Jet Propulsion Laboratory
California Institute of Technology

Europa Clipper: Ocean World Explorer

Dr. Melora Larson

(based on a presentation developed by Robert Pappalardo and Cynthia Phillips Jet Propulsion Laboratory, California Institute of Technology)

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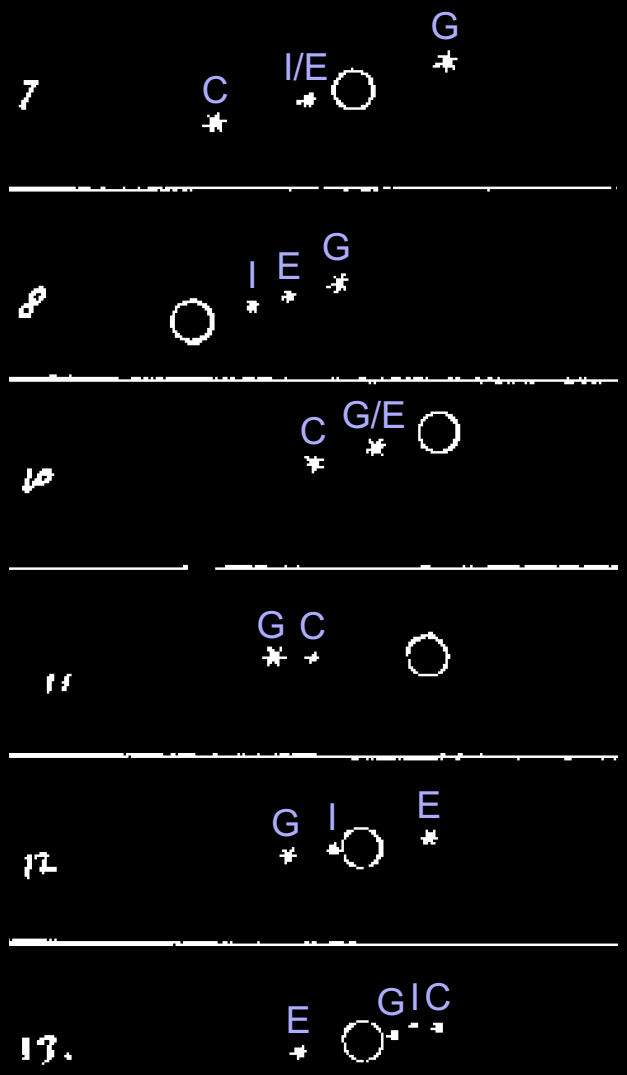
Planets

Jupiter from the Earth

The Galilean Moons: January 1610

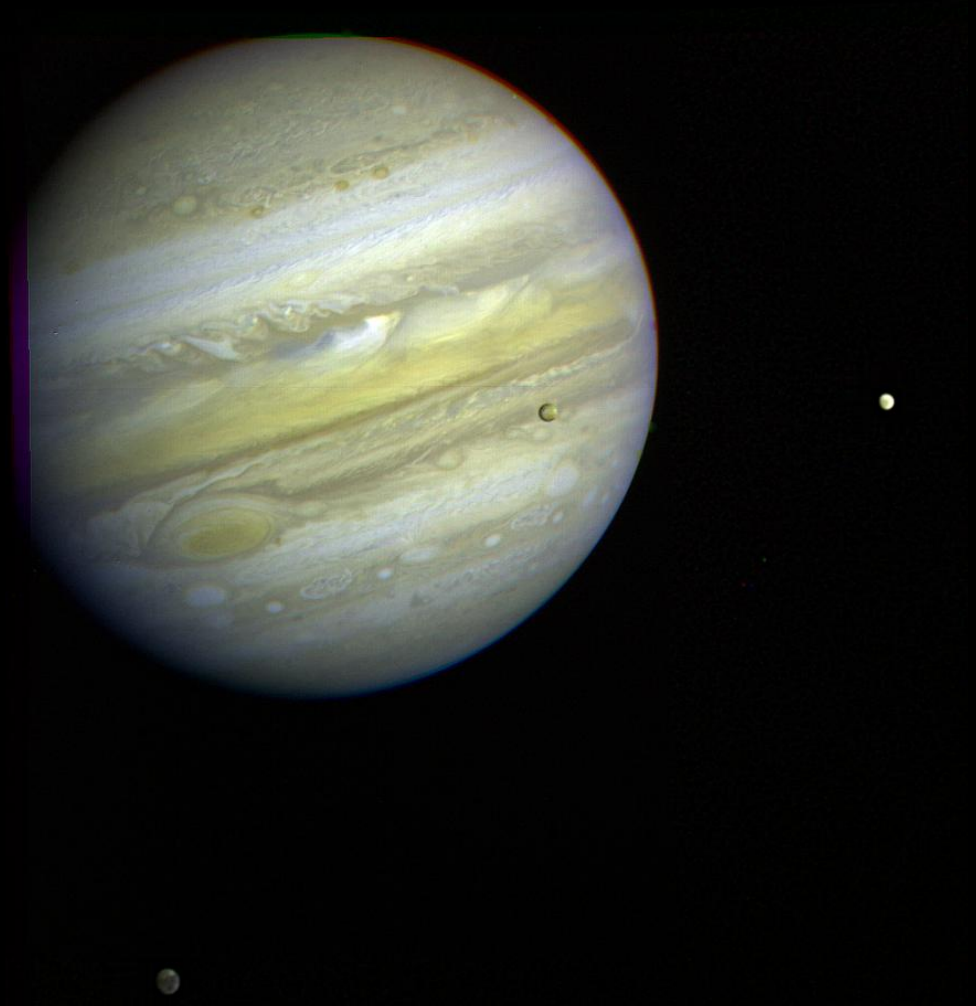


I - Io
E - Europa
G - Ganymede
C - Callisto

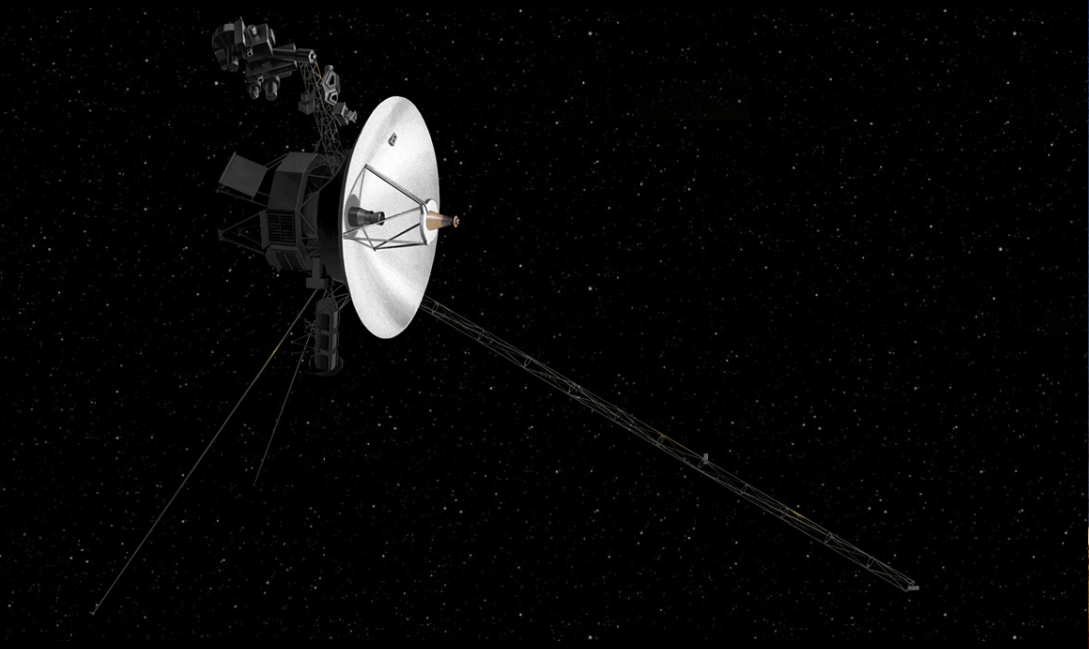
Jupiter Visitors & Explorers

9 spacecraft:

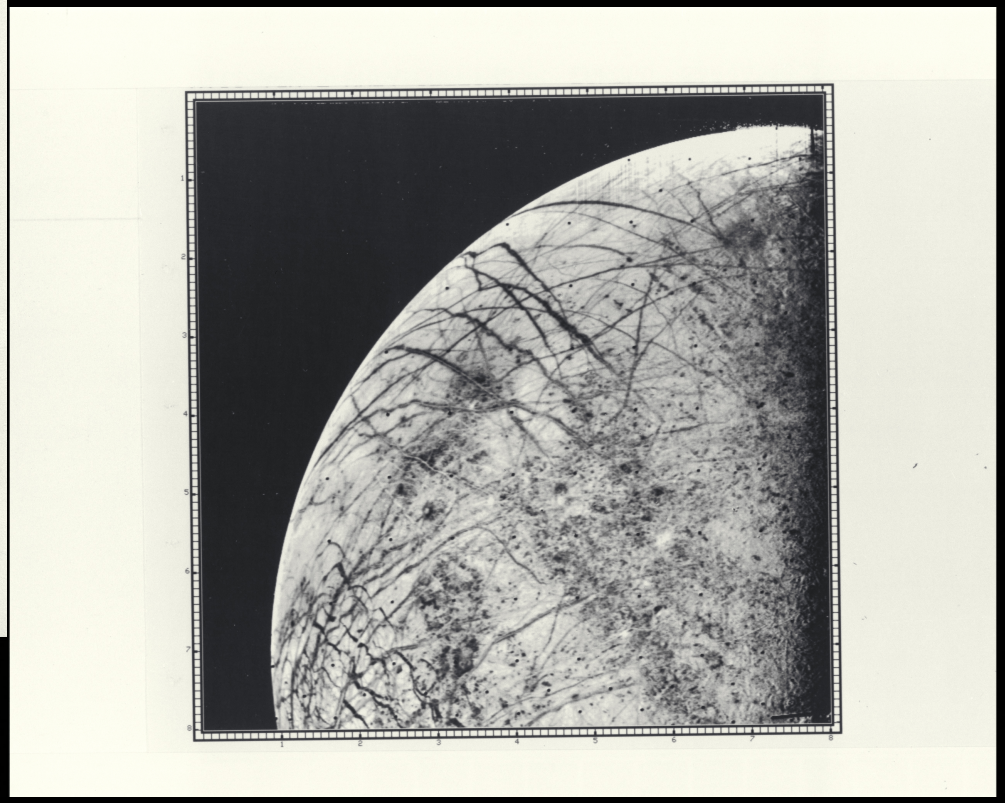
- 1973: Pioneer 10
- 1974: Pioneer 11
- 1979: Voyager 1
- 1979: Voyager 2
- 1992: Ulysses
- 1995-2003: Galileo
- 2000: Cassini
- 2007: New Horizons
- 2016: Juno



Voyager

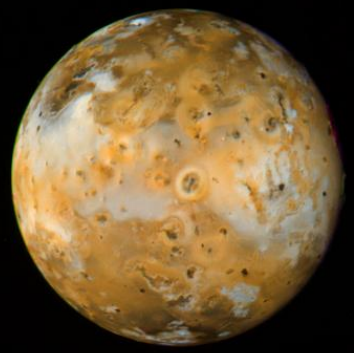


Europa's First closeup: Voyager 2



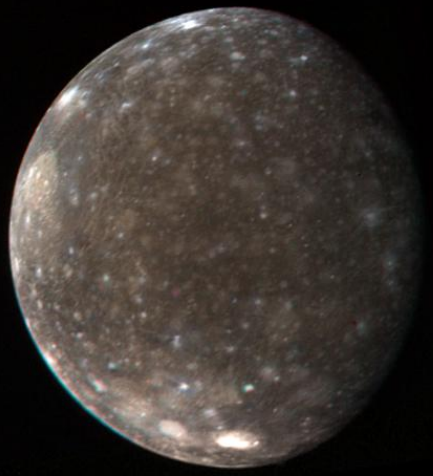
Galilean Moons from Voyager 2

Io



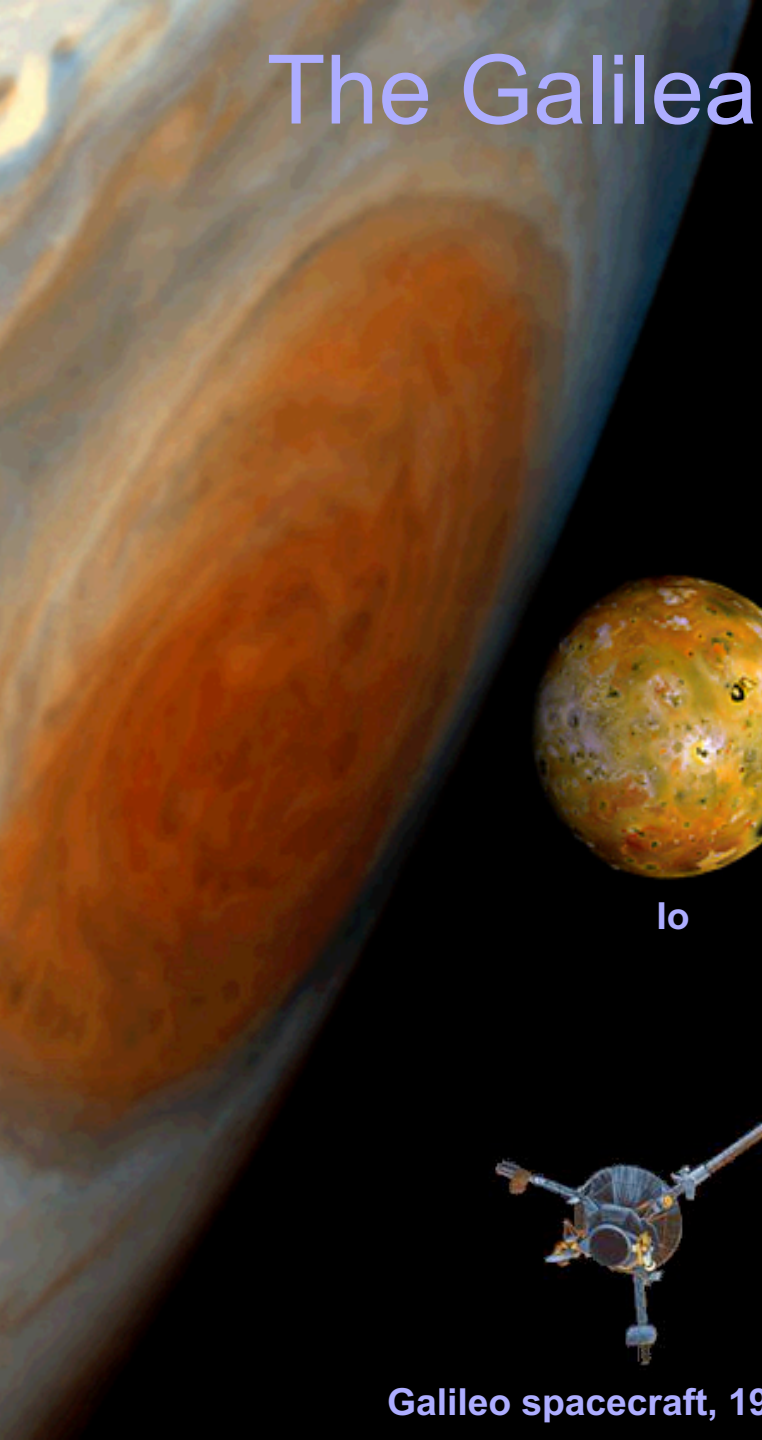
Europa

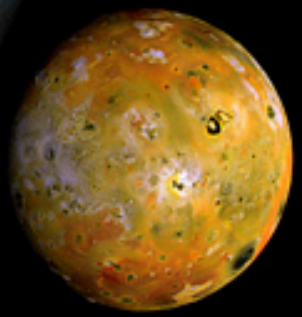
Ganymede



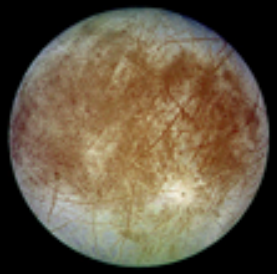
Callisto

The Galilean Moons from Galileo



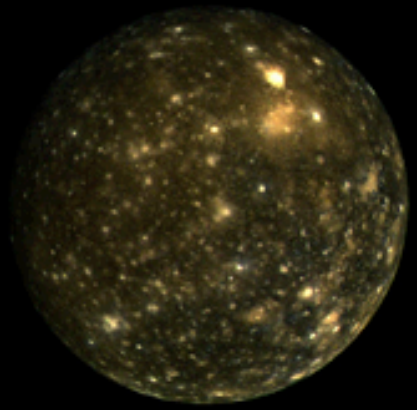


Io



Europa

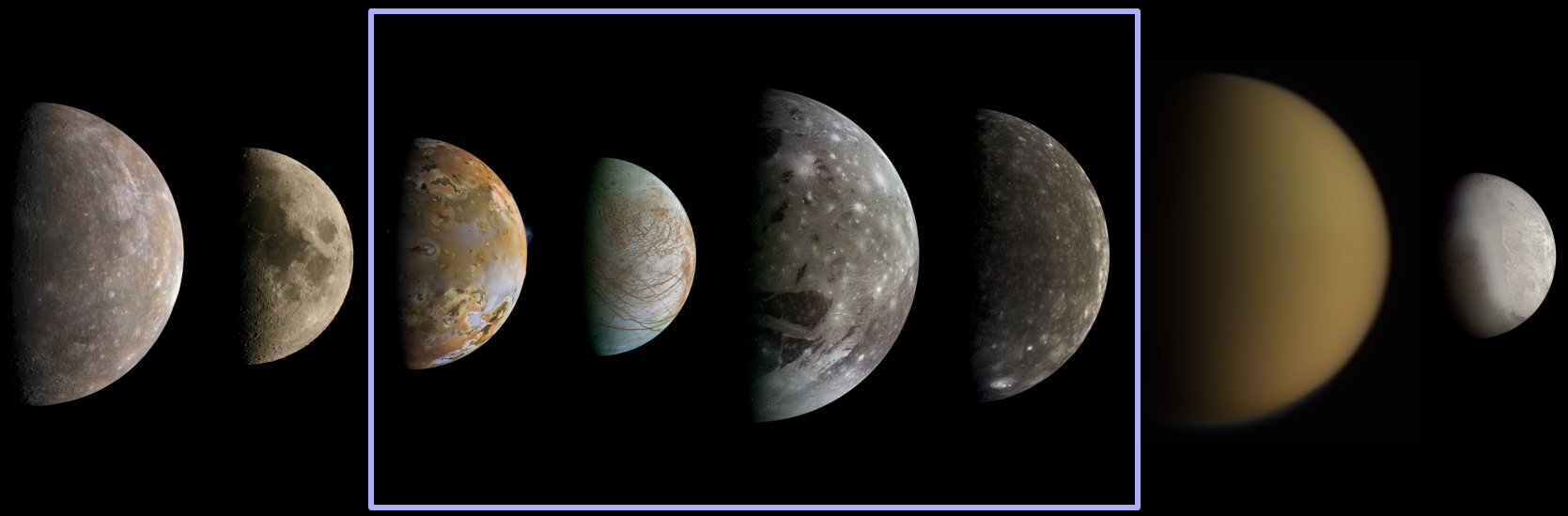
Ganymede



Callisto

Galileo spacecraft, 1995-2003

Comparisons



Mercury (4,879 kilometers), the Moon (3,475), Io (3,639), Europa (3,125), Ganymede (5,265), Callisto (4,819), Titan (5,150, but it appears 5,550 with its atmosphere), and Triton (2,706).

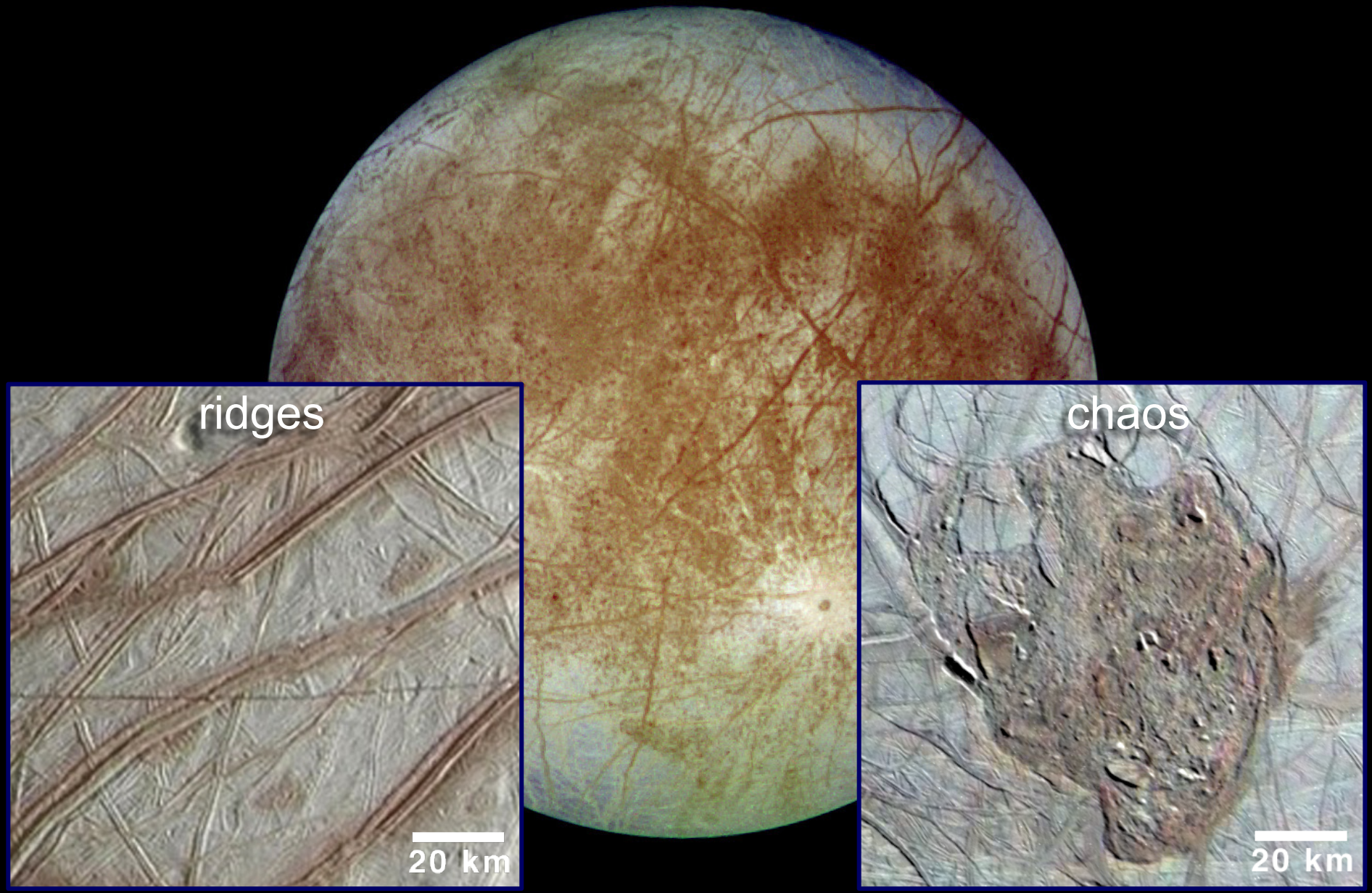
All images NASA / JPL / Ted Stryk except the Moon (Alfredo Balreira) and Titan (NASA / JPL / SSI / Emily Lakdawalla). Montage by Emily Lakdawalla.

Europa & Impact Craters

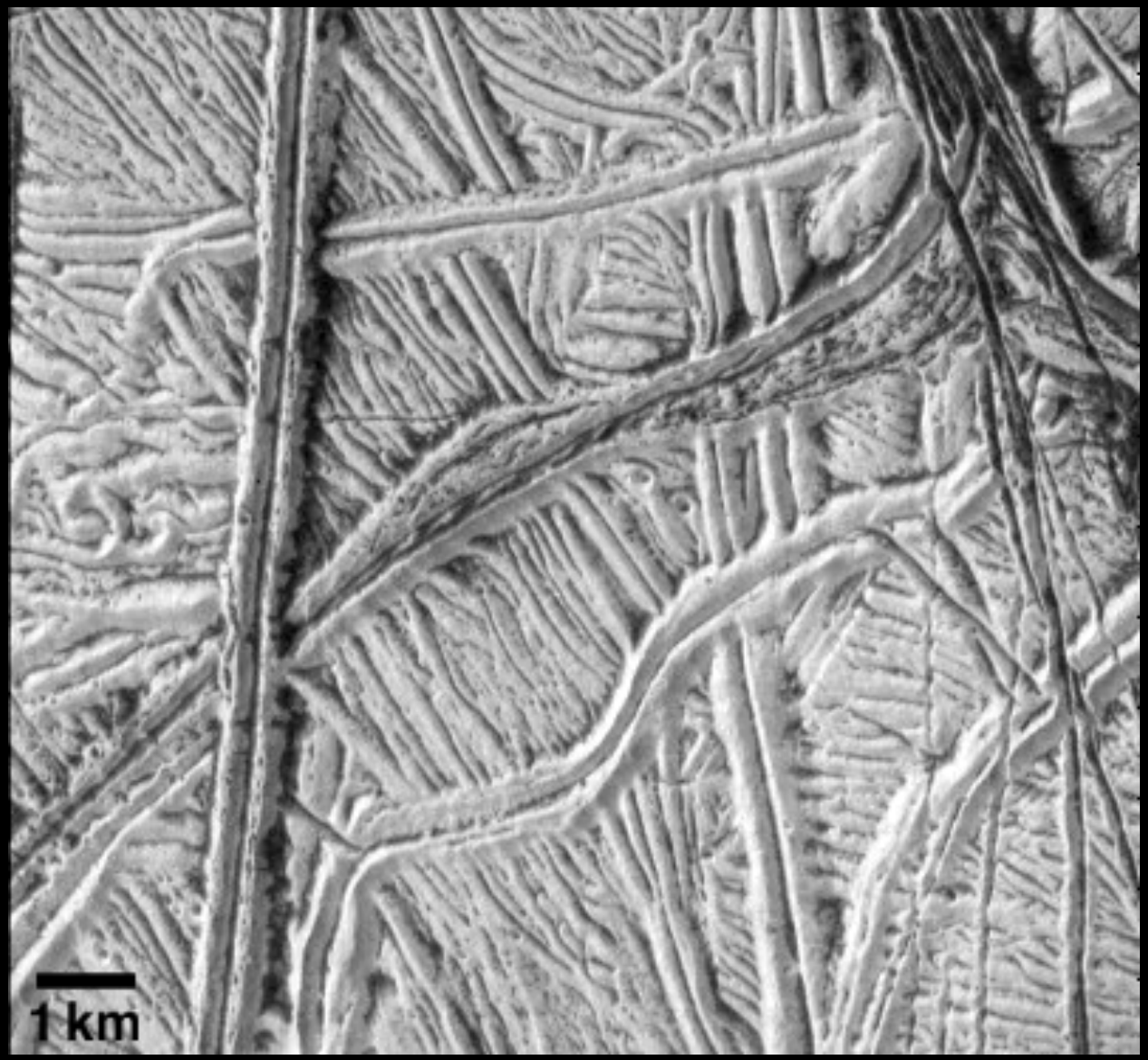
Ganymede

Europa

Europa's Surface



Ridges

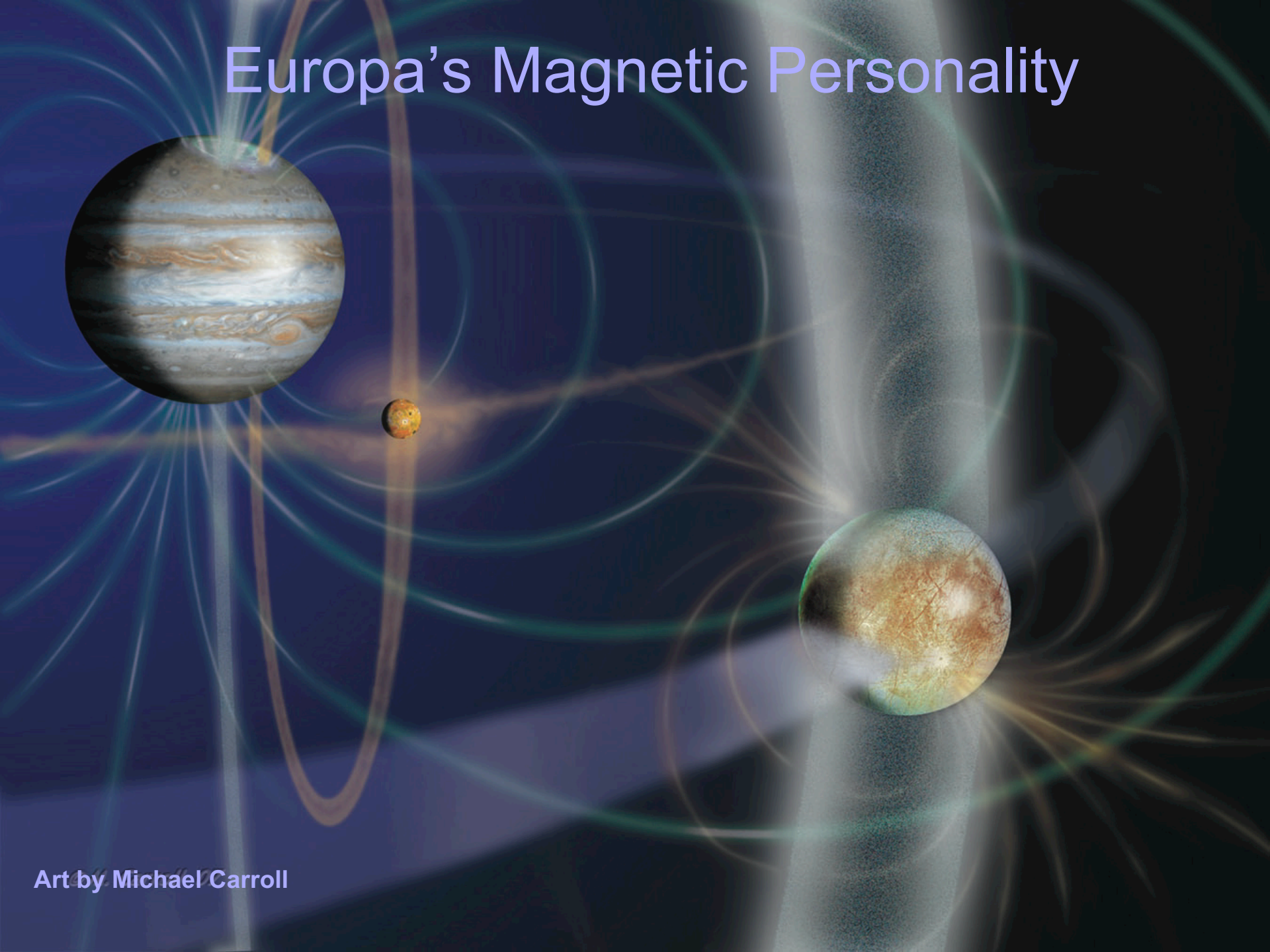


Argadnel Regio, Europa

San Andreas Fault, Earth

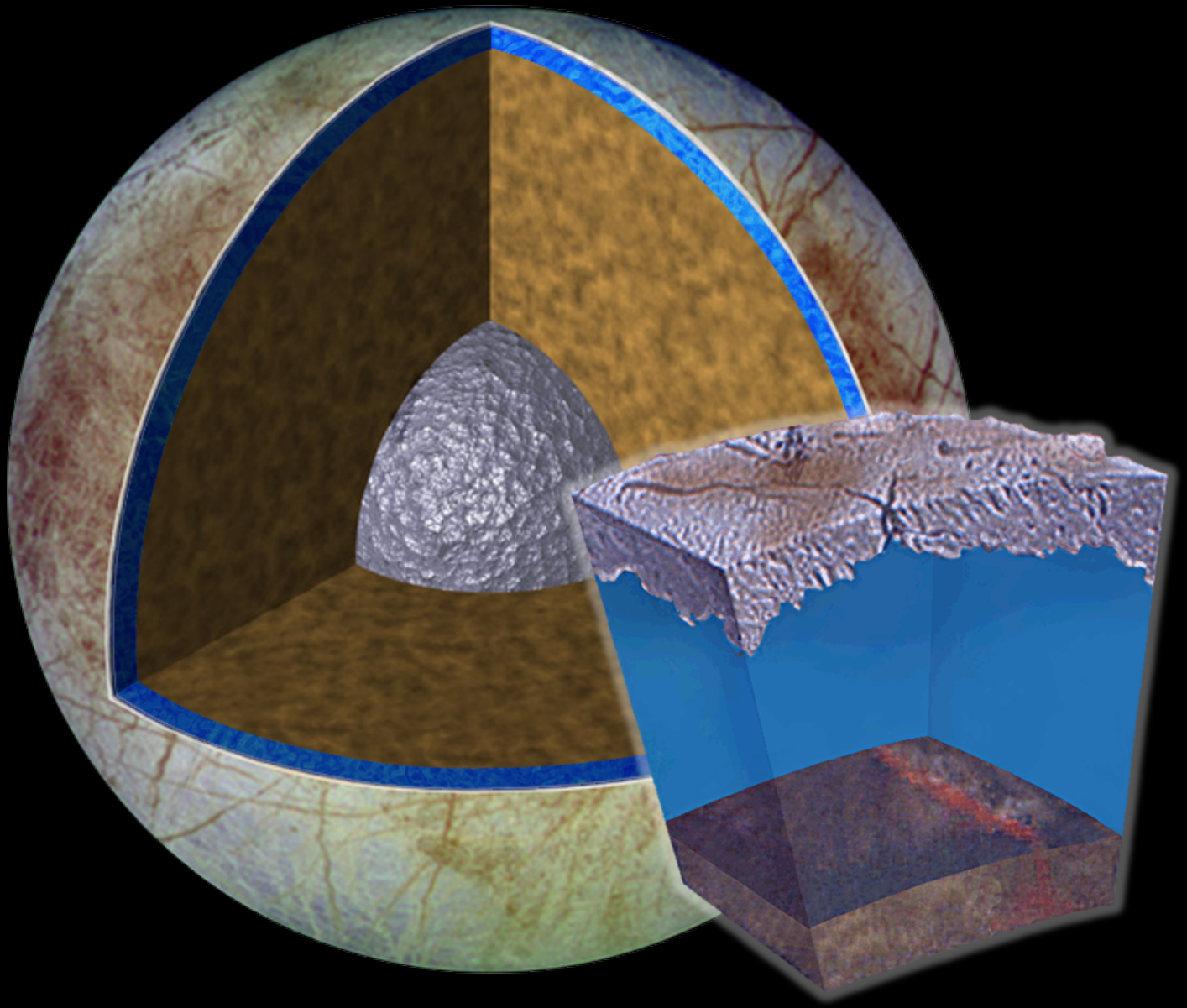
Impacts

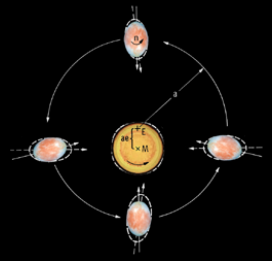
Europa's Magnetic Personality



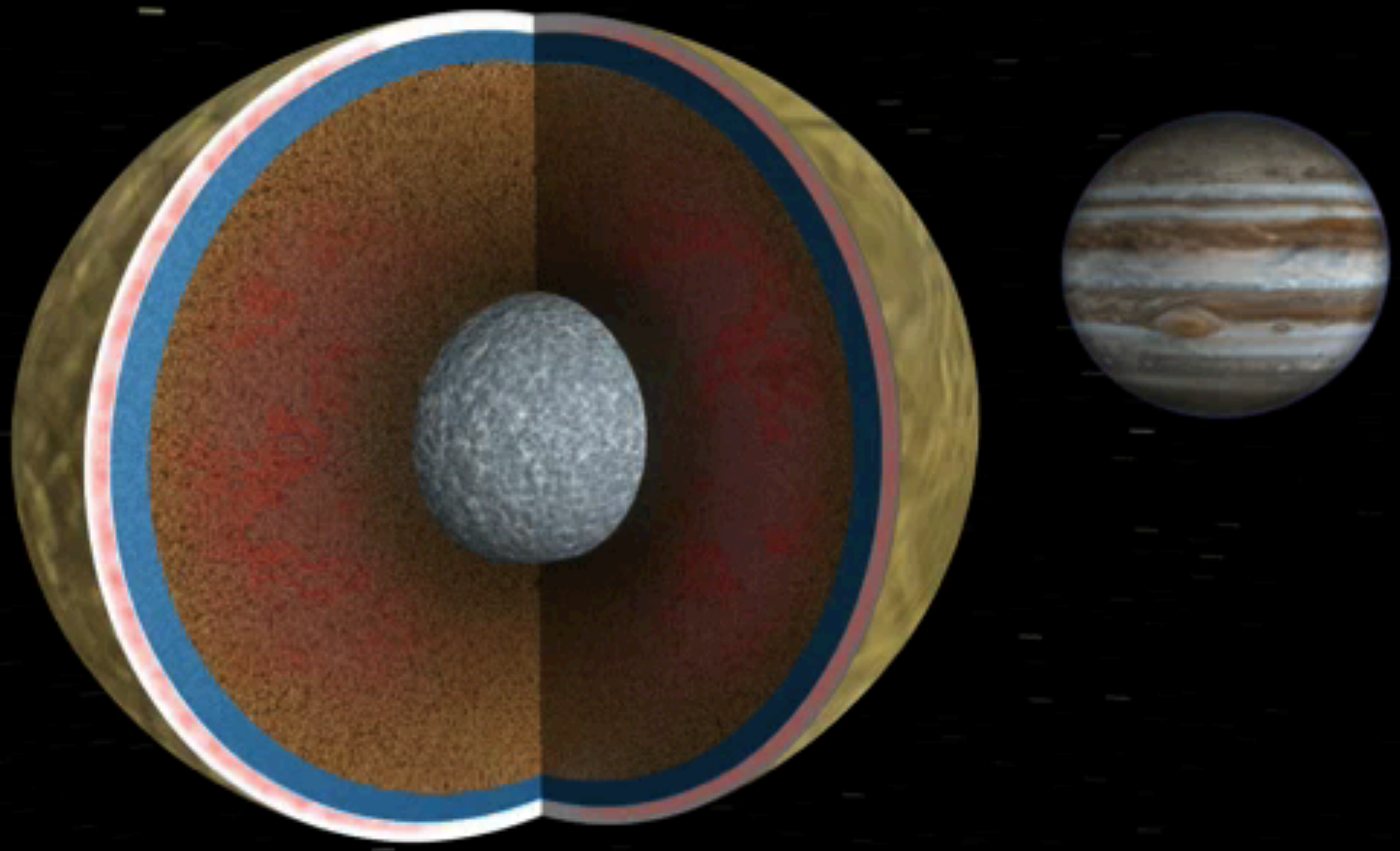
Art by Michael Carroll

Europa's Interior

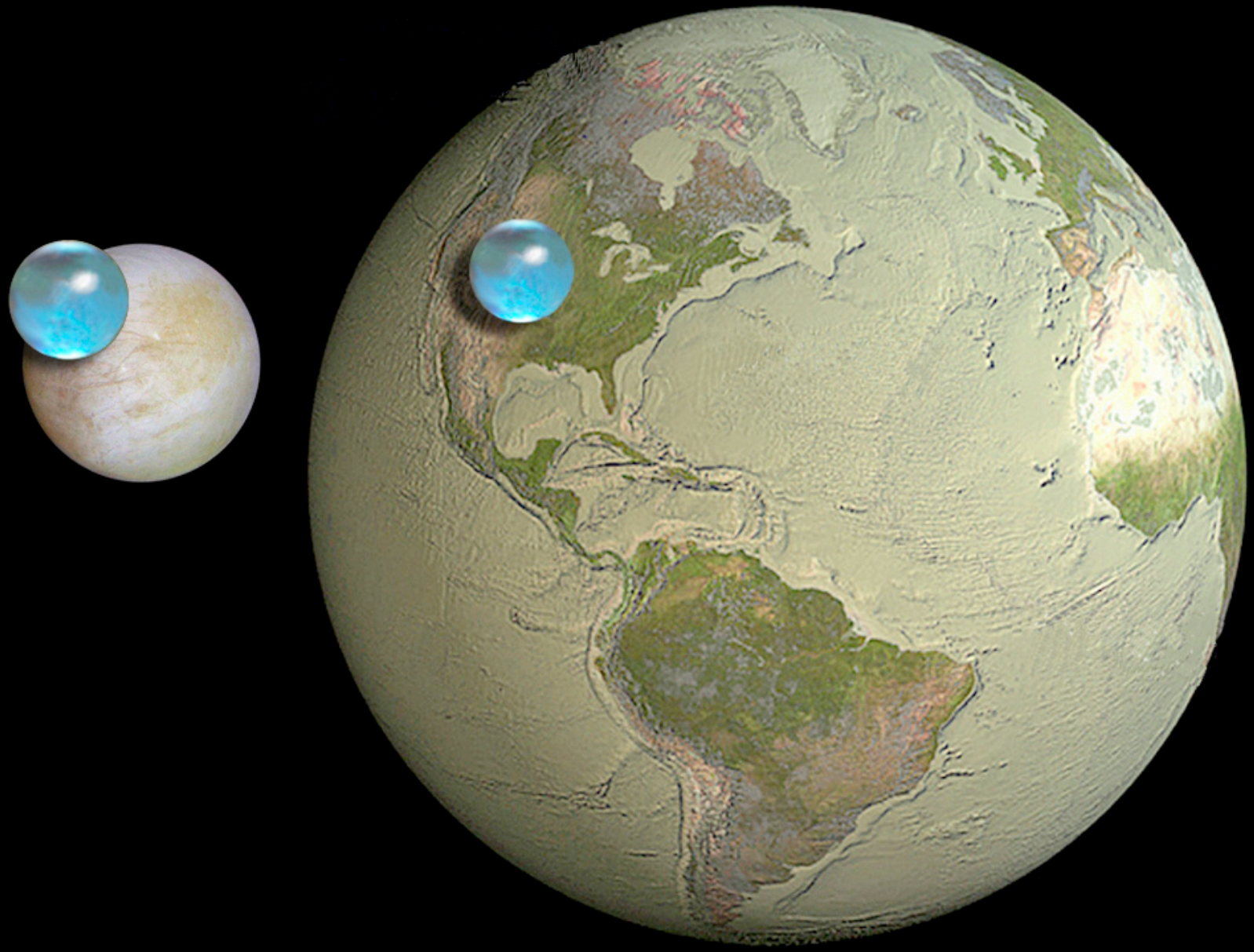




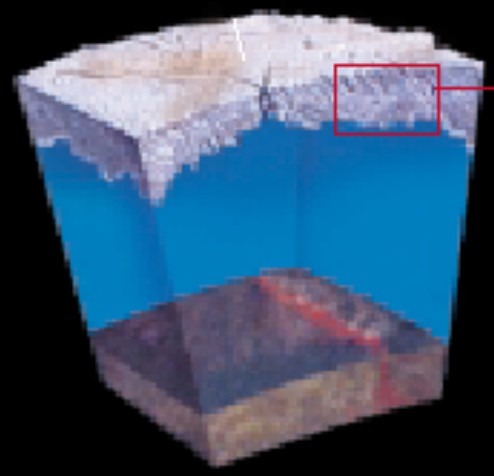
Tidal Flexing

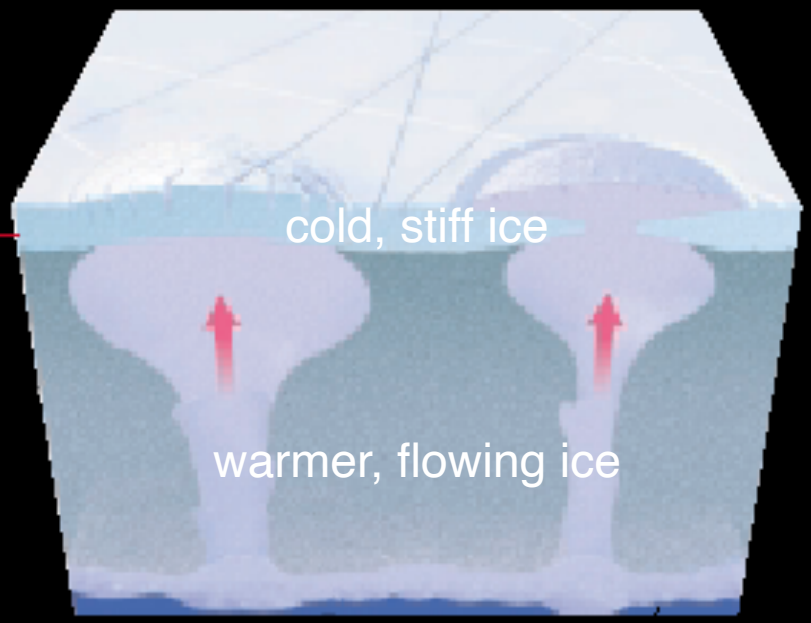


Europa: More Water Than Earth



Icy “Lava Lamp”





ocean

Chaos

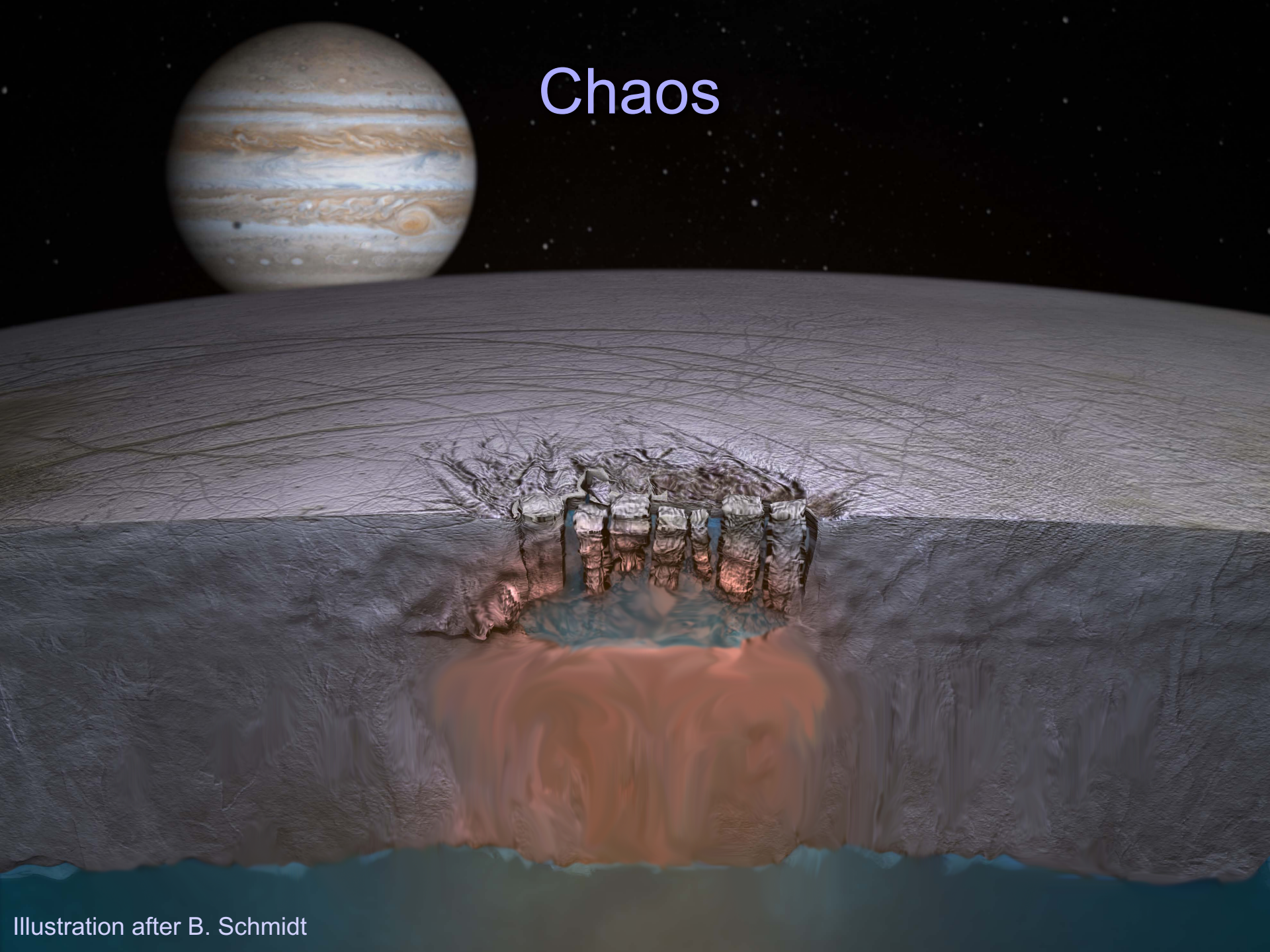
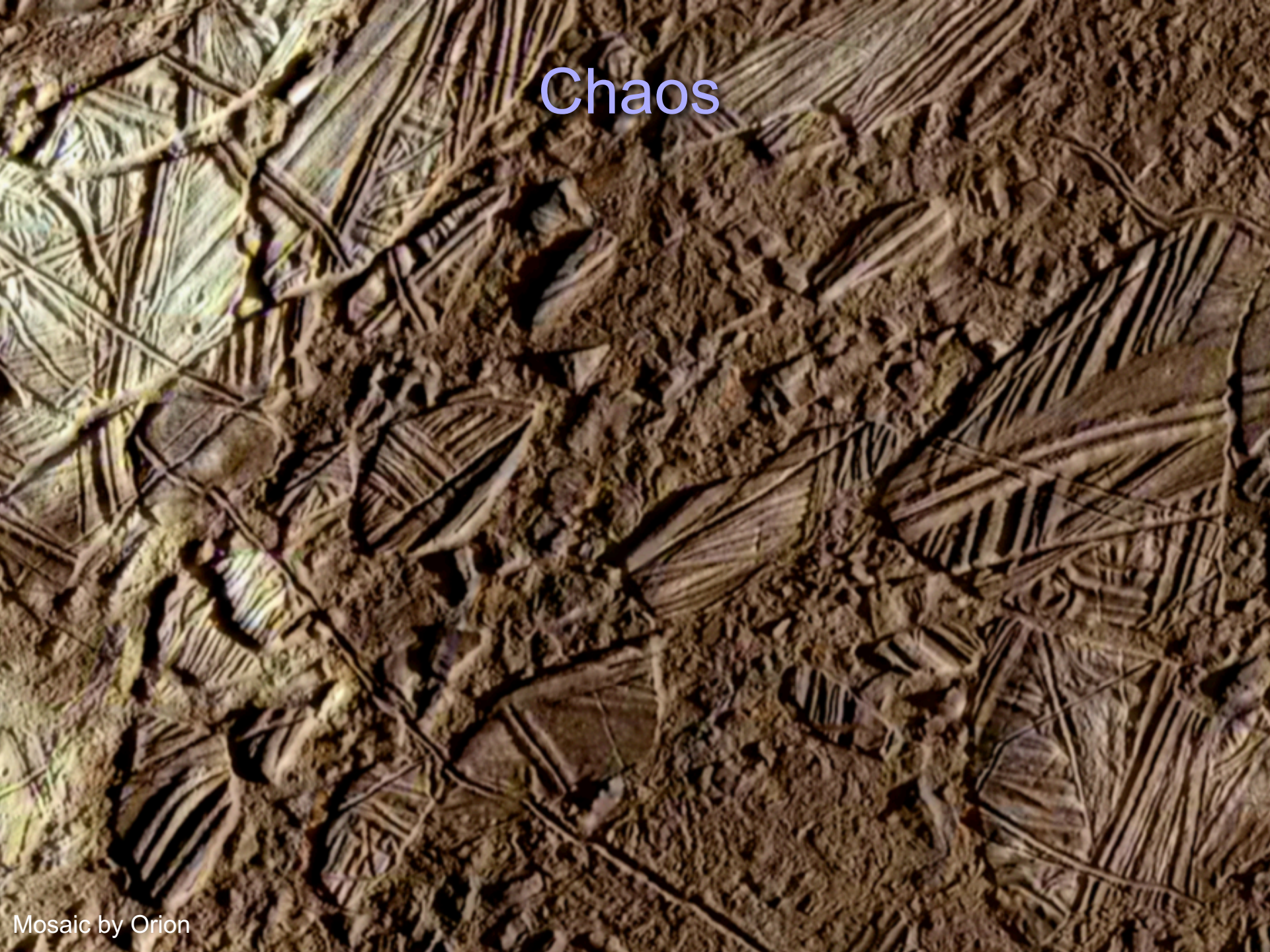
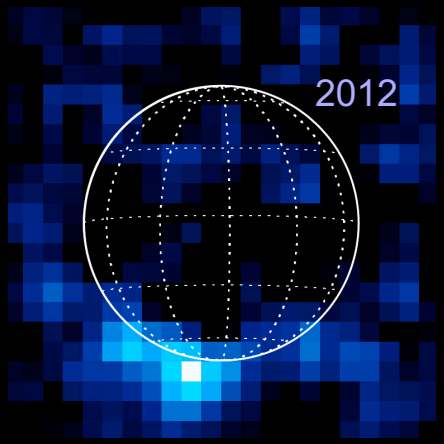
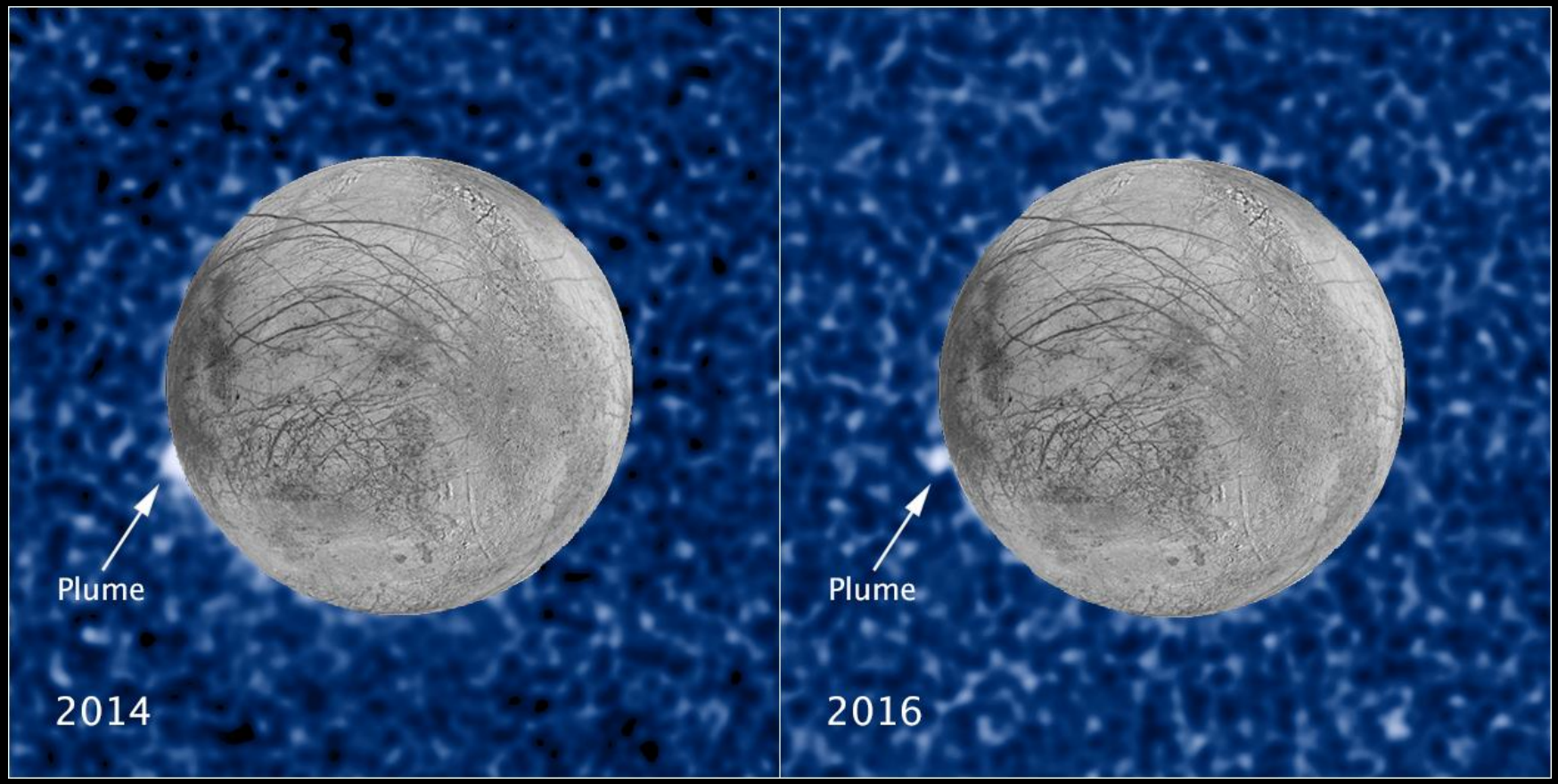


Illustration after B. Schmidt


Chaos
Mosaic by Orion

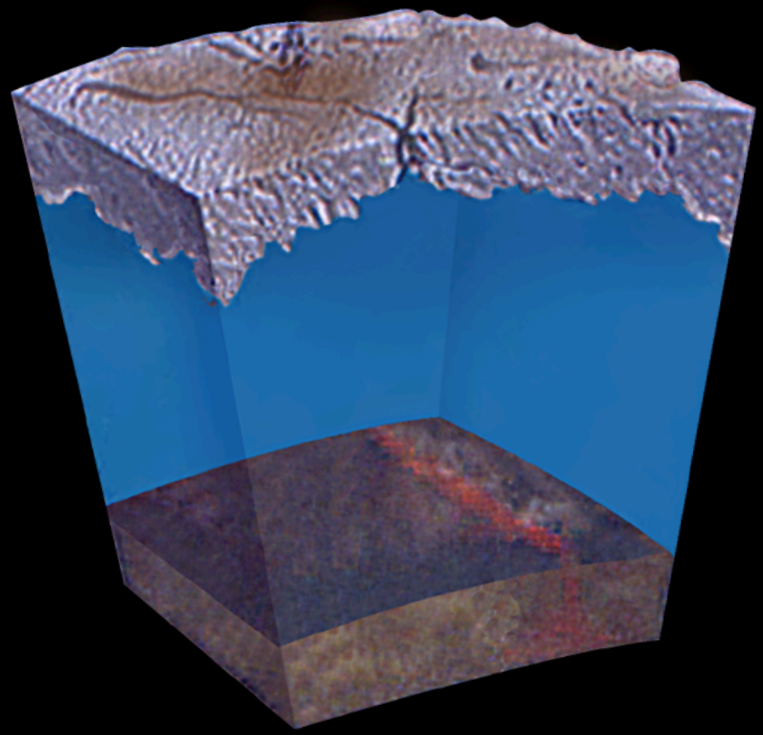
Plumes?

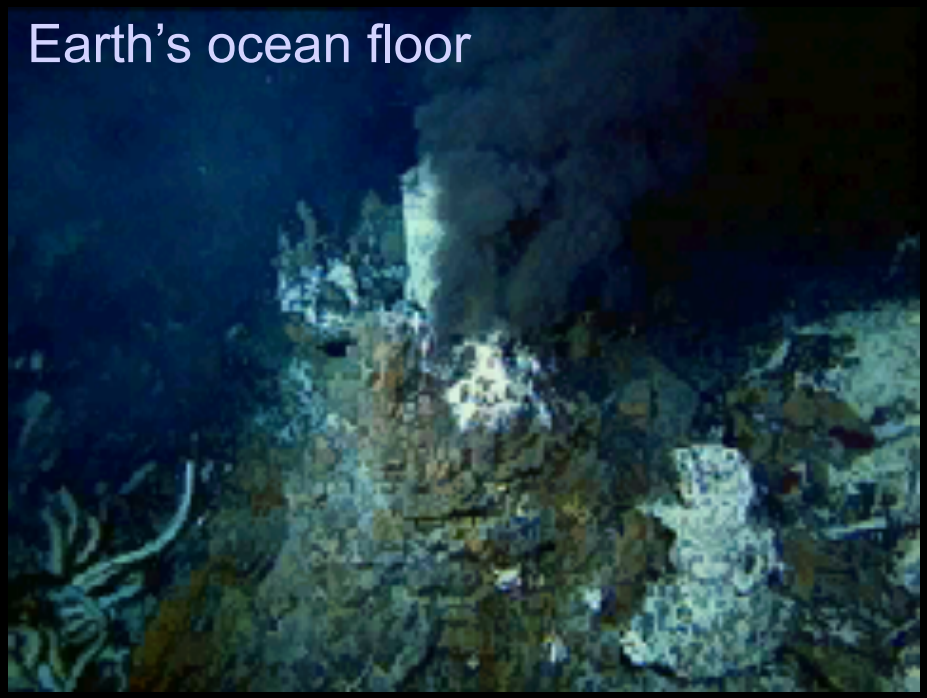




Ingredients for Life?

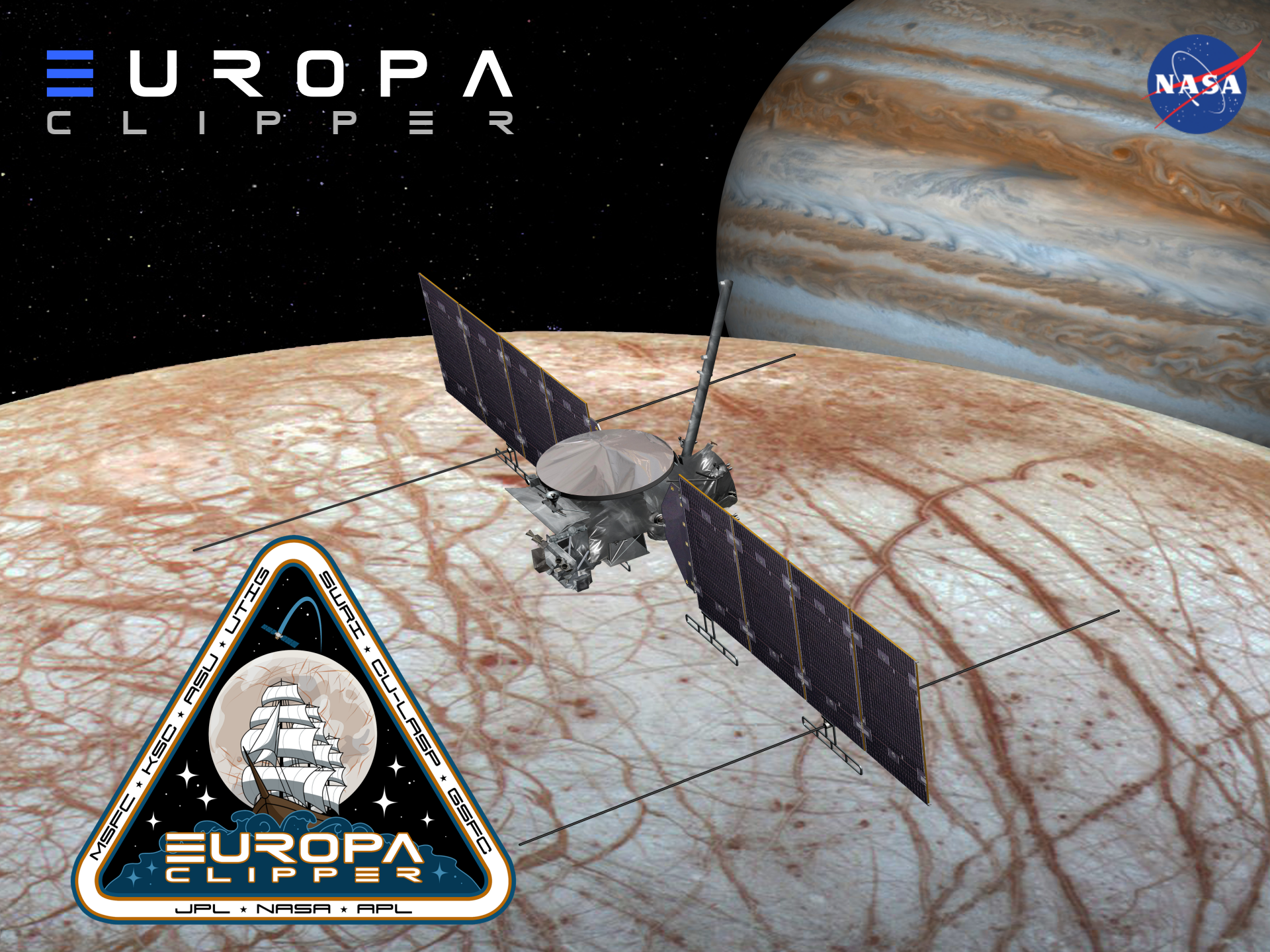
- Water: *Much more than all of Earth's oceans*
- Essential elements: *From formation and impacts*
- Chemical energy: *From above and below*
- Stability: *"Simmering" for 4 billion years*





Woods Hole Oceanographic Institution

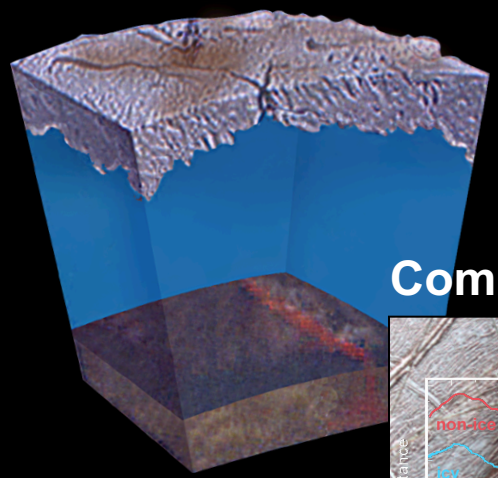
EUROPA CLIPPER



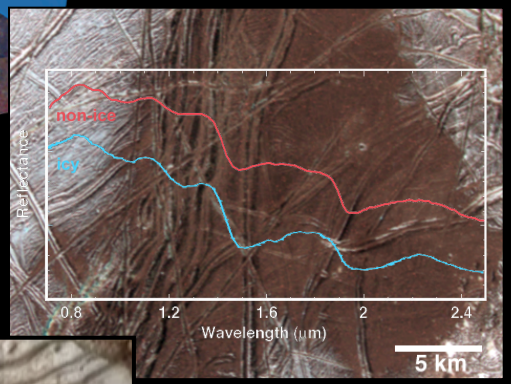
Europa Mission Science

Goal: Explore Europa to investigate its habitability

Ocean & Ice Shell

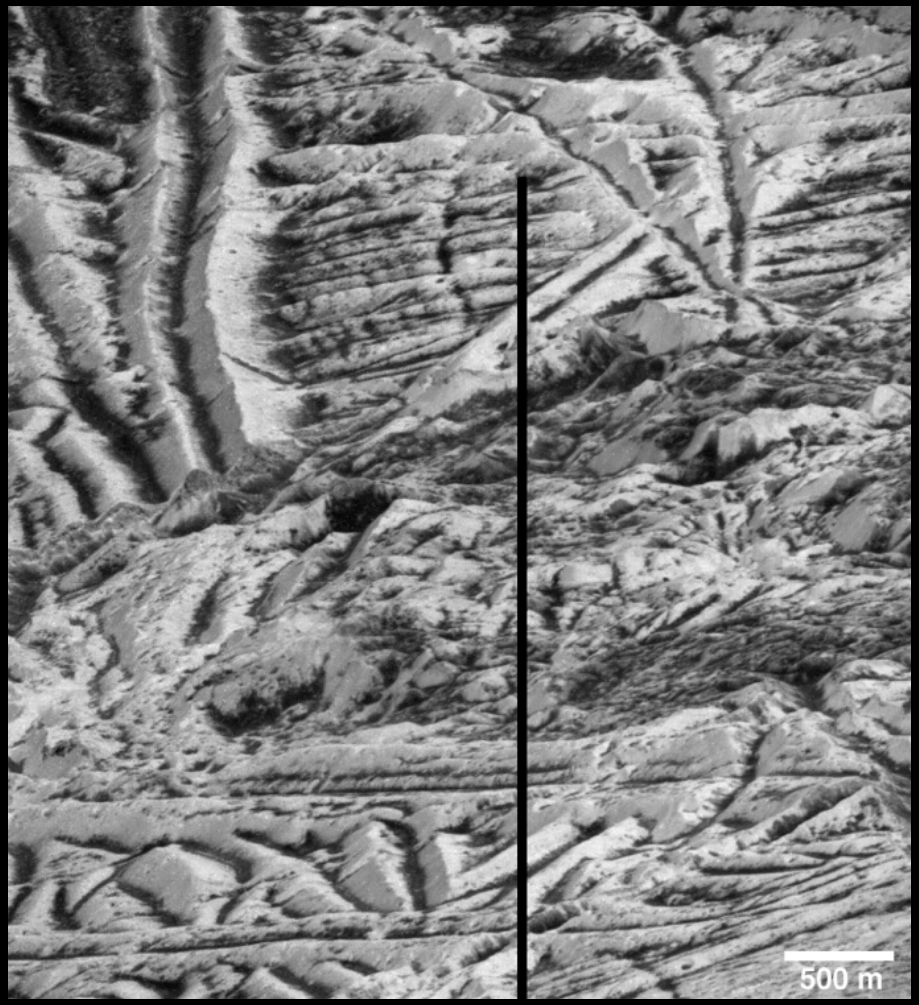


Composition

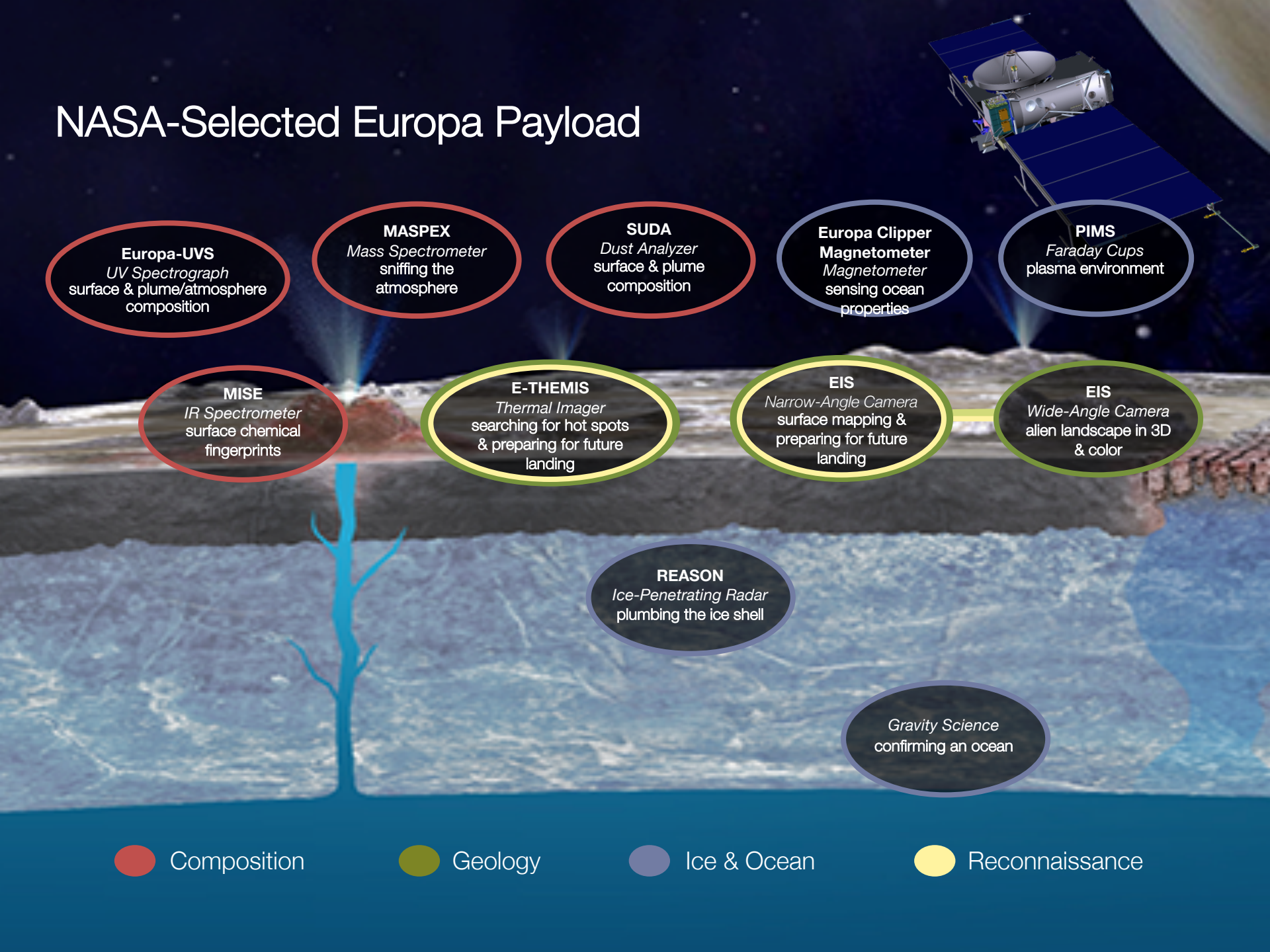


Geology

Reconnaissance

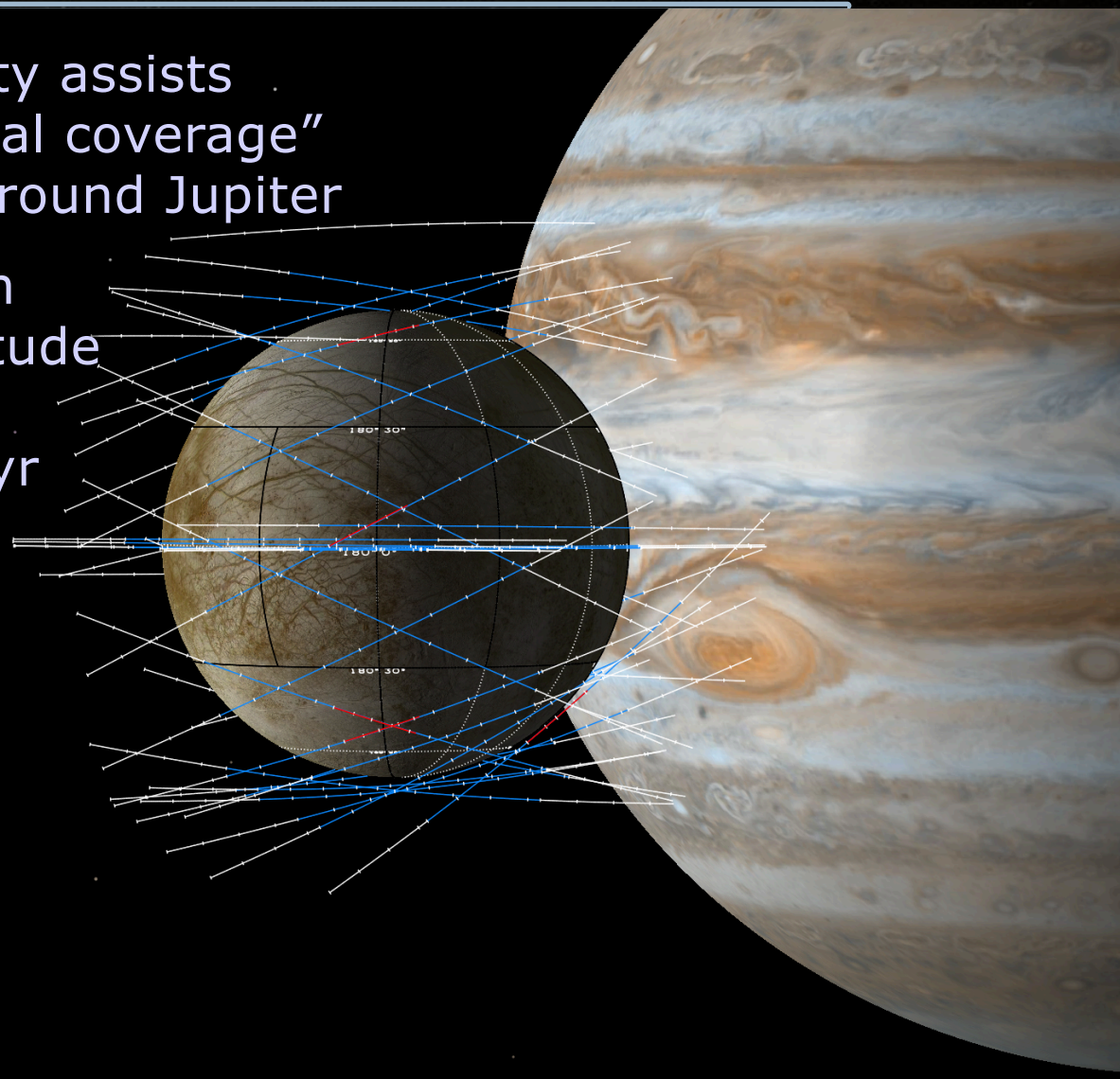


NASA-Selected Europa Payload



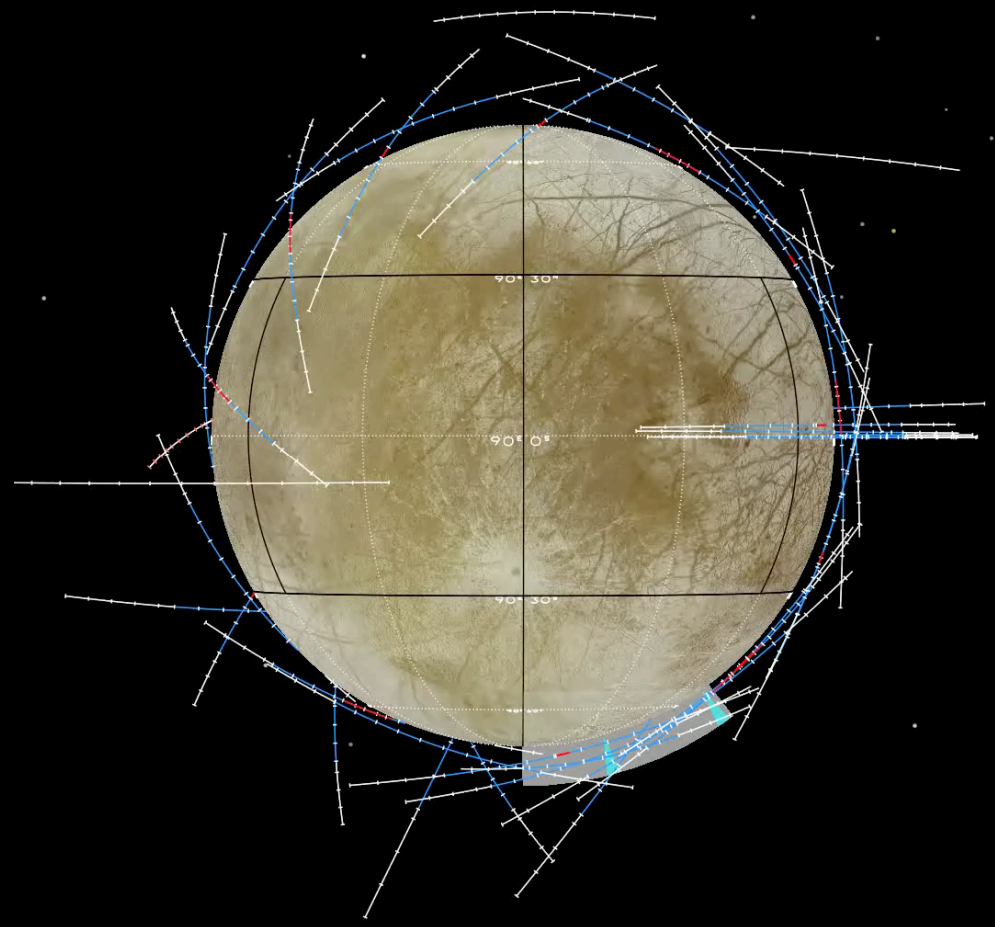
A Global Web of Fly-bys

- Multiple satellite gravity assists enables "global-regional coverage" of Europa from orbit around Jupiter
- Current mission design consists of 46 low-altitude flybys of Europa from Jupiter orbit over 3.5 yr
- Minimizes time in high radiation environment
- Simple repetitive operations

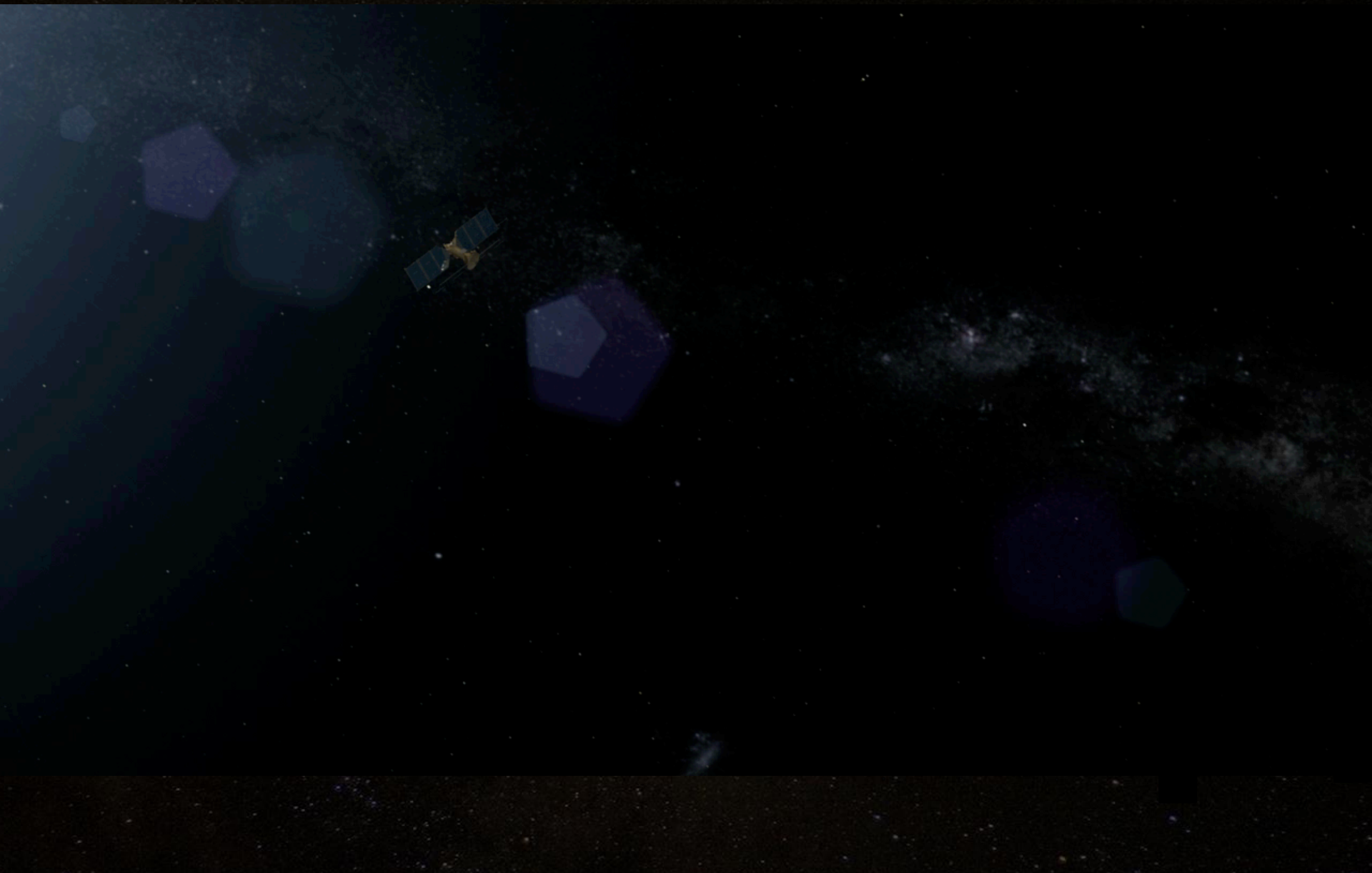


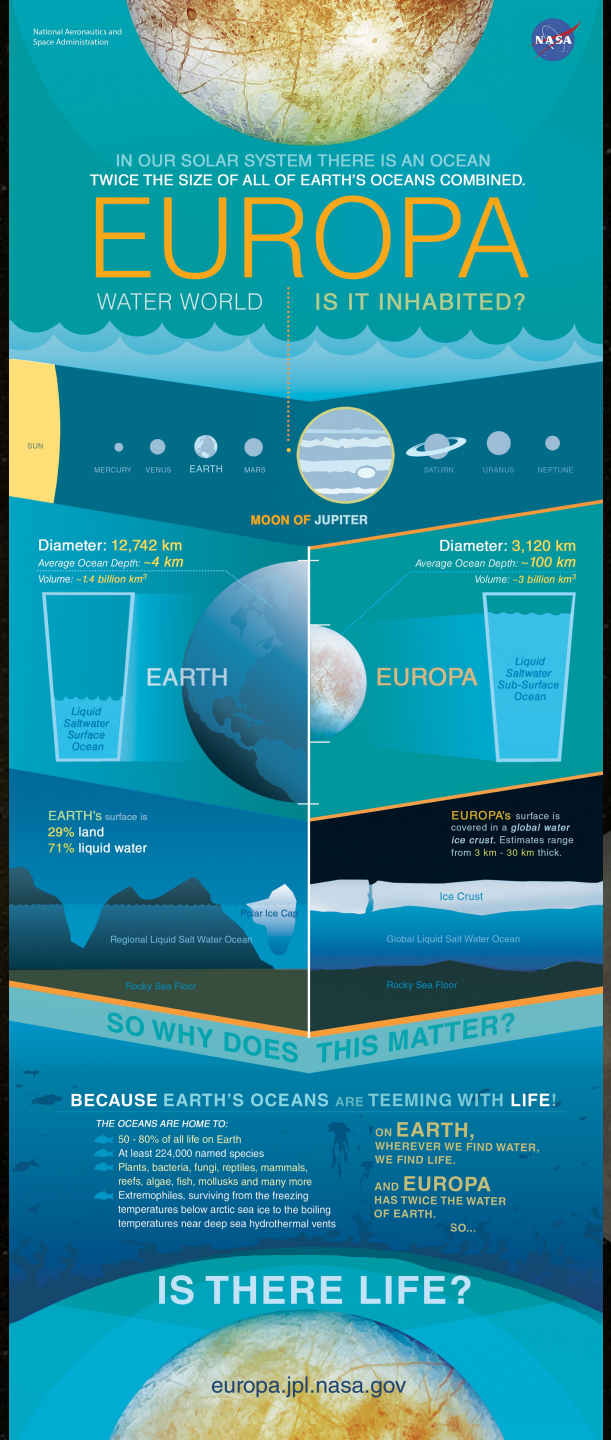
Coverage in Plumes Region

13F7-A21 Trajectory



Europa Mission Concept




National Aeronautics and Space Administration
NASA
IN OUR SOLAR SYSTEM THERE IS AN OCEAN
TWICE THE SIZE OF ALL OF EARTH'S OCEANS COMBINED.
EUROPA
WATER WORLD
IS IT INHABITED?
SUN
MERCURY
VENUS
EARTH
MARS
SATURN
URANUS
NEPTUNE
MOON OF JUPITER
Diameter: 12,742 km
Average Ocean Depth: ~4 km
Volume: ~1.4 billion km³
EARTH
Liquid Saltwater Surface Ocean
Diameter: 3,120 km
Average Ocean Depth: ~100 km
Volume: ~3 billion km³
EUROPA
Liquid Saltwater Sub-Surface Ocean
EARTH'S surface is
29% land
71% liquid water
Polar Ice Cap
Regional Liquid Salt Water Ocean
Rocky Sea Floor
EUROPA'S surface is covered in a global water ice crust. Estimates range from 3 km - 30 km thick.
Ice Crust
Global Liquid Salt Water Ocean
Rocky Sea Floor
SO WHY DOES THIS MATTER?
BECAUSE EARTH'S OCEANS ARE TEEMING WITH LIFE!
THE OCEANS ARE HOME TO:
50 - 80% of all life on Earth
At least 224,000 named species
Plants, bacteria, fungi, reptiles, mammals, reefs, algae, fish, mollusks and many more
Extremophiles, surviving from the freezing temperatures below arctic sea ice to the boiling temperatures near deep sea hydrothermal vents
ON EARTH, WHEREVER WE FIND WATER, WE FIND LIFE.
AND EUROPA HAS TWICE THE WATER OF EARTH.
SO...
IS THERE LIFE?
europa.jpl.nasa.gov

http://www.nasa.gov/europa

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California Institute of Technology

jpl.nasa.gov

Astonishing geology and the potential to host the conditions for simple life make Jupiter's moon Europa a fascinating destination for future exploration. Beneath its icy surface, Europa is believed to conceal a global ocean of salty liquid water twice the volume of Earth's oceans. Tugging and flexing from Jupiter's gravity generates enough heat to keep the ocean from freezing. On Earth, wherever we find water, we find life. What will NASA's Europa mission find when it heads for this intriguing moon in the 2020s?

NASA Jet Propulsion Laboratory
www.jpl.nasa.gov