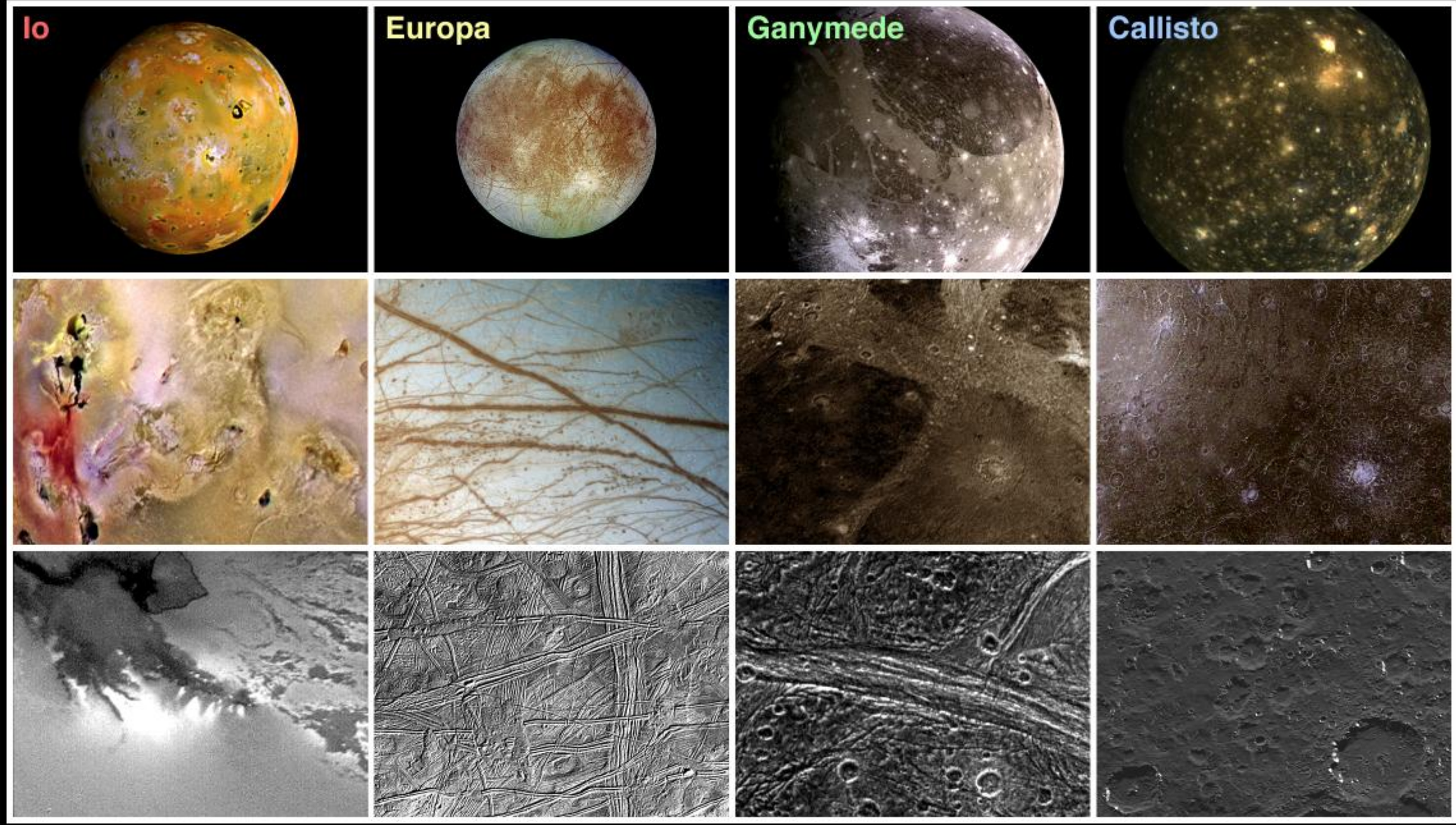


Not all the terrestrial worlds are planets. For example, the Galilean worlds are the four largest moons of Jupiter: Io, Europa, Ganymede, and Callisto.

	Io	Europa	Ganymede	Callisto
mean density (grams/cc)	3.4	3.1	1.9	1.8
	rock/silicates		ice/rock	

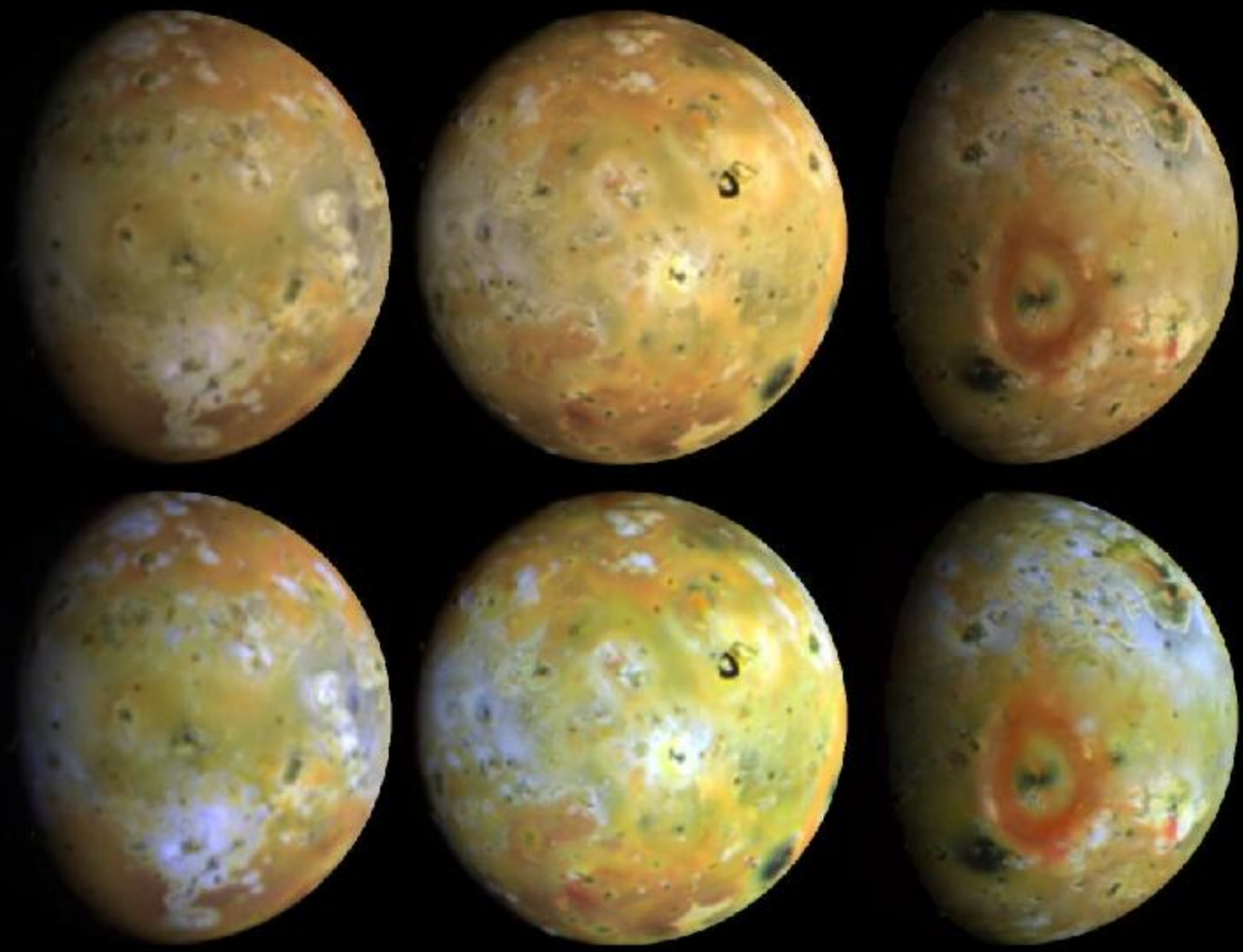
They each have special characteristics related to their formation process, but have the following traits in common:

1) all orbit Jupiter

2) they all are tidally locked to Jupiter

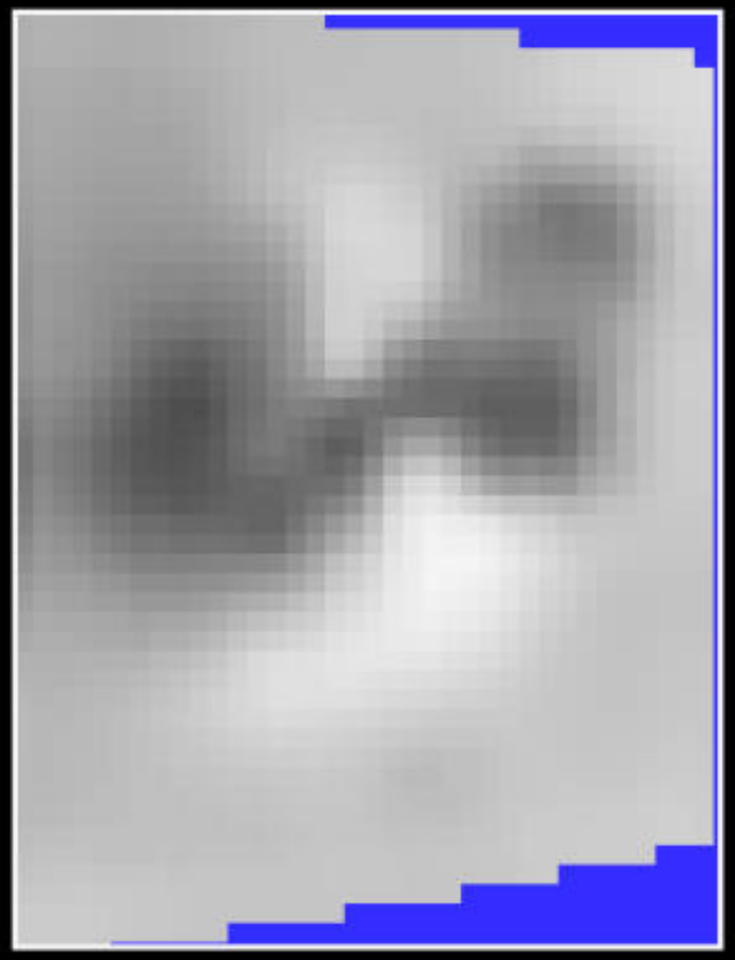
3) they all have radii larger than our Moon

4) the inner moons have densities higher than outer moons (implies that Jupiter was much warmer in the past, such that the moons formed near Jupiter have less of the volatile elements such as CO2 and H2O)

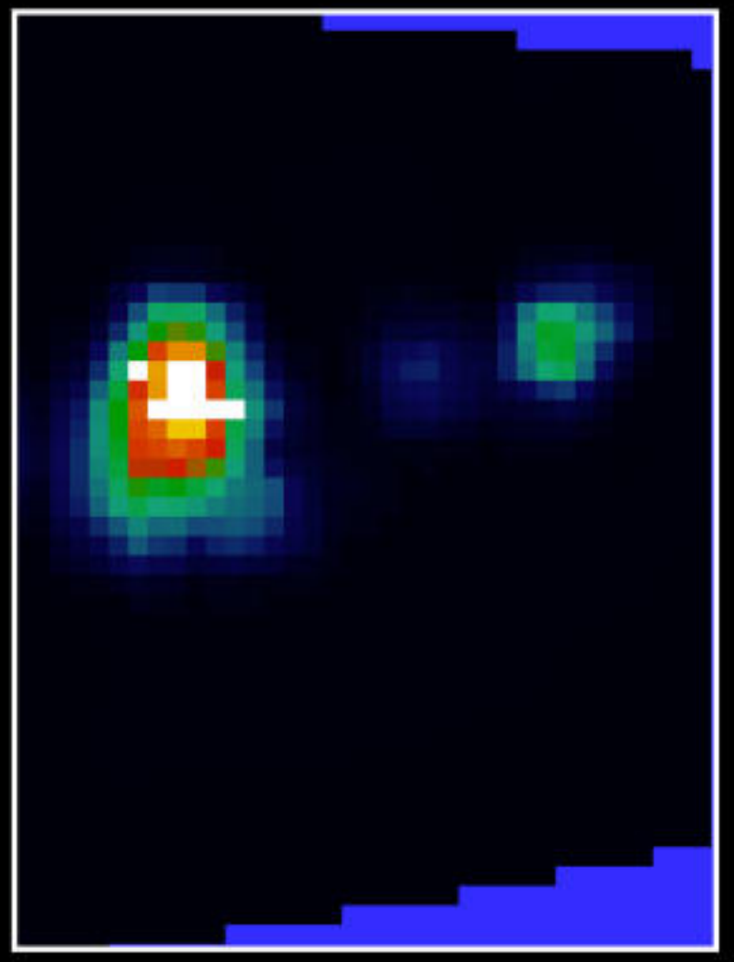


Io (Jupiter I) is the innermost of the four Galilean moons of Jupiter and, with a diameter of 3,642 kilometers, the fourth-largest moon in the Solar System.

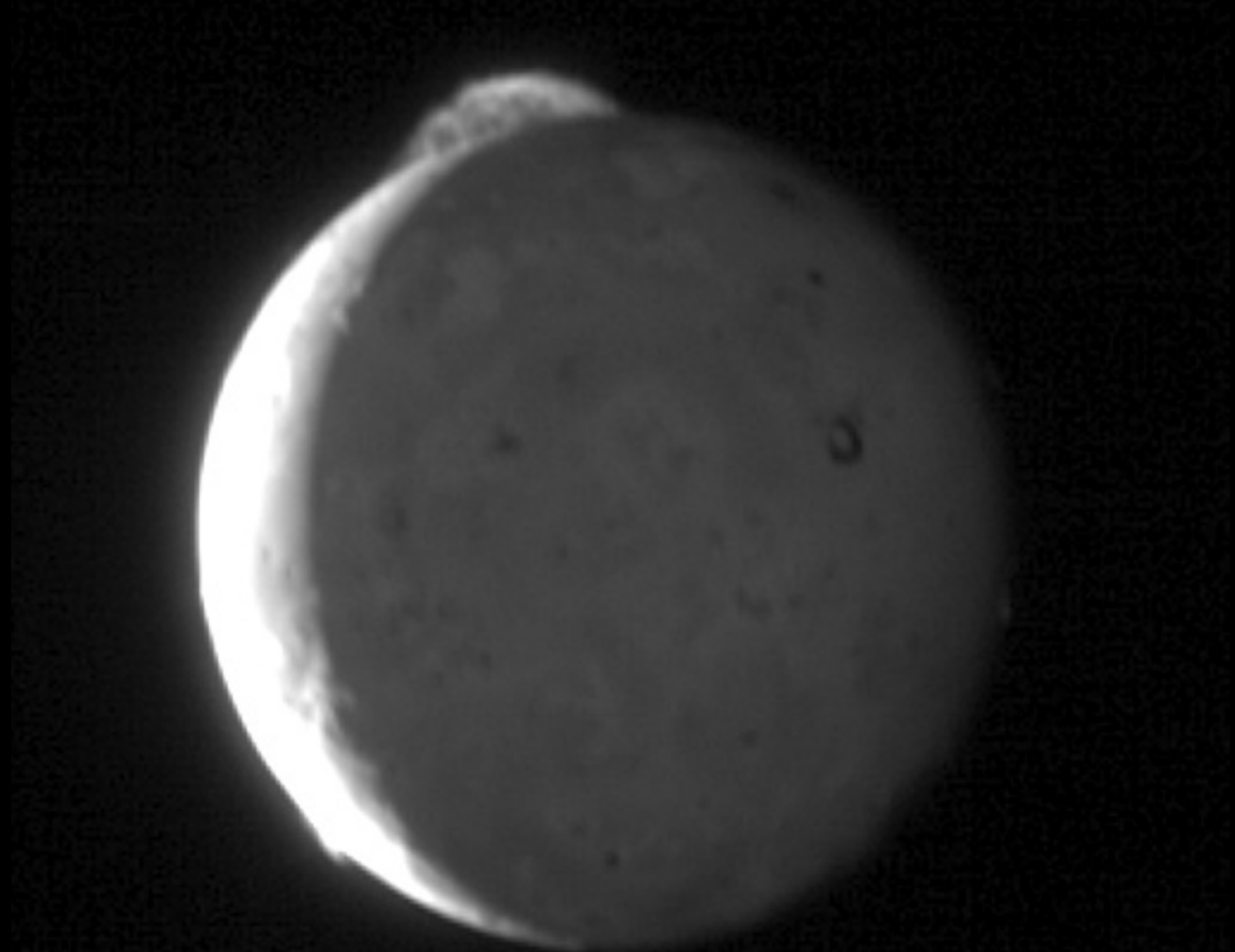
surface of Io is a mottled yellow, reds and blackish-browns = sulfur compounds, where different colors correspond to regions with different temperatures. The mean temperature on Io's surface is about -143 C (-230 F).



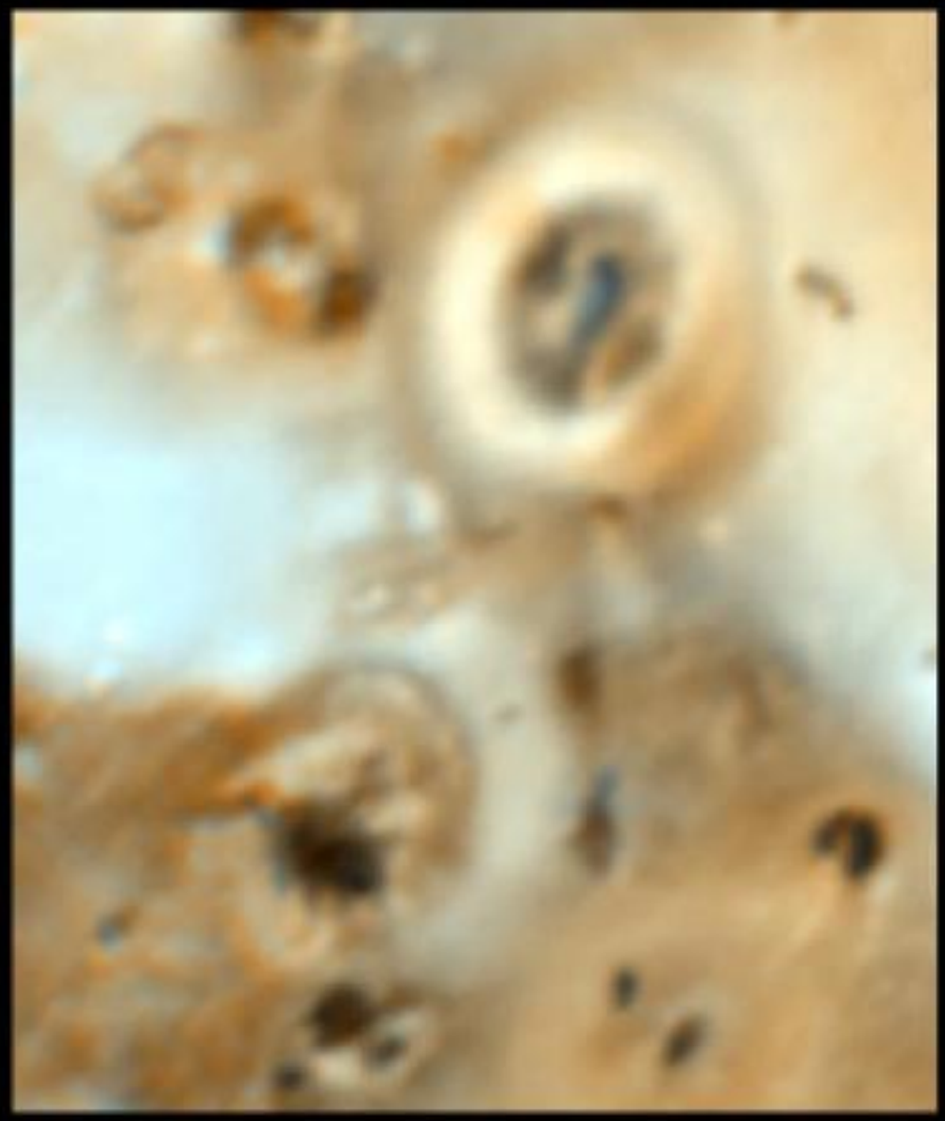
~ 1.2 microns

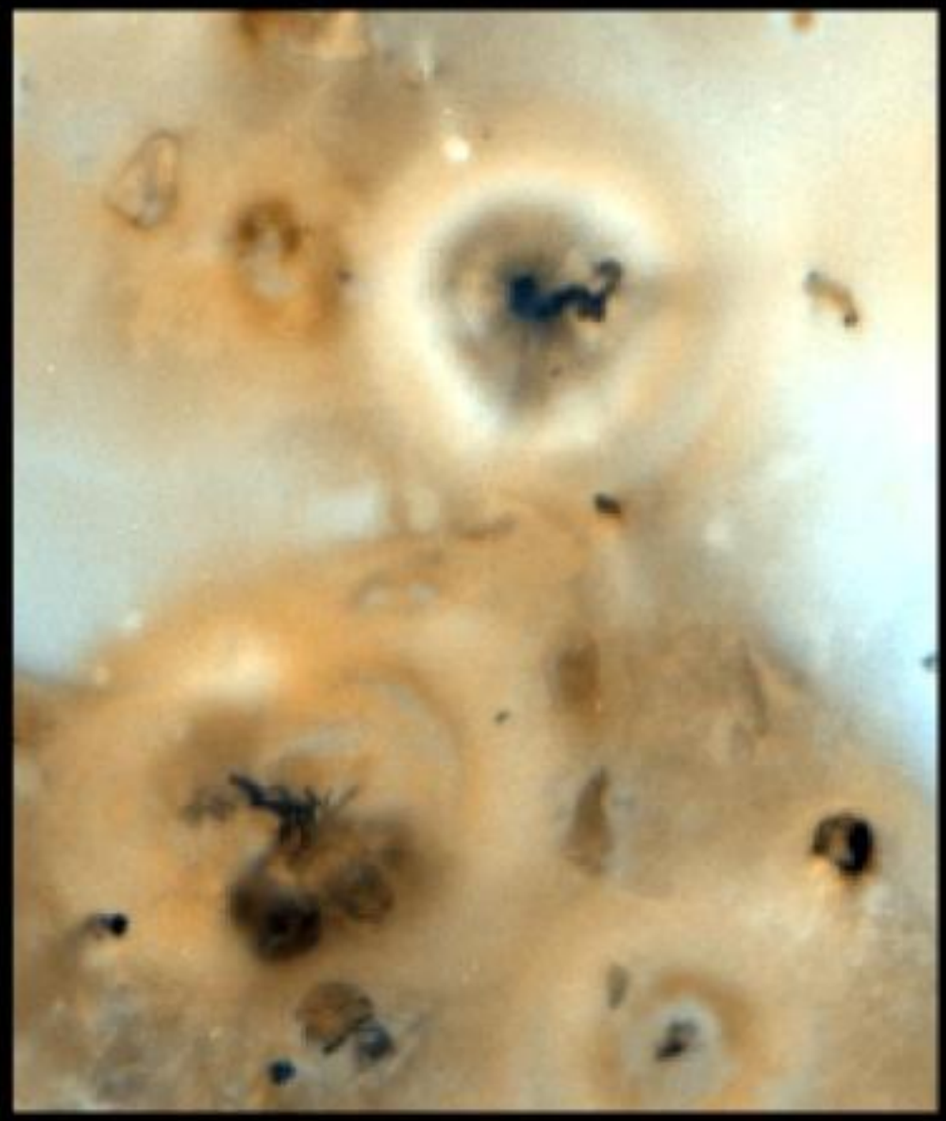


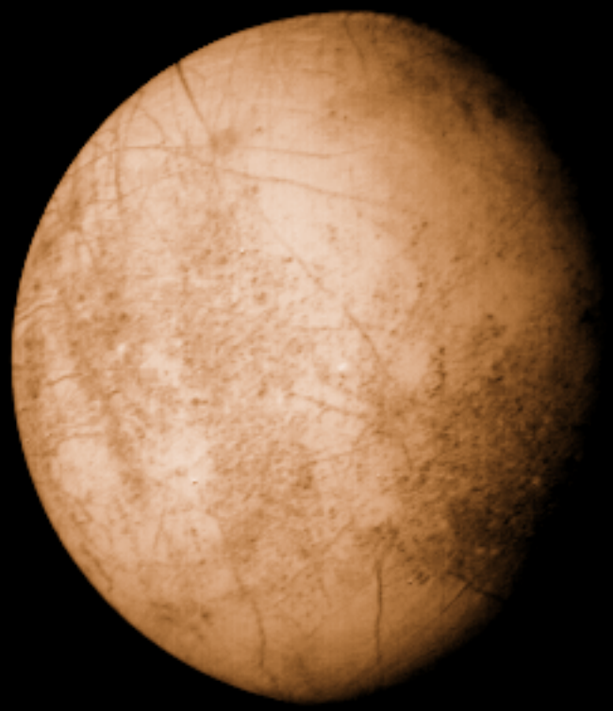
~ 4.5 microns



active plumes (not volcanos since there is no mantle), geysers of molten sulfur and SO2. The mechanism for heating Io's core is tidal friction from Jupiter. Jupiter's gravitational field is much stronger than, say, the Moon's on the Earth. The tides pull and squeeze the core of the moons around Jupiter producing mechanical friction. This friction is turned into heat, which makes the inner moons much more active than the outer moons. When liquid sulfur on surface flows into vents and makes contact with the hot interior, there is an explosive conversion into gas producing the geysers.

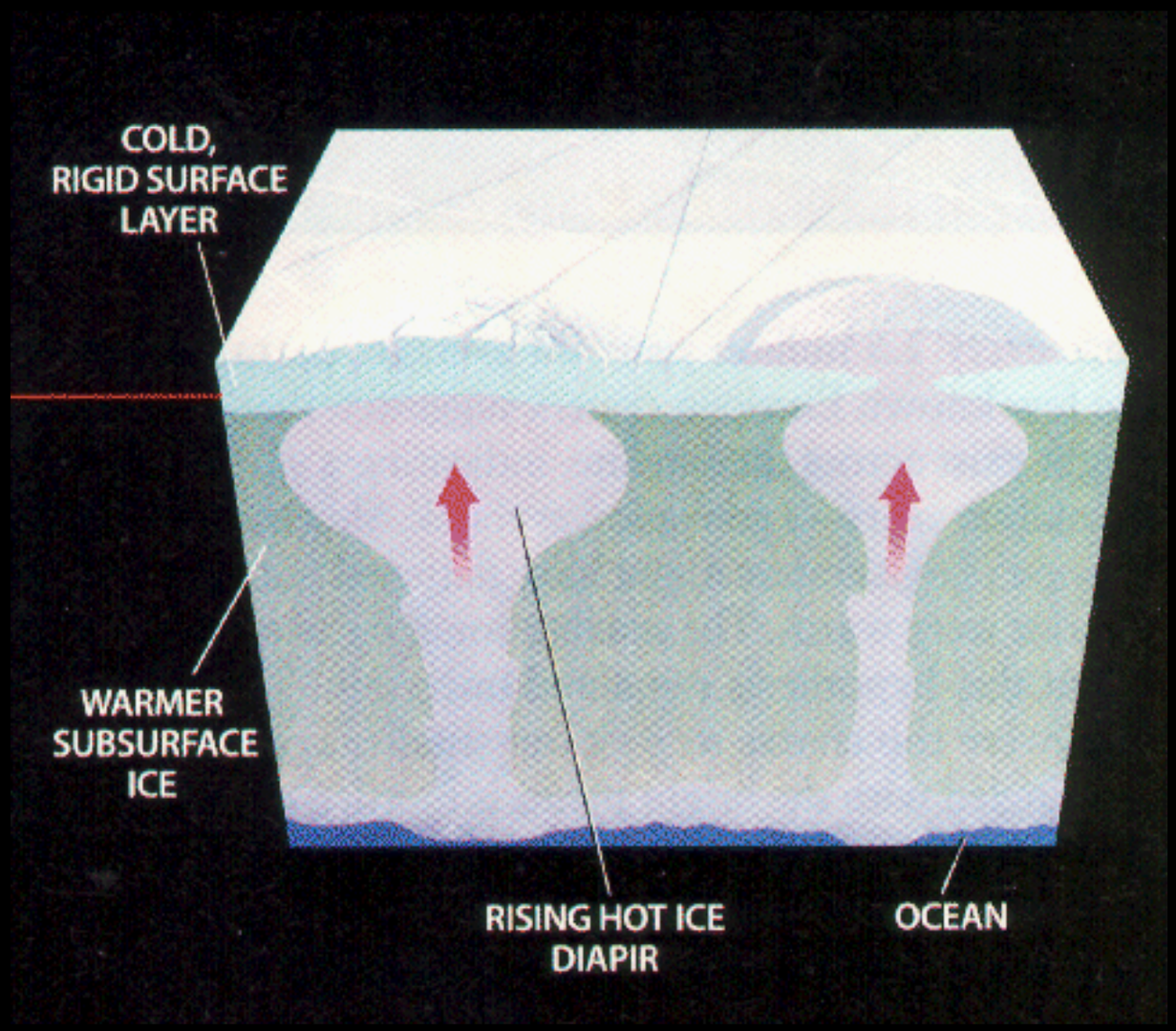


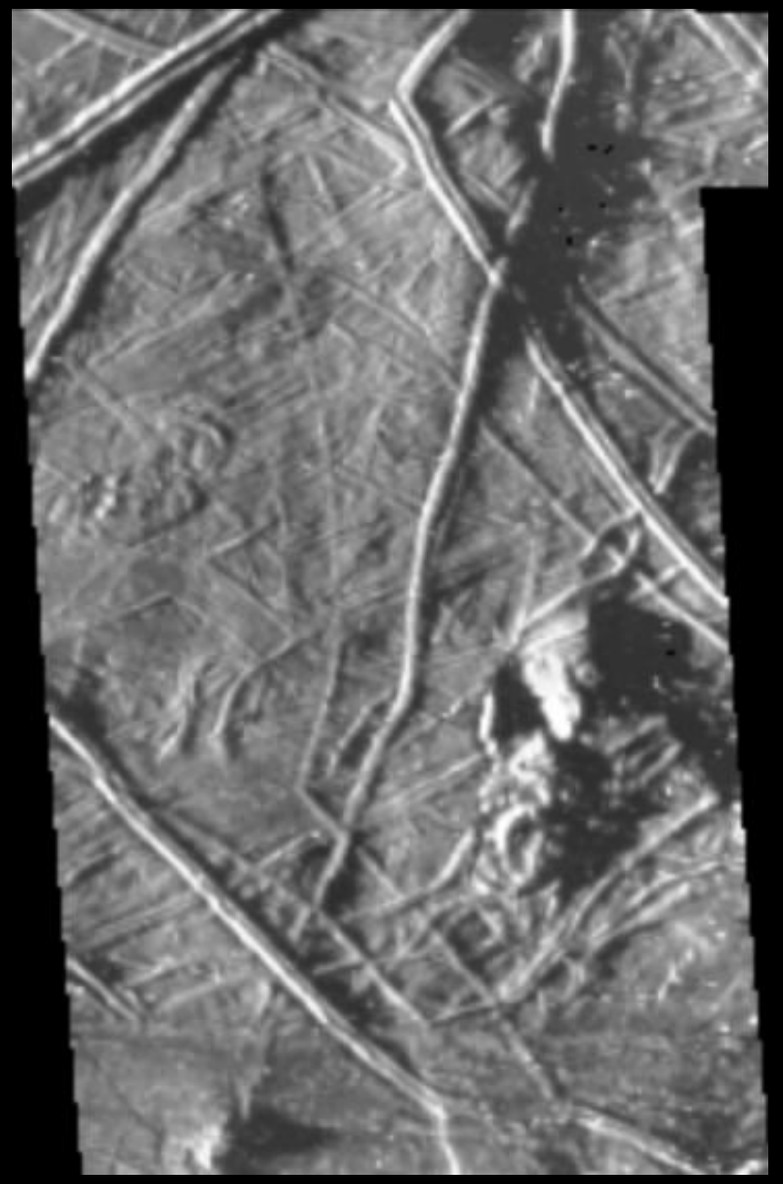


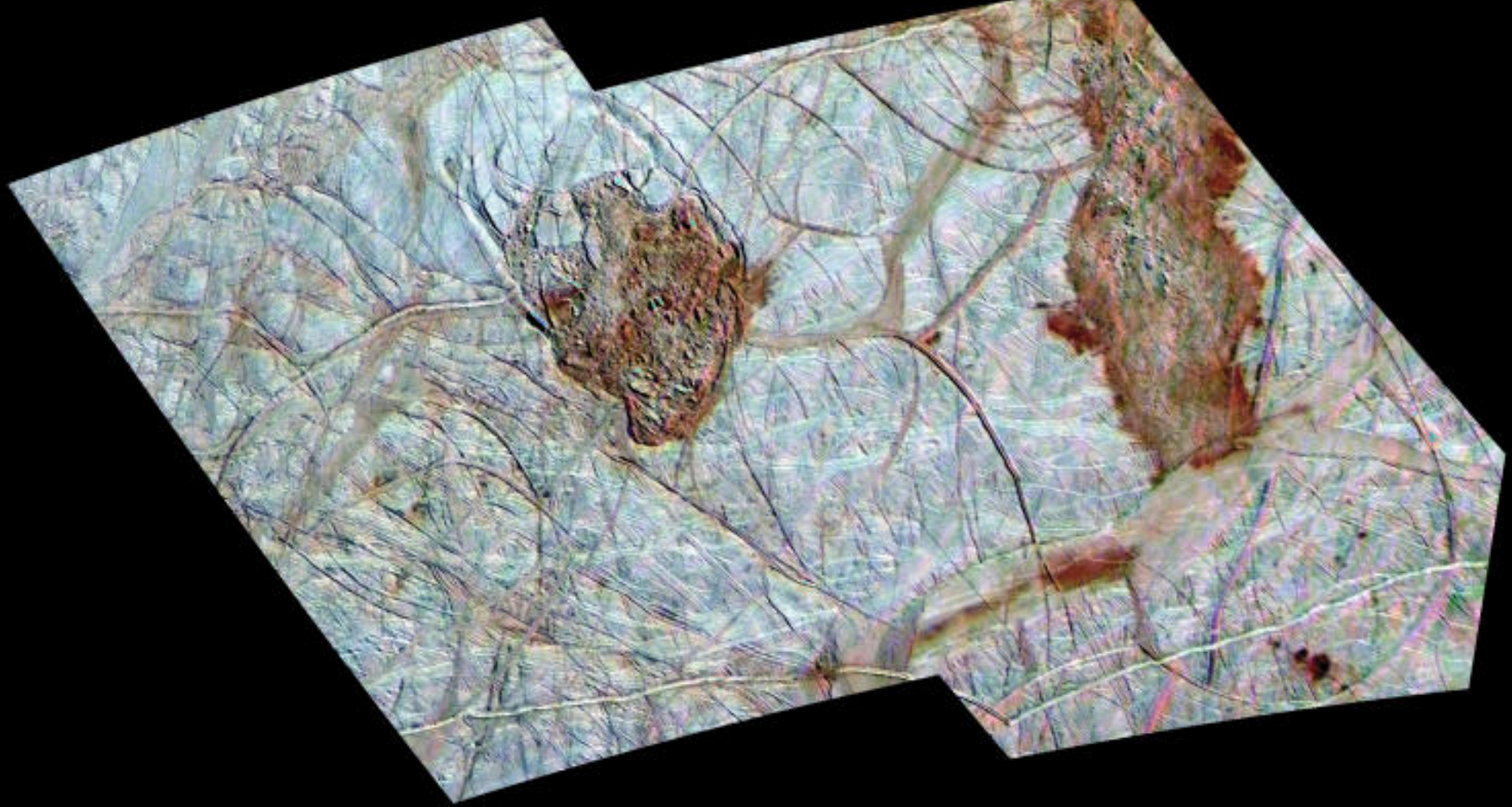


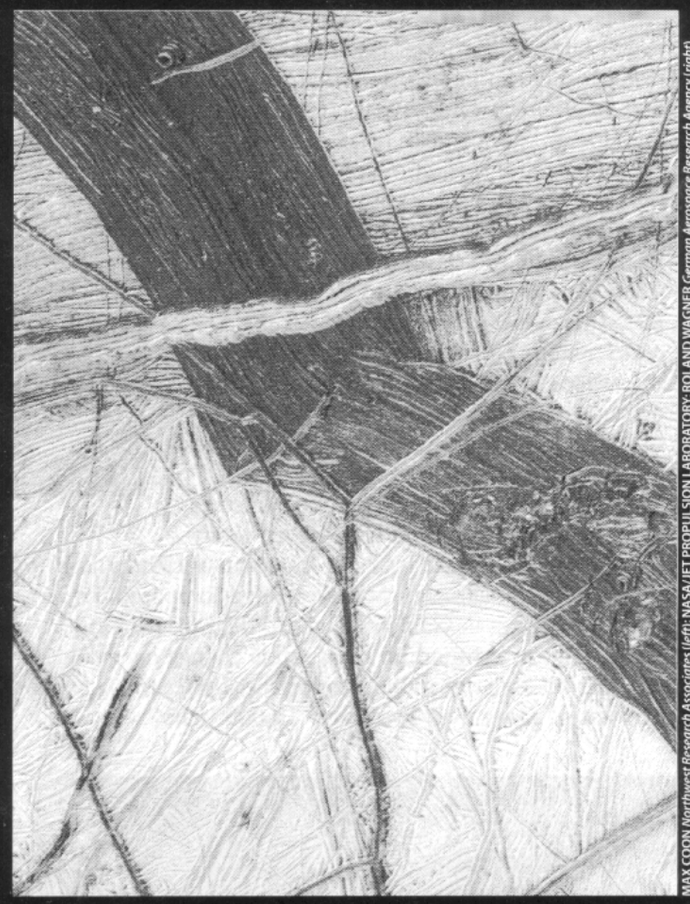
Europa (Jupiter II), the second of the four Galilean moons, is the second closest to Jupiter and the smallest at 3121.6 kilometers in diameter, which is slightly smaller than the Moon.

It is one of the smoothest objects in the Solar System, with a layer of water surrounding the mantle of the planet, thought to be 100 kilometers thick. The smooth surface includes a layer of ice, while the bottom of the ice is theorized to be liquid water. The apparent youth and smoothness of the surface have led to the hypothesis that a water ocean exists beneath it, which could conceivably serve as an abode for extraterrestrial life.



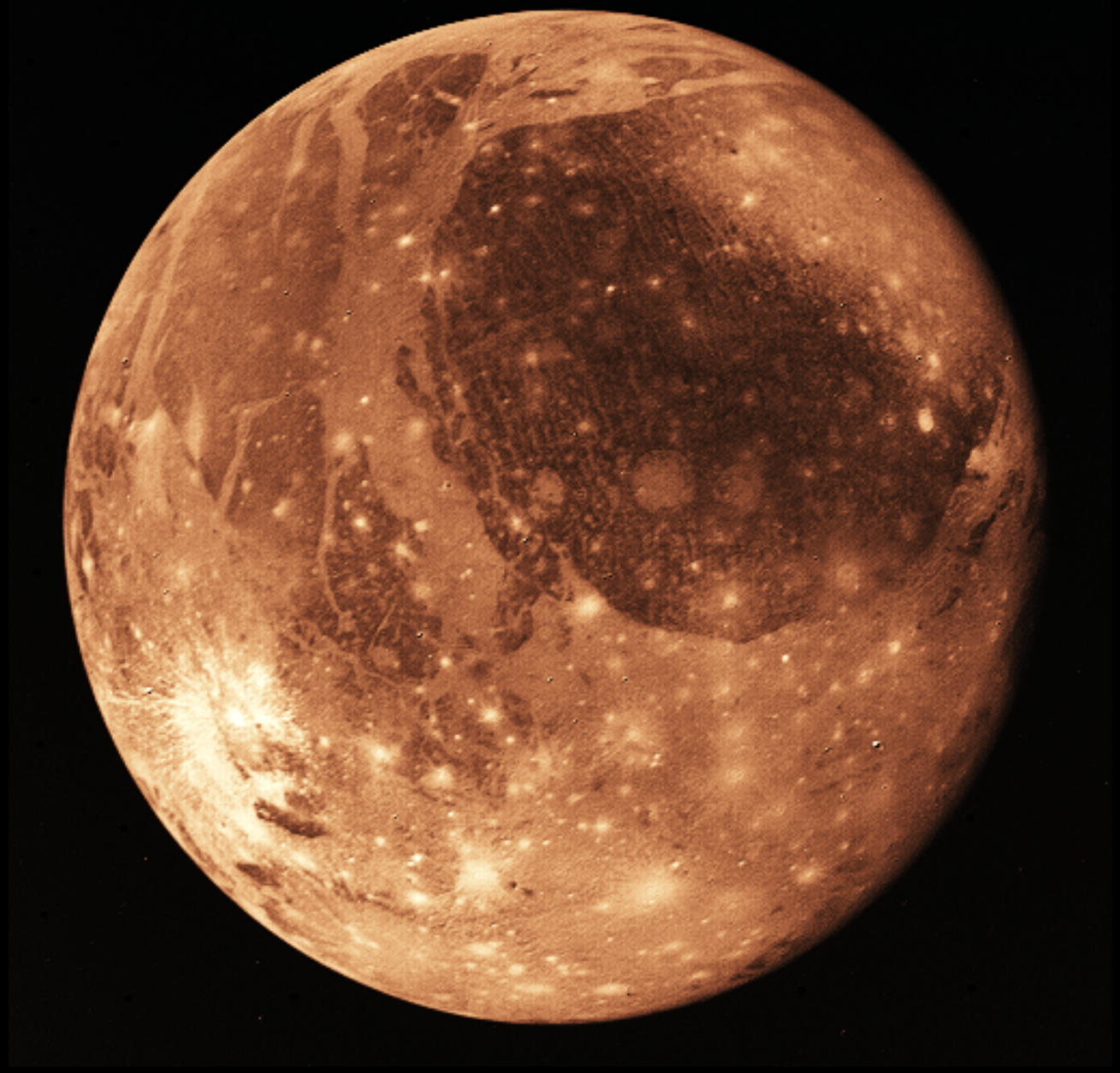




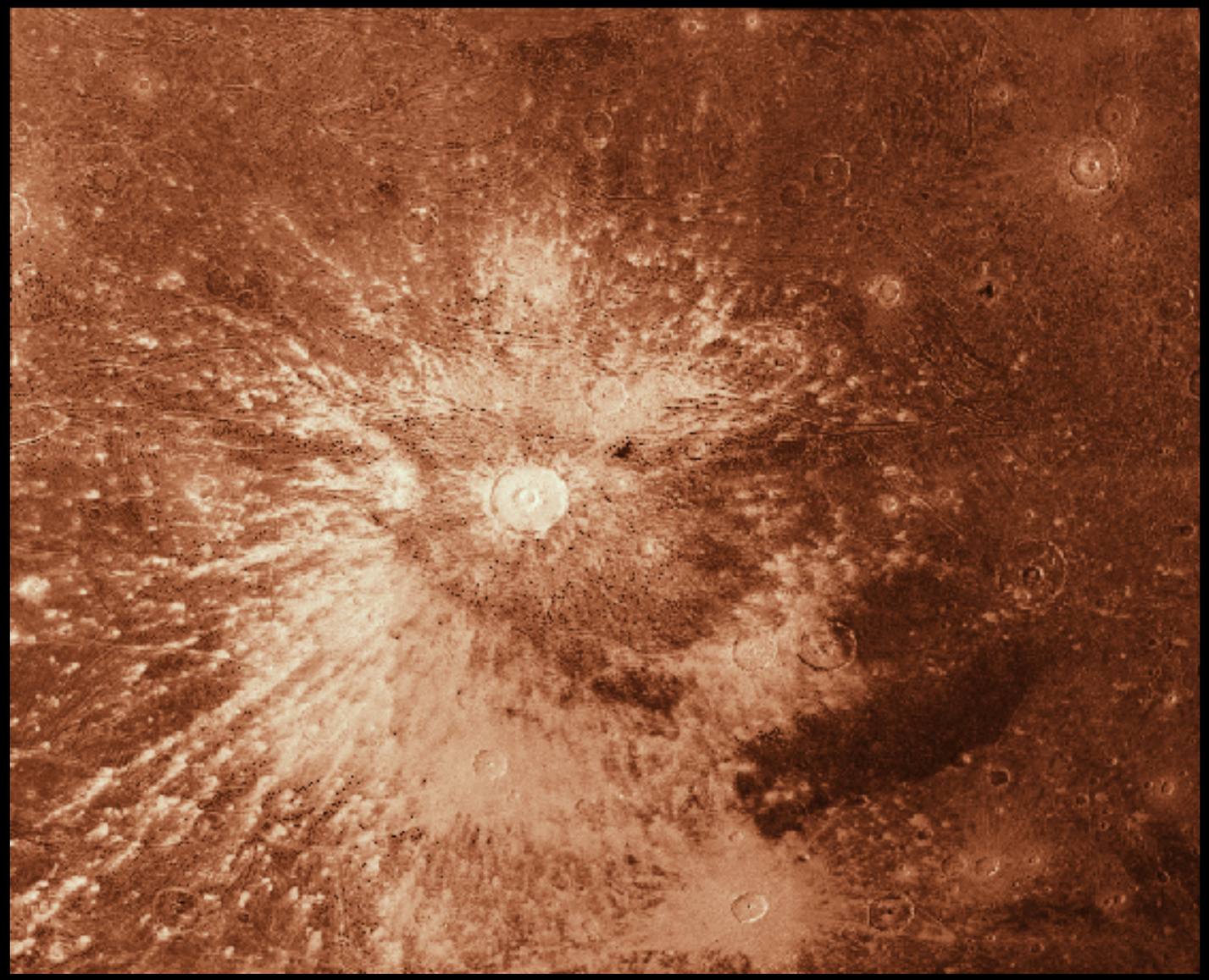


CRACKS IN THE ICE on Earth (*left*) and Europa (*right*) bear a superficial resemblance. In terrestrial polar seas, floating ice breaks apart to expose darker liquid water, which quickly freezes. The cracks can slam closed to push up ridges. On Europa, however, the dark bands and paired ridges are thought to result from tectonic processes. The scale is vastly different: this break in the sea ice is 100 meters wide, whereas the dark band on Europa is more than 15 kilometers wide.

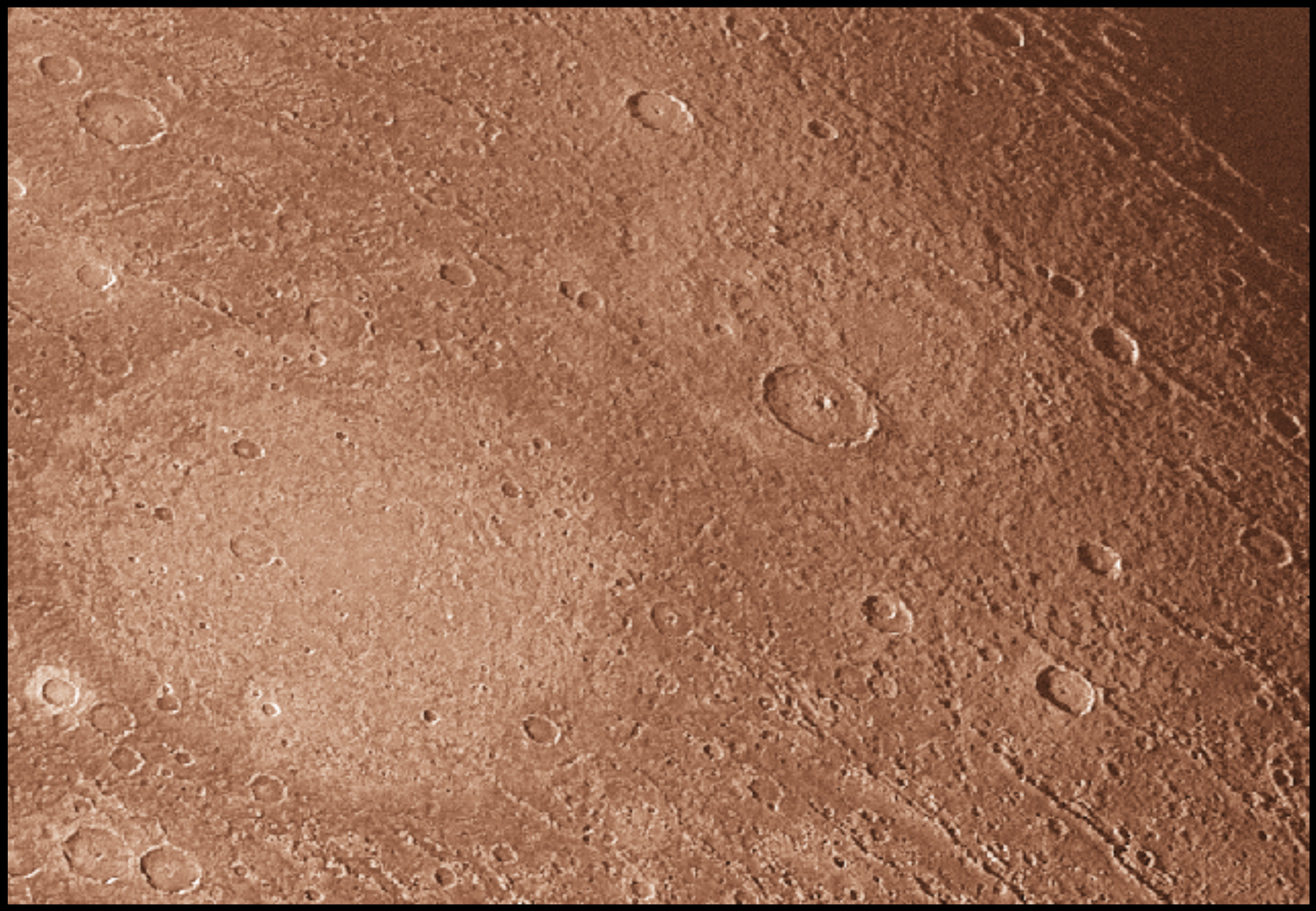
MAX COON *Northwest Research Associates (left)*; NASA/JET PROPULSION LABORATORY; ROLAND WAGNER *German Aerospace Research Agency (right)*

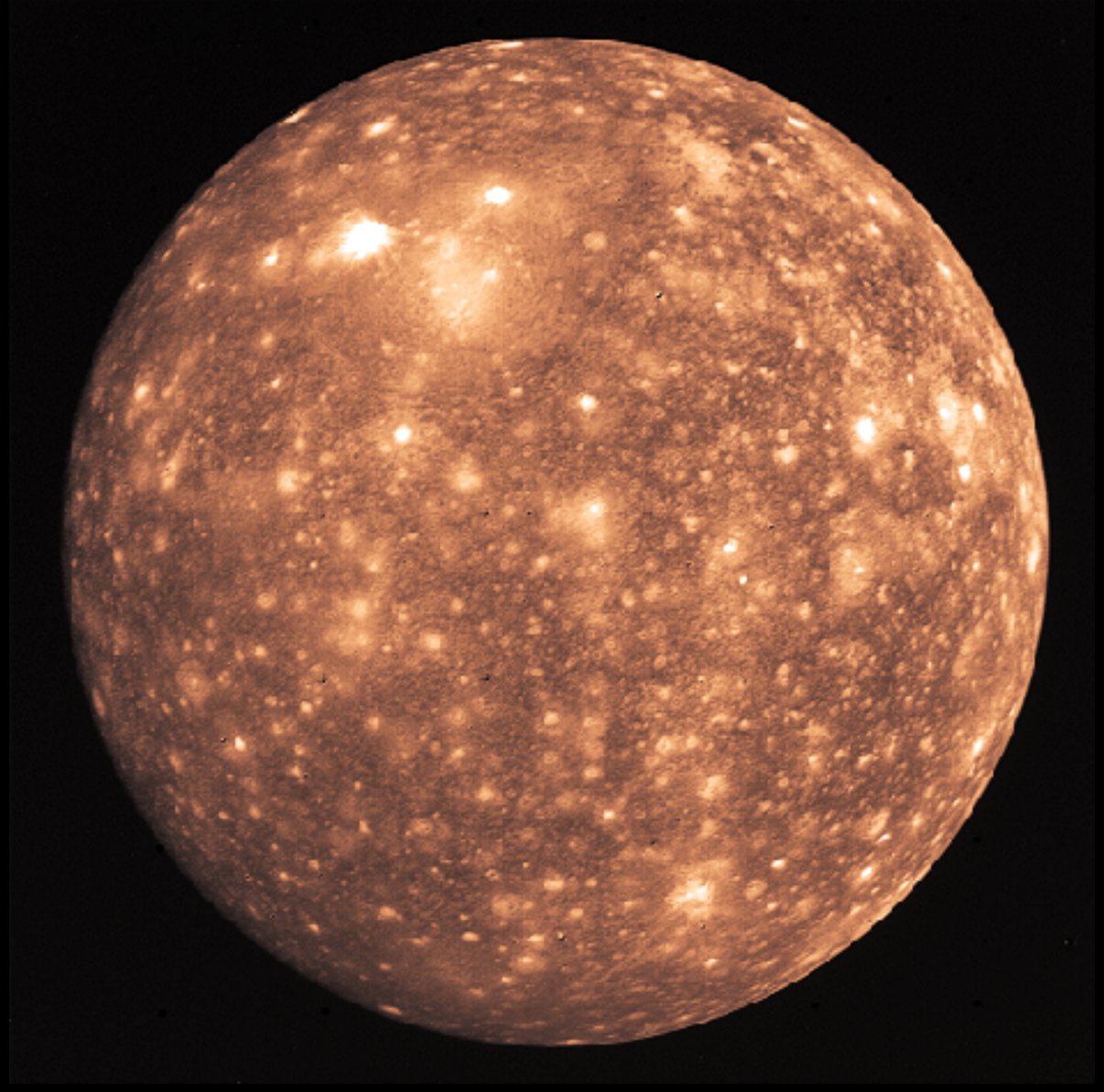


Ganymede (Jupiter III), the third Galilean moon is named after the mythological Ganymede, cupbearer of the Greek gods and Zeus's beloved.

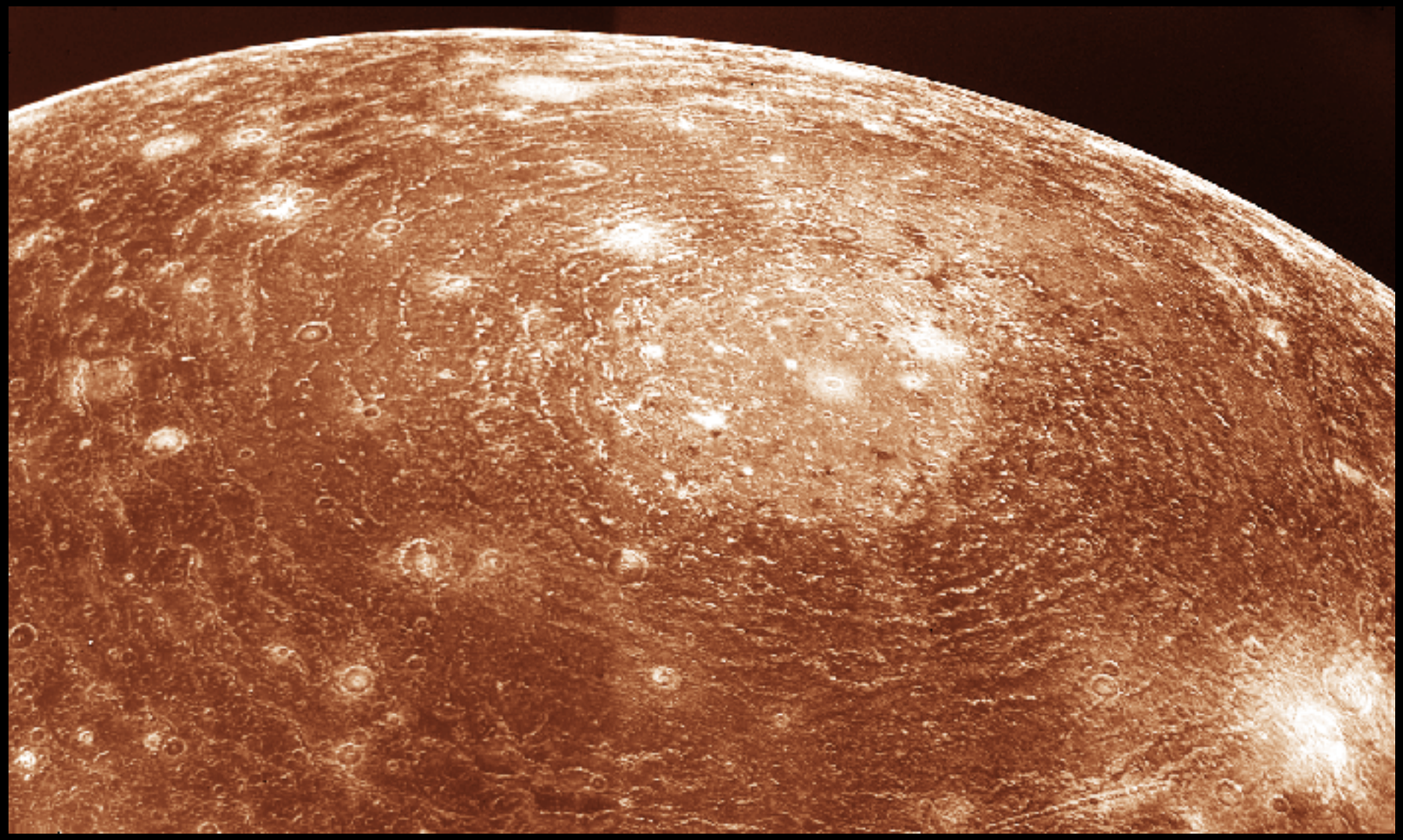


Ganymede is composed primarily of silicate rock and water ice, and a salt-water ocean is believed to exist nearly 200 km below Ganymede's surface, sandwiched between layers of ice.

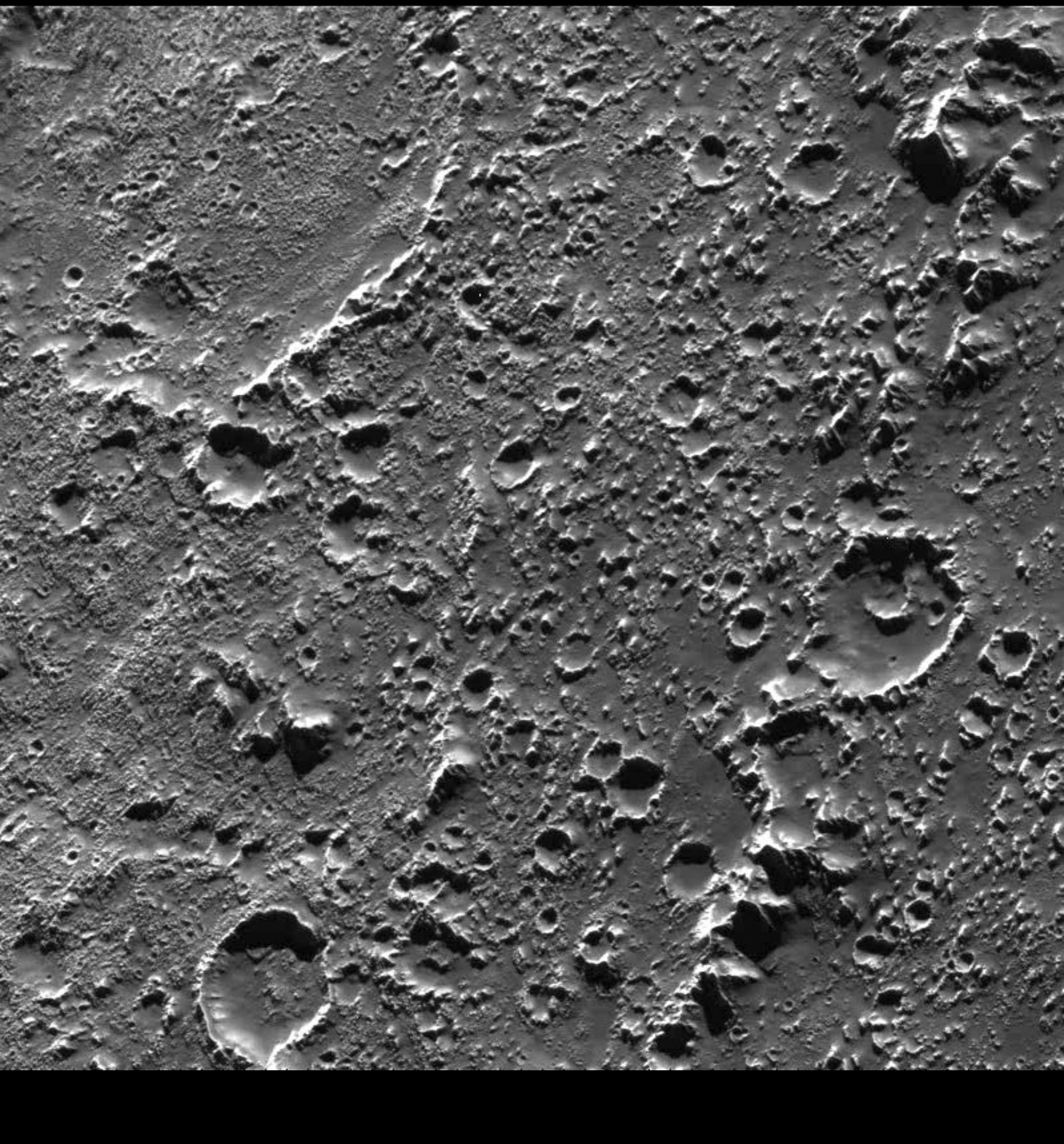


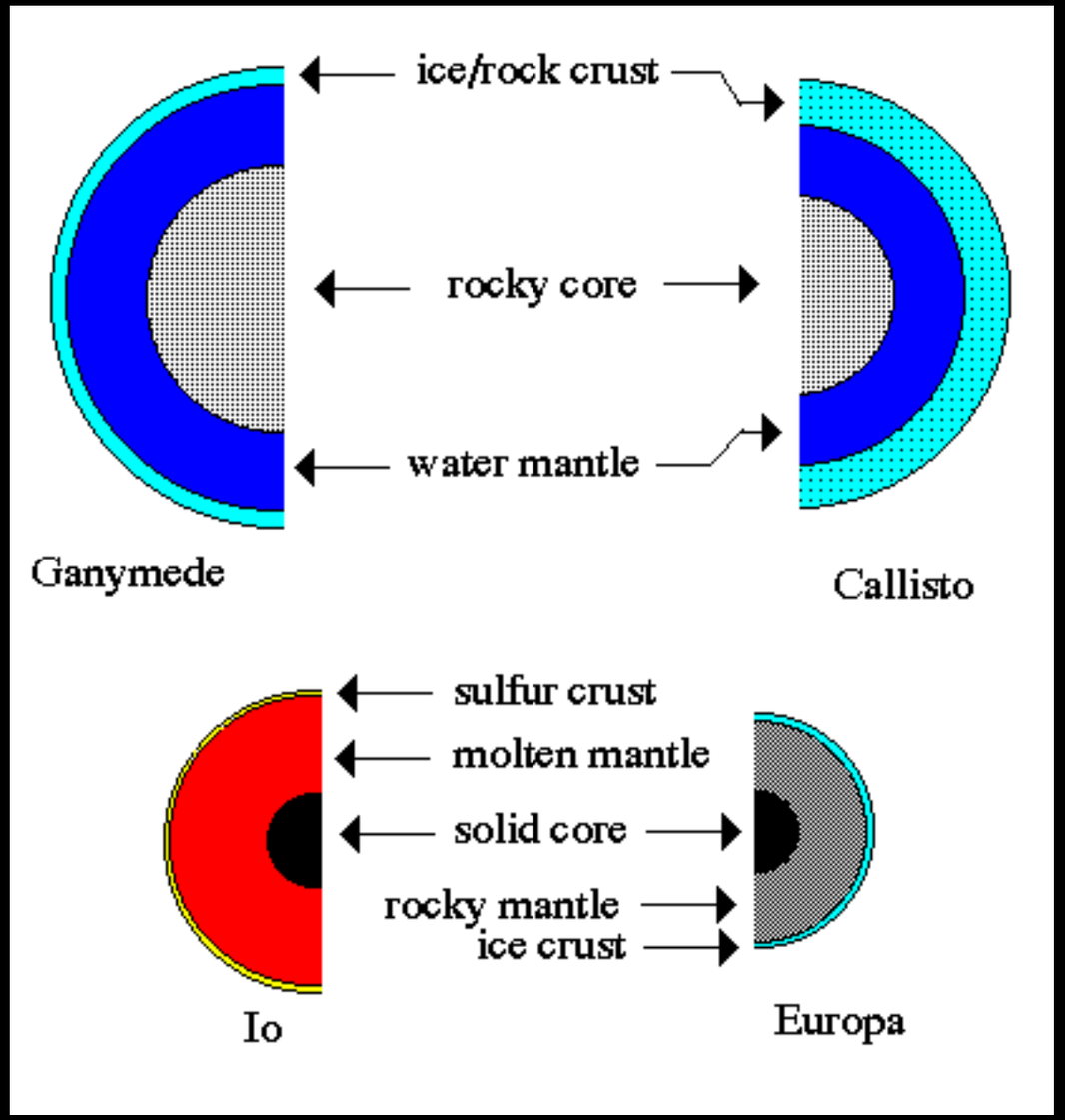


Callisto (Jupiter IV) is the fourth and last Galilean moon, and is the second largest of the four, and at 4820.6 kilometers in diameter, it is the third largest moon in the Solar System.



It does not form part of the orbital resonance that affects three inner Galilean satellites and thus does not experience appreciable tidal heating. Callisto is composed of approximately equal amounts of rock and ices, which makes it the least dense of the Galilean moons. It is one of the most heavily cratered satellites in the Solar System



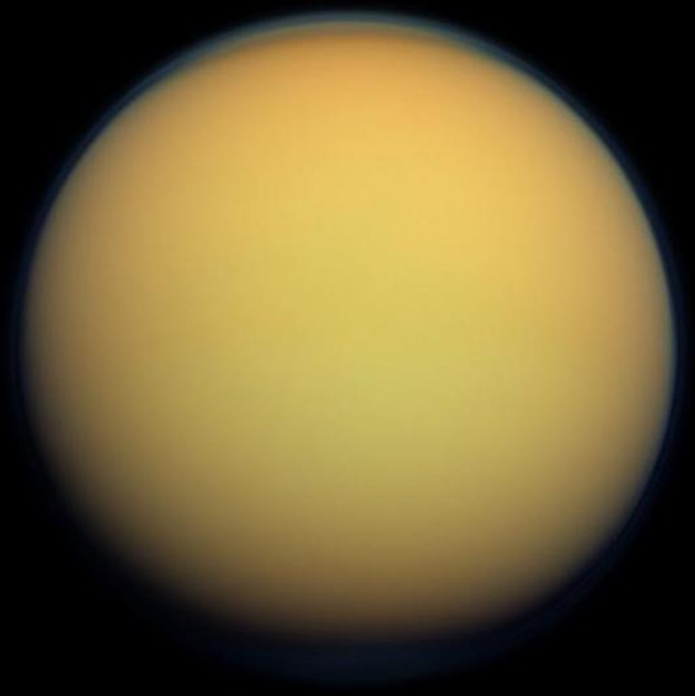


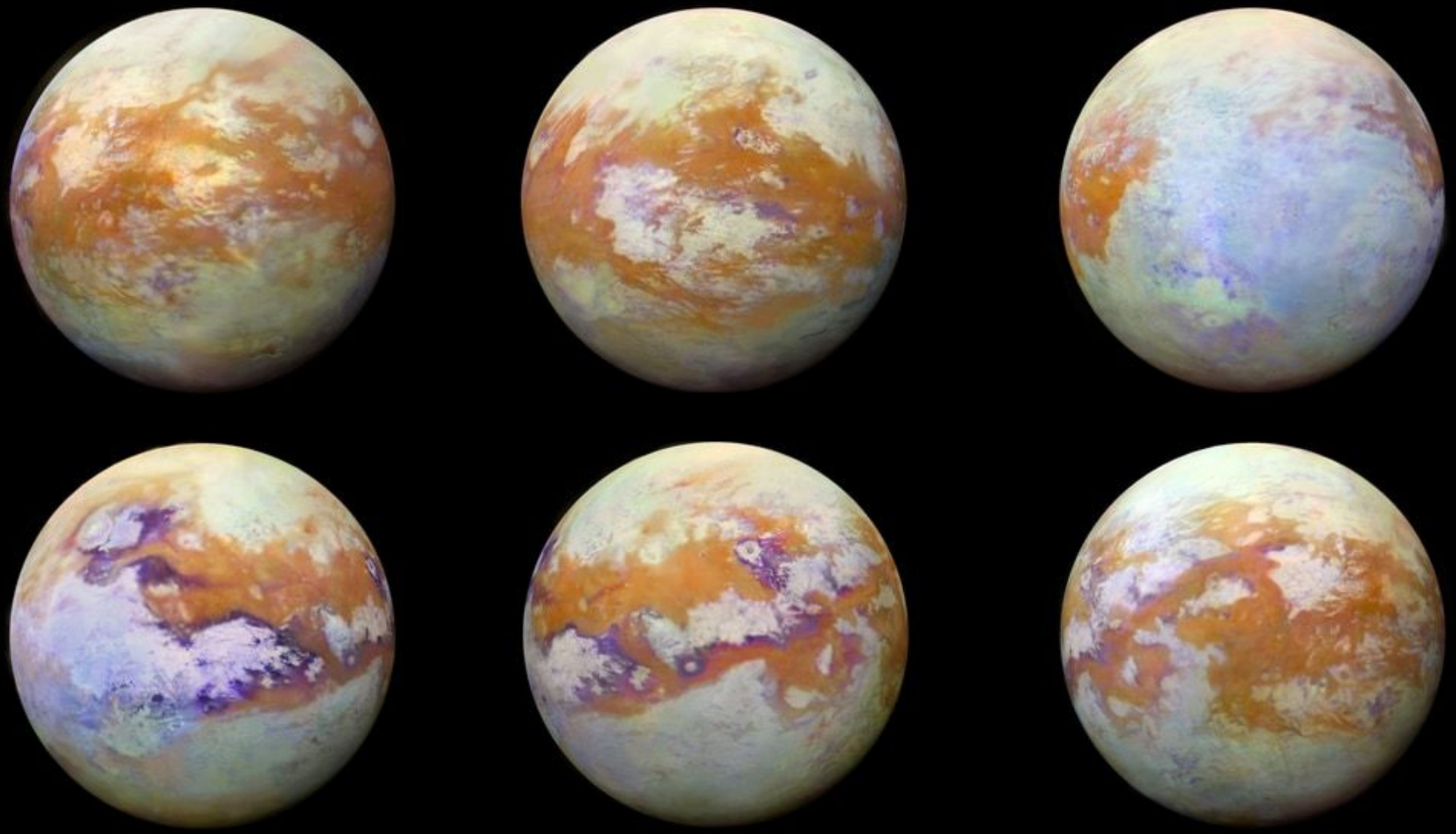
mini-Solar System model where the closer moons are rocky, high density and the outer moons are icy, low density

geological activity decreases with distance from Jupiter, due to the decreasing tidal friction from Jupiter on interior of moons - this has a marked influence on the appearance of their surfaces

little or no atmospheres

high icy component to crust of all moons





Titan is the largest moon of Saturn. It is the only moon known to have a dense atmosphere, and the only object in space other than Earth where clear evidence of stable bodies of surface liquid has been found.

Titan has a heavy atmosphere (1.4 times the Earth's) with structure in the form of haze - reddish color from organic molecules formed by breakdown of CH4 (methane) by cosmic rays. The composition of atmosphere is 90% N2, 7% CH4, 2% Ar and traces of ethane, acetylene, ethylene, propane and hydrogen cyanide (i.e. smog)

4 Nov 2022
Webb NIRCam

6 Nov 2022
Keck NIRC-2

Lower atmosphere

Surface

Cloud A

Cloud B

Cloud A

Cloud B

Cloud A

Cloud B

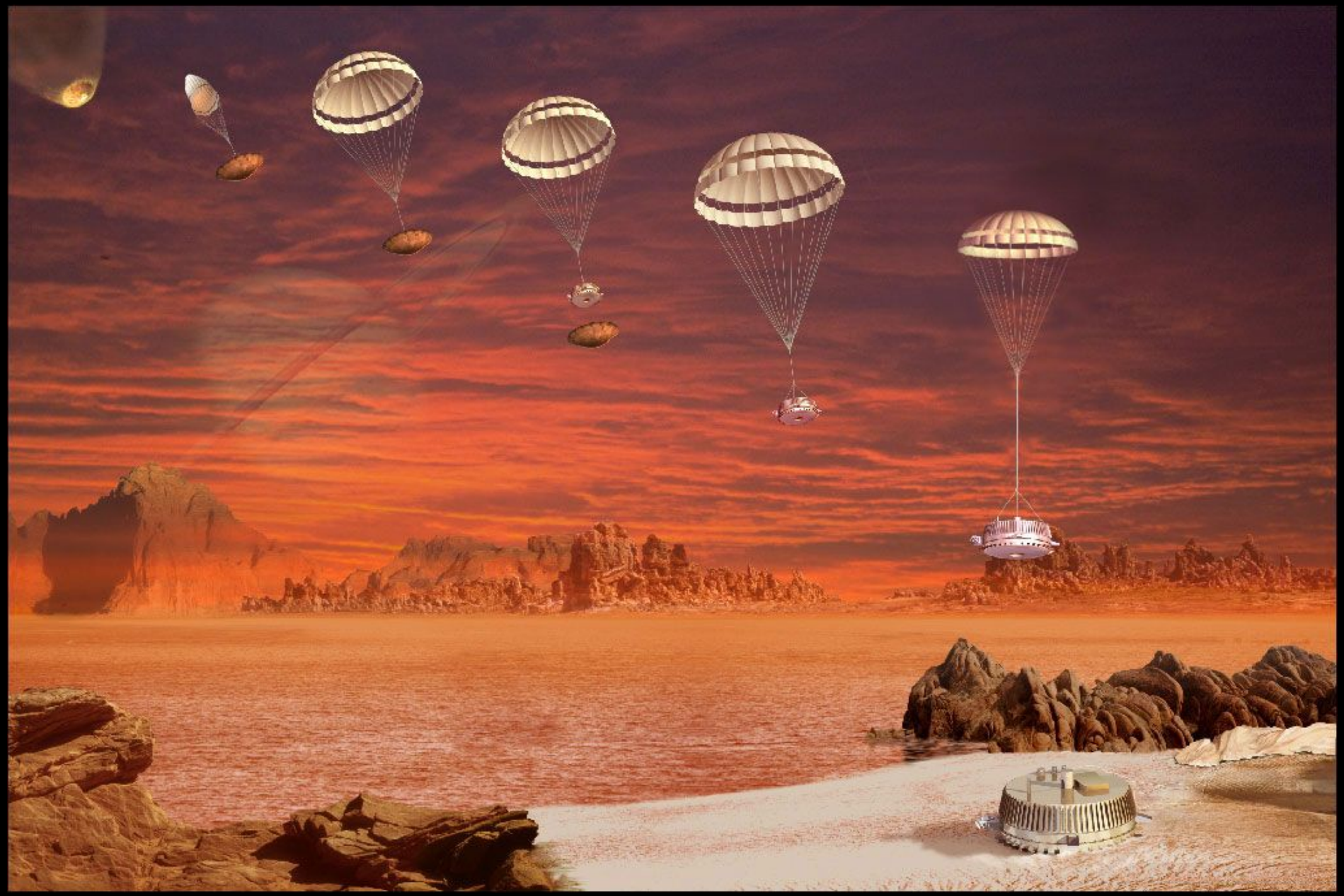
Kraken Mare

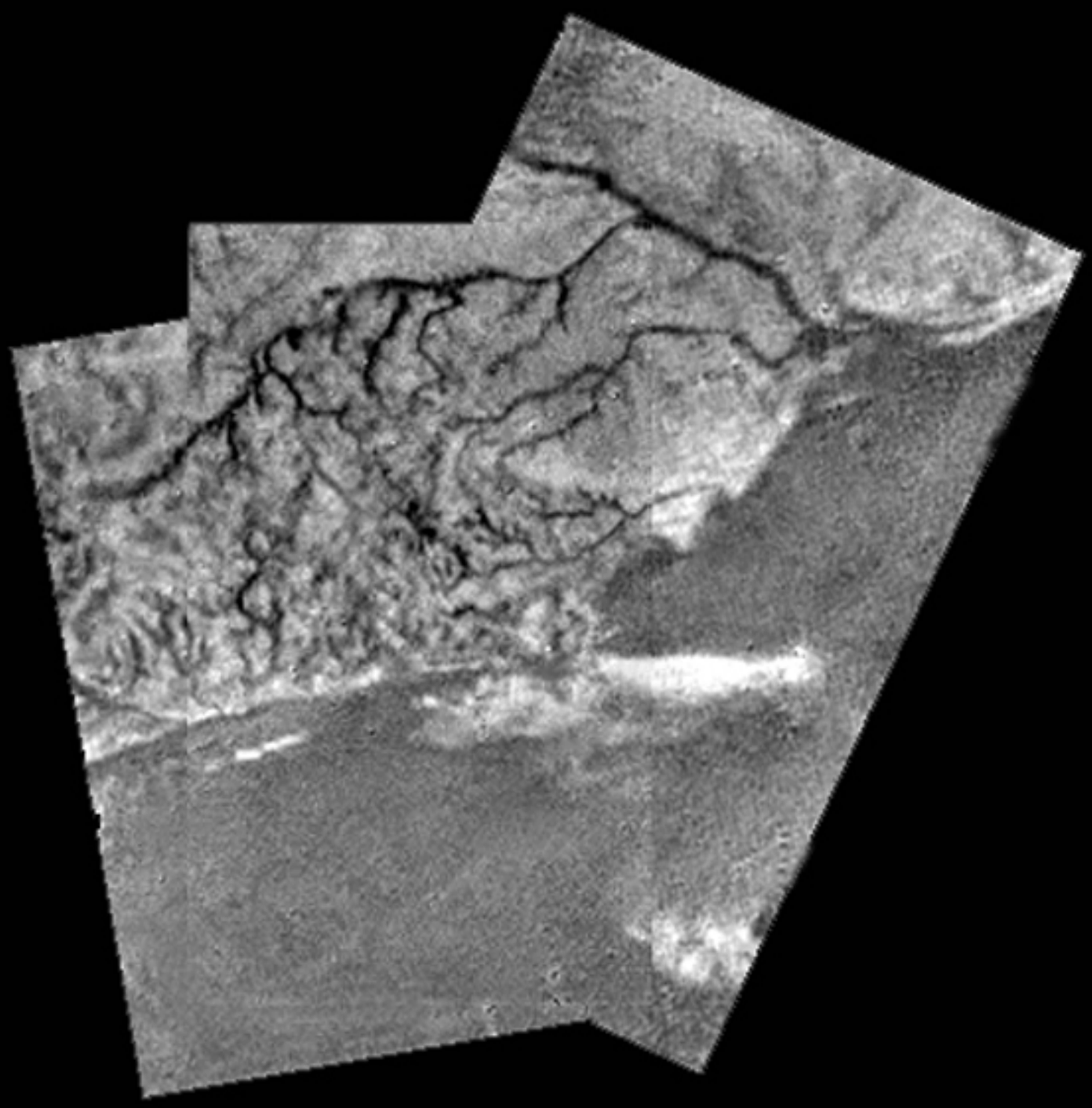
Adiri

Belet

Belet

Atmospheric haze





Above is a mosaic of three frames taken by the lander as it entered Titans atmosphere. It shows detail of a high ridge area including the flow down a major river channel (liquid methane river) into what appears to be a "wet" plain.

Above is a color image from the surface of Titan. Rocks near the bottom are pebble-sized, objects in the middle of the frame are meters in size. The surface is darker than expected, consisting of a mixture of water and hydrocarbon ice. There is evidence of erosion indicating fluid activity in the recent past.


The Moon
Io
JUPITER
Europa
JUPITER
Triton
NEPTUNE
Callisto
JUPITER
Titania
URANUS
Rhea
SATURN
Oberon
URANUS
Titan
SATURN
Iapetus
SATURN
Umbriel
URANUS
Ariel
URANUS
Dione
SATURN
Tethys
SATURN
Ganymede
JUPITER
Hyperion
Mimas
Proteus
Miranda
Enceladus
Adobe Stock | #397915663