The Search for Methane Gas Emission Features in Nili Fossae, Syrtis Major, and Isidis Planitia, Mars

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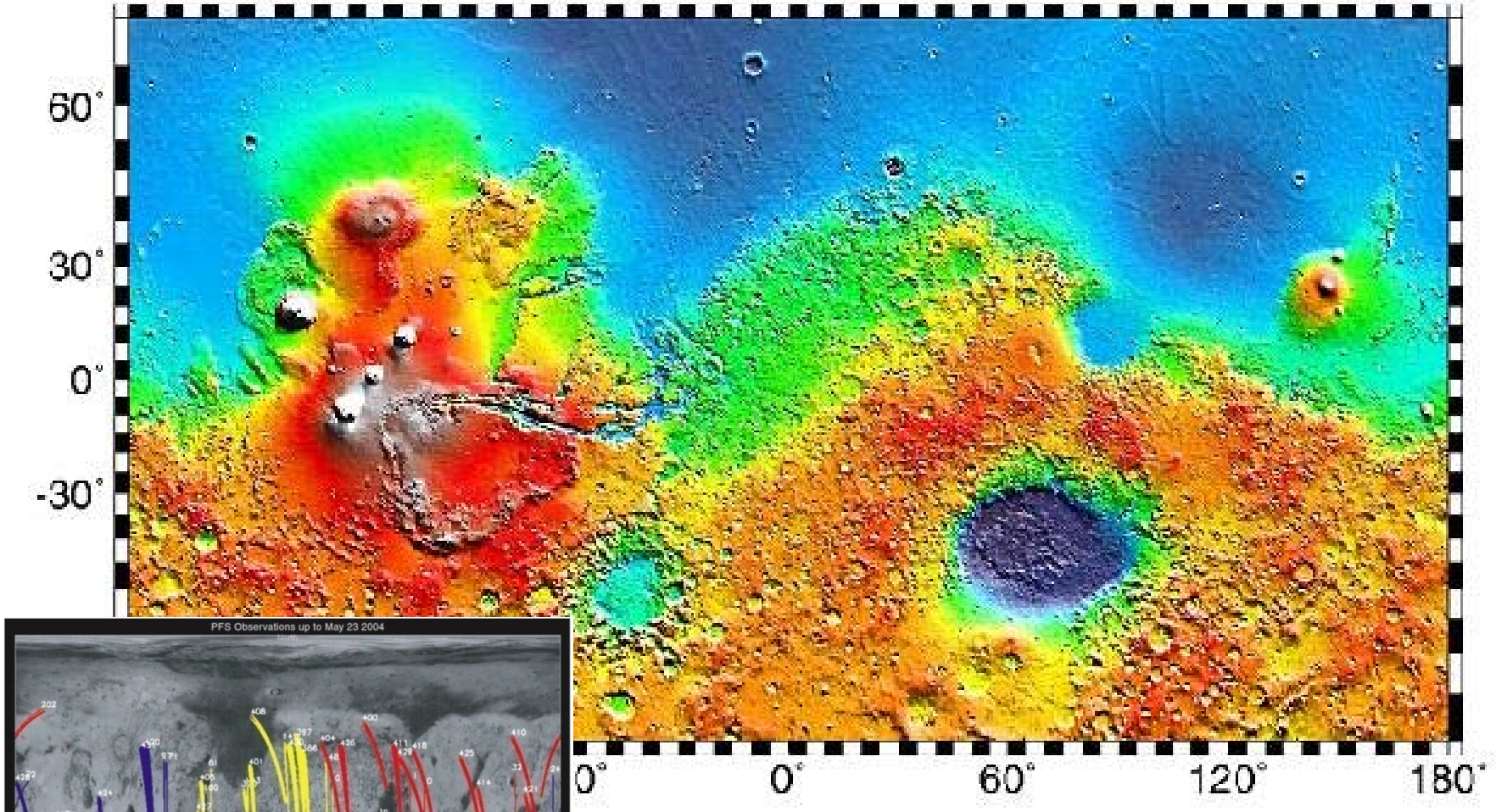
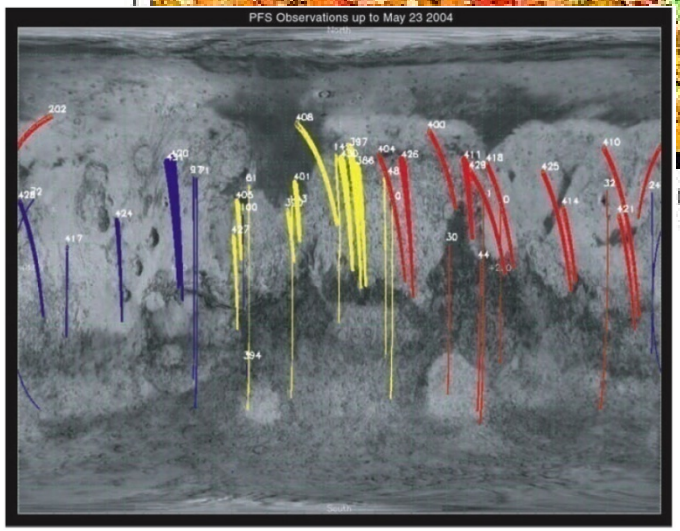
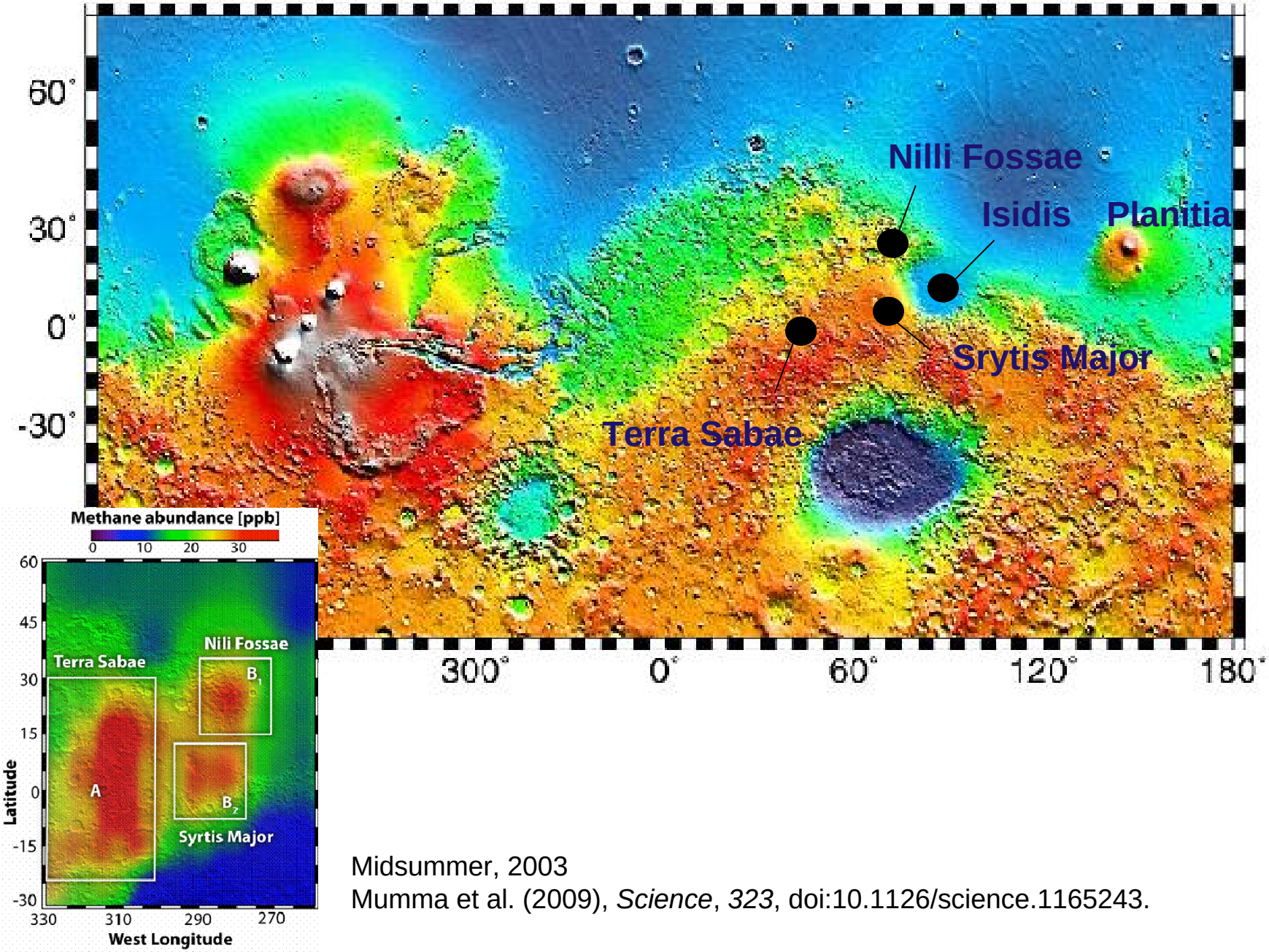




End of northern winter 2004
Formisano et al. (2004), *Science*, *306*, 1758-1761.



Midsummer, 2003

Mumma et al. (2009), *Science*, *323*, doi:10.1126/science.1165243.

Methane concentration in the Martian atmosphere:

- Seasonal dependency

  High during the northern summer

  but low during the northern winter

  (Geminale et al., 2008; Mumma et al. 2009)

- Geographical restriction

  (e.g., Mumma et al. 2009: plumes at -30°S-30°N, 260-330°W)

Methane emission on Mars:

- Still unsolved question.
- Effect of season-dependant solar illumination?
- Decomposition of methane clathrate?

(e.g., Ori et al., 2000; Prieto-Ballesteros et al. 2006; Chastain and Chevrier, 2007; Elwood Madden et al., 2007)

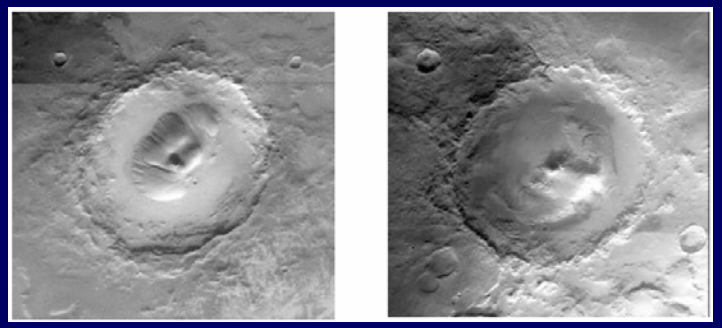
Production process(es)?

Emission through history

Geological investigation of emission-rich zones

Proposed gas- and gas hydrate-related geomorphic processes on Mars:

The processes involve fluid, ice, gas, clathrate, and detritus.



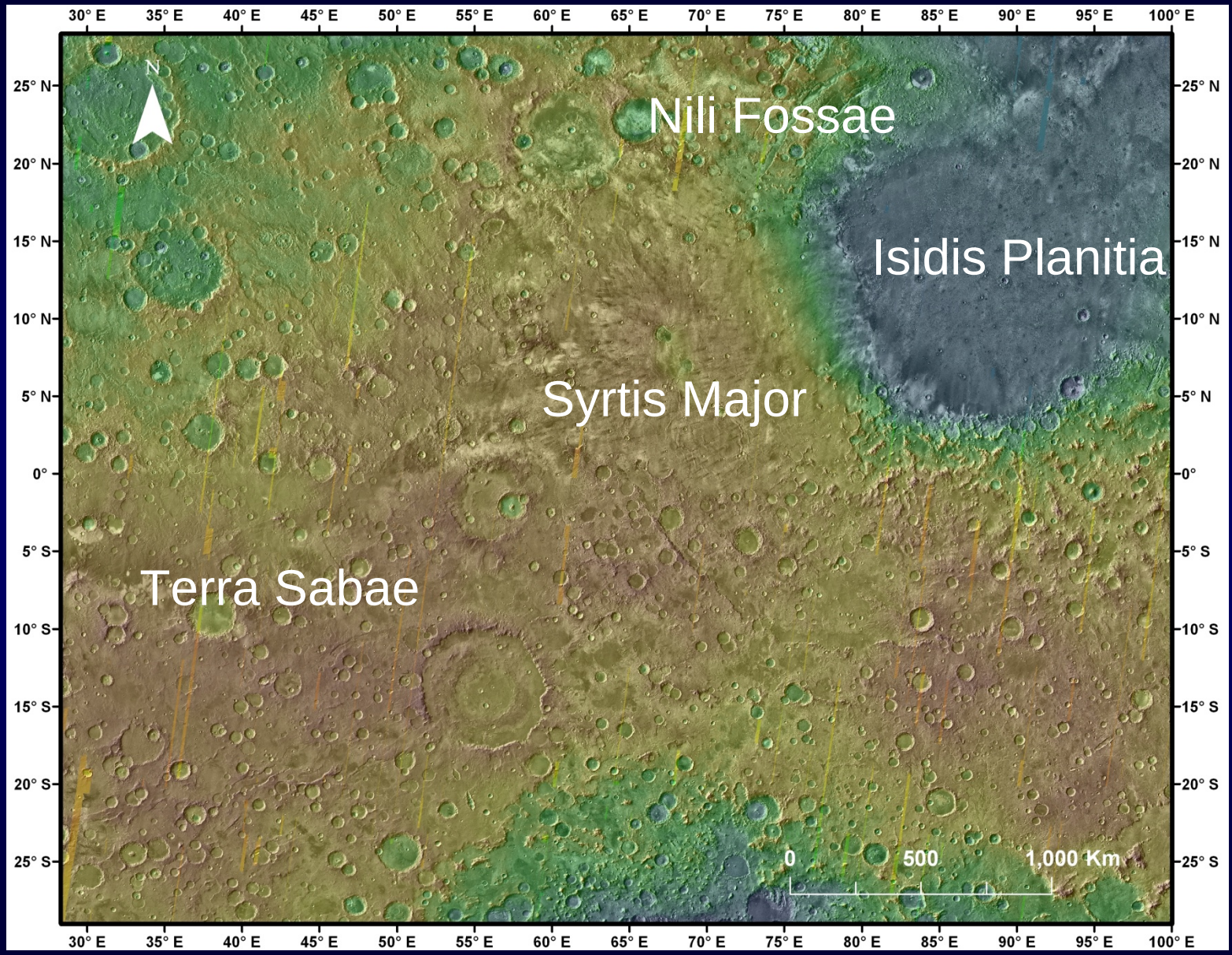
- Bulge/mound formation

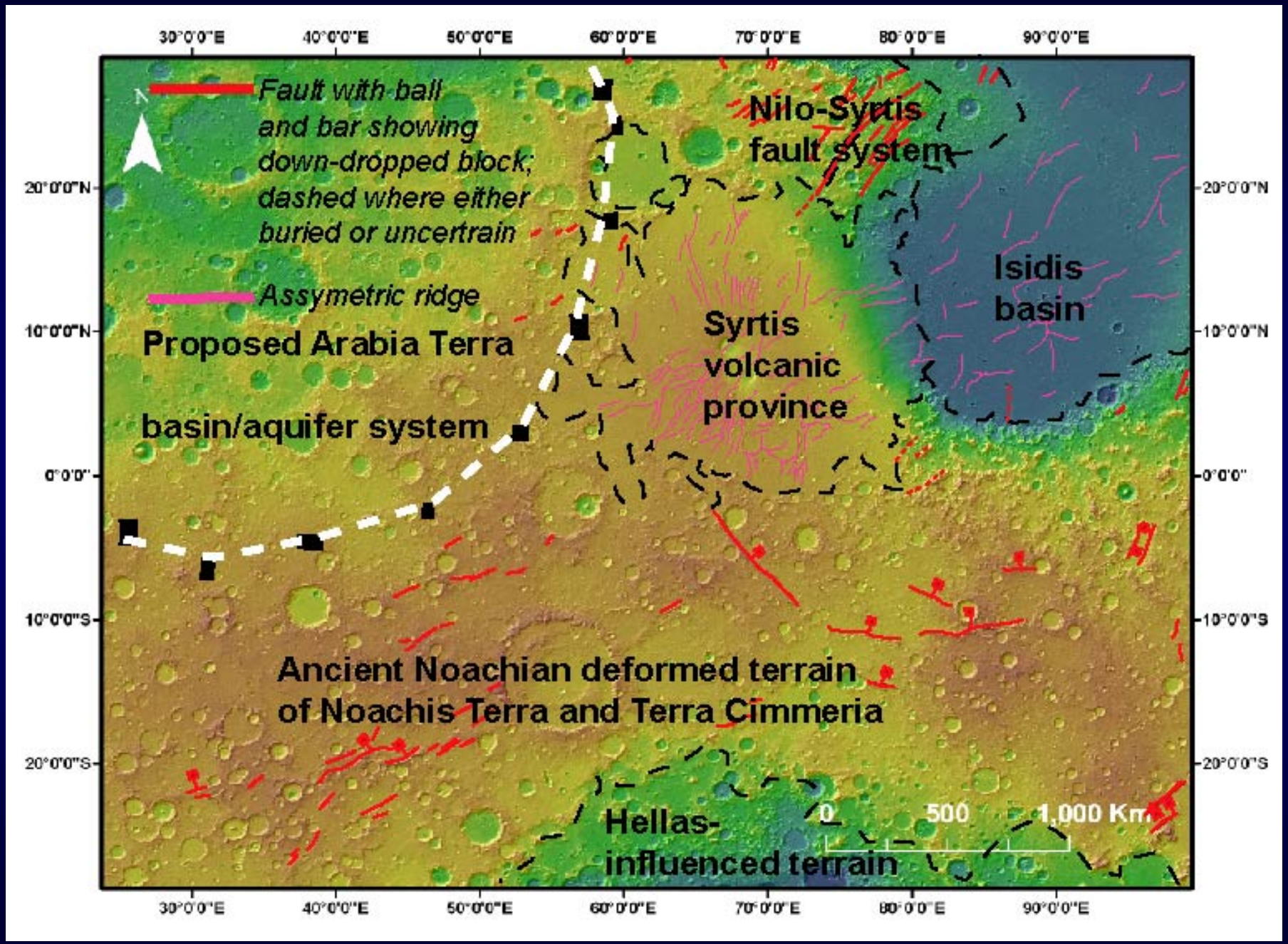
  (Ori and Baliva, 1999; Ori et al., 2000;

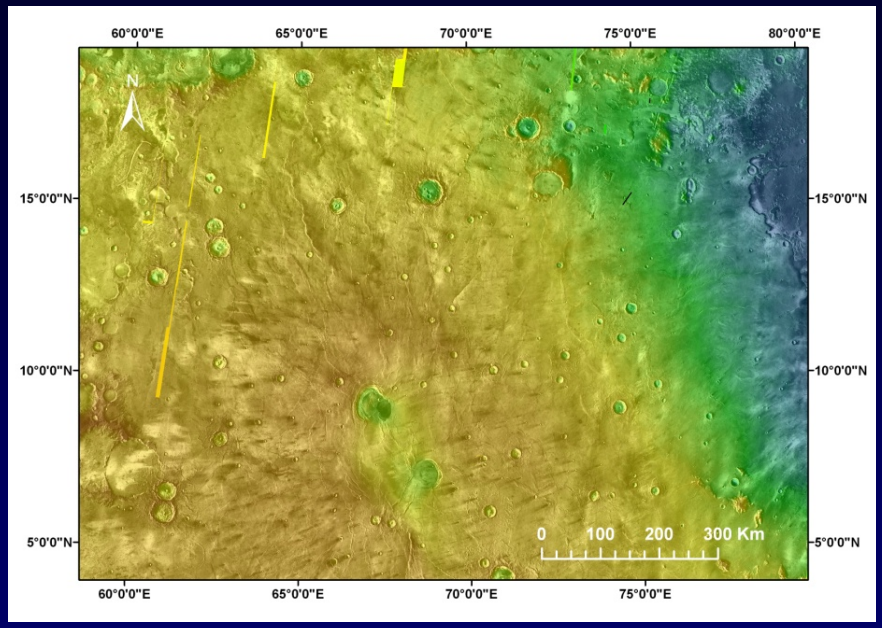
  Ori et al., 2001)

- Chaotic terrain formation

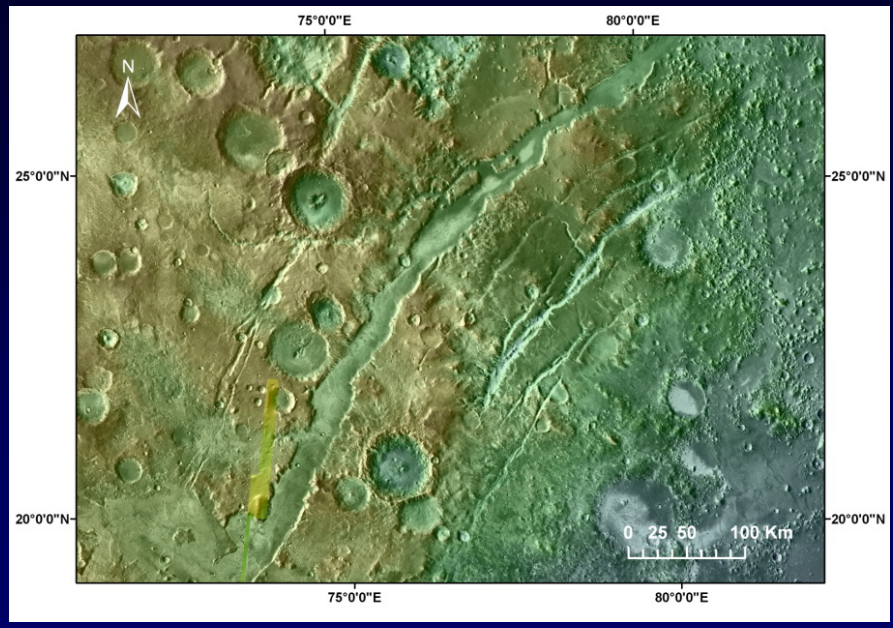
  (Komatsu et al., 2000; Rodriguez et al., 2006)


30° E
35° E
40° E
45° E
50° E
55° E
60° E
65° E
70° E
75° E
80° E
85° E
90° E
95° E
100° E
25° N
20° N
15° N
10° N
5° N
0°
5° S
10° S
15° S
20° S
25° S
N
Nili Fossae
Isidis Planitia
Syrtis Major
Terra Sabae
0
500
1,000 Km

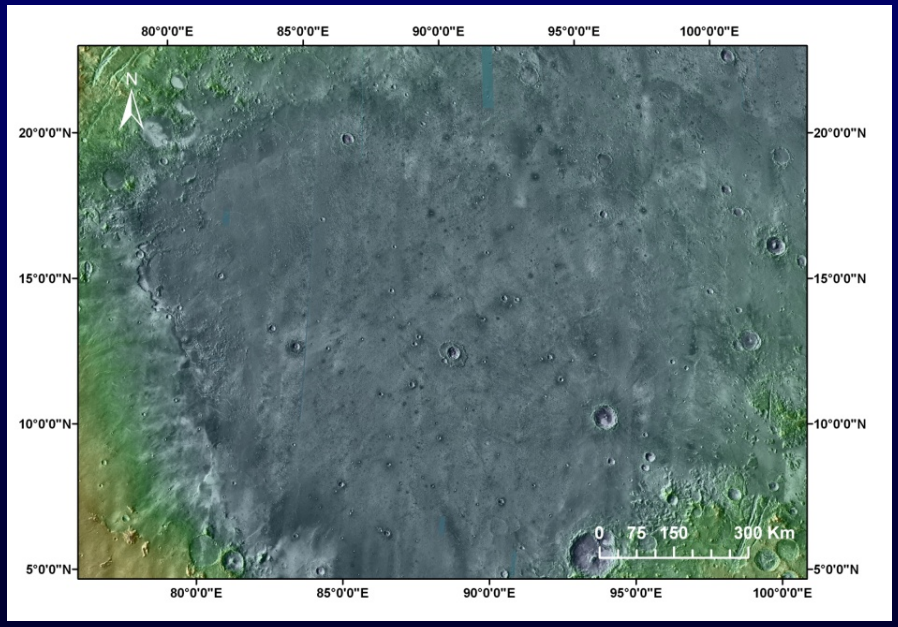

30°0'0"E
40°0'0"E
50°0'0"E
60°0'0"E
70°0'0"E
80°0'0"E
90°0'0"E
20°0'0"N
10°0'0"N
0°0'0"
10°0'0"S
20°0'0"S
Fault with ball and bar showing down-dropped block; dashed where either buried or uncertrain
Assymetric ridge
Proposed Arabia Terra basin/aquifer system
Nilo-Syrtis fault system
Isidis basin
Syrtis volcanic province
Ancient Noachian deformed terrain of Noachis Terra and Terra Cimmeria
Hellas-influenced terrain
0
500
1,000 Km



Syrtis Major



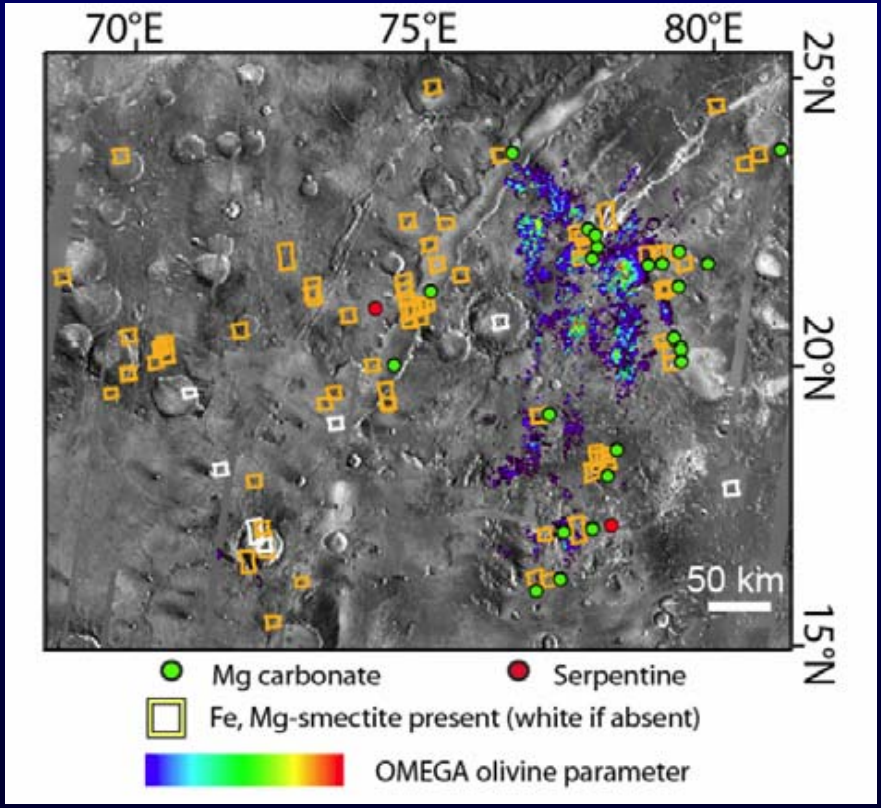
Nili Fossae



Isidis Planitia

Nilli Fossae:

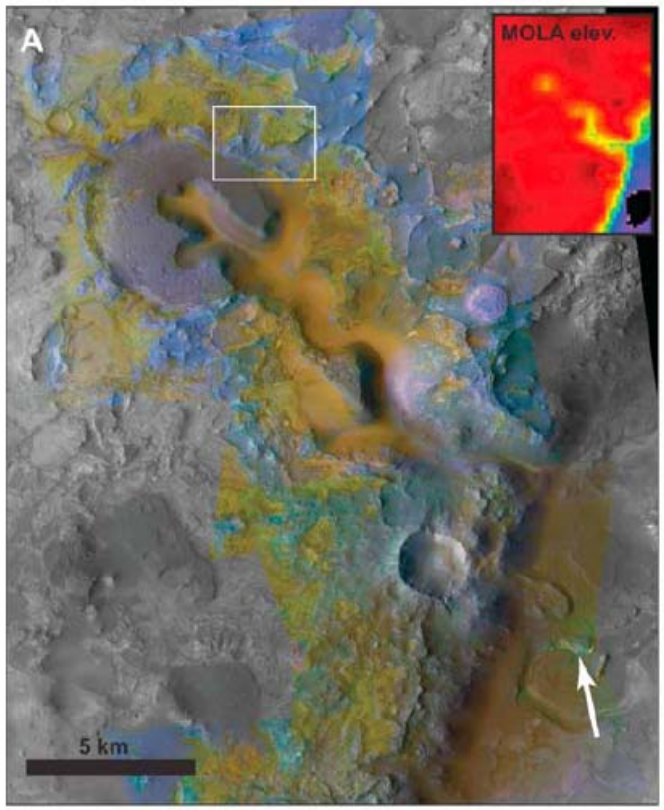
- Nilli Fossae is characterized by a wide variety of minerals including olivine, philosilicates, serpentine, silica, and carbonate.

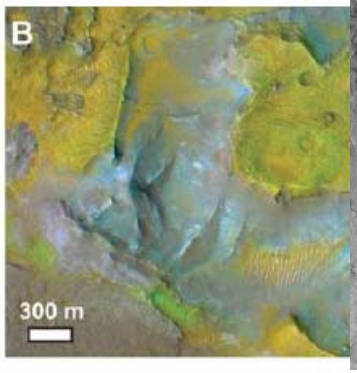


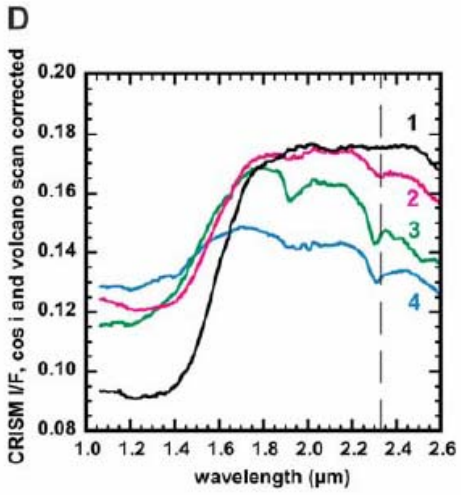
Non-biogenic production of methane?
(e.g., Lyons et al., 2005;
Oze and Sharma, 2005)

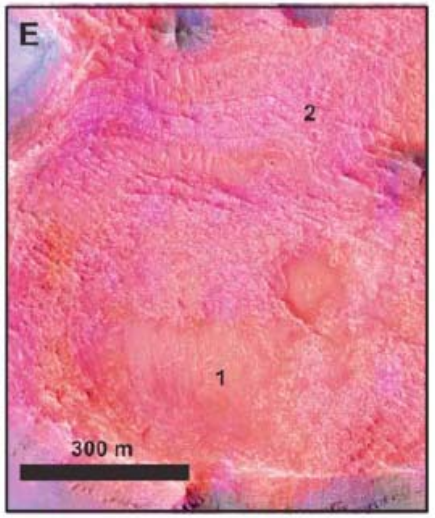
Ehlmann et al. (2009), LPSC abstract, #1787

Ehlmann et al. (2009)





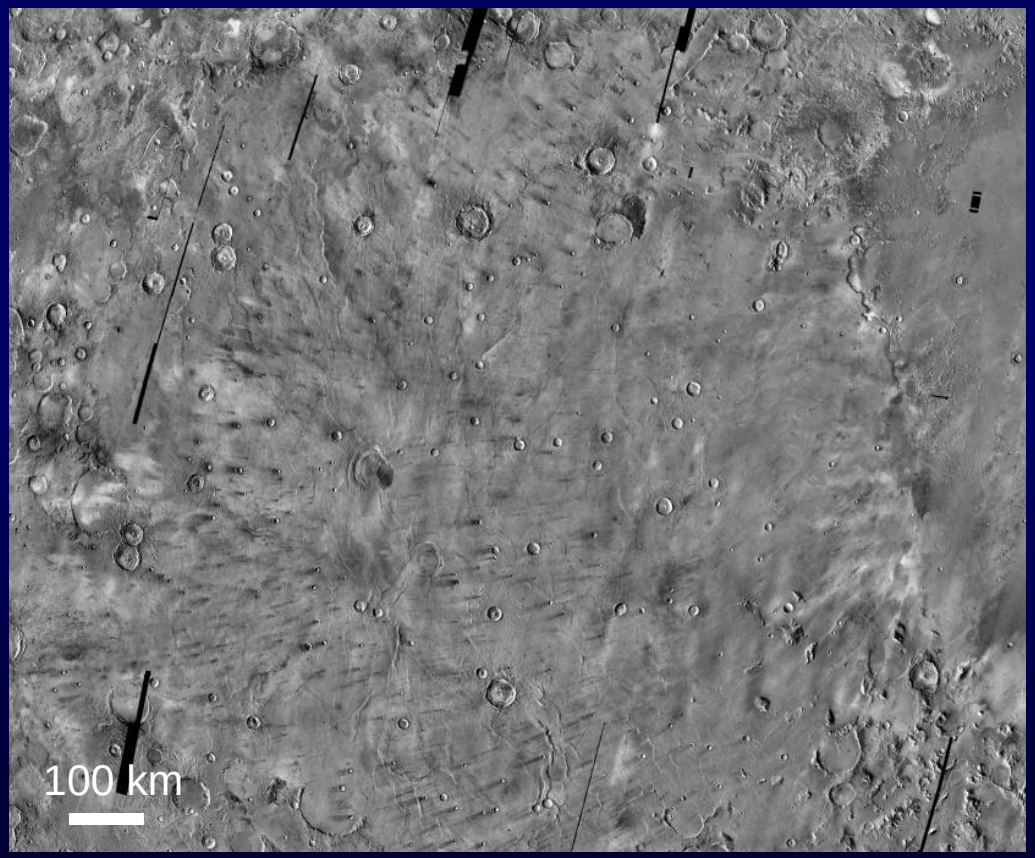




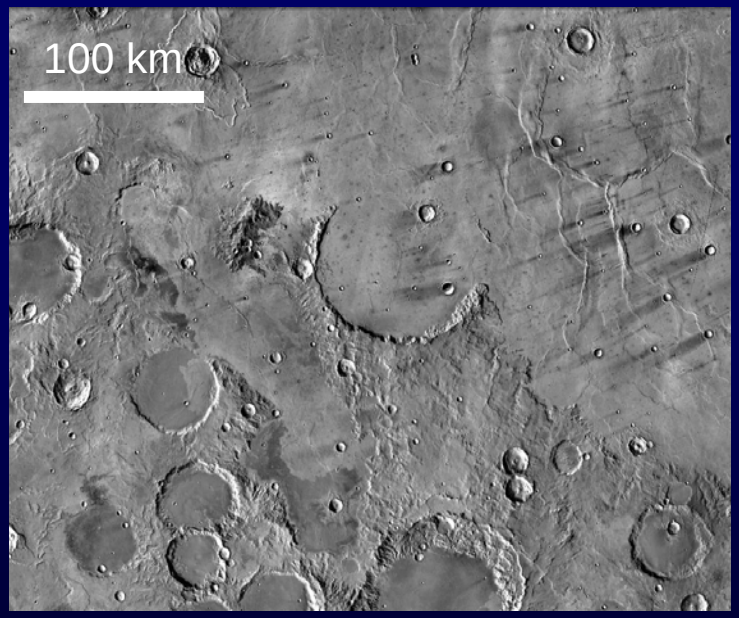
CTX image

Syrtis Major:

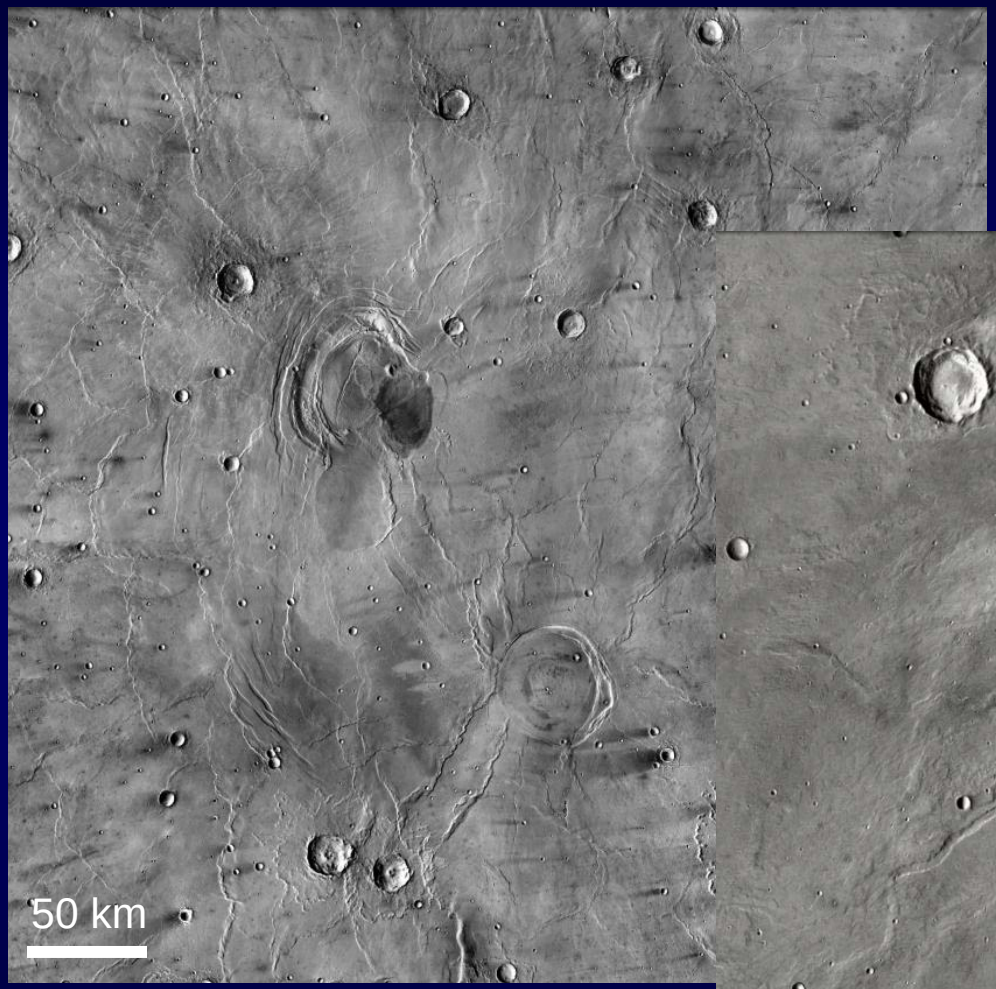
- Syrtis Major is a volcanic zone characterized by probable lava flow units.



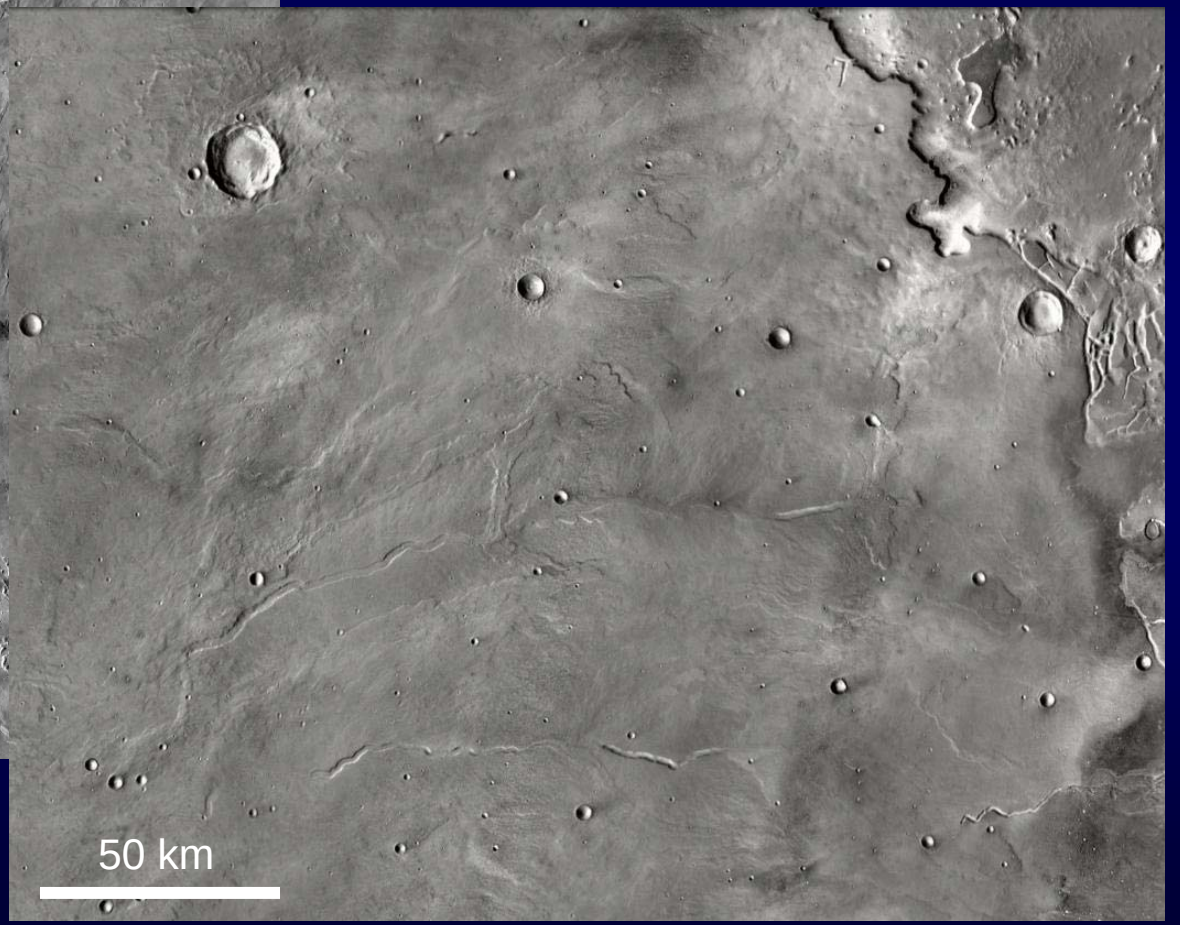
THEMIS Daytime IR



THEMIS Daytime IR

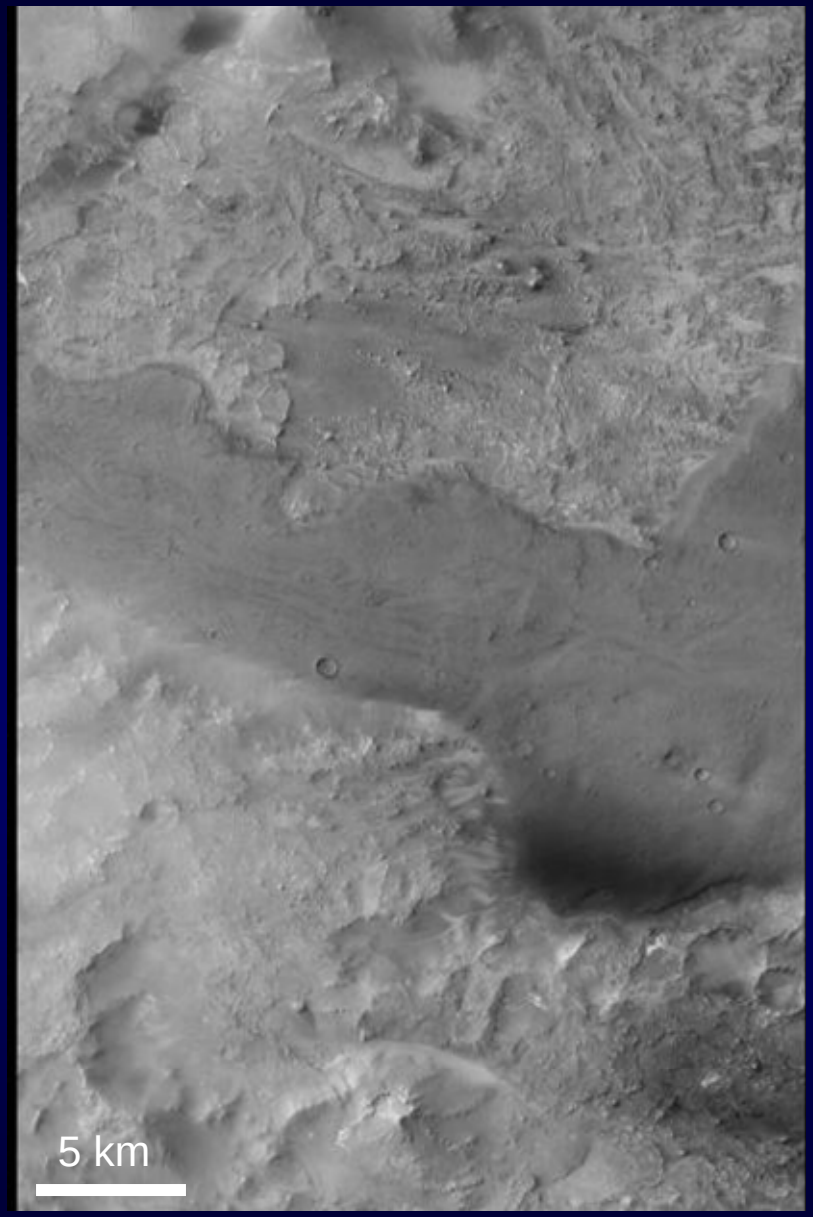


THEMIS Daytime IR



THEMIS Daytime IR

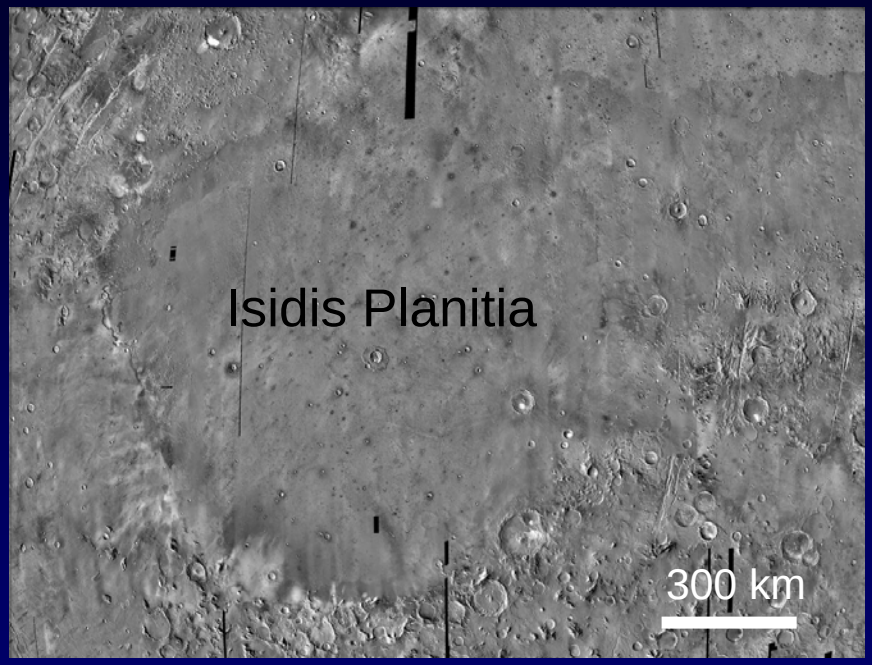
HRSC image



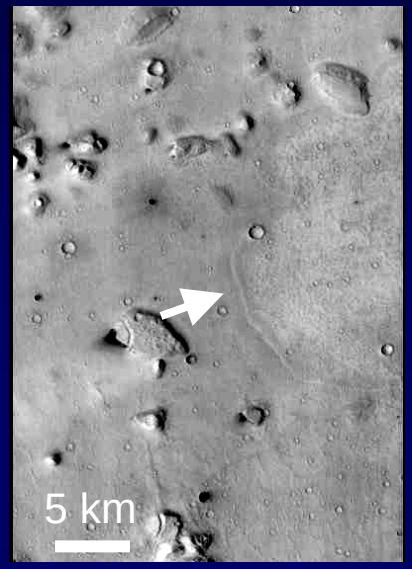
CTX image

Isidis Planitia:

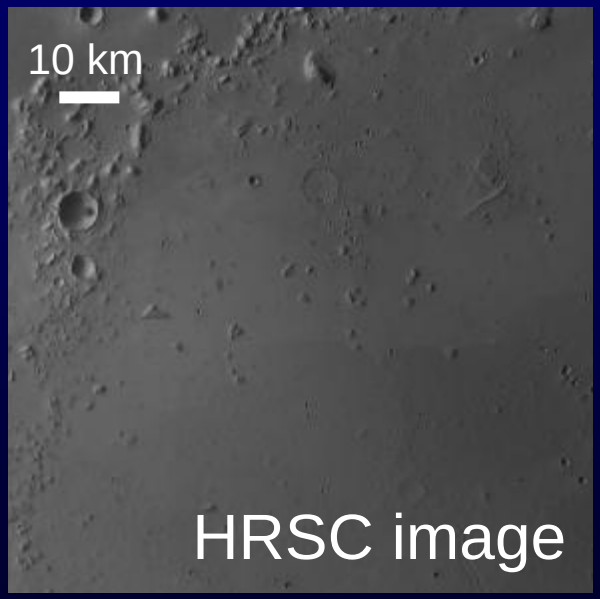
- Isidis Planitia is a large ancient impact basin. There are a number of mounds (a few hundreds meters wide) extensively distributed on the basin floor.
- The proposed origins of the mounds include pseudocraters, peri-glacial features, volcanoes and mud volcanoes.



THEMIS Daytime IR

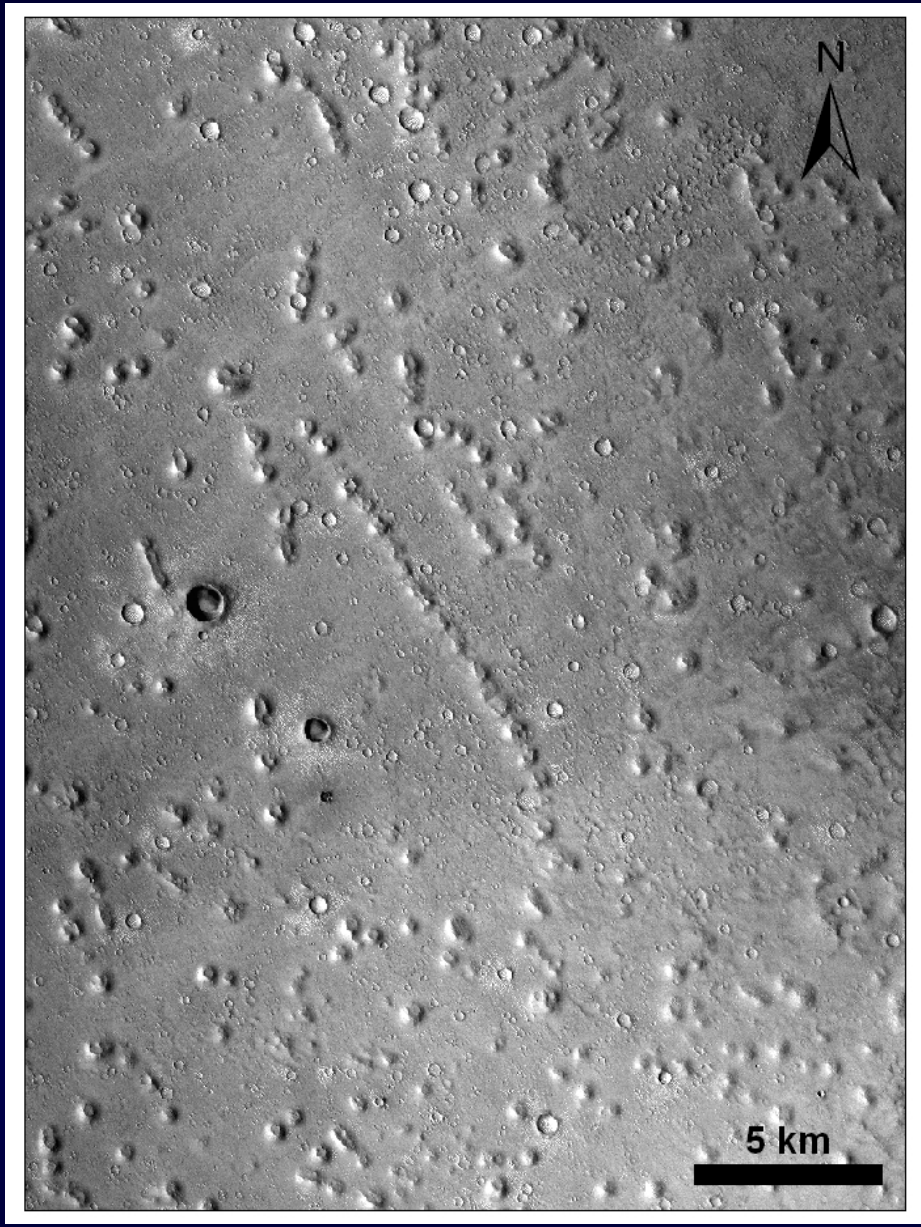


CTX image



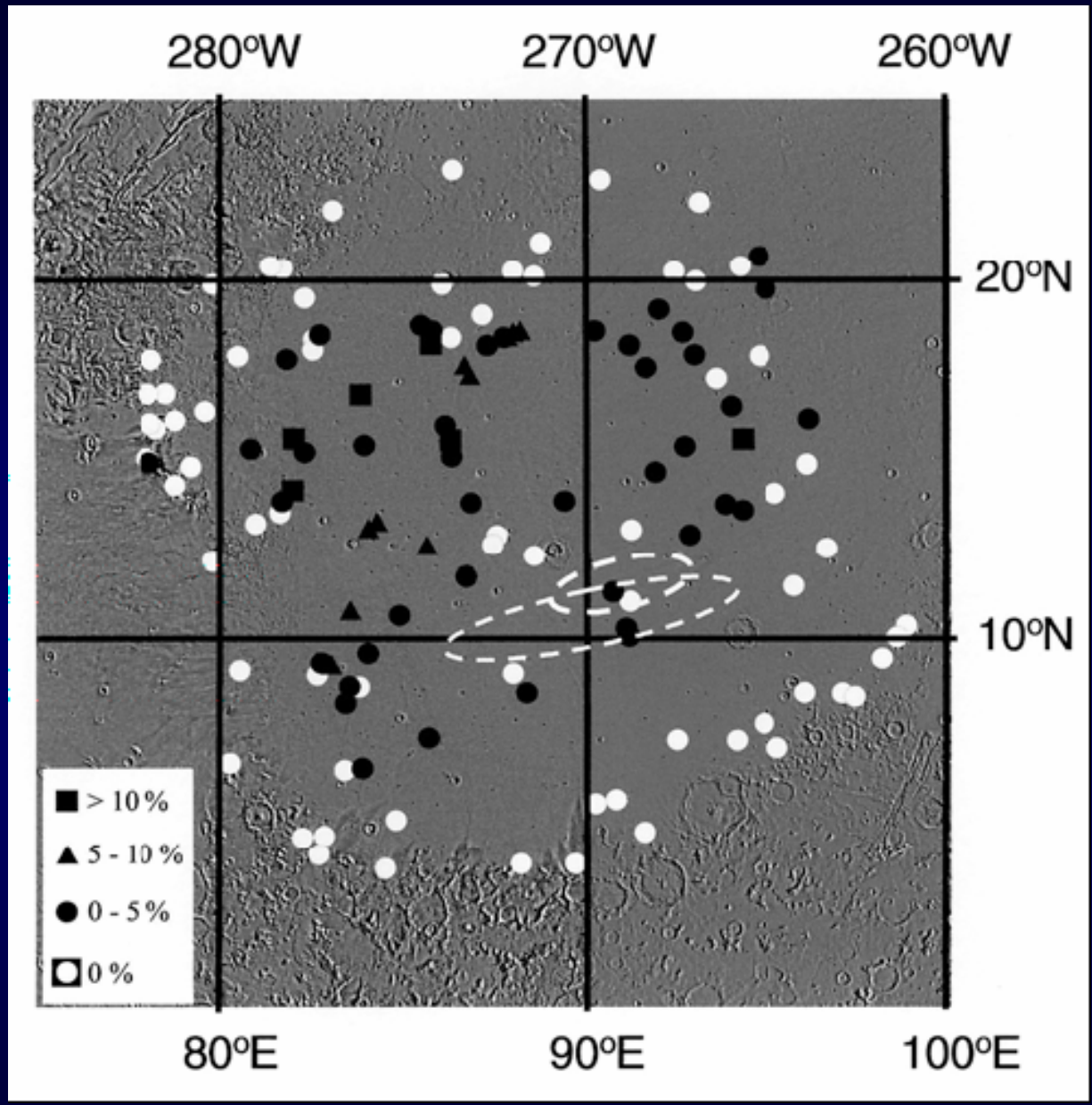
HRSC image

Isidis Planitia plains units
Early Amazonian (Tanaka et al., 2005)



CTX image

Isidis Planitia mounds



Bridges et al. (2003)

Possible origins of the mounds in Isidis Planitia

- Pseudocraters
  (e.g., Frey and Jarosewich, 1982)

- Peri-glacial features
  (e.g., Grizzaffi and Schultz, 1989;
  Rossbacher and Judson, 1981;
  Witbeck and Underwood, 1984)

- Volcanic cones (e.g., cinder cones/tuff cones)
  (e.g., Plescia, 1980; Hodges and Moore, 1994;
  Bridges et al., 2003)

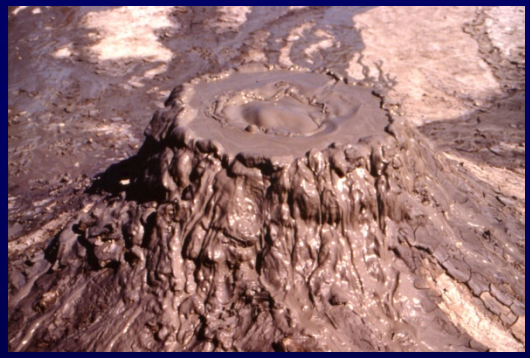
- Mud volcanoes
  (e.g., Davis and Tanaka, 1995; Tanaka et al., 2000;
  Ori et al. 2001)

Terrestrial analogues

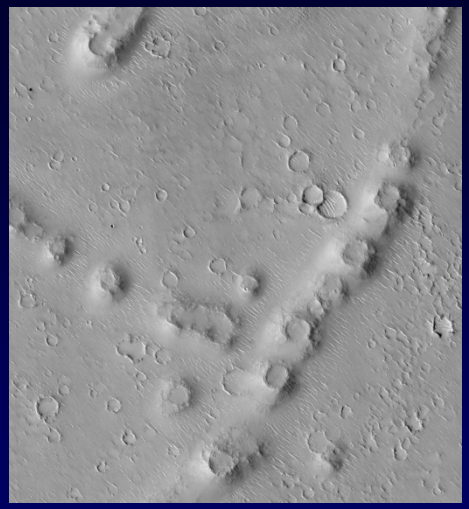
Pseudocraters

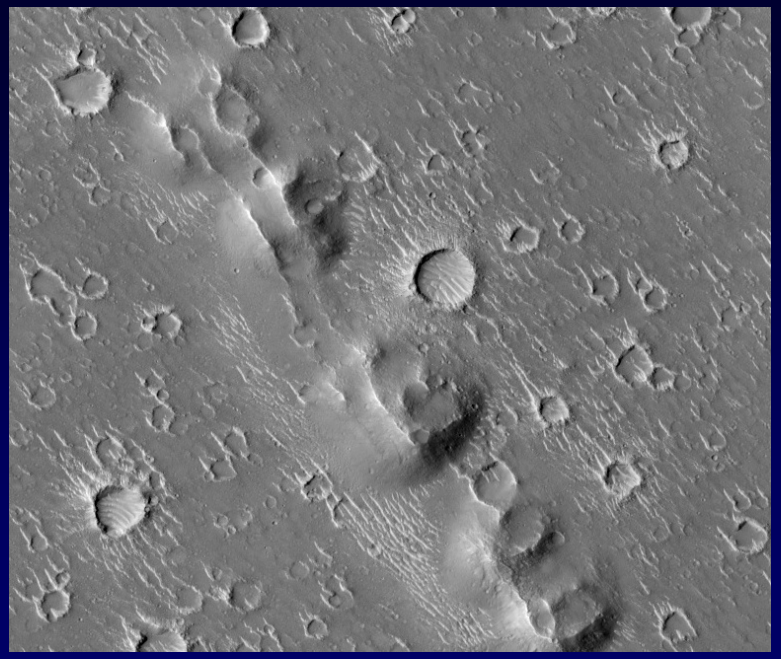
Pingos

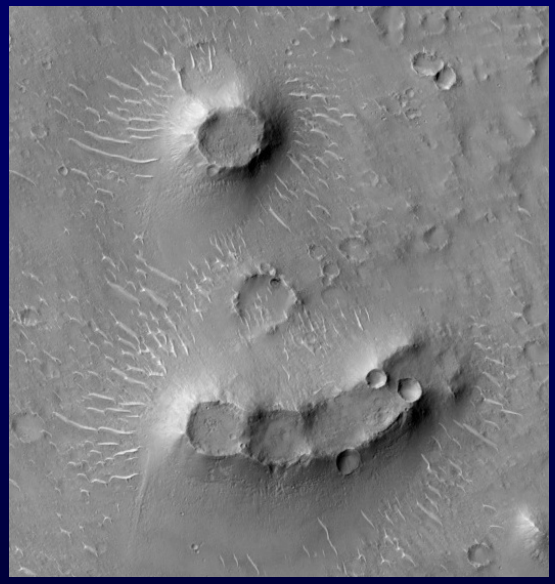
Volcanic cones



Mud volcanoes







HiRISE images

Isidis Planitia mounds

Isidis Planitia THEMIS Nighttime IR + CTX image

Conclusions

- Recent spacecraft and telescopic observations revealed seasonal and geographical characteristics of the atmospheric methane distribution on Mars.
- The methane-rich regions have landforms/mineralogy with possible implications for past methane-related geological processes.