The Red Planet in »3D«
New Views of Mars

HRSC
DLR's *High Resolution Stereo Camera* on ESA's Mars Express Orbiter

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and the HRSC Experiment Team
DLR Institute of Planetary Exploration

15 February 2007

Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

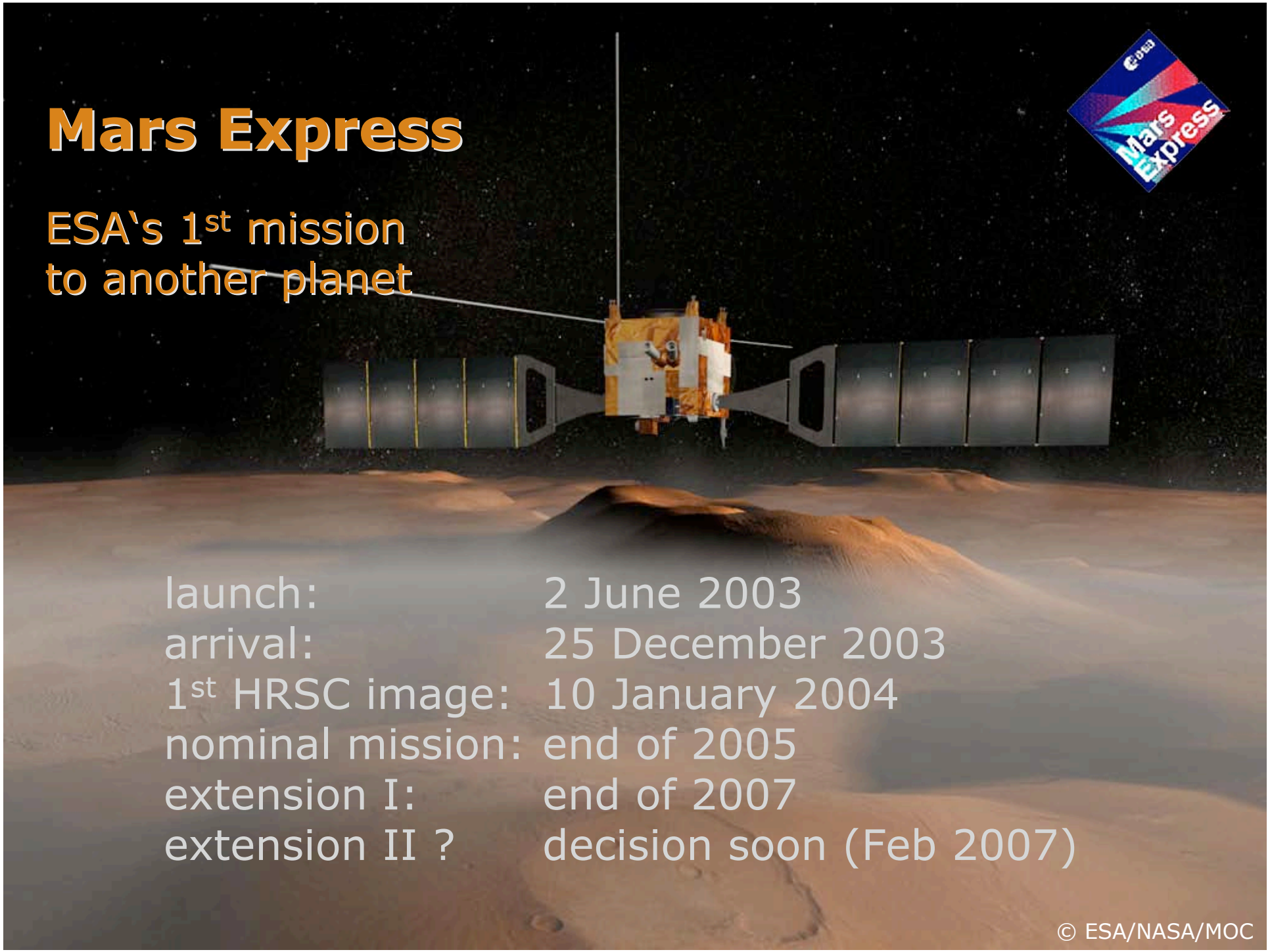
All HRSC images:

© ESA/DLR/FU Berlin (G. Neukum)

For further information, see:

www.dlr.de/mars
www.dlr.de/mex
www.esa.int
www.sci.esa.int

… or contact DLR‘s
Regional Planetary Image Facility (RPIF): rpif@dlr.de
… or the author: ulrich.koehler@dlr.de


Mars Express
ESA's 1st mission
to another planet
launch: 2 June 2003
arrival: 25 December 2003
1st HRSC image: 10 January 2004
nominal mission: end of 2005
extension I: end of 2007
extension II ? decision soon (Feb 2007)
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The instrument:

HRSC – High Resolution Stereo Camera

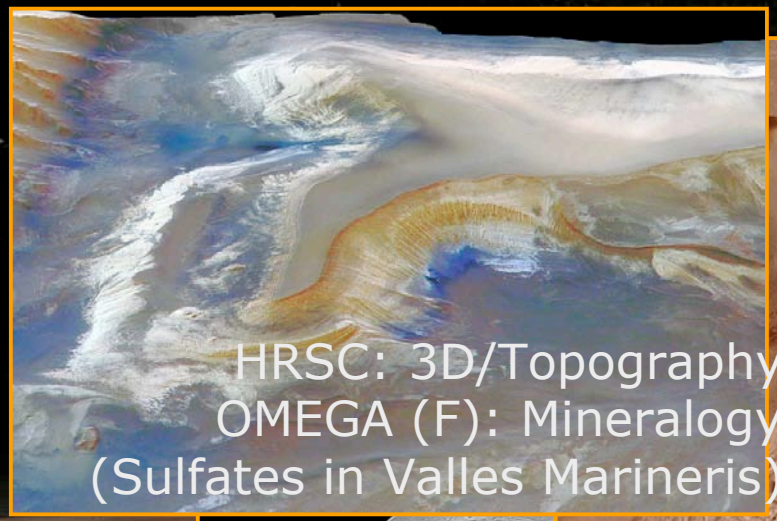
The HRSC's Science Team Goal:

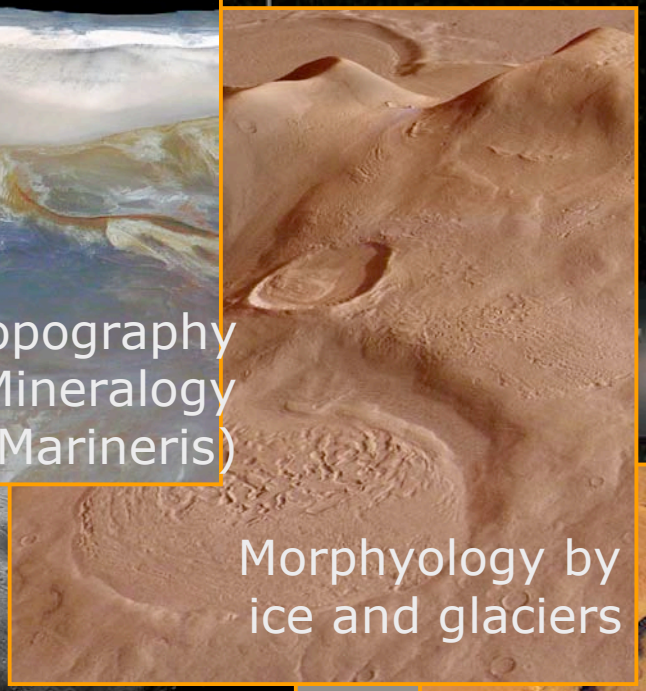
- Global mapping of Mars in high resolution, colour, and stereo

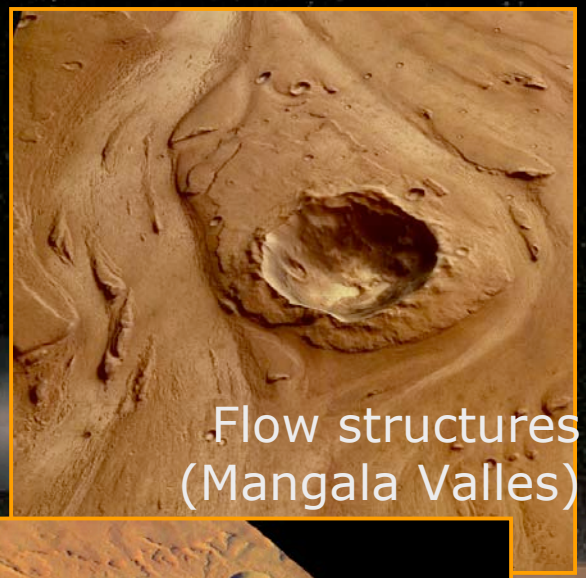
… and answering fundamental geological questions:

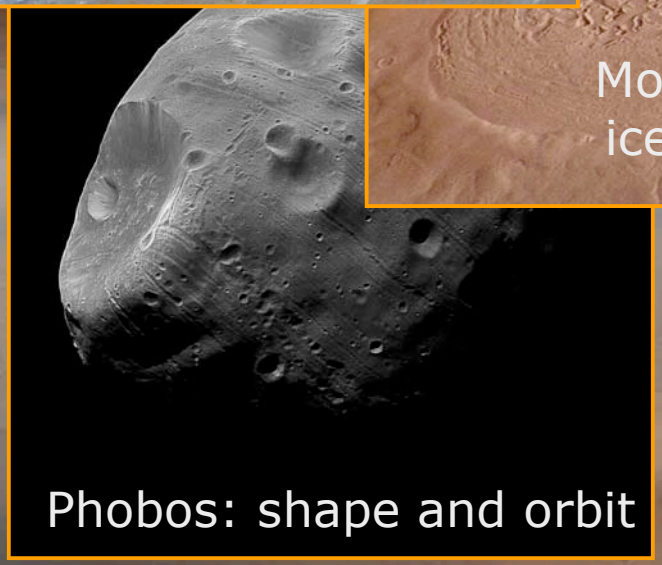
- The search for the traces of water on the surface of Mars

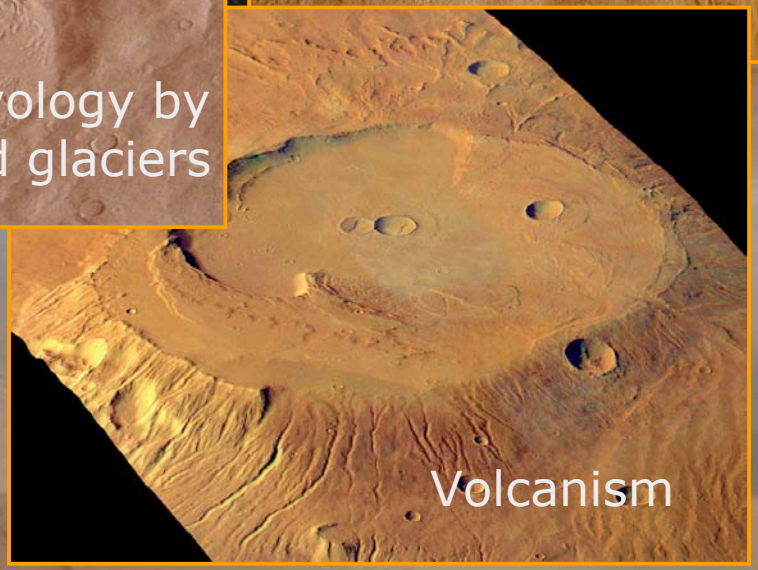
ESA's Mars Express Mission: 2004-2007









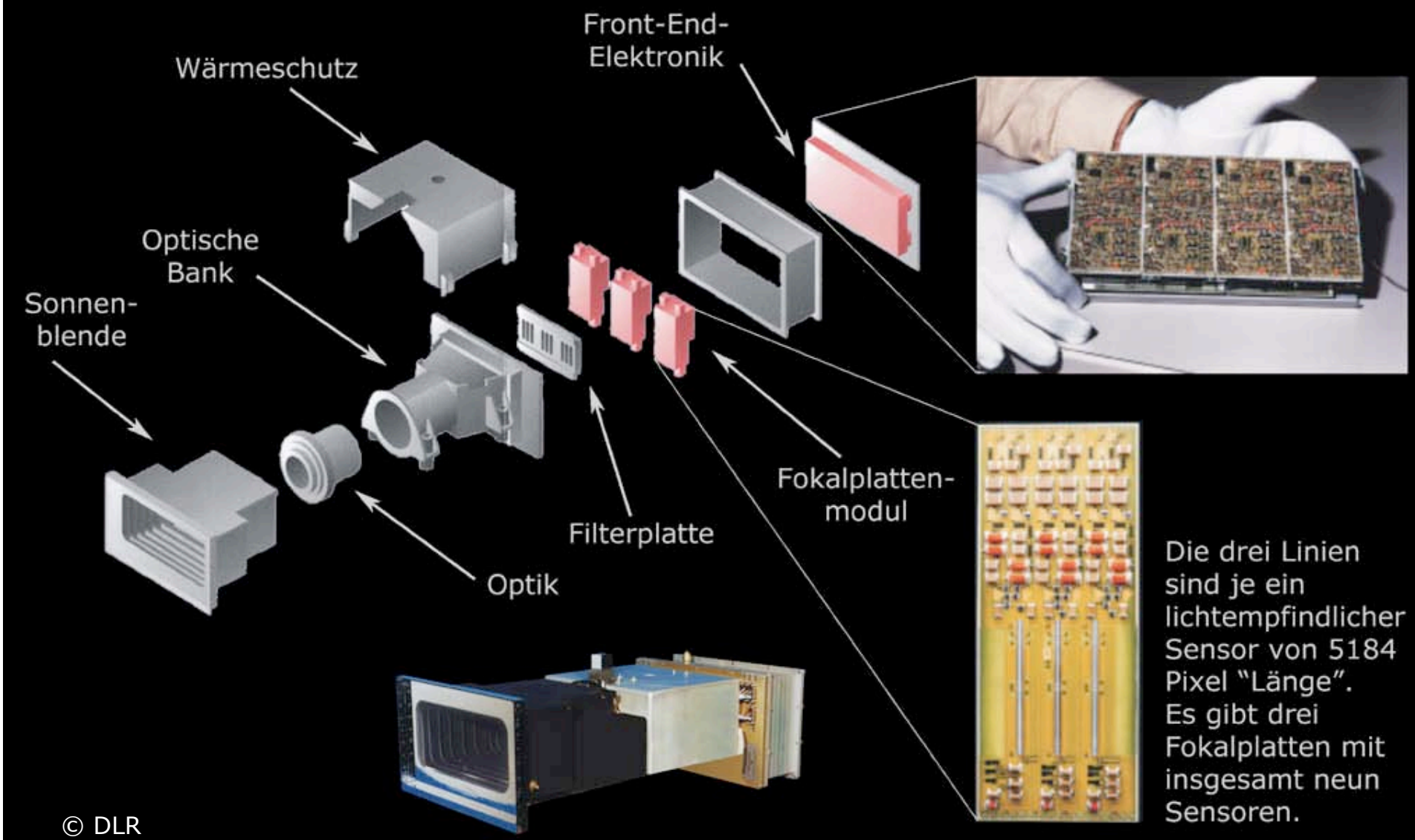


~2 Terabyte topographical raw data

HRSC
High Resolution Stereo Camera

- High Resolution (≥ 10m/pxl @ periapsis, ~250 km)
- Three-dimensional imaging
- Multispectral imaging
- **S**uper **R**esolution **C**hannel (≥ 2.3 m/pxl)

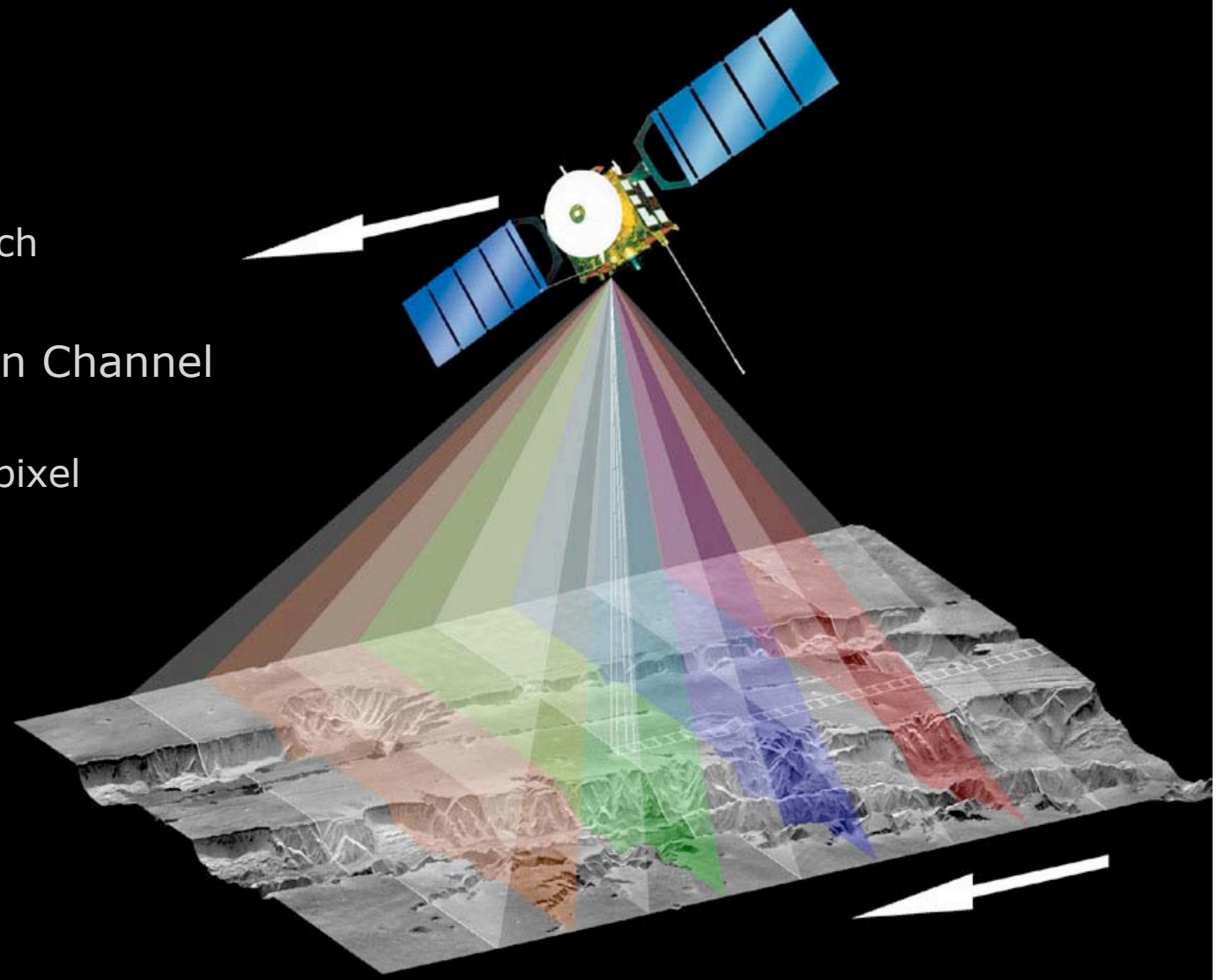
HRSC – modules



Die drei Linien sind je ein lichtempfindlicher Sensor von 5184 Pixel "Länge". Es gibt drei Fokalplatten mit insgesamt neun Sensoren.

Function Principle of HRSC

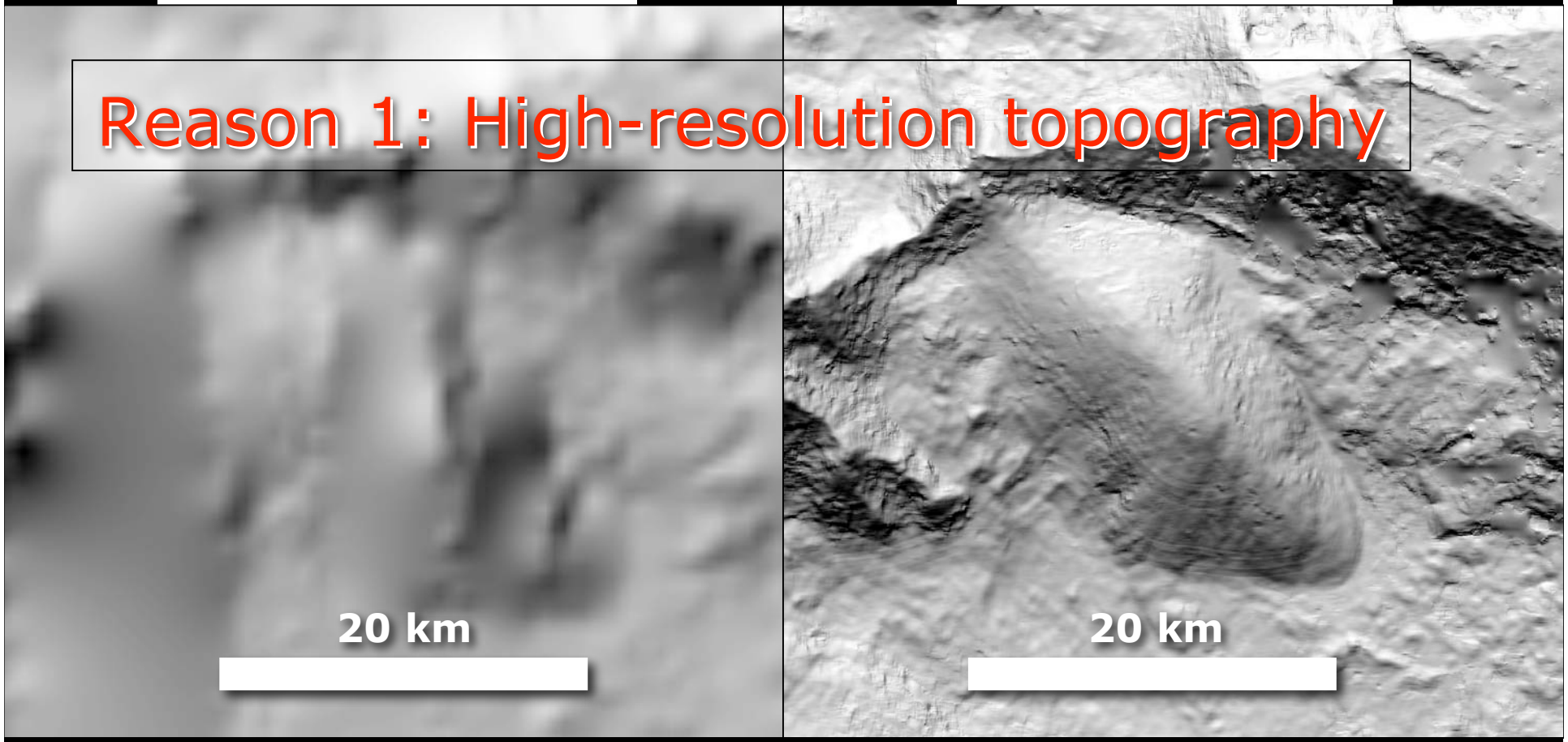
- Stereo scanner
  - 9 line sensors
  - 5184 pixel each
- Super Resolution Channel
  - array sensor
  - 1024 x 1024 pixel



Why HRSC?

MGS-MOLA: 463 m/pixel)

MEX-HRSC: 50 m/pixel

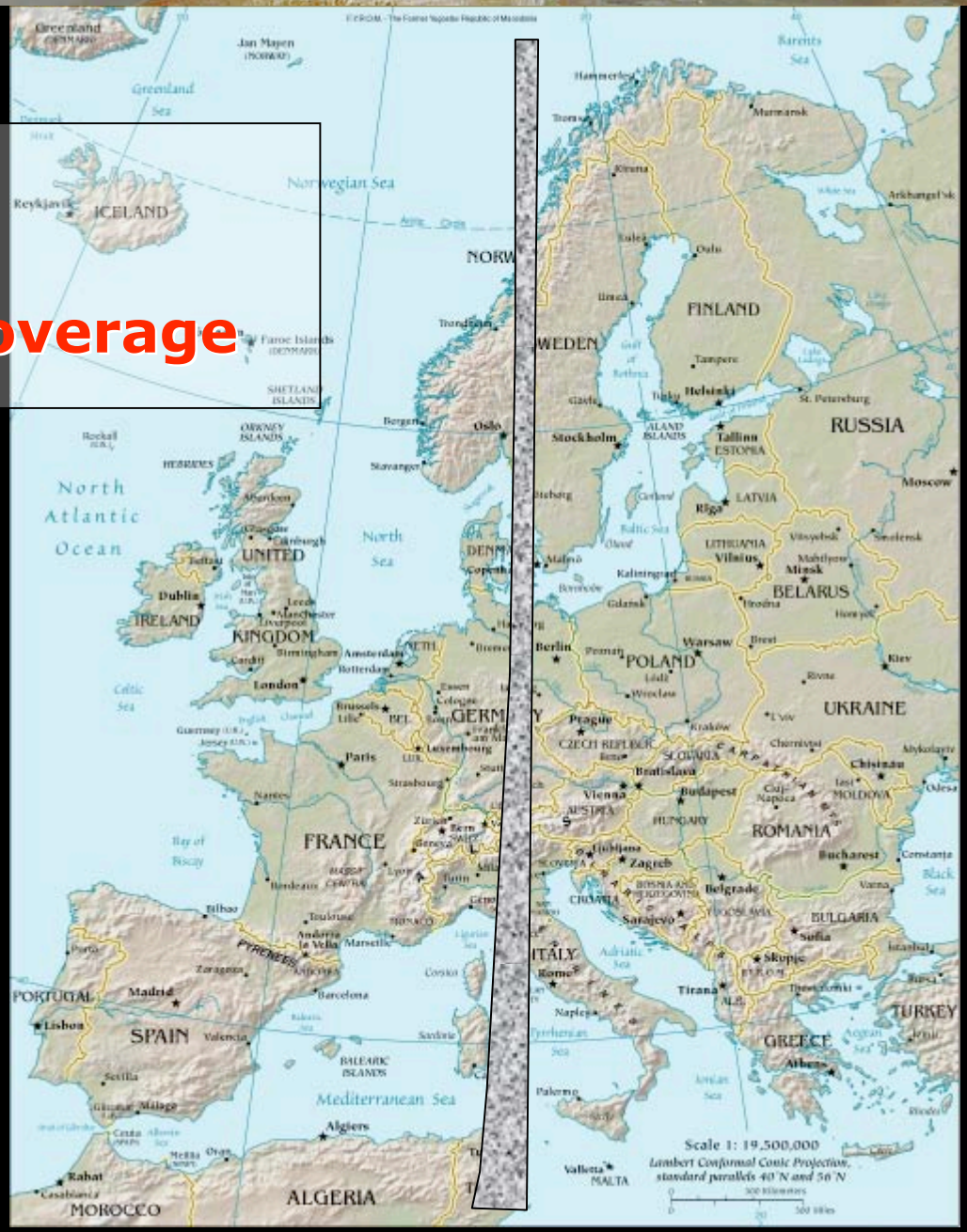


Shaded Digital Elevation Models (DTM) – no images!

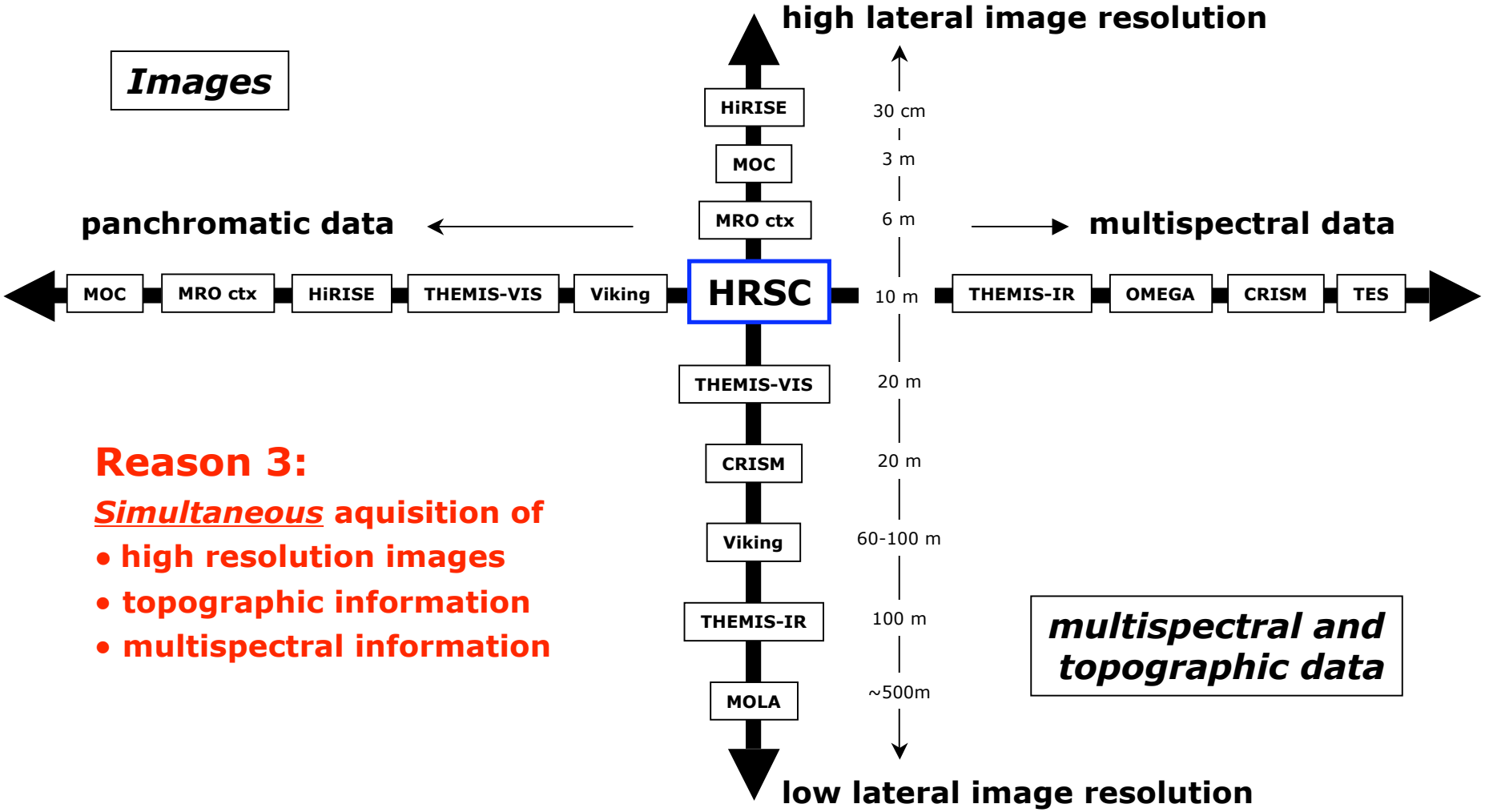
Why HRSC?

Reason 2: Large coverage

Ground image resolution: 10-30 m/pixel



Why HRSC?



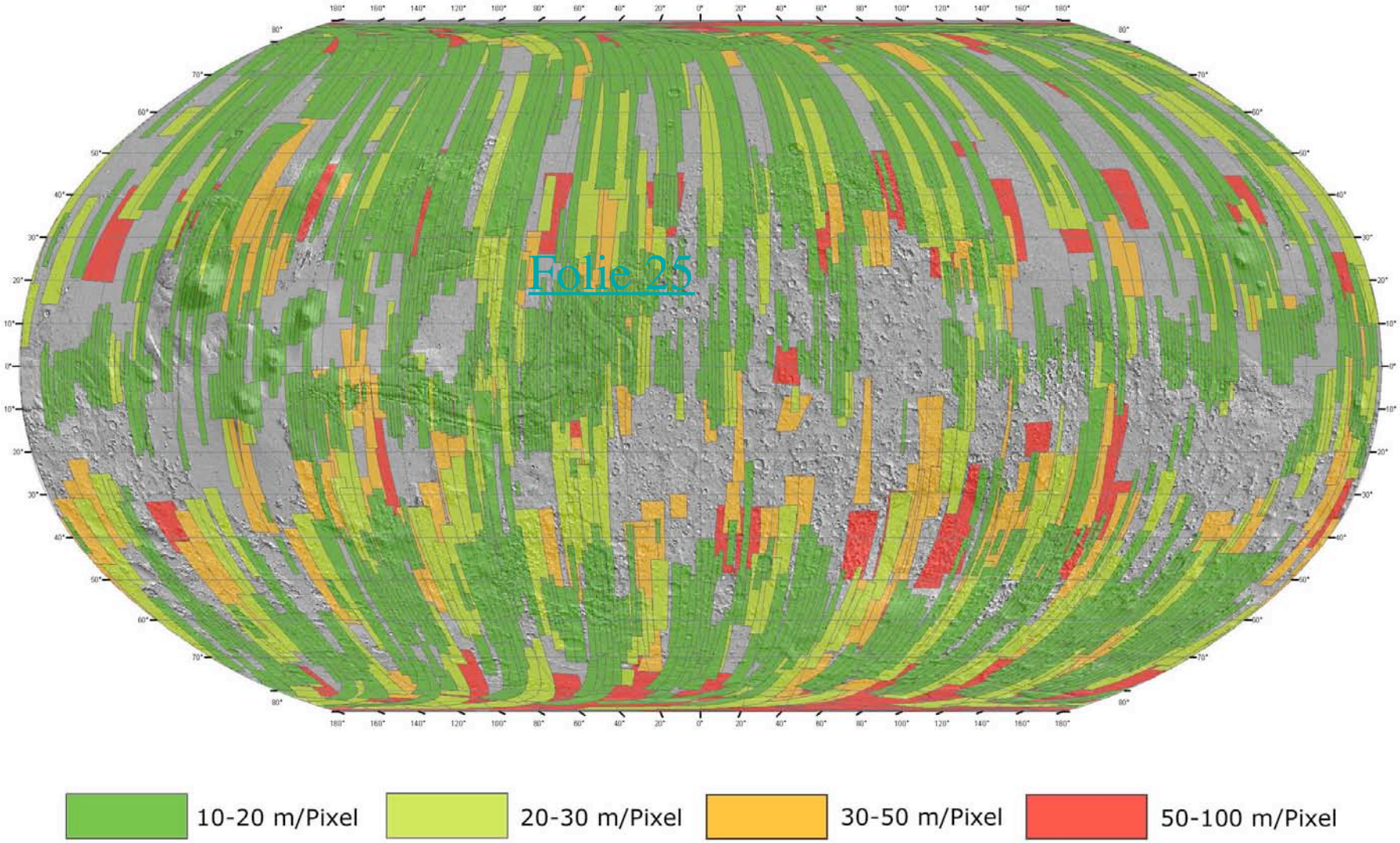
Reason 3:

Simultaneous **aquisition of**

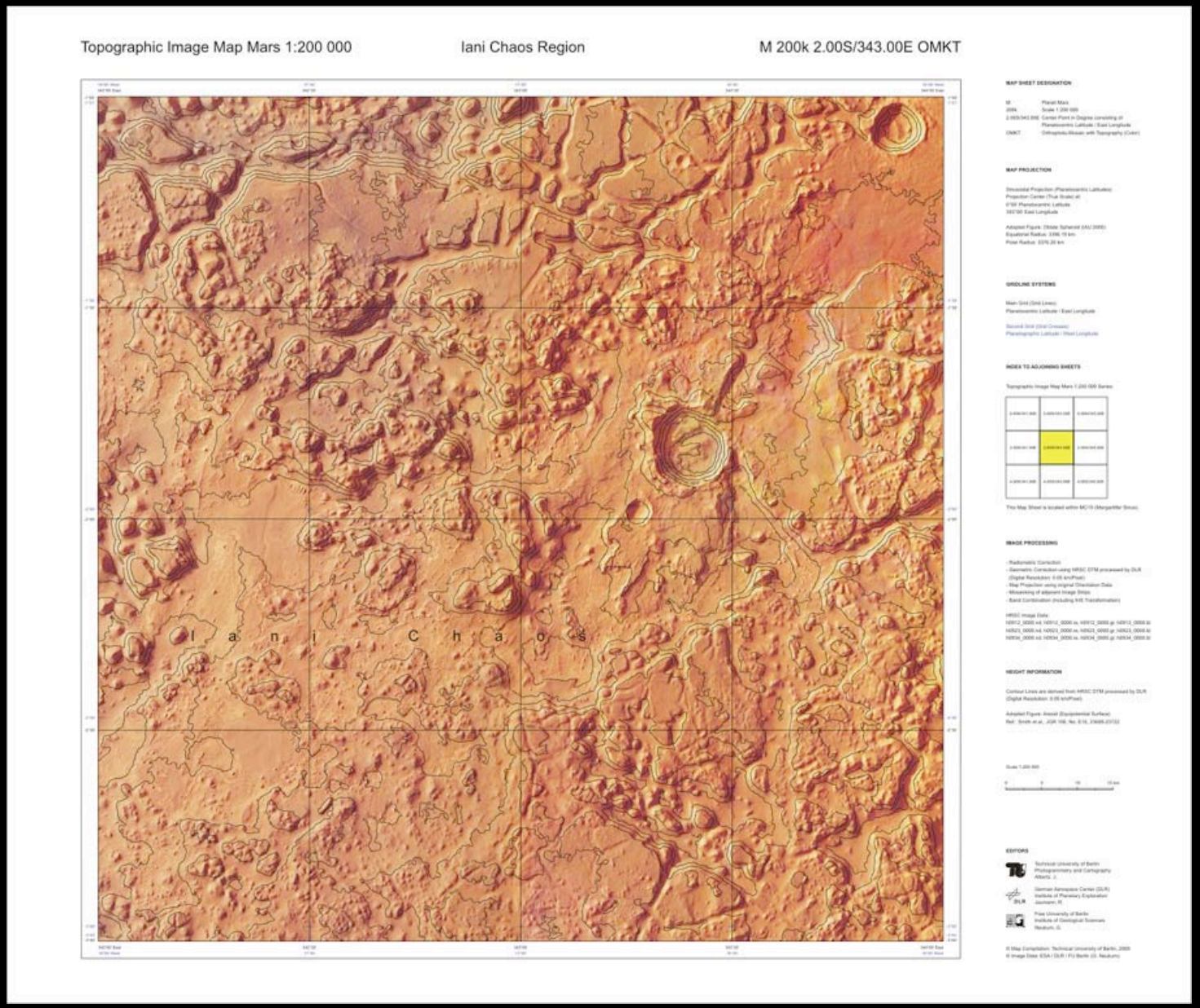
- **high resolution images**
- **topographic information**
- **multispectral information**

Therefore: HRSC is a perfect data set for base maps

HRSC coverage after three years in orbit



Topographic Image Map 1:200,000



HRSC Experiment Team at DLR Berlin

» Development, planning and construction of a space-qualified stereo camera for a mission to Mars, together with partners from the industry

» Camera management and control

» Processing of raw data

- decompression
- radiometric correction
- geometric correction
- digital terrain models

» Delivery to HRSC science team

HRSC Science Team

- US Geological Survey, Menlo Park
- US Geological Survey, Flagstaff
- Jet Propulsion Laboratory, Pasadena
- Arizona State University, Tempe
- Brown University, Providence
- University of Hawaii, Honolulu
- Cornell University, Ithaca

- FU Berlin
- TU Dresden
- Uni Hannover
- DLR-Institute
- MPI für Aeronomie
- Universität Köln
- TU Berlin
- TU München
- Universität der Bundeswehr
- TU Clausthal
- Uni Münster

- Lab. de Geol. Dynamique, Paris
- Observatoire de Toulouse
- IAS
- (exchange w. OMEGA)

- Vernadsky Institute, Moscow
- Inst. of Dynamics of Geospheres, Moscow

HRSC image of
Olympus Mons

Orbit 0037

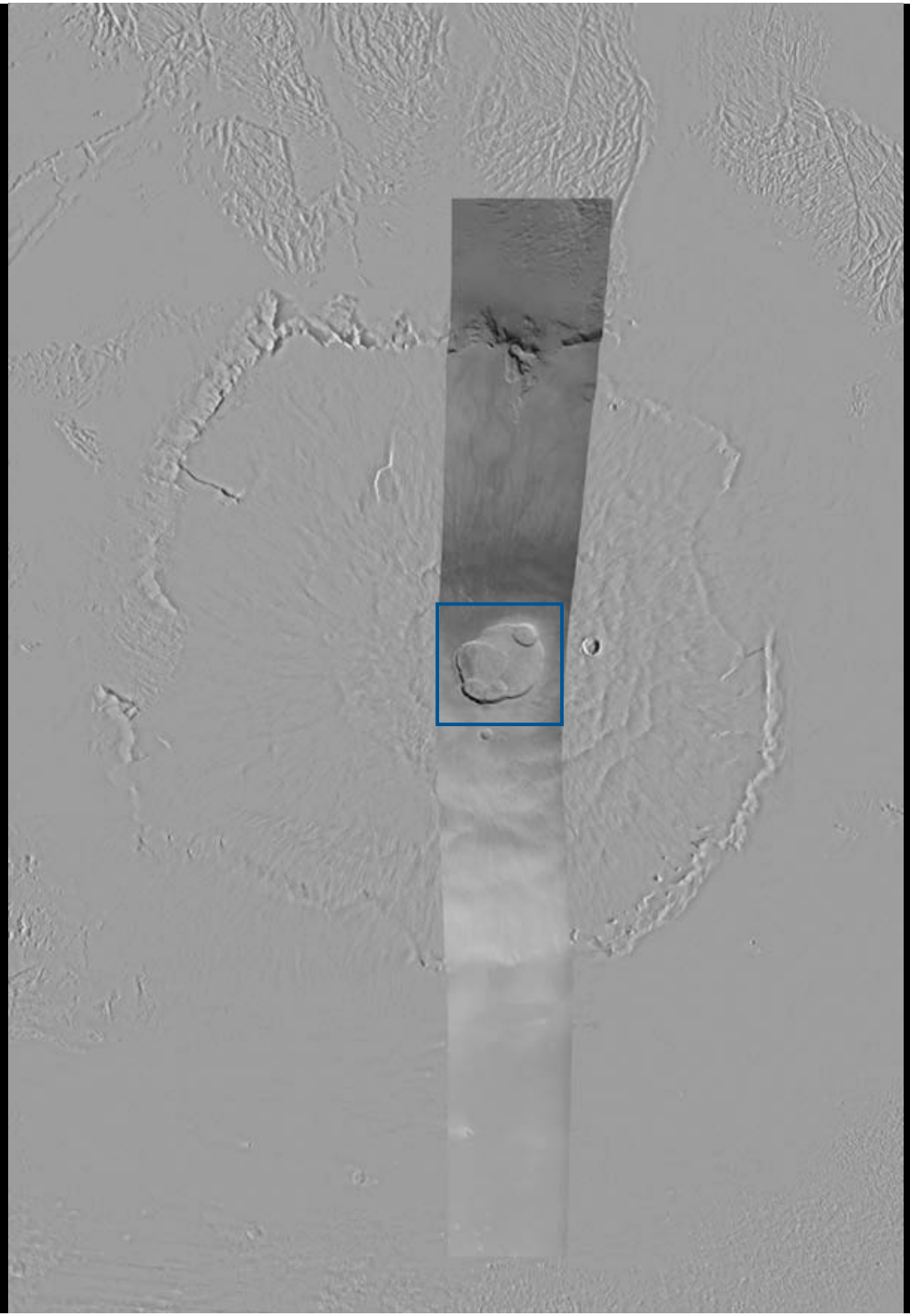
Image-strip width
approx. 80-100 km

Image-strip length
approx. 800 km

Resolution
~15-20 m/pixel

Box:

Zoom of following
images

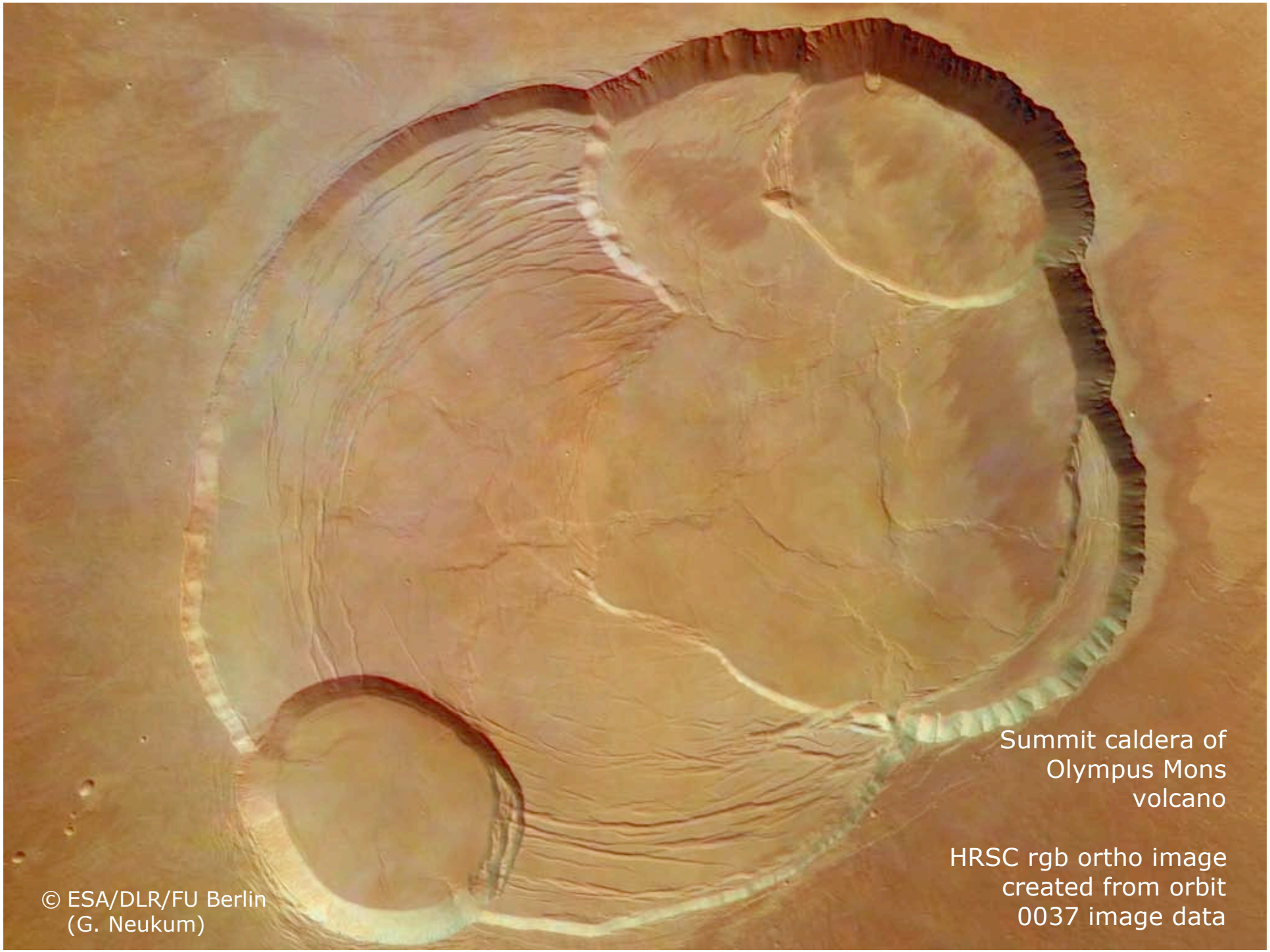


HRSC nadir
image of
Olympus Mons
(central part)

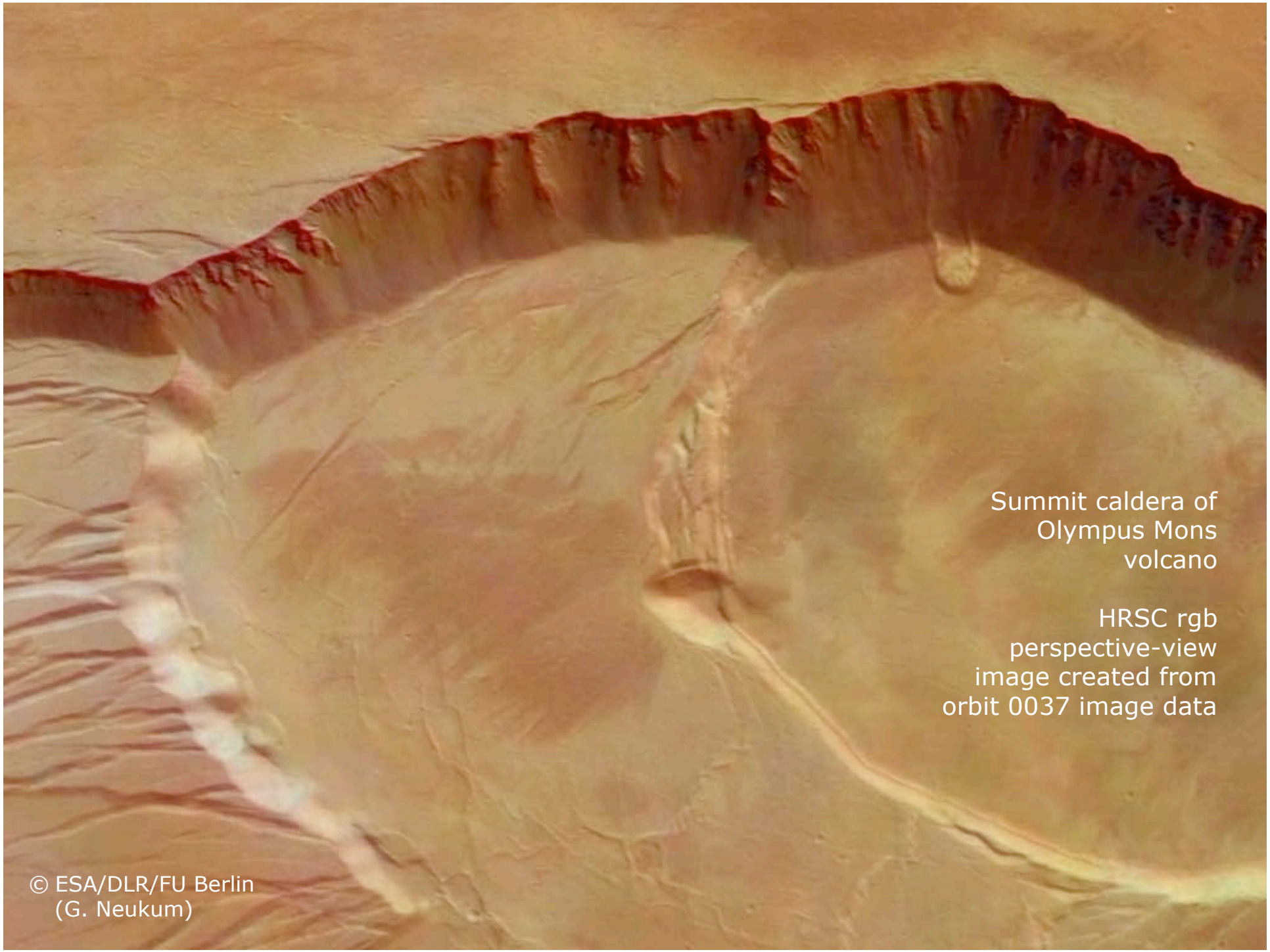
Orbit 0037

Frame size
~80x120 km

Resolution
~15 m/pixel


Summit caldera of
Olympus Mons
volcano
HRSC rgb ortho image
created from orbit
0037 image data
© ESA/DLR/FU Berlin
(G. Neukum)

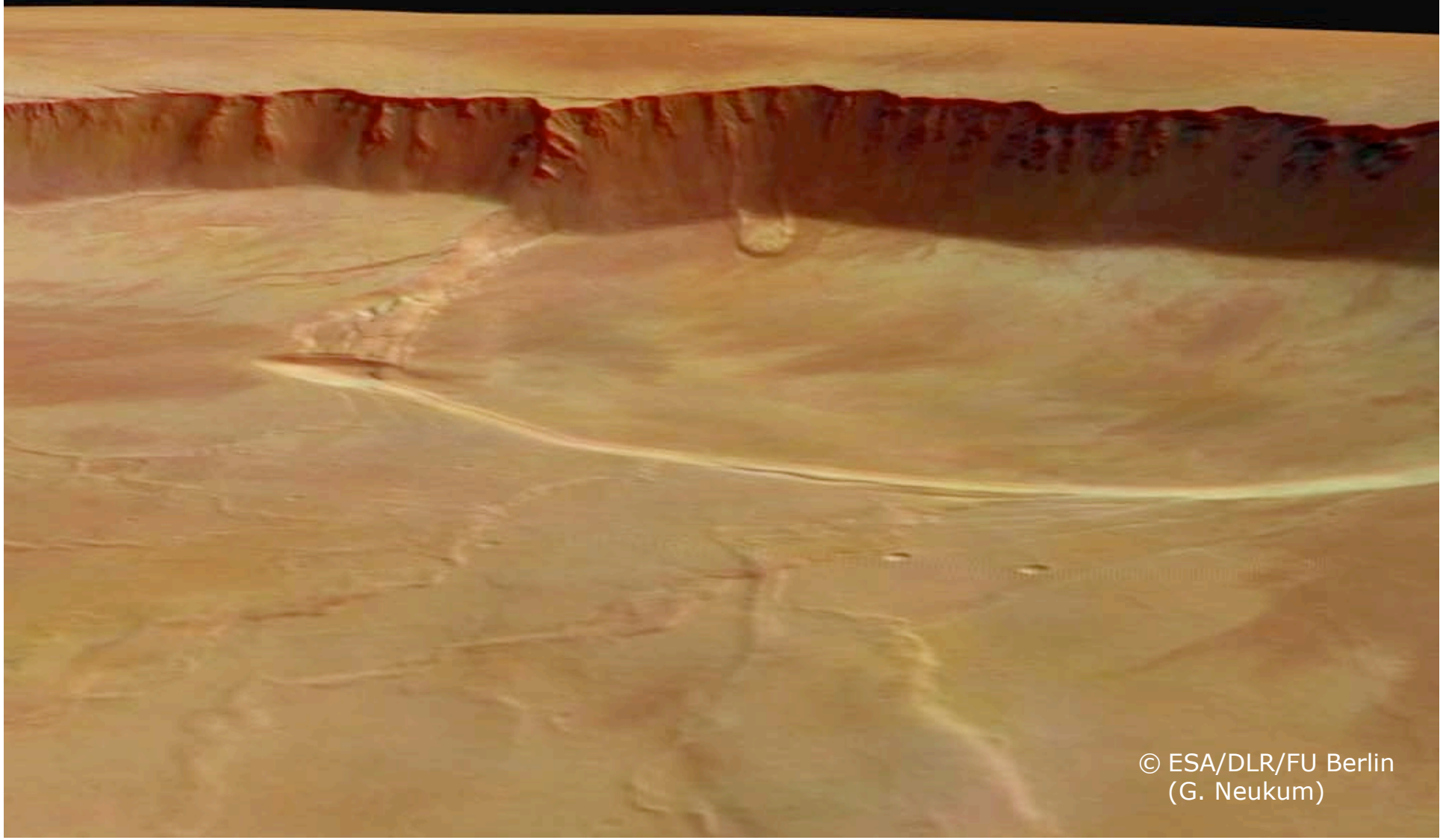

Summit caldera of
Olympus Mons
volcano
HRSC rgb ortho
image zoom created
from orbit 0037
image data
© ESA/DLR/FU Berlin
(G. Neukum)

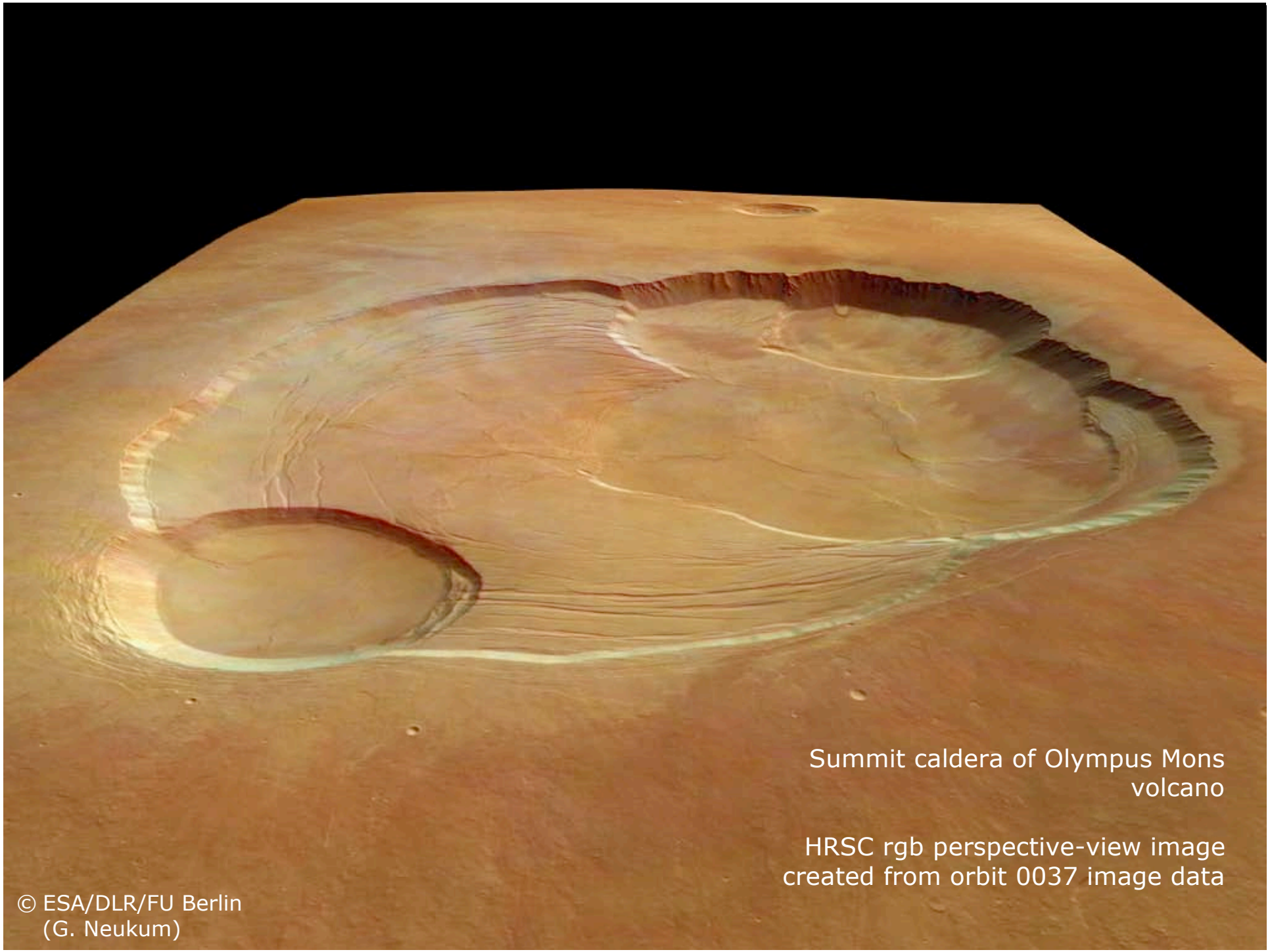

Summit caldera of
Olympus Mons
volcano
HRSC rgb
perspective-view
image created from
orbit 0037 image data
© ESA/DLR/FU Berlin
(G. Neukum)

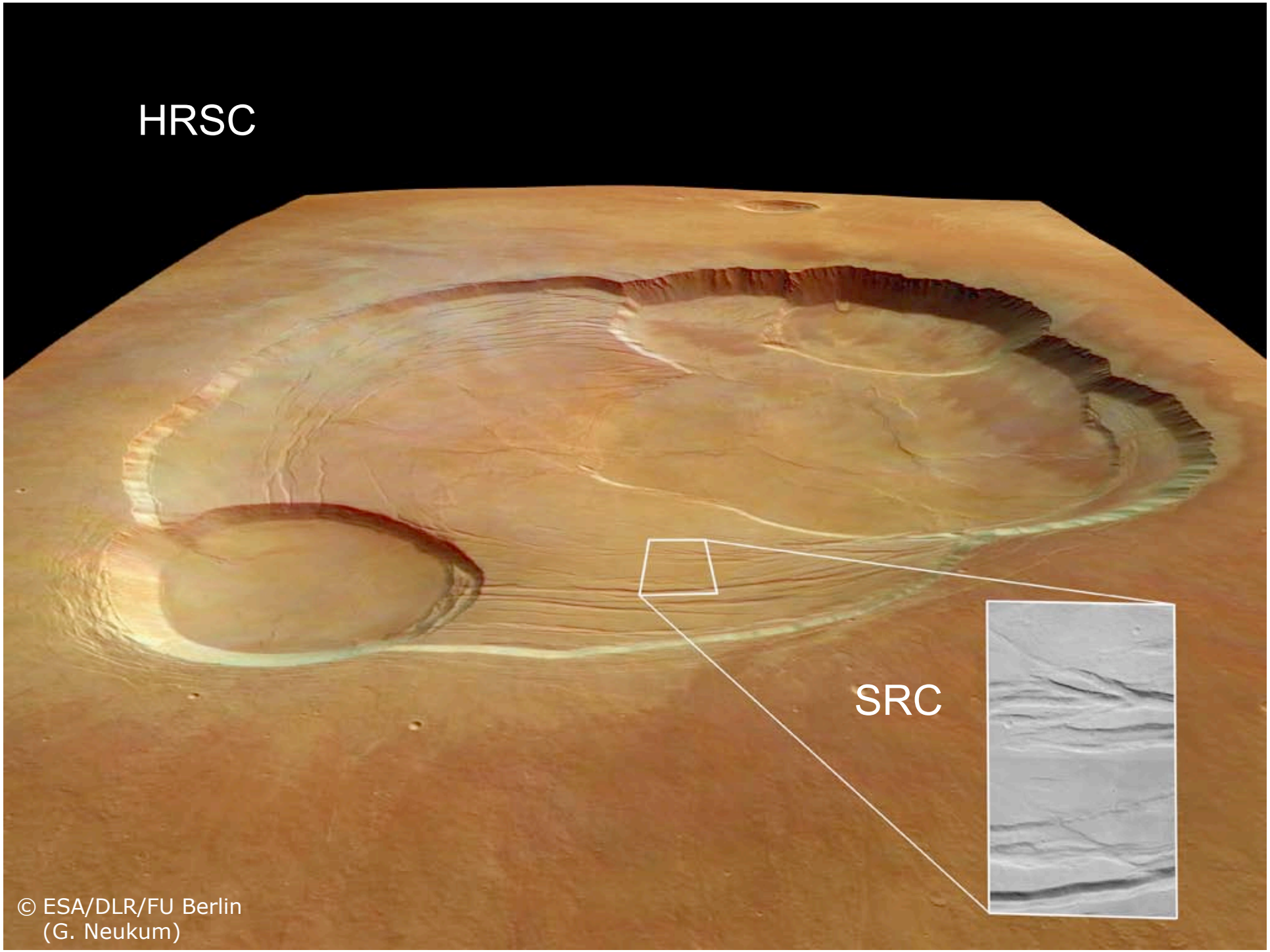

Summit caldera of
Olympus Mons
volcano
HRSC rgb
perspective-view
zoom-image created
from orbit 0037 image
data
© ESA/DLR/FU Berlin
(G. Neukum)

Summit caldera of Olympus
Mons volcano

HRSC rgb perspective-view
zoom-image created from orbit
0037 image data




Summit caldera of Olympus Mons volcano
HRSC rgb perspective-view image created from orbit 0037 image data
© ESA/DLR/FU Berlin (G. Neukum)



From Earth to Mars …

… and back!

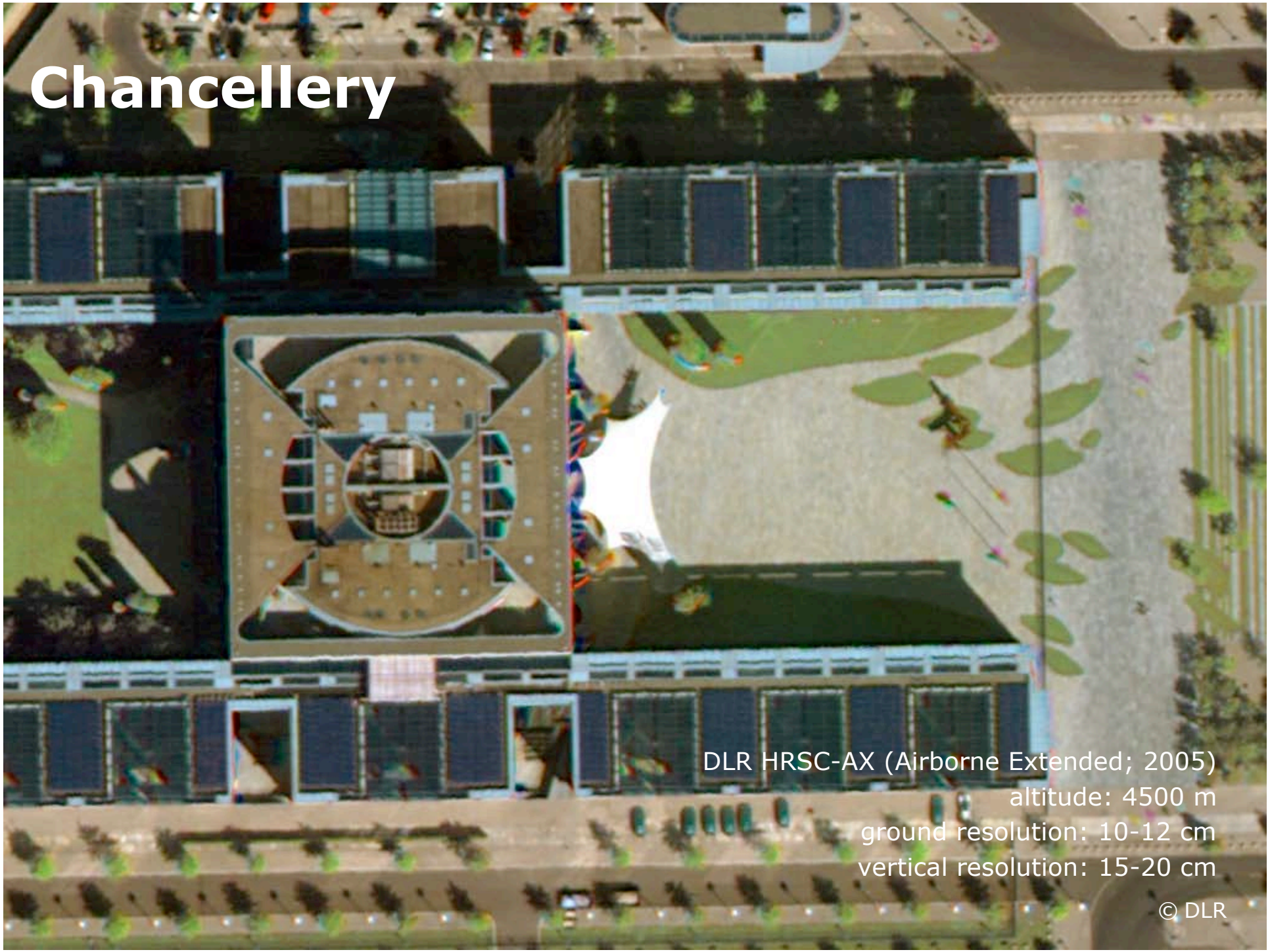
HRSC-AX (»Airborne Extended«)

The Mars Camera for Earthlings: 9 sensors w/ 12,000 pixels

Altitude: 4,500m • Resolution: 15 cm/Pixel • May 2005

HRSC-AX (Airborne Extended): The Mars Camera on an Airplane

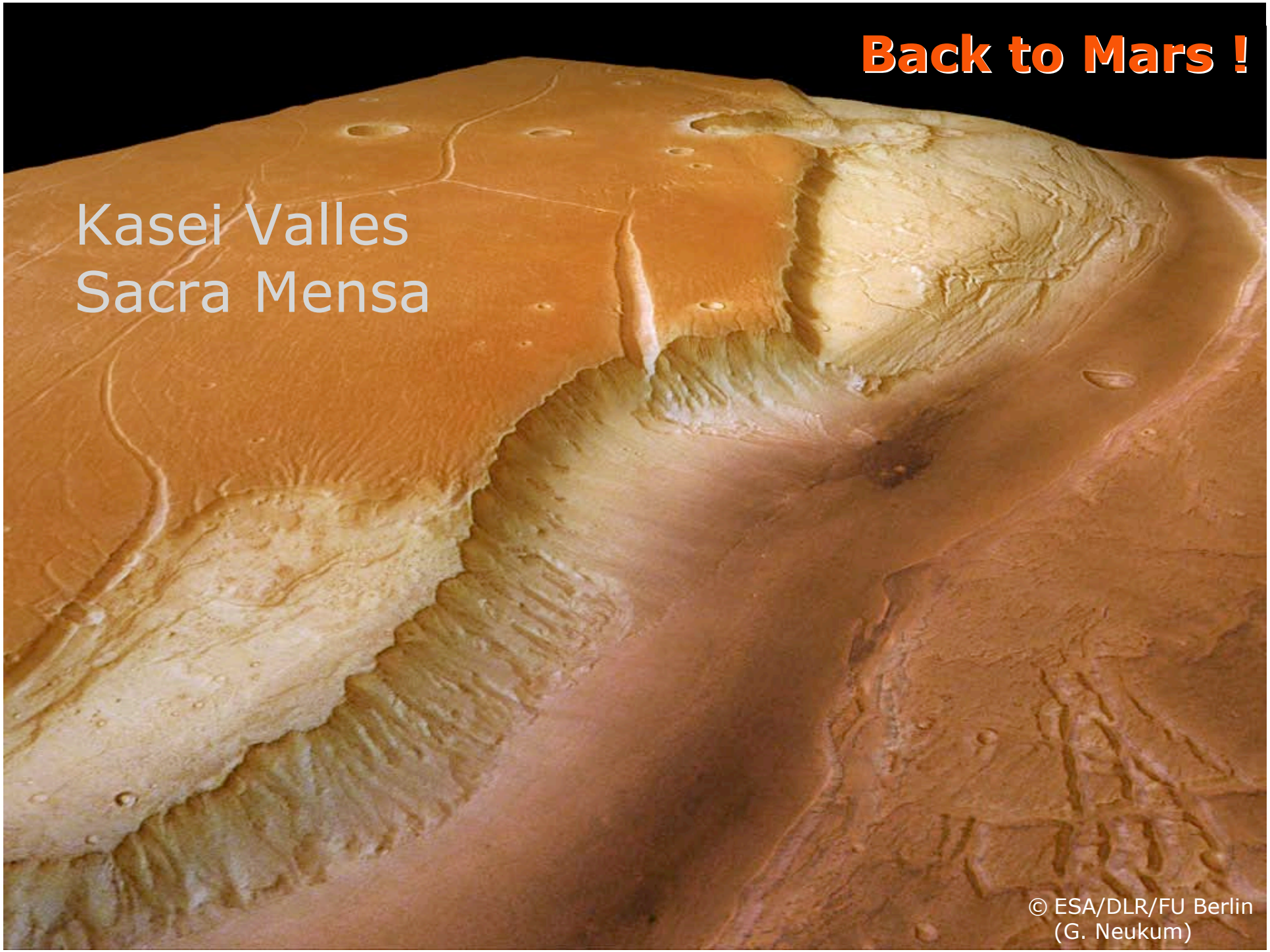
Government buildings and Reichstag in Berlin; 2003


Chancellery
DLR HRSC-AX (Airborne Extended; 2005)
altitude: 4500 m
ground resolution: 10-12 cm
vertical resolution: 15-20 cm
© DLR

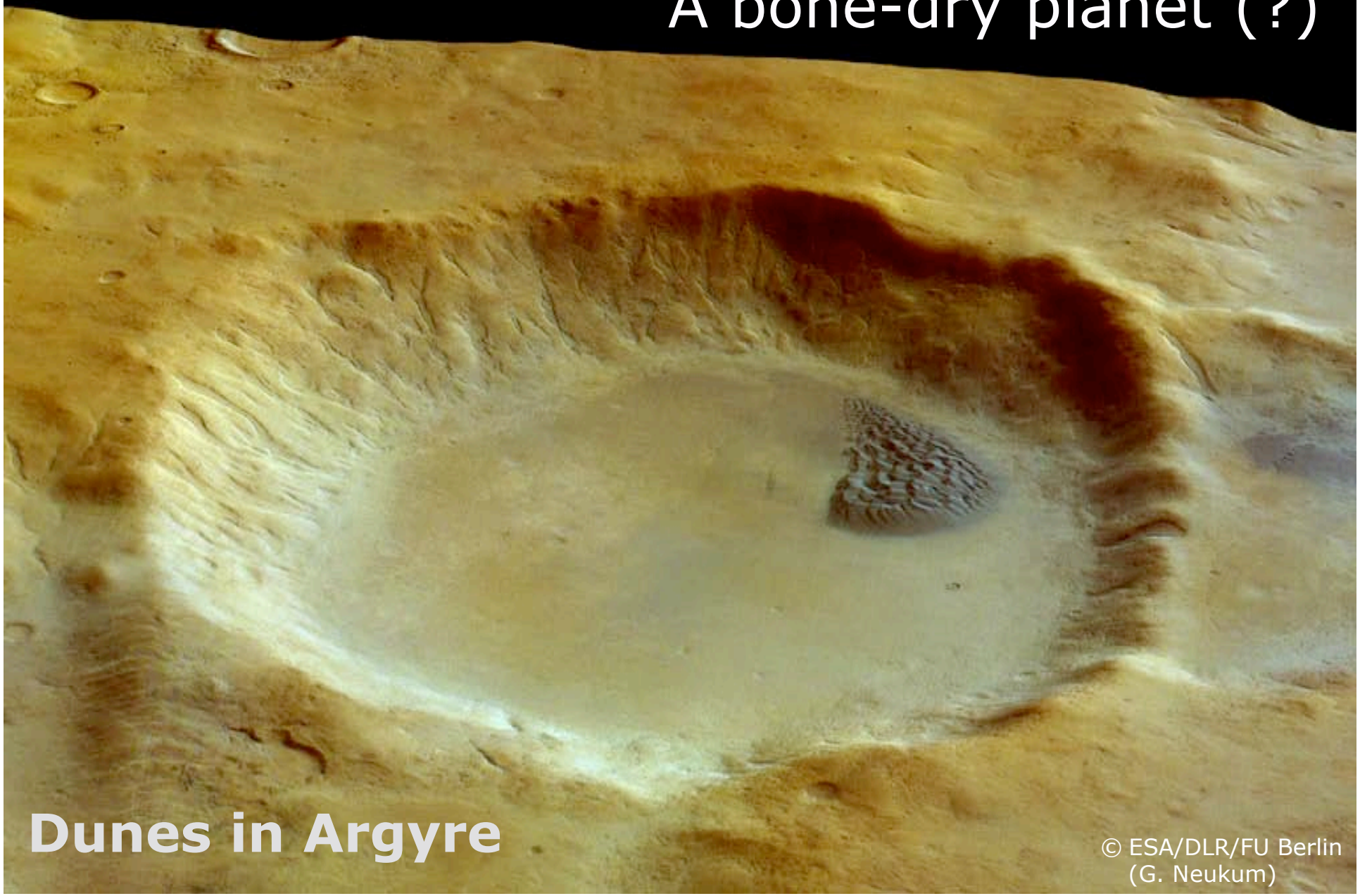

Brandenburg Gate
DLR HRSC-AX (Airborne Extended; 2005)
altitude: 4500 m
ground resolution: 10-12 cm
vertical resolution: 15-20 cm
© DLR

Reichstag

DLR HRSC-AX (Airborne Extended; 2005)
altitude: 4500 m
ground resolution: 10-12 cm
vertical resolution: 15-20 cm


Back to Mars !
Kasei Valles
Sacra Mensa
© ESA/DLR/FU Berlin
(G. Neukum)

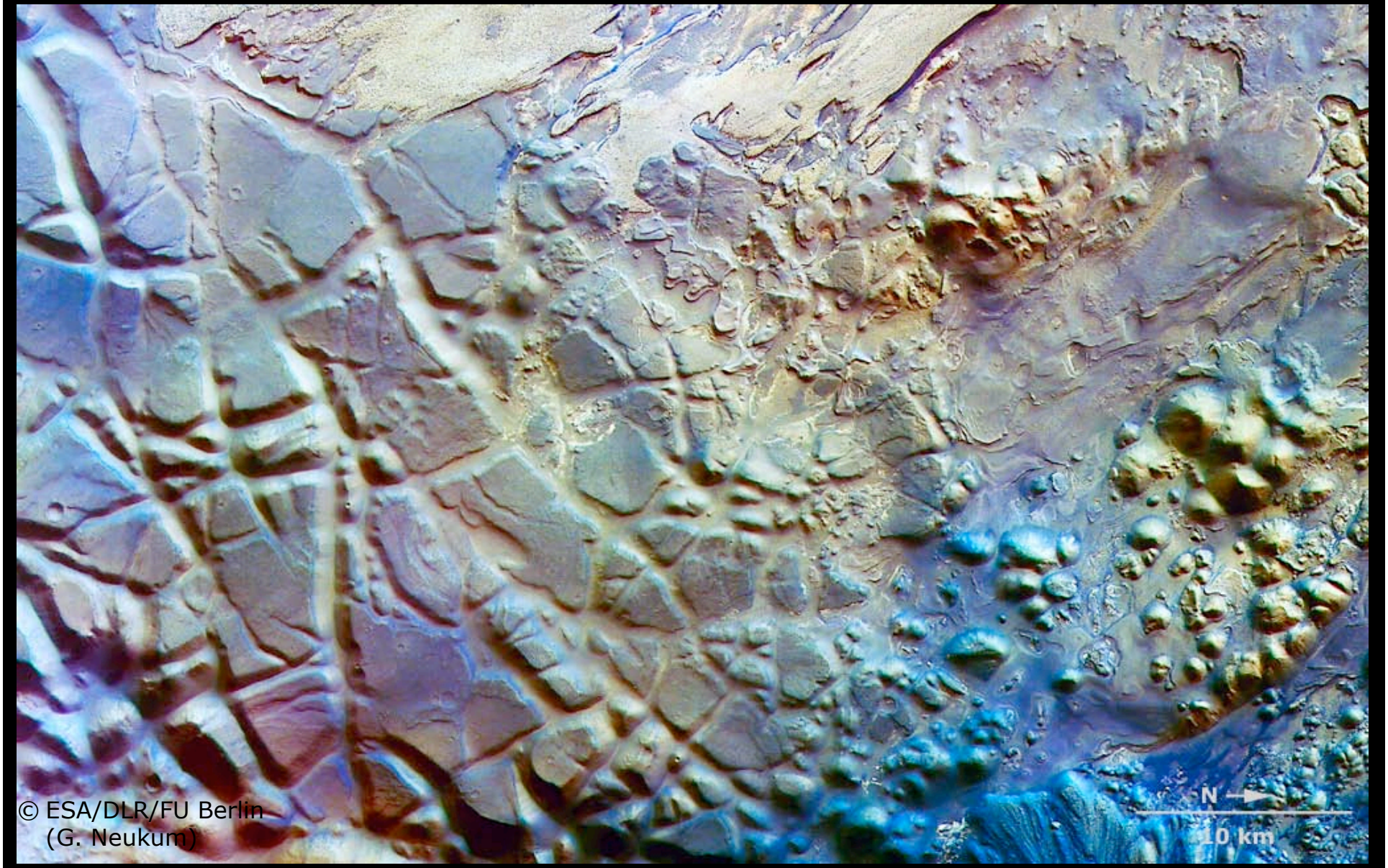
Mars today:
A bone-dry planet (?)

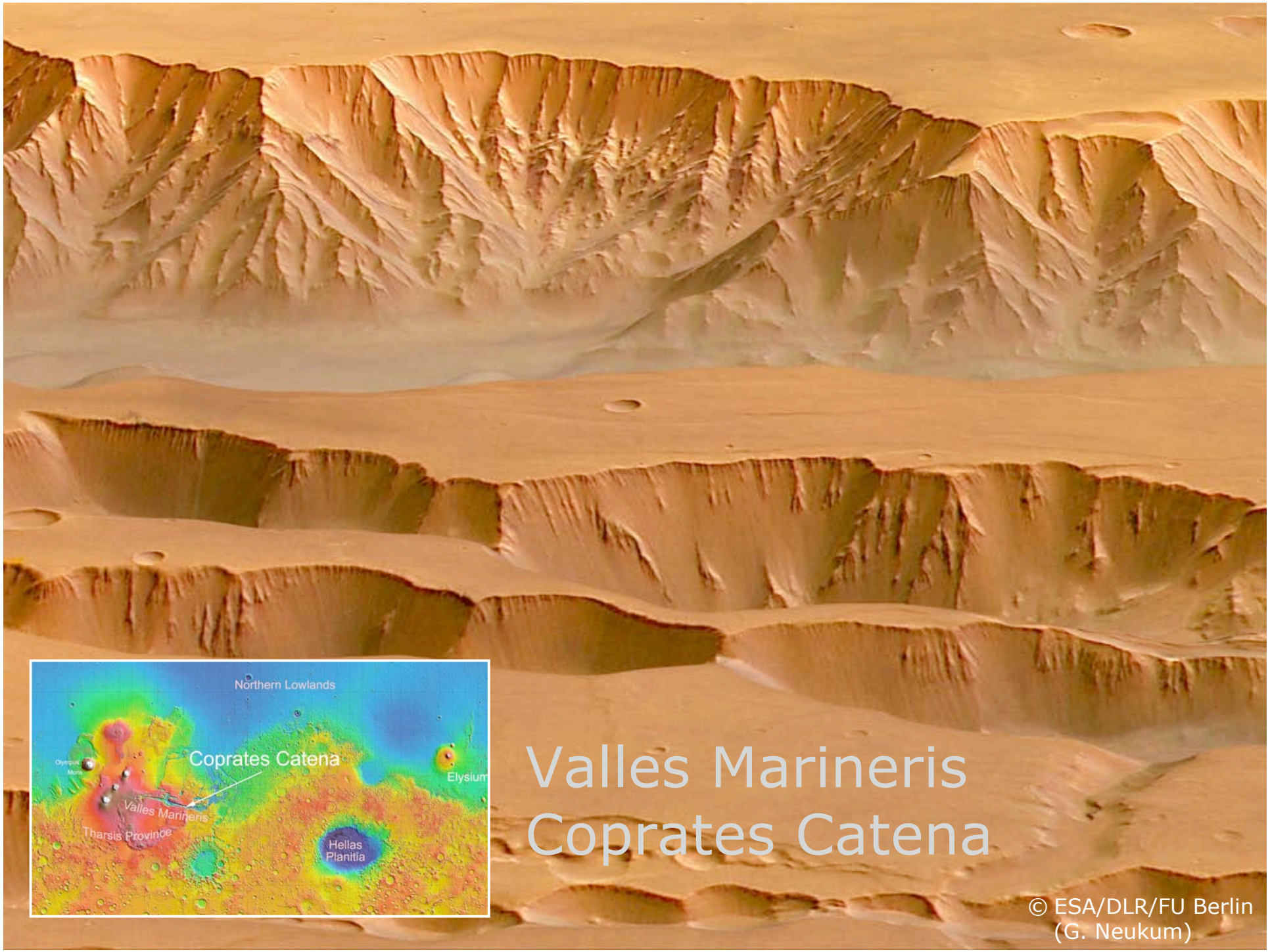


Dunes in Argyre

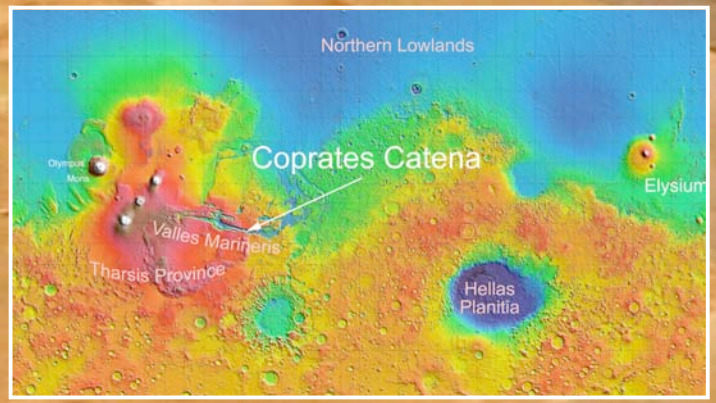
Hesperia Planum - »Butterfly Crater«

Aram Chaos (colour-coded)

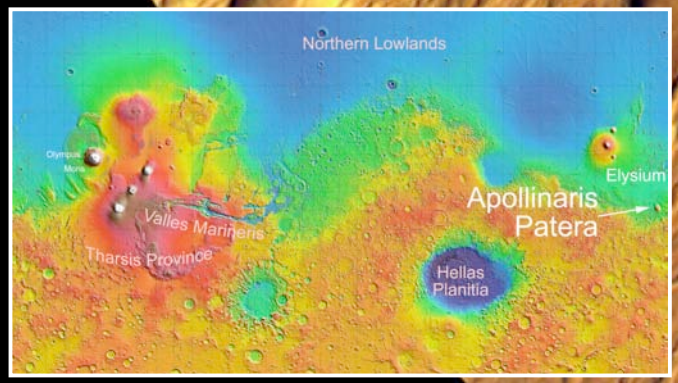



Northern Lowlands
Coprates Catena
Elysium
Valles Marineris
Tharsis Province
Hellas Planitia
Valles Marineris
Coprates Catena
© ESA/DLR/FU Berlin
(G. Neukum)

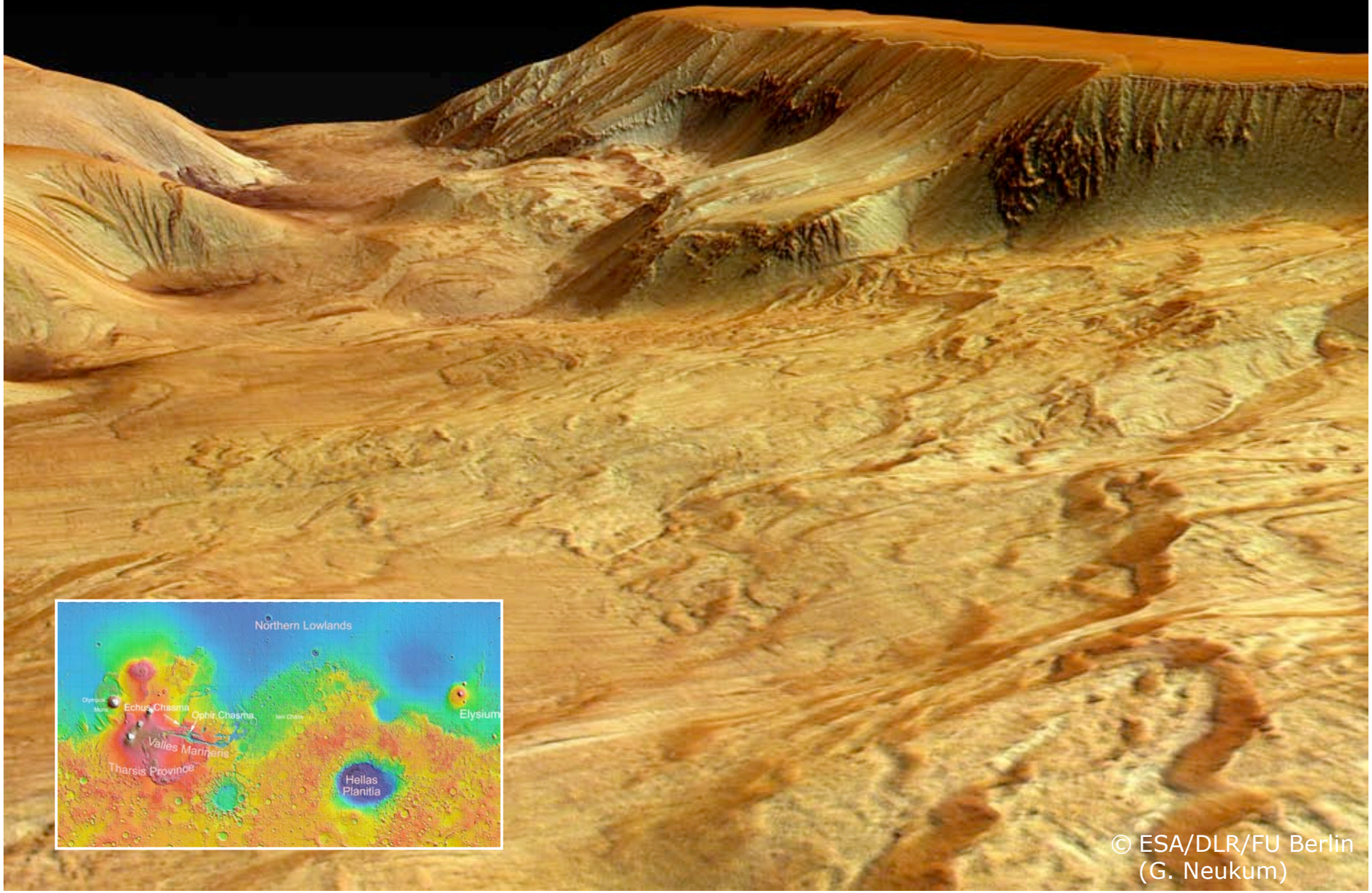
Valles Marineris – Coprates Catena

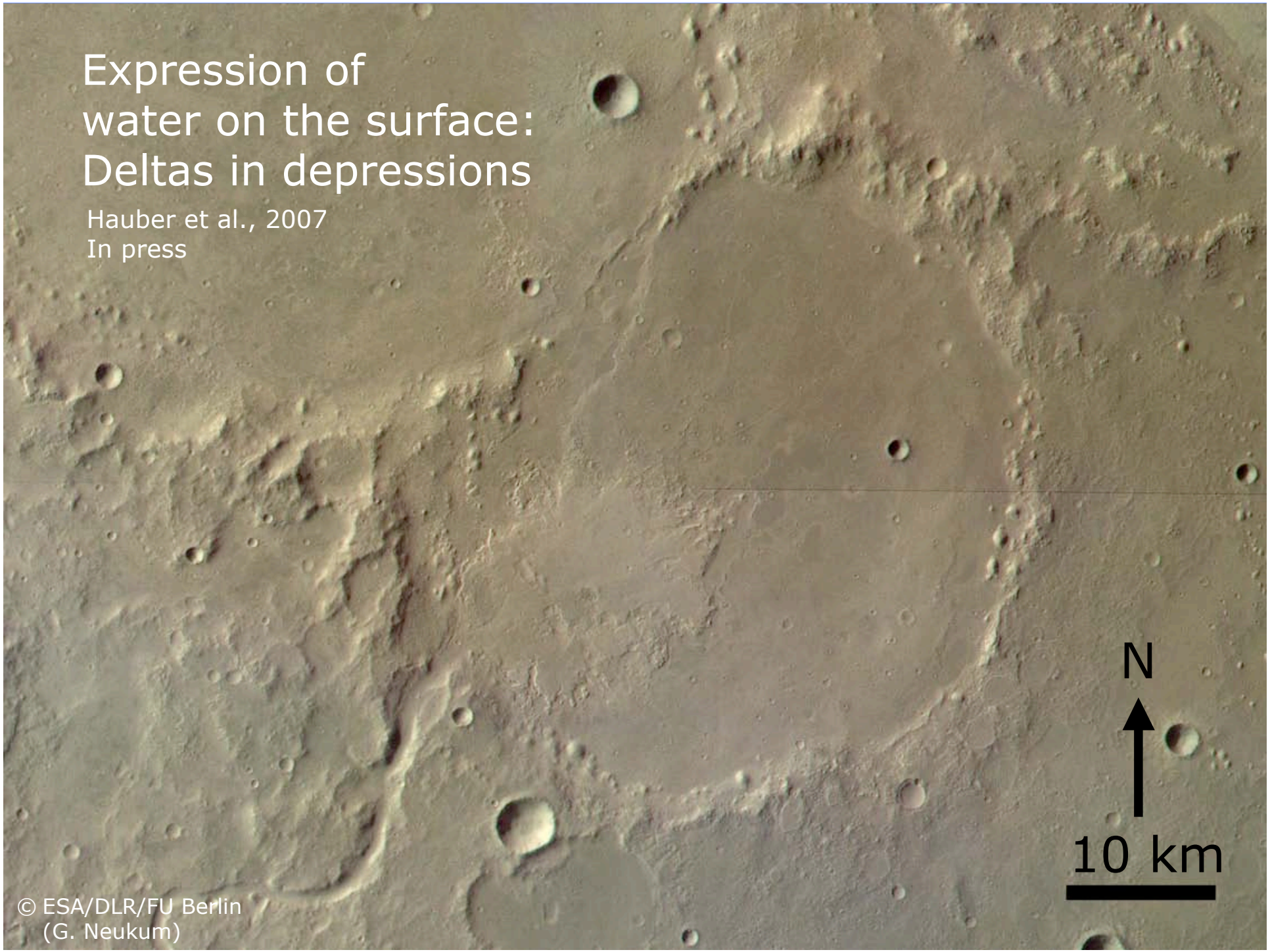


Apollinaris Patera

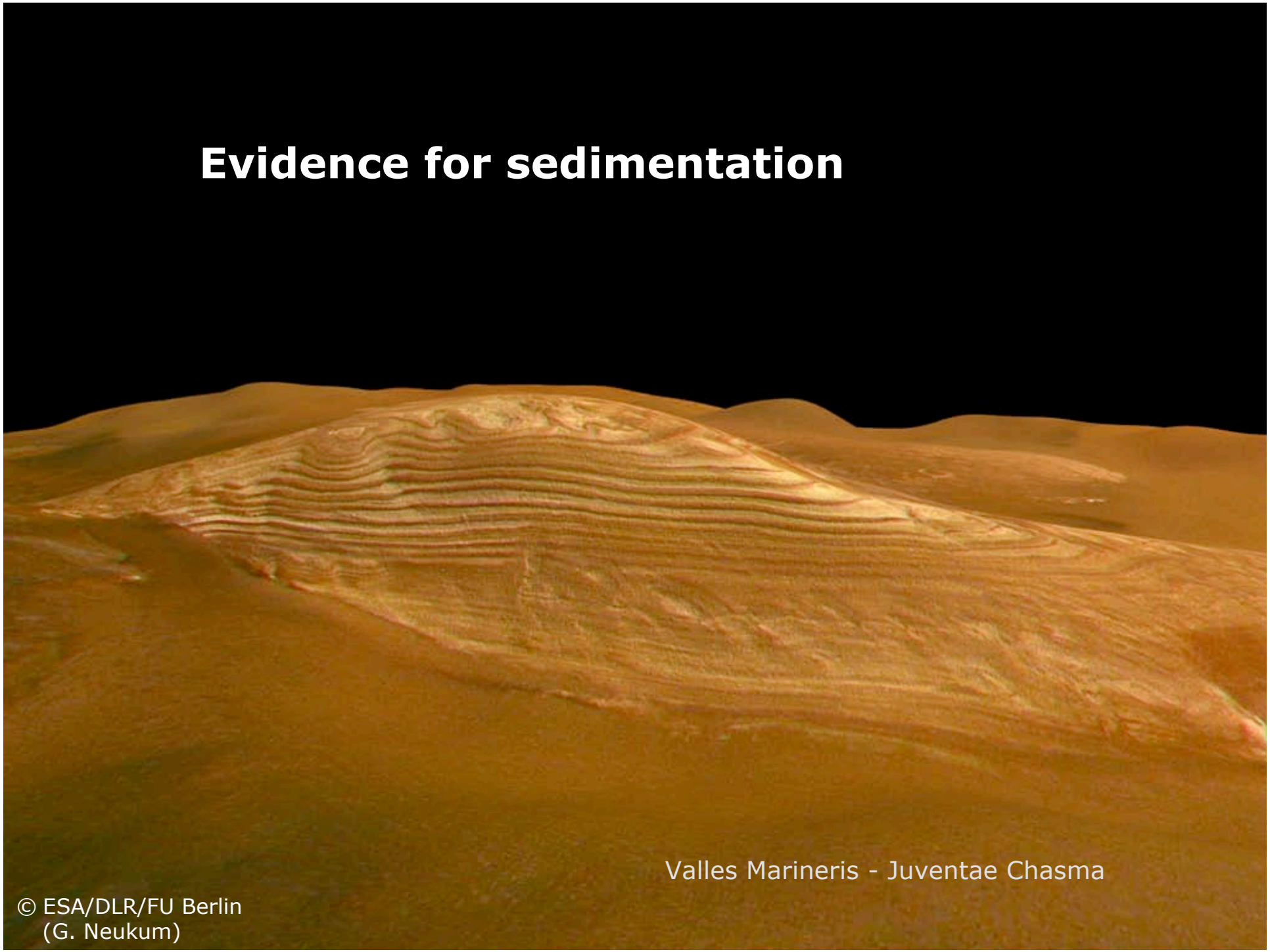


Ophir Chasma

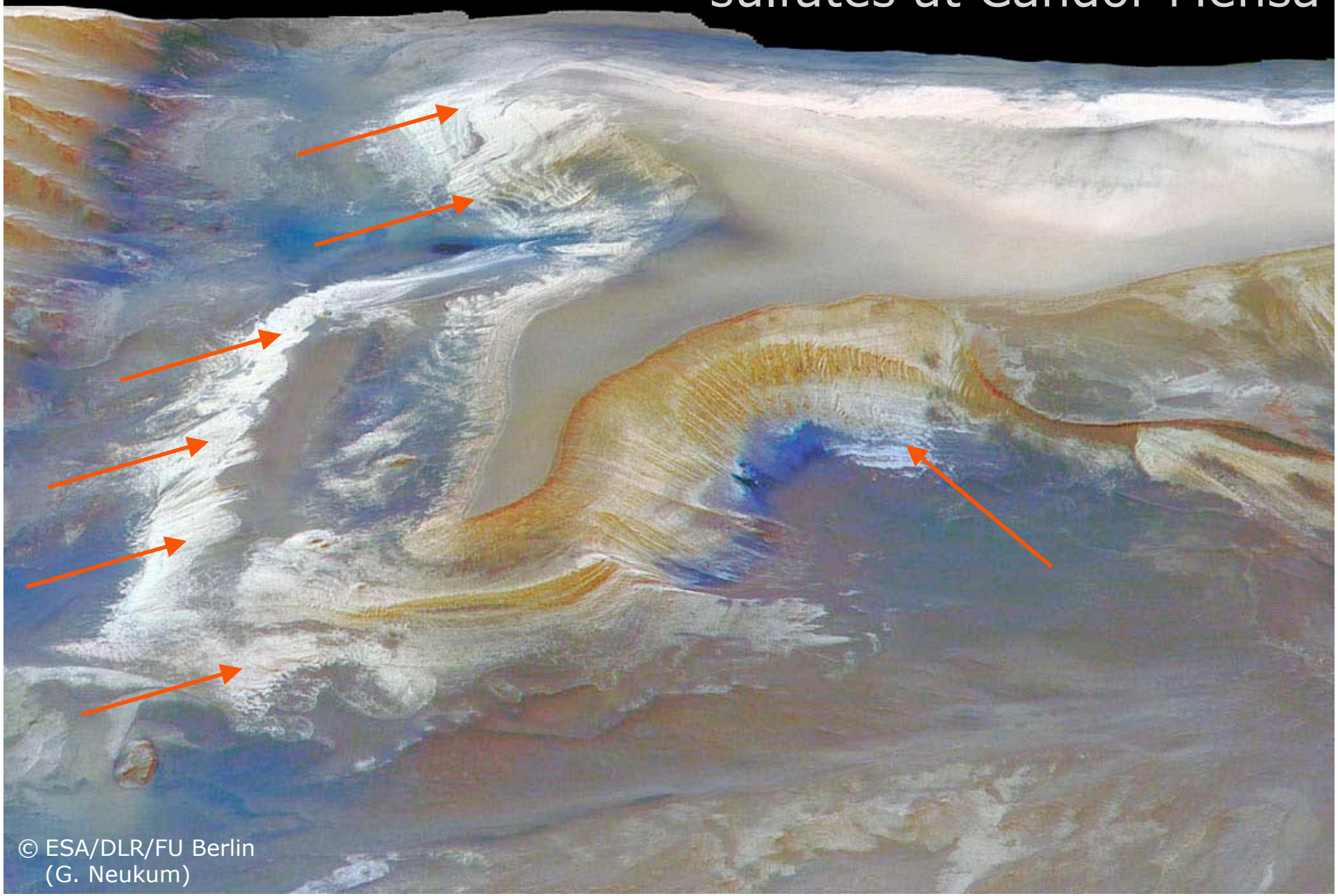



Expression of
water on the surface:
Deltas in depressions
Hauber et al., 2007
In press
N
10 km
© ESA/DLR/FU Berlin
(G. Neukum)

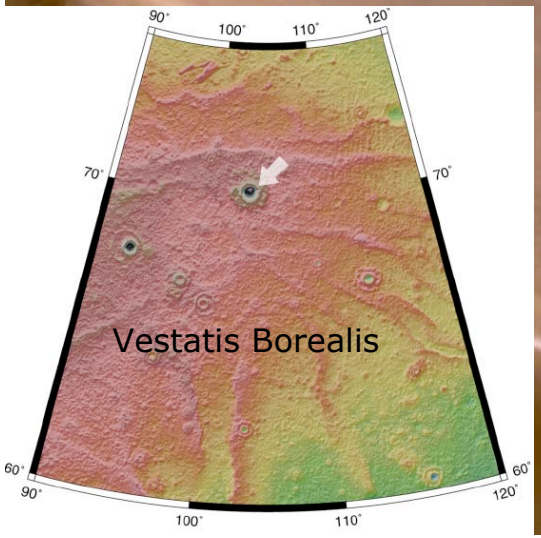
Evidence for sedimentation

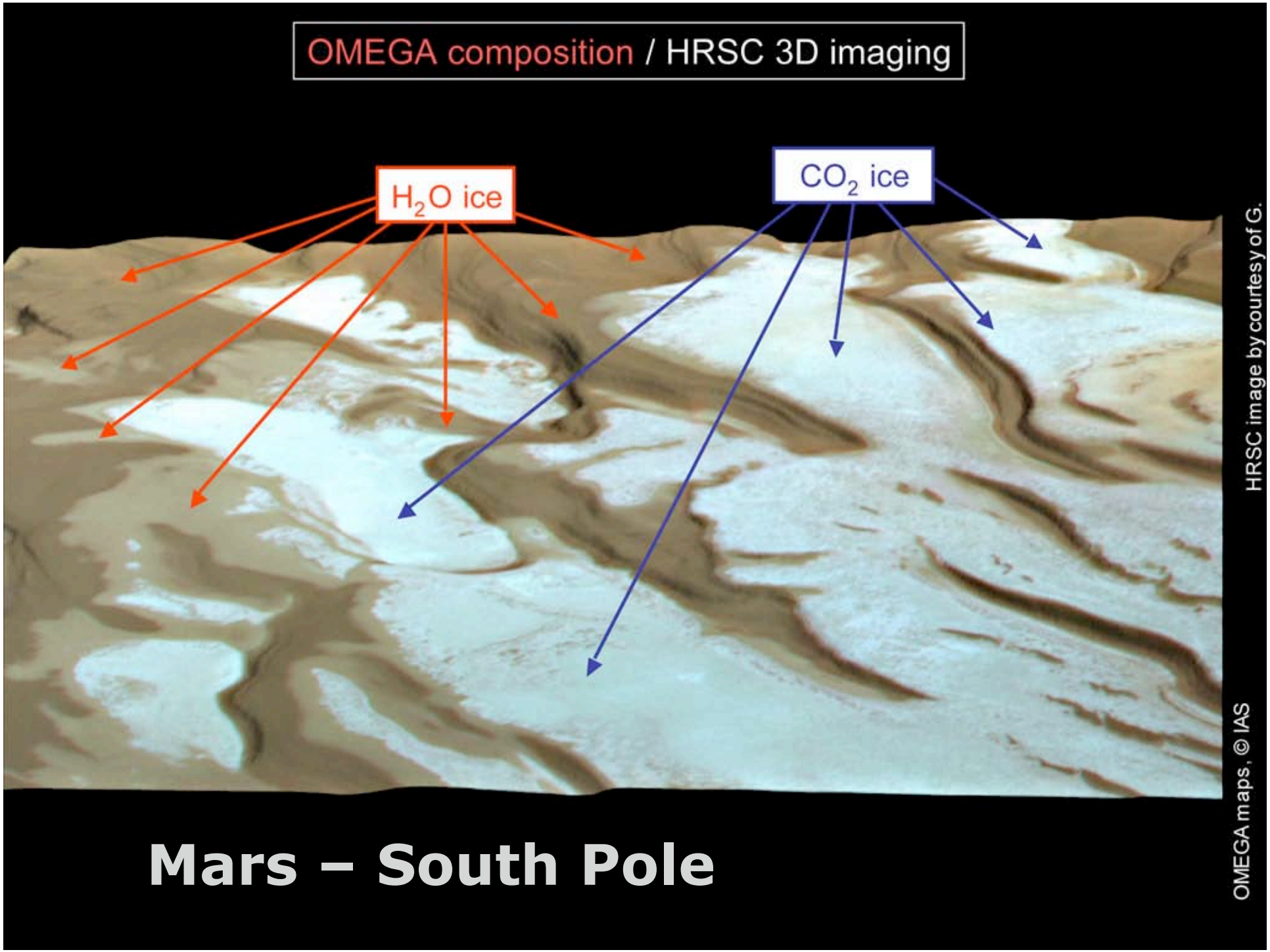


HRSC topography + OMEGA spectroscopy: sulfates at Candor Mensa

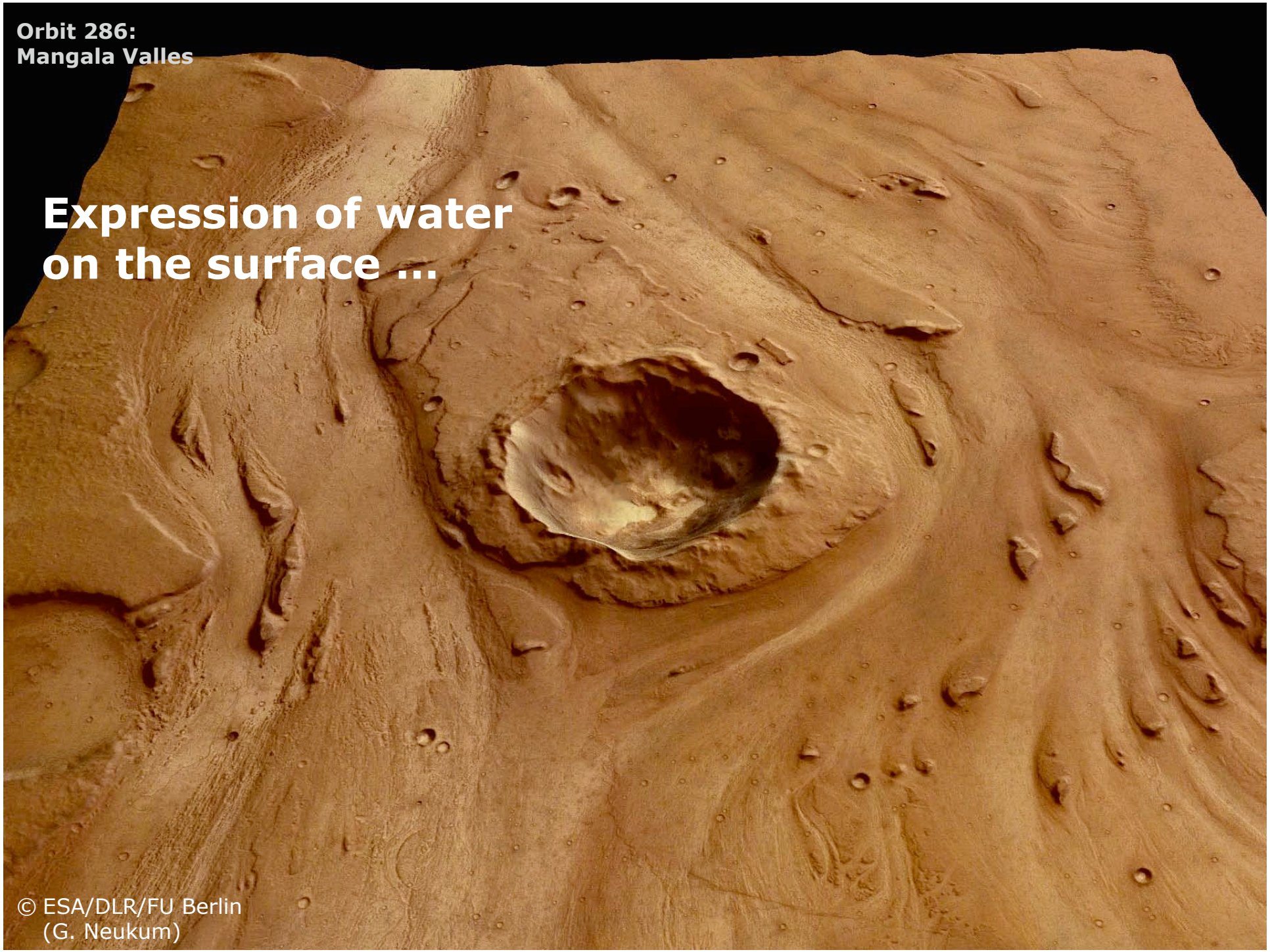


Near-recent water/ice on the surface: North-polar plains

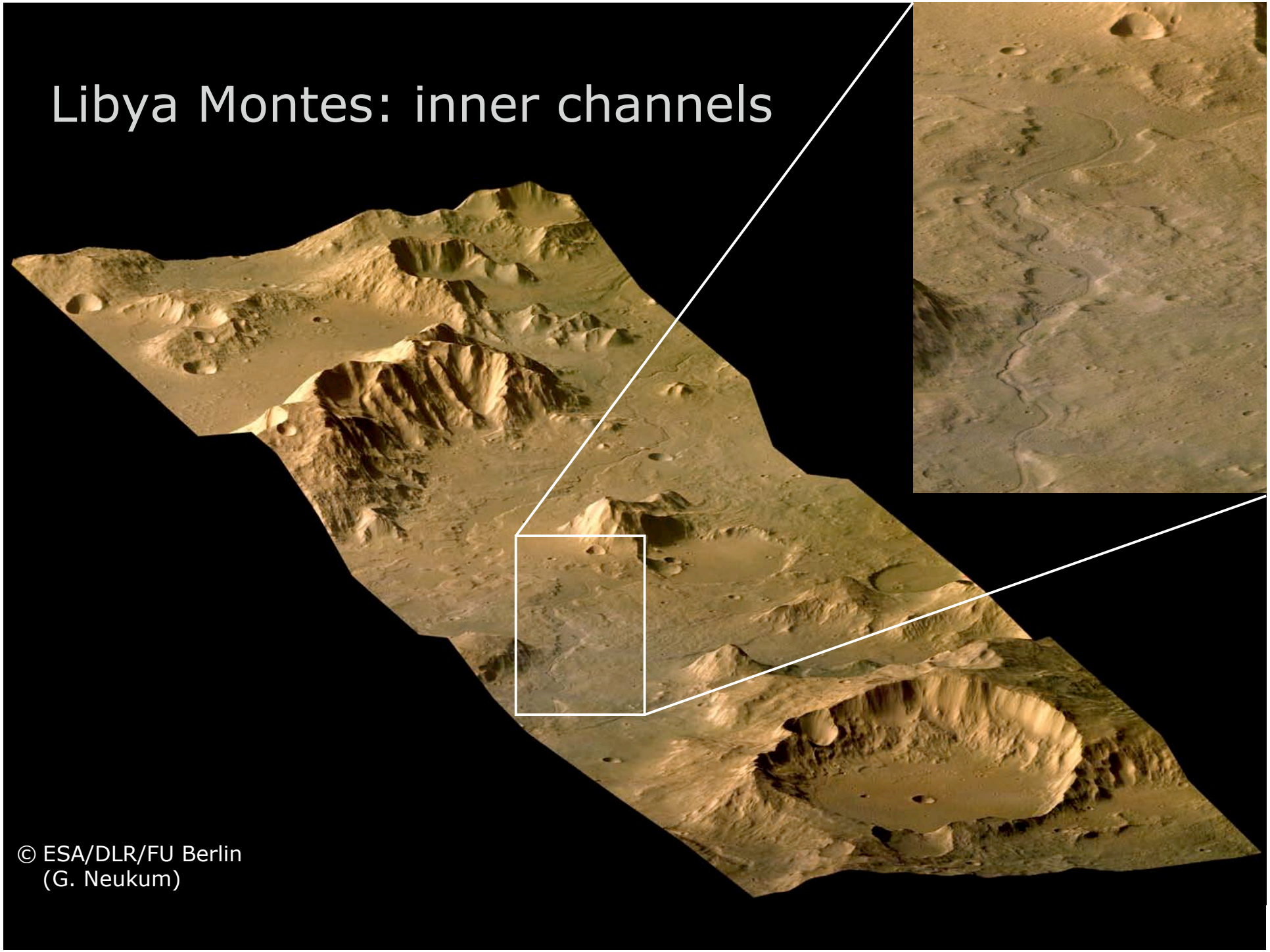


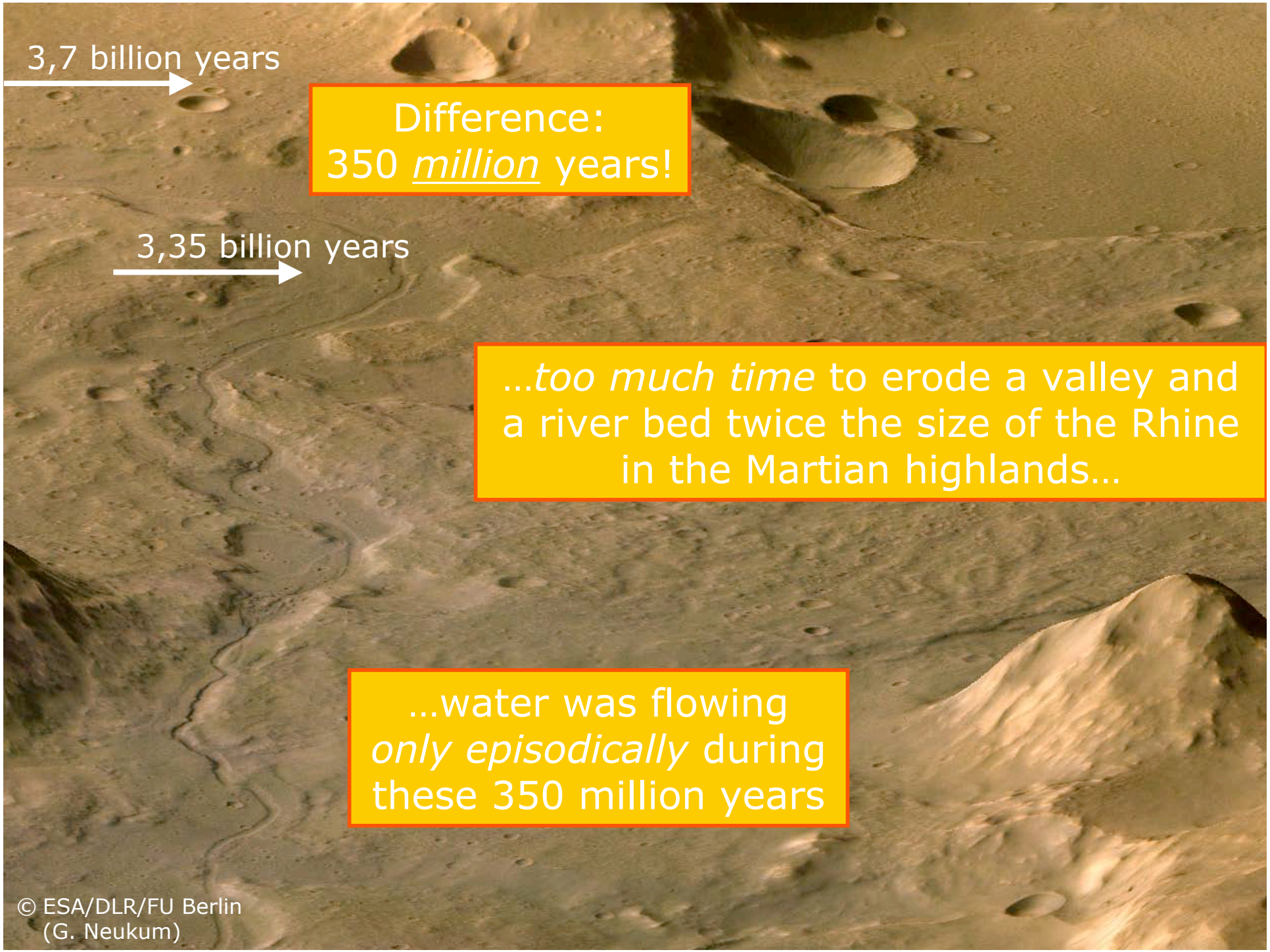


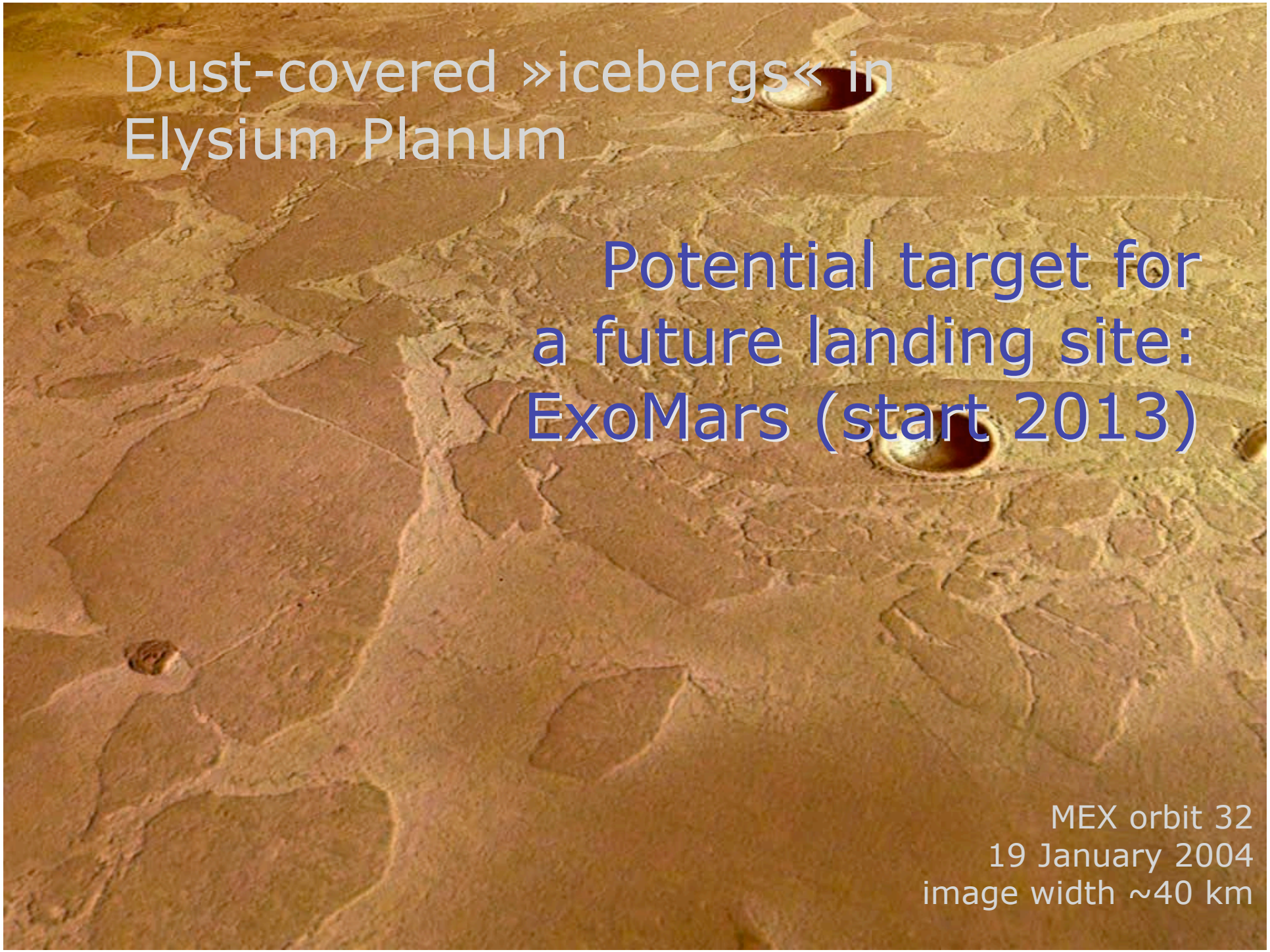
Mars – South Pole


Orbit 286:
Mangala Valles
Expression of water
on the surface …
© ESA/DLR/FU Berlin
(G. Neukum)

Libya Montes: inner channels




3,7 billion years
Difference:
350 *million* years!
3,35 billion years
…*too much time* to erode a valley and a river bed twice the size of the Rhine in the Martian highlands…
…water was flowing *only episodically* during these 350 million years
© ESA/DLR/FU Berlin
(G. Neukum)


Dust-covered »icebergs« in Elysium Planum
Potential target for a future landing site: ExoMars (start 2013)
MEX orbit 32
19 January 2004
image width ~40 km