Mars Orbiter Laser Altimetry Data
From “Geoblemes”
To “Astroblemes”

Grove K. Gilbert
(1843-1918)

Robert S. Dietz
(1914-1995)
174 Identified Impact Structures On Earth
What can we learn by studying Impact Craters on Mars?
Discoveries from Mars

>40,000 crater ≥ 5km
Martian Gully, Familiar Signs

Before-and-after pictures taken by NASA's Mars Global Surveyor spacecraft show what appear to be deposits of materials left by bursts of water flowing down the sides of gullies.

AUG. 1999  SEPT. 2005

The New York Times; photographs from NASA
Craters with Concentric Ridges

~13.2 km crater at 35.1° N, 84.4° E
(section from V18095023)

~9.2 km crater at 33.1° N, 81.1° E
(section from V1908101)
Craters with Concentric Ridges
Tempe Fossae, Mareotis Fossae, Phlegra Montes, & Utopia Planitia - lack of craters in Equatorial Region (±30°)

Squyres 1979; Squyres and Carr 1986
- Ice-rich mass wasting
- Evidence: occurrence and similarity to debris aprons; sharp break in slope between the rim and floor.

Zimbelmann et al. 1988
- Aeolian depositional model
- Evidence against ice-creep model: uniform layering; lack of flow outside of rim and around obstacles; small strain rates needed
Craters with Concentric Ridges

~13.2 km crater at 35.1° N, 84.4° E (section from V18095023)
11 separate concentric ridges, ~287 m
~9.2 km crater at 33.1° N, 81.1° E (section from V1908101)
Circular mounds, ~161-242 m
Web-like pattern perpendicular

Wall slope for these craters typically ranges from ~4°-1°
Ice-Enhanced Mass Wasting?

~12 km crater at 36.0° N, 80.5° E (section from V20354002)

Crater fill material around obstacles
Flows originating at the rim with compressional ridges around obstacles - convex

Thick: 126 m
Length: 1.78 km
Craters Pitted-floor Texture

~17 km Unnamed Crater
at 41.4° N, 87.7° E
Quasi-linear furrows or grooves
Length: ~2-6 km; Width: ~373 m

Zimbelman et al. 1988
Craters Pitted-floor Texture

Korteniemi et al. (2005)
Soare and colleagues (2005)

“Thermokarst” - due to obliquity changes

Earth: selective thawing of ground ice or permafrost

Mars: disturbance of the thermal equilibrium of the near-surface ground ice
Craters Pitted-floor Texture

V0328003

V10457016

~15 km crater at 40.9° N, 98.3° E
Deposits with associated vents
Thermokarst-related?

V10457016

Dark deposit: long axis 7.4 km and short axis 4.2 km in length
Light deposit: 3 lobes, extension of ~2.1 km South
Aeolian Deflation Exposing Near-Surface Ground Ice

• First: removed the surface mixture of regolith and volatiles forming the dark deposit
  – possibly in a similar manner to that of the gas jets on the south polar cap (Hansen et al. 2007).

• Second: emanation of meltwater produced by thawing of the previously uncovered ground ice.

• Recent
Distance | Bulge R | Ratio
---|---|---
4.5 km | 4.5 km | 0.6
2.9 km | 1.8 km | 0.8
4.6 km | 4.6 km | 0.6
Discoveries from Mars

Hebrus Vallis

- Channel system
- Originates close to the base of the Elysium volcanic complex
- Criss-crossing of channels not typical for fluvial systems

THEMIS Visible Images

~19 m/pixel
Discoveries from Mars

Noachis Terra

• Dune field in located on the floor of Rabe Crater.
• Dunes' height: 150 to 200 meters
Discoveries from Mars

Eos Chasma

- Several landslides
- Northern wall has failed in an upside-down bowl shape
Discoveries from Mars

Dalmatian terrain

- Dark spots are dark dunes in depressions where the ice has defrosted to reveal underlying material
Summary & Conclusions

• Evidence for ice-enhanced mass-wasting origin for concentric fill material: flows coming from the rim crest, convex shape of the outflows, and flow around obstacles.

• Dark deposits Pitted-Floor Craters: formation of deposits in recent times suggests they are related to aeolian processes rather than a period of high obliquity.

• THEMIS images favor an ice-enhanced origin for the features

• The vast majority of craters displaying anomalous landforms studied are located within Utopia Planitia.
NASA's Spirit (August 23, 2005)
"My husband has a morbid fear of asteroids."