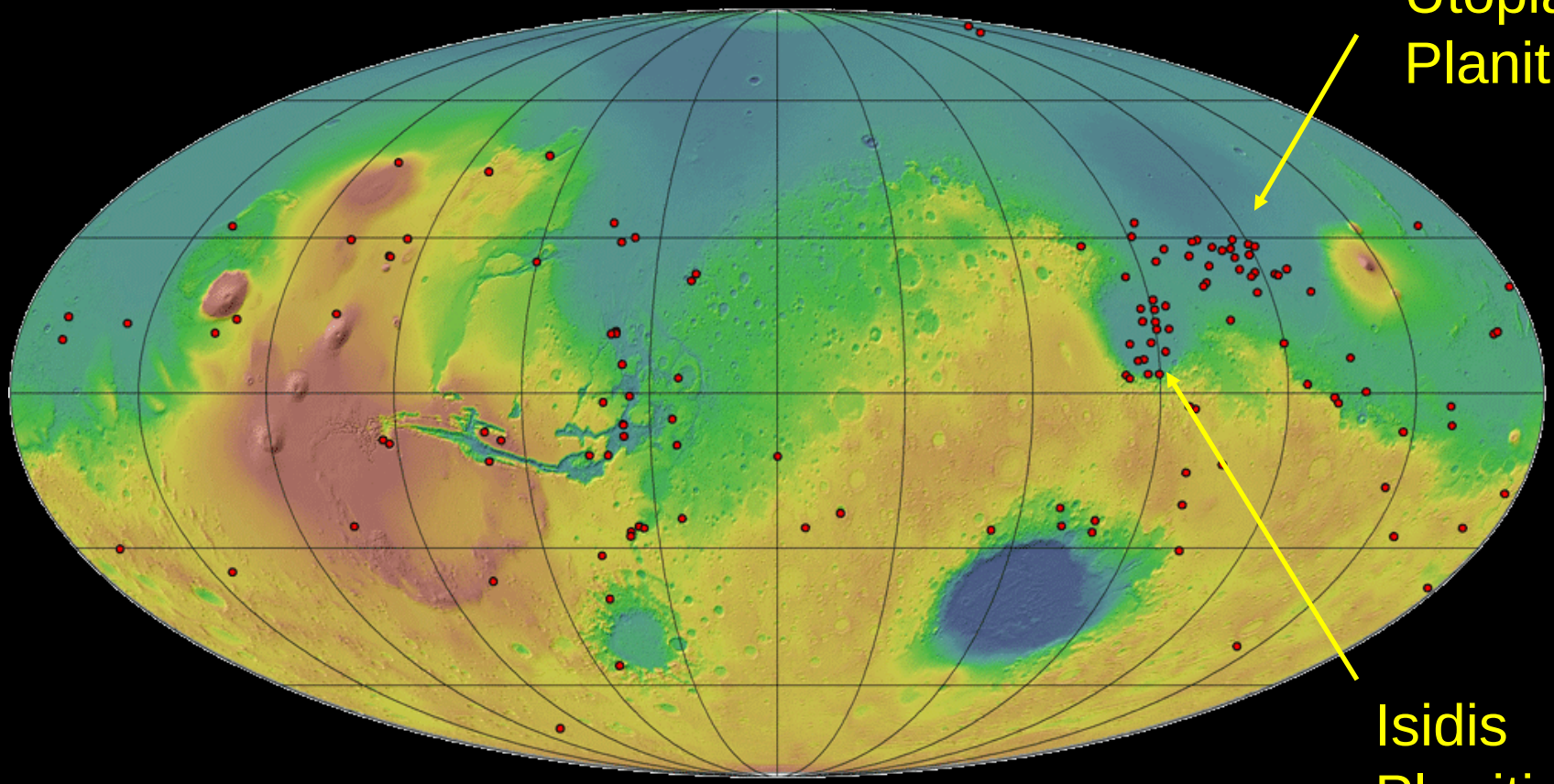
Jankowski, D. G. and Squyers, S. W. (1993) *Icarus, 106,* 365-379.

Pathare, A. V. et al. (2005) *Icarus 174,* 396-418.

Viscous relaxation – larger craters



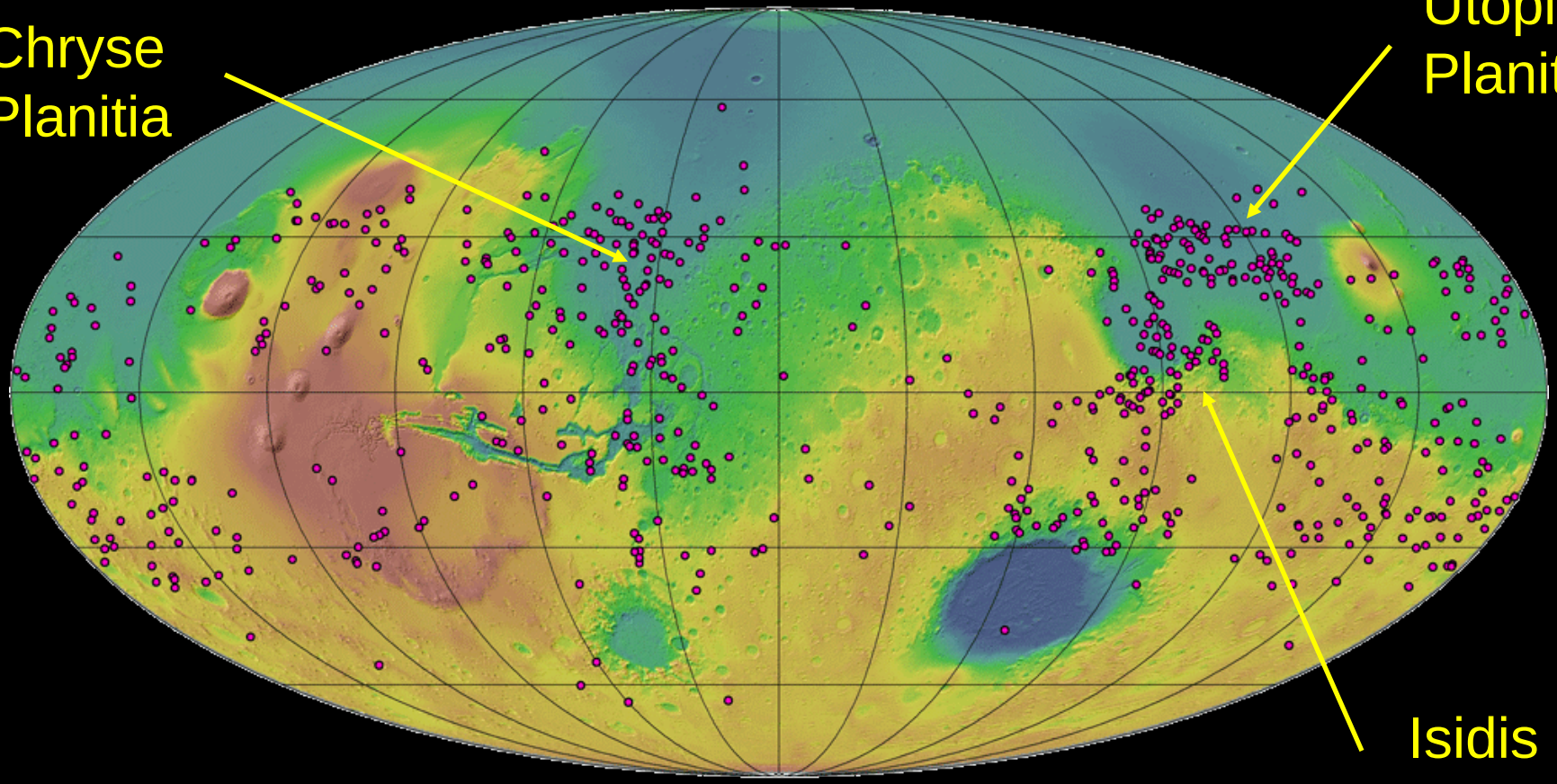
100 Deepest Craters on Mars



133 craters with d/D >= 0.18
Average D = 7 km

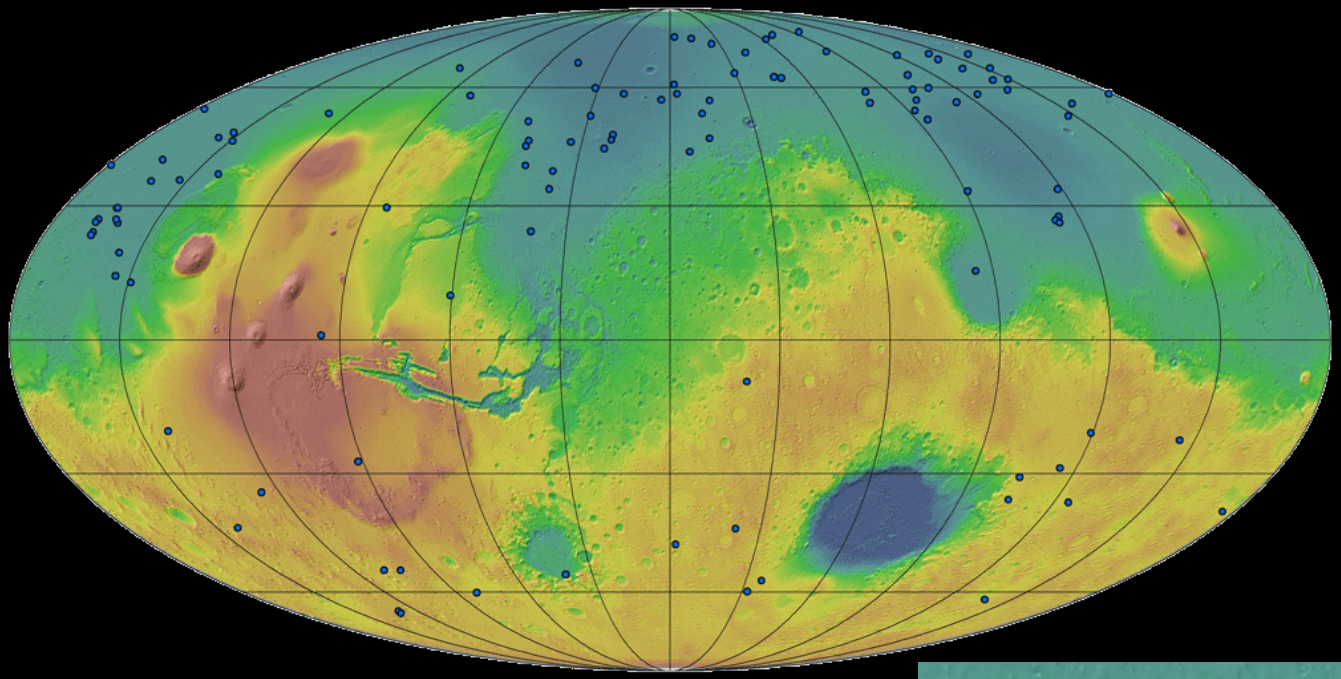
J. Boyce et al., (2006), Deep impact craters in the Isidis and southwestern Utopia Planitia regions of Mars: High target material strength as a possible cause, GRL., 33, L06202

Other Deep Craters on Mars



652 craters with 0.18 > d/D >= 0.15
Average D = 6 km

100 Shallowest Craters on Mars



110 craters with d/D < 0.006
Average D = 29.5 km

Conclusions

- Auto-detection of craters from topography has arrived! New types of analysis are possible for surfaces represented by elevation grids (Mars, Moon, Mercury).

- Geographical distribution of d/D on Mars supports the existence of cryoshpere and provides constraints on its extent.

- Deepest craters on Mars are concentrated in two or three locations. Strong target materials?