Europe at Mars:
Eight years of Mars Express science

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esa

→ ESA'S FLEET ACROSS THE SPECTRUM

Thanks to cutting edge technology, astronomy is today unveiling a new universe around us. With ESA's fleet of spacecraft, science can explore the full spectrum of light, see into the hidden infrared universe, visit the untamed and violent universe, chart our galaxy and even look back at the dawn of time.

herschel
Unveiling the cool and dusty Universe

jwst
Striving to observe the first light

gaia
Surveying a billion stars

hst
Expanding the frontiers of the visible Universe

planck
Looking back at the dawn of time

xmm-newton
Seeing deeply into the hot and violent Universe

integral
Seeking out the extremes of the Universe

radio waves
microwaves
sub mm
infrared
optical
ultraviolet
x-rays
gamma rays

European Space Agency

esa

soho
Facing the Sun

venus express
Studying Venus' atmosphere

mars express
Investigating the Red Planet

bepicolombo
Exploring Mercury

cassini-huygens
Studying the Saturnian system
and landing on Titan

cluster
Measuring Earth's magnetic shield

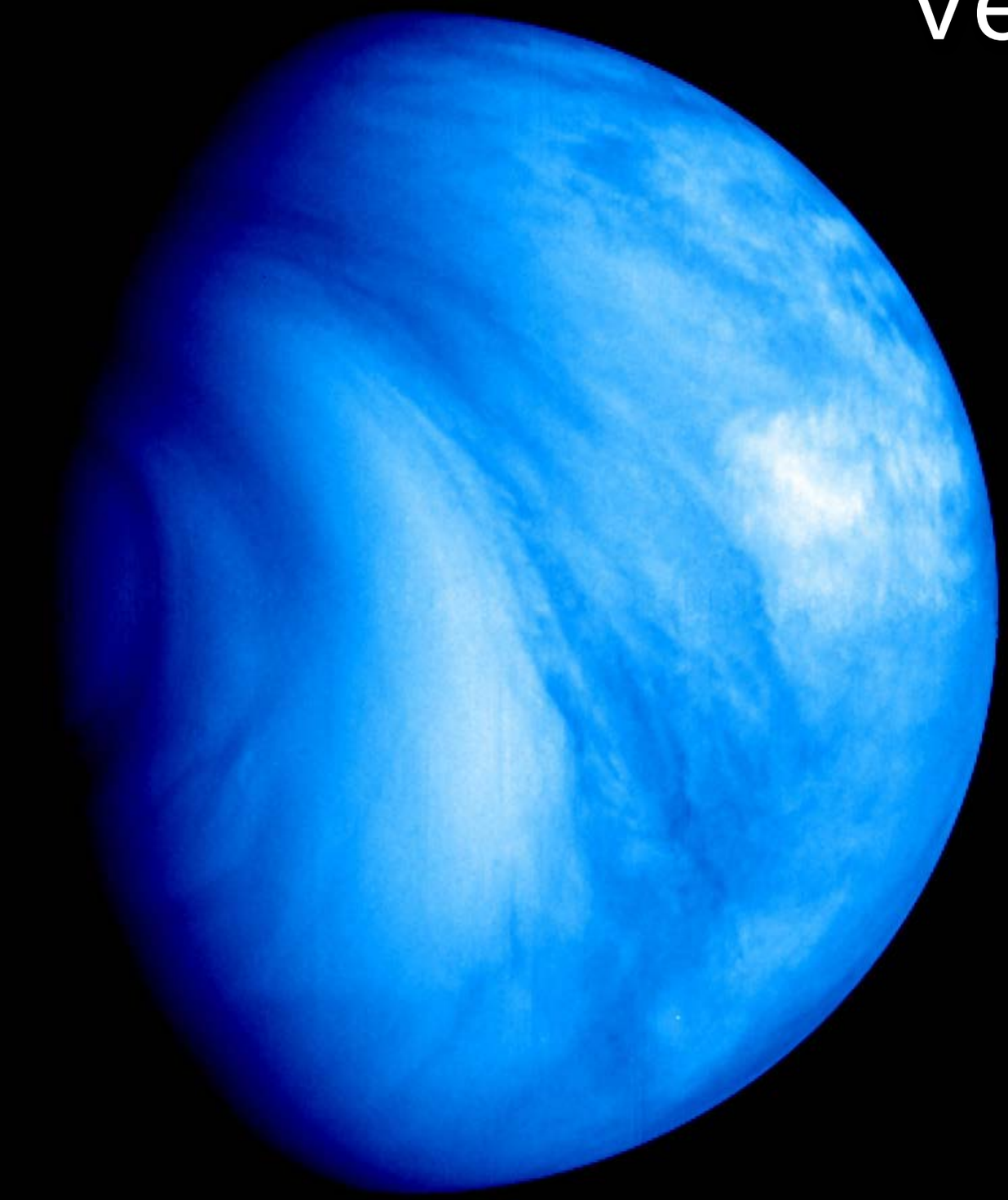
rosetta
Chasing a comet

→ ESA'S FLEET IN THE SOLAR SYSTEM

The Solar System is a natural laboratory that allows scientists to explore the nature of planets. ESA's missions to our planetary neighbours have transformed our view of the celestial neighbourhood. The planets that exist today are the result of 4.6 billion years of formation and subsequent development. Studying how they appear now allows us to unlock the mysteries of their past and to predict how they will change in the future.

European Space Agency

Venus



ESA Venus Express VMC ultraviolet image

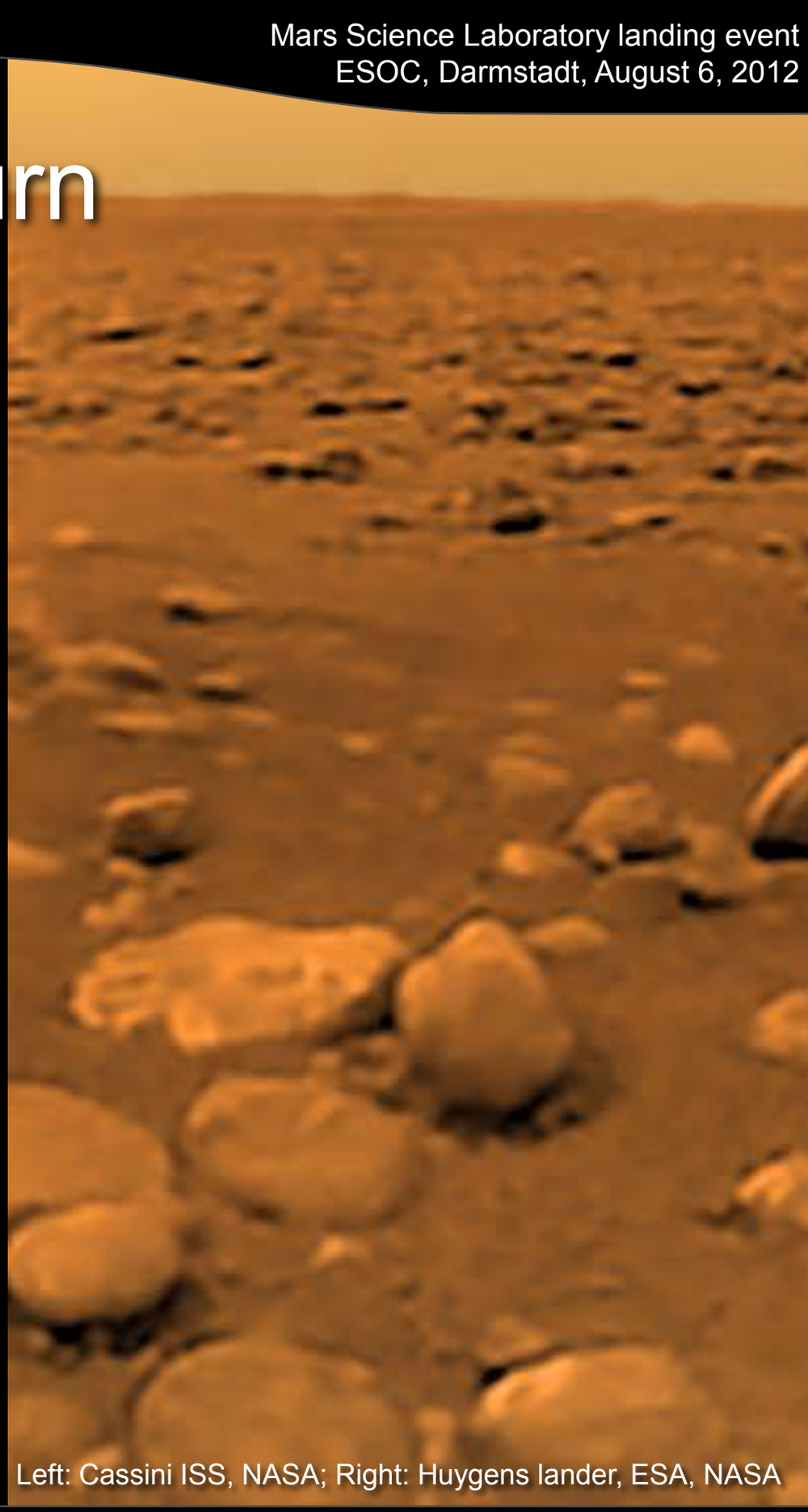
Soviet Venera-13 data from 1982, Russian Academy of Sciences
Reprocessed by Don P. Mitchell

Ganymede at Jupiter

ESA JUICE mission
Launch 2022
Arrive at Jupiter 2030

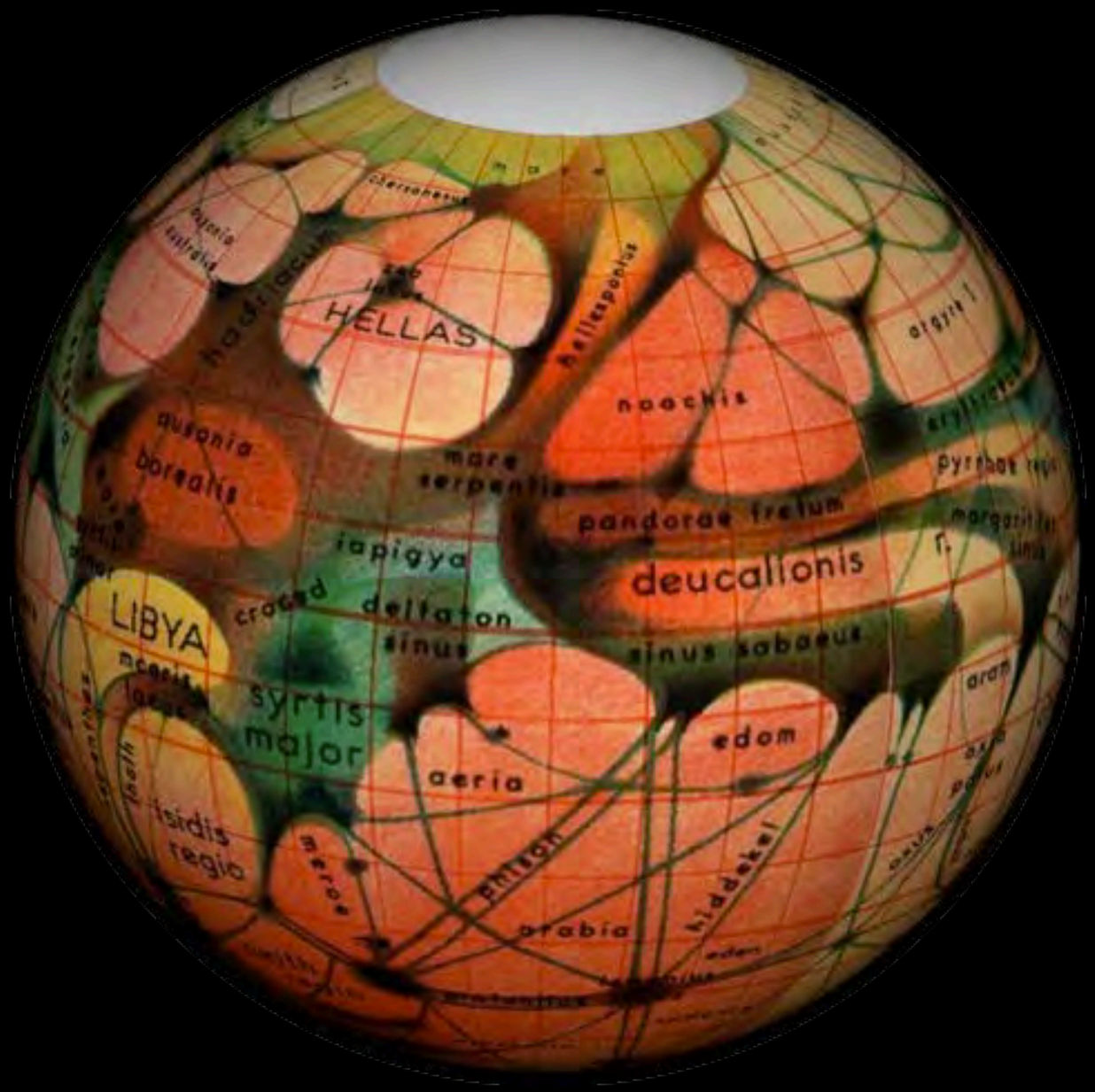
NASA Galileo data, reprocessed by Ted Stryk, colourised by wanderingspace

Titan at Saturn



Left: Cassini ISS, NASA; Right: Huygens lander, ESA, NASA

Mars: then and now



"Canals" of Mars at the end of the 1800s

Hubble Space Telescope view of Mars in 2003

Ruen, Antoniadi, Hess, Gallant / NASA-ESA HST

Mars

Gusev crater:
Spirit landing site

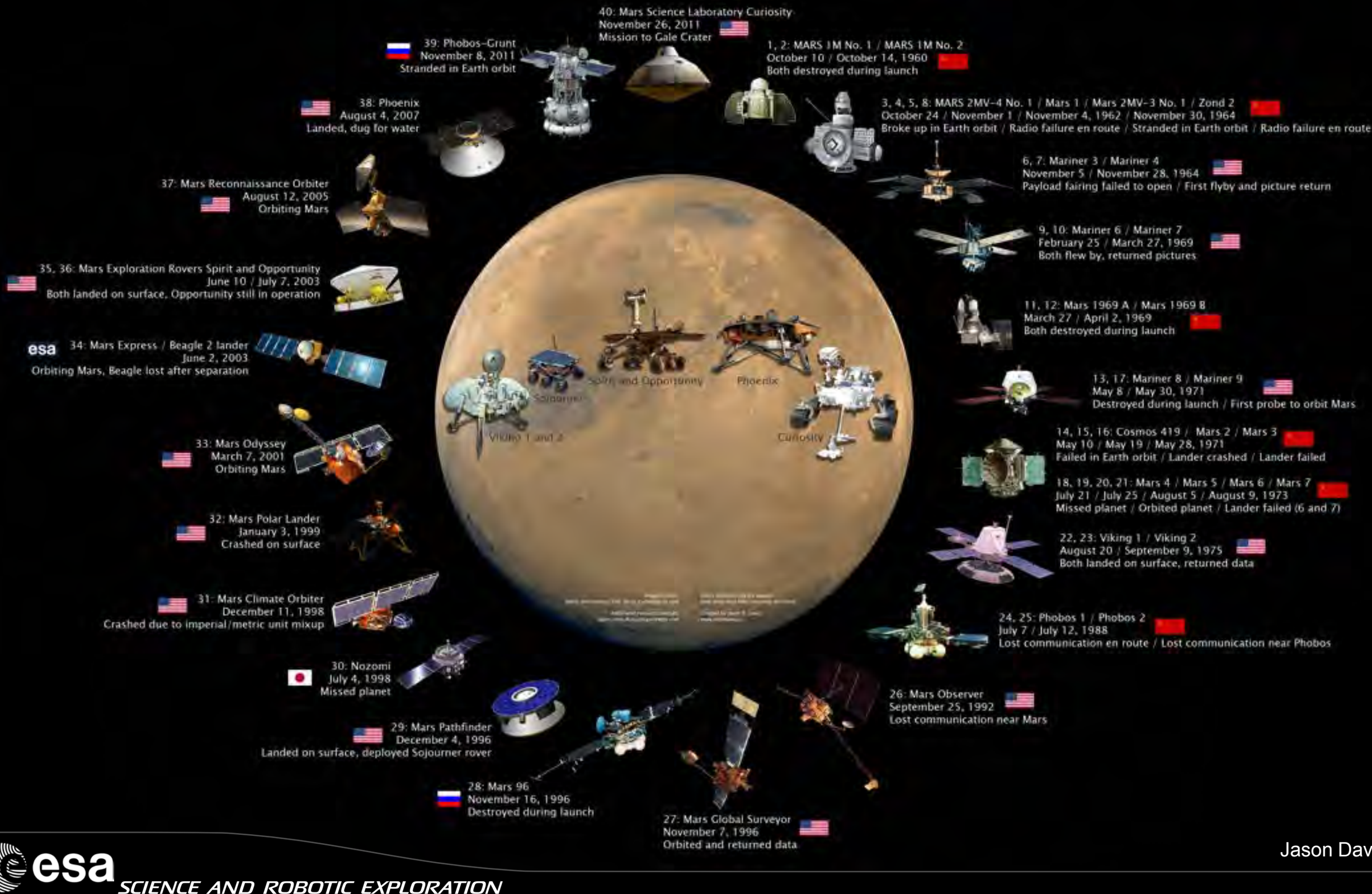
Gale crater:
Curiosity landing site

Phobos

Shadow of
Phobos

Image taken by Rosetta, February 24, 2007 / OSIRIS team, ESA, reprocessed by Emily Lakdawalla

Mars exploration family portrait



On the surface: almost like being there

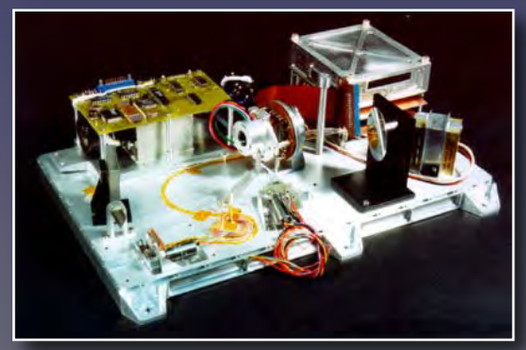
Martian sunset as seen by Mars Exploration Rover Spirit / NASA

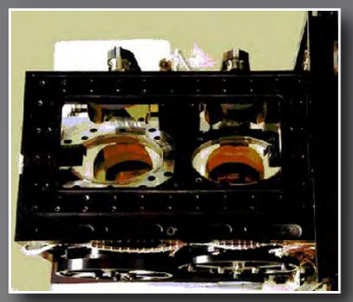
Mars Express spacecraft

Mars Express on the launch stack at Baikonur

Mars Express instrumentation (I)

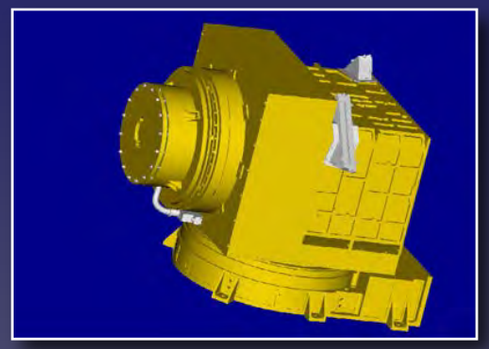
- OMEGA: Visible and Infrared Mineralogical Mapping Spectrometer
  - Determination of surface composition and circulation
- SPICAM: Ultraviolet and Infrared Atmospheric Spectrometer
  - Determination of atmospheric composition
- MARSIS: Sub-Surface Sounding Radar Altimeter
  - Search for water in the sub-surface
- PFS: Planetary Fourier Spectrometer
  - Study of atmospheric composition and circulation

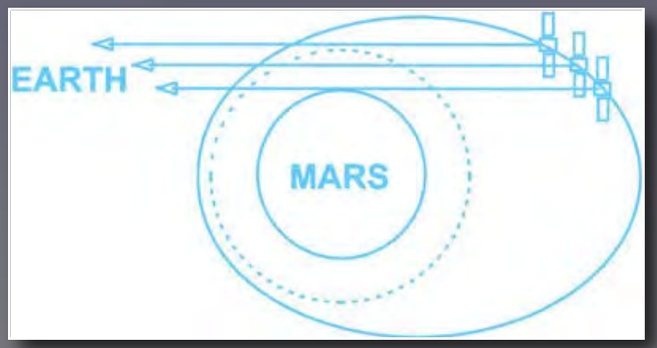




Mars Express instrumentation (II)

- ASPERA: Analyser of Space Plasma and Energetic Atoms
  - How the solar wind erodes the martian atmosphere
- HRSC: High Resolution Stereo Camera
  - High resolution surface imaging
- MaRS: Mars Radio Science Experiment
  - Sounding of the internal structure, atmosphere, and environment
- Beagle-2: Lander
  - Geochemistry and exobiology



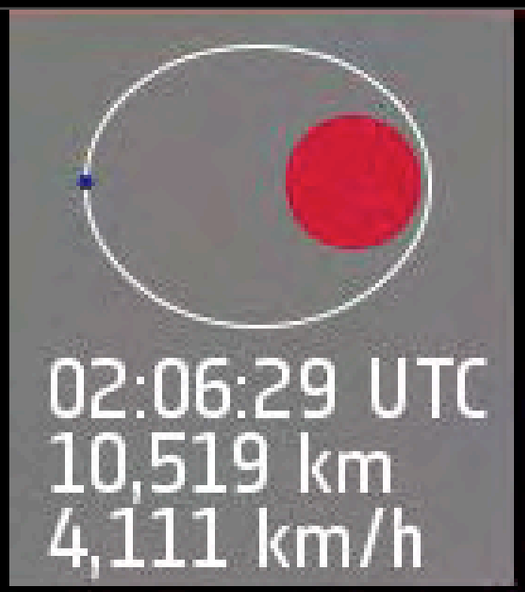


Mars Express launch

Launch on Soyuz-Fregat from Baikonur on June 2, 2003

Mars Express in orbit

ESA Mars planetary physics mission, in operation since 2003



MEX Visual Monitoring Camera / ESA

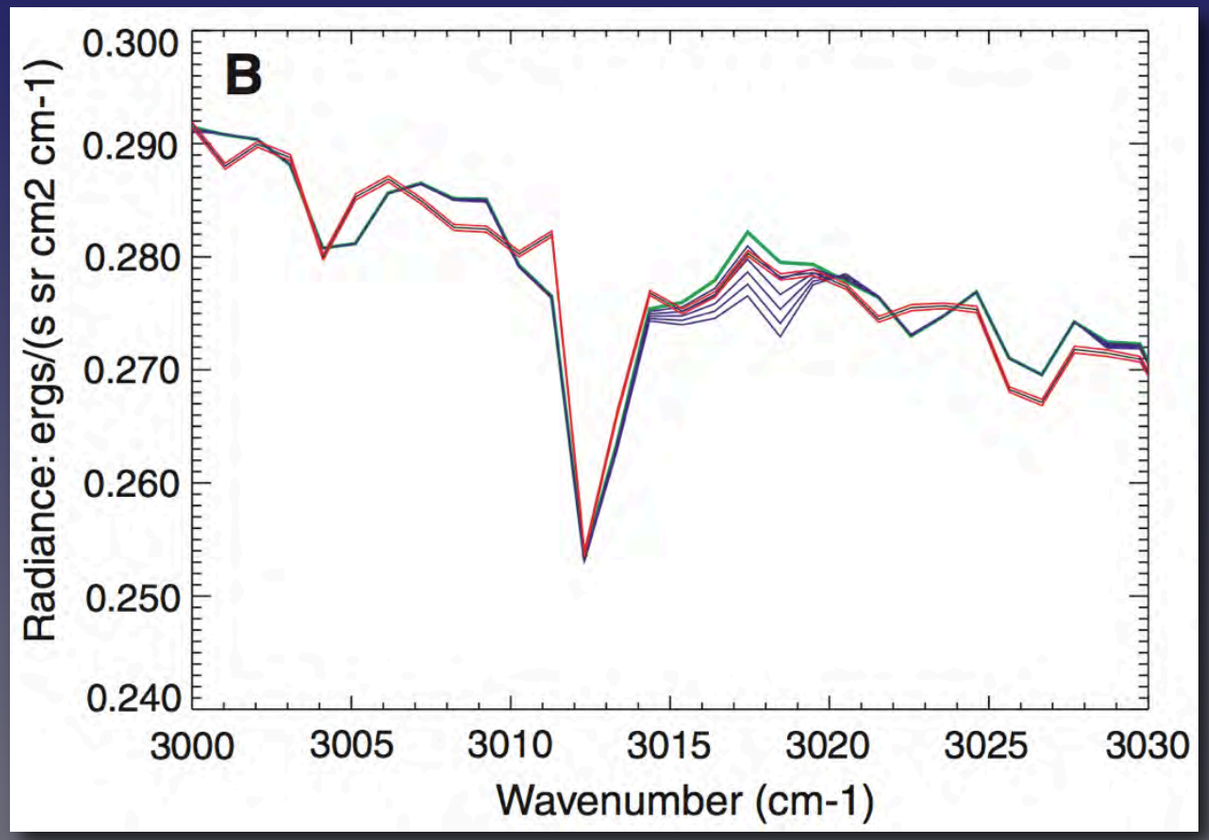
The enigmatic martian moons

Mars Express HRSC of Phobos image taken in 2010 / ESA, DLR, FU Berlin (G. Neukum)

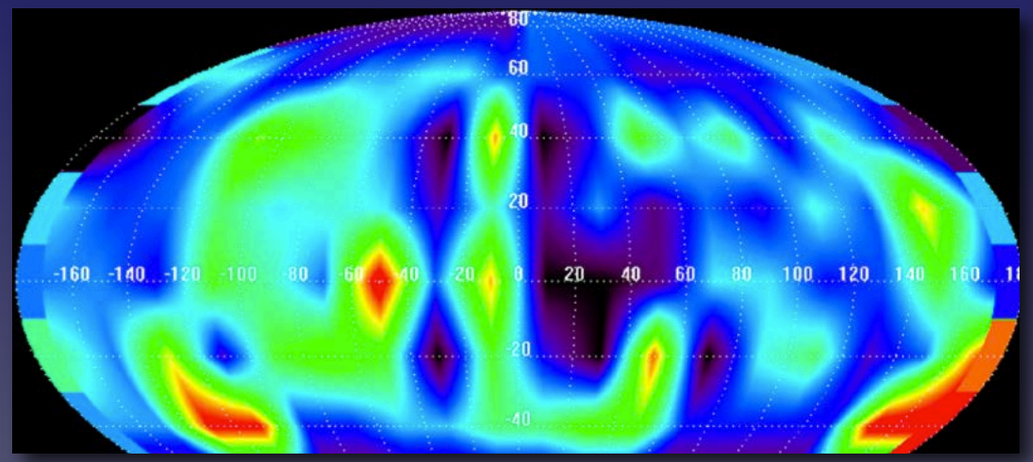
Phobos close fly-by

Five MEX HRSC images from Jan 2011 morphed by SolSysGallery / ESA, DLR, FU Berlin (G. Neukum)

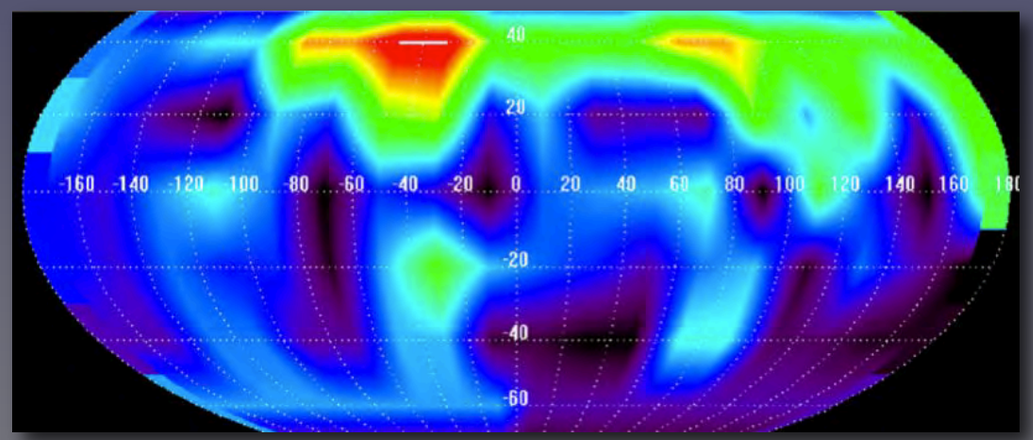
Methane in the martian atmosphere



Black / red: PFS data with 1σ confidence limits
Green: synthetic spectrum with 0 ppbv CH_4
Violet: synthetic spectra with 10, 20, 30, 40, 50 ppbv CH_4



Northern spring



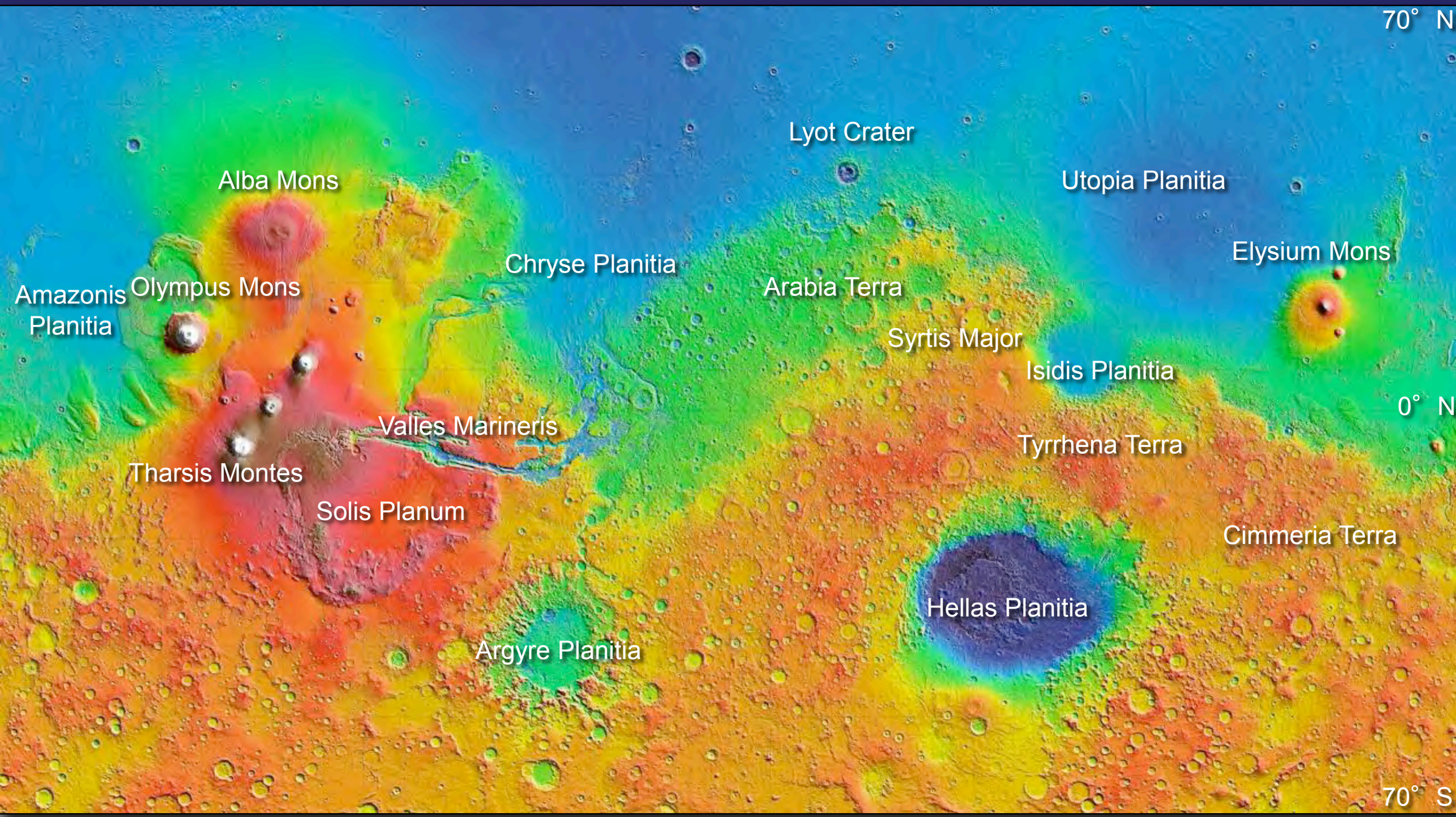
Northern autumn

CH_4 column density from 0 to ~15 x 10^{-15}

- Small amounts of methane detected by MEX; later confirmed from Earth
- Origin potentially biological; geochemical processes also possible
- Variable with location and season: should be long-lived and uniform
- Rapidly destroyed by unknown surface processes; hostile to organics?

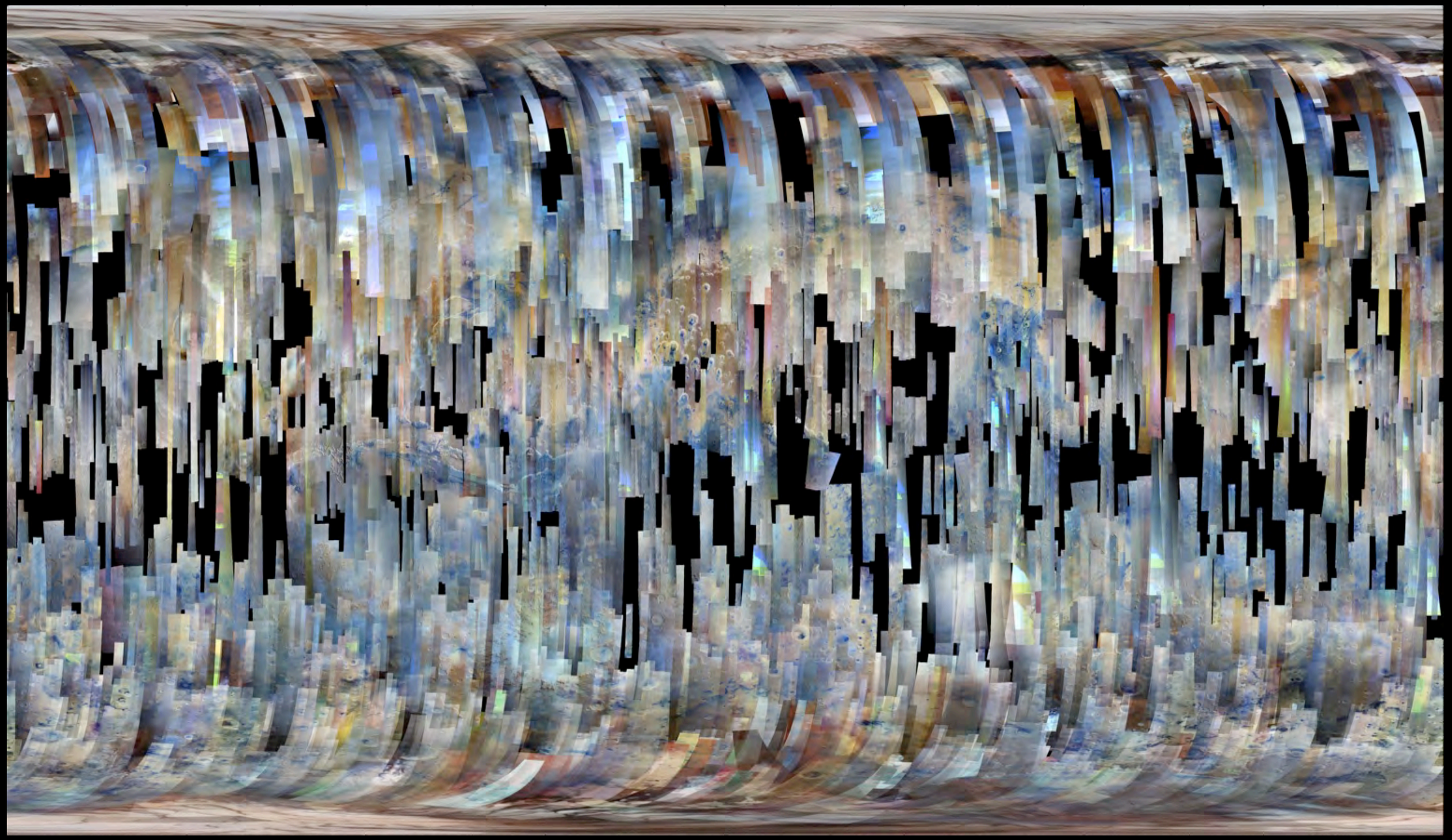
PFS data, Formisano et al. 2004, Nature; Geminale et al. 2011, PSS / ESA

The complex surface of Mars



Mars Orbiter Laser Altimeter, MGS / NASA

Mars Express imaging coverage to date



Mars Express HRSC images / ESA (Fred Jansen), DLR, FU Berlin (G. Neukum)

Chaotic terrain due to water, faults, & craters

MEX HRSC image of Kasei Valles & Sacra Fossae boundary / ESA, DLR, FU Berlin (G. Neukum)

Northern ice cap on Mars at summer solstice

MEX HRSC image / ESA, DLR, FU Berlin (G. Neukum)

Water-ice filled crater

MEX HRSC image of Vastitas Borealis / ESA, DLR , FU Berlin (G. Neukum)

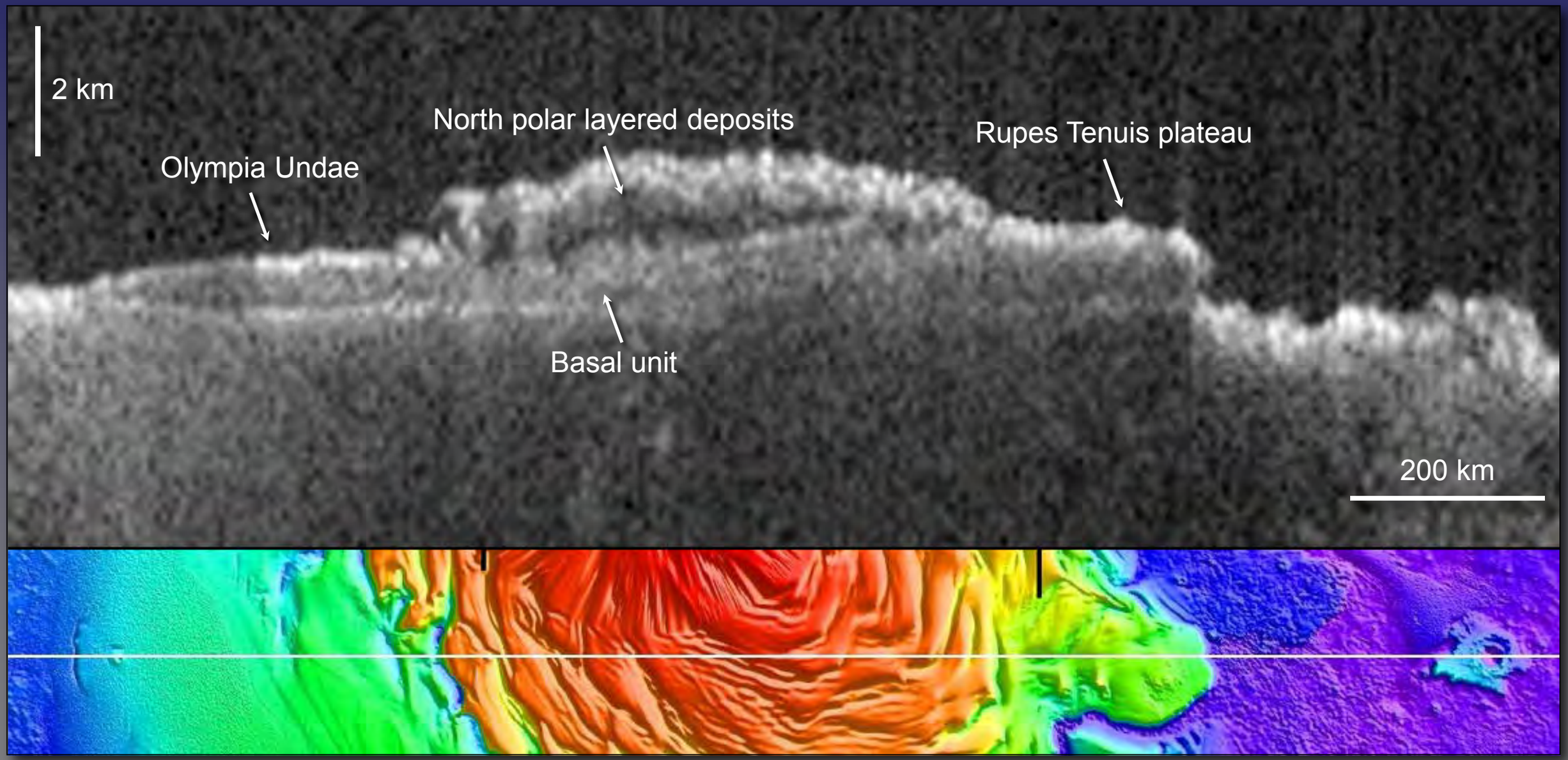
Fossil river delta in Eberswalde crater

MEX HRSC image / ESA, DLR, FU Berlin (G. Neukum)

Water-ice glaciers just below the surface

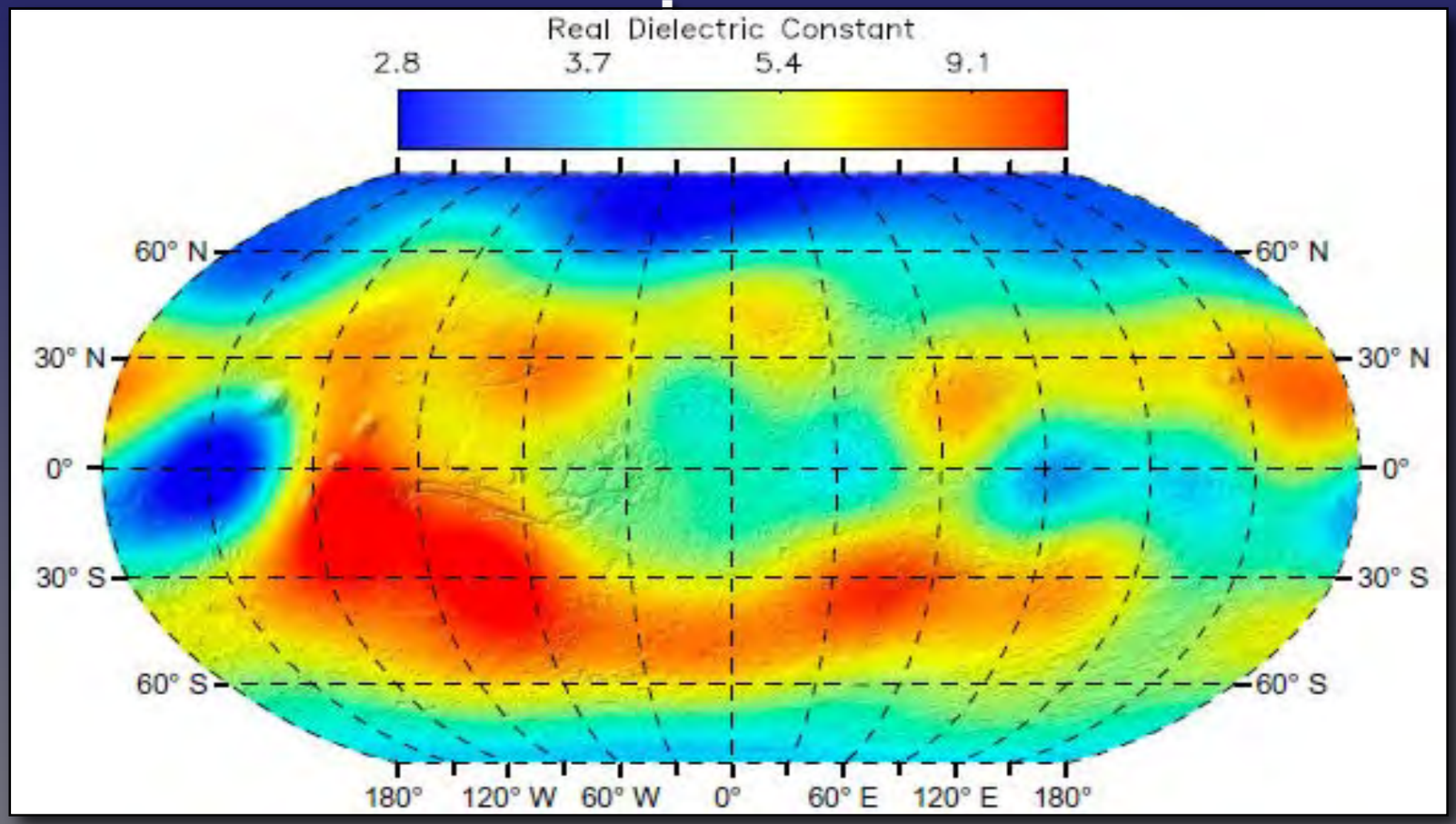
MEX HSRC image of lobate debris aprons in Phlegra Montes, Elysium province / ESA, DLR, FU Berlin (G. Neukum)

Probing below the surface



Single 2–5MHz radar pass over North Pole in June 2011 / Mars Express MARSIS / ESA, ASI, NASA

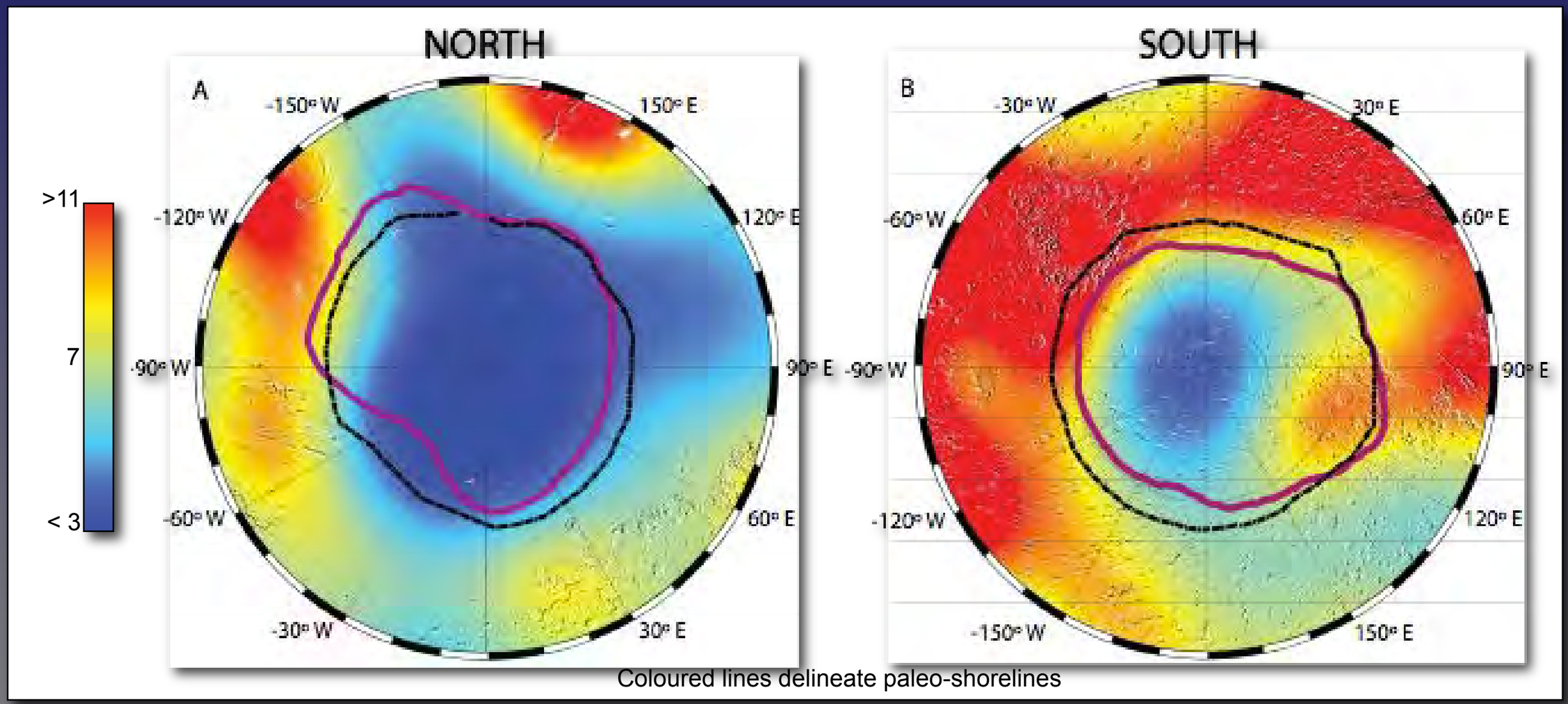
Inventory of equatorial sub-surface water



- MARSIS radar echo map at 3–5 MHz
- Probes sub-surface to few tens of metres depth
- Low dielectric constant (<3) reveals presence of water ice
- Total volume of ice ~ 10^6 km^3, equivalent to polar cap
- Ice at equator perhaps due to “climatic excursion”; now sublimating

MEX MARSIS, Mouginot et al. 2010, Icarus / ESA

A short-lived polar ocean?



Coloured lines delineate paleo-shorelines

- High dielectric constant in south: high-density volcanic materials
- Low in north: low-density sediments, subsurface ice, or mixture of both
- Result of massive and likely brief inundation ~ 3 Gyr ago: “Oceanus Borealis”

MEX MARSIS / Mouginot et al. 2012, GRL / ESA

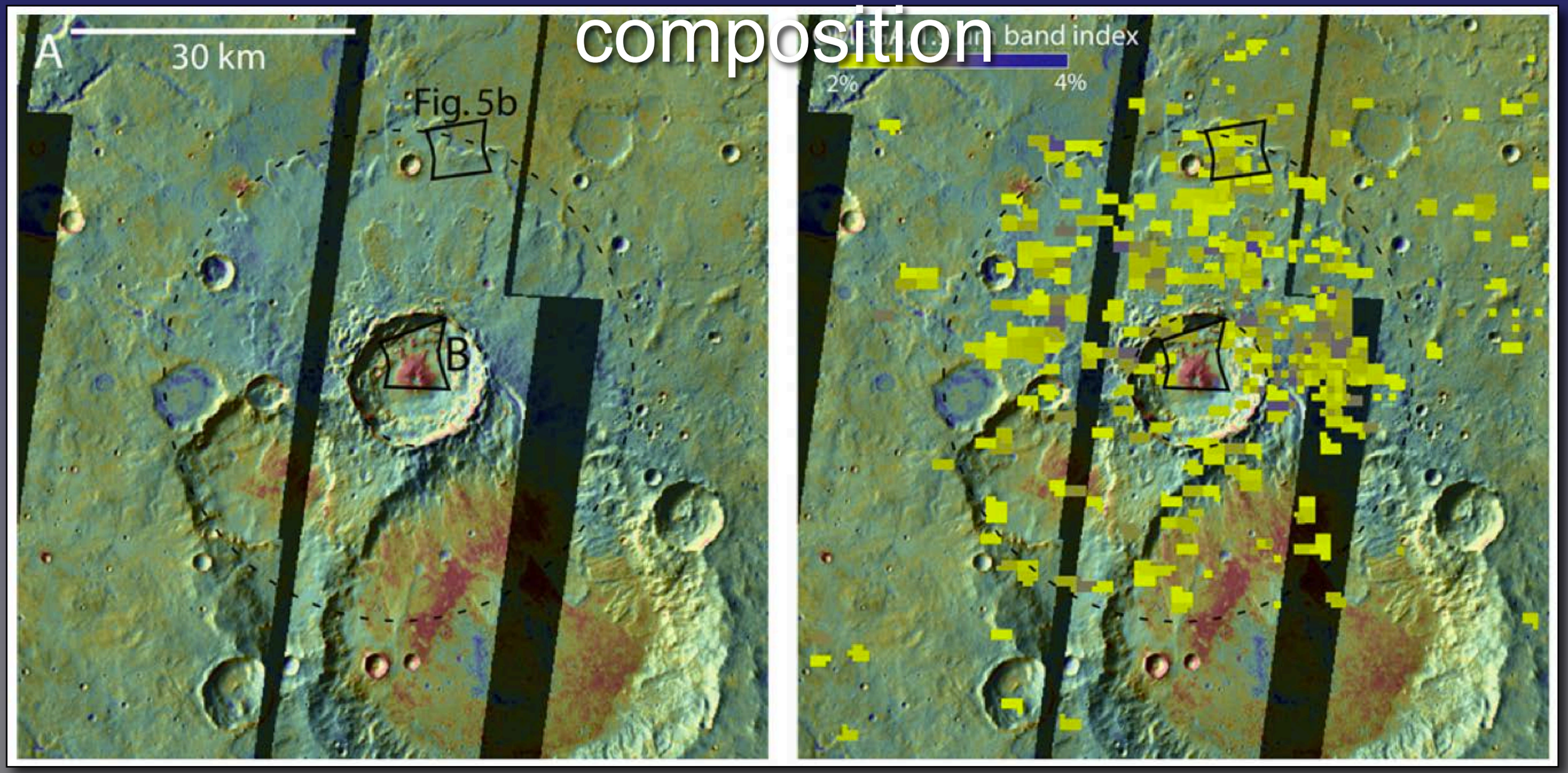
Mars, a few billion years ago?

Daien Ballard, based on NASA MGS MOLA data, with updated shorelines, recent volcanoes removed

Impact craters excavate sub-surface material

MEX HRSC image of crater in Melas Dorsa region / ESA, DLR, FU Berlin (G. Neukum)

Spectroscopy reveals the mineral composition



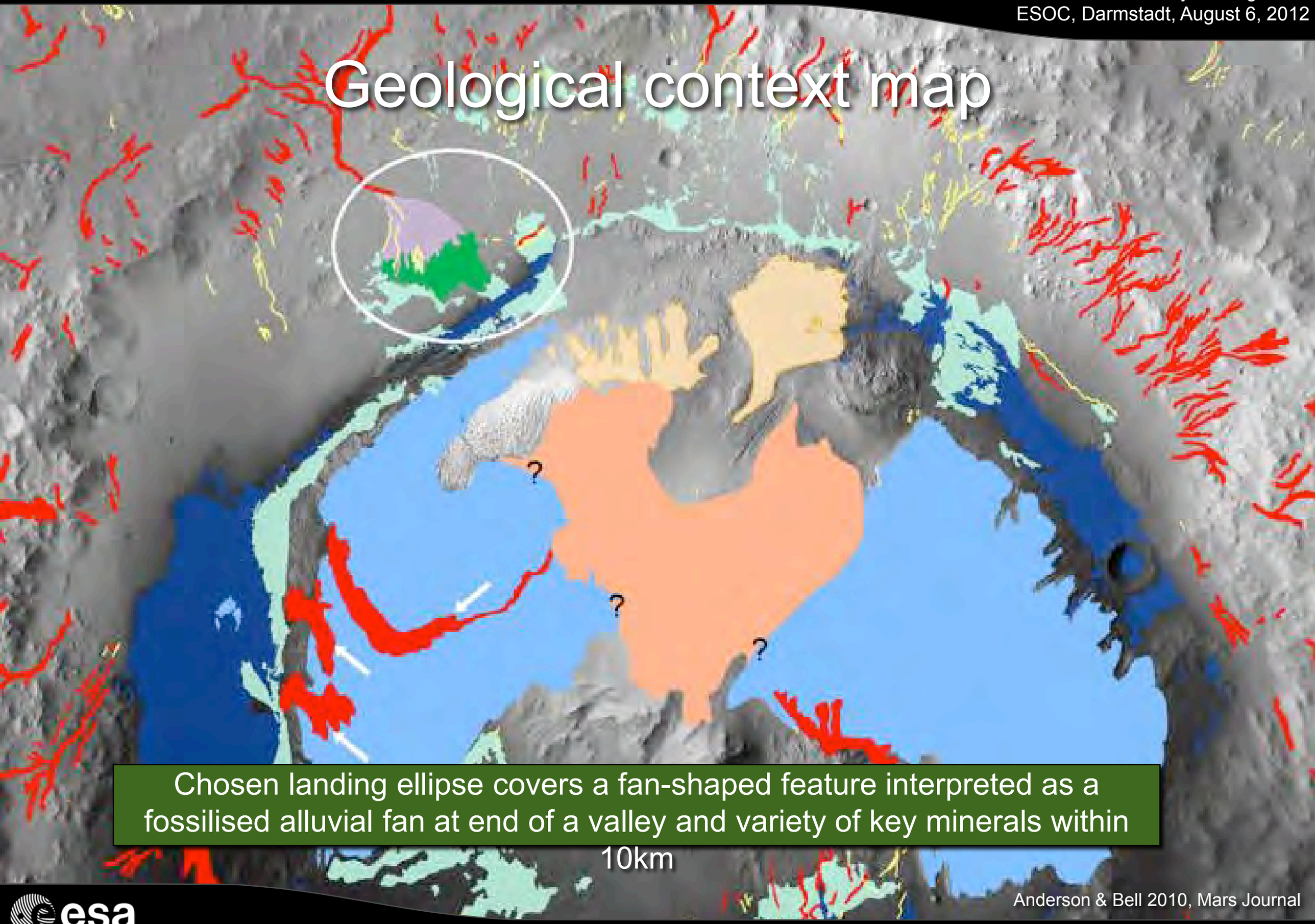
Debris aprons surrounding craters in southern highlands contain hydrated minerals formed at high temperatures (~100–300° C) in deep (few km) subsurface

MEX OMEGA mapping in Tyrrhena Terra over Mars Odyssey IR images / Loizeau et al. 2012, Icarus / ESA, NASA

So, why Gale crater today?

Combined MEX HRSC, MRO Context Camera, and Viking data / NASA, ESA, DLR, FU Berlin (G. Neukum)

Geological context map



Chosen landing ellipse covers a fan-shaped feature interpreted as a fossilised alluvial fan at end of a valley and variety of key minerals within

Anderson & Bell 2010, Mars Journal

Mineral treasure chest within driving distance

Green: phyllosilicates
Blue/magenta: sulphates
Red: olivine
Orange: mixed sulphates and clays

MRO CRISM data / NASA

Drück die Daumen für Curiosity!

NASA

Vielen Dank