Geographical Distribution of Crater Depths on Mars

Tomasz F. Stepinski
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

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


Comparison to Barlow Catalog

D < 5 km

5< D < 10 km
Comparison to Barlow Catalog

15 < D < 20 km

20 < D < 25 km
Depth-Diameter Relation

Noachian

Hesperian

Amazonian
Geographical Distribution of $d/D$

- $D < 5$ km (35,738 craters)
- $5 < D < 10$ km (21,614 craters)

Smaller craters are relatively deeper in equatorial regions.
Geographical Distribution of $d/D$

$10 < D < 15$ km (6594 craters)

$15 < D < 20$ km (3788 craters)

correlation between latitude and $d/D$ starts to break down for larger craters
Geographical Distribution of d/D

20 < D < 25 km  (2180 craters)

D > 25 km  (5971 craters)

no correlation between Latitude and d/D for large craters
Implications for Cryosphere

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

Viscous relaxation – larger craters

D > 10 km

small z/D regime

z <= 4 km

D > 10 km

small z/D regime

z <= 4 km
100 Deepest Craters on Mars

133 craters with \( d/D \geq 0.18 \)
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

- Isidis Planitia
- Utopia Planitia
- Chryse Planitia
- Isidis Planitia

652 craters with $0.18 > \frac{d}{D} \geq 0.15$
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 cryosphere and provides constraints on its extent.

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