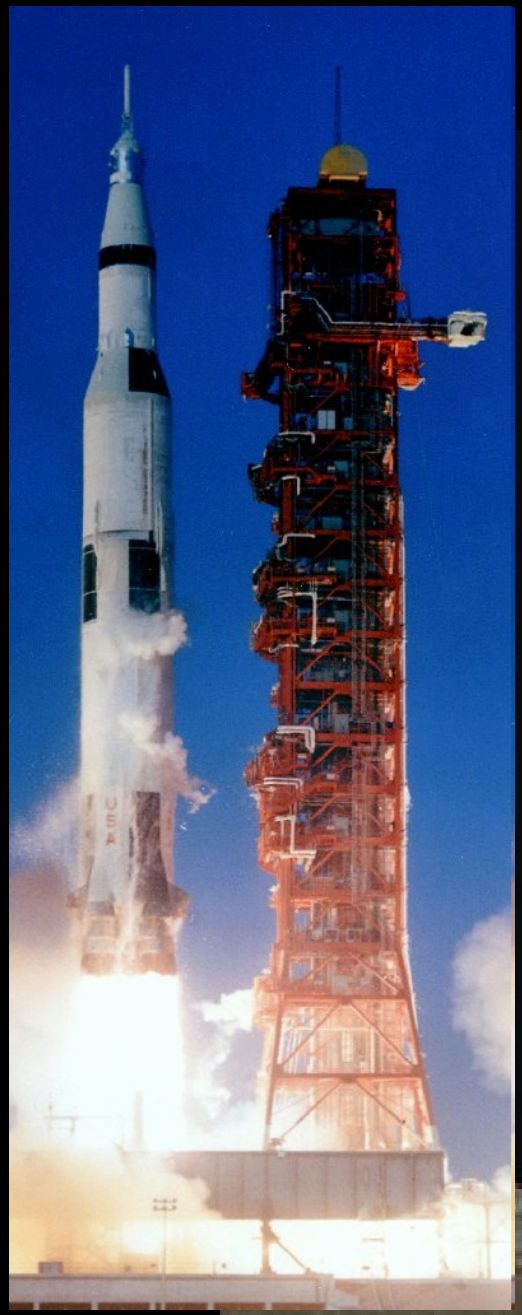
Planetology

Unlocking the Secrets of the Solar System

Tom Jones and Ellen Stofan


USA

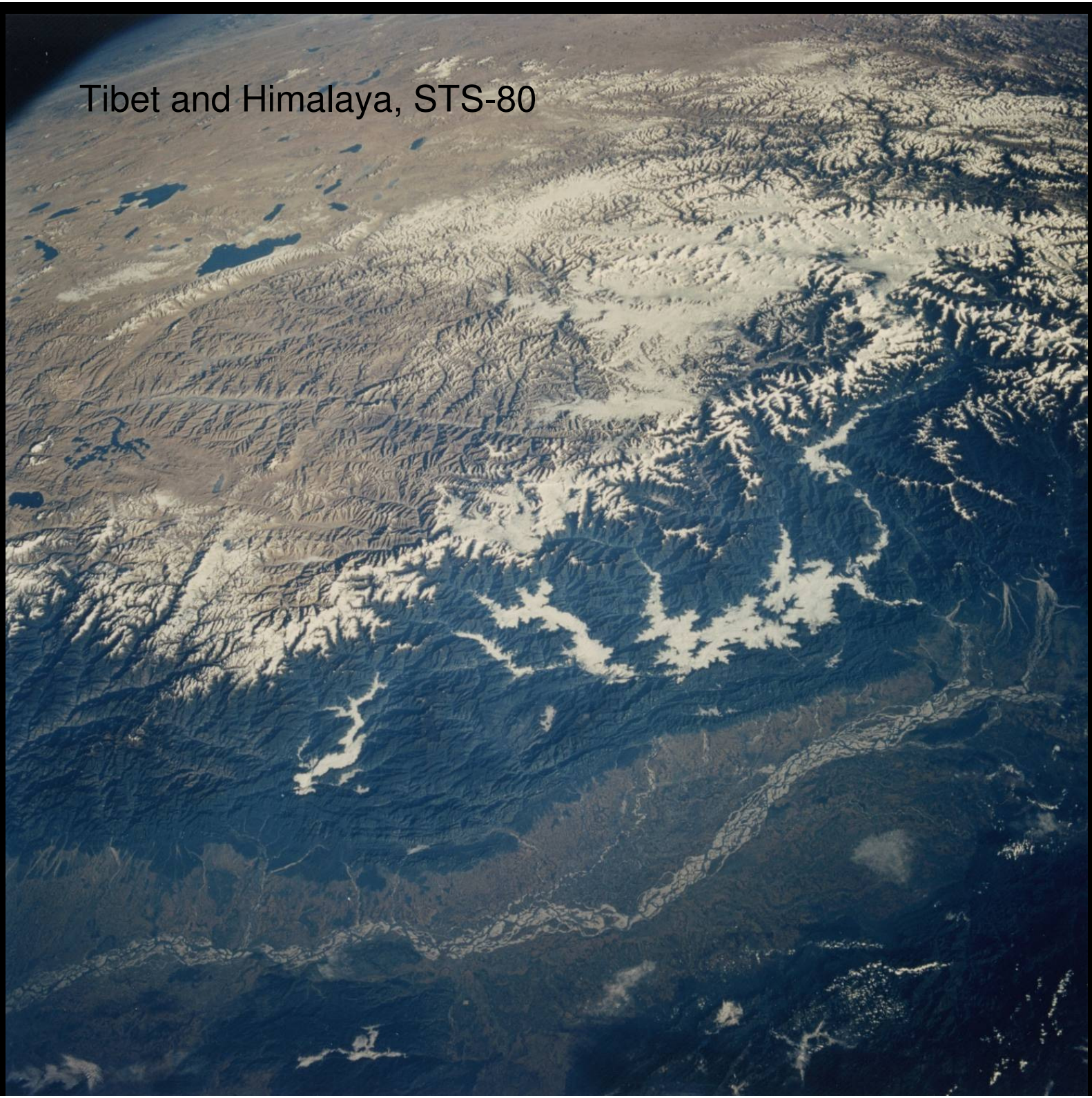
Overview

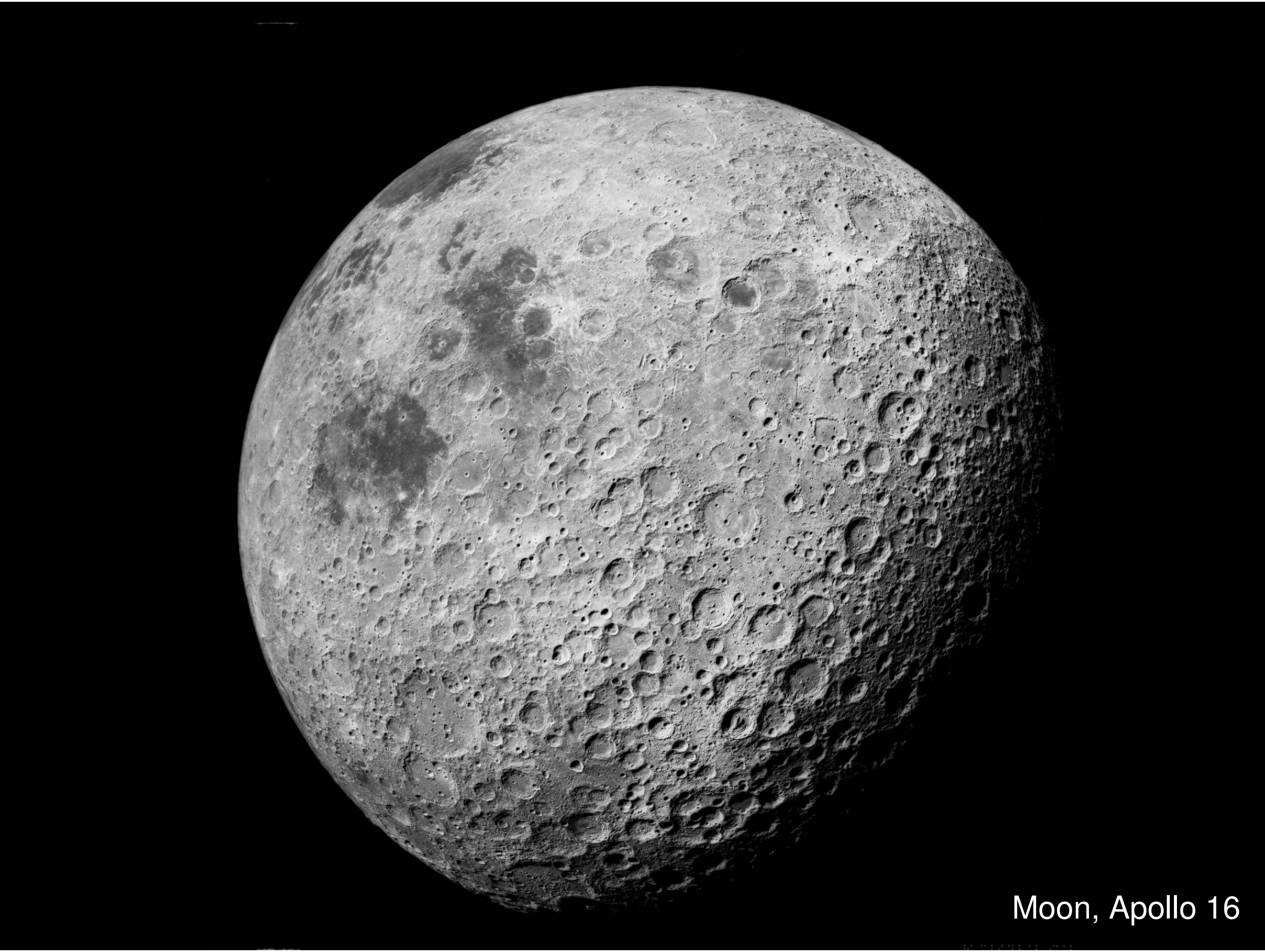
- Examples from the pages of Planetology
- Experiences from the "field"
- Earth, our home, is also our classroom


Australia, STS-80

Chaiten Volcano, Chile

UPI Gutierrez


Tibet and Himalaya, STS-80



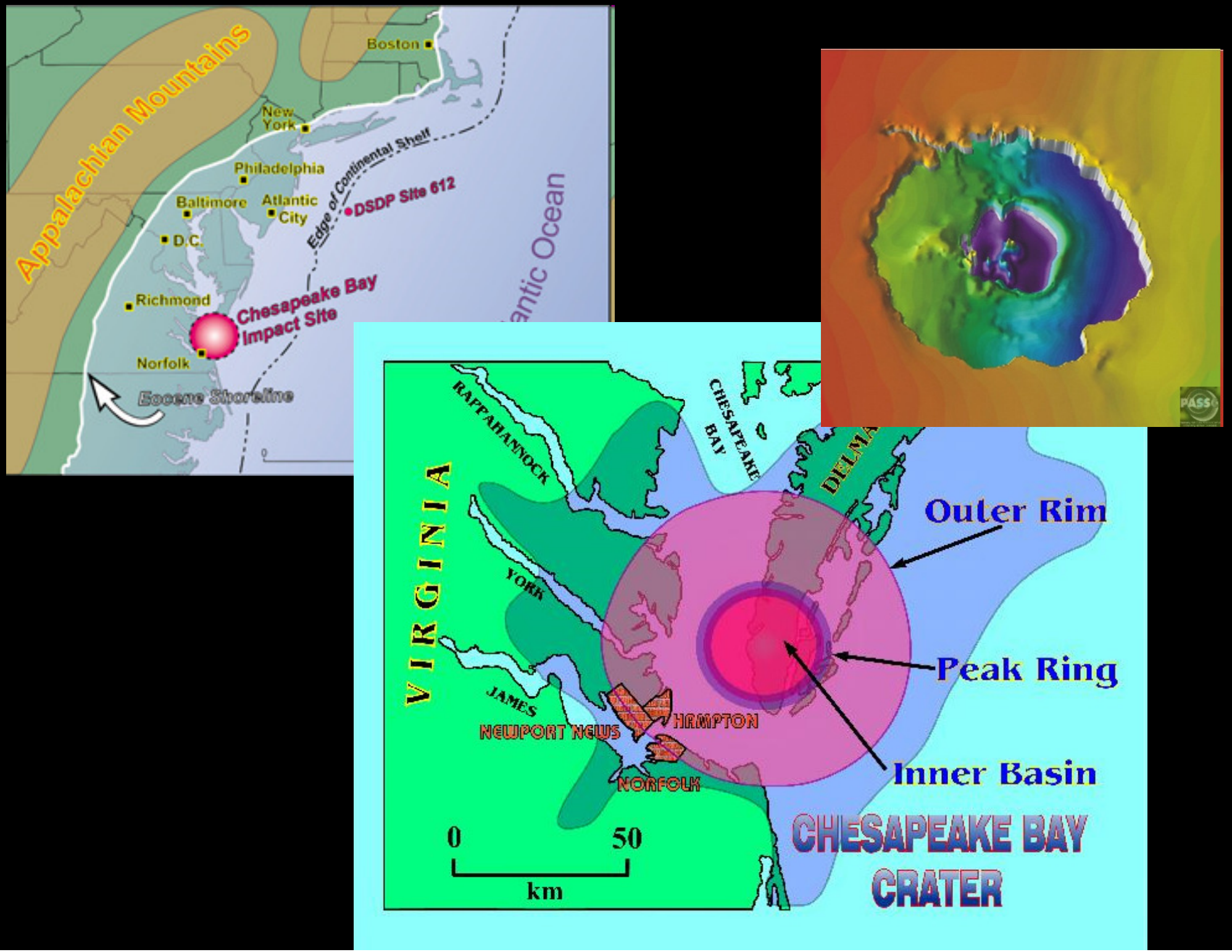
Moon, Apollo 16

Barringer Crater, Arizona

Shorty Crater, Apollo 17
1972

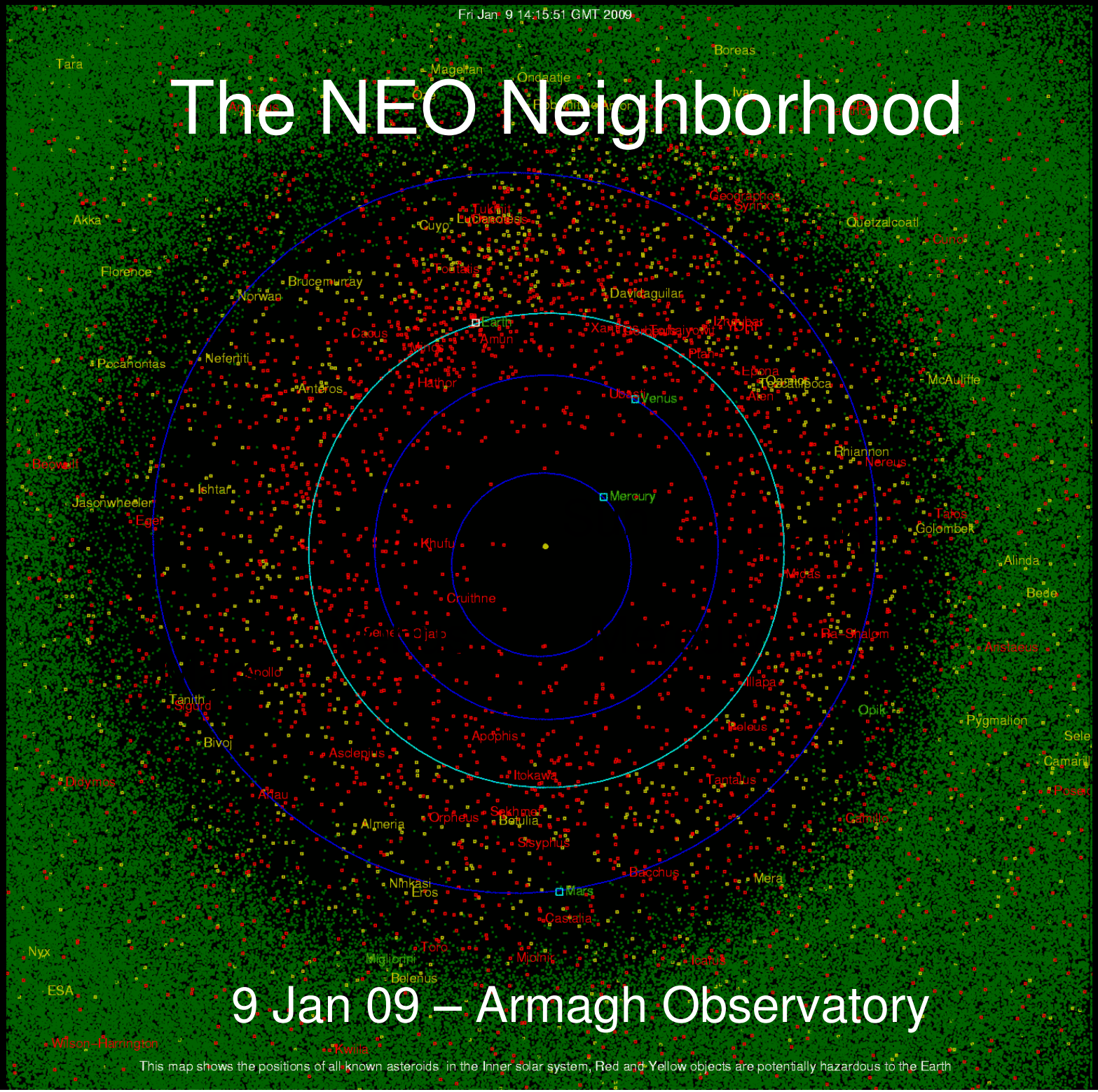

Victoria Crater, MRO

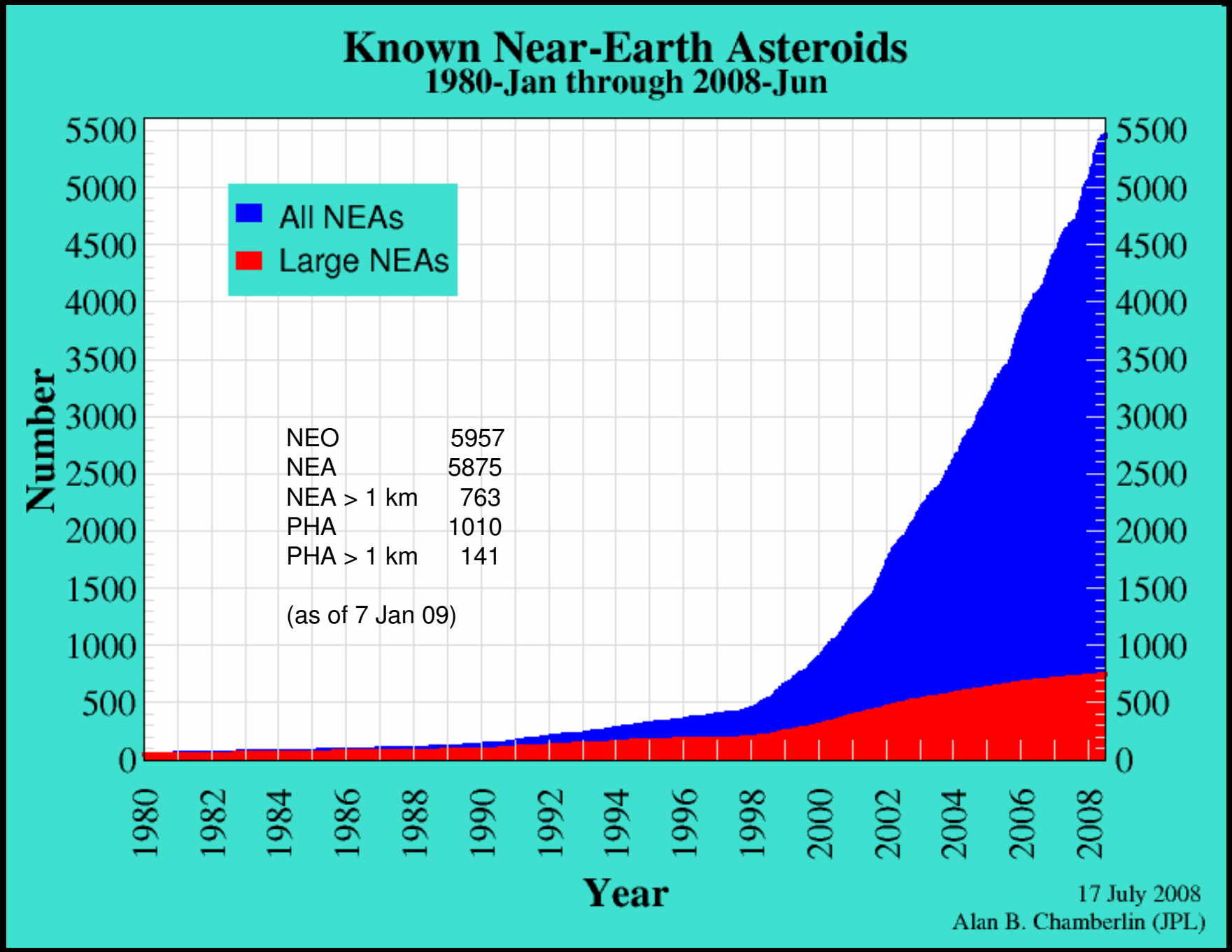
Bedrock, Victoria Crater, Mars


Appalachian Mountains
Boston
New York
Philadelphia
Baltimore
Atlantic City
DSDP Site 612
Edge of Continental Shelf
D.C.
Richmond
Chesapeake Bay Impact Site
Norfolk
Eocene Shoreline
RAPPAHANNOCK
CHESAPEAKE BAY
VIRGINIA
YORK
JAMES
NEWPORT NEWS
HAMPTON
NORFOLK
Outer Rim
Peak Ring
Inner Basin
0
50
km
CHESAPEAKE BAY CRATER

Itokawa (JAXA)

100 m

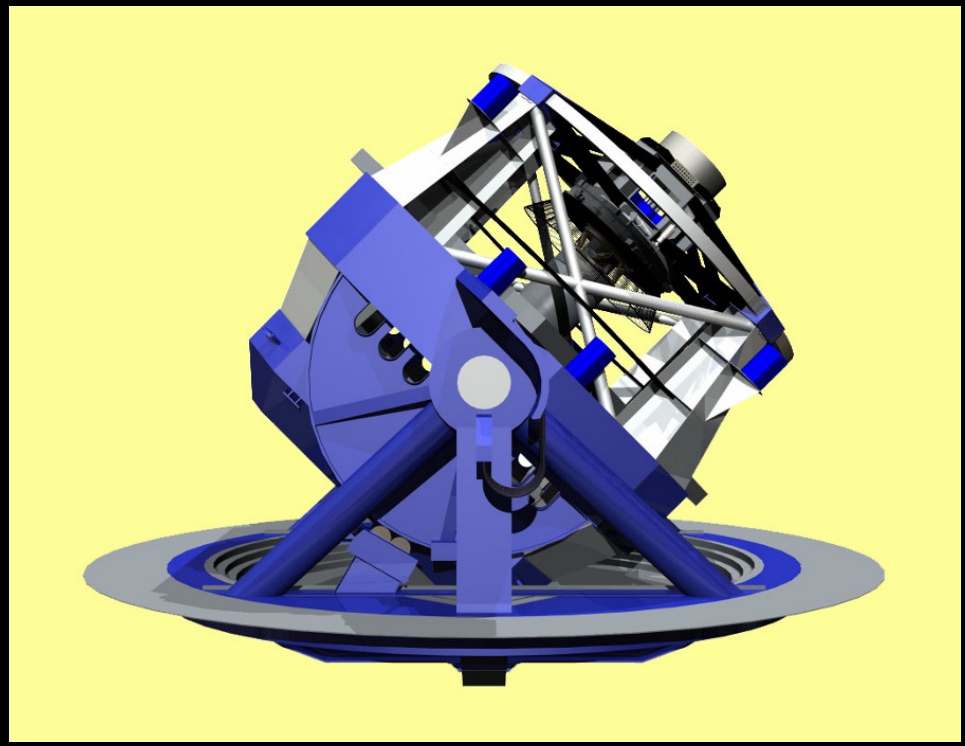

Fri Jan 9 14:15:51 GMT 2009
The NEO Neighborhood
Tara
Boreas
Magellan
Ondaatje
Ivar
Akka
Florence
Brucemurray
Norwan
Davidaguilar
Quetzalcoatl
Cuno
Geographos
Syrinx
Cuyo
Eucharistes
Tukmit
Foxtatis
Caous
Amun
Izhdubar
Pocahontas
Nefertiti
Anteros
Hathor
Venus
Ubasti
Ebona
Toxcatlpoca
Alen
McAuliffe
Bhiannon
Nereus
Beowulf
Ishtar
Jasonwheeler
Ege
Mercury
Khufu
Cruithne
Talos
Golombek
Alinda
Midas
Bede
Ra-Shalom
Aristaeus
Illapa
Apollo
Tanith
Sigurd
Bivoj
Asclepius
Apophis
Opik
Pygmalion
Sele
Camarij
Didymos
Itokawa
Tantalus
Posei
Altau
Orpheus
Sekhmet
Betulia
Almeria
Camillo
Sisyphus
Bacchus
Mera
Nnkasi
Eros
Mars
Castalia
Nyx
Toro
Midnight
Icarus
Belenus
ESA
Wilson-Harrington
Kwiila
9 Jan 09 – Armagh Observatory
This map shows the positions of all known asteroids in the Inner solar system, Red and Yellow objects are potentially hazardous to the Earth


Known Near-Earth Asteroids
1980-Jan through 2008-Jun
All NEAs
Large NEAs
NEO 5957
NEA 5875
NEA > 1 km 763
PHA 1010
PHA > 1 km 141
(as of 7 Jan 09)
Number
Year
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
17 July 2008
Alan B. Chamberlin (JPL)

New Systems Will Expand Search

500,000 new NEOs by 2020

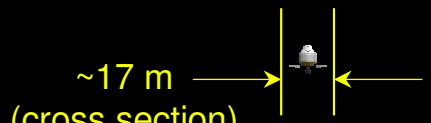
Pan-STARRS-1

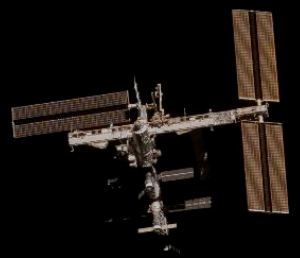


8.4m "LSST"
(Large-aperture Synoptic Survey Telescope)

Asteroid Itokawa, ISS, and CEV Orion

CEV Orion



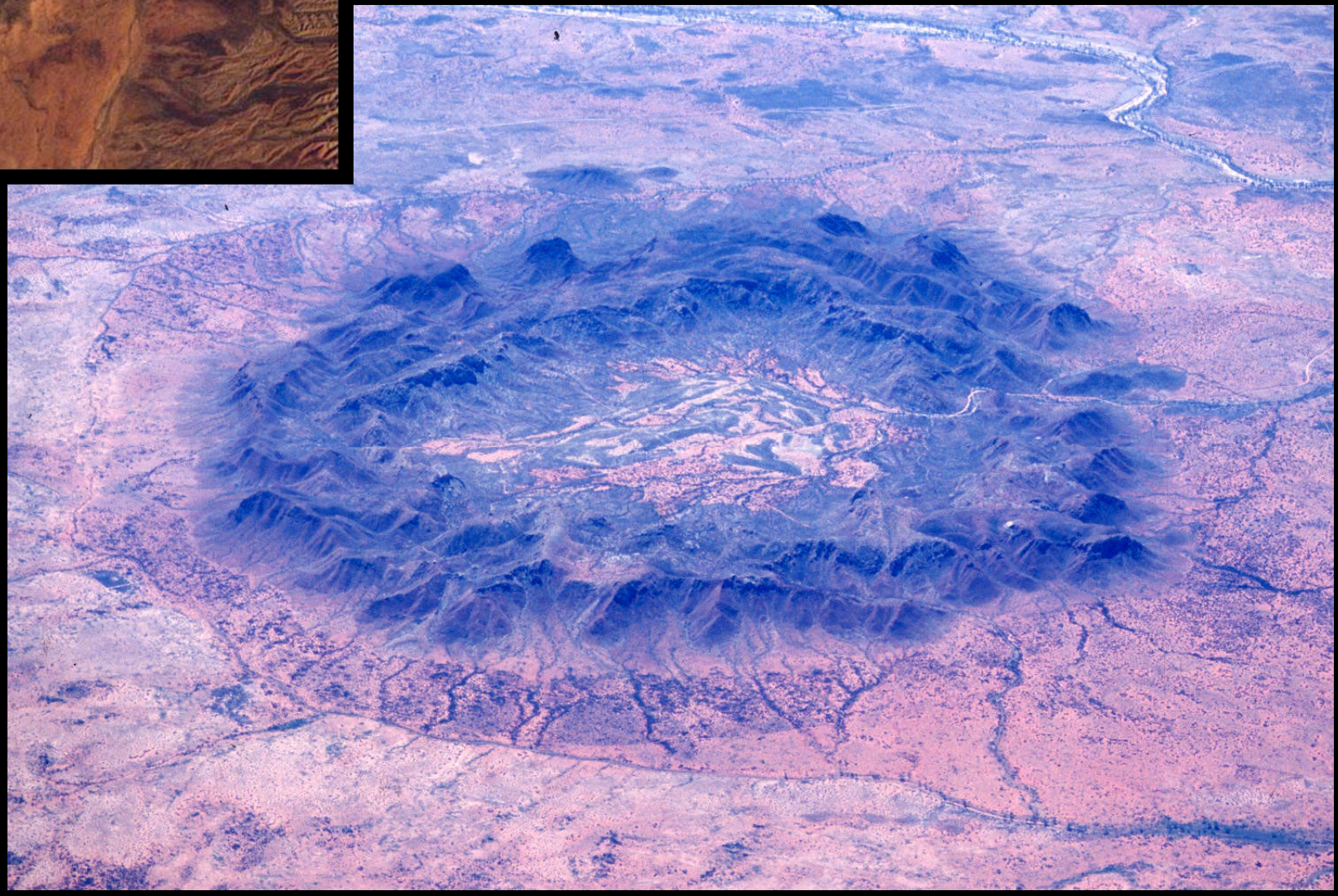


540 meters

~100 meters
(ISS at 12A.1 Stage)

JAXA, NASA

Gosses Bluff, Australia
Age: 142 my – Diam: 22 km



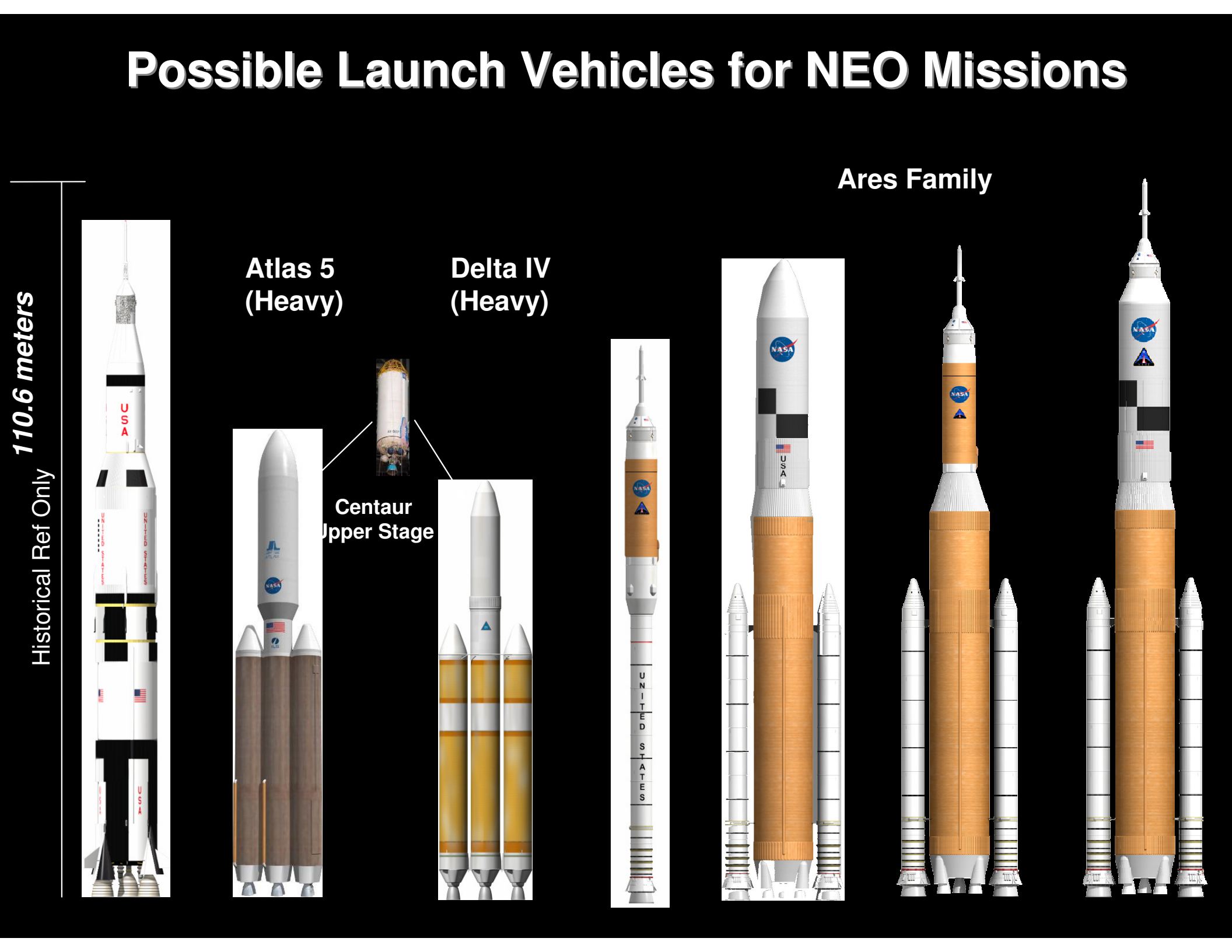
NEOs – Why Go?

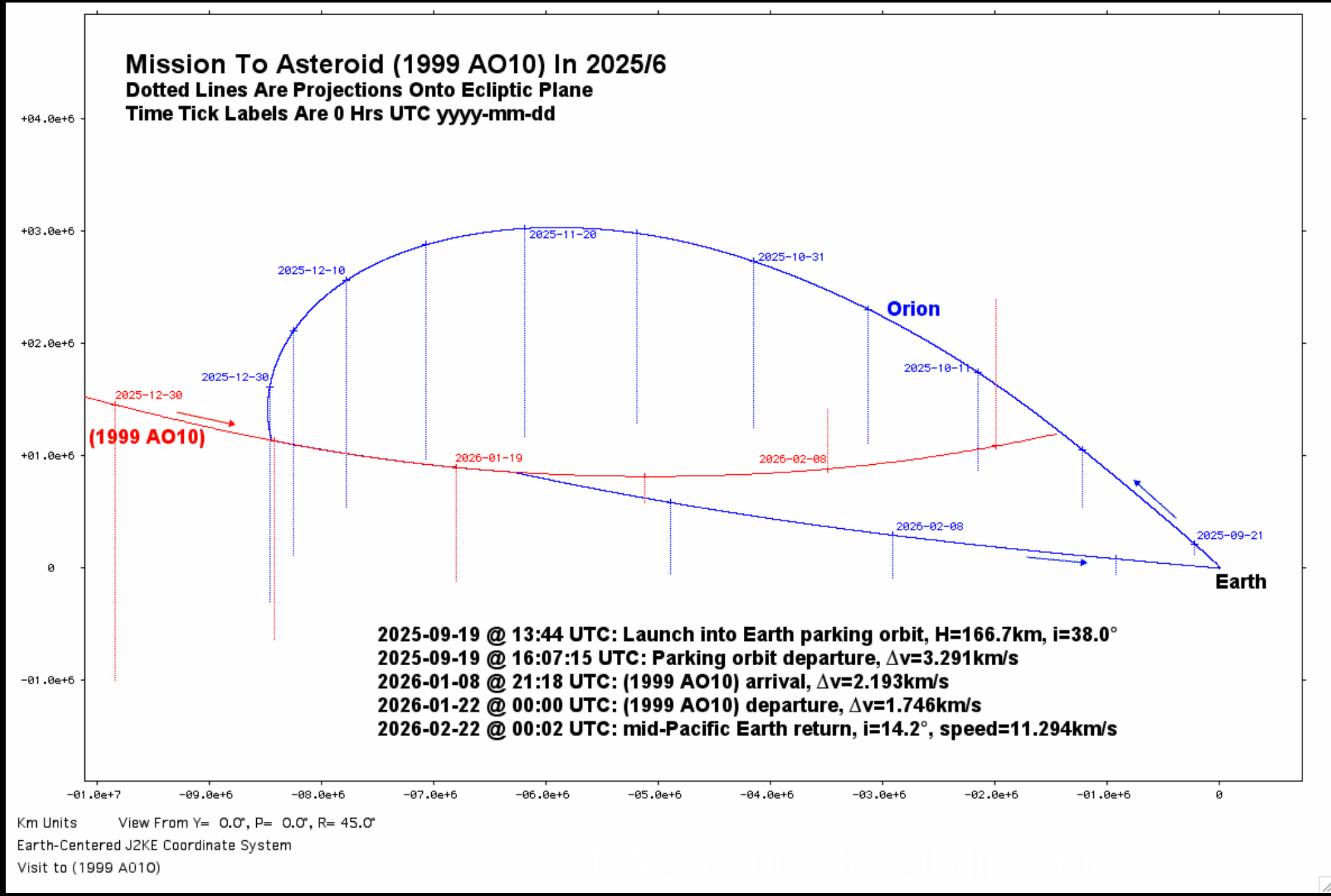
A common sense use of our space technology…
…to help eliminate the possibility of this:

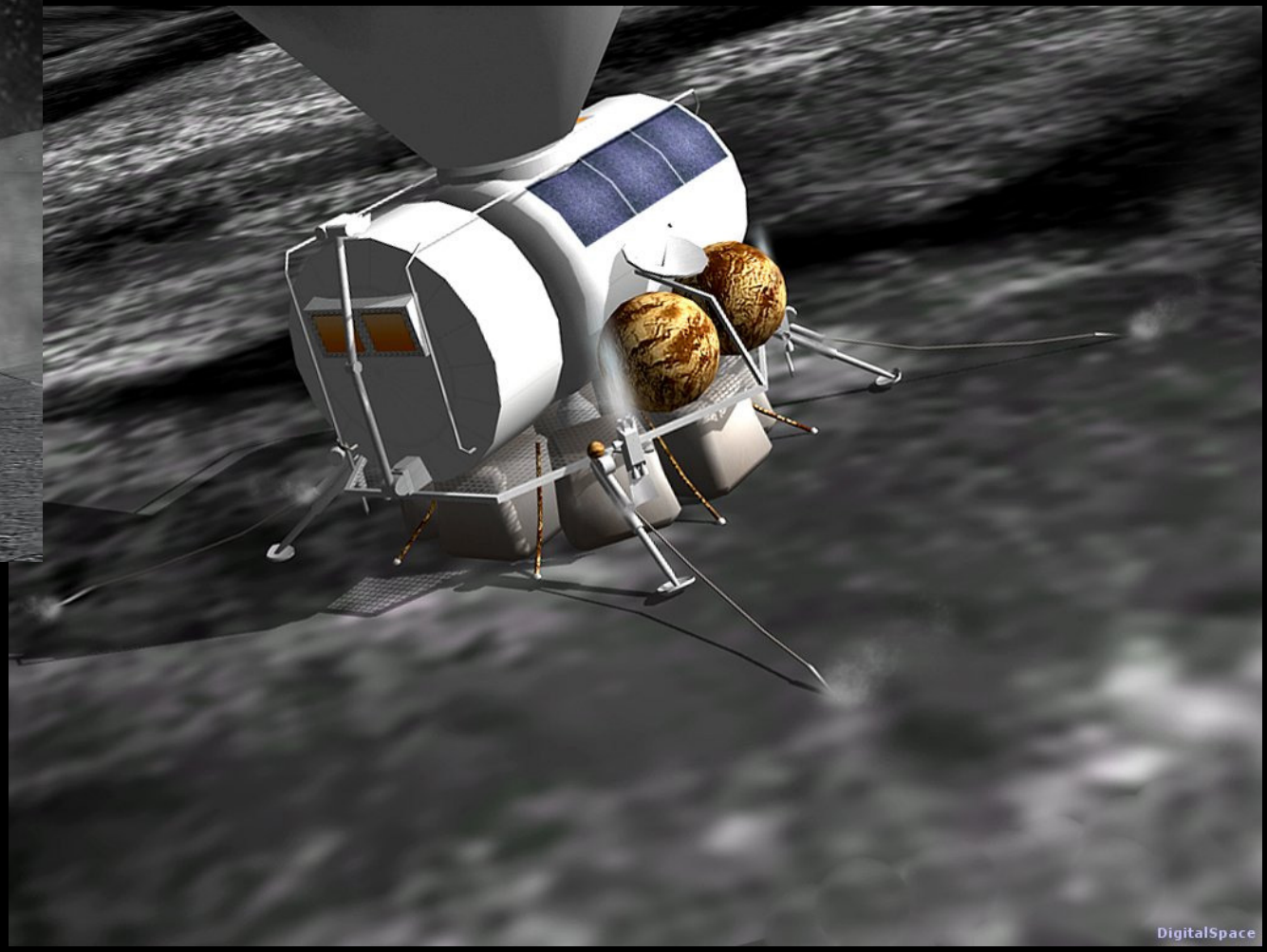
Pingualuit Crater,
Quebec

Tunguska

Possible Launch Vehicles for NEO Missions




Mission To Asteroid (1999 AO10) In 2025/6
Dotted Lines Are Projections Onto Ecliptic Plane
Time Tick Labels Are 0 Hrs UTC yyyy-mm-dd
+04.0e+6
+03.0e+6
+02.0e+6
+01.0e+6
0
-01.0e+6
-01.0e+7
-09.0e+6
-08.0e+6
-07.0e+6
-06.0e+6
-05.0e+6
-04.0e+6
-03.0e+6
-02.0e+6
-01.0e+6
0
2025-11-20
2025-10-31
2025-12-10
Orion
2025-12-30
2025-10-11
2025-12-30
(1999 AO10)
2026-01-19
2026-02-08
2026-02-08
2025-09-21
Earth
2025-09-19 @ 13:44 UTC: Launch into Earth parking orbit, H=166.7km, i=38.0°
2025-09-19 @ 16:07:15 UTC: Parking orbit departure, Δv=3.291km/s
2026-01-08 @ 21:18 UTC: (1999 AO10) arrival, Δv=2.193km/s
2026-01-22 @ 00:00 UTC: (1999 AO10) departure, Δv=1.746km/s
2026-02-22 @ 00:02 UTC: mid-Pacific Earth return, i=14.2°, speed=11.294km/s
Km Units View From Y= 0.0°, P= 0.0°, R= 45.0°
Earth-Centered J2KE Coordinate System
Visit to (1999 AO10)


DigitalSpace

The Asteroid Option

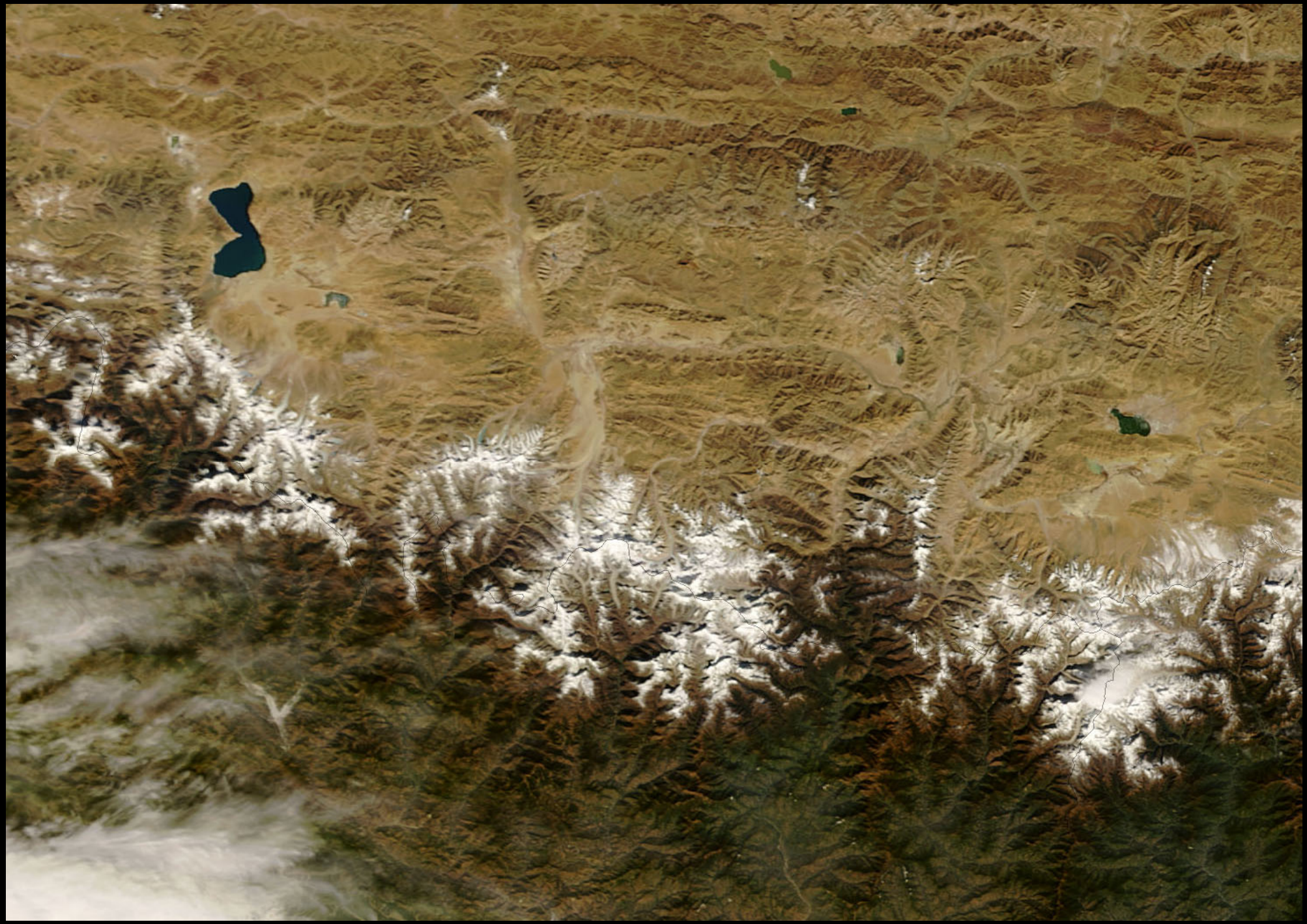
Highly visible and dramatic exploration:

From 0.05 AU,
Earth is apparent size
of a BB held at 2.4 m

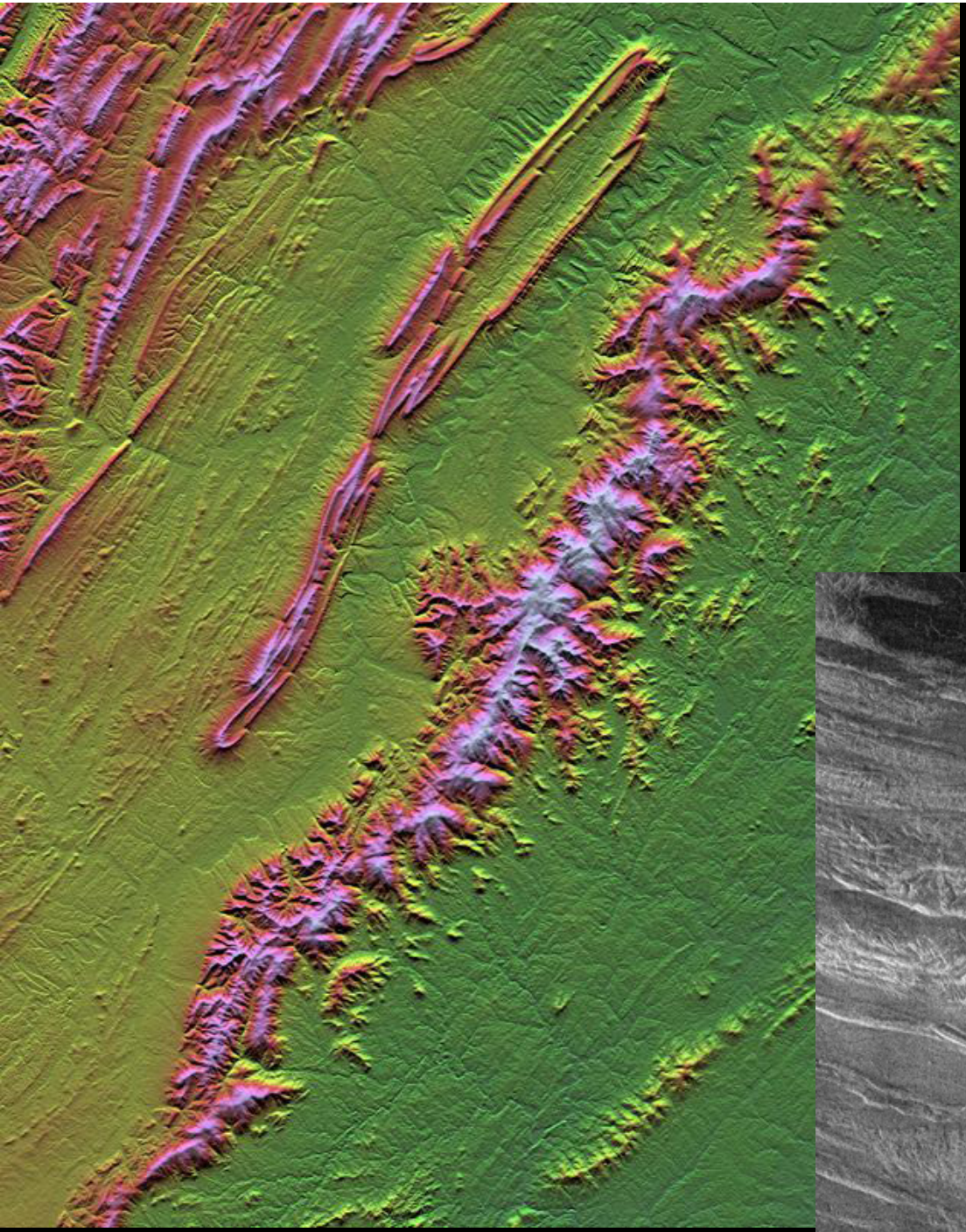
NEO Missions: Stepping Stones to Mars

Summary

- NEOs can be reached with planned systems
- New and different science
- Resources a certainty
- Exploration momentum
- Right for the Planet



Folded mountains on Venus and Earth

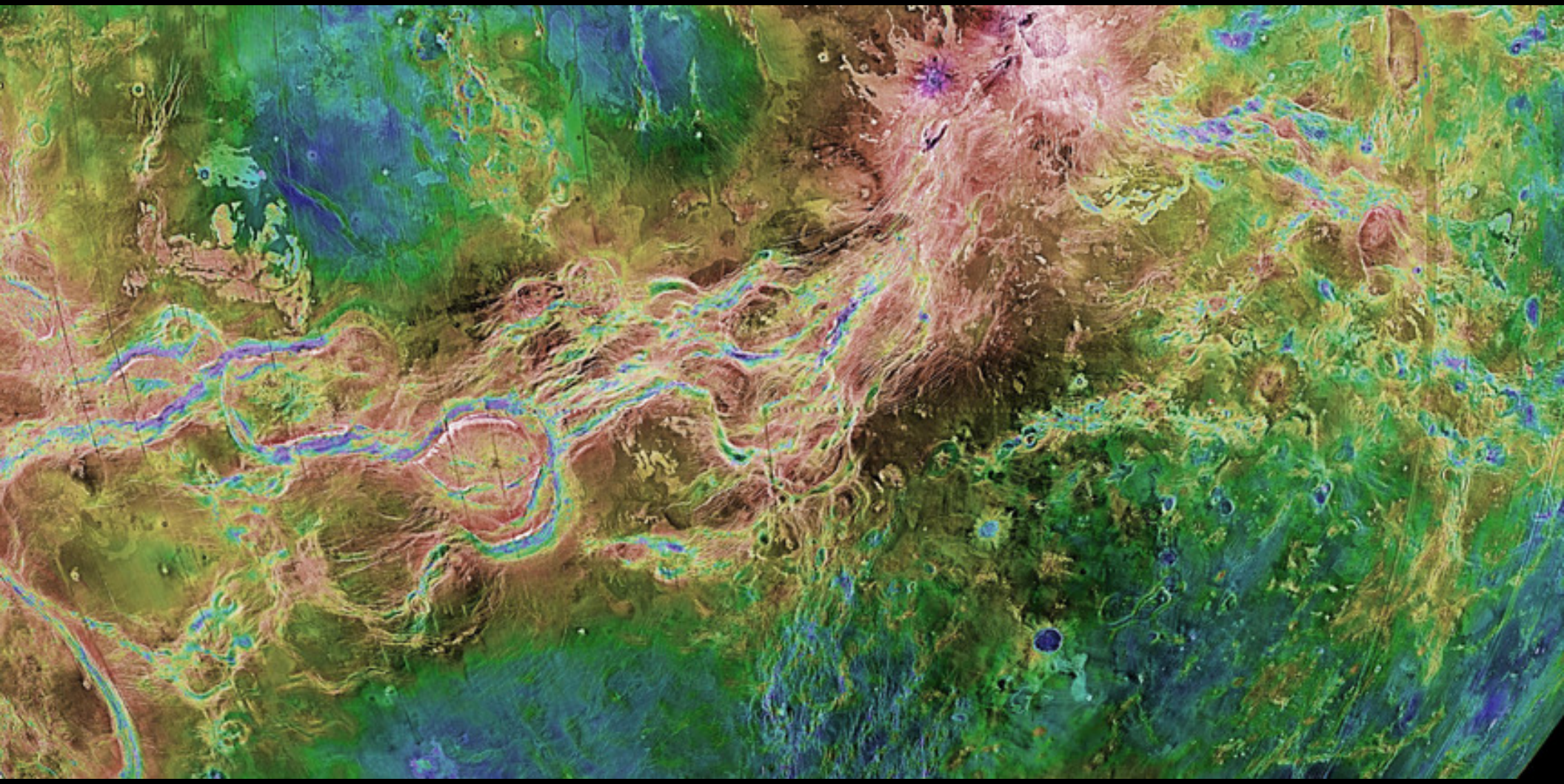


PIA03383
Shenandoah National Park

Faults slice through L.A.

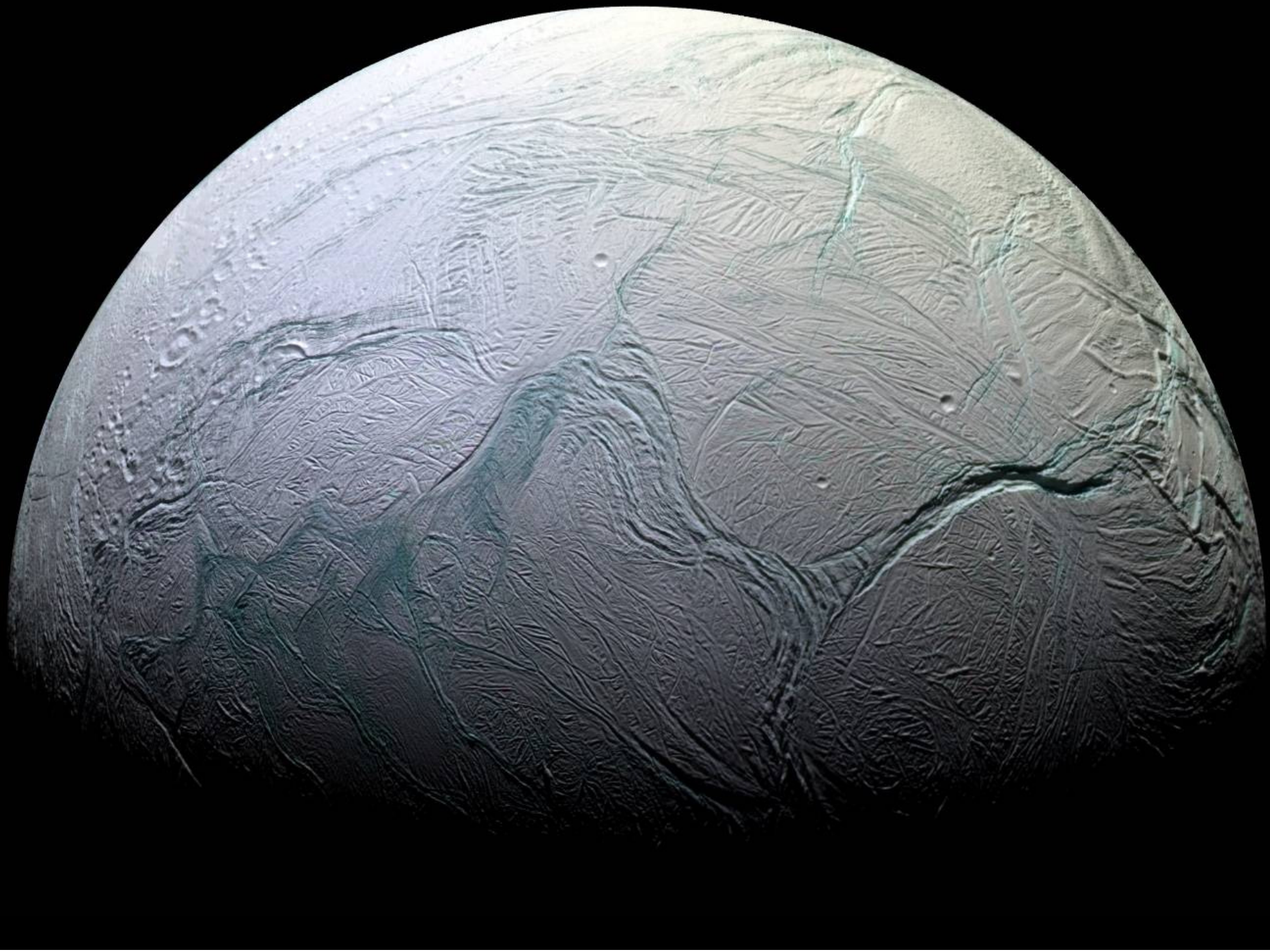
PIA03376: **SRTM** / **Landsat**

Tectonics: Surfaces in Motion

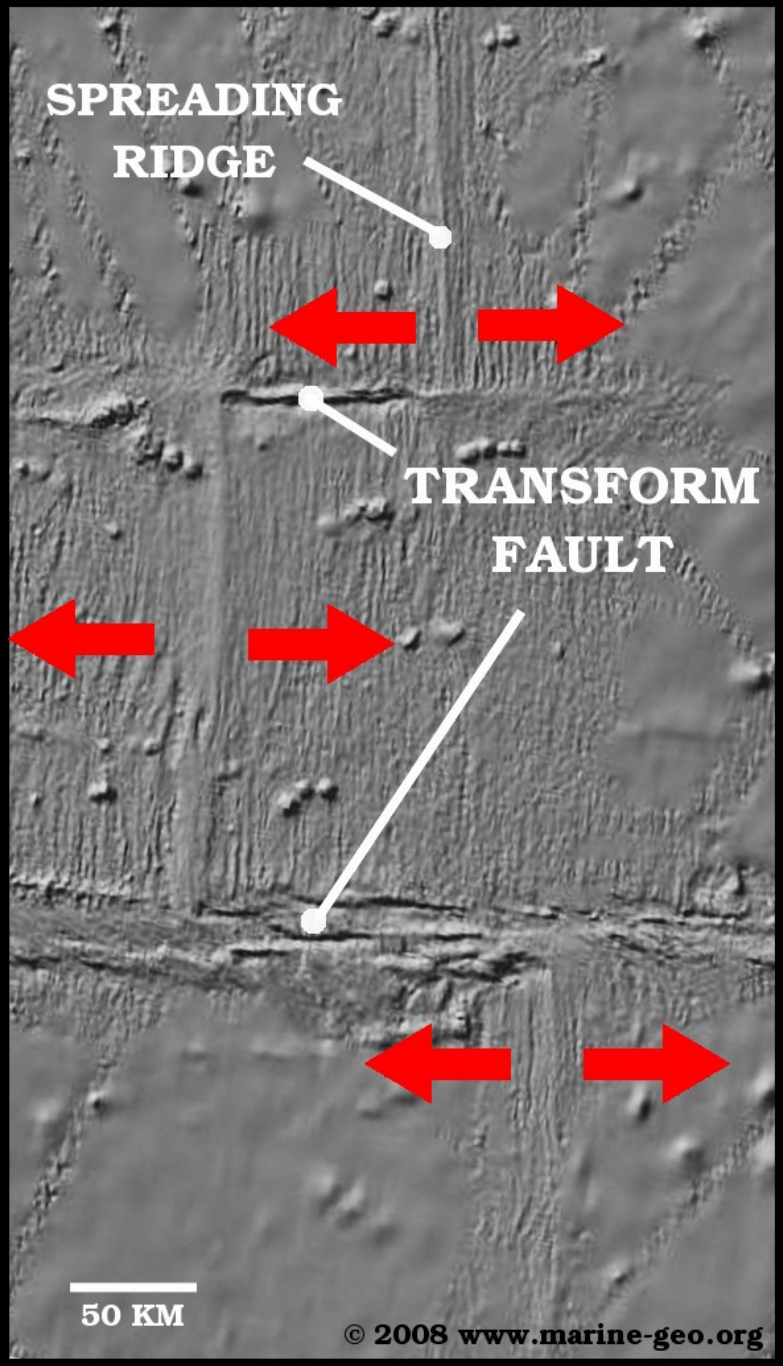


Venus Rift Zones, Magellan

Enceladus – Oct 5, 2008



EARTH
(East Pacific Rise)



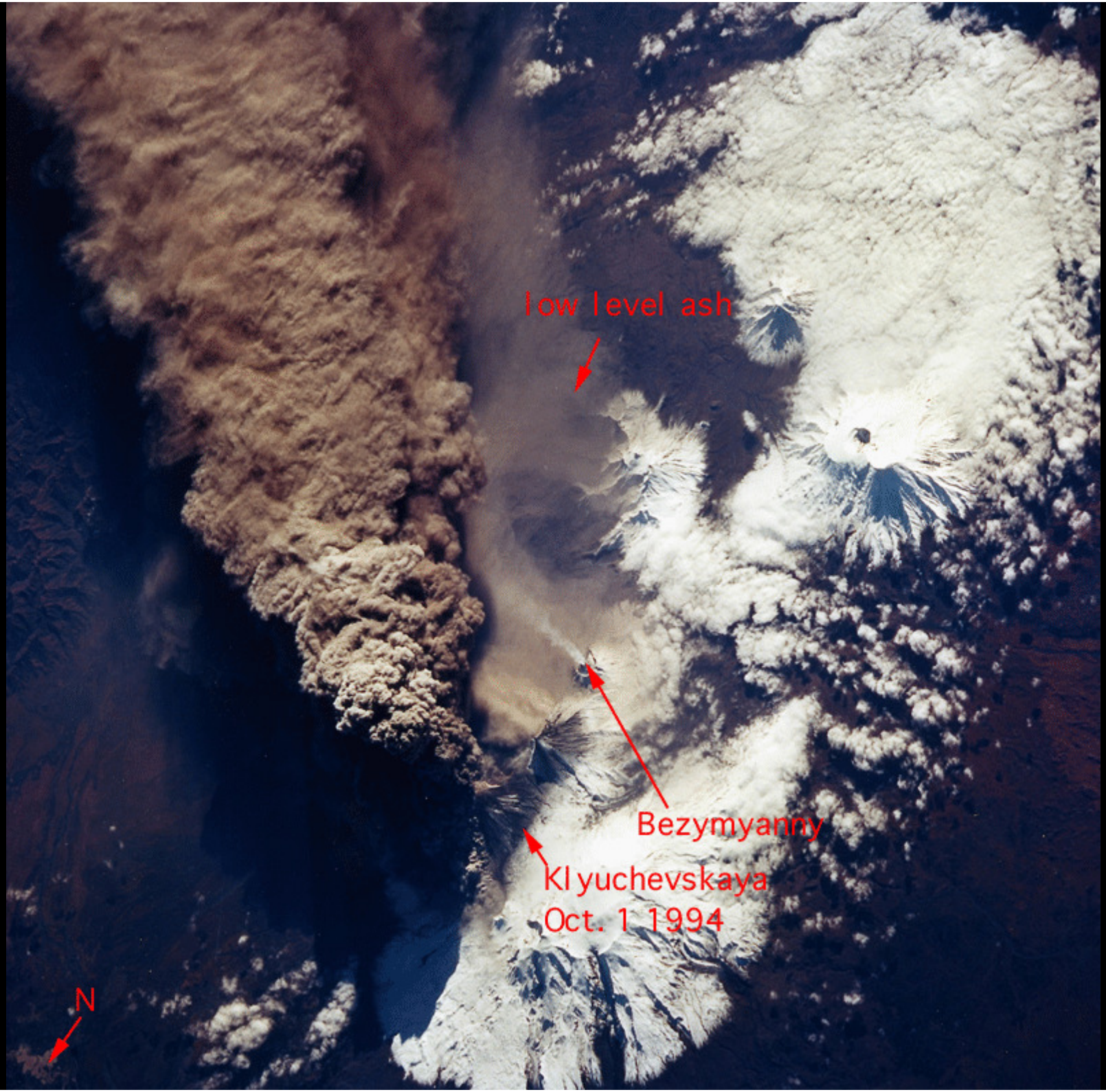
ENCELADUS
(South Polar Terrain)

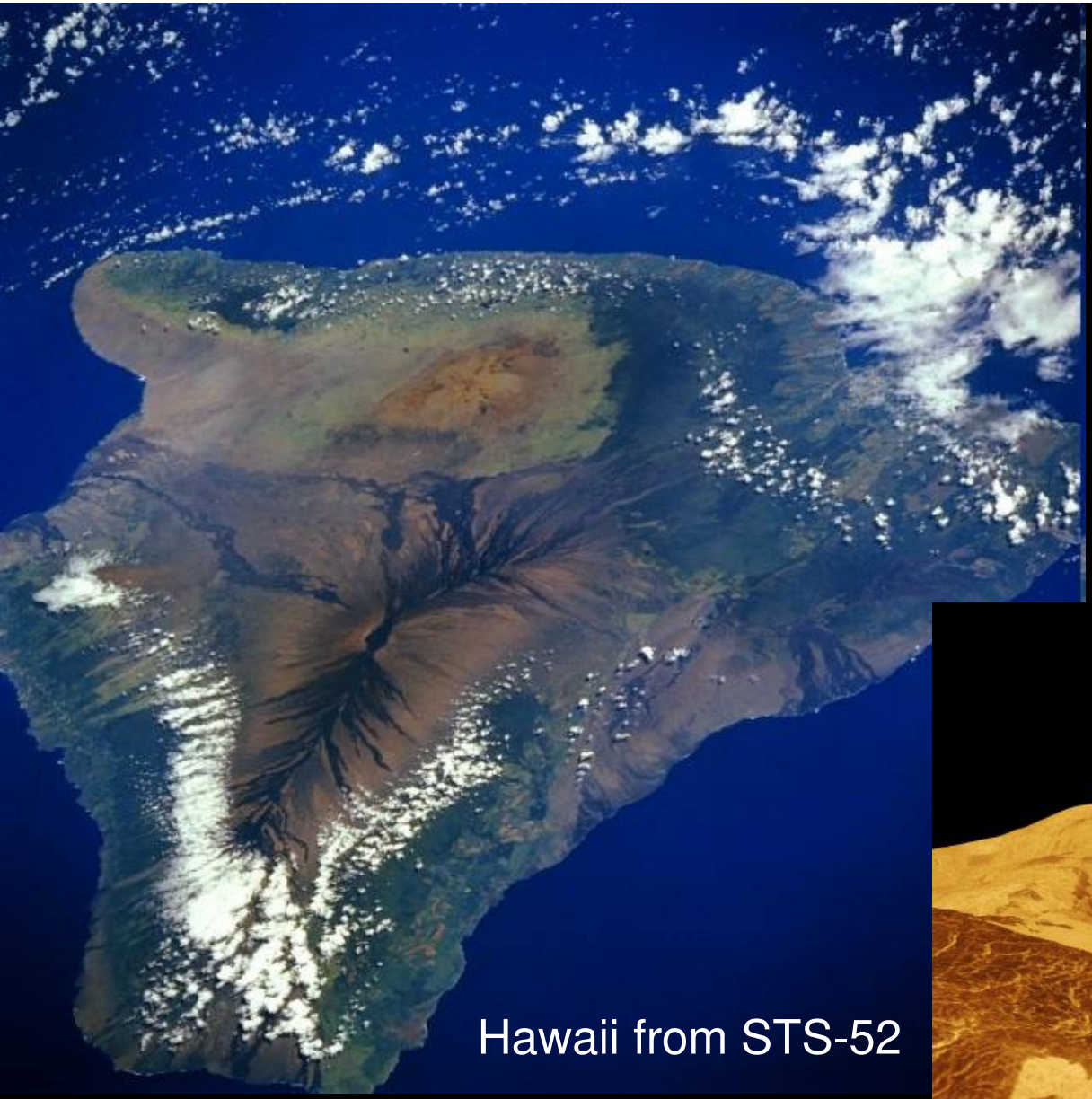
Mt. Etna, Sicily, from ISS

ISS005E19024

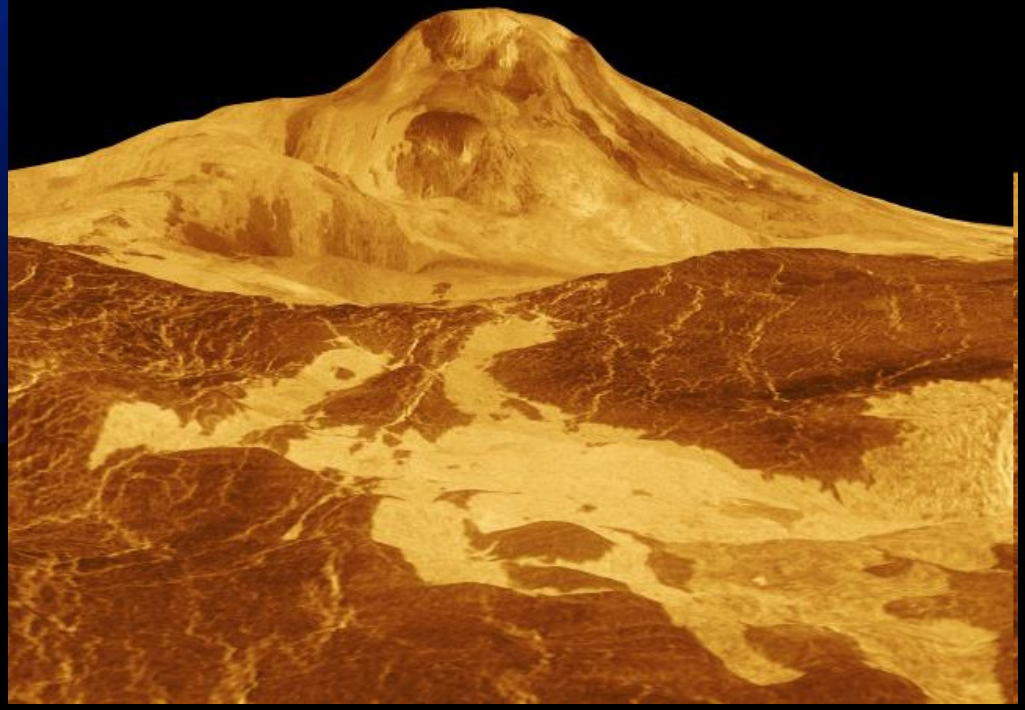
ISS018-E-05643

Kamchatka from STS-68

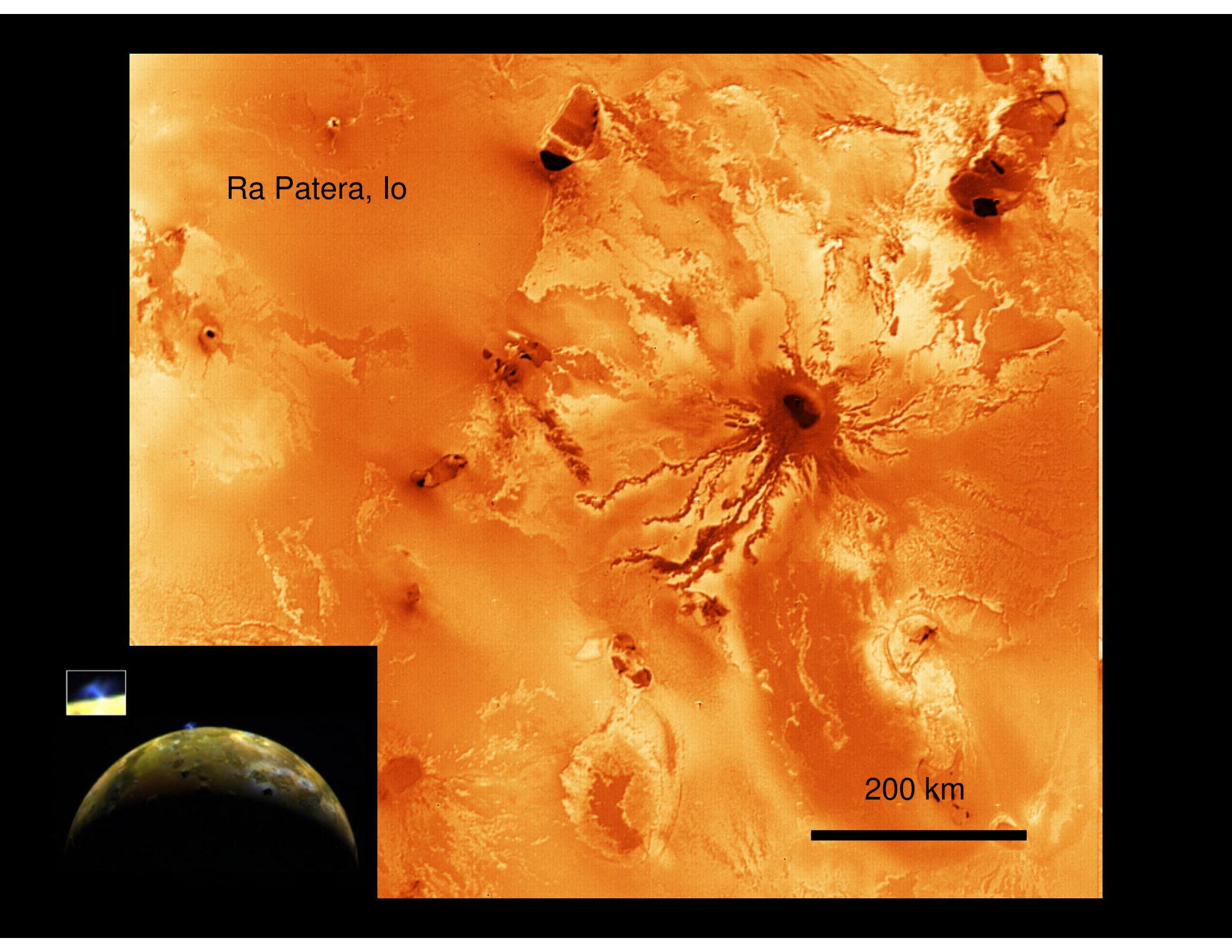

low level ash
Bezymyanny
Klyuchevskaya
Oct. 1 1994
N

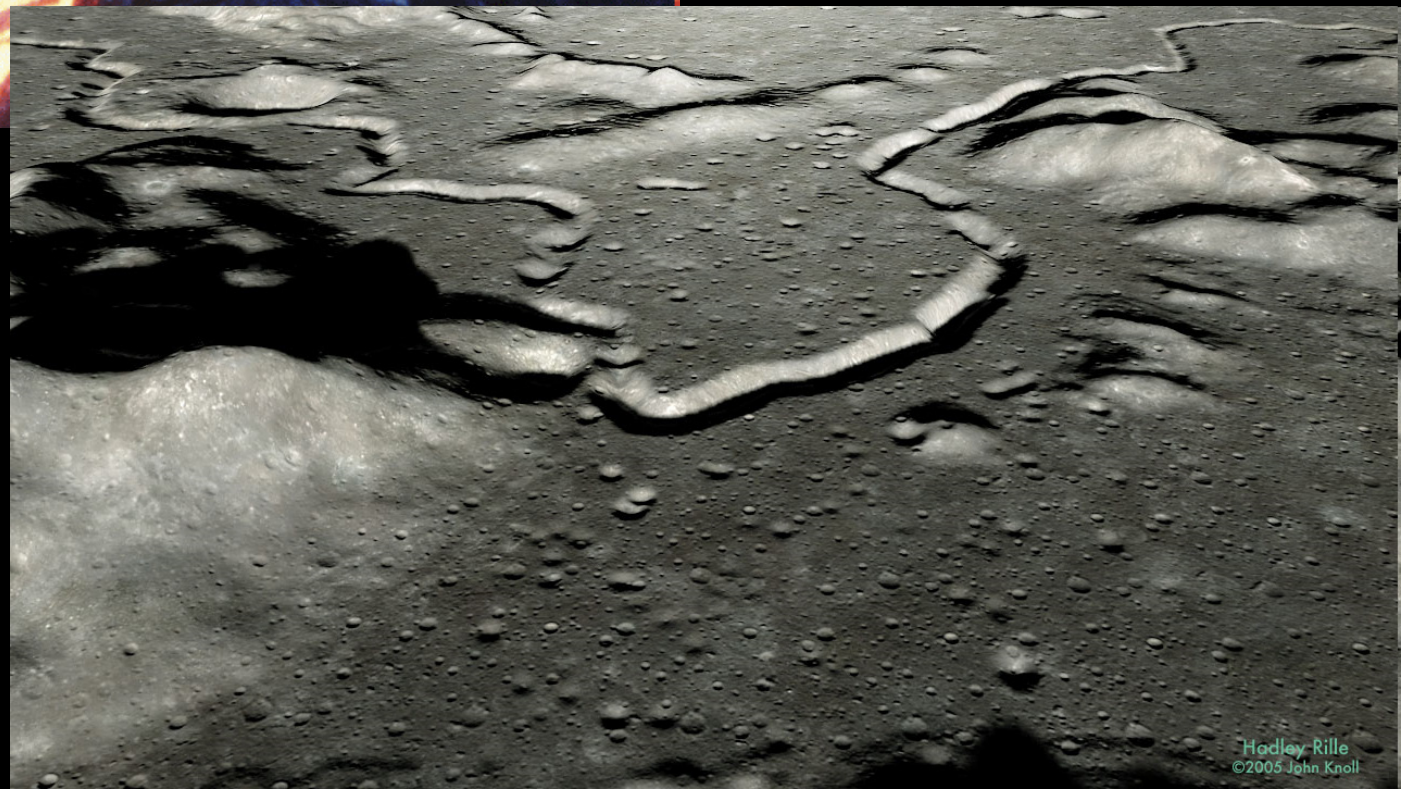


Hawaii from STS-52

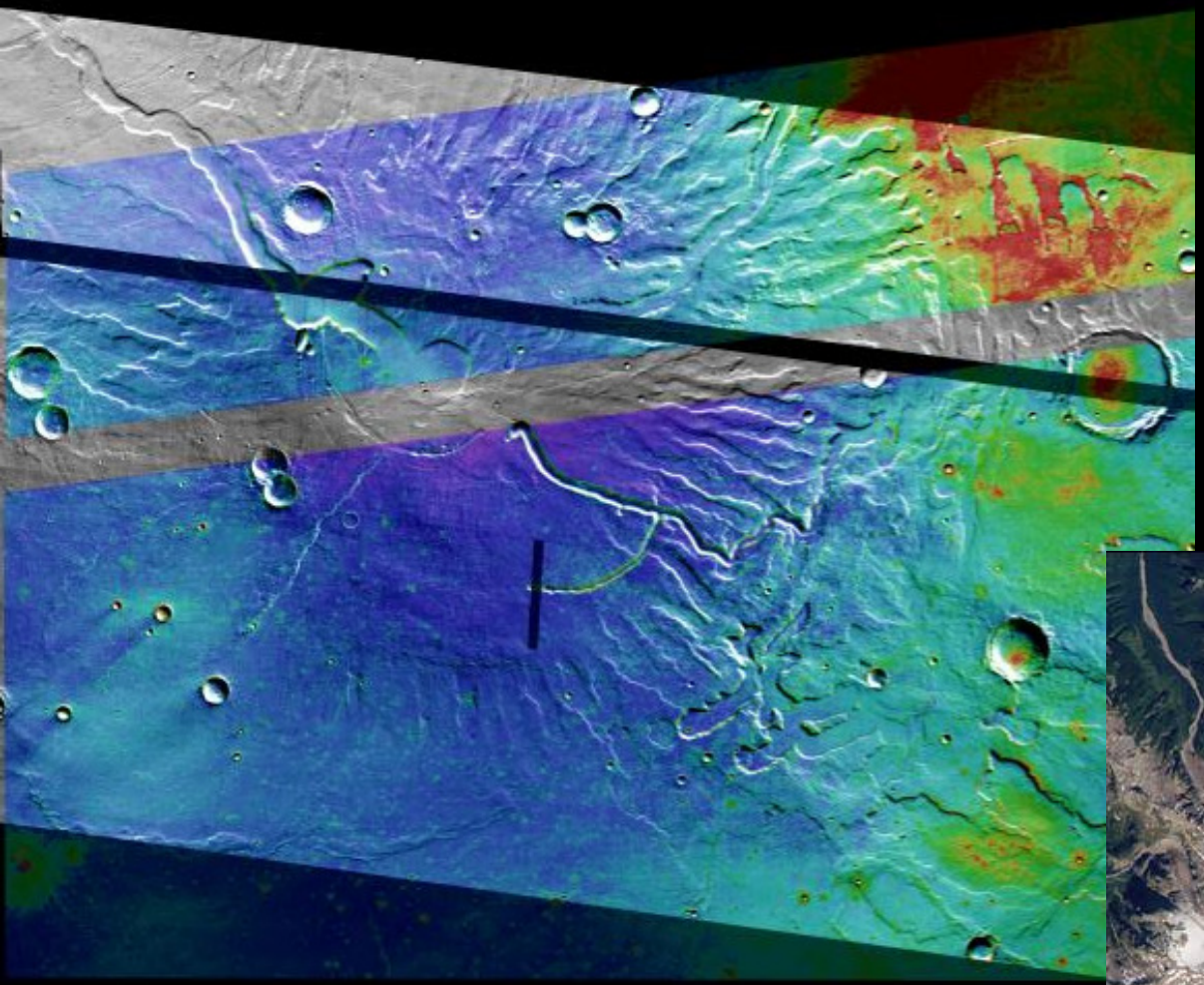


Maat Mons, Venus


Ra Patera, Io
200 km



Hadley Rille, Moon

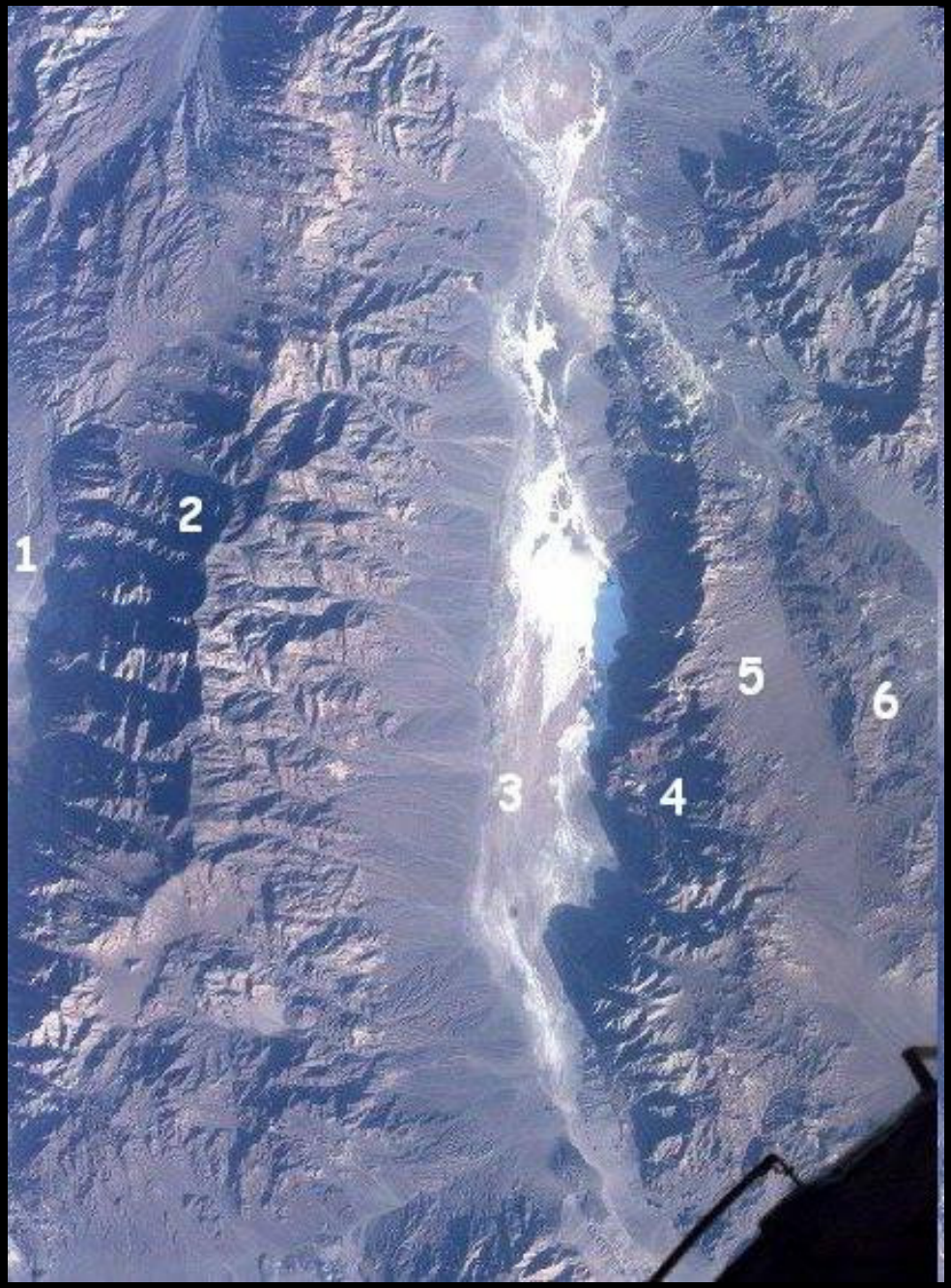


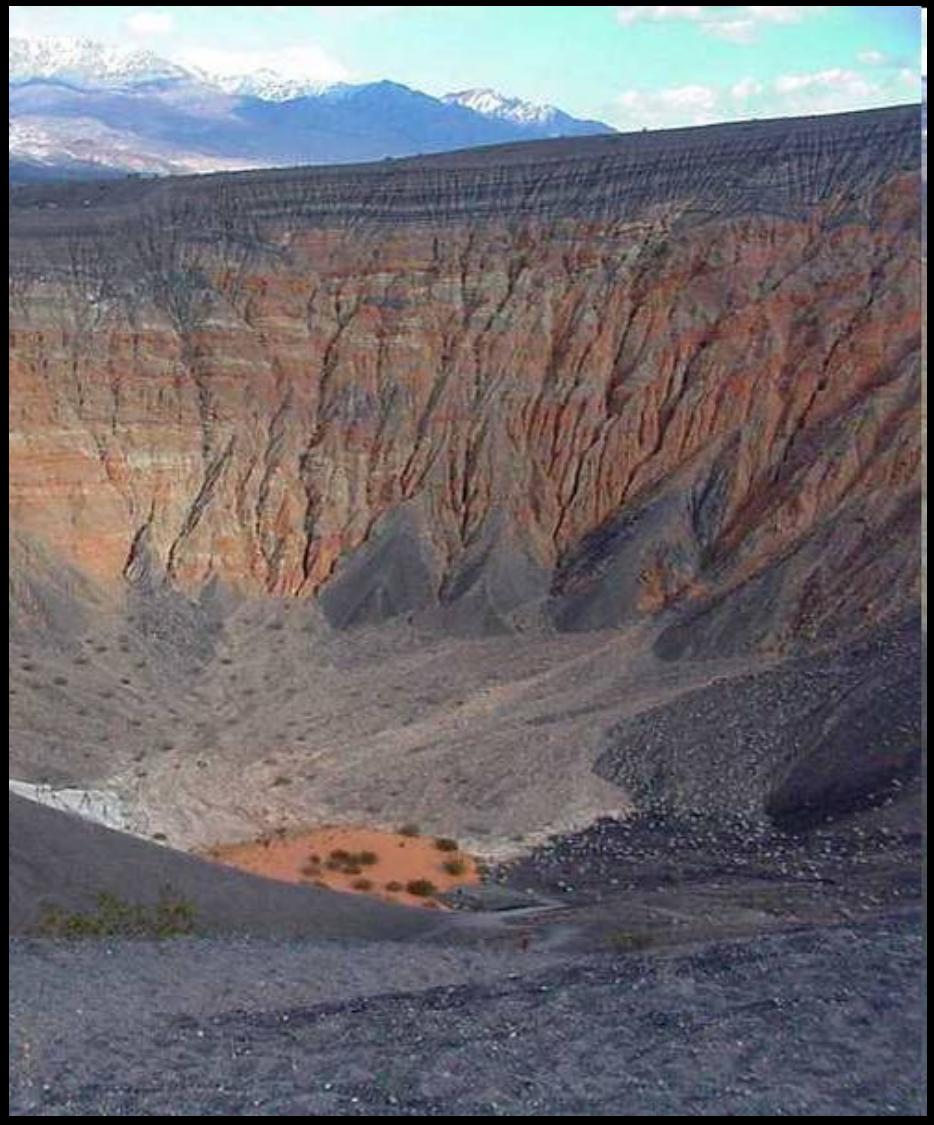
Tyrrhena Patera (Mars Odyssey)

Mt. Rainier, Washington


Grand Canyon, STS-98

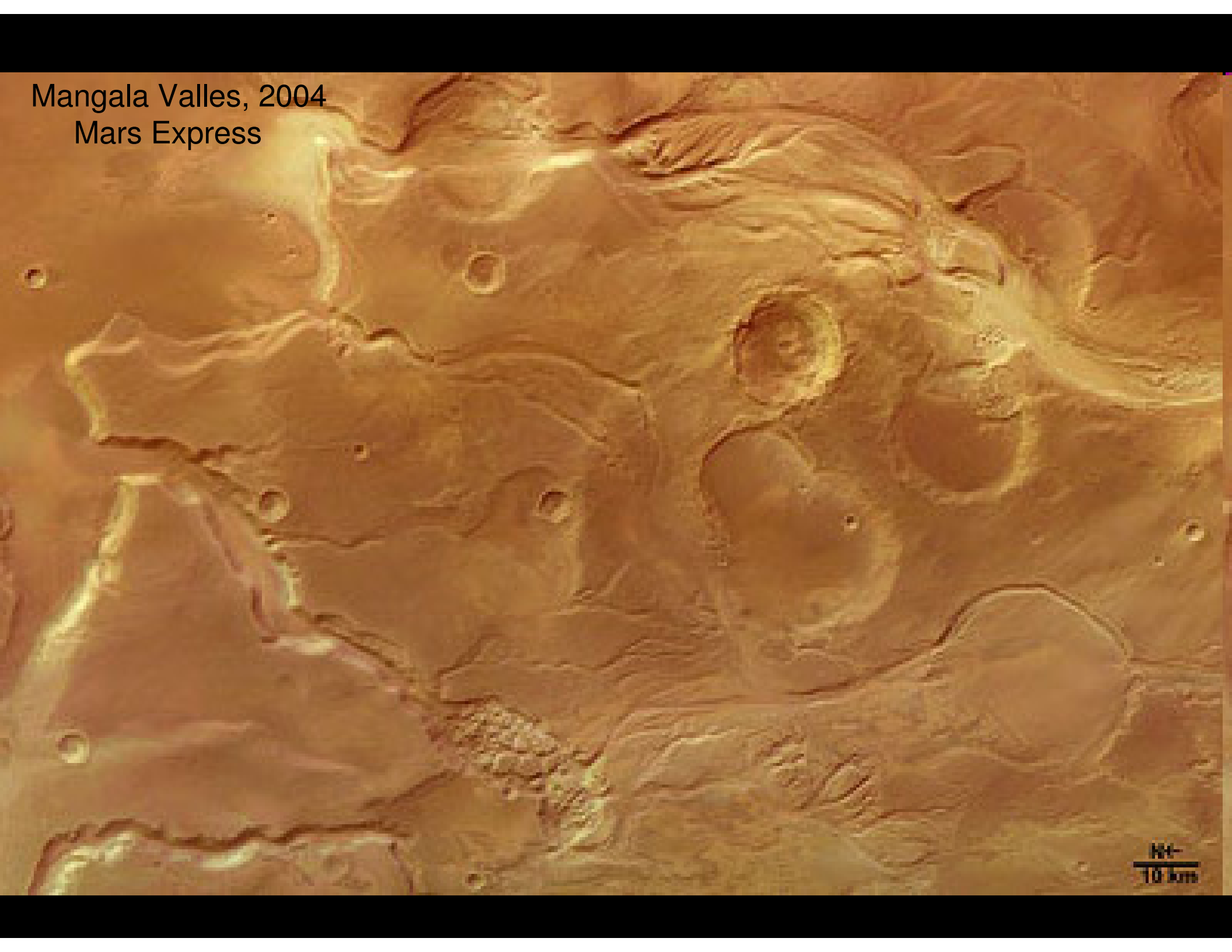
STS091-707-12

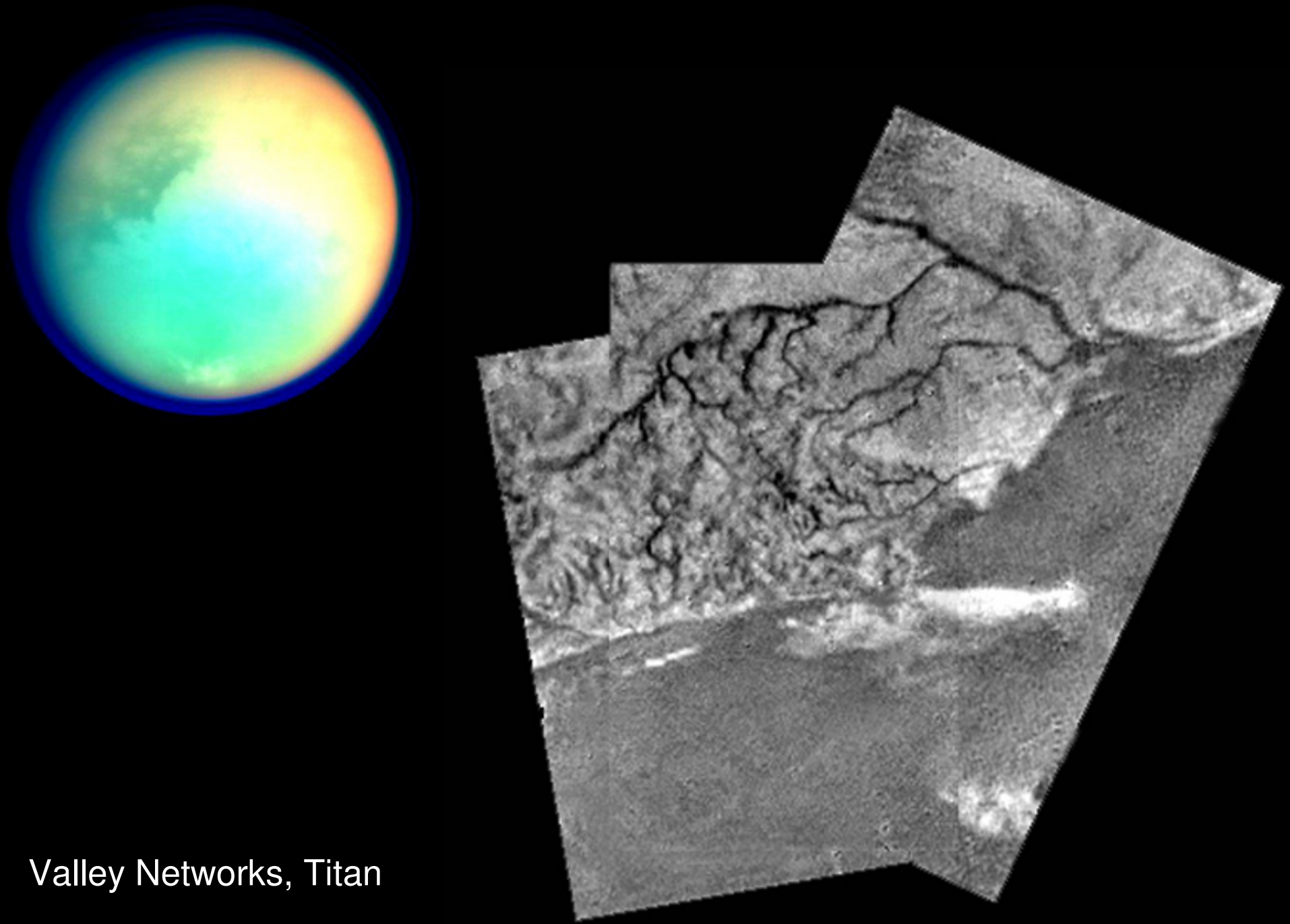




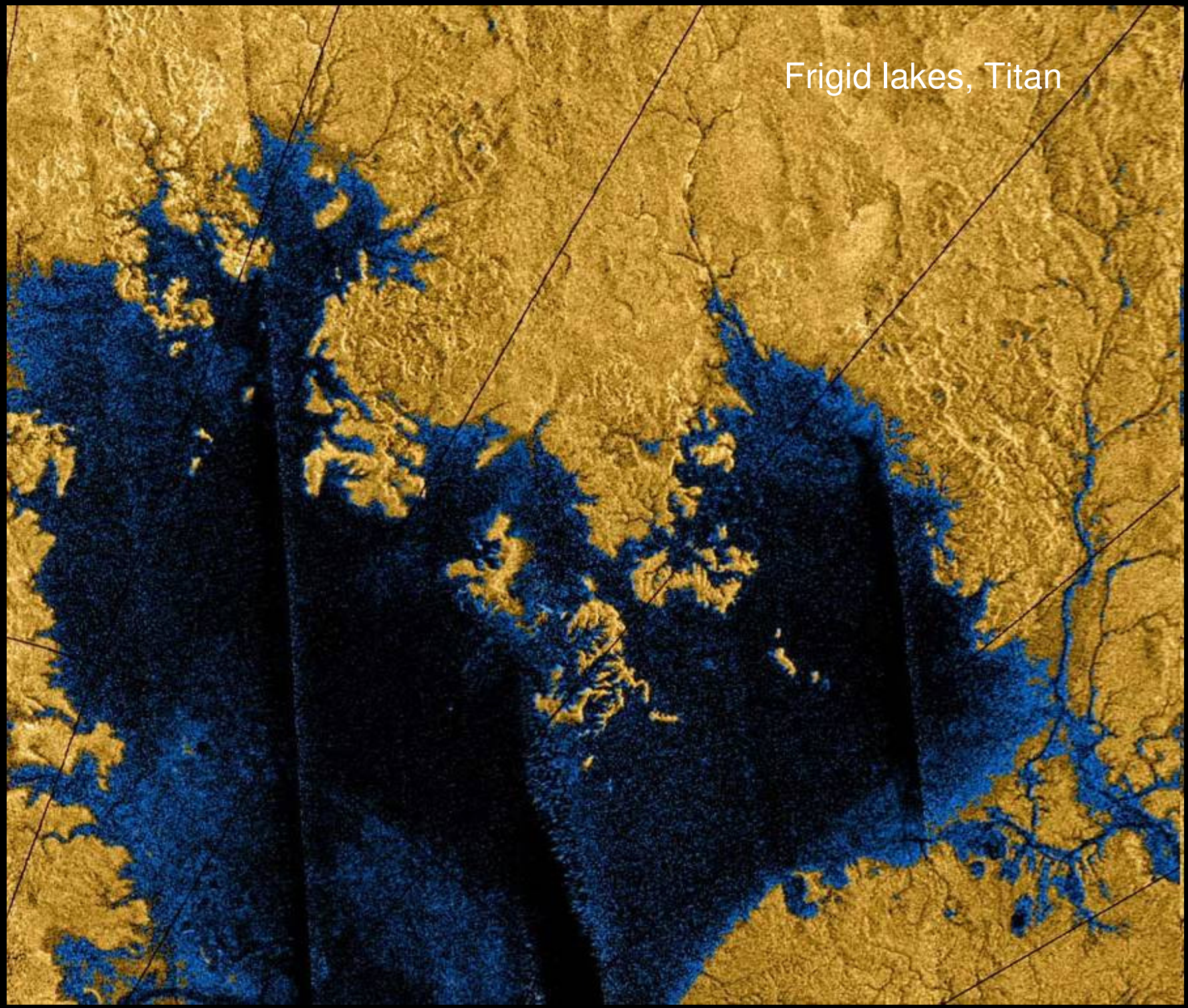
Fluids -- Death Valley & Ubehebe Crater

Spectacular Gullies Near Gorgonum Chaos (MRO)


Mangala Valles, 2004
Mars Express
10 km

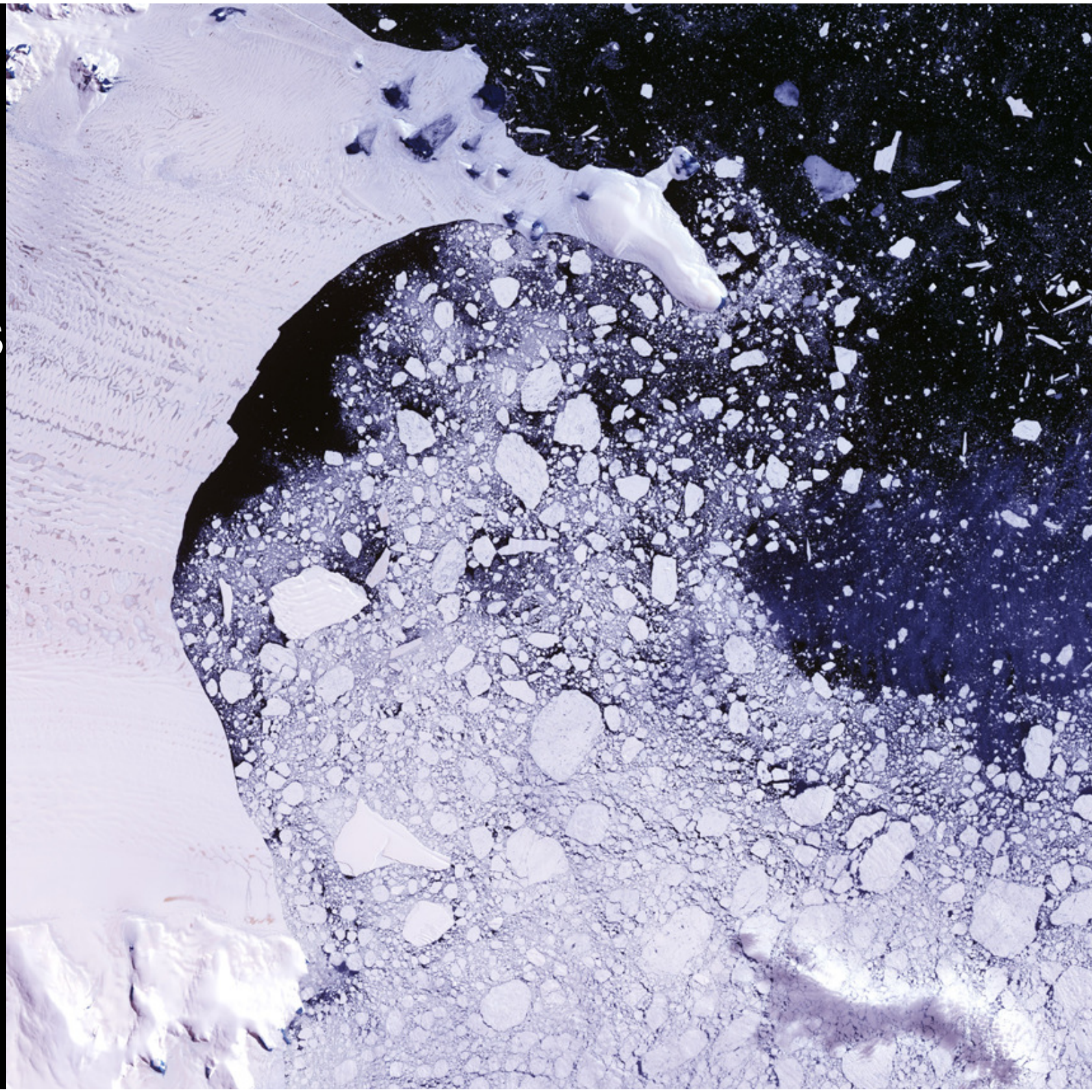


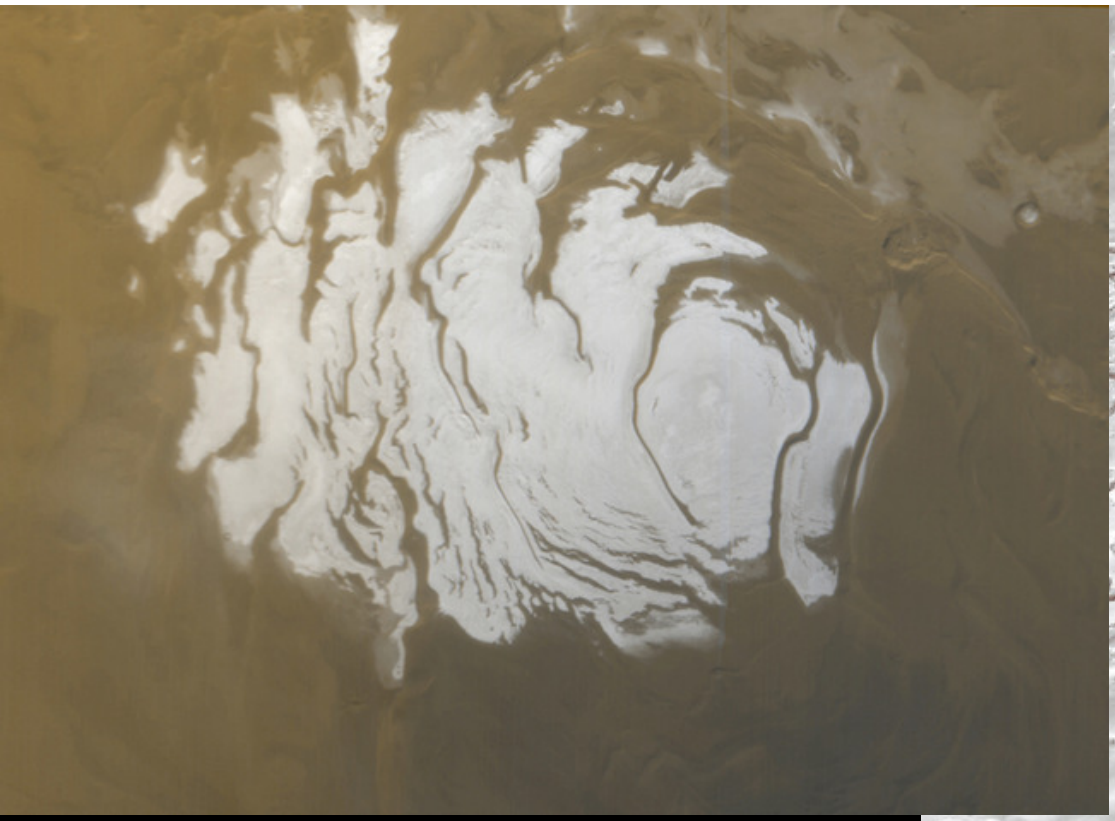
Valley Networks, Titan

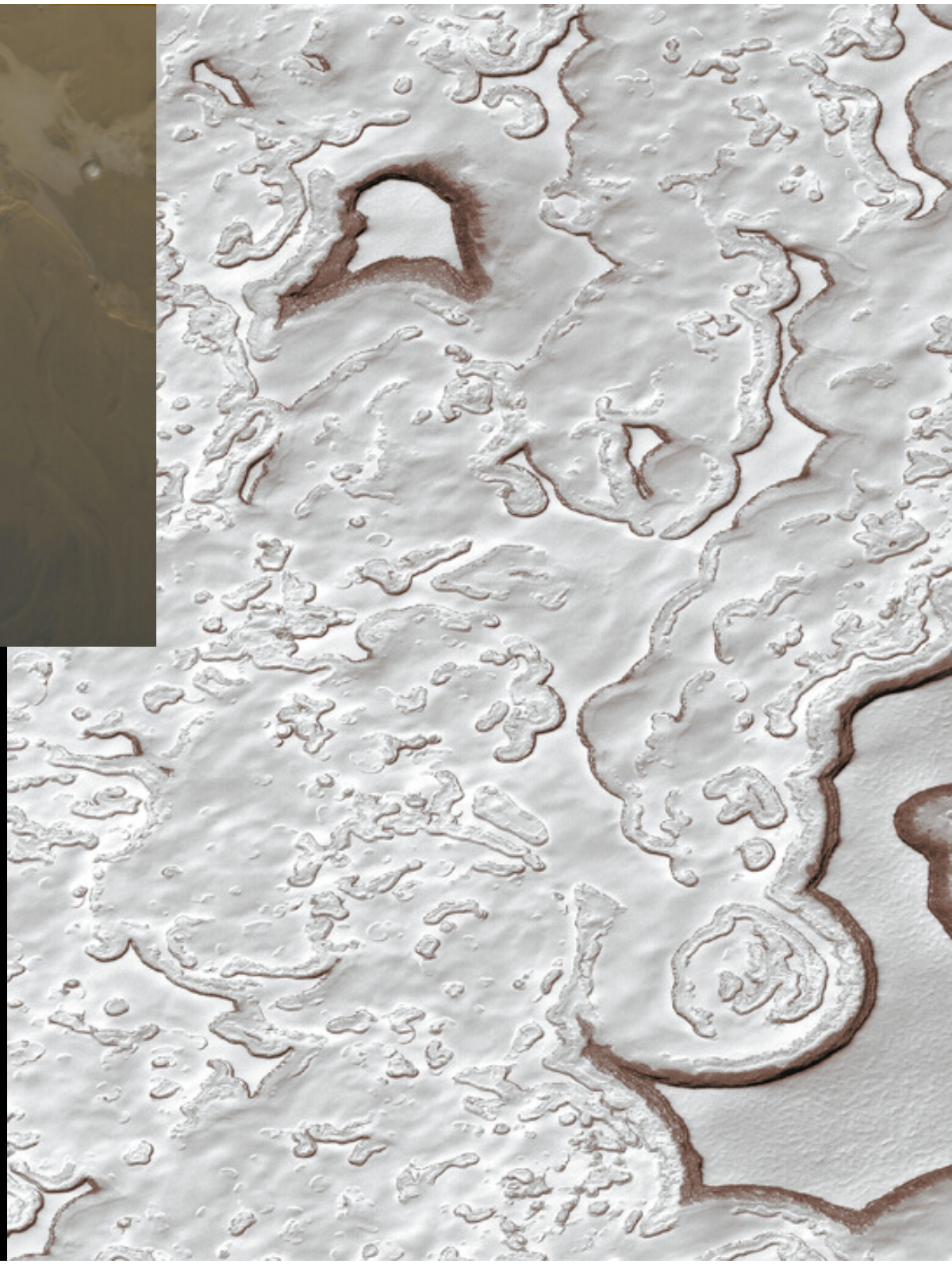

Frigid lakes, Titan


Frigid lakes, Earth

Frozen Landscapes







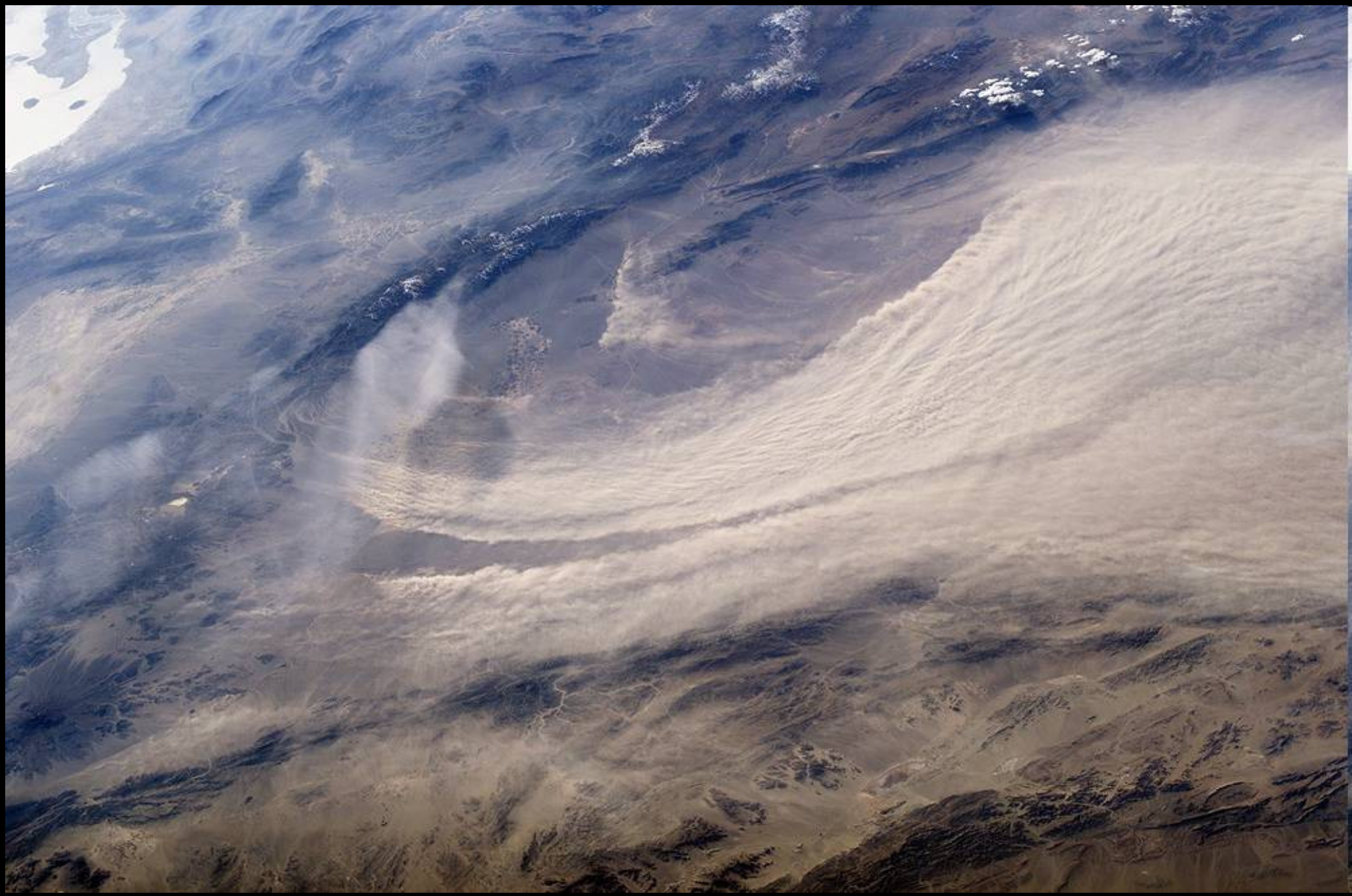
South Pole, Mars

Steven Pinker


STS059-154-159

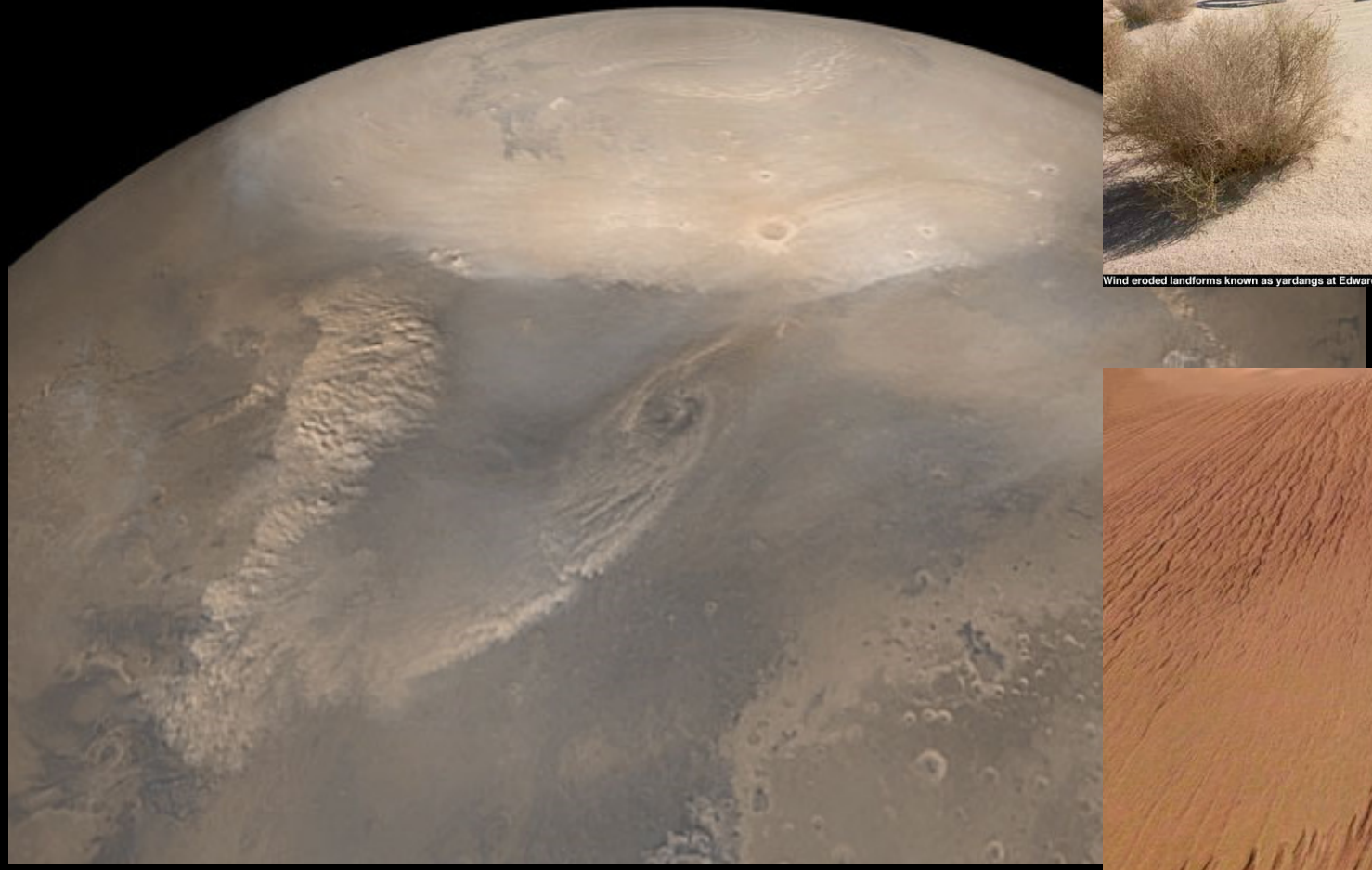
Malaspina Glacier from STS-66

Deuteronilus Mensae, from Mars Express



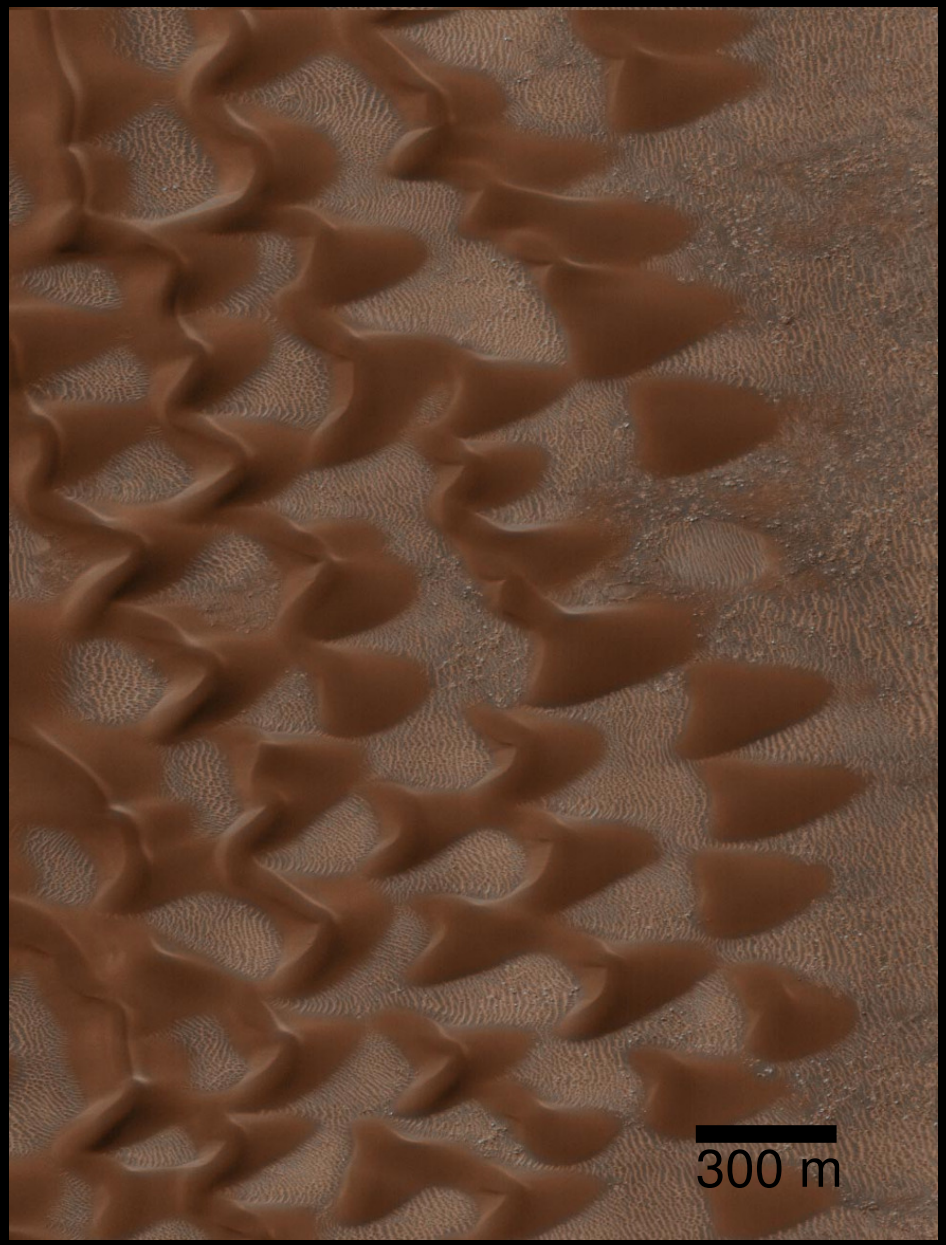
Kerman Desert, SE Iran, near Bam – ISS-08

North polar dust storm, MGS, Dec 2002

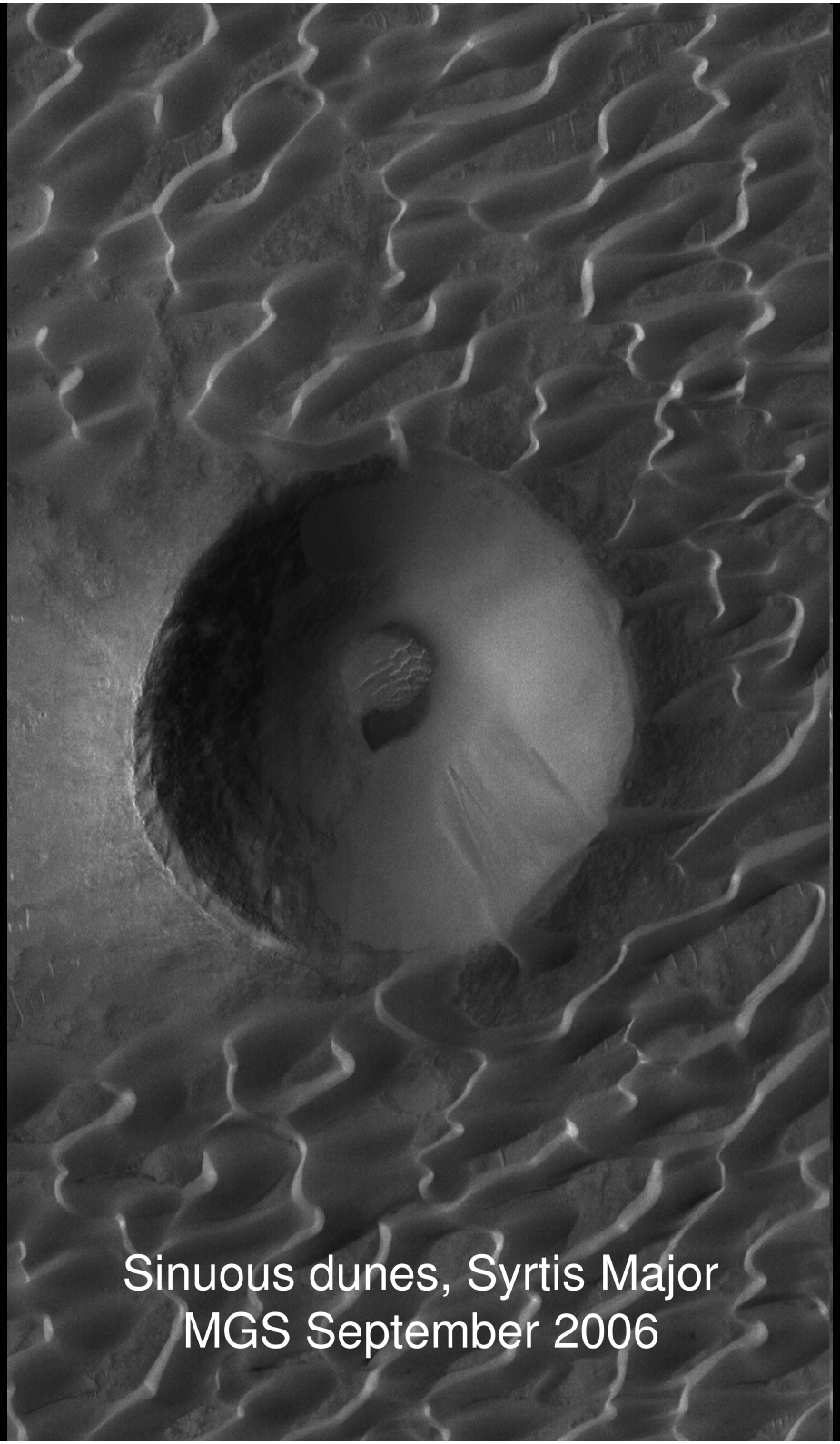


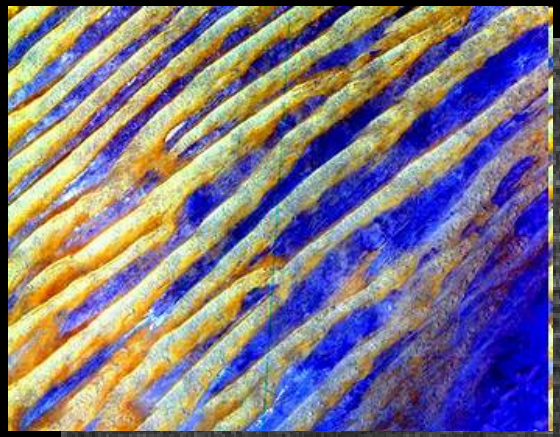
Wind eroded landforms known as yardangs at Edwards Air Force Base in California. Perhaps the only erosional landforms made by wind. TMcG-Oct.04

Tifernine Dunes, Algeria



Barchan Dunes, Proctor Crater


Sinuous dunes, Syrtis Major
MGS September 2006



Rub' al Khali, Saudi Arabia (ASTER)

Titan Dunes

The Search for Life

3.8 by ago- single celled organisms

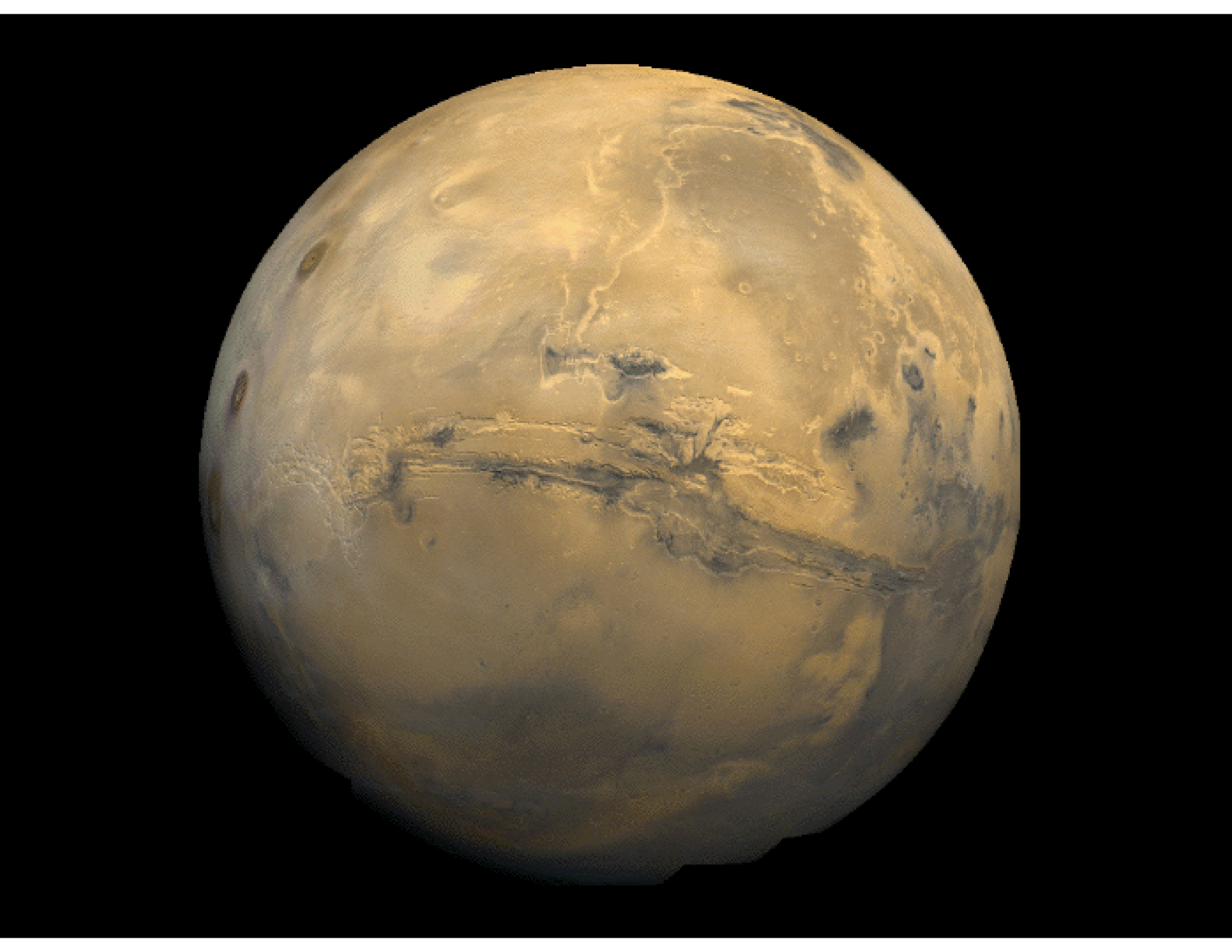
~2 by- multi-celled life

600 my -- simple fauna (Ediacra)

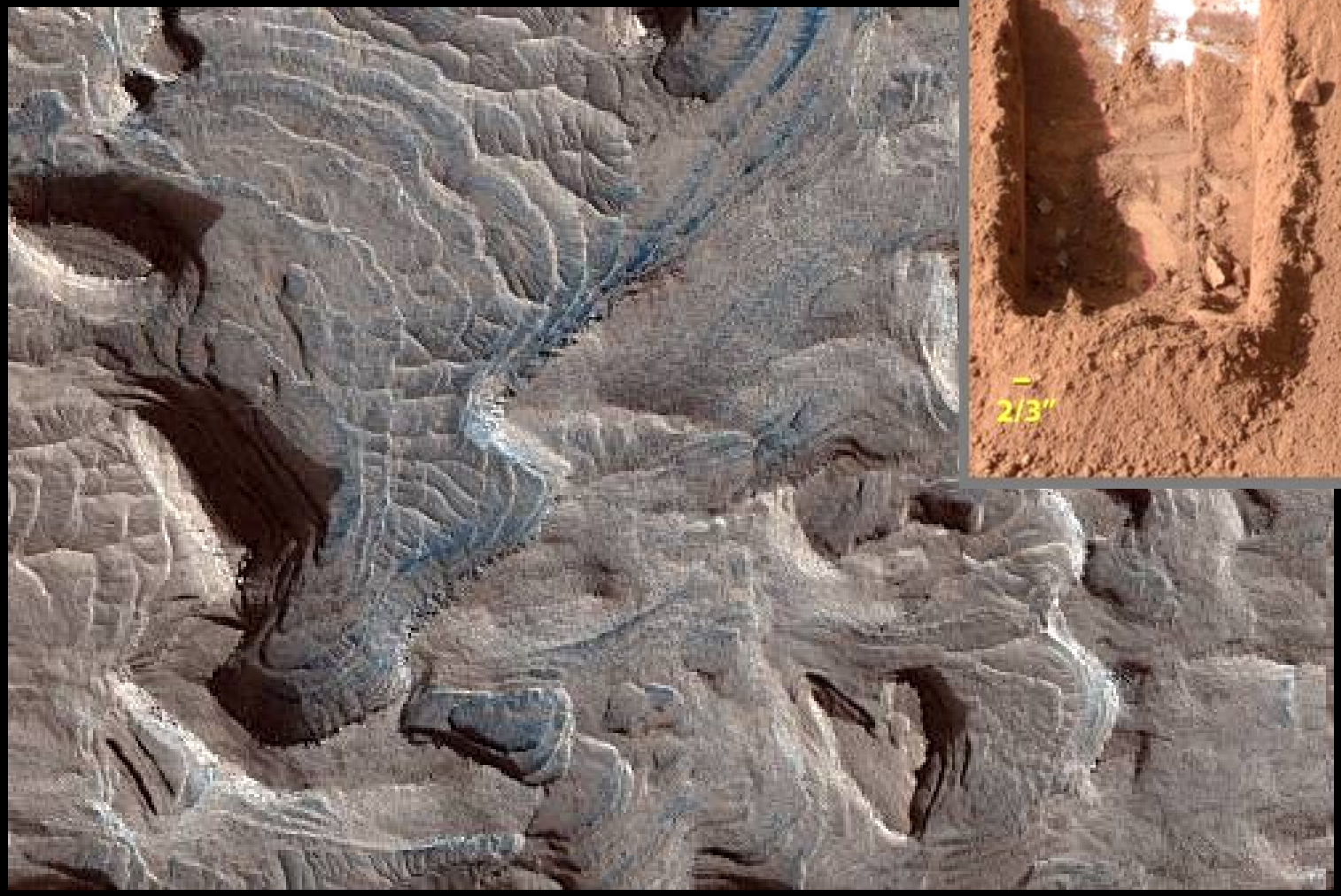
475 my -- land plants

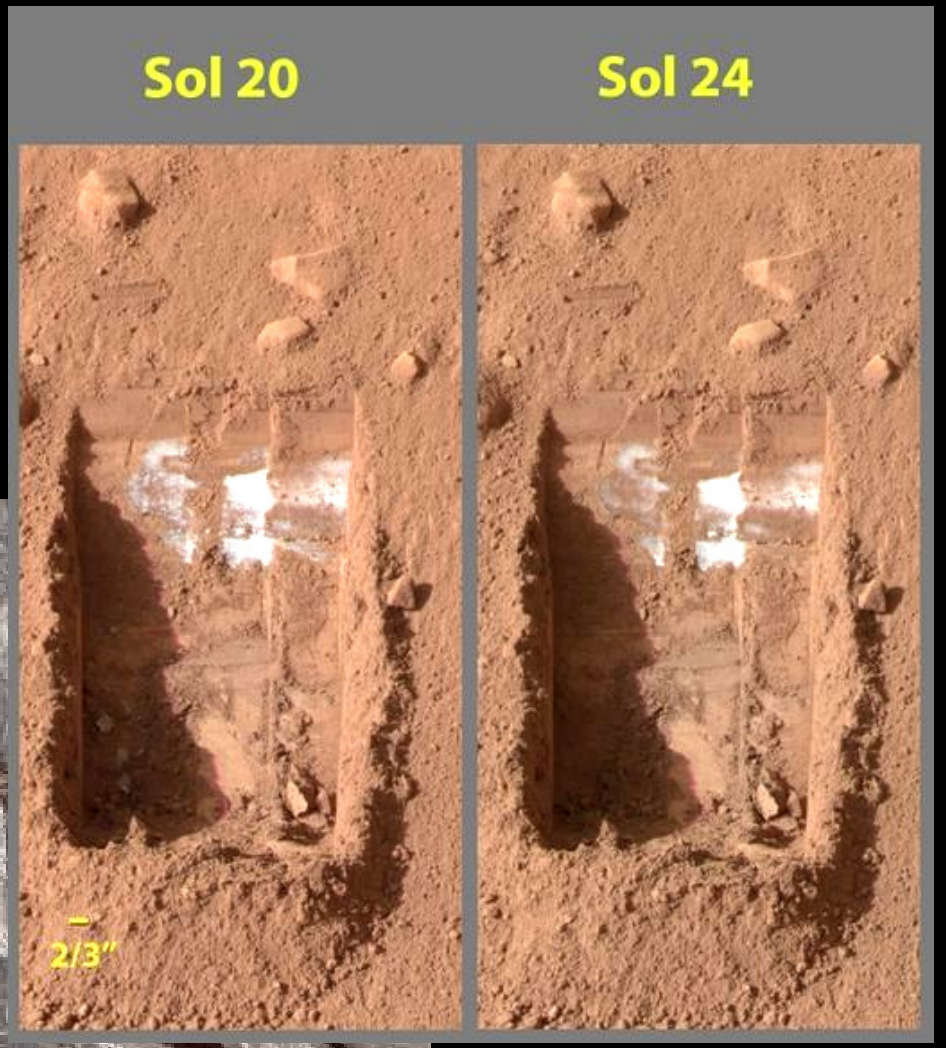
200 my -- mammals

2.5 my -- Homo species

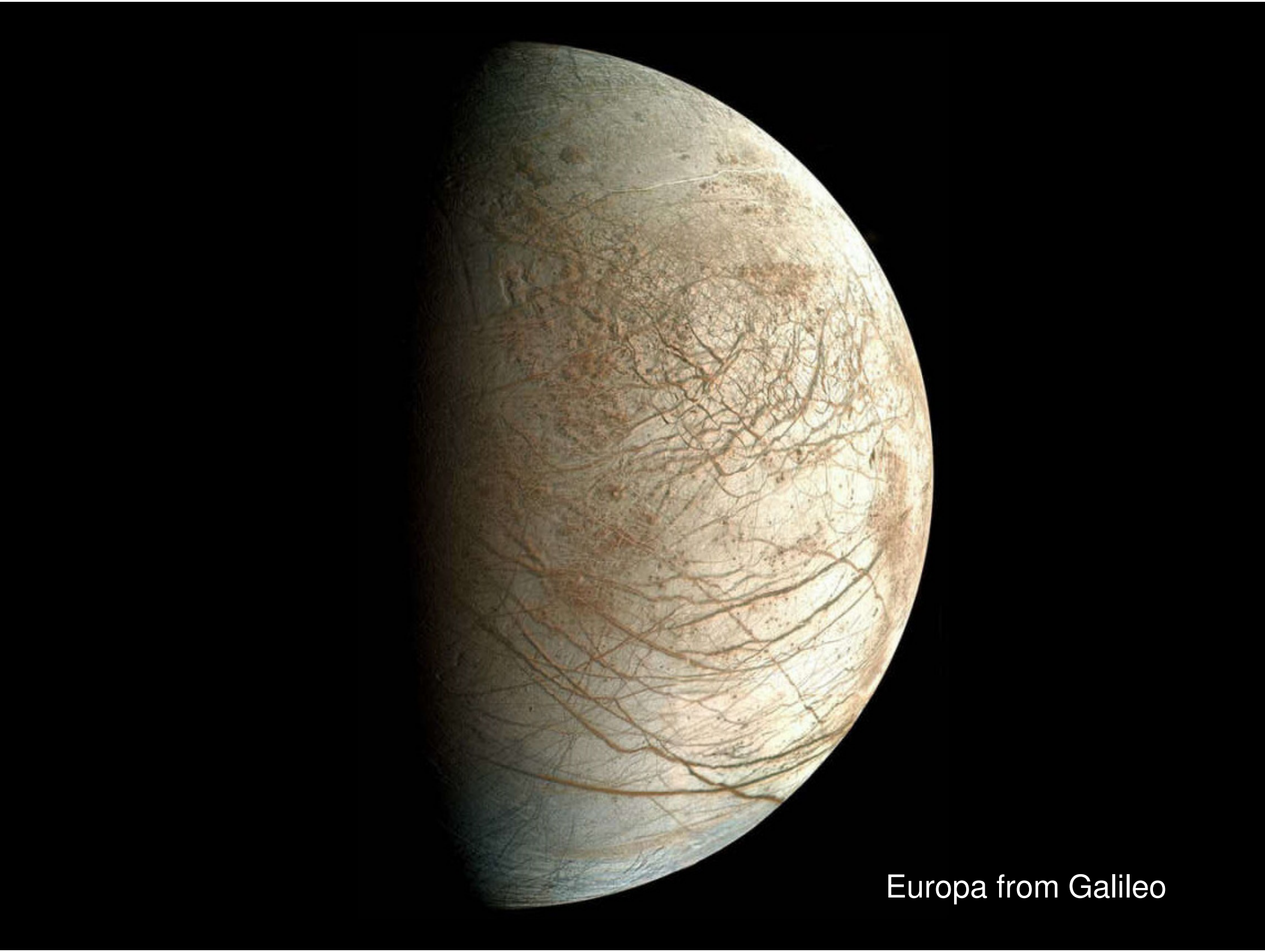


Mars: Follow the Water

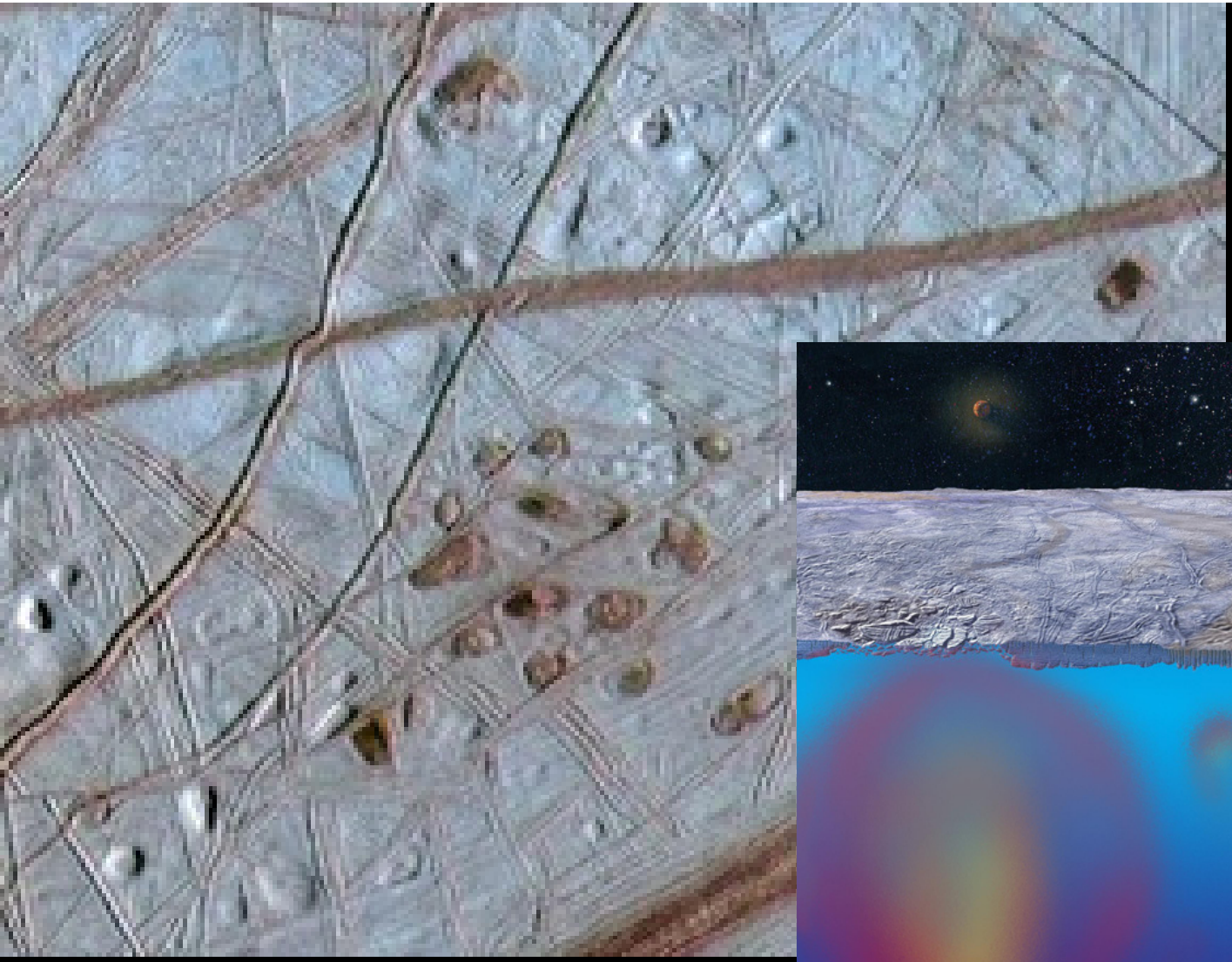


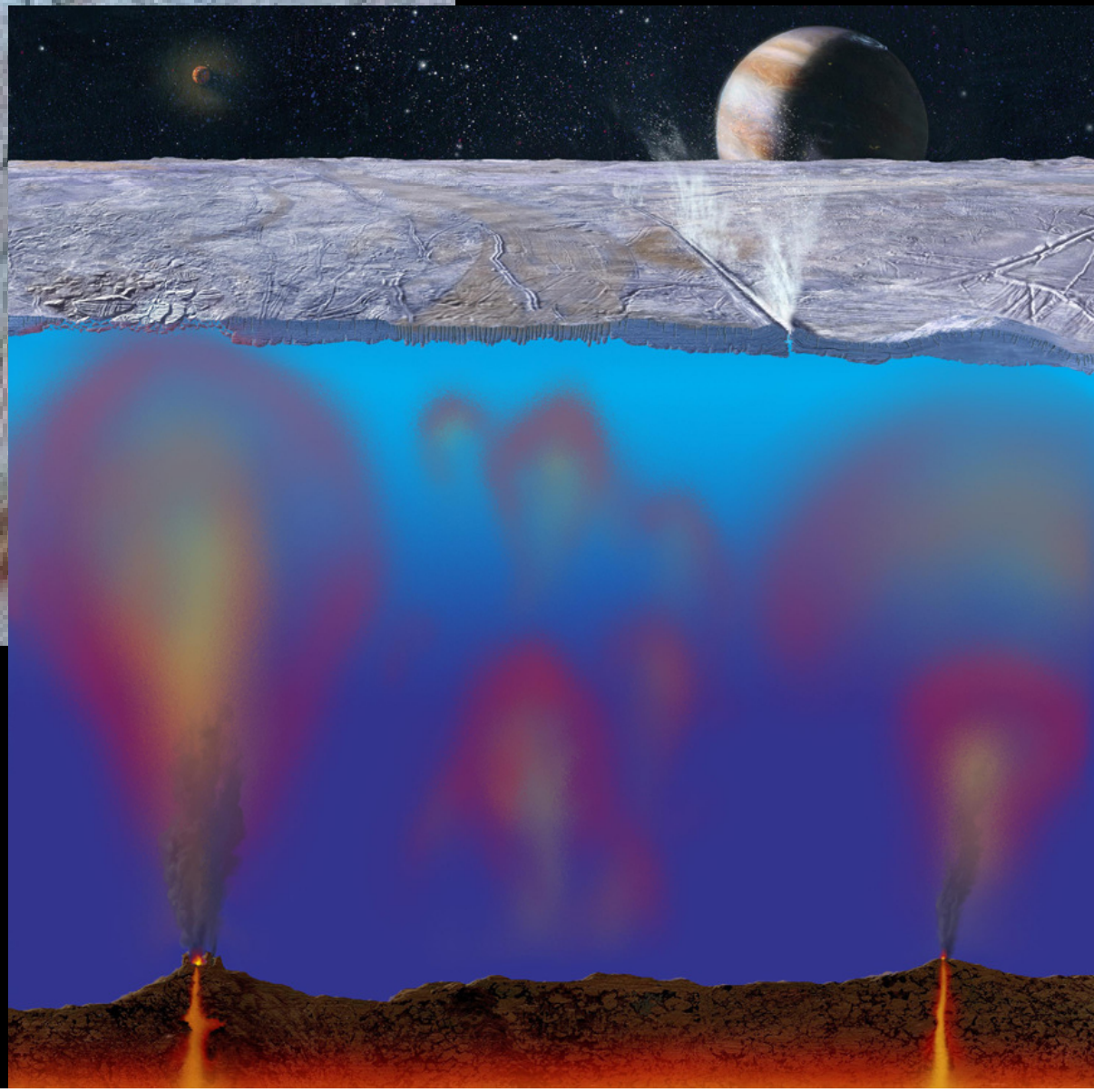


Layers in Becquerel Crater
PSP_004078_2015

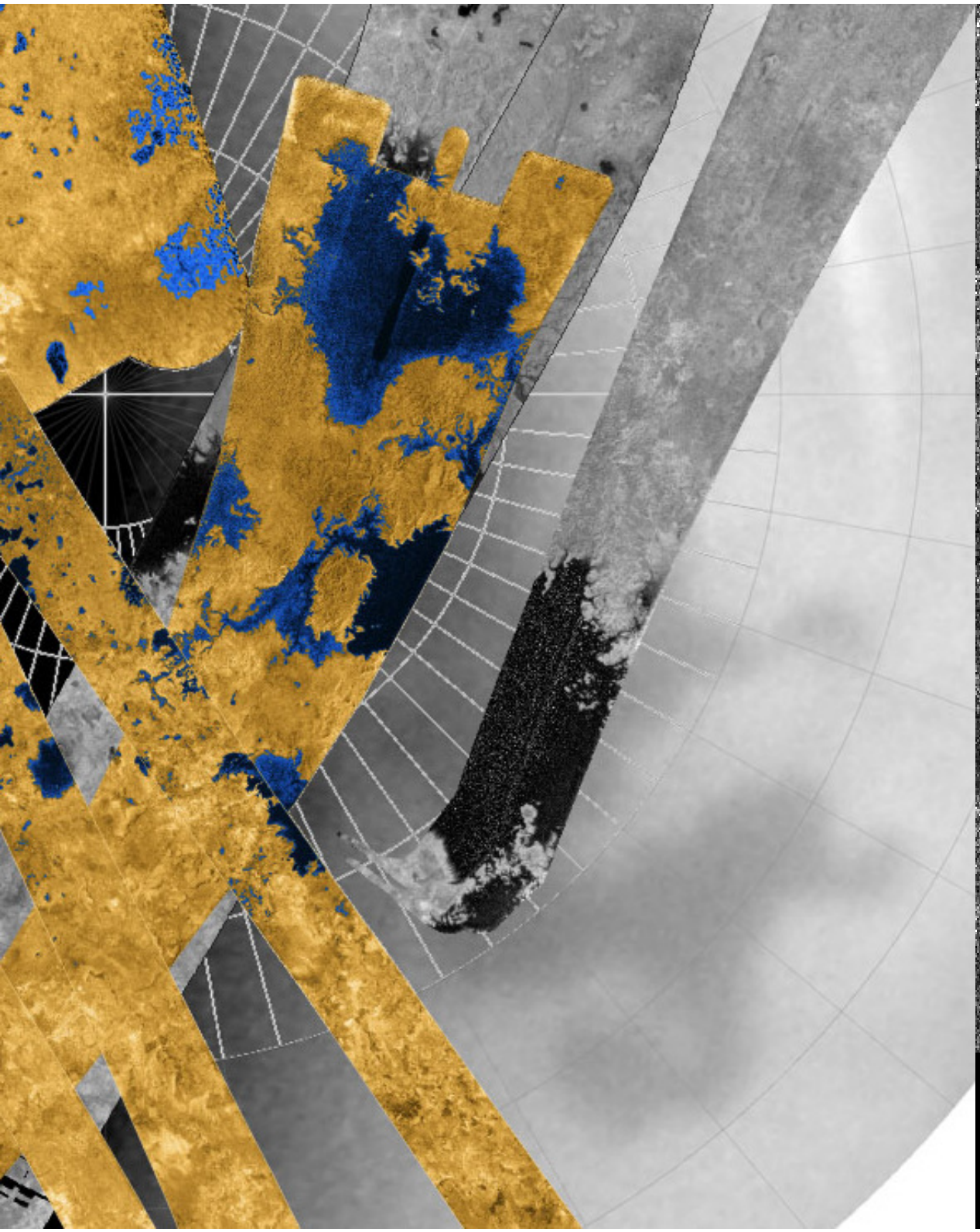


Europa from Galileo



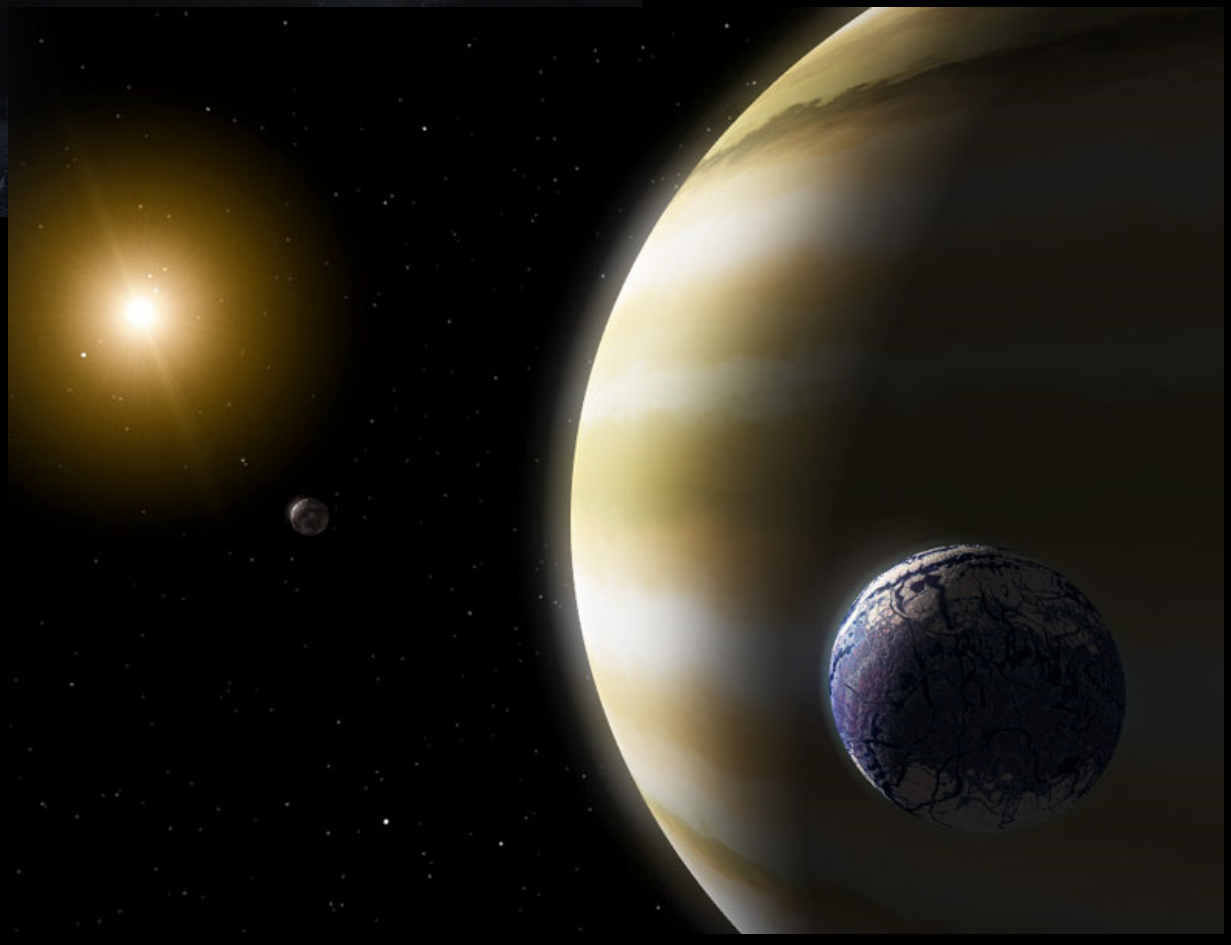


Europa



Titan

Keck interferometer

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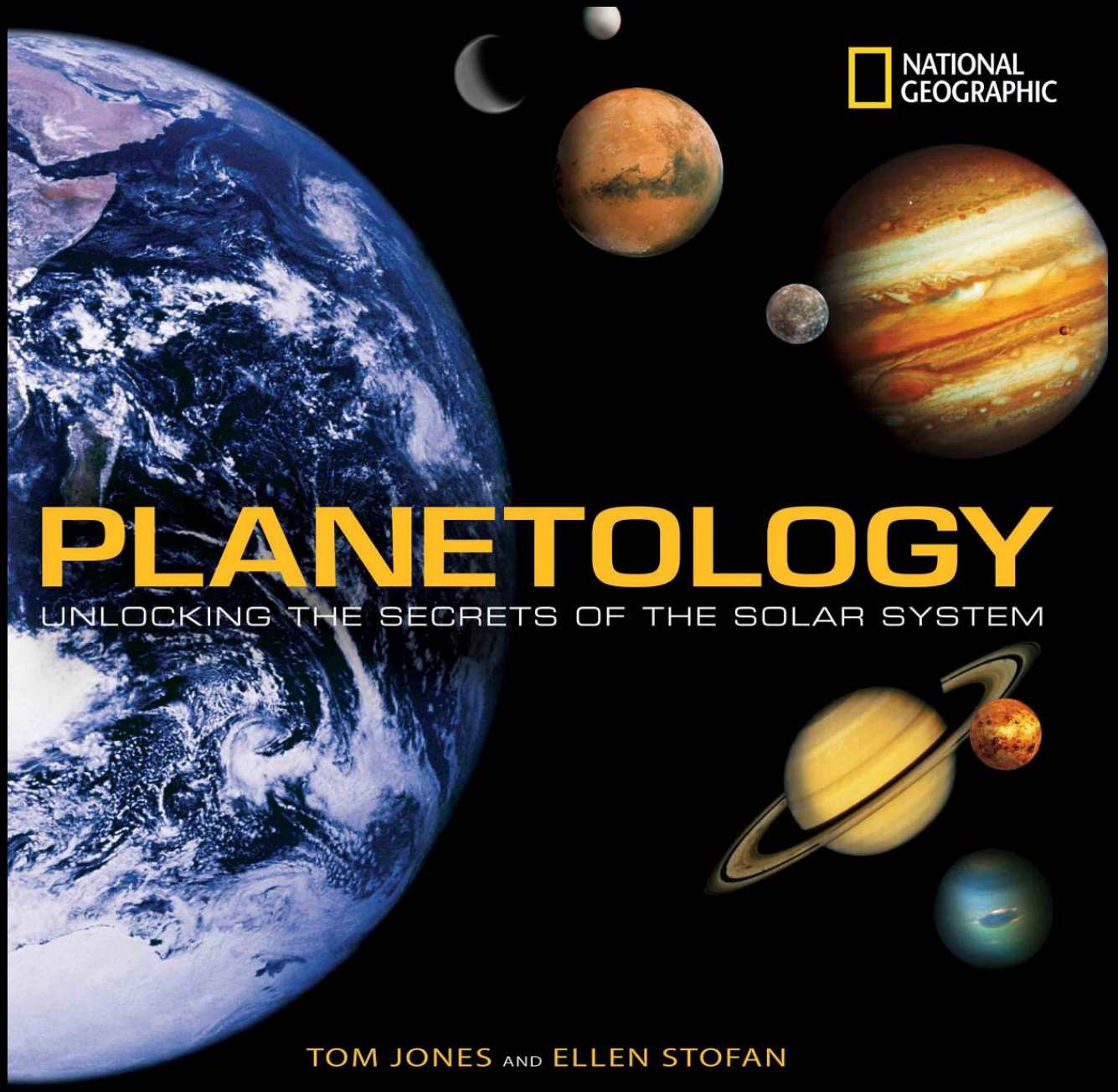

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