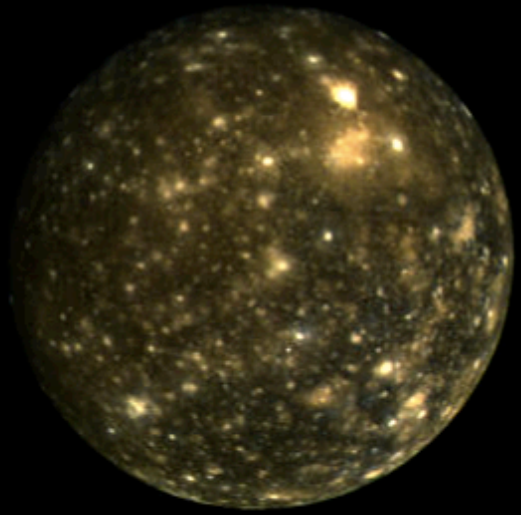
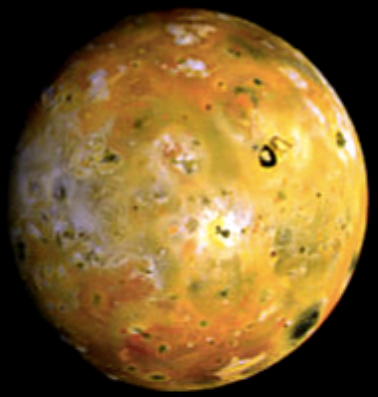

Ganymede
5262 km
Titan
5150 km
Callisto
4806 km
Mercury
4879 km
Io
3642 km
Moon
3476 km
Europa
3138 km
Triton
2706 km

The Galilean Moons of Jupiter

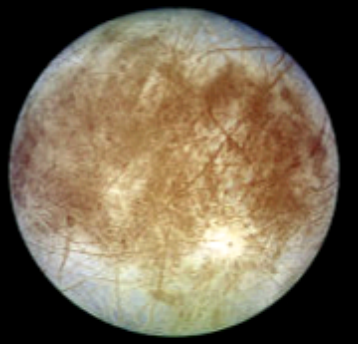
Ganymede
(5262 km)



Callisto
(4806 km)



Io
(3642 km)



Europa
(3130 km)

Moon (3474 km)

The Galilean Moons all orbit in the same direction around Jupiter.

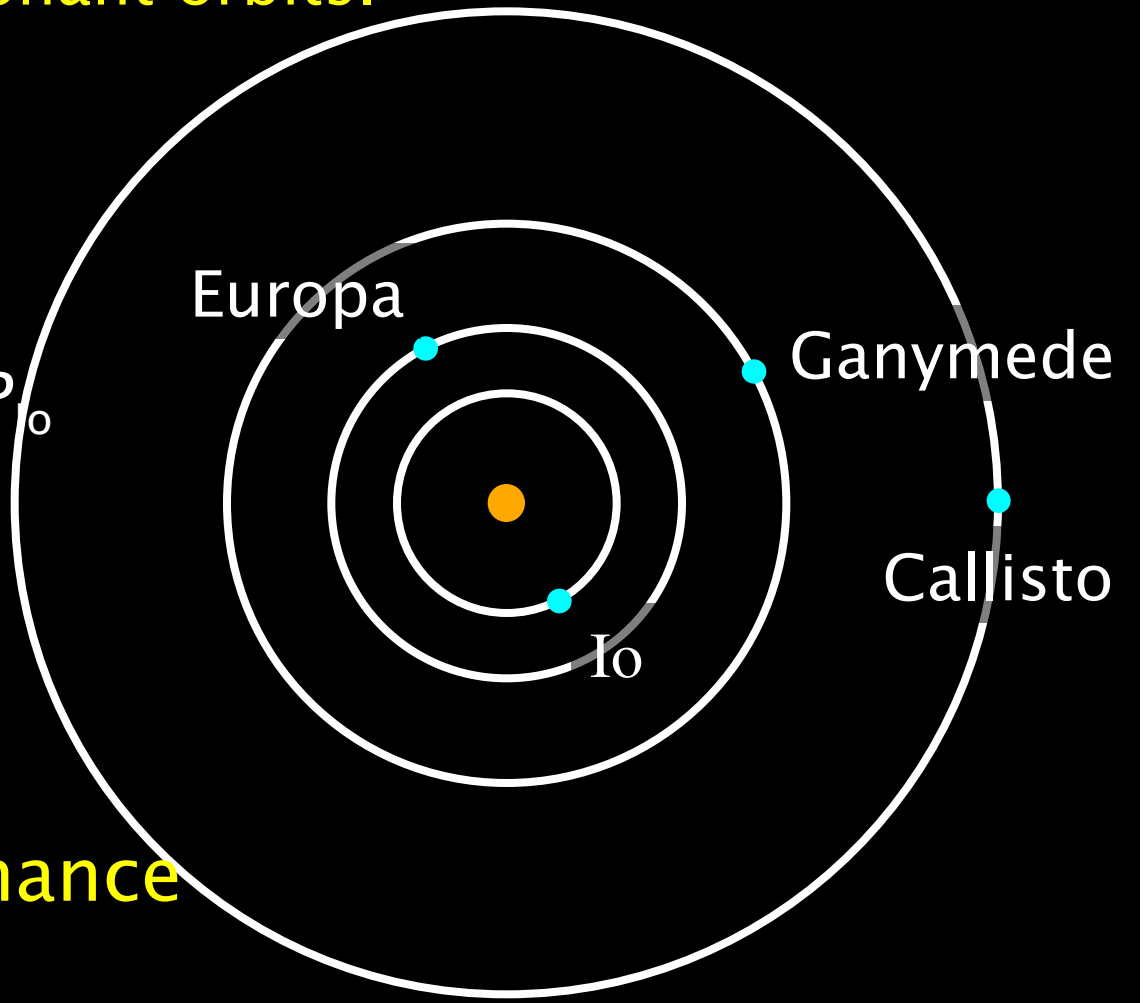
The inner 3 are on resonant orbits.

$P_{Io} = 1.8^d$

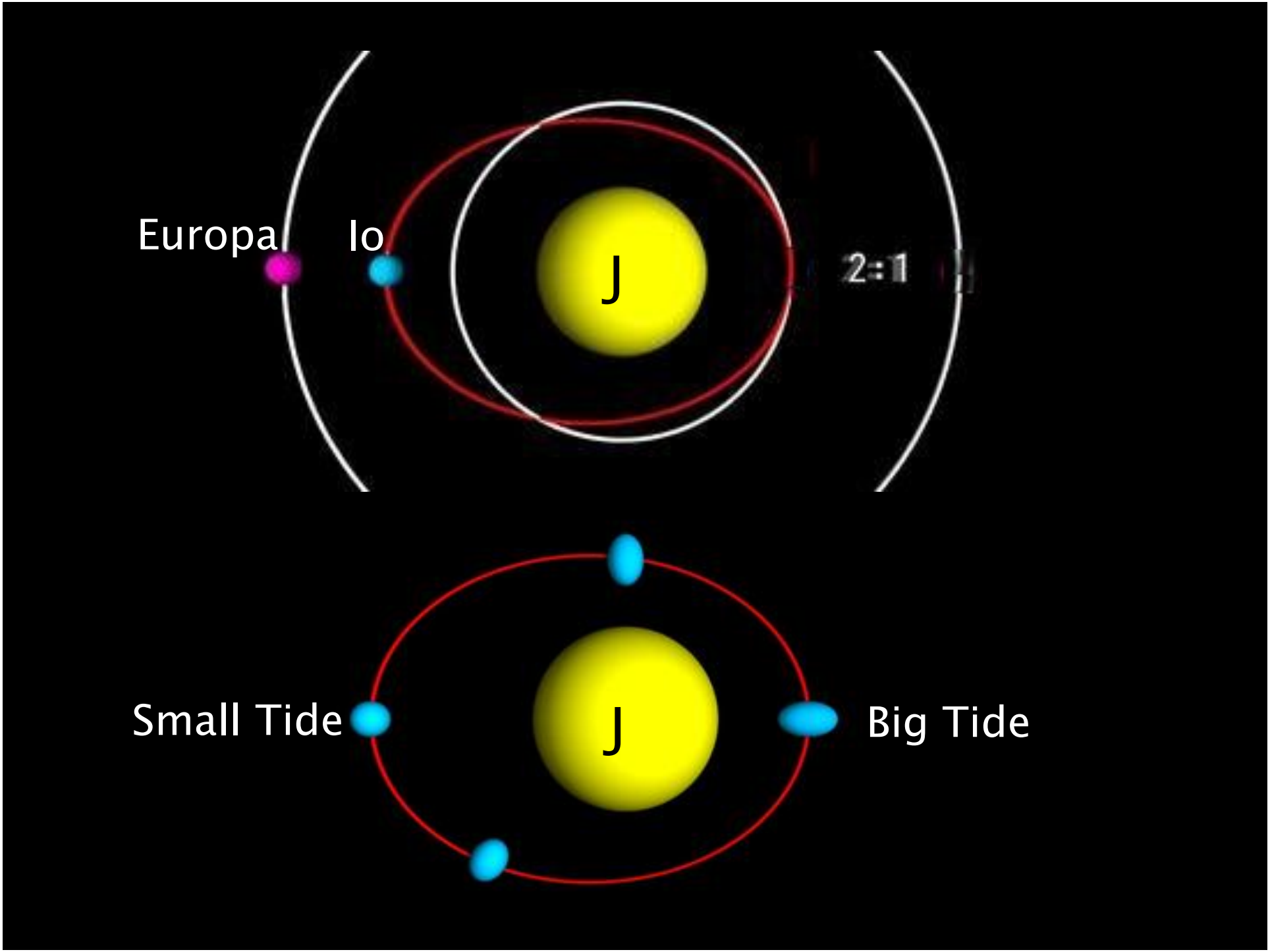
$P_{Europa} = 3.6^d = 2 \times P_{Io}$

$P_{Ganymede} = 7.2^d = 4 \times P_{Io}$

$P_{Callisto} = 16.7^d$

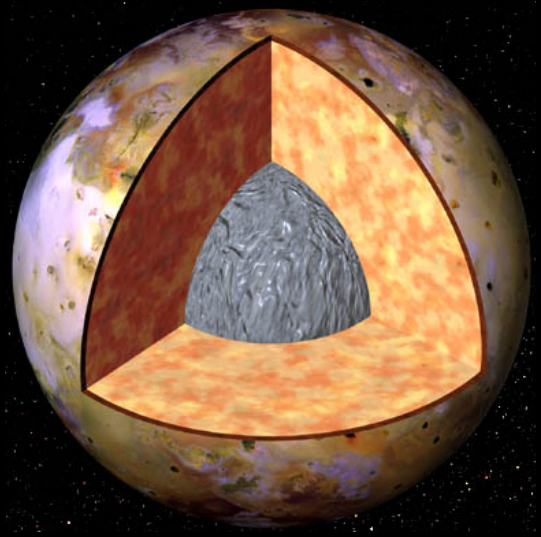


4:2:1 Laplace Resonance

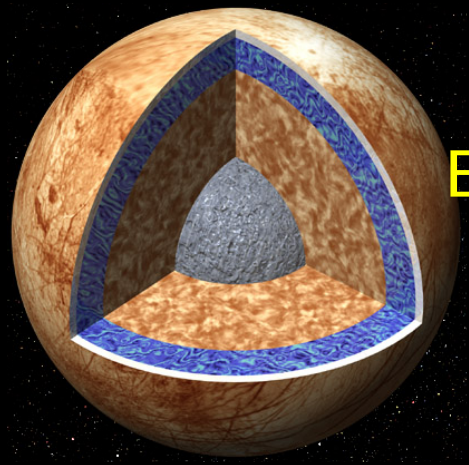

Europa
Io
J
2:1
Small Tide
J
Big Tide

Io and Europa

Mean densities of 3600 & 3000 kg m^{-3}, respectively

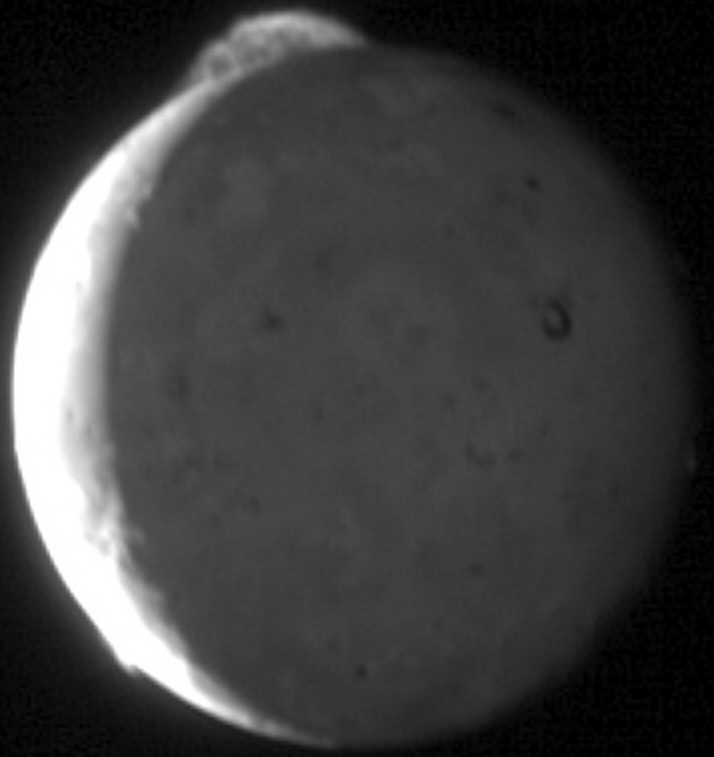


Io: Rocky crust, molten mantle & many active volcanoes



Europa: Icy lithosphere & rocky core. Likely has a deep-water ocean.

Io's active volcanoes



Tvashtar 2007 Feb 26
[New Horizons]

Io in eclipse, showing volcanic Hotspots 2007 Feb 27
[New Horizons]

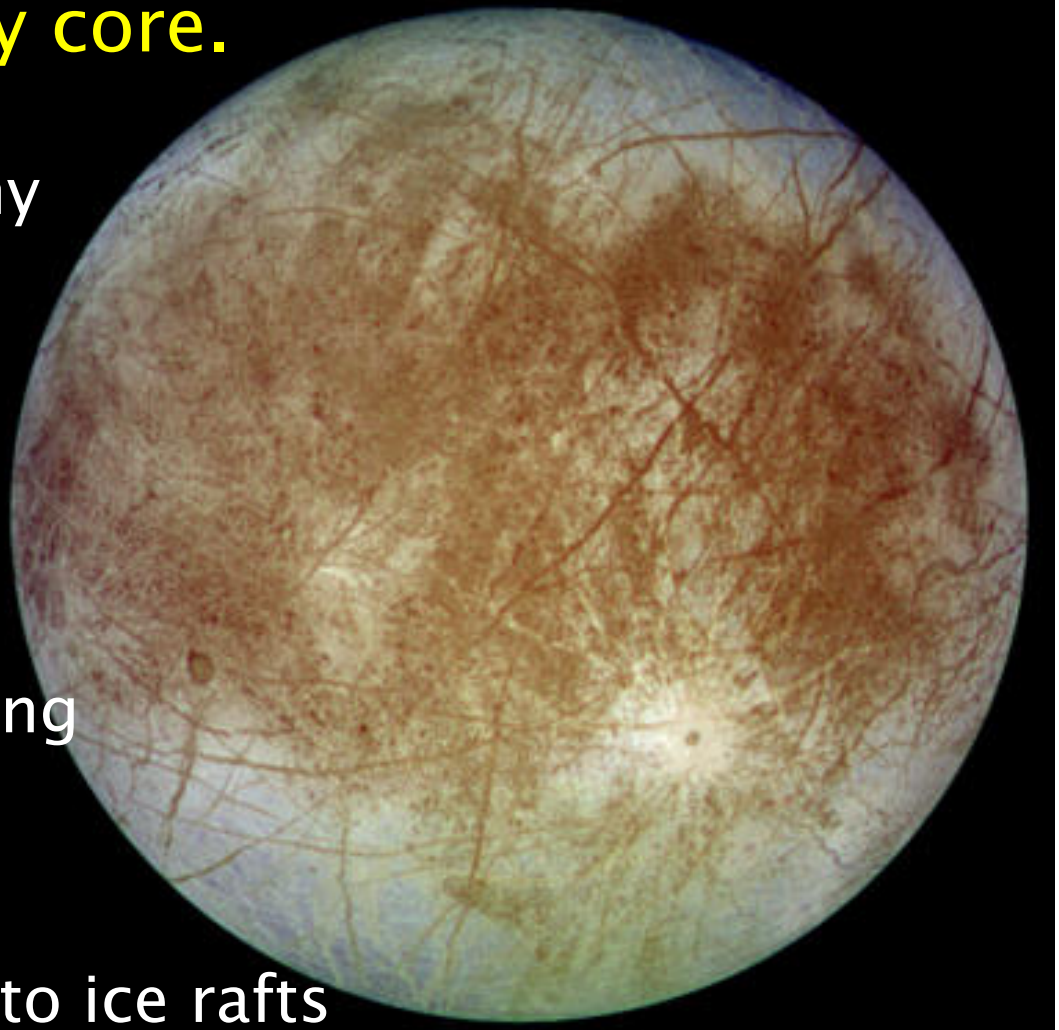
Europa has a smooth, young icy surface covering a large rocky core.

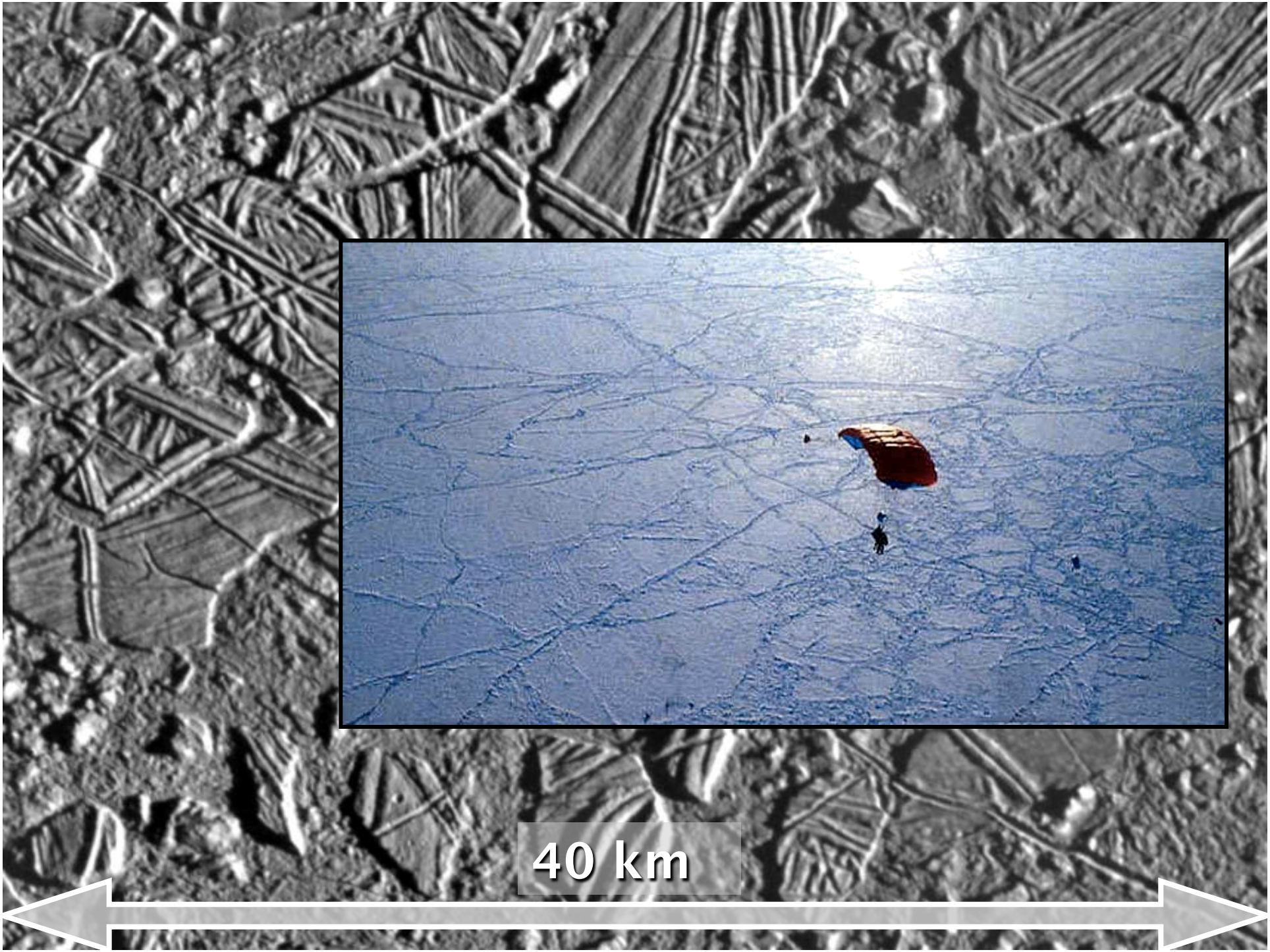
Composed of bright, shiny water ice.

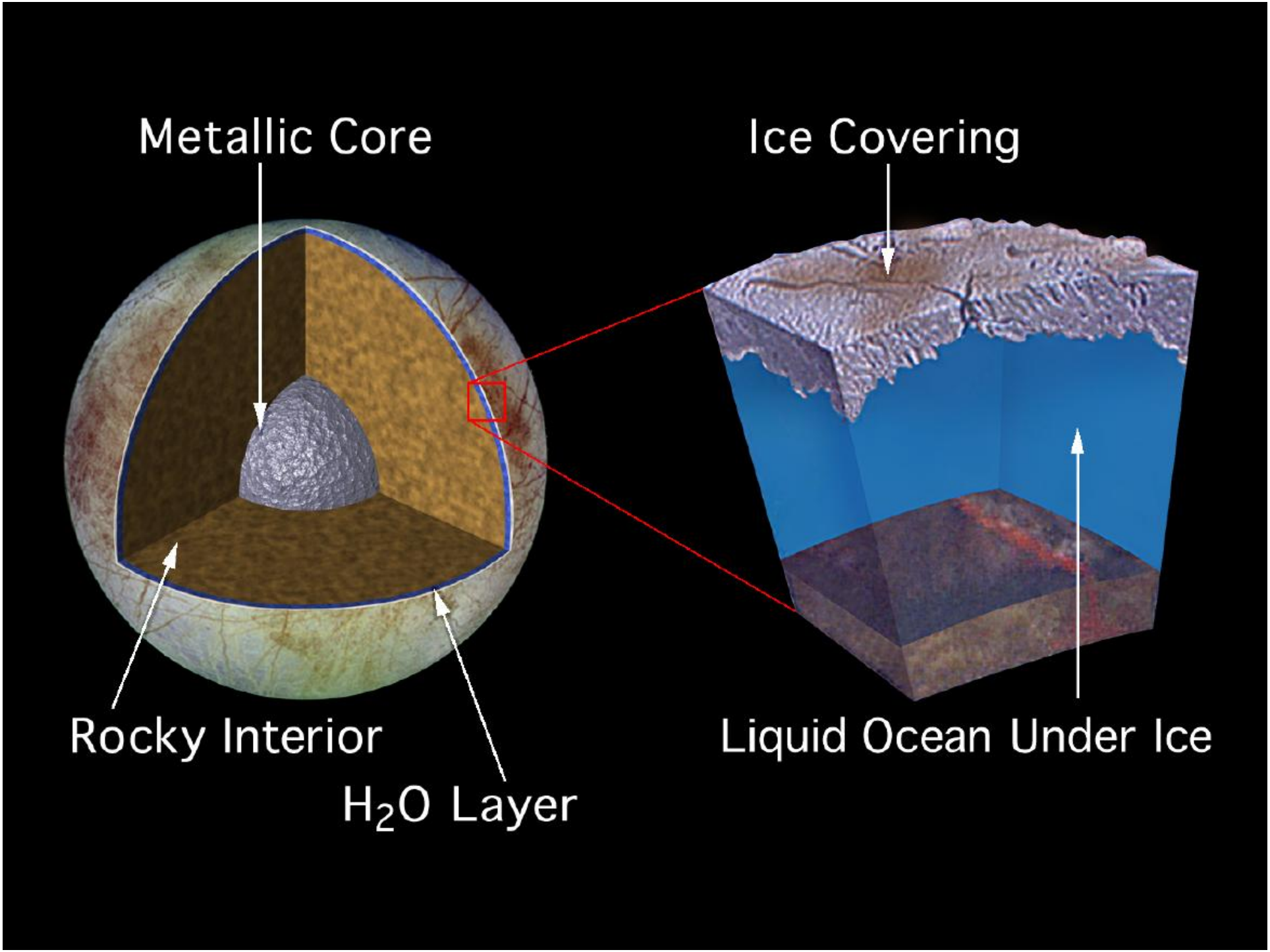
Very few impact craters implies a young surface

Repaved by water geysering through cracks in the ice.

Ice surface is fractured into ice rafts and floes a few kilometers across



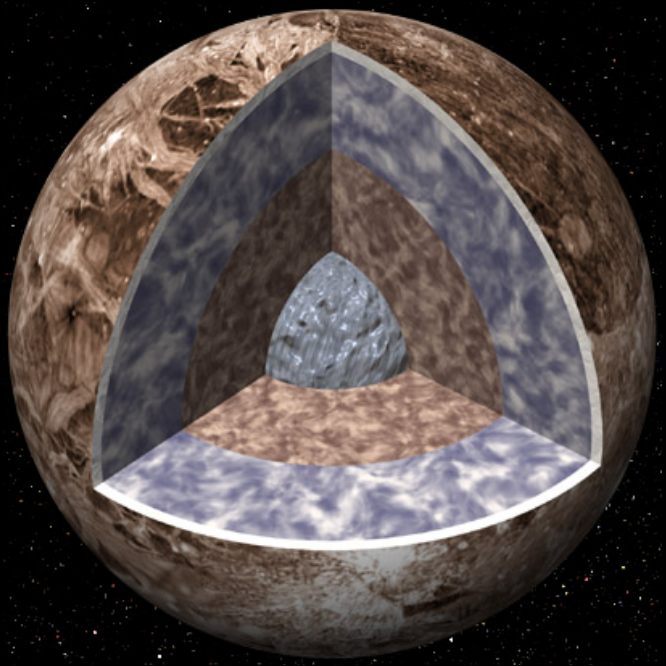

40 km


Metallic Core
Ice Covering
Rocky Interior
H_2O Layer
Liquid Ocean Under Ice

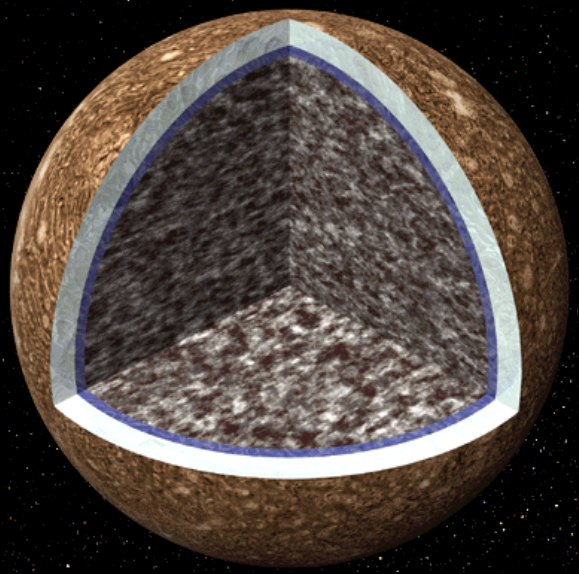
Ganymede & Callisto are mixed ice & rock, low-density moons.

Mean densities of ~1900 kg m^{-3}

Deep ice mantles over rocky/icy cores.



Ganymede



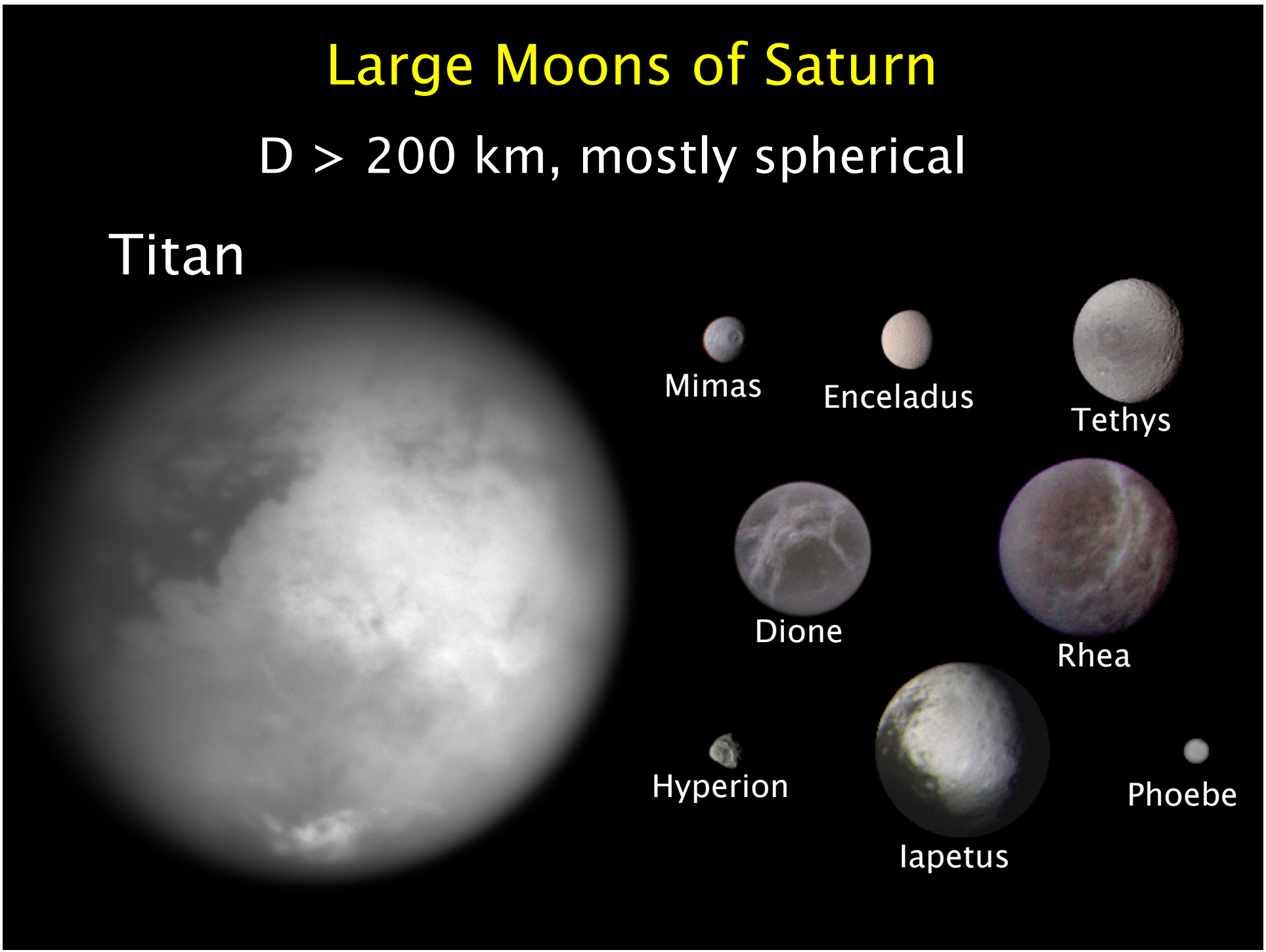
Callisto

Old, heavily cratered surfaces

They lack internal heat and are geologically inactive.

Large Moons of Saturn

D > 200 km, mostly spherical



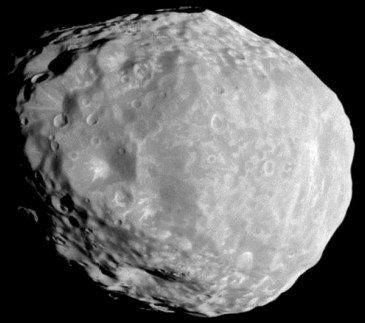
Tiny Irregular Moons of Saturn

D < 200 km

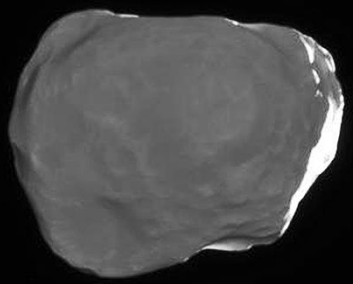
Epimetheus

Pandora

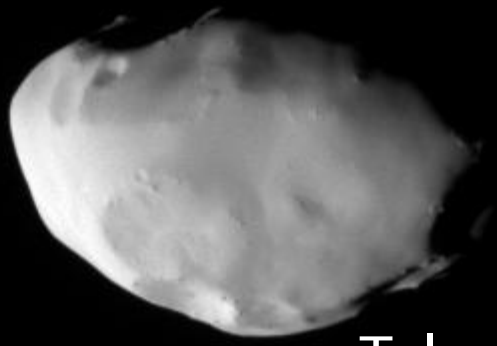
Janus



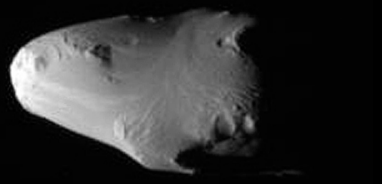
Prometheus



Helene



Telesto



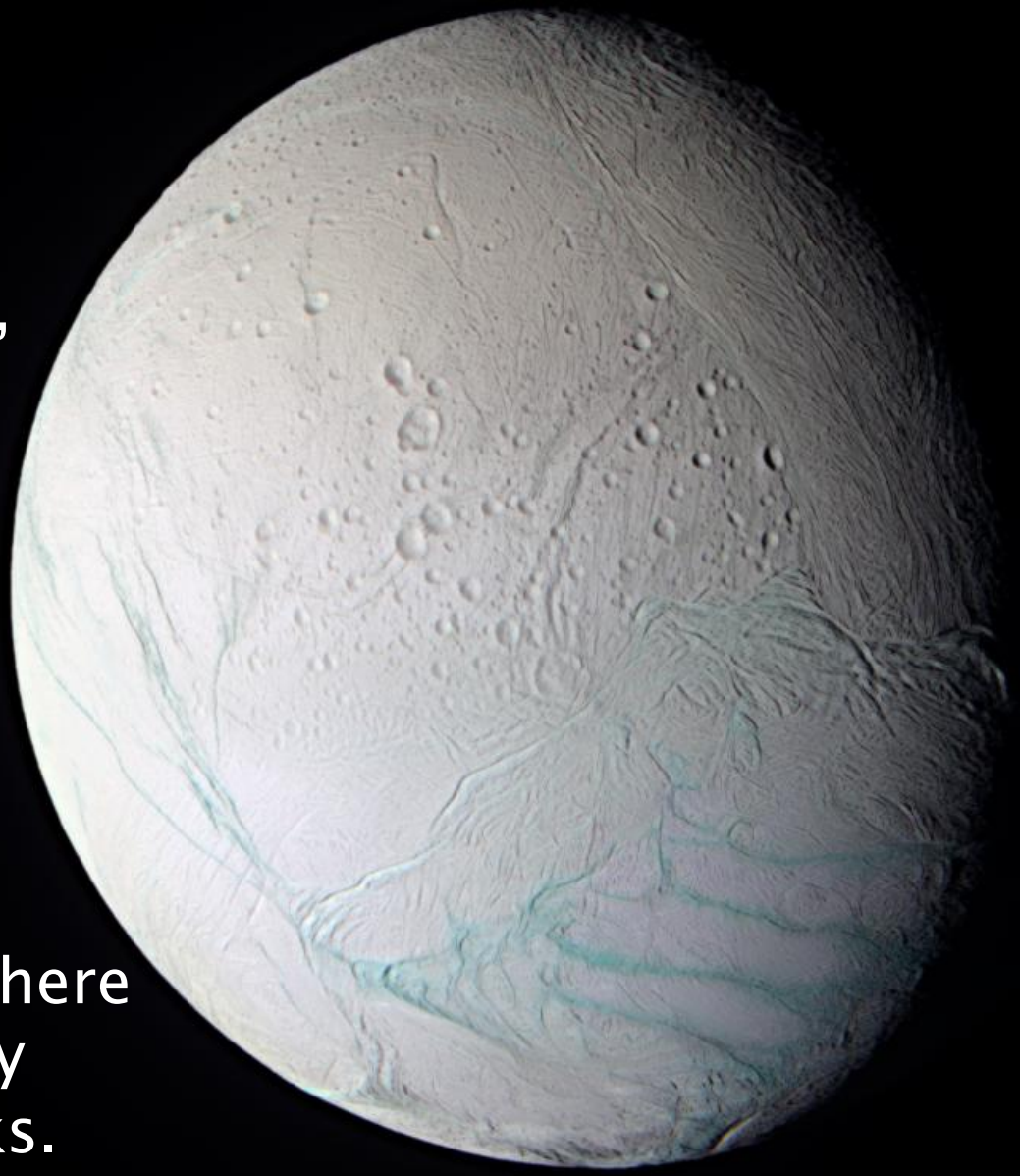
Calypso

Enceladus is covered in fresh, clean ice.

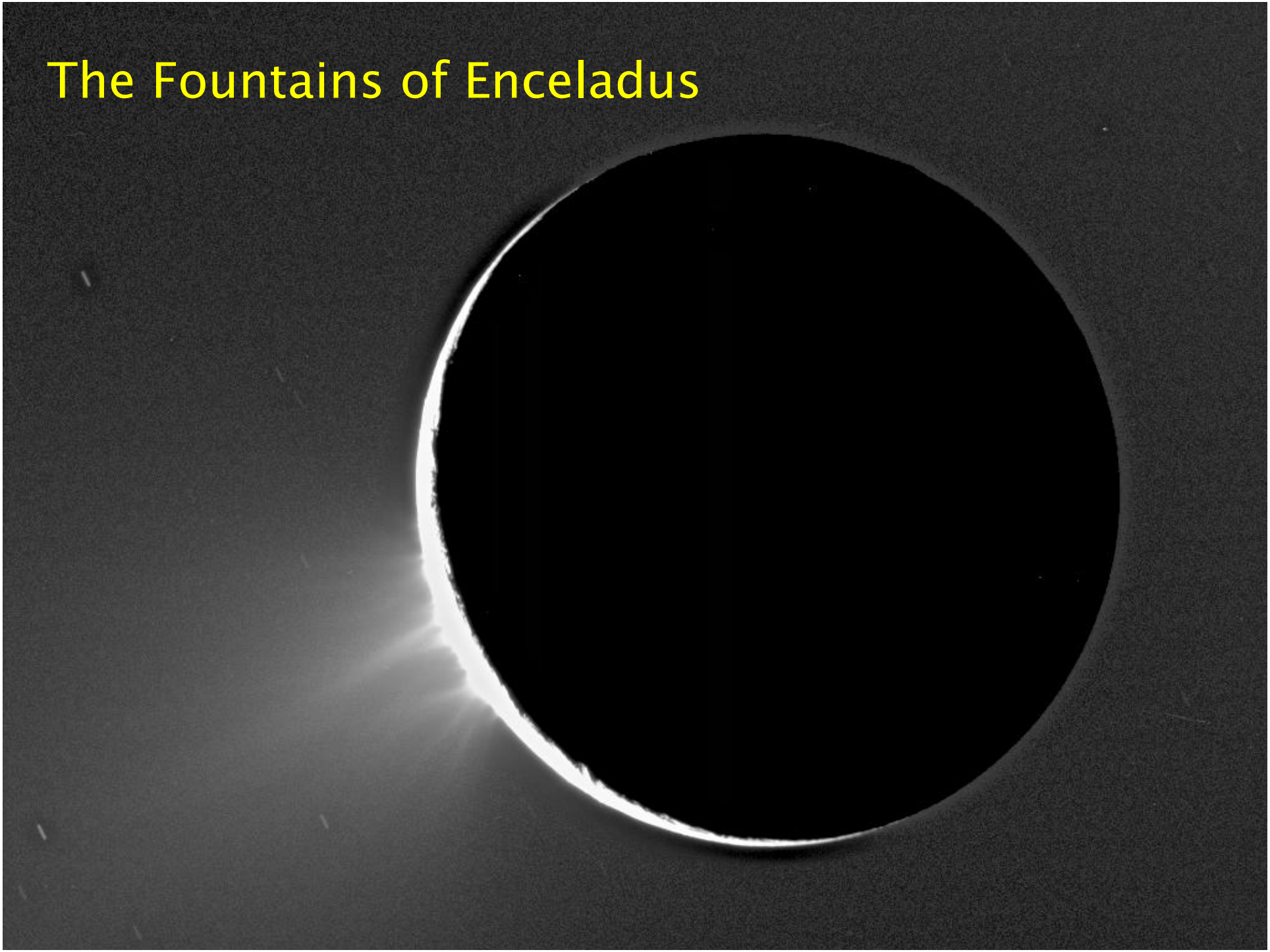
Surface is lightly cratered, especially in the south.

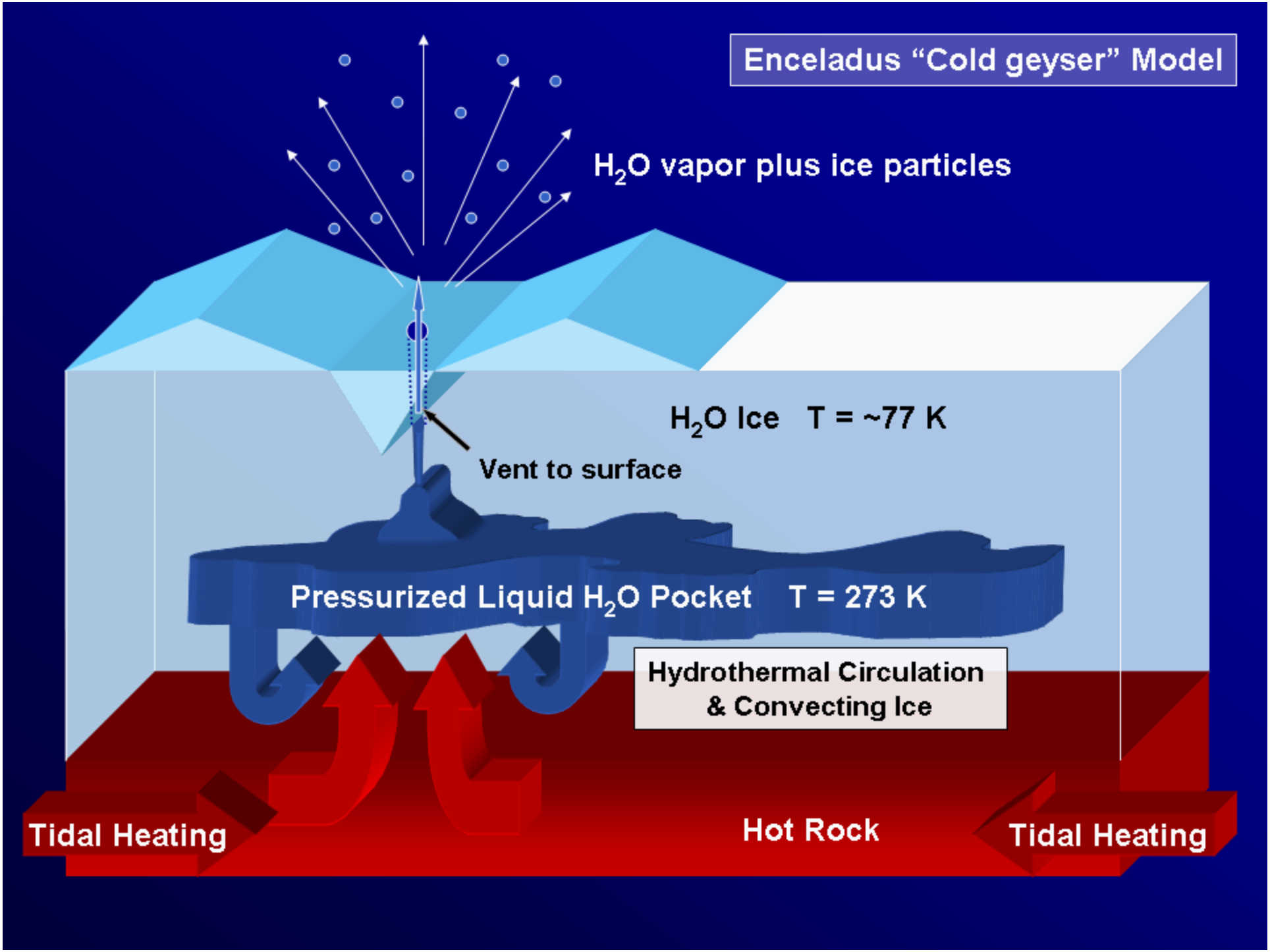
Tectonic features include scarps, grooves, and ridges, showing geologic activity.

A thin H_2O-vapor atmosphere & fresh surface ices fed by fountains at surface cracks.



The Fountains of Enceladus




Enceladus "Cold geyser" Model
H_2O vapor plus ice particles
H_2O Ice T = ~77 K
Vent to surface
Pressurized Liquid H_2O Pocket T = 273 K
Hydrothermal Circulation & Convecting Ice
Tidal Heating
Hot Rock
Tidal Heating

Titan

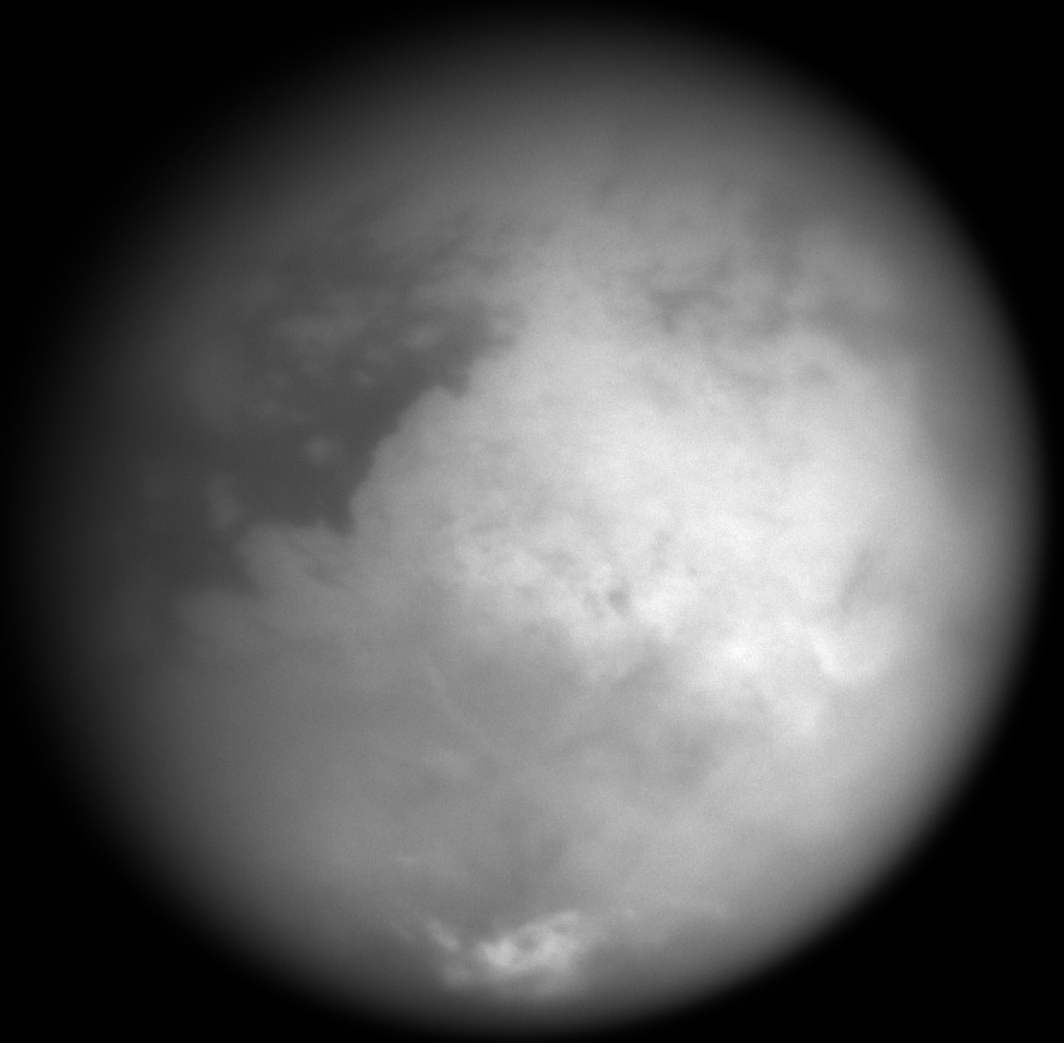
Radius: 2575 km

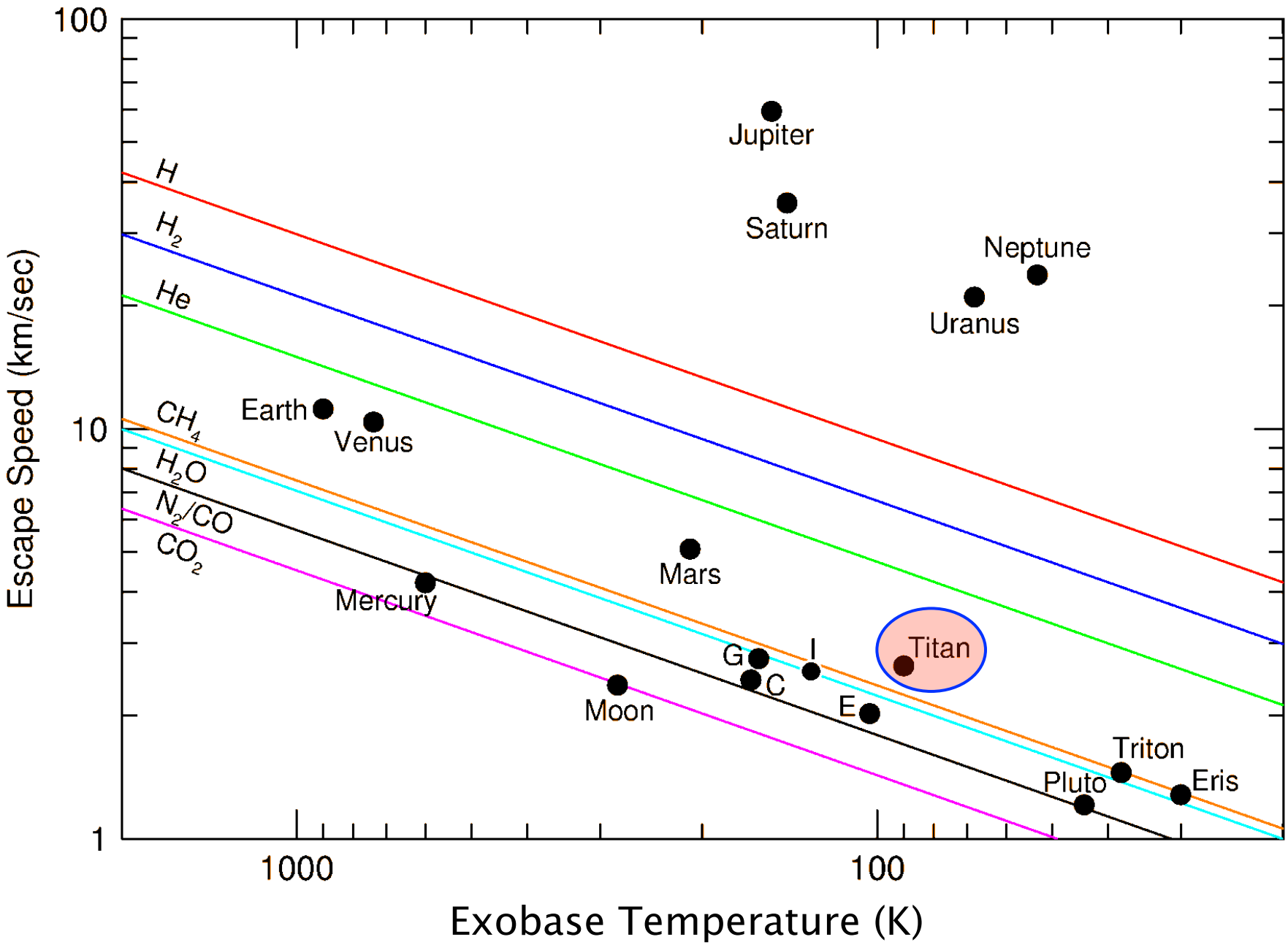
Density: ~1900 kg m^{-3}

Icy mantle over a rocky core.

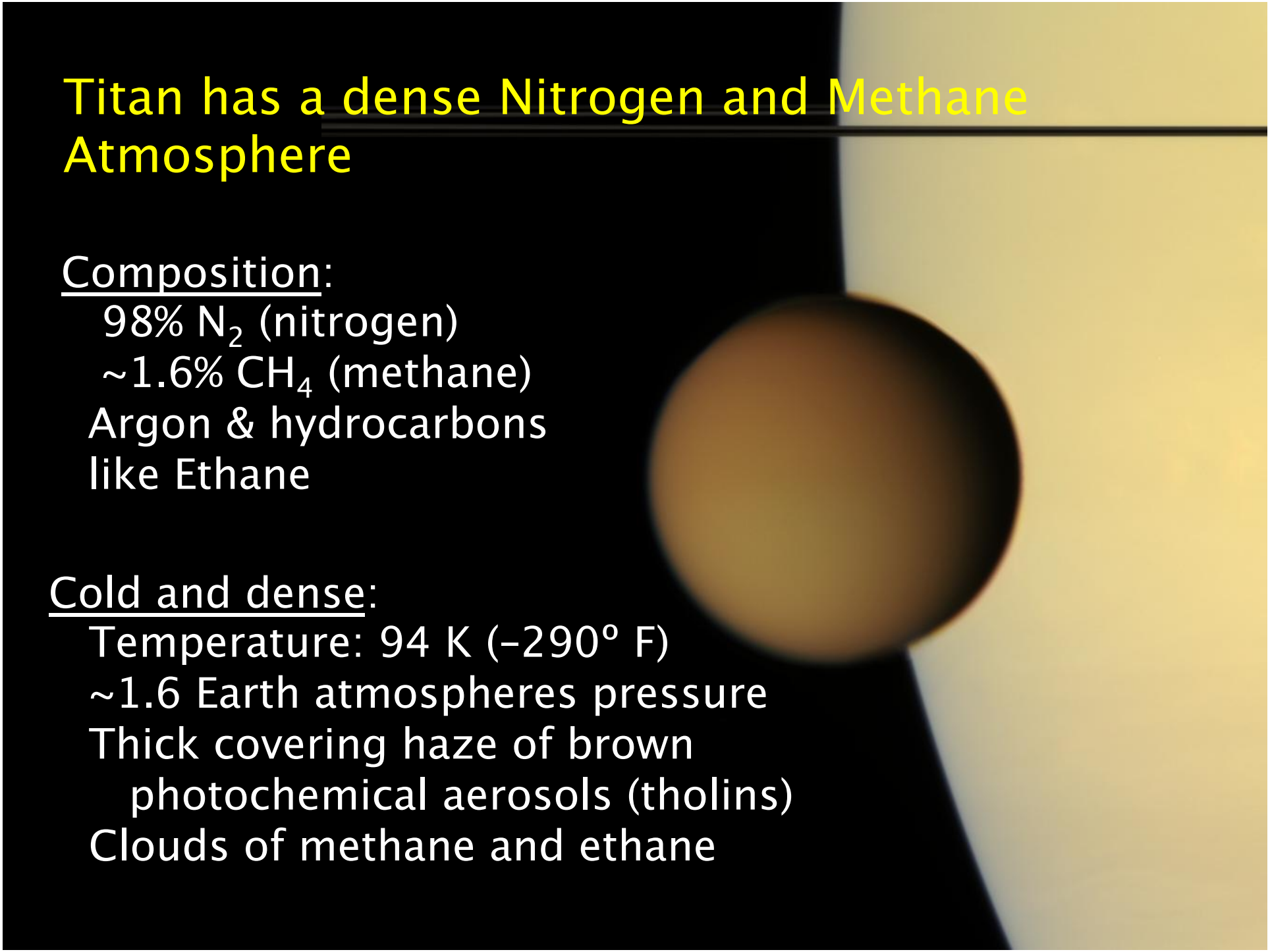
Cold enough to retain a heavy atmosphere of Nitrogen and Methane.

Pressure is high enough to have liquid methane on the surface.




100
10
1
Escape Speed (km/sec)
1000
100
Exobase Temperature (K)
H
H2
He
CH4
H2O
N2/CO
CO2
Jupiter
Saturn
Neptune
Uranus
Earth
Venus
Mars
Mercury
Moon
G
I
C
E
Titan
Triton
Pluto
Eris

Titan has a dense Nitrogen and Methane Atmosphere



Composition:

98% N_2 (nitrogen)

~1.6% CH_4 (methane)

Argon & hydrocarbons like Ethane

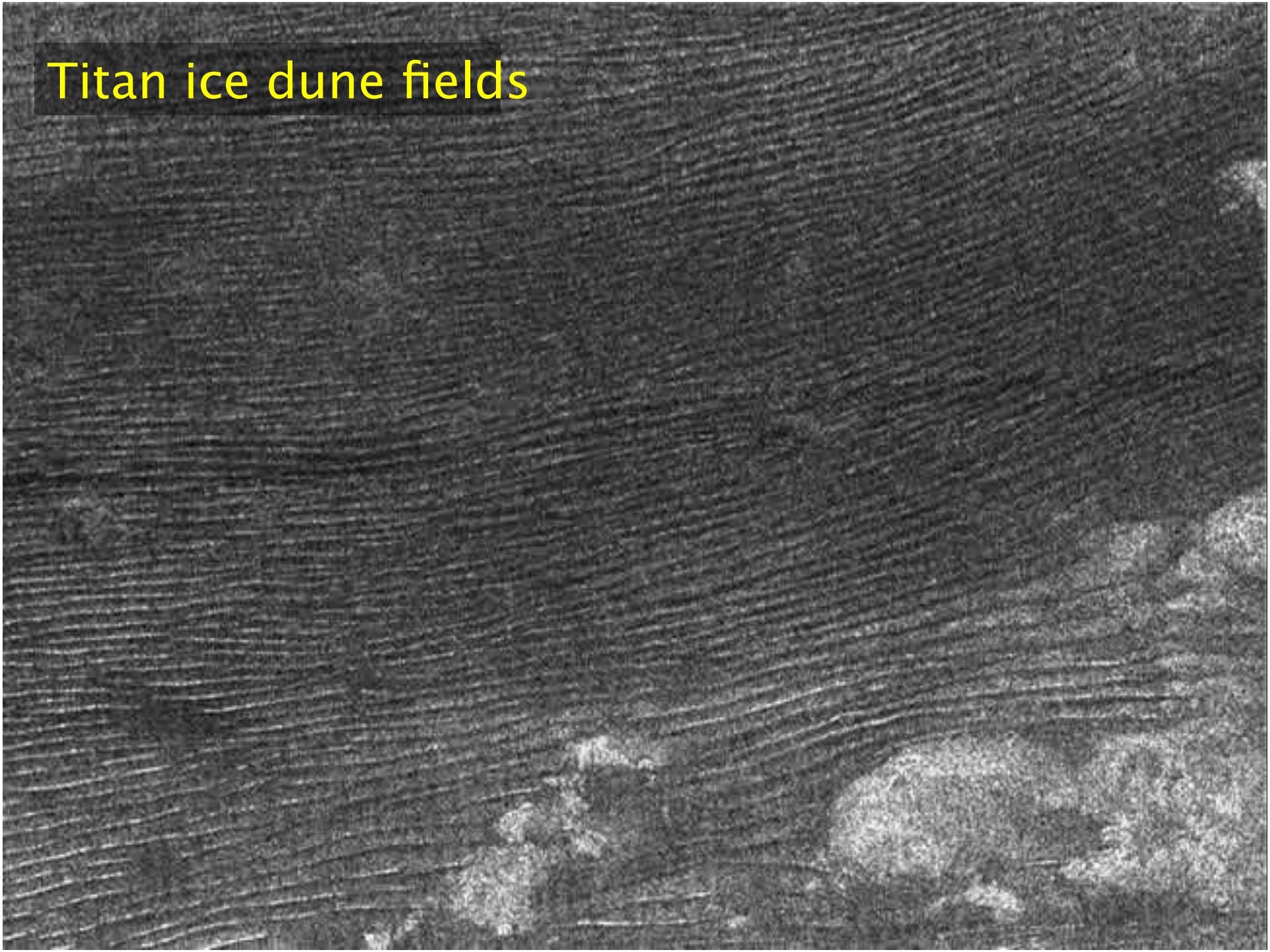
Cold and dense:

Temperature: 94 K (-290º F)

~1.6 Earth atmospheres pressure

Thick covering haze of brown photochemical aerosols (tholins)

Clouds of methane and ethane

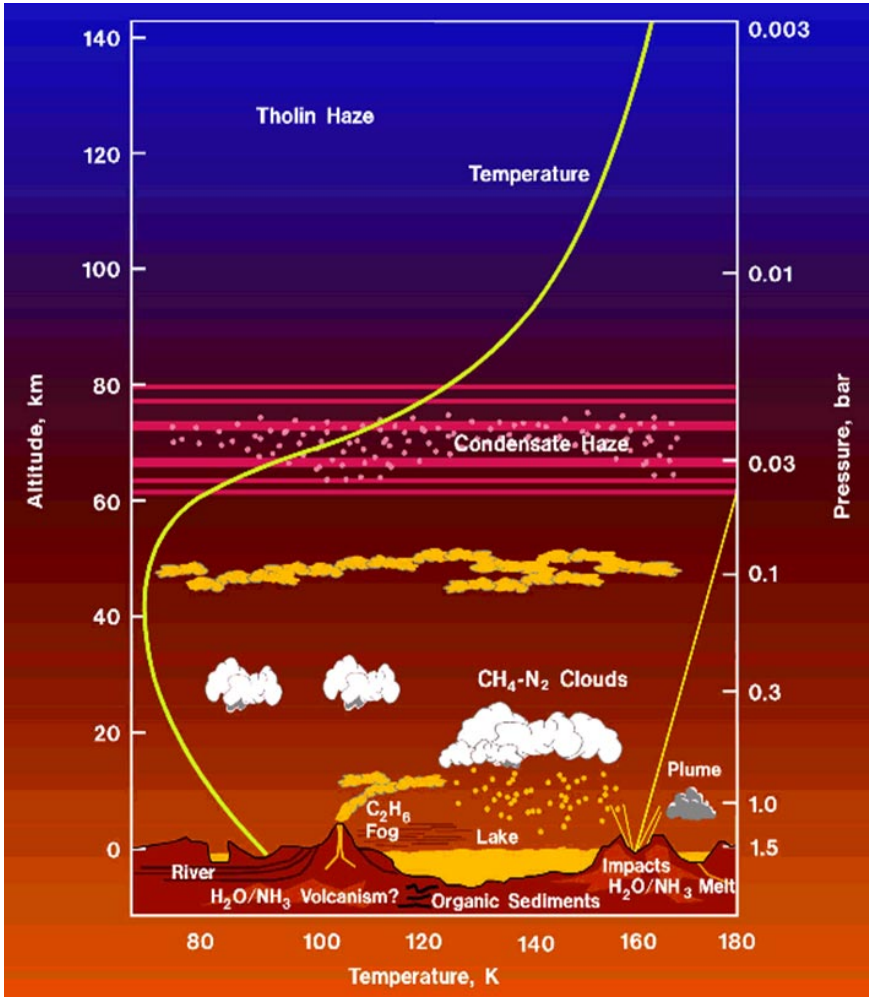

Titan ice dune fields

Methane (CH_4) plays the same role on Titan that water does on the Earth.

All three phases of methane exist at Titan's temperature & pressure

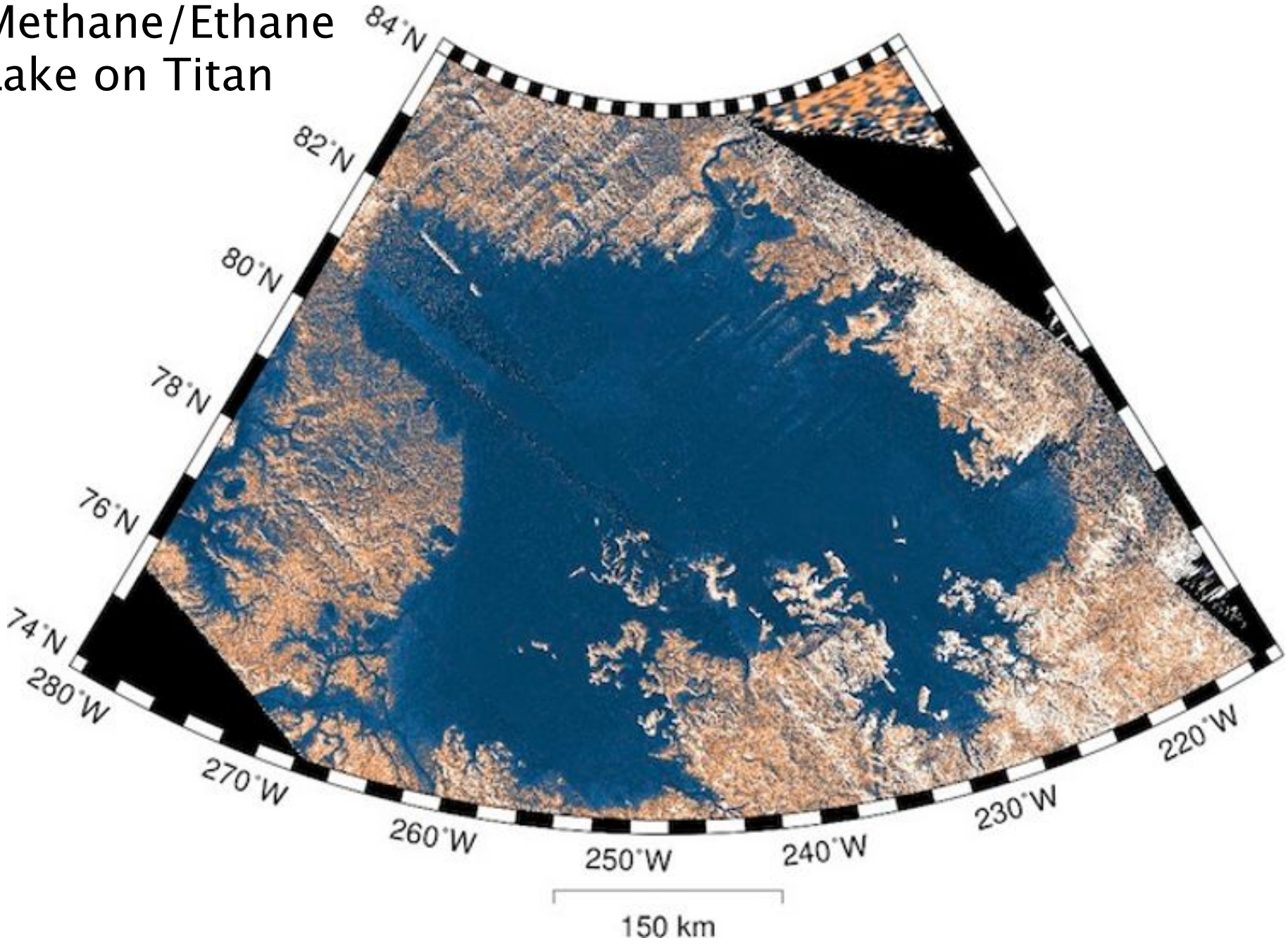
Atmospheric methane condenses into clouds that rain liquid methane.

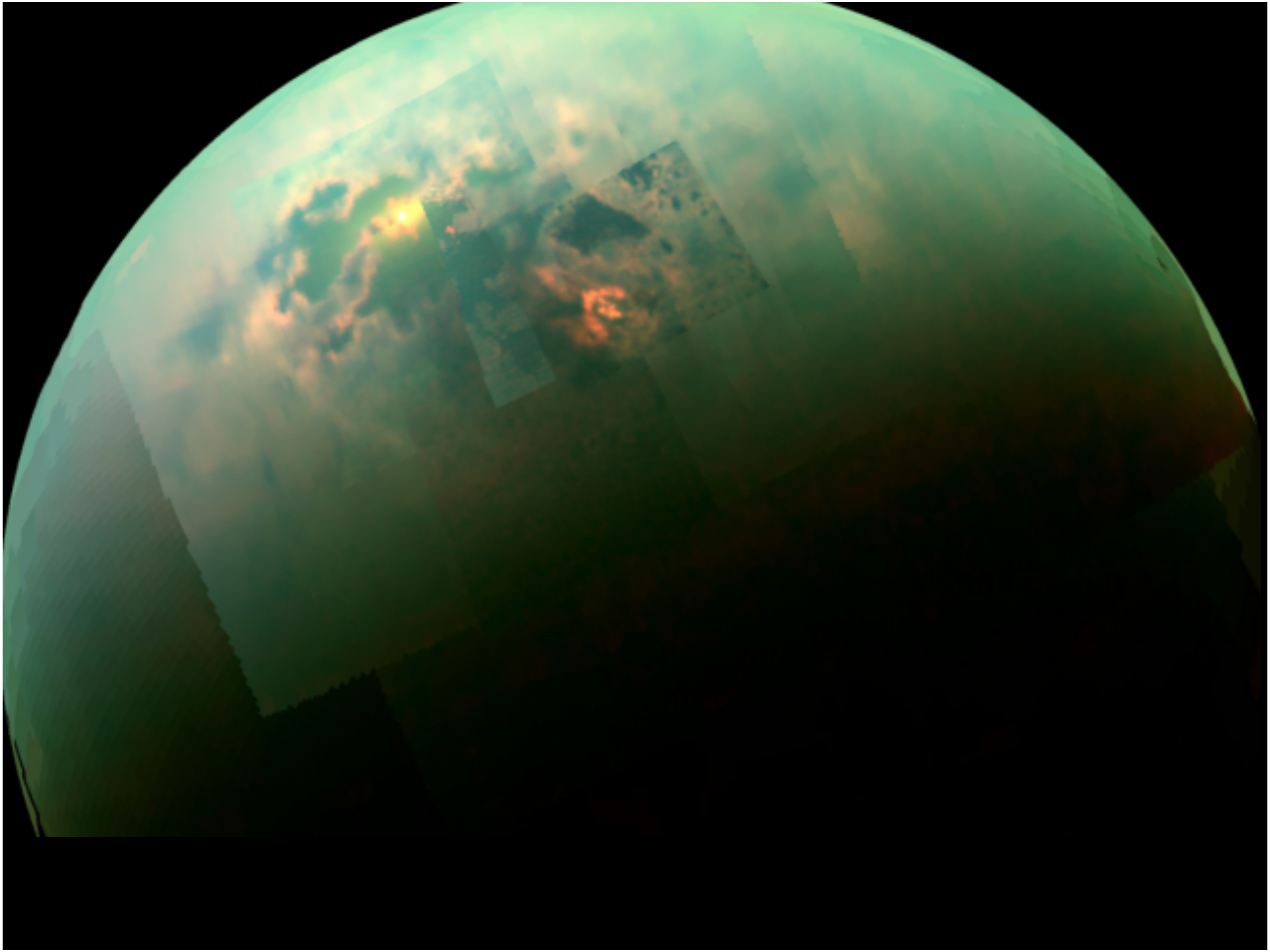
Methane "Mud Flats" are water ice grains & liquid methane.



Liquid methane/ethane lakes found at the poles.

Methane/Ethane
Lake on Titan



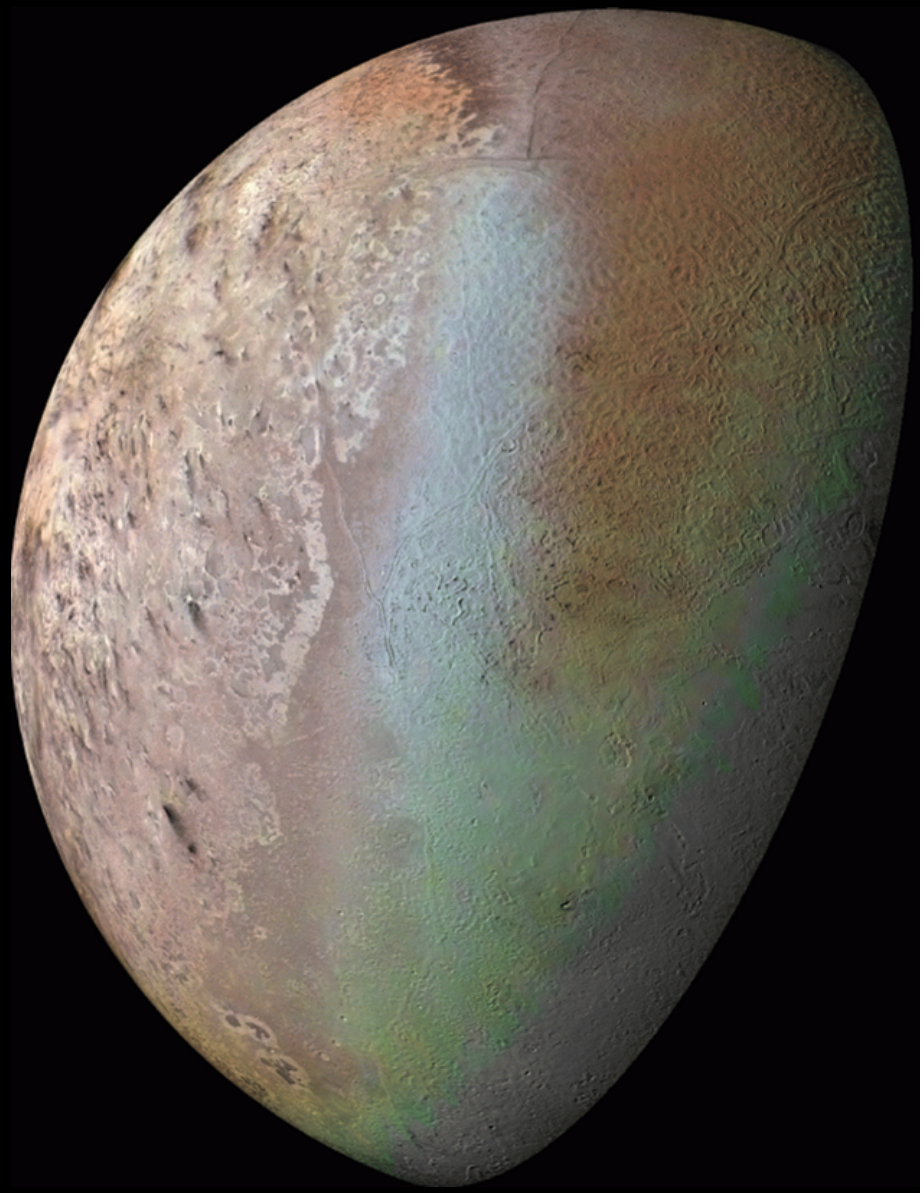


Triton: Neptune's Icy Moon

Diameter: 2710 km (21% R_E)
Mean density: ~2050 kg m^{-3}
Icy mantle over a rocky core.

Temperature 34 K (-398° F)
N_2, CH_4, CO_2, H_2O & CO ices
Thin N_2 Atmosphere

Young surface with few craters



Smooth plains paved over by Cryovolcanic flows

N_2 Geysers:
Plumes of ices & dark particles
Swept downwind, making dark streaks

Feeds Triton's thin N_2 atmosphere