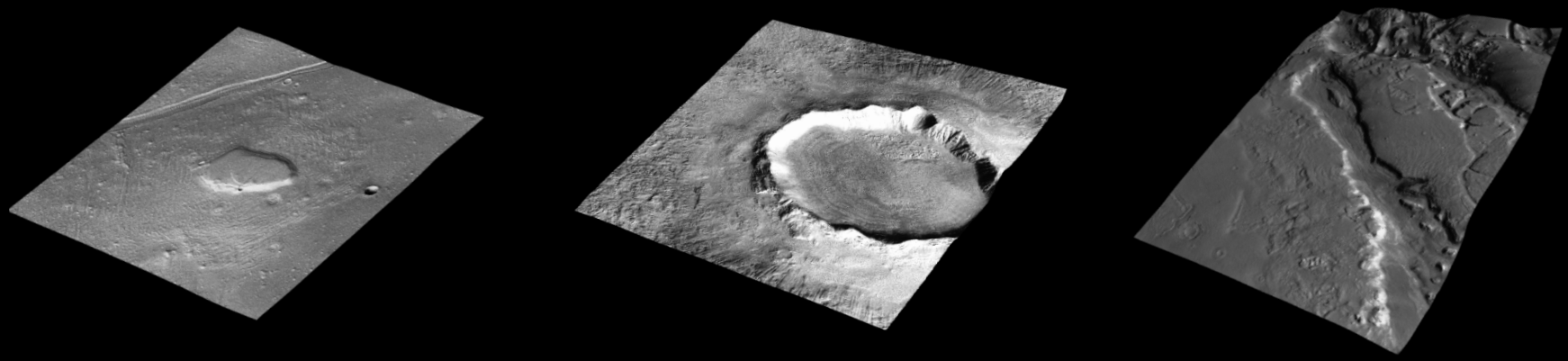

Evidence of widespread degraded Amazonian-aged ice-rich deposits in the transition between Elysium Rise and Utopia Planitia, Mars:

Guidelines for the recognition of degraded ice-rich materials

Gro Birkefeldt Møller Pedersen[1,2]

James W. Head [3]

1 Department of Earth Sciences, Aarhus University

2 Nordic Volcanological Center, University of Iceland

3 Planetary Geoscience Group, Brown University

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1) Unusual location

2) Degraded ice-rich deposits

3) Guidelines

Implications for

A) Extent of periglacial deposits
B) Degradation stages
C) Formation model

Results from Pedersen and Head (2010)
PSS 58, p.1953-1970

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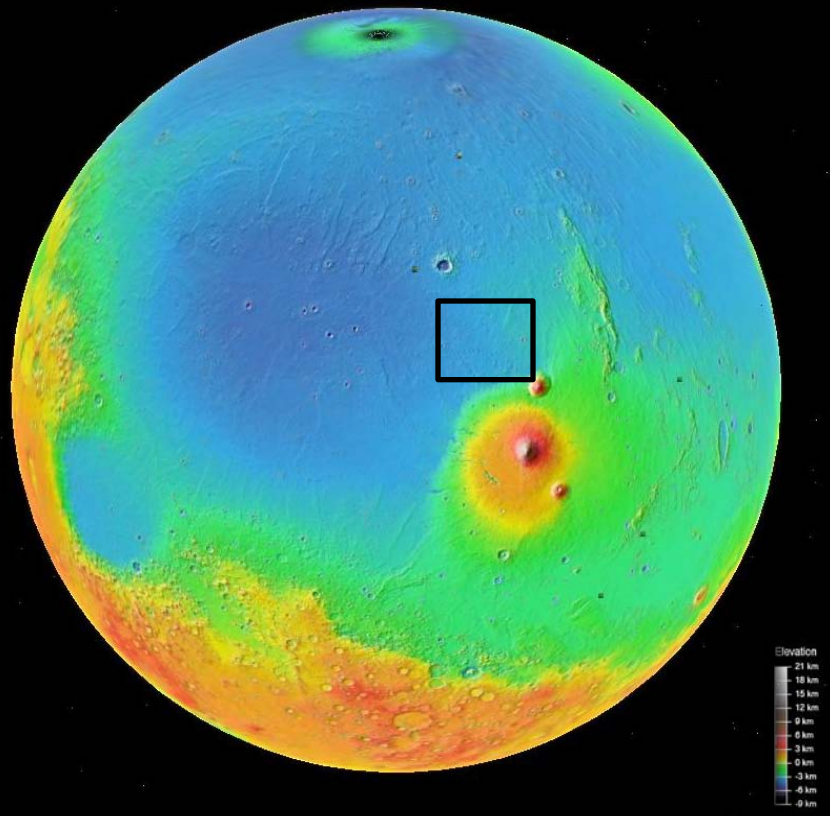
Agenda

1. Introduction
2. The Galaxias region
3. Results
    i. Concentric crater fill
    ii. Lobate debris aprons
    iii. Lineated valley fill
    iv. RMC distribution
4. Implications
5. Conclusions and future work



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Introduction

Concentric crater fill (CCF)
Lobate debris aprons (LDA)
Lineated valley fill (LVF)

Known since:
Carr and Schaber (1977) and Squyres (1978)

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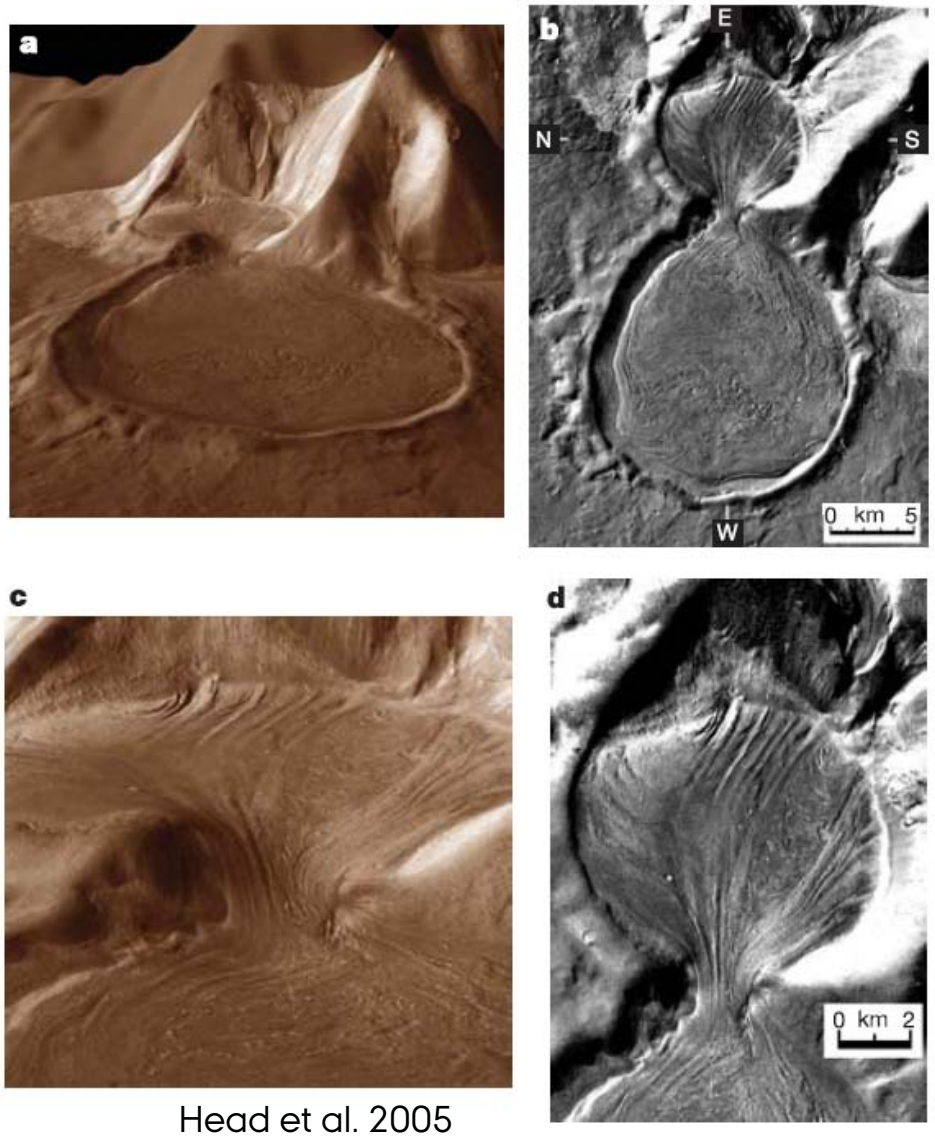

Head et al. 2005

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Introduction

Concentric crater fill (CCF)
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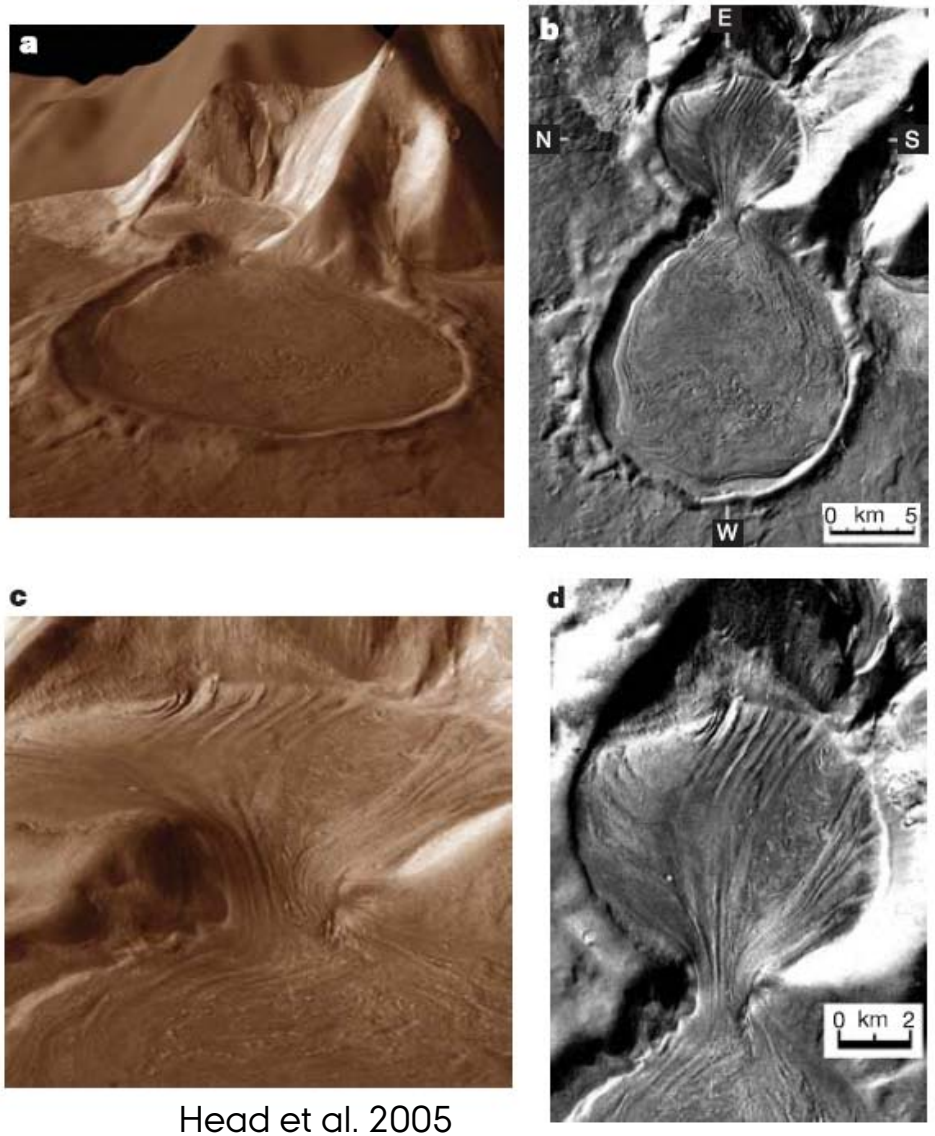
Characteristics:

- Distinct lineations
- Basket ball texture
- Convex profiles
- Ring-mold craters (RMC)/
- Oyester-shell craters



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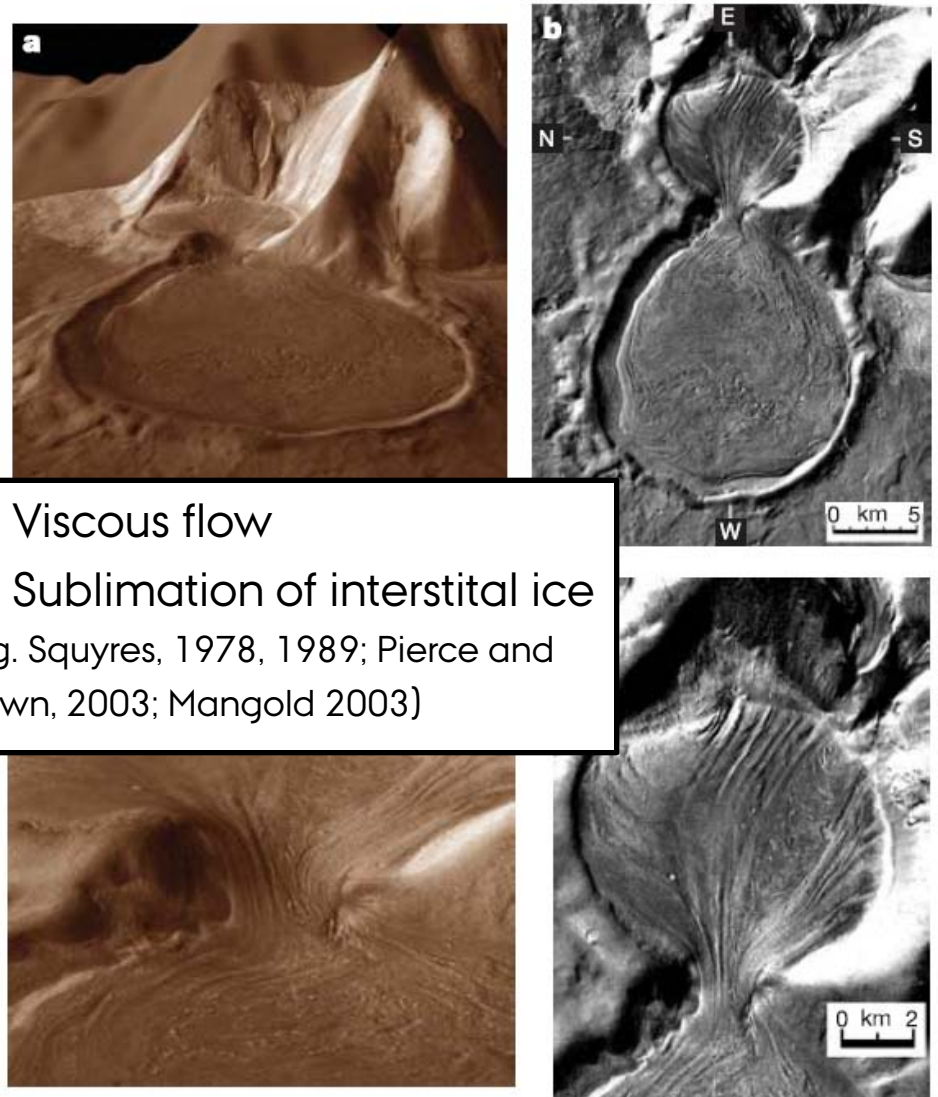
- Ring-mold craters (RMC)/
- Oyester-shell craters

→ Viscous flow
→ Sublimation of interstital ice
(E.g. Squyres, 1978, 1989; Pierce and Crown, 2003; Mangold 2003)



Head et al. 2005

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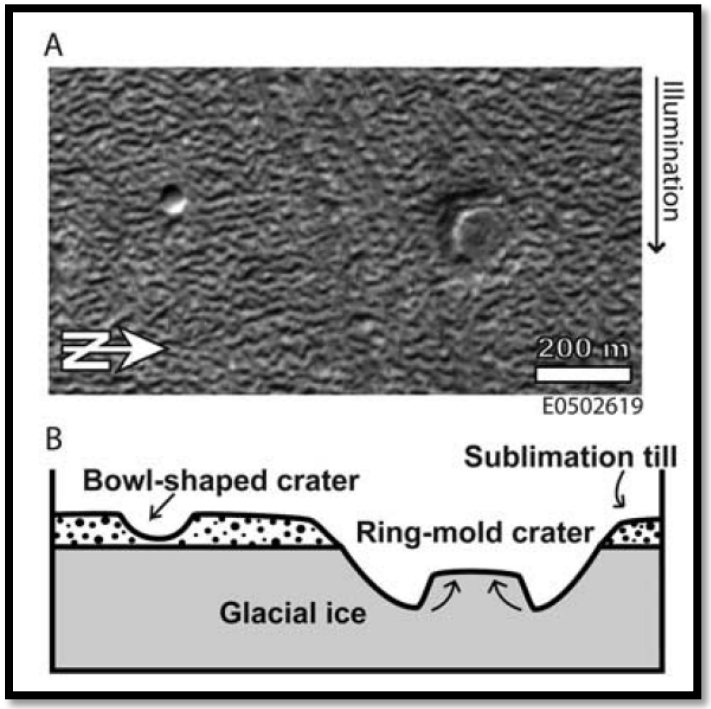
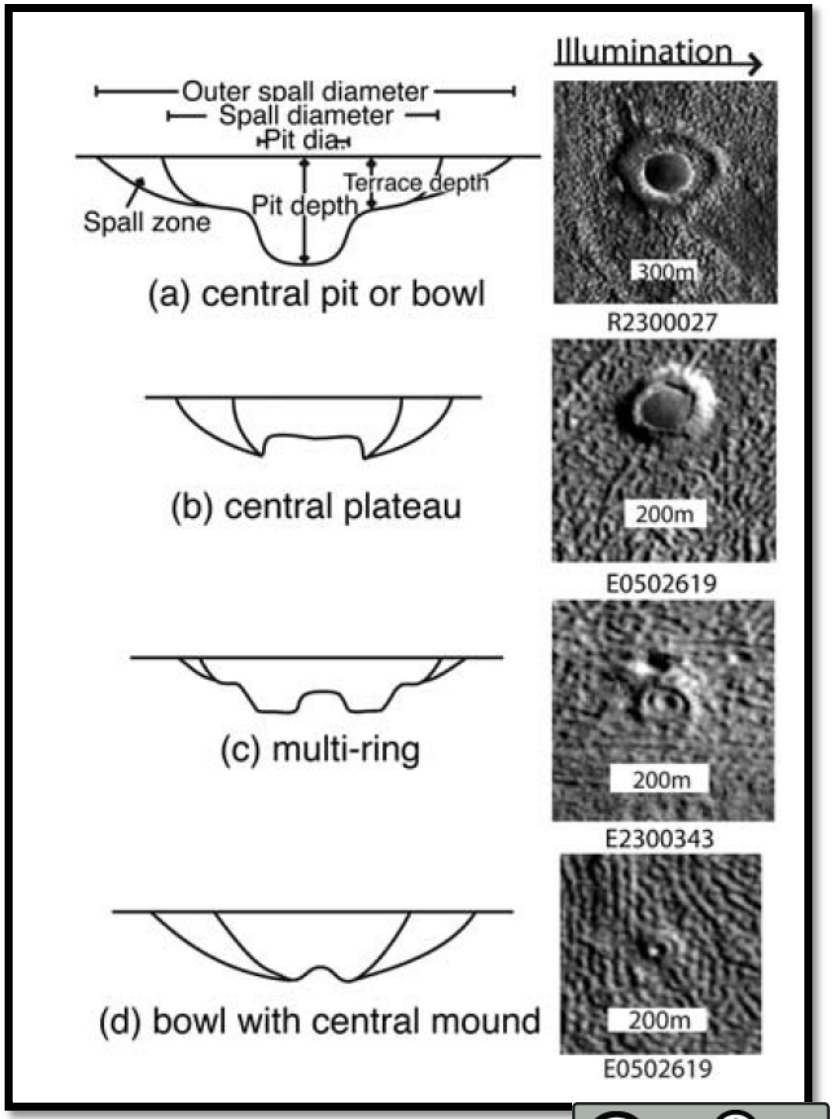
Ring-mold craters (RMC):

- Concentric crater forms shaped like a truncated torus.
- Formed within LDA and LVF
- Suggested to be impacts into ice-rich substrate below a thin substrate

Kress and Head (2008)





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Introduction

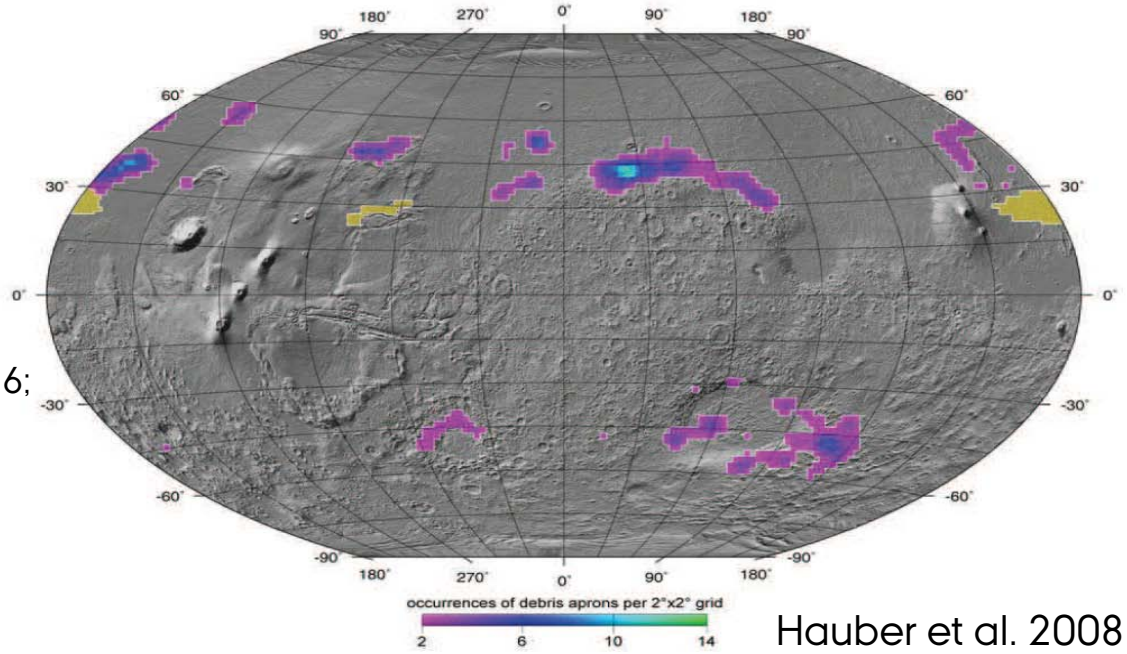
Distribution:

Two 25° wide latitudinal bands

-Northern hemisphere: 40° N

-Southern hemisphere: 45° S

(Squyres,1979; Squyres and Carr, 1986; Hauber et al., 2008)



Hauber et al. 2008

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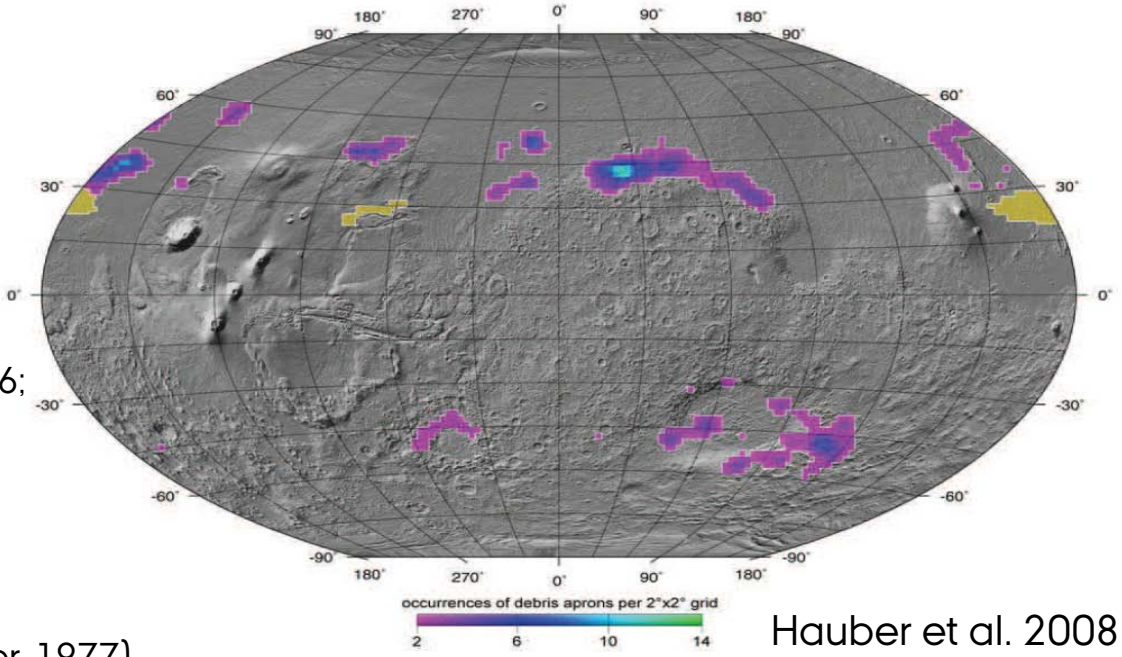

Hauber et al. 2008

Suggested formation models:

(1) Frost creep (Carr and Schaber, 1977)
(2) Ice-lubricated rockfall (Squyres, 1978)
(3) Landslides (Lucchitta, 1984; Mangold and Allemand, 2001)
(4) Glacial origin (E.g. Head et al., 2005, 2006; Hauber et al., 2005; Dickson et al., 2008)

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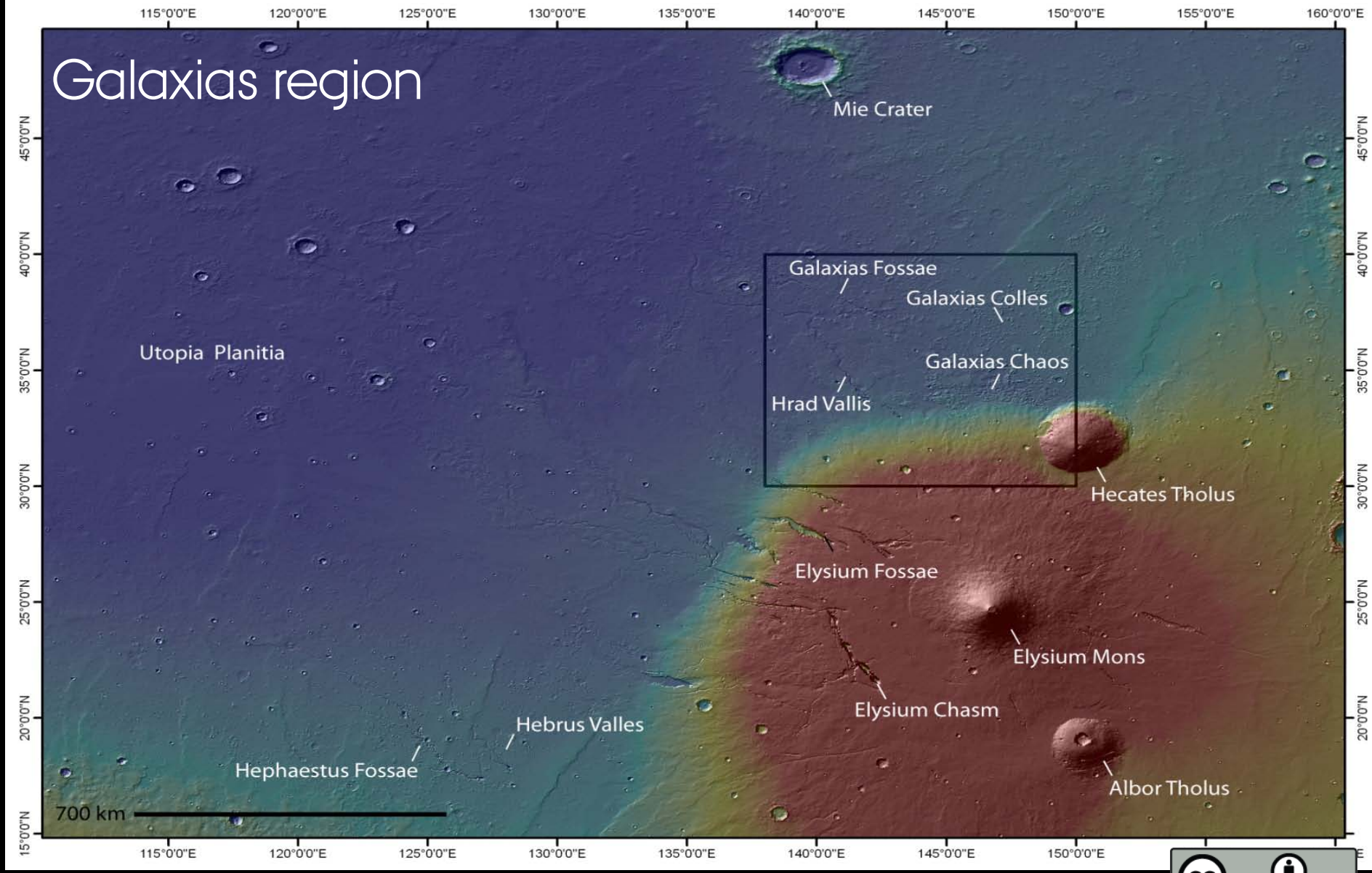
Galaxias region



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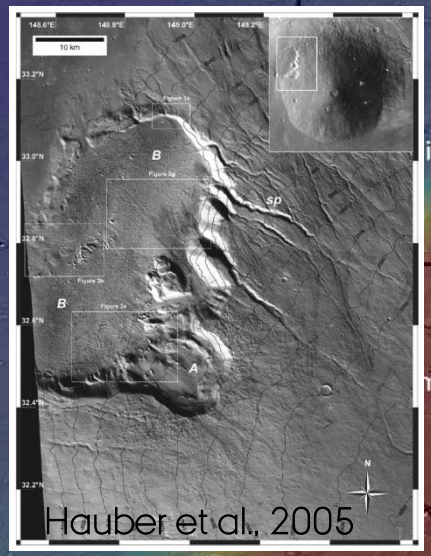

Mie Crater
Galaxias Fossae
Galaxias Colles
Galaxias Chaos
Utopia Planitia
Hecates Tholus
Elysium Mons
Elysium Chasm
Hebrus Valles
Hephaestus Fossae
Albor Tholus
700 km

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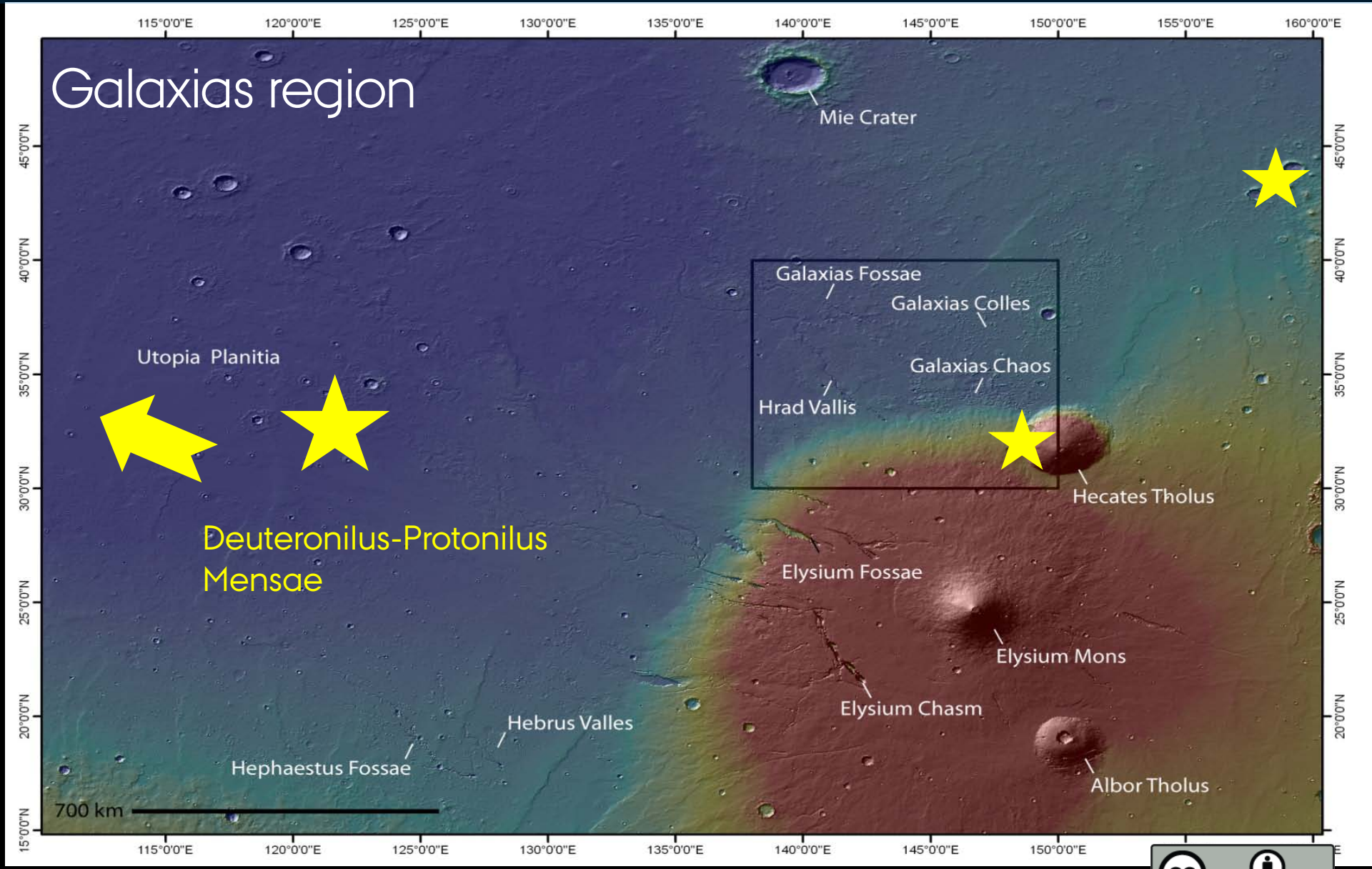

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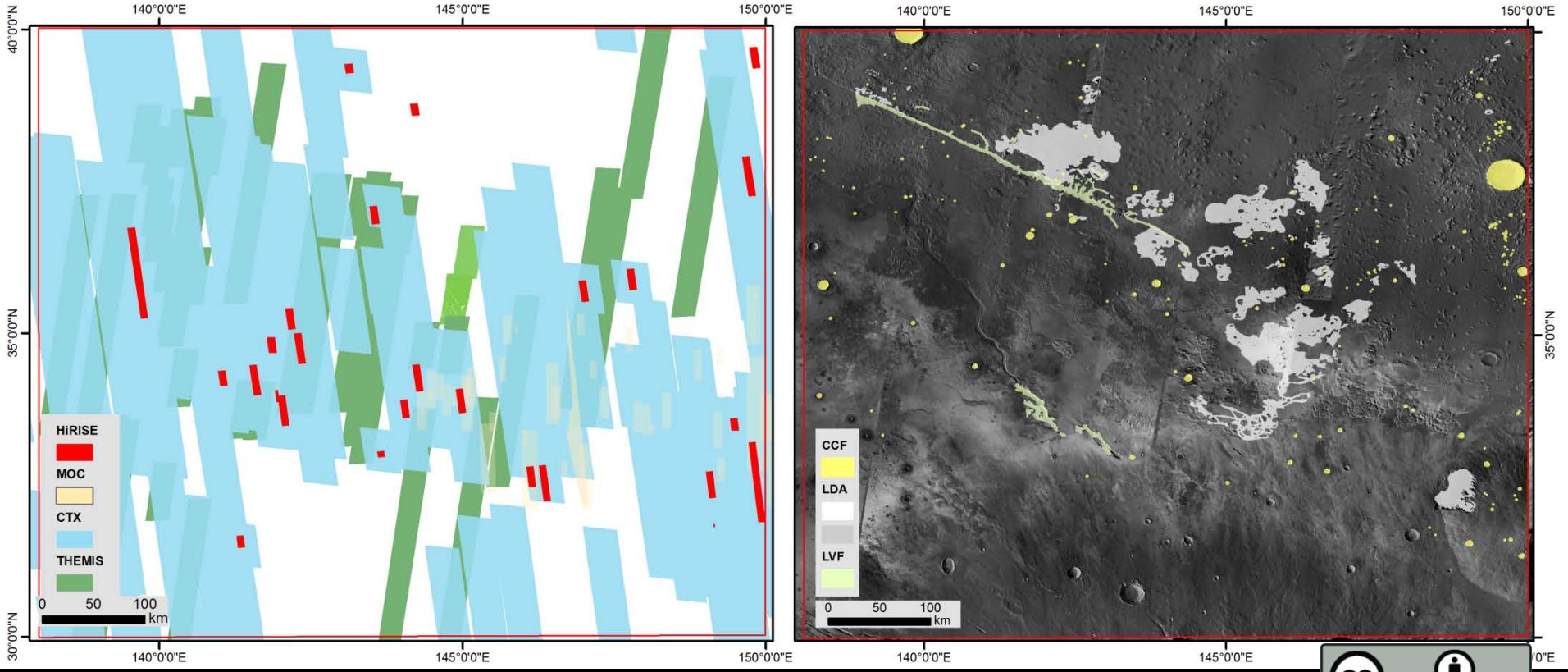
Data

- HiRISE (~ 0.5m/pixel)
- MOC (~ 5m/pixel)
- CTX (~ 6m/pixel)
- THEMIS VIS (~ 18-40m/pixel)

Resolution of imagery should be at least 20m/pixel and preferably below 10 m/pixel.

Clear correlation between ice-rich deposits and high resolution data



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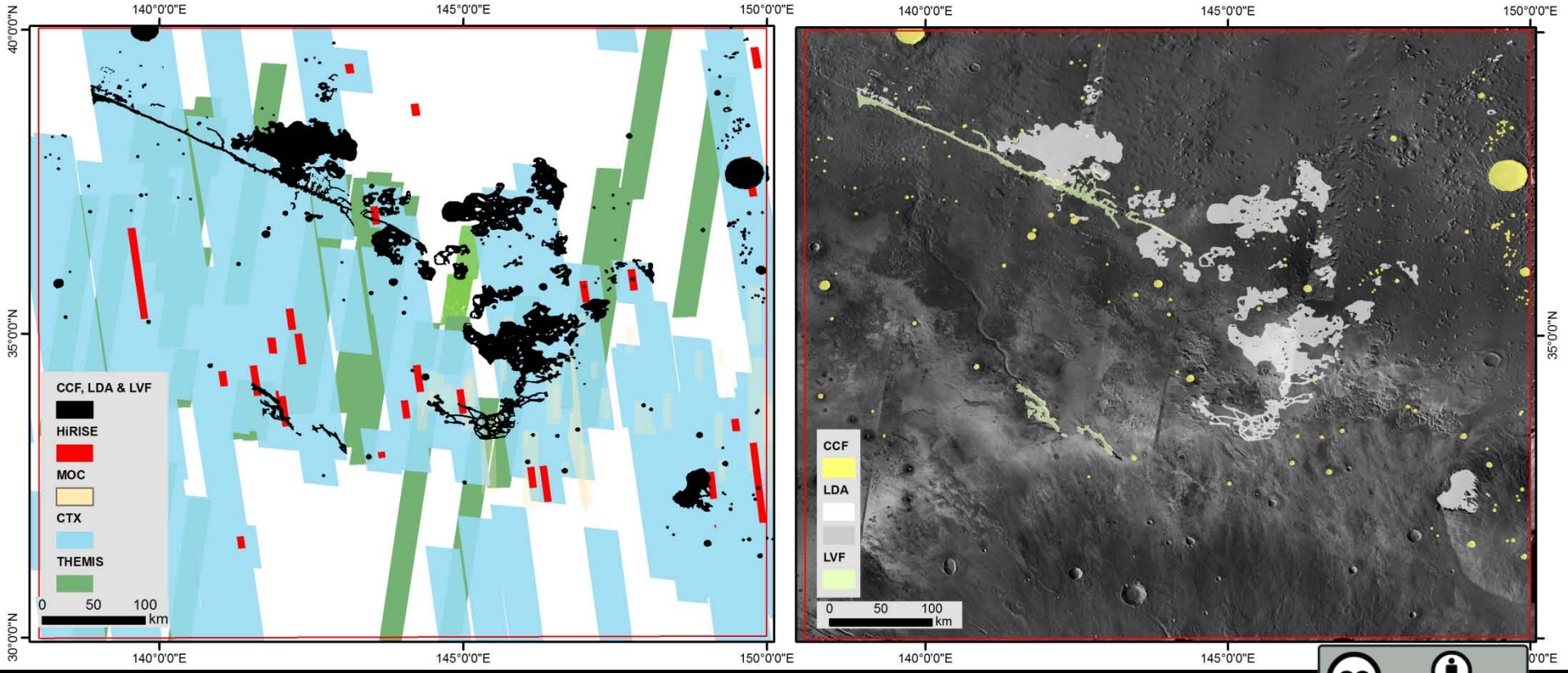

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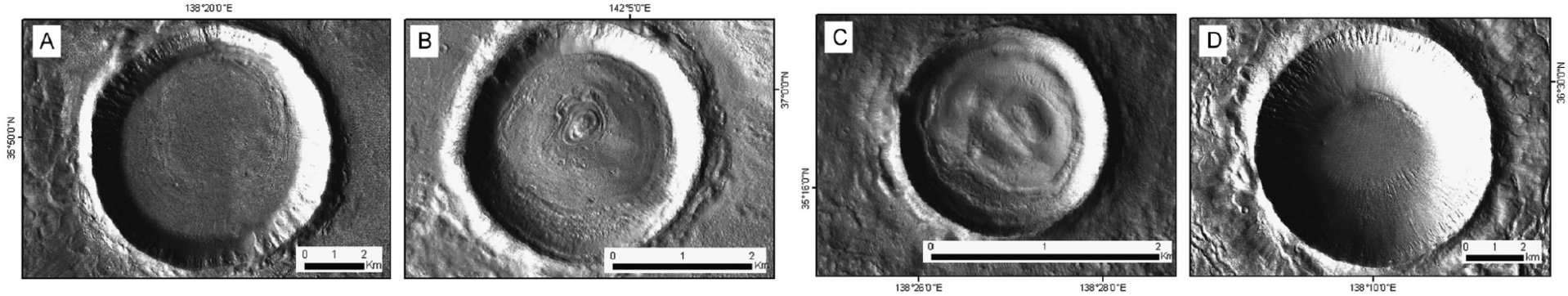
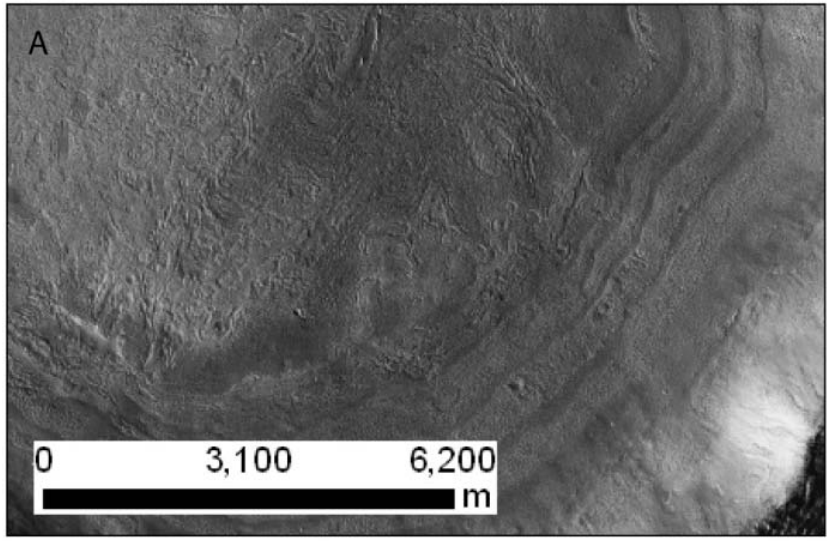
CCF: Galaxias region



- 212 examples (9500m^2 -800km^2): Total coverage 1600 km^2
- Distribution: 31.2–40 N, 138–150 E ; elevation range between -4250m and 4575m (~ 9km).
- Different stages of CCF: Pristine (A), Degraded (B-C), final CCF deposit/starting CCF acc. (D)
  - (A) Horizontal surface, concentric zones, lineations, chaotic lace pattern, Regular RMCs
  - (B-C) Upward convex/ Irregular surface, raised rim fractures, trim line features
  - (D) Thin deposit covering the deepest part of the crater.



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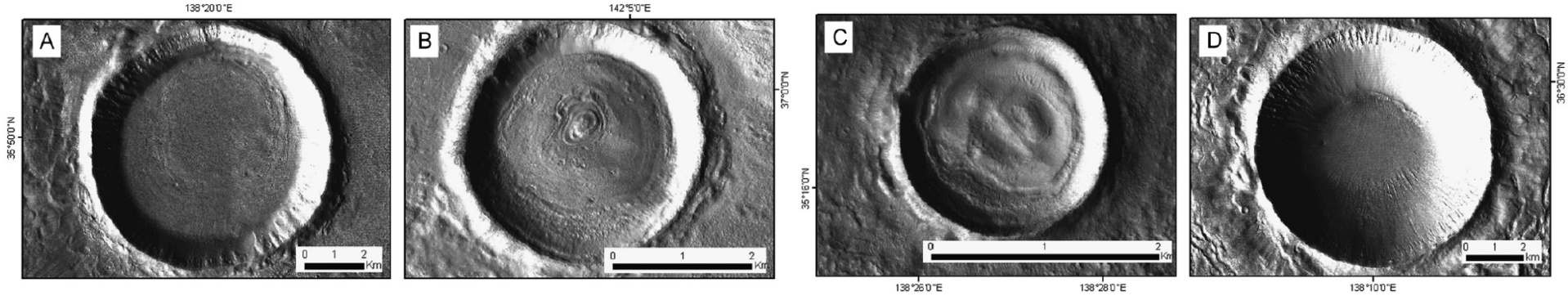

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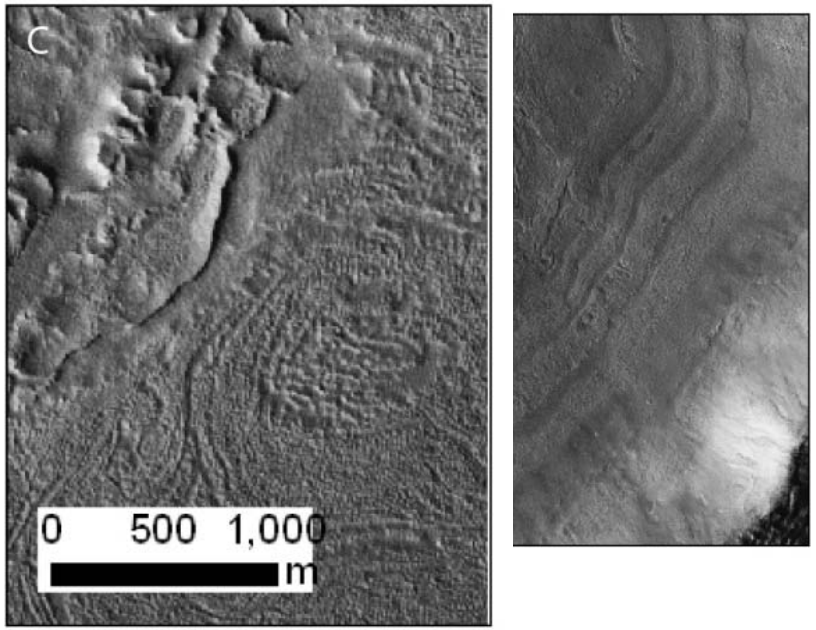

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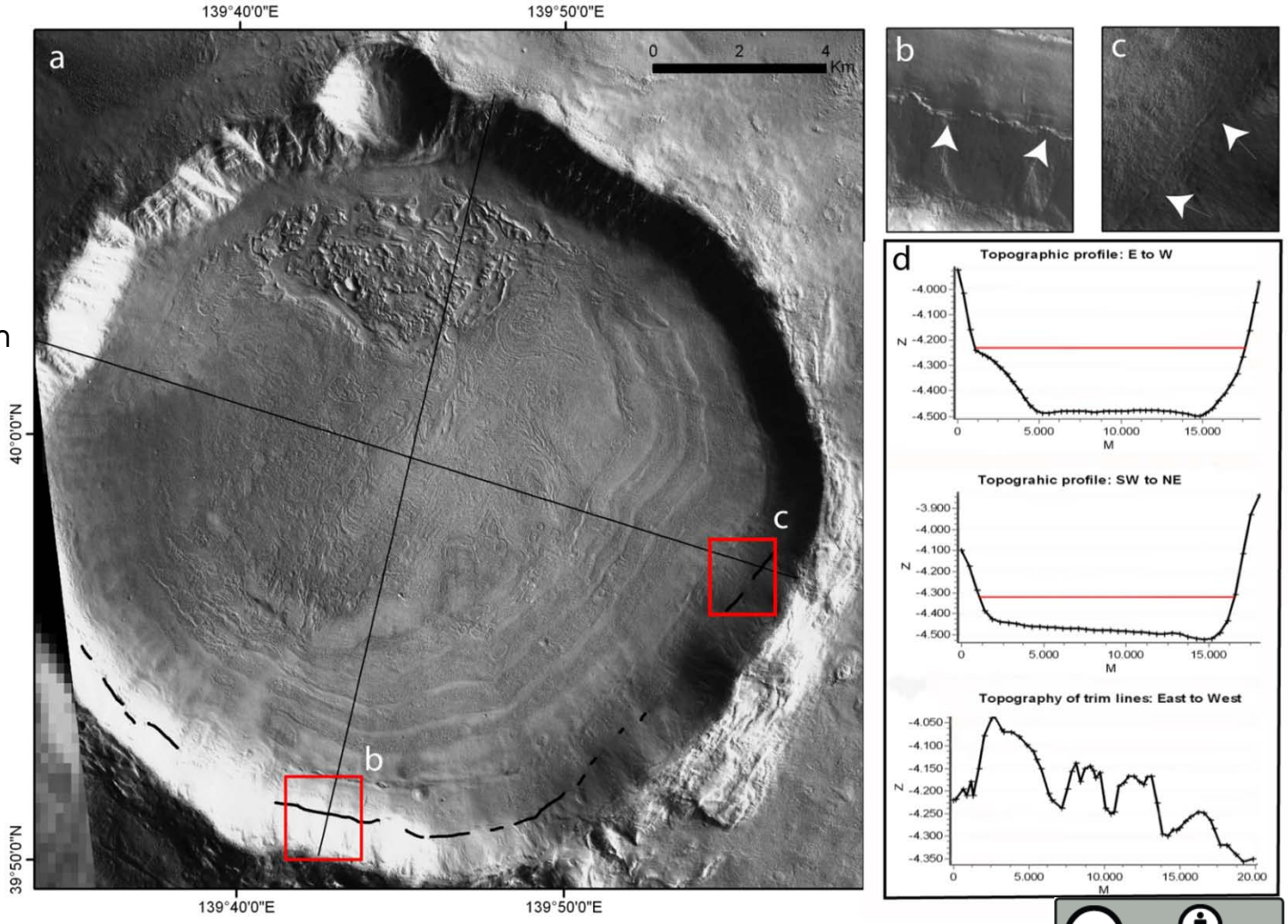
CCF: Galaxias region

Trim-lines:

- Parallel to crater rim
- Coincide with break in slope (E-W)
- Elevation of trom lines: [-4000m; -4400]

→ Deflation: 150-350 m

→ Variable CCF thickness over short distances.



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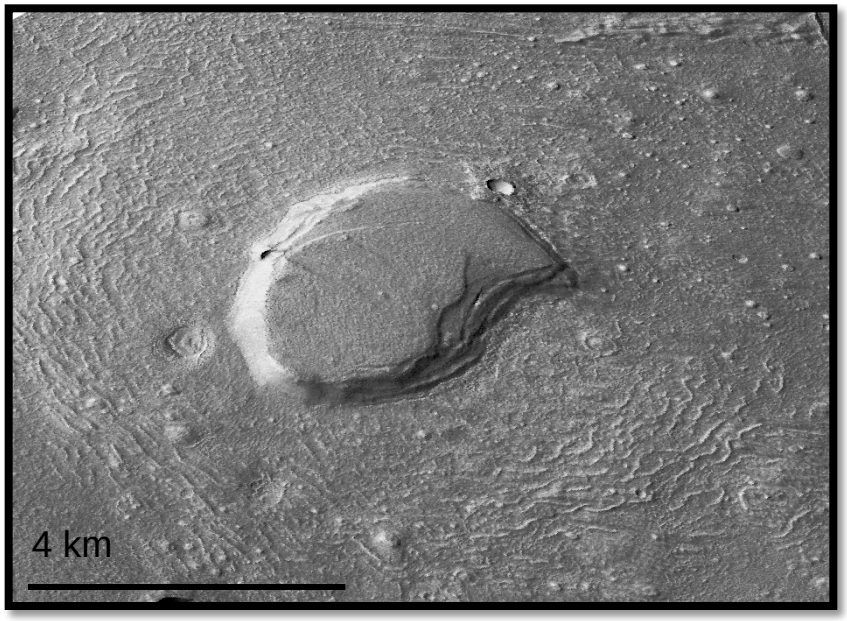
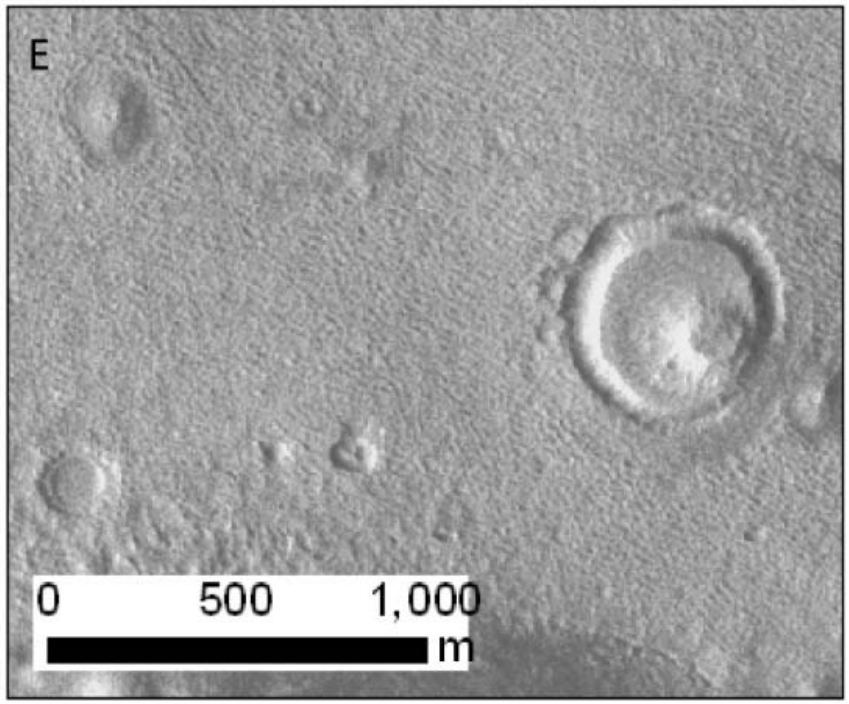
LDA: Galaxias Region



- Total coverage ~15,700 km^2
- Distribution: 32.1–39.7N, 141.2–148.61E
- Elevation range : -0m to -4000m
- Surrounding 100-300m high mesas
- Higher albedo than surroundings
- Texture: pitted; lineated; squared; fish scale
- Topography: convex upward-uneven



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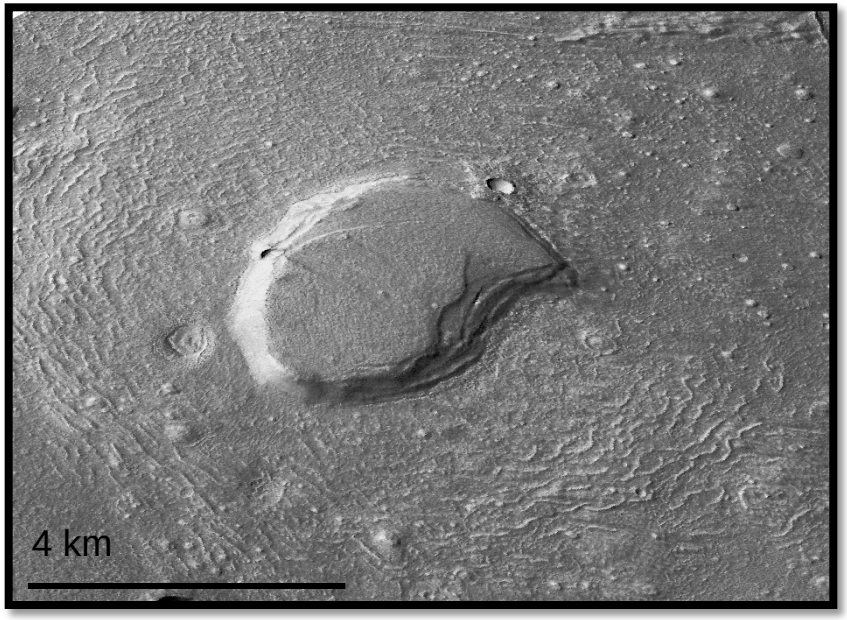

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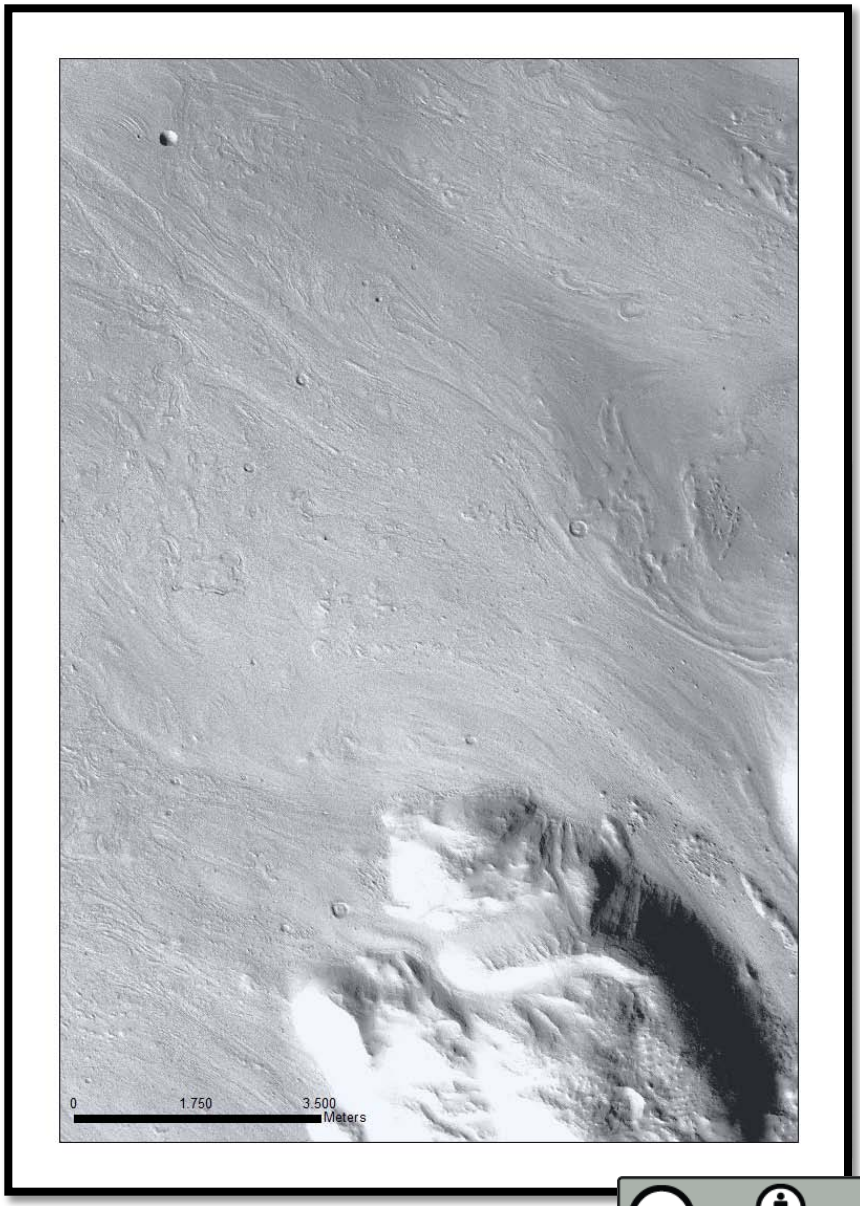

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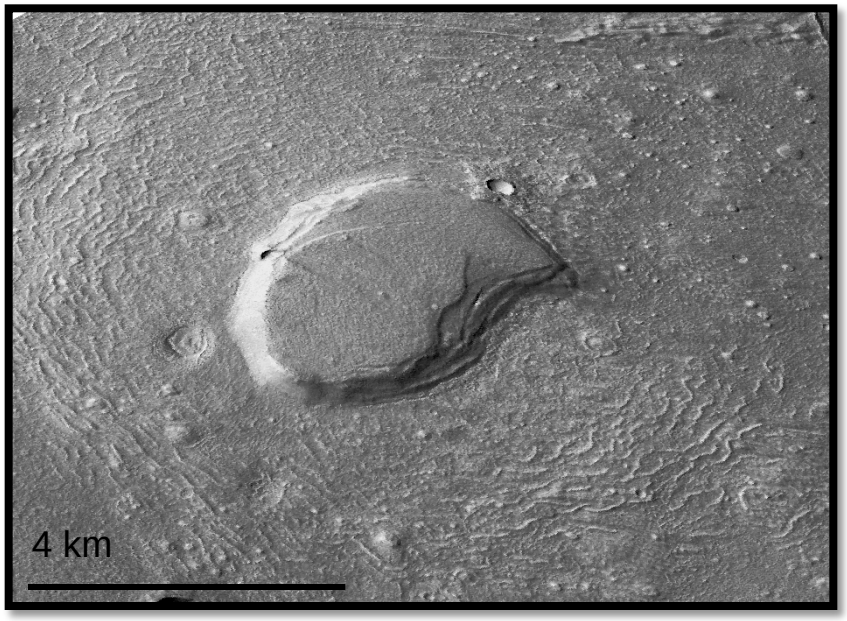

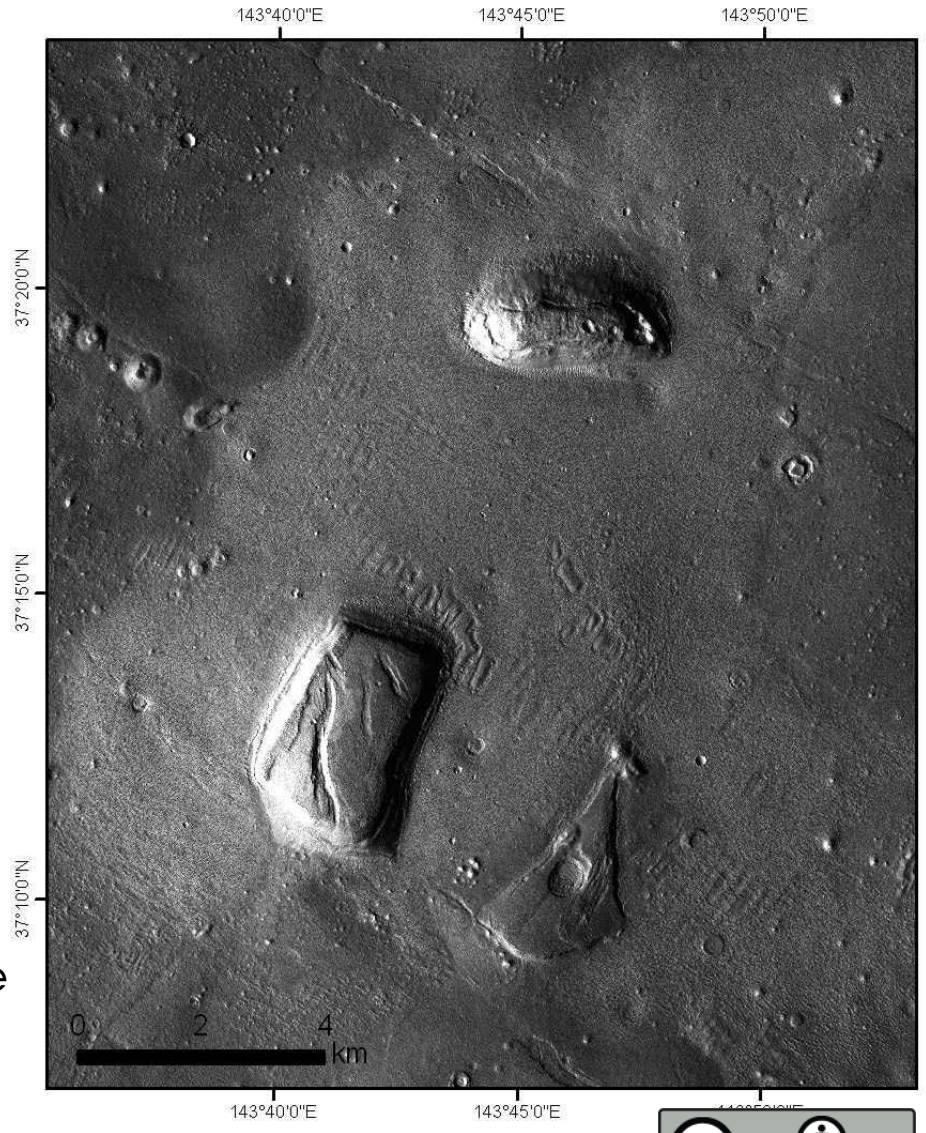

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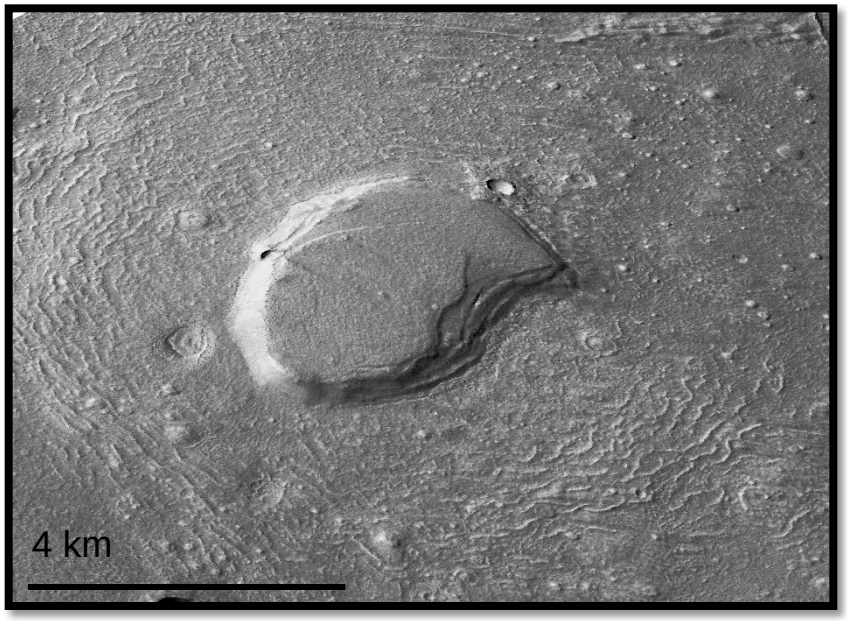

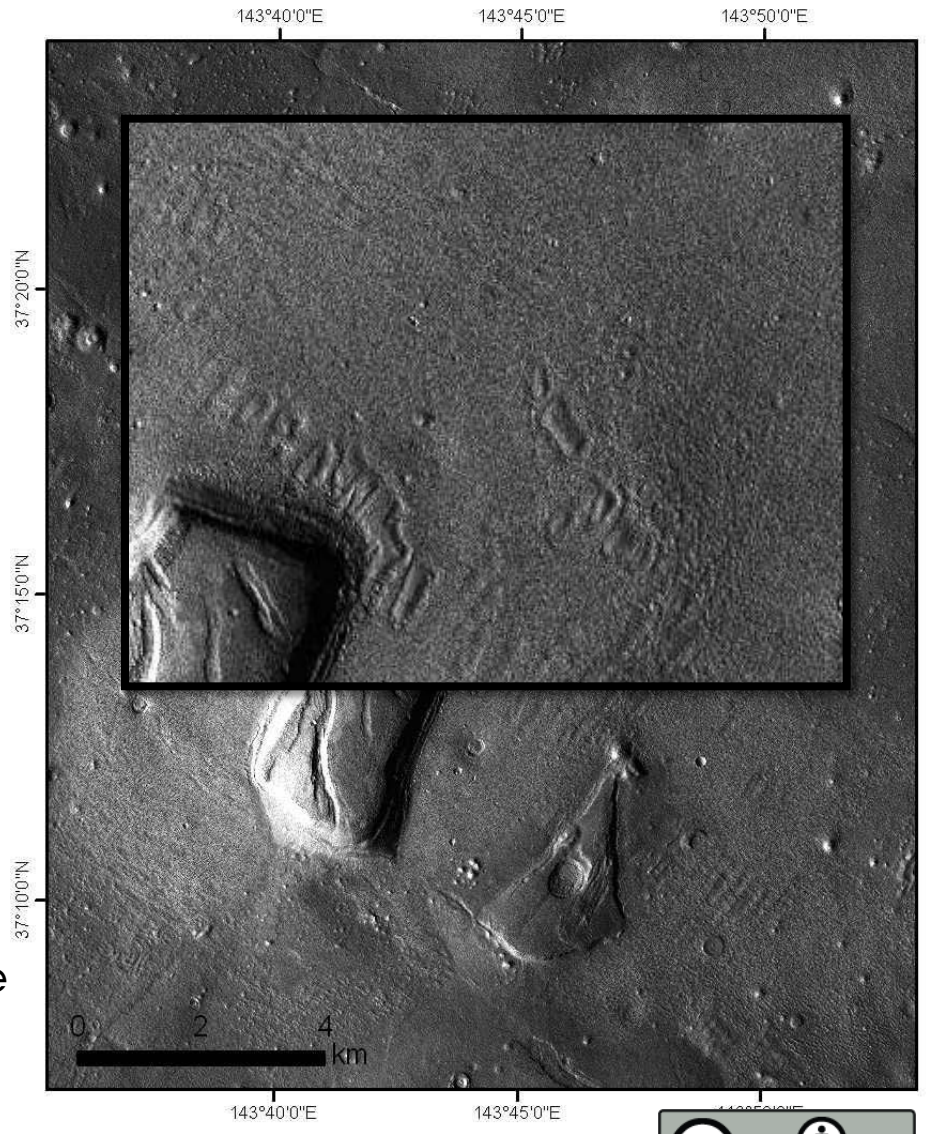

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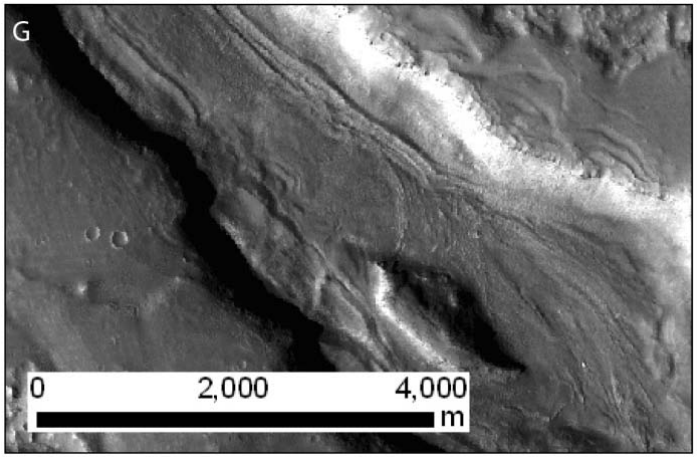
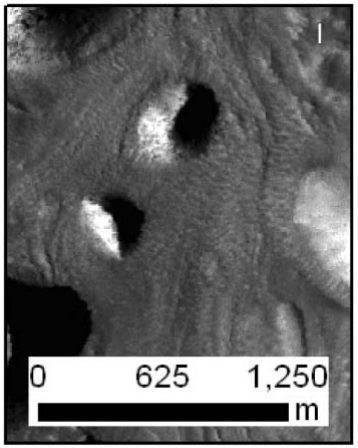
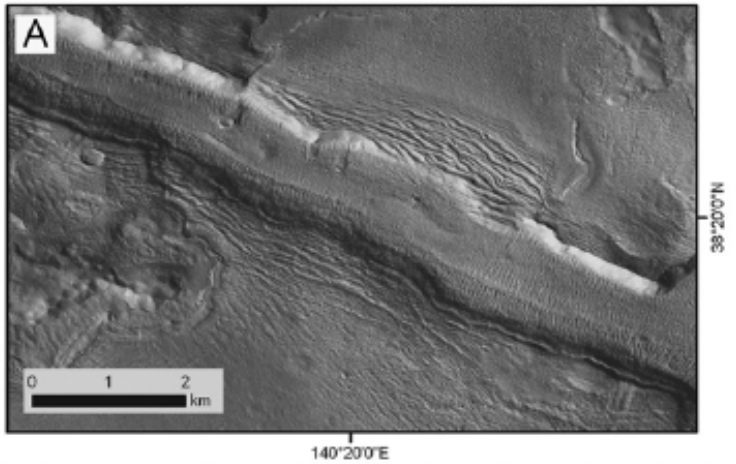
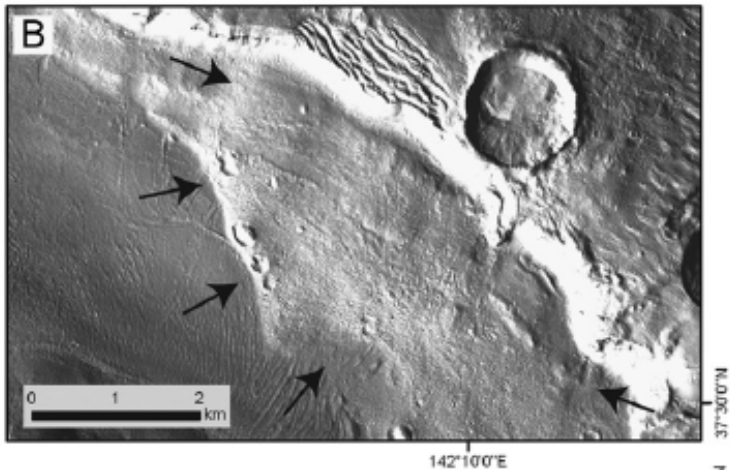
LVF: Galaxias Region









Total coverage ~990 km^2 + 420 km^2
Galaxias Fossae (-4100m to -4300m)
Hrad Vallis (-3800m to -4000m)

150-400m deeper than the surroundings
Higher albedo than surroundings
Texture: pitted; lineated; deflection and confluence of flow around obastacles: ice fall morphologies.

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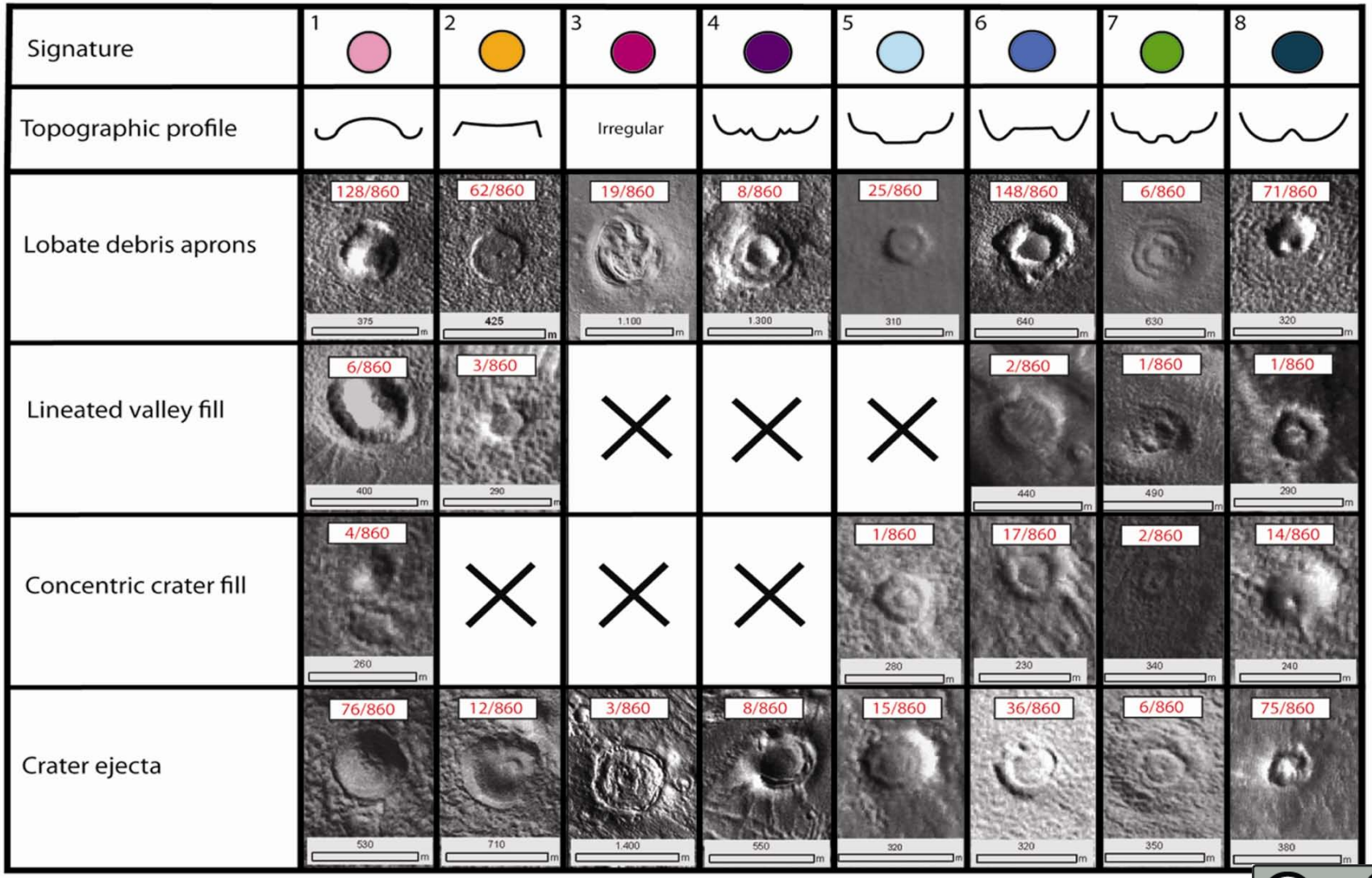
Ring-mold craters (RMC): Galaxias Region



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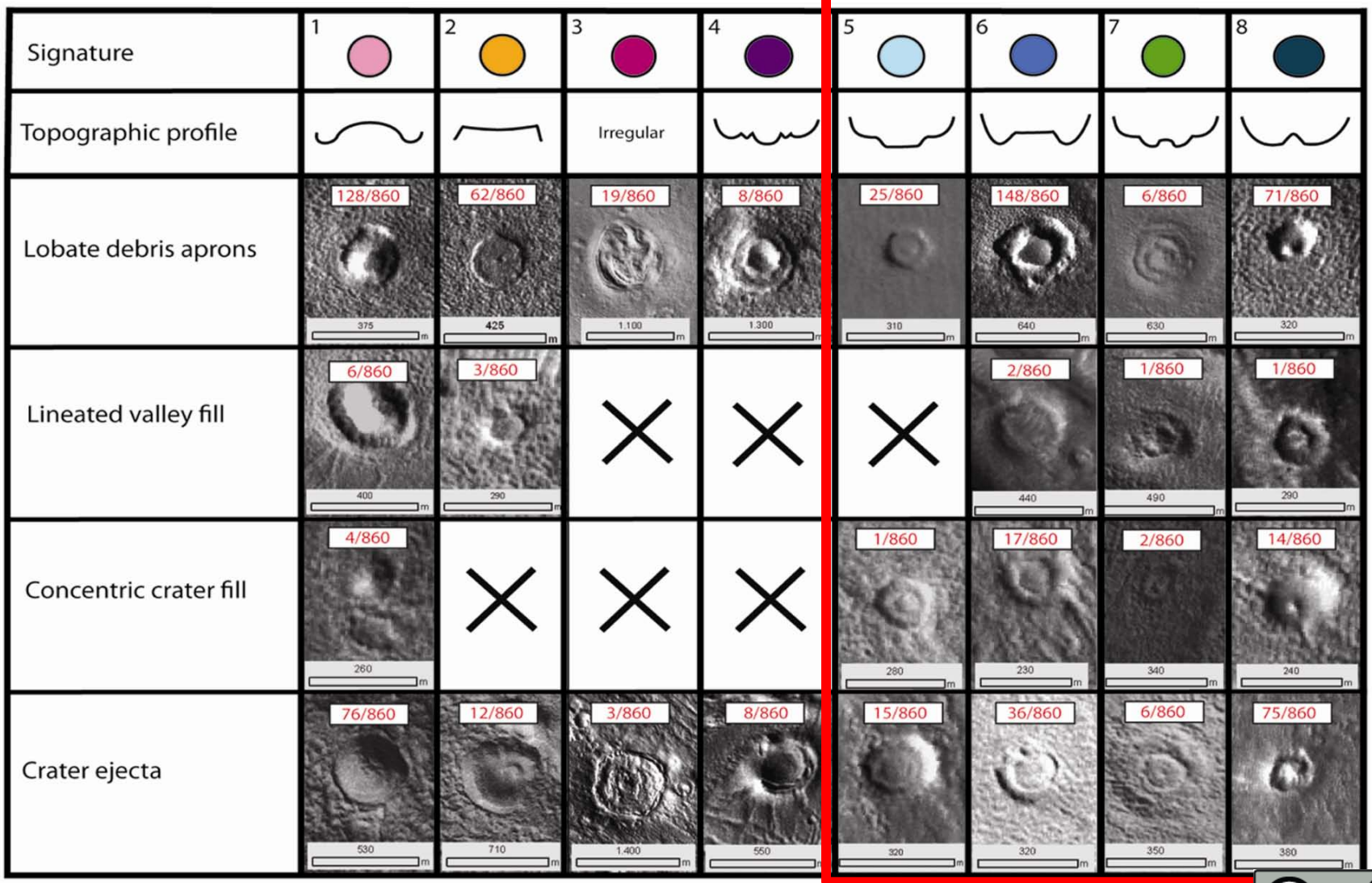

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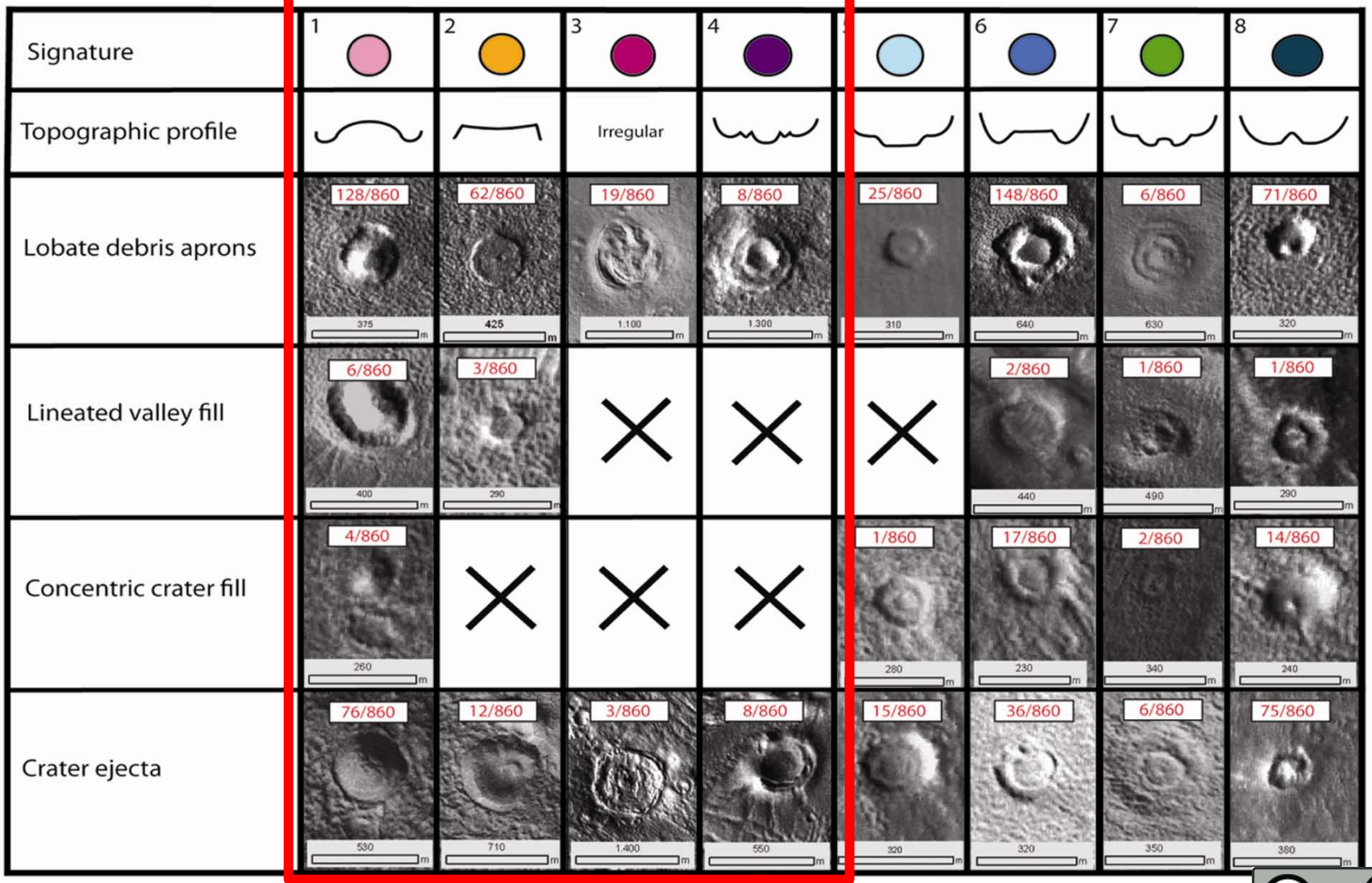

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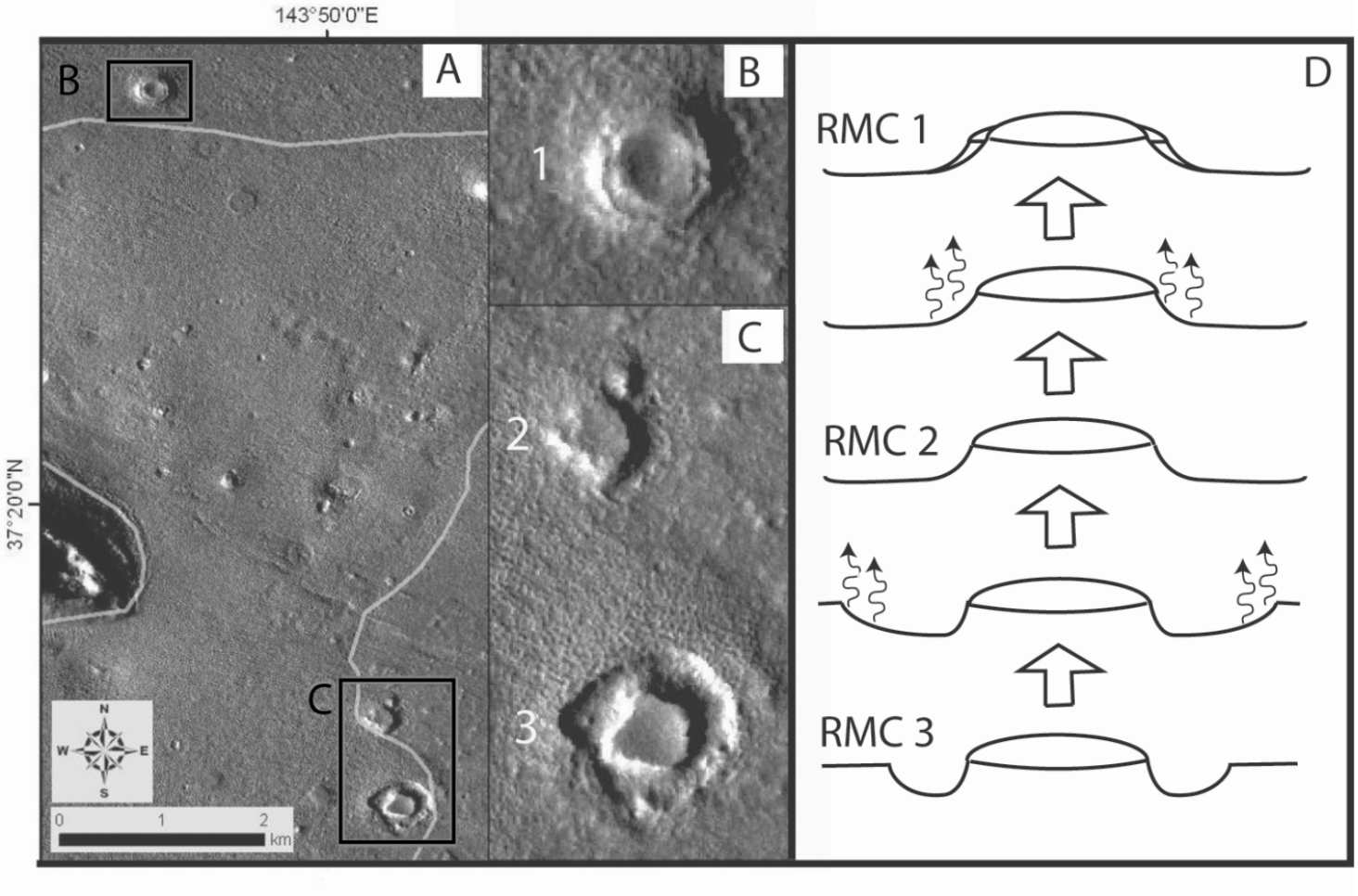
Ring-mold craters (RMC): Galaxias Region

Degradational sequence



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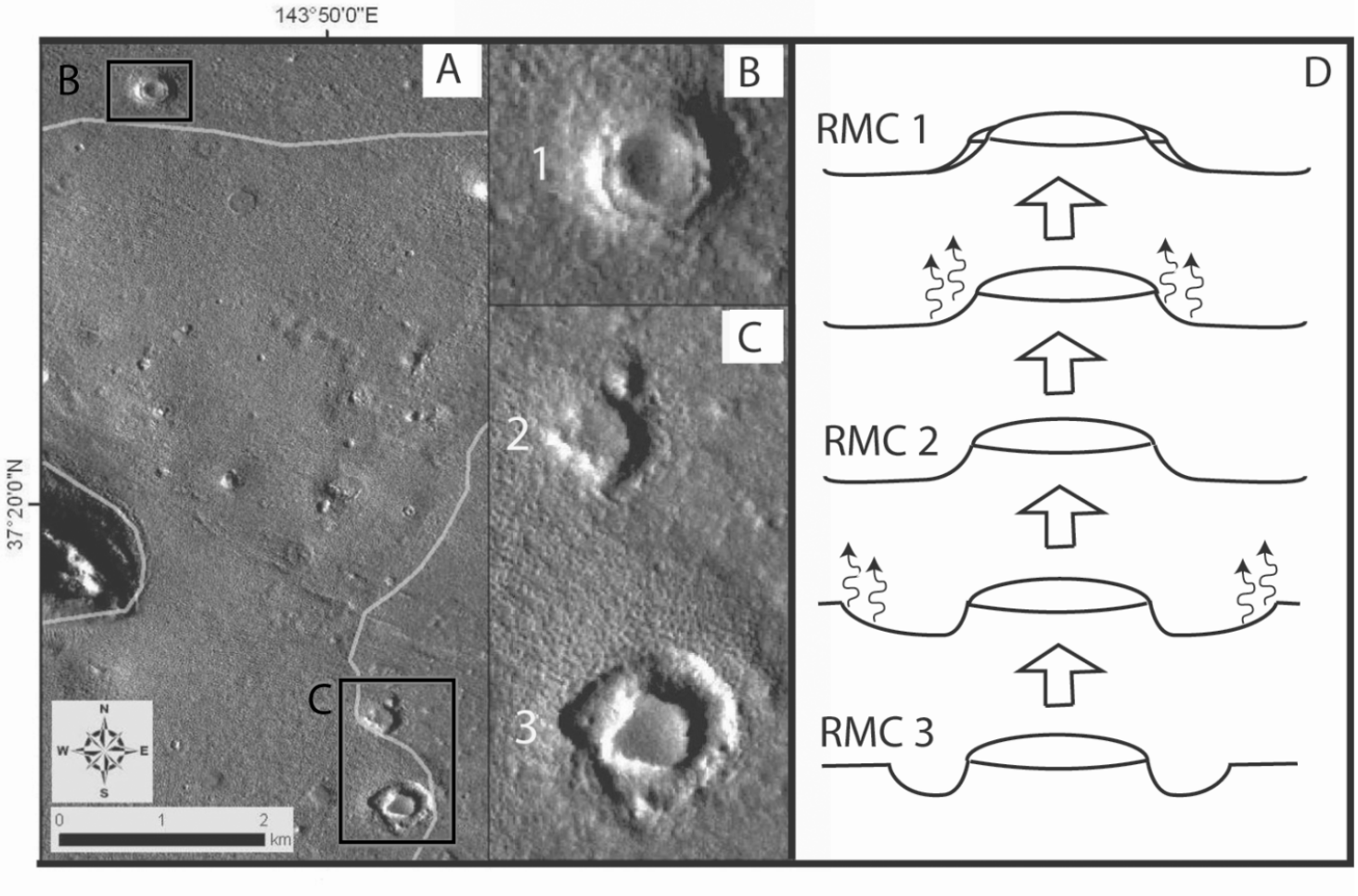

Degradation of plateau sides
→
Concentric fracturing

Sublimation
→
Depression grows

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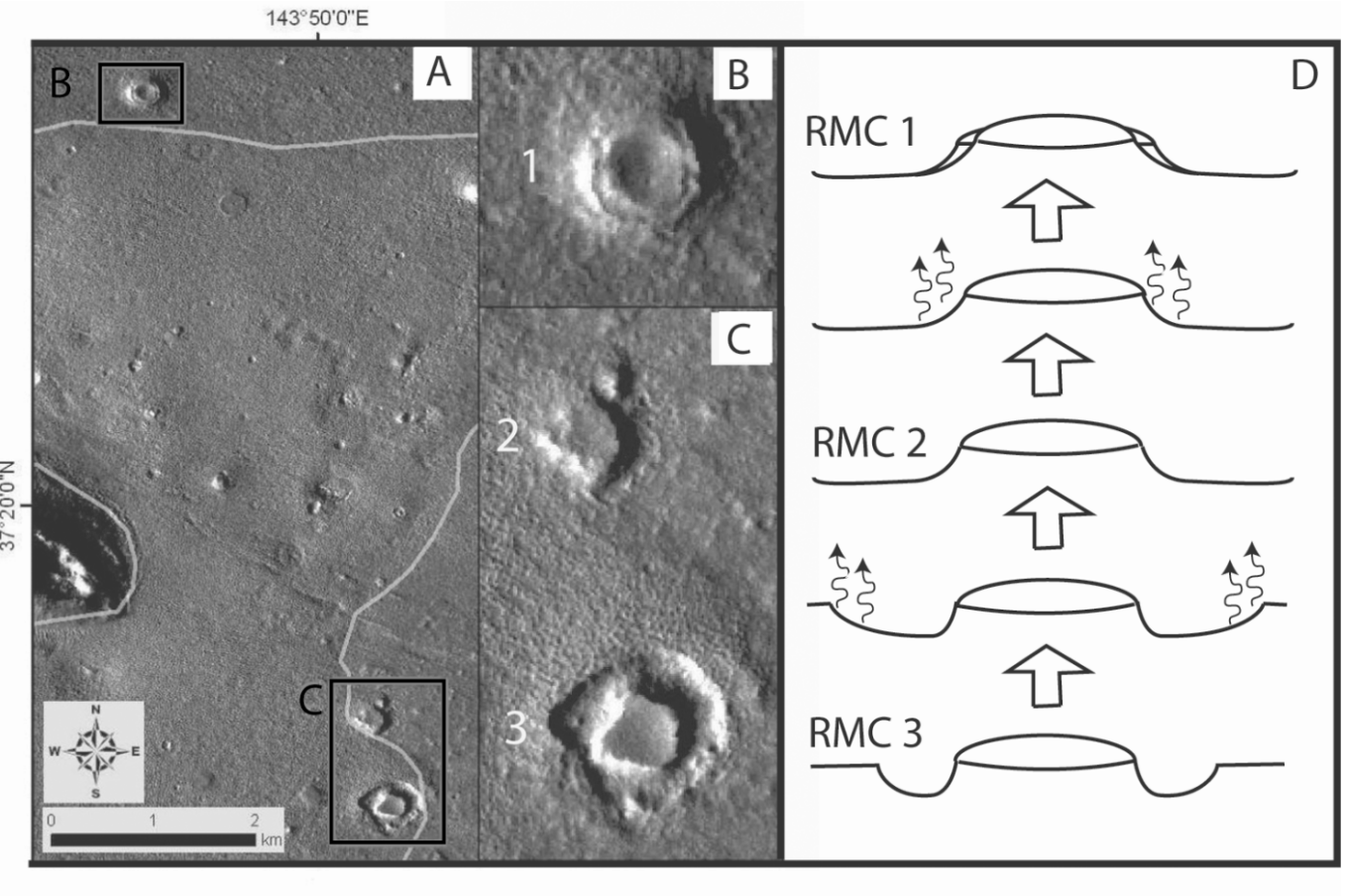
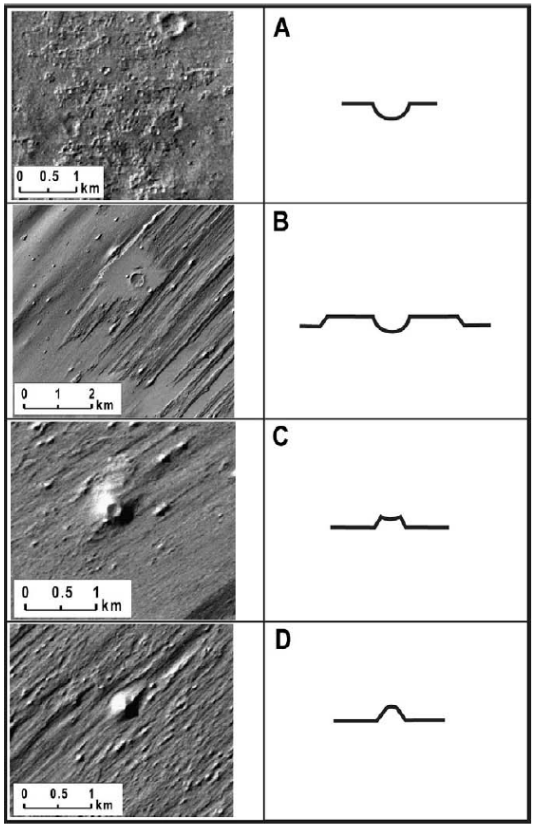
Ring-mold craters (RMC): Galaxias Region

Degradational sequence





Kerber and Head, 2010

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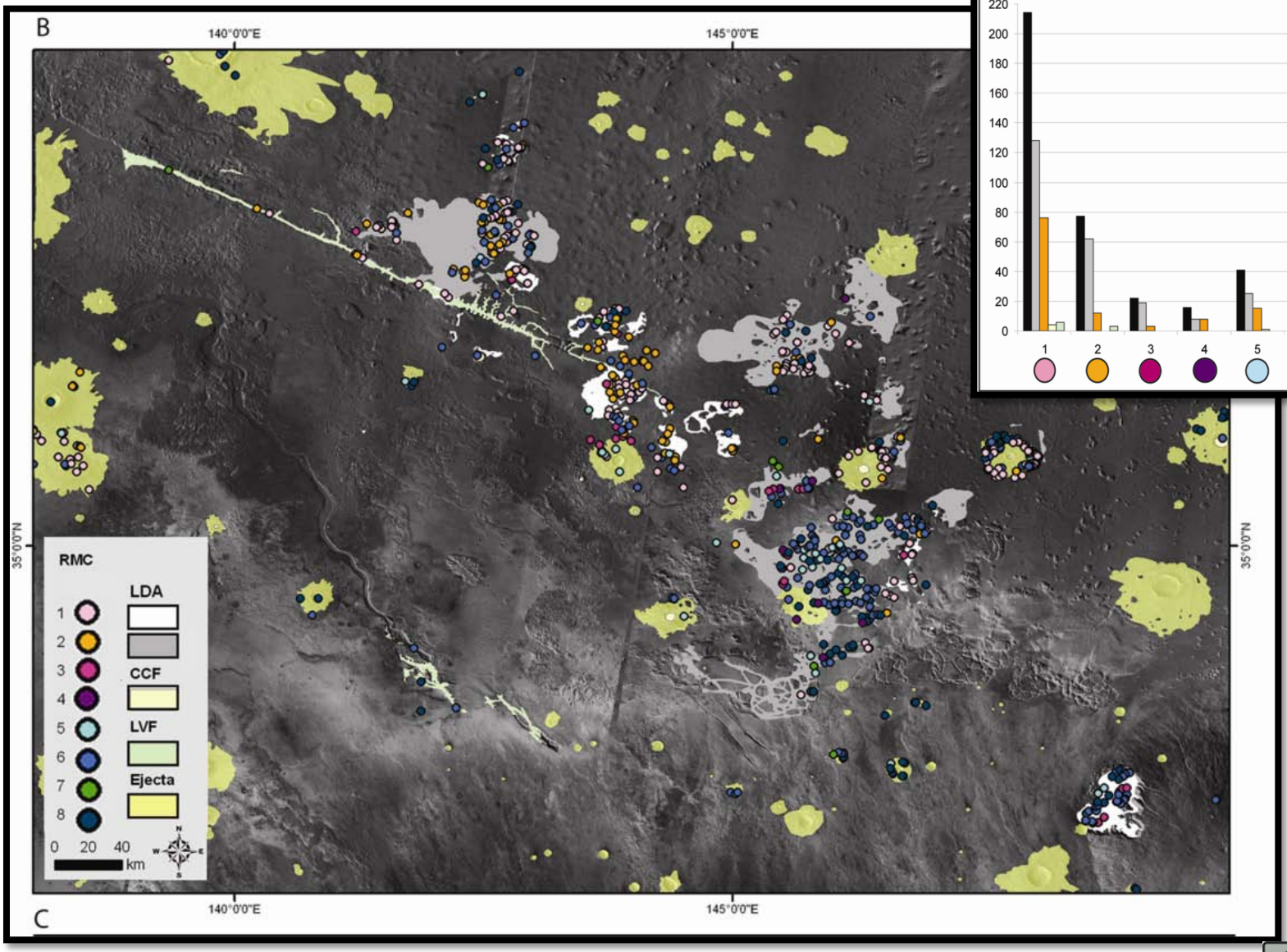

Implications

CCF deposits:

- Distribution: Latitude (31.2-40 N) and altitude (-4250m-4575m)
  →Coexists under very different conditions
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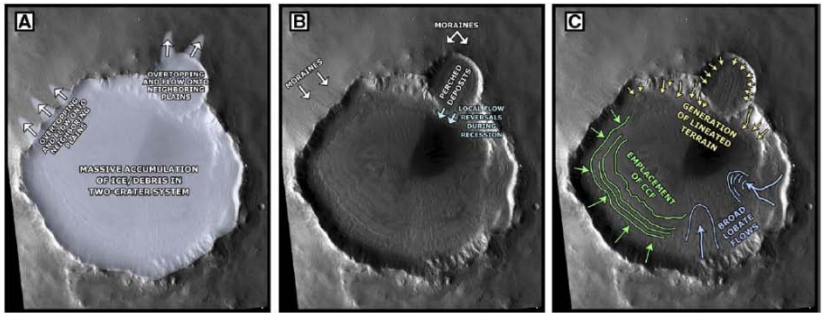
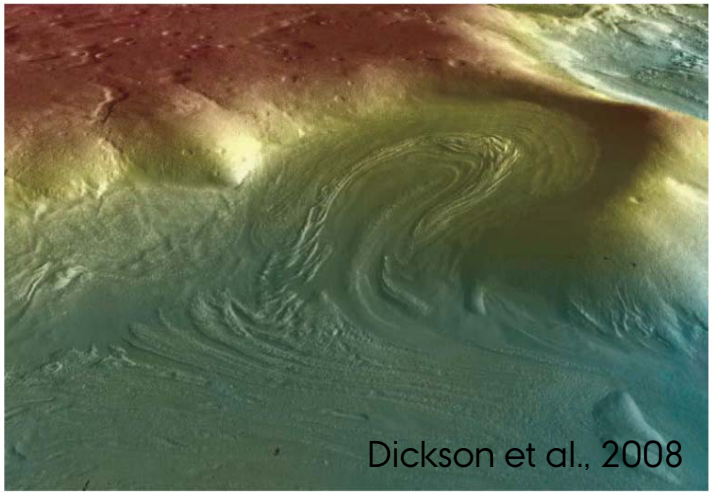
Other studies show deflation :

- CCF: 650m;1000m (Pearce et al., 2011; Dickson et al. 2010)
- LVF: 800;900m (Morgan et al. 2009; Dickson et al., 2008)



Dickson et al., 2010



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  - Degradational regime: Reflect different substrate lag: thickness, content of dust and rock

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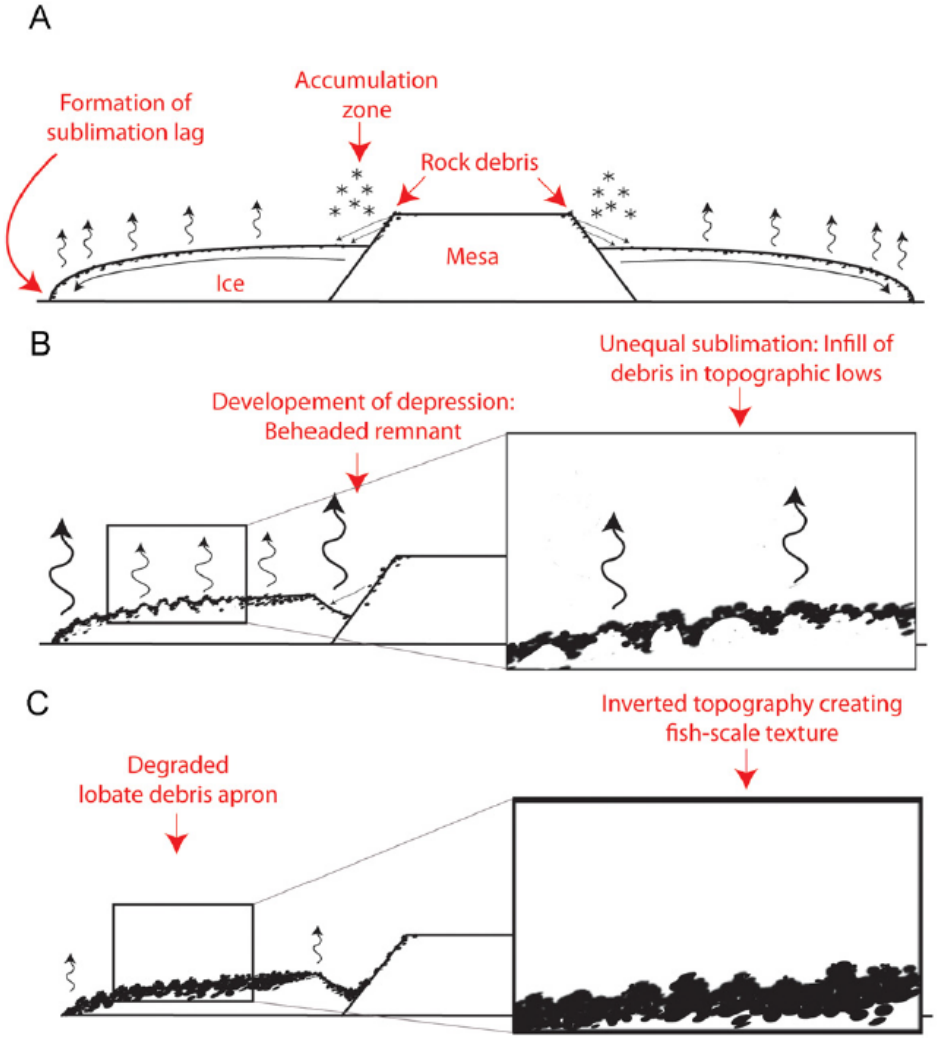
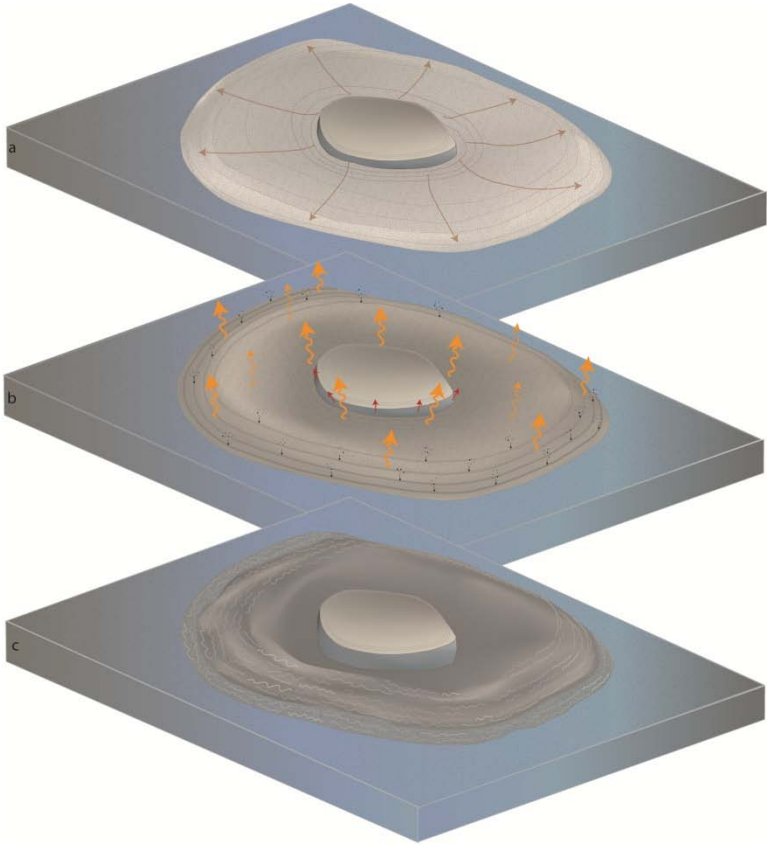
Model for LDA degradation stages





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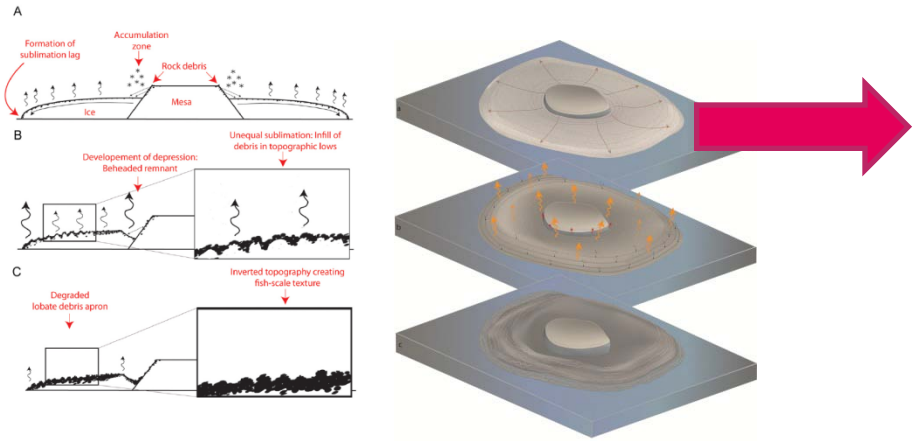

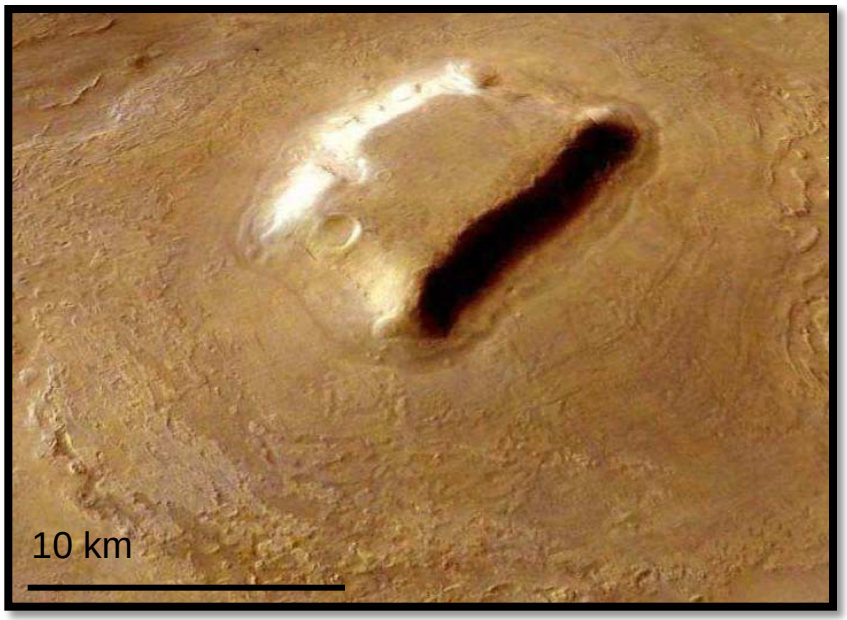

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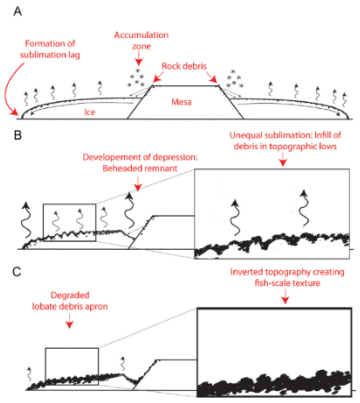

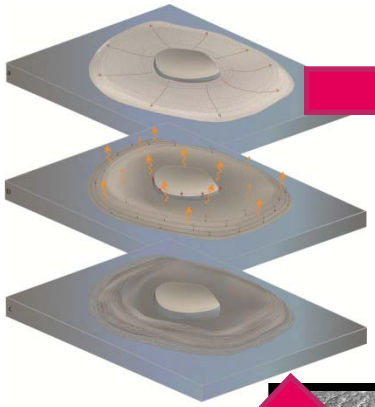

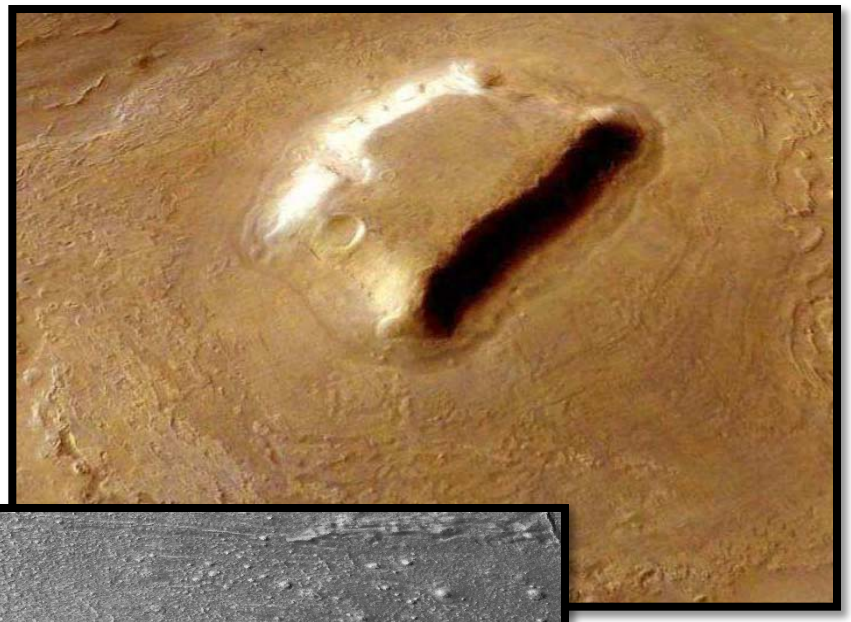

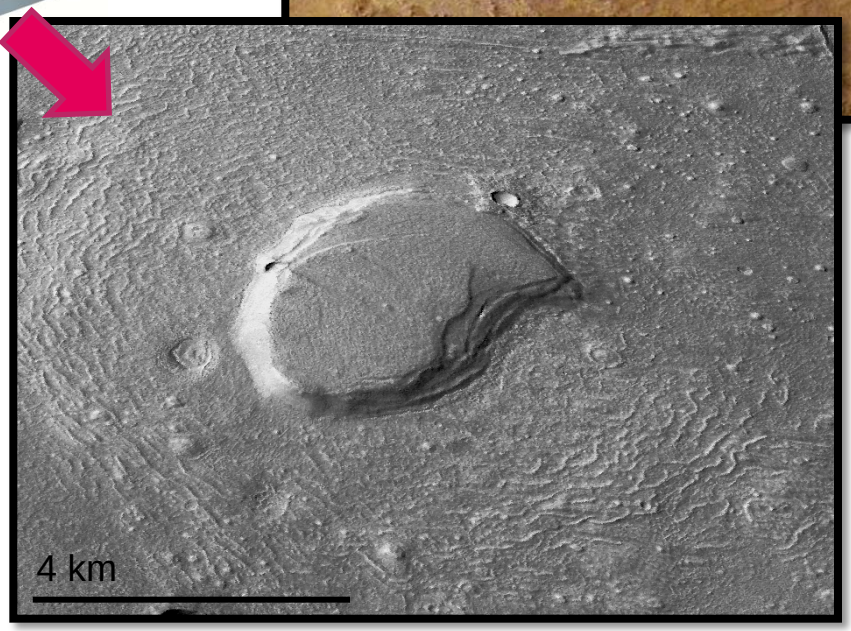

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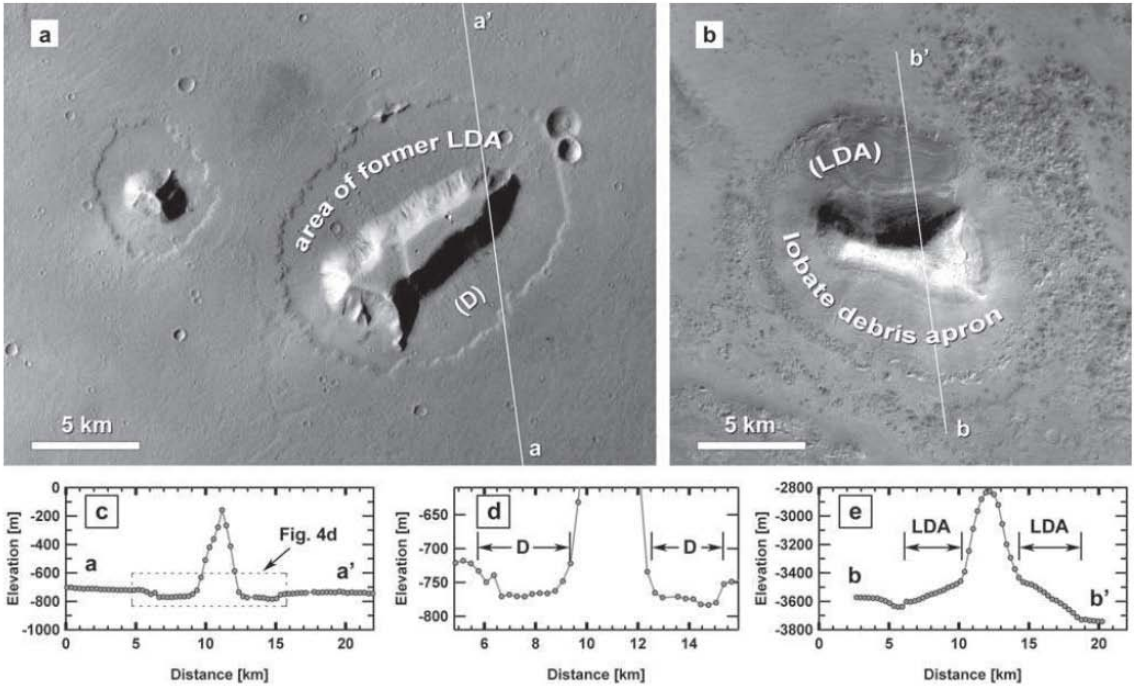
Degradational stages of LDA



Hauber et al., 2008

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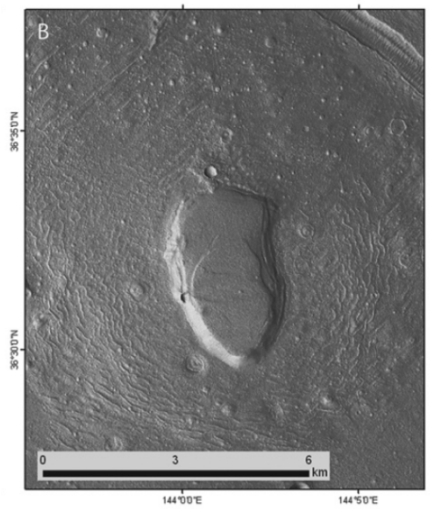
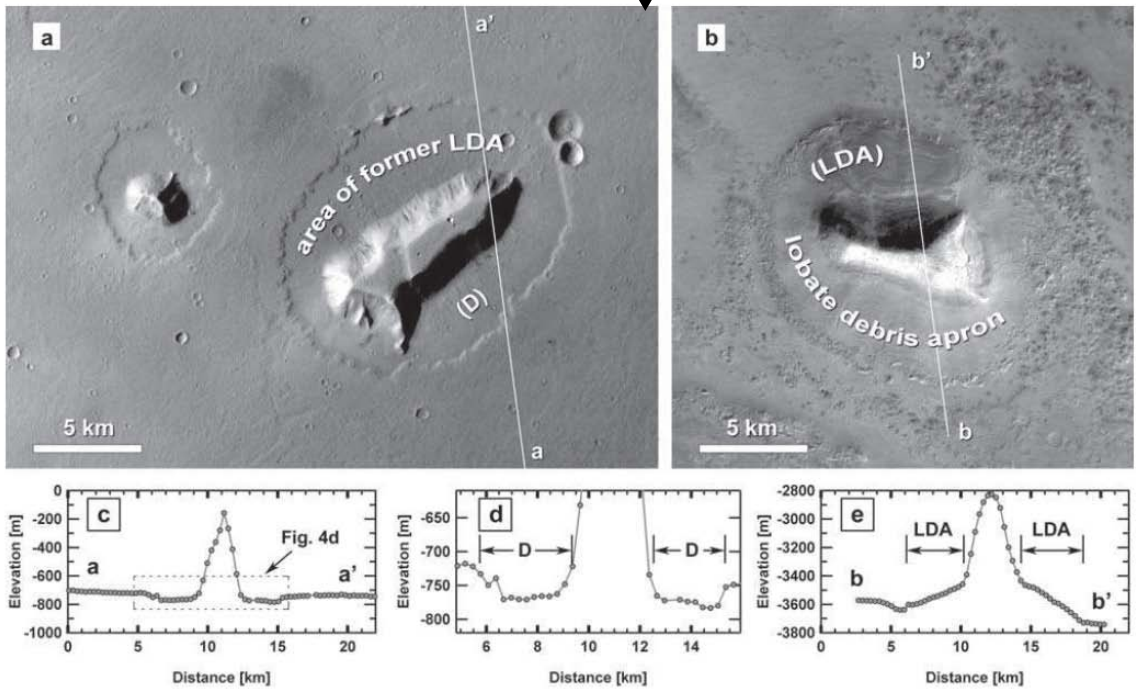
Deposits in the Galaxias region:

Link for understanding Amazonian-aged degradation processes of ice-rich deposits





Hauber et al., 2008

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Conclusions and future work

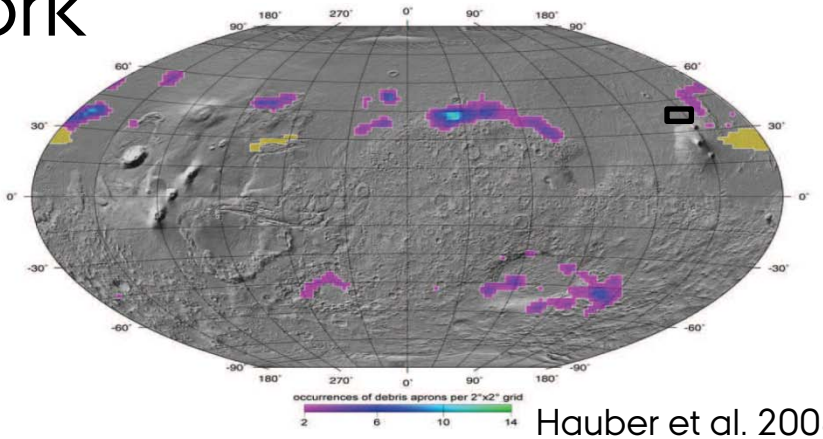
Ice-rich material more **widespread** on Mars than previously suggested (Squyres, 1979; Squyres and Carr, 1986; Hauber et al., 2008)

Degradational story to resolve

Results favour **ice depositional model**

Rather than
(1)rock fall/ landslide model
(2) Lubrication of regolith by vapour diffusion
Because of the low relief of the Galaxias region

Better understanding the temporal and spatial continuum of ice-rich morphologies on Mars → Mars climate history



Hauber et al. 2008

Future work:
(1) Constrain the degradation stages
-RMC morphology
-Textures
(2) Evaluate impact of variable substrate lag

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FACULTY OF SCIENCE
AARHUS UNIVERSITY

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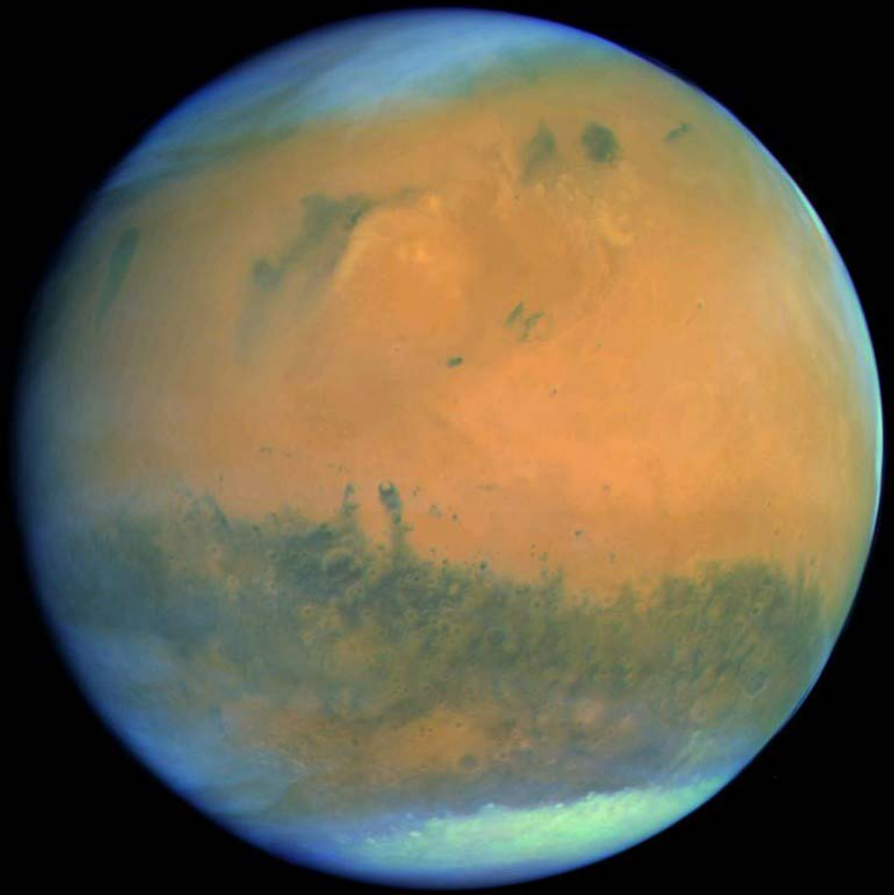
4. April 2011 EGU



Thanks for your attention

Credit

NASA/ESA/ JPL/ DLR/ Malin Space Science Systems

University of Arizona/ Arizona State University/ FU/ Brown University

Go