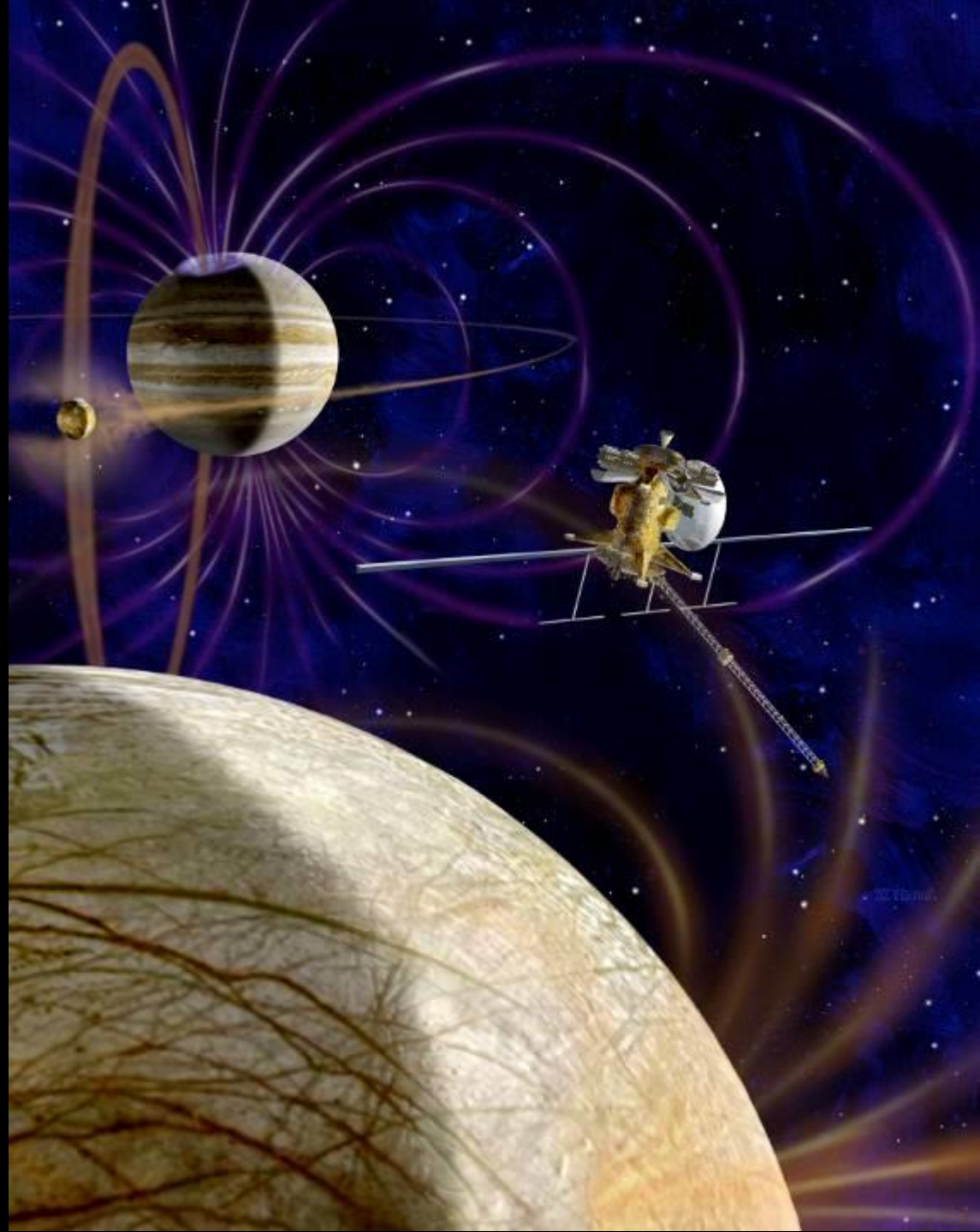




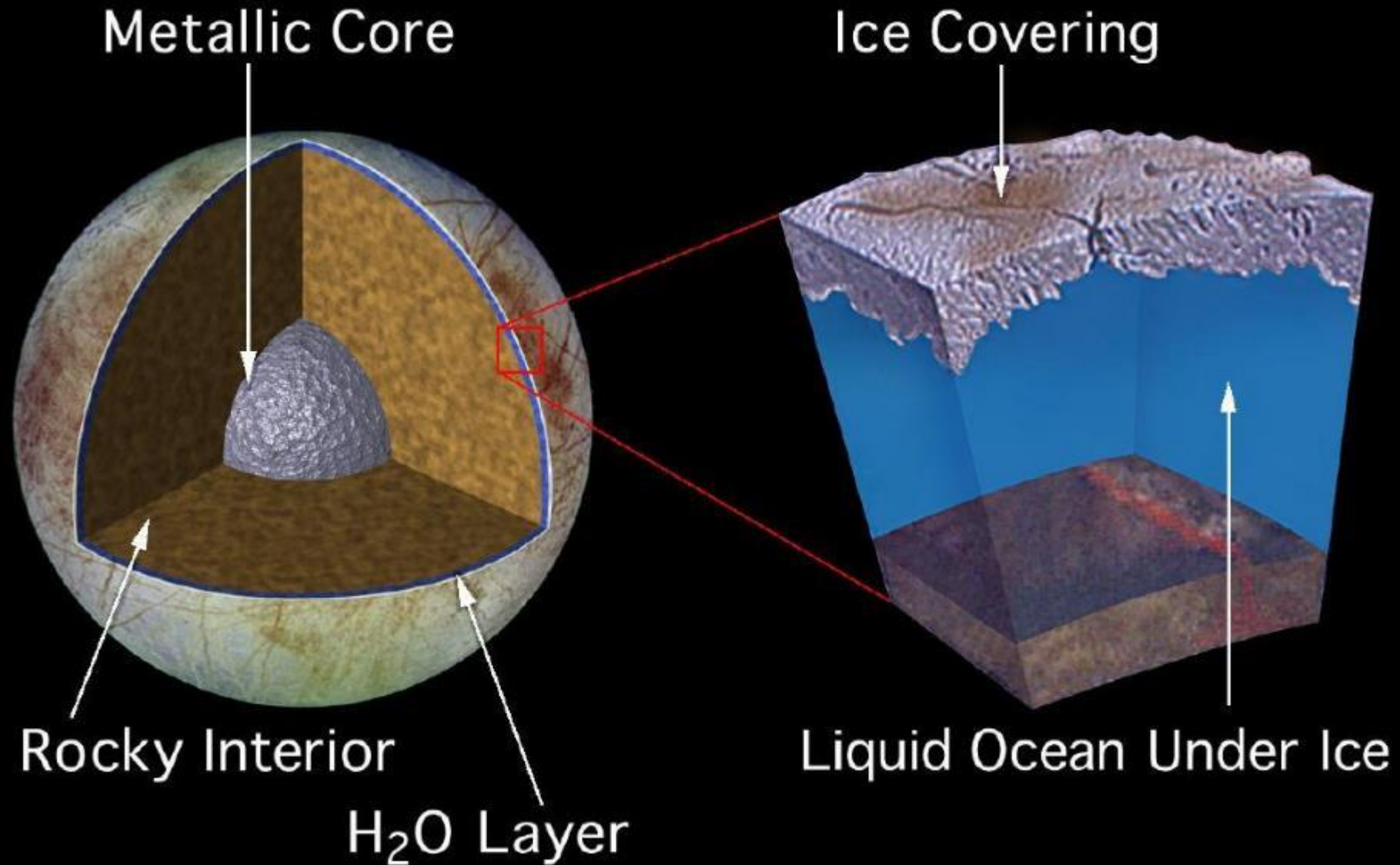
Next NASA
flagship
mission:
Europa
Clipper

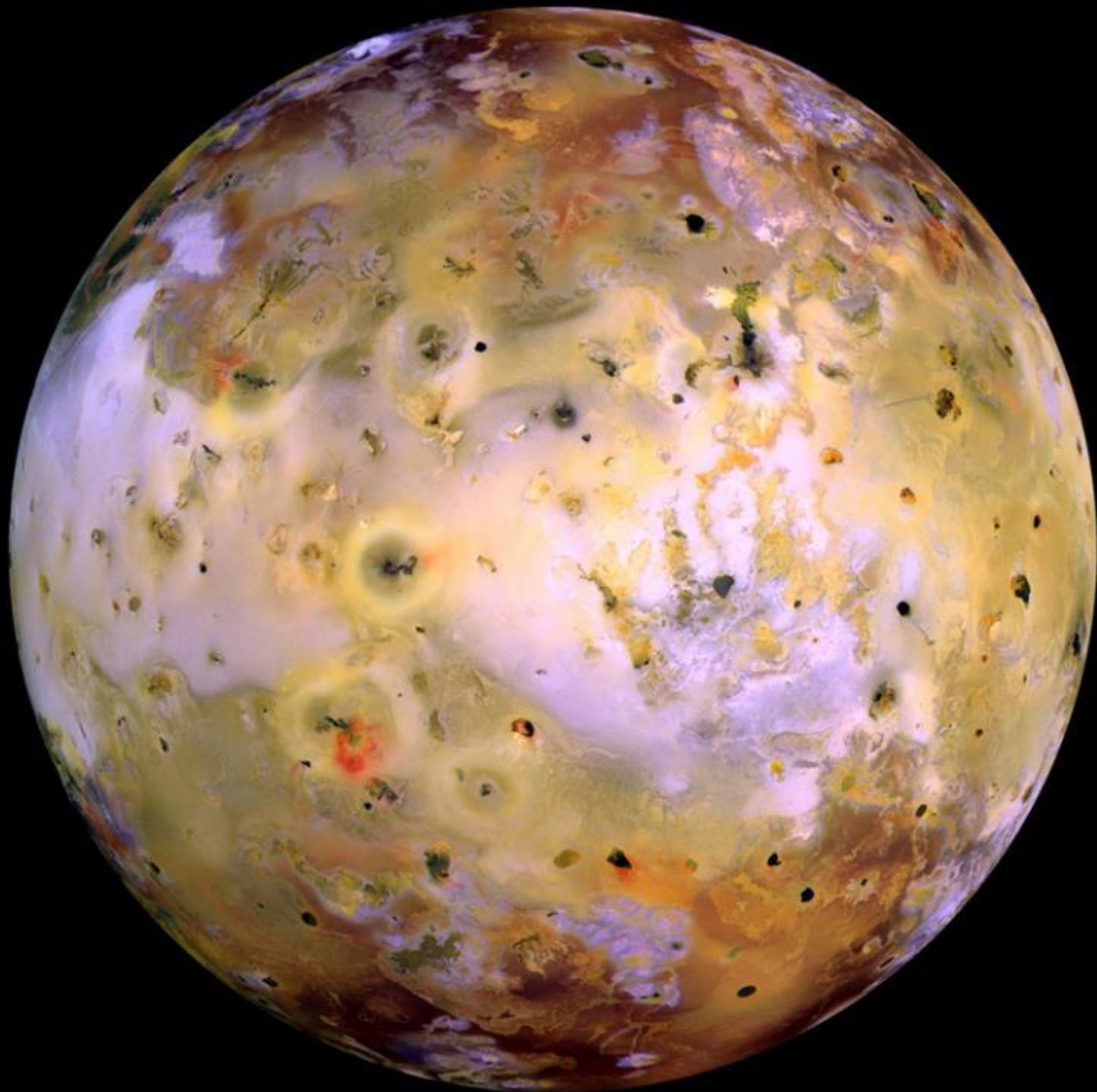
Orbiter (maybe
lander too...)

launch 2022
At Europa 2026!

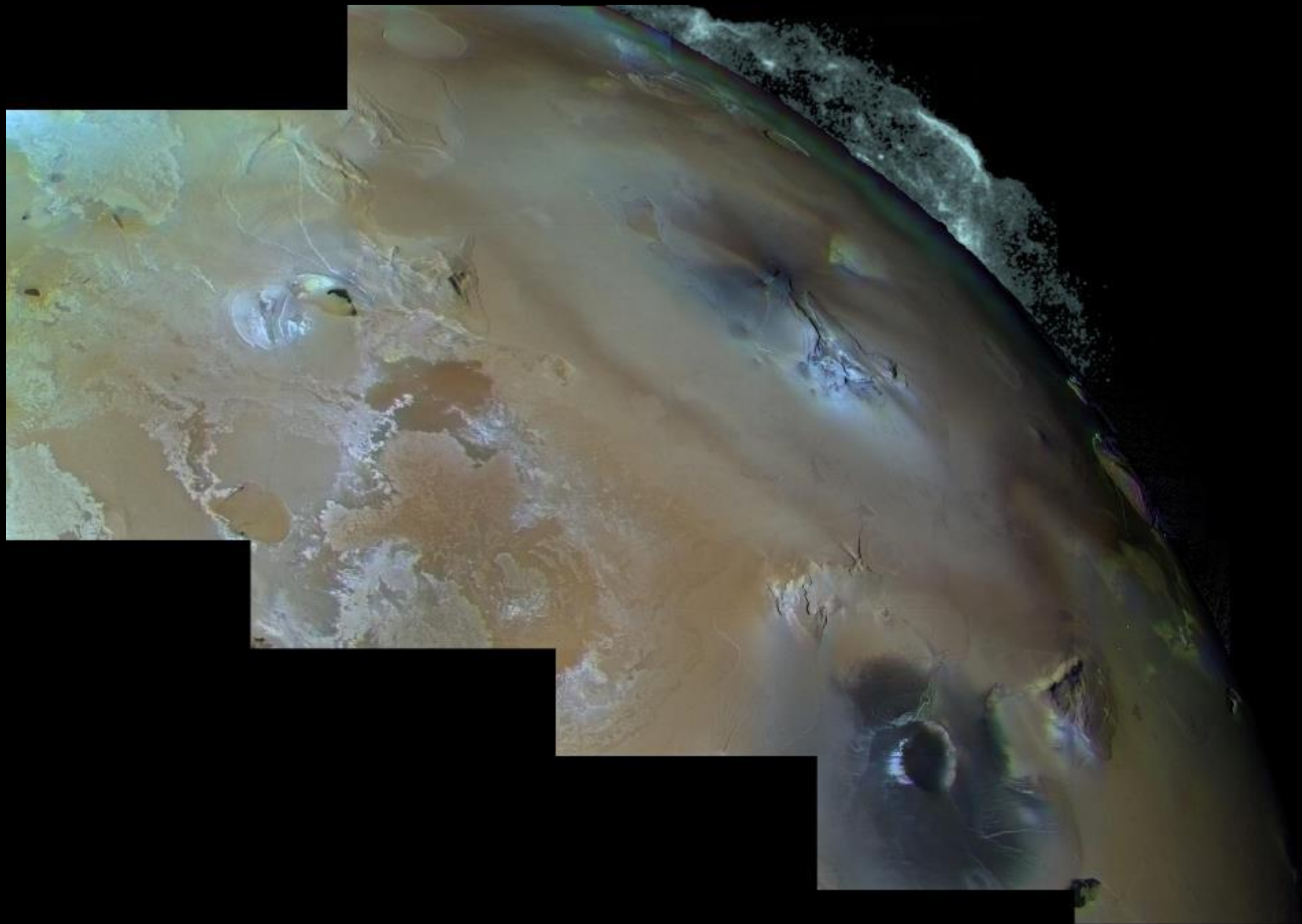


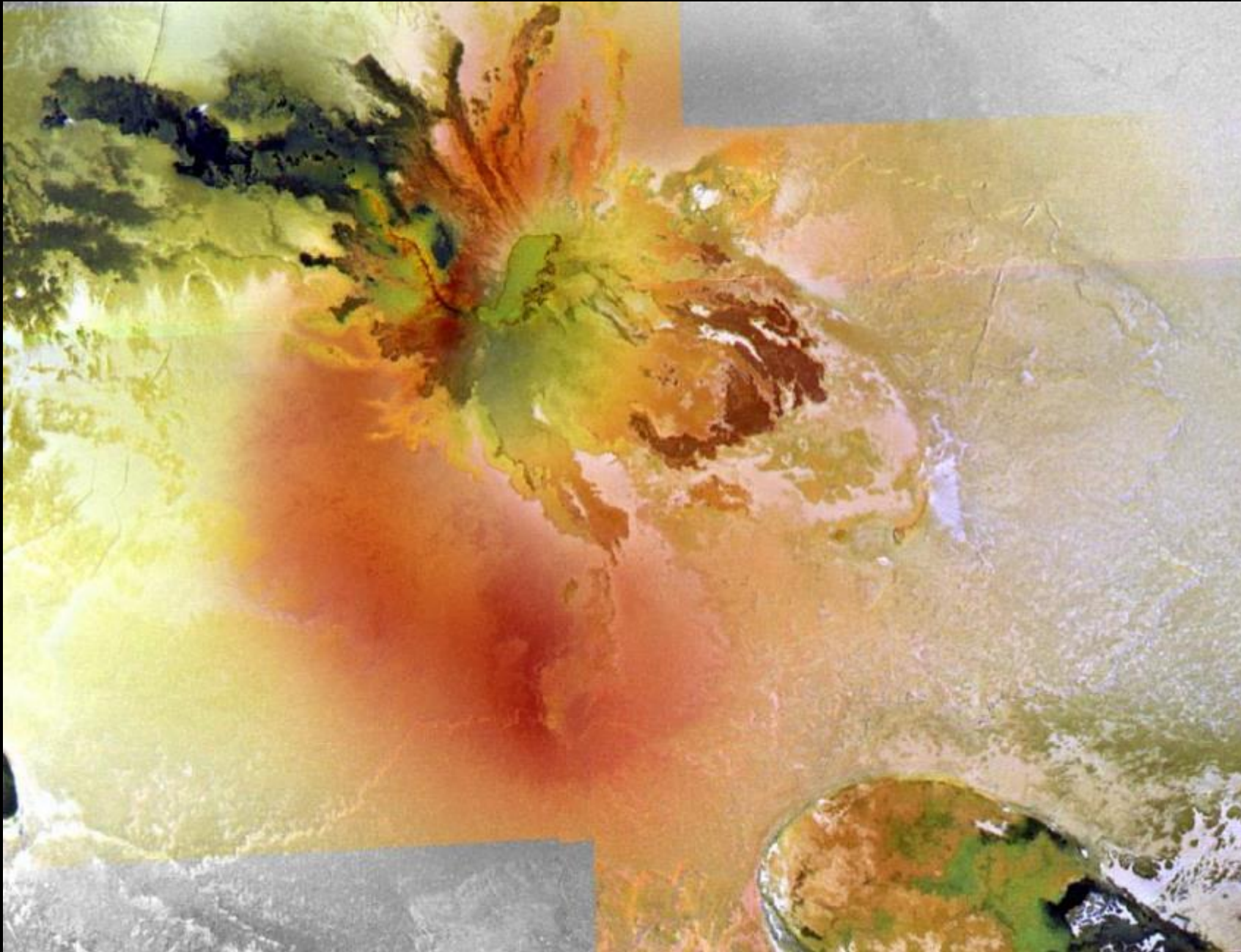
Europa has a liquid ocean under an icy shell



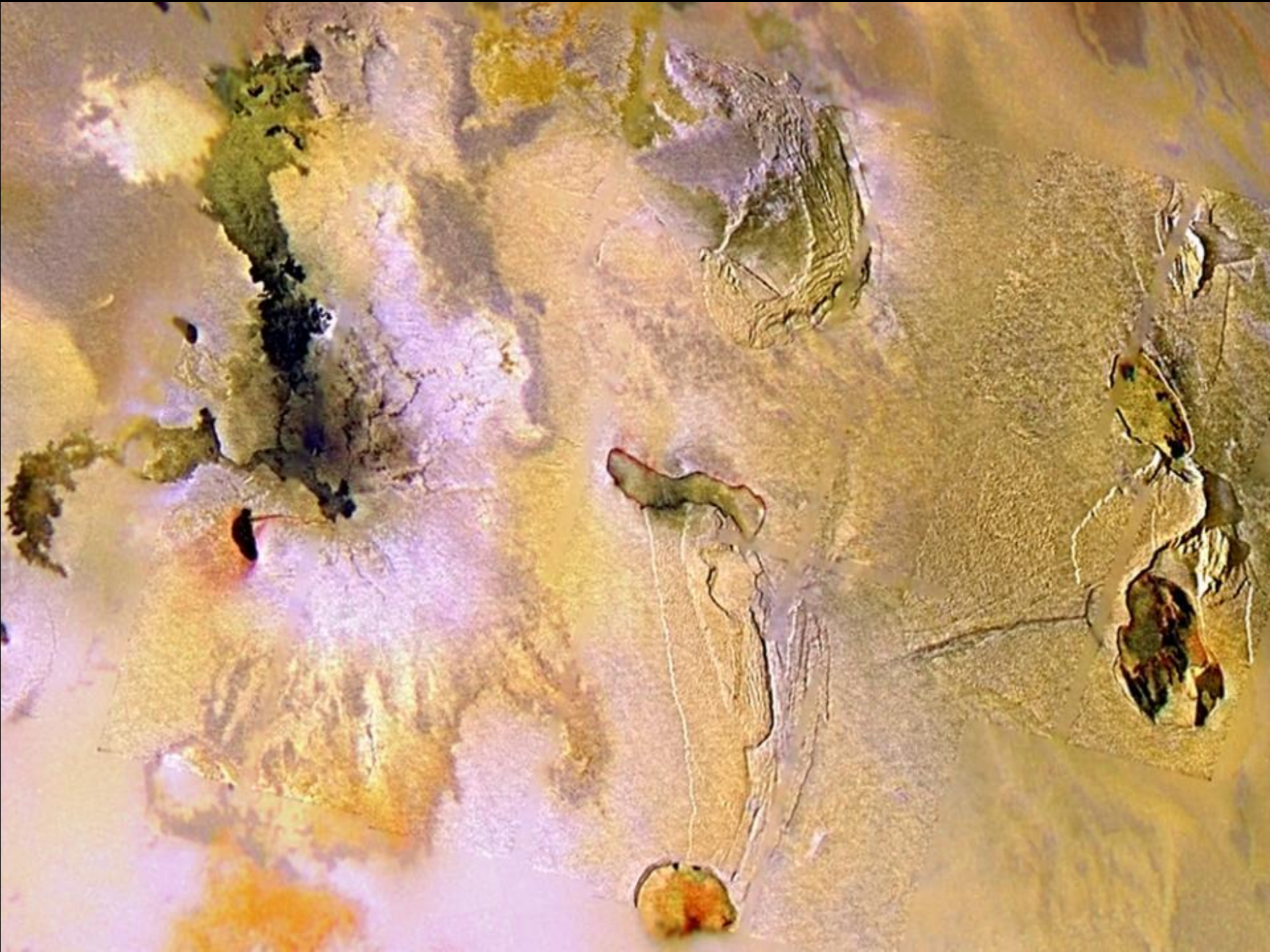


Io

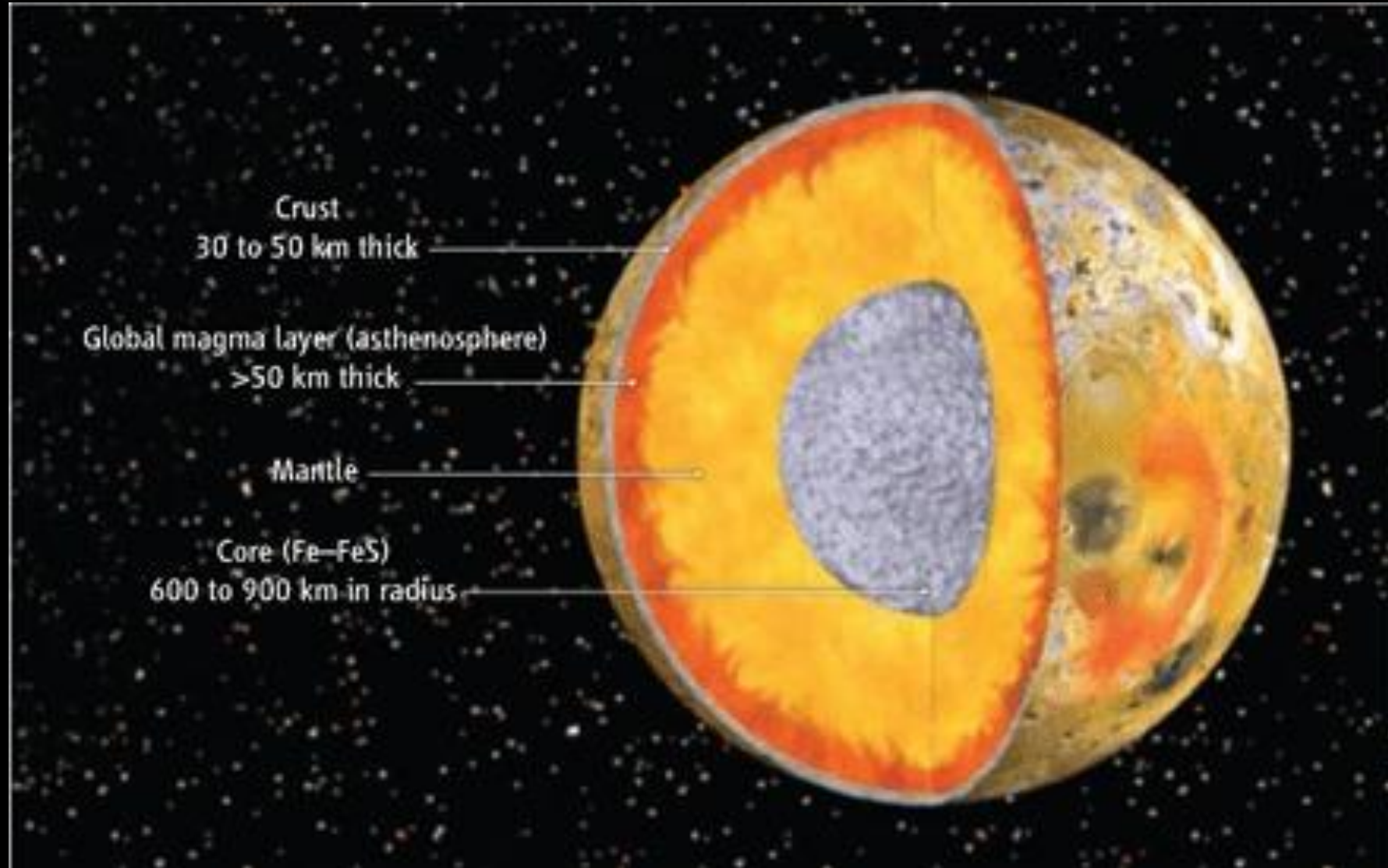




- Io is covered
in volcanoes
- Why?



Layer of magma, globally, under crust.



Comparison of Jupiter's Moons



Moons of Jupiter

Satellite	Size (km)	Density (g/cm ³)	Composition (Ice%)	Craters
Io	3630	3.57	0%	0
Europa	3138	2.97	10%	Few tens
Ganymede	5262	1.94	50%	Many
Callisto	4800	1.86	55%	Saturated

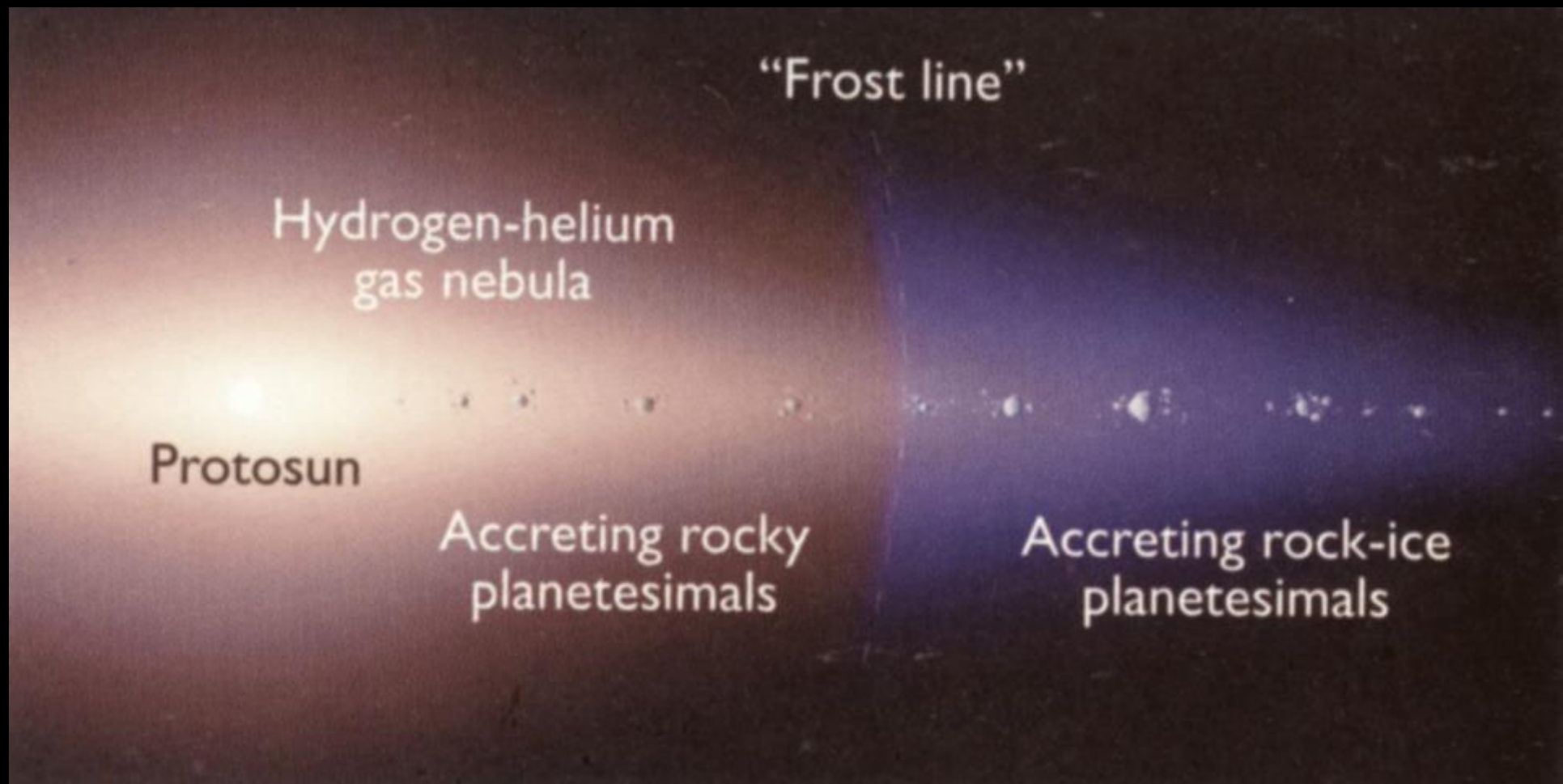
Why are they so different?

- What are the two main differences?
- **Composition**
 - Density
 - Color
- **Internal energy - Affects surface features**
 - Surface age
 - Number of craters
 - Active geologic processes

Composition

Ancient Frost Lines

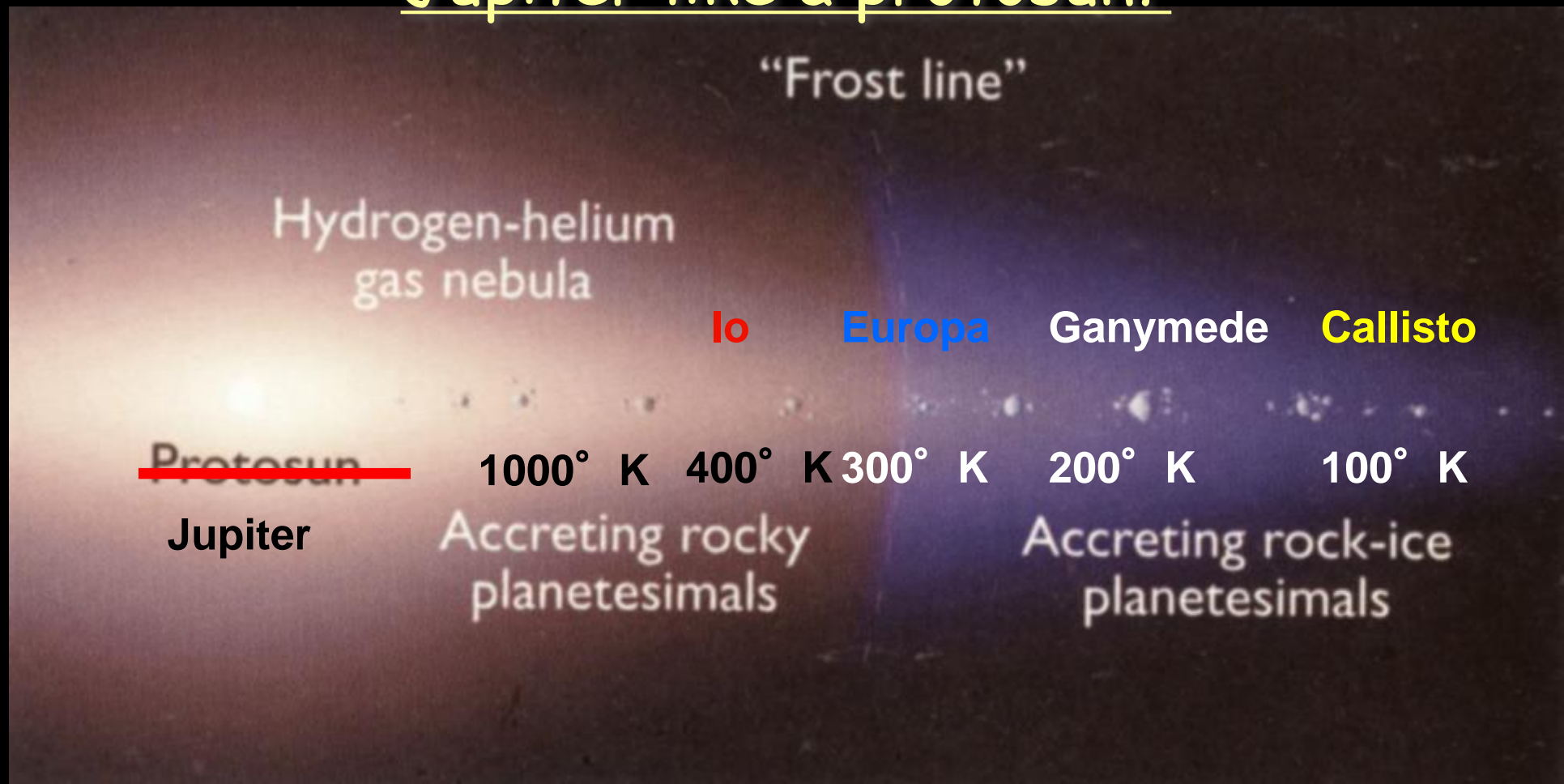
Gasses and water couldn't condense until Jupiter



Ancient Frost Lines

Mini nebula at Jupiter??

Inner gas/water-poor, outer gas/water-rich
Jupiter like a protosun?



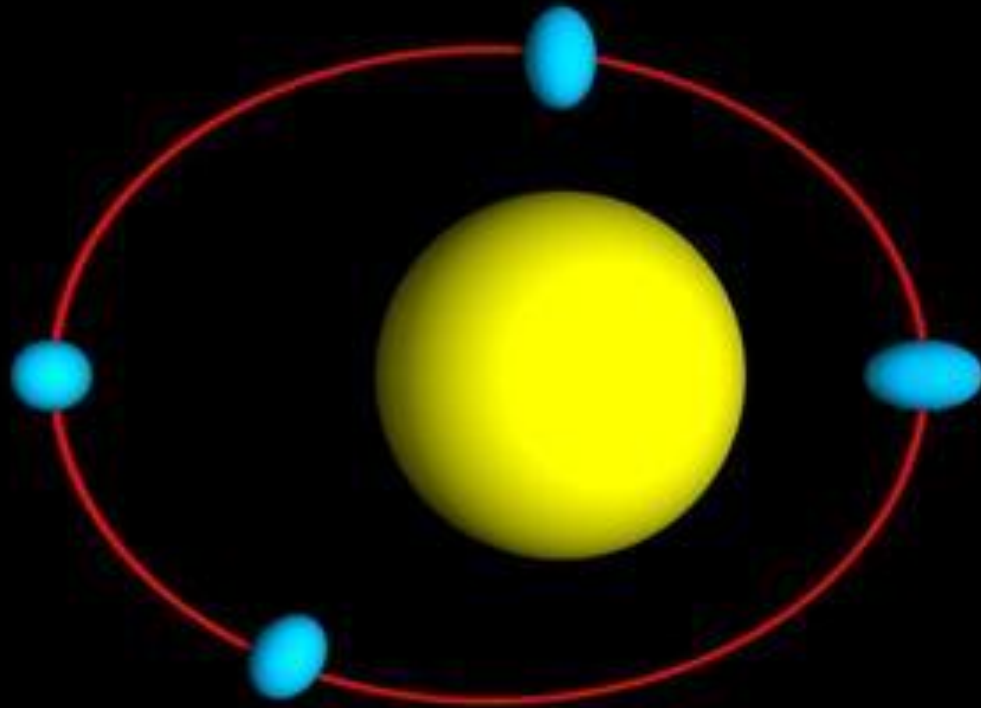
Internal Energy - Surface Features

Tides

- Mass pulls on other mass
- Think of Earth's tides - from the Moon pulling on water

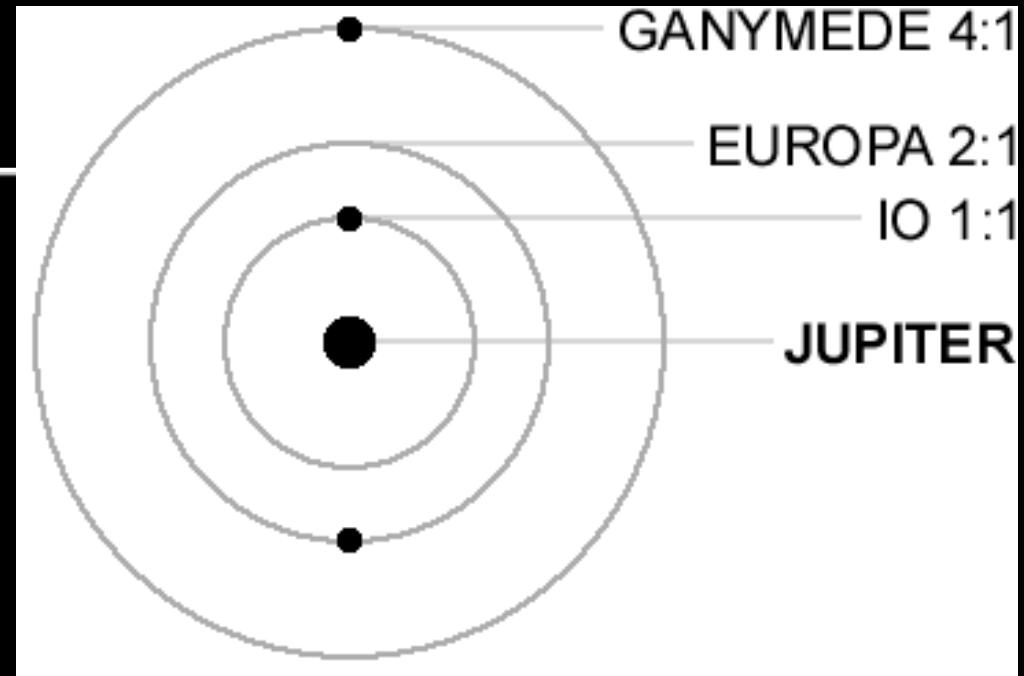
Tides

- If satellites are close enough, planets can even pull on the rocks and interiors
- If the distance changes, rocks slide past each other, causing friction and heating

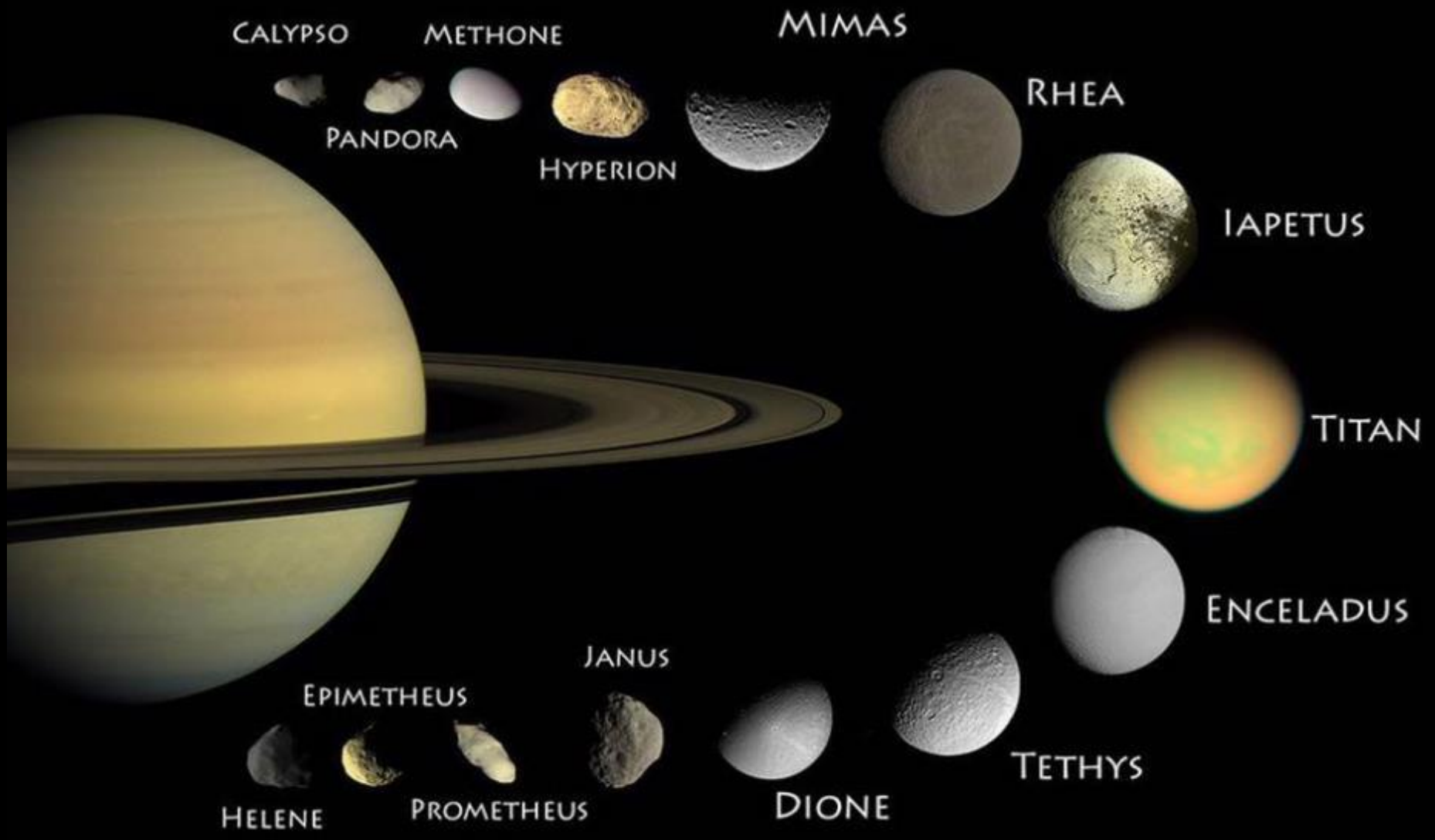


Tidal Heating of Galileans

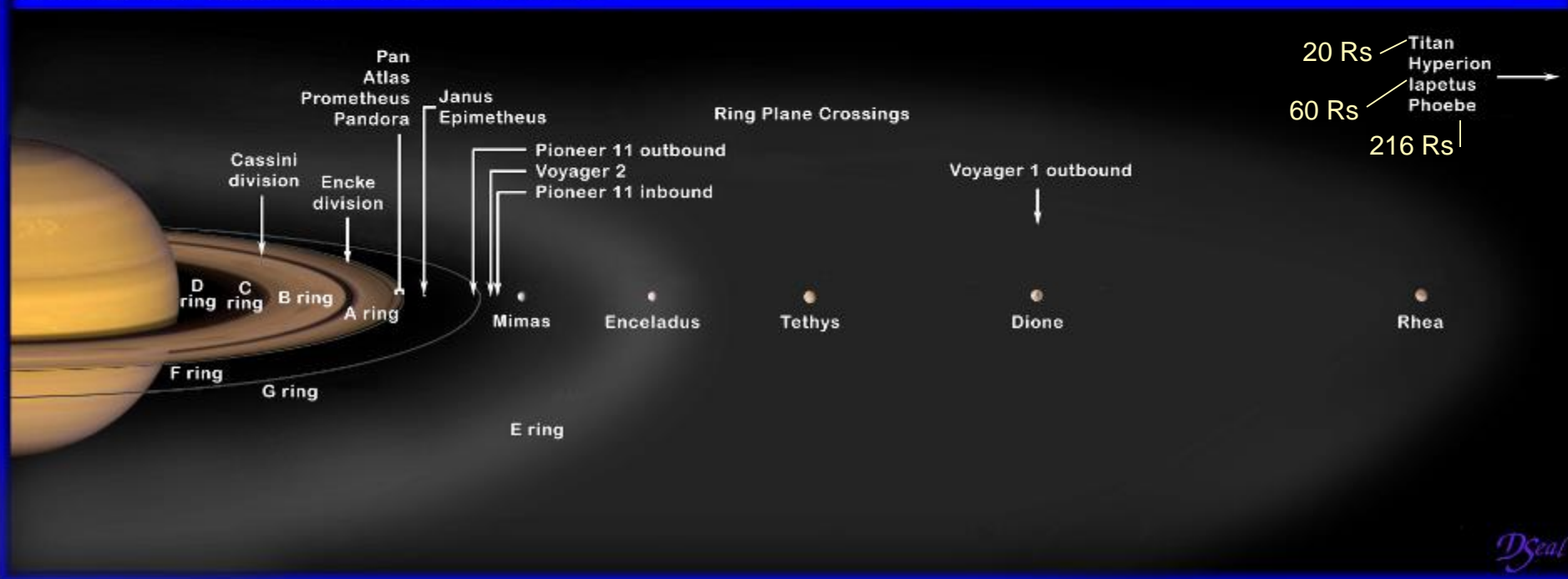
- JUPITER PULLS ON ORBITS - KEEPS THEM OVAL SHAPED
- Bodies sometimes close to Jupiter, sometimes far away
- Causes heating and melting



SATURN'S MOONS



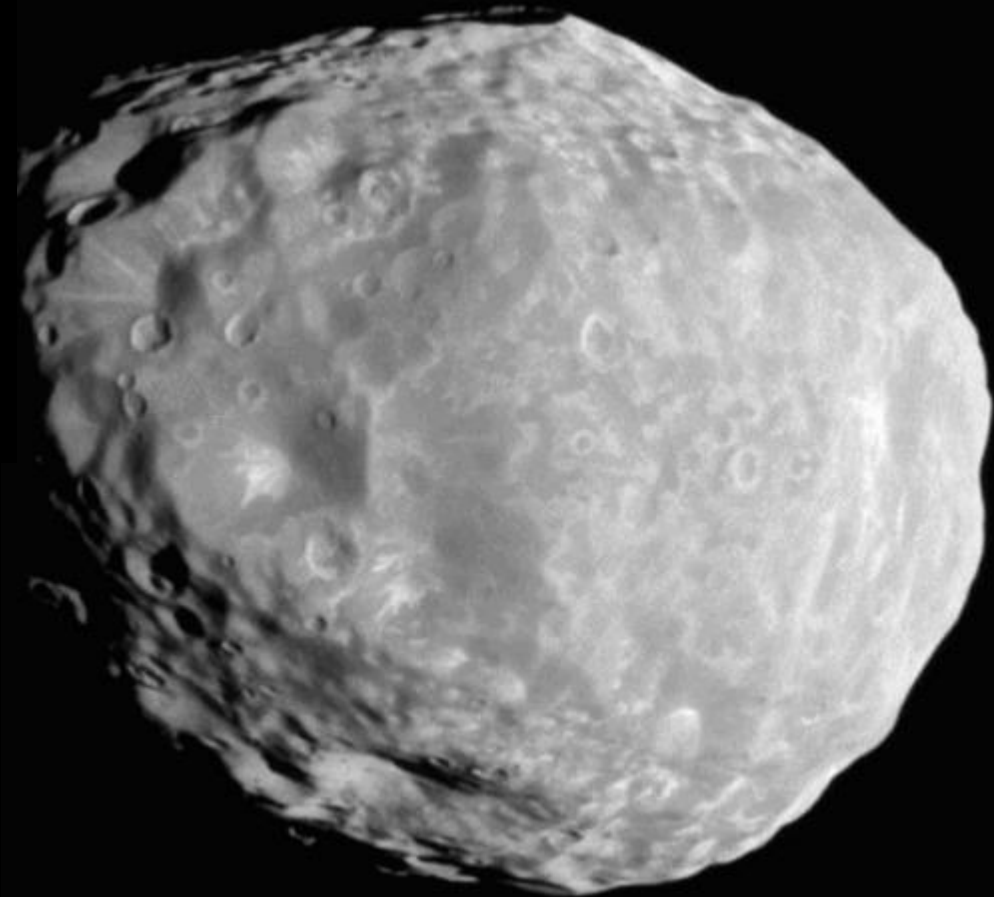
Saturn's Satellites and Ring Structure



Ring Shepherd Satellites



Epimetheus

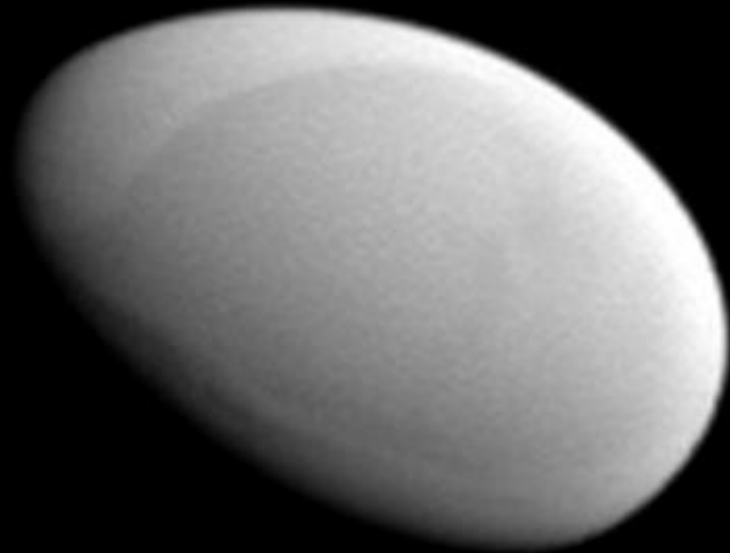


Janus

Ring Shepherd Satellites

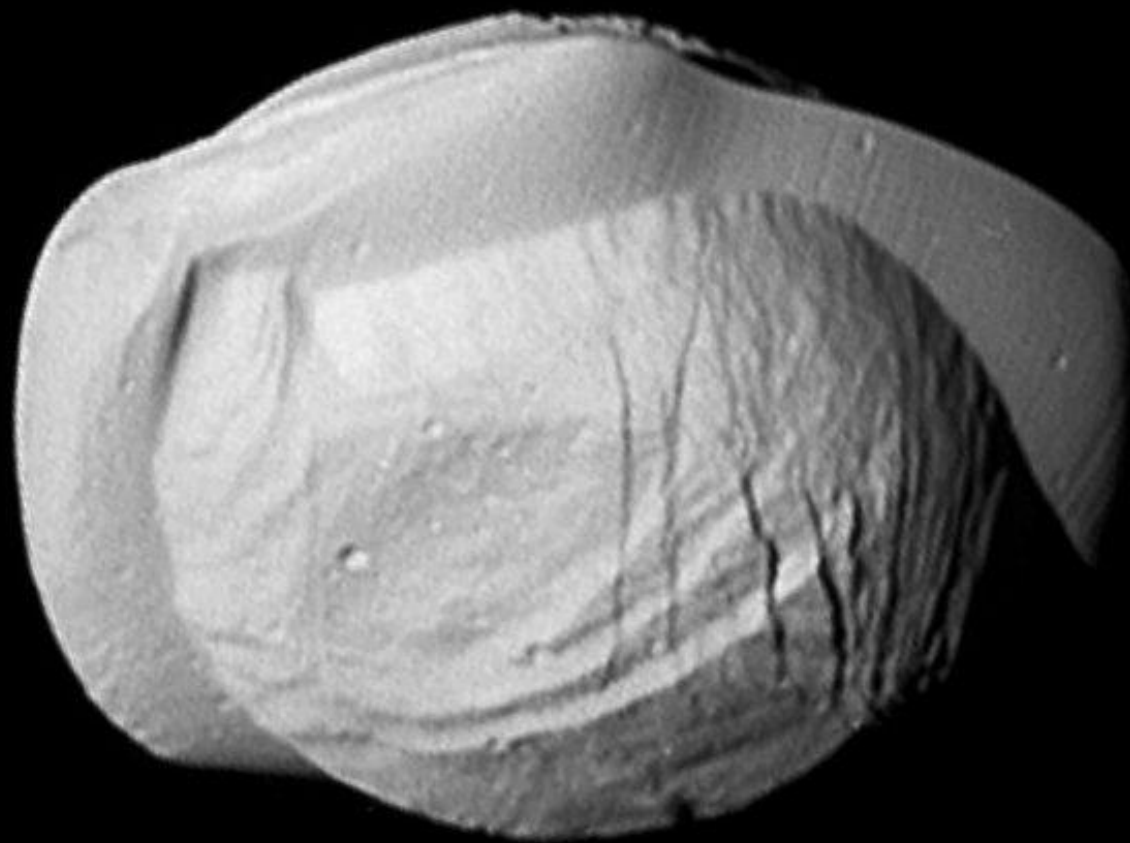


Pandora



Methone

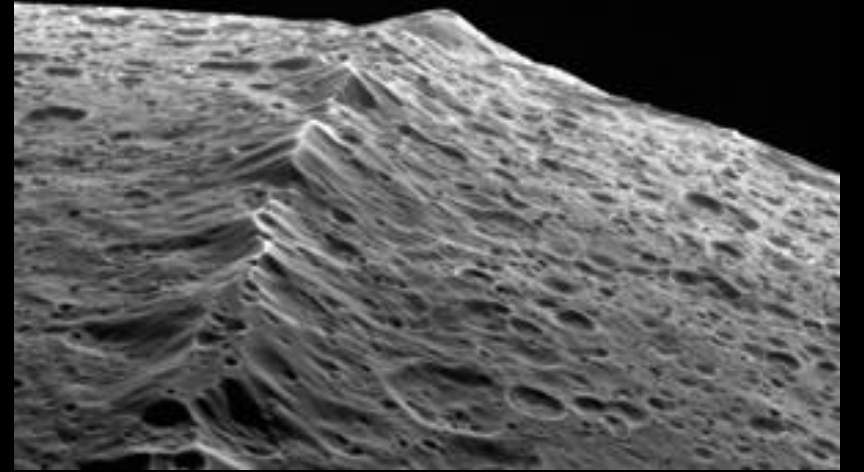
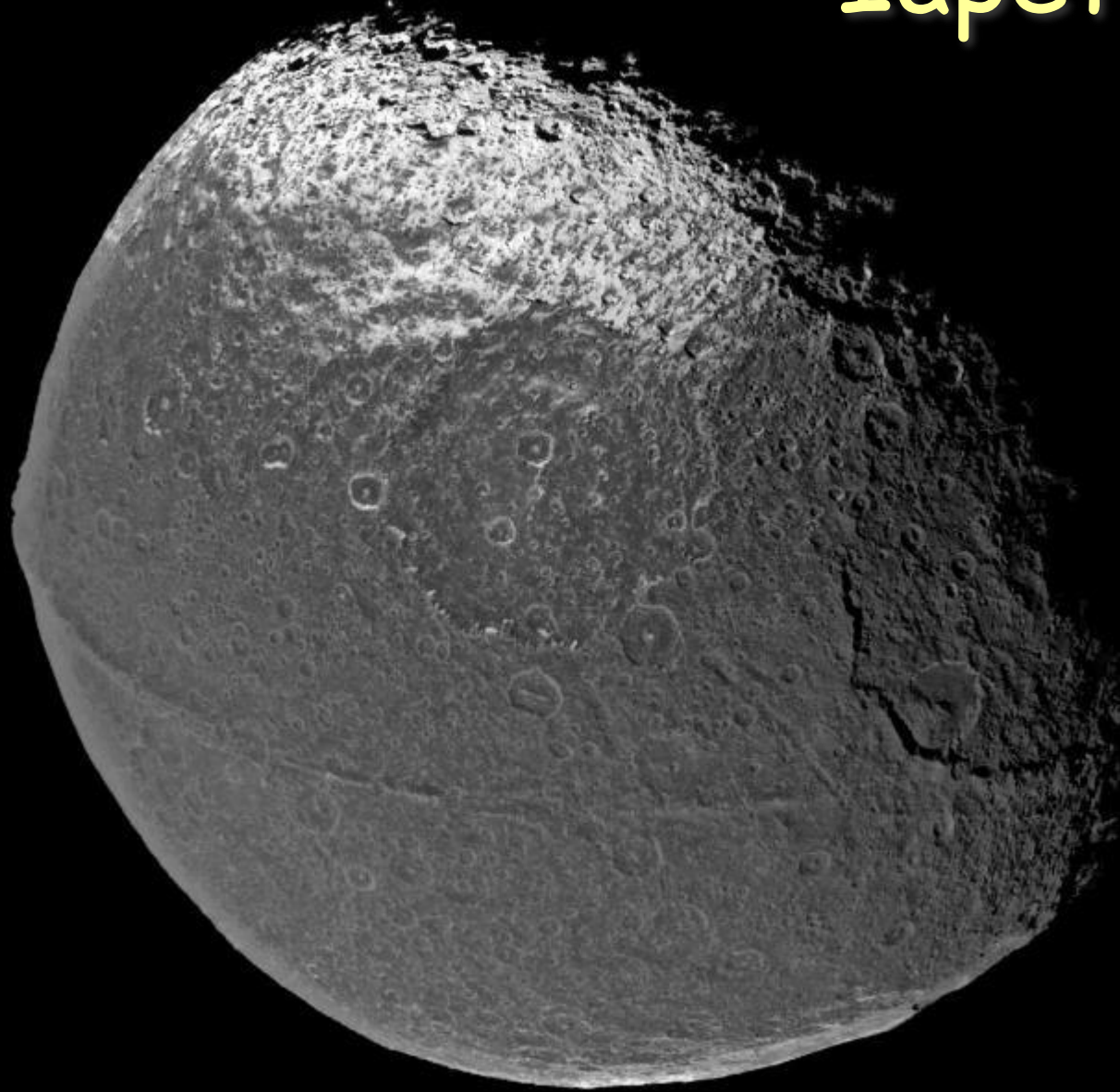
Ring Shepherd Satellites



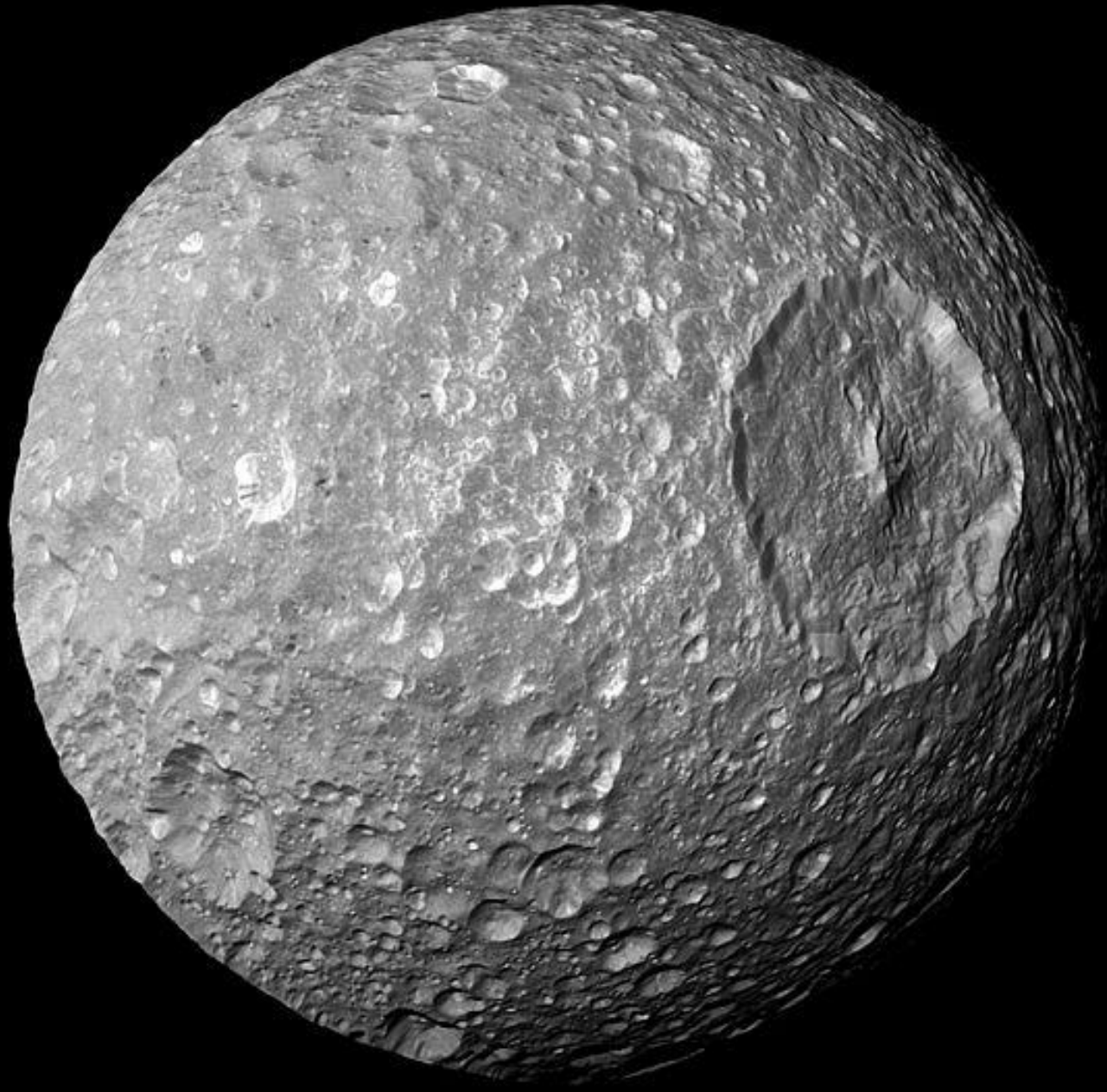
Pan-!



Iapetus

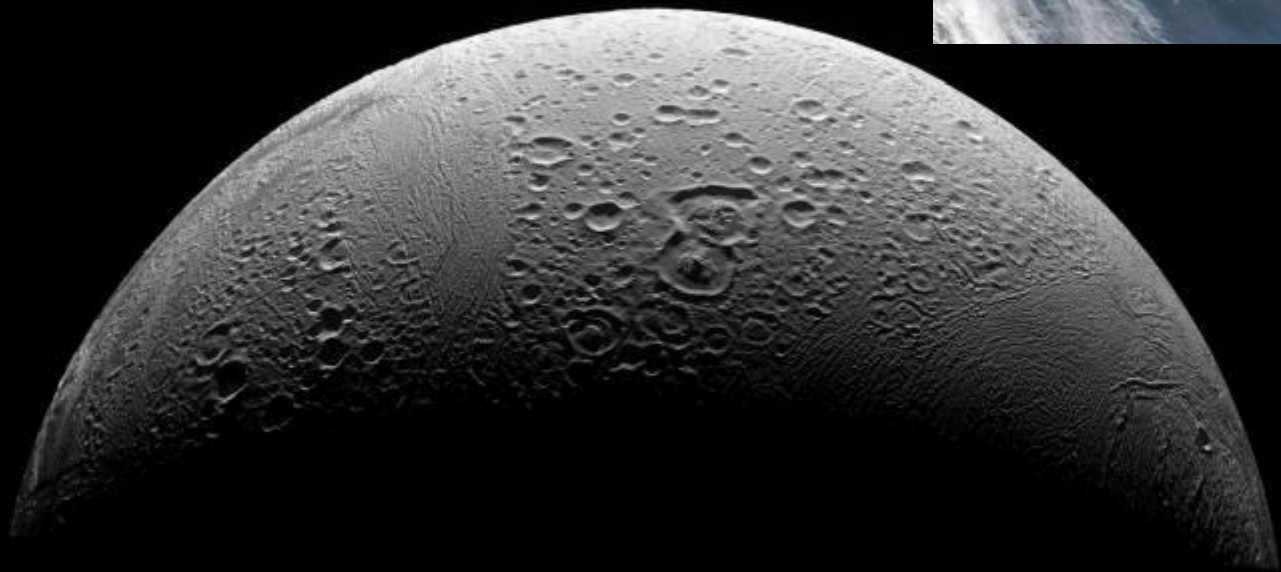


MIMAS

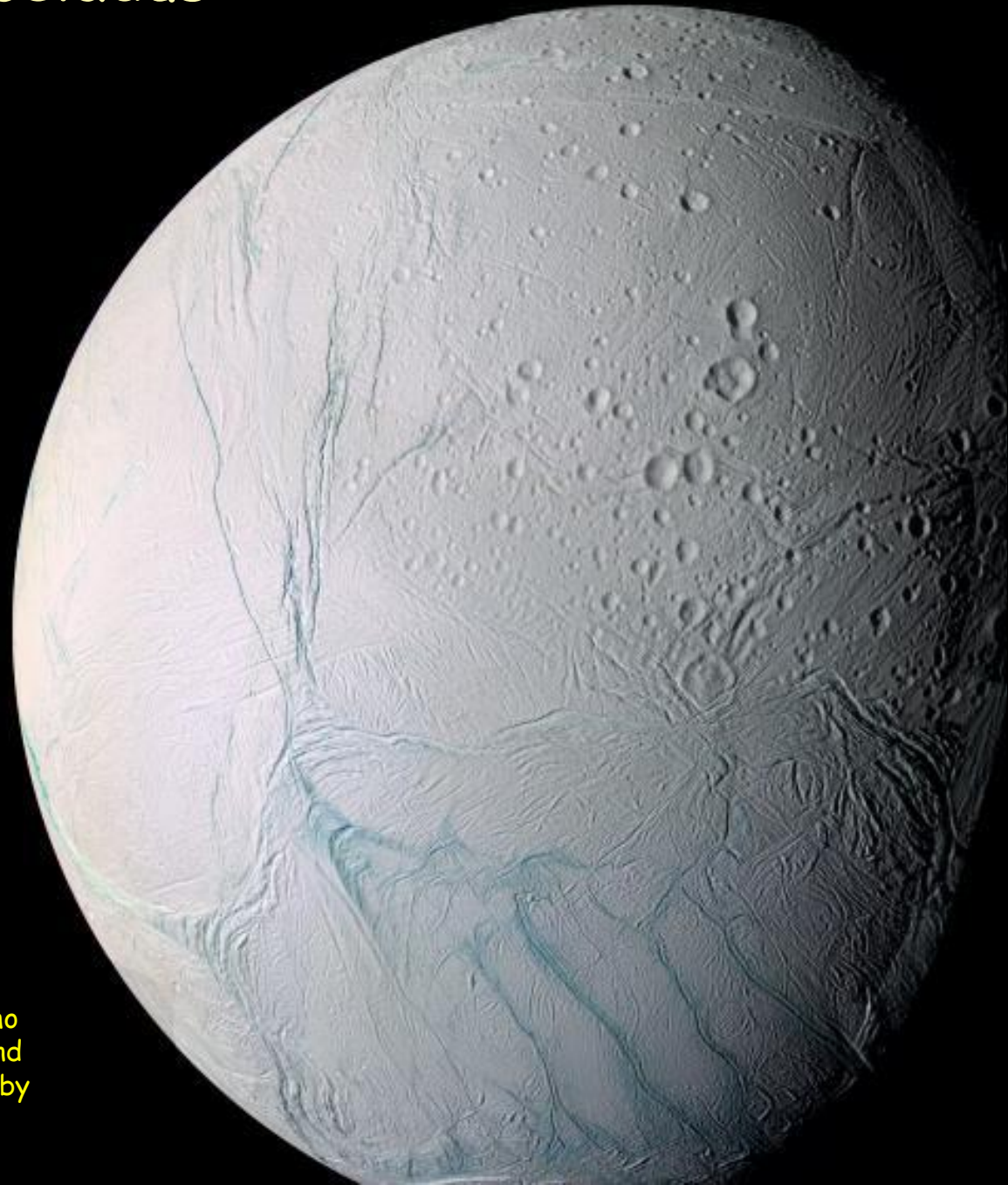




Tiny Enceladus

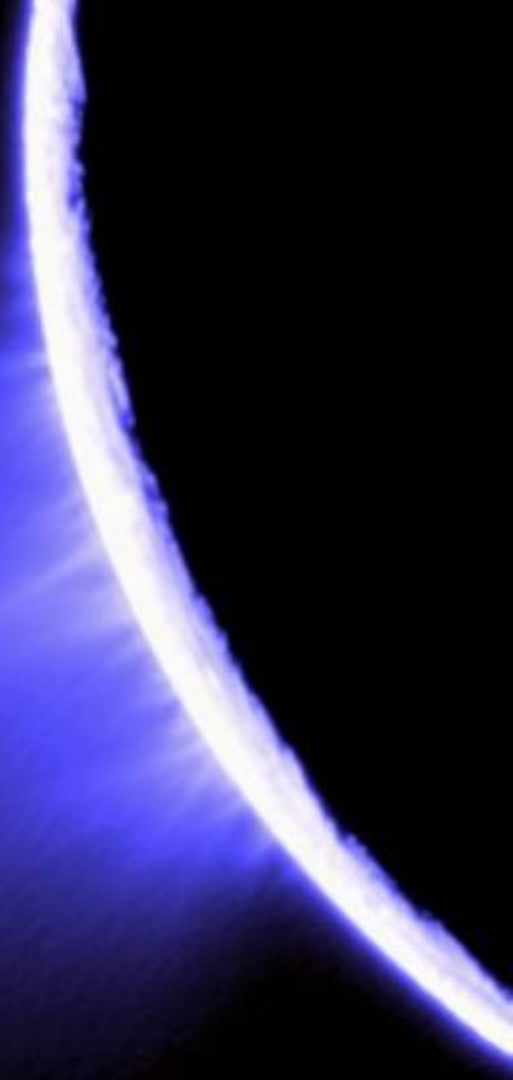


Bright Enceladus

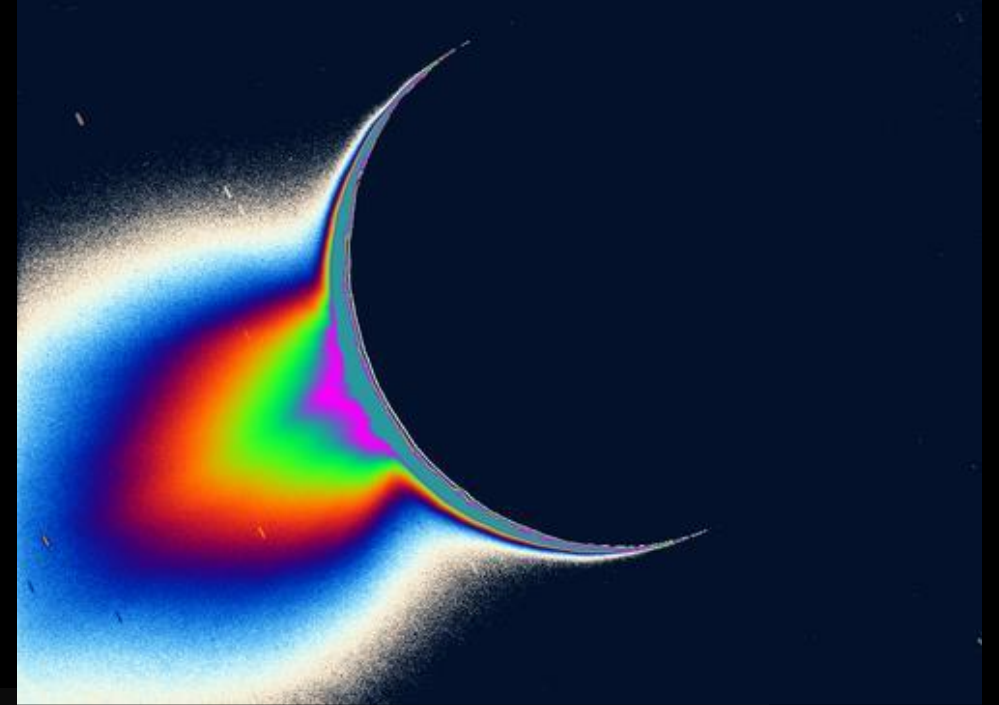


In Greek mythology
Enceladus was a Titan who
was defeated in battle and
buried under Mount Etna by
Athena.

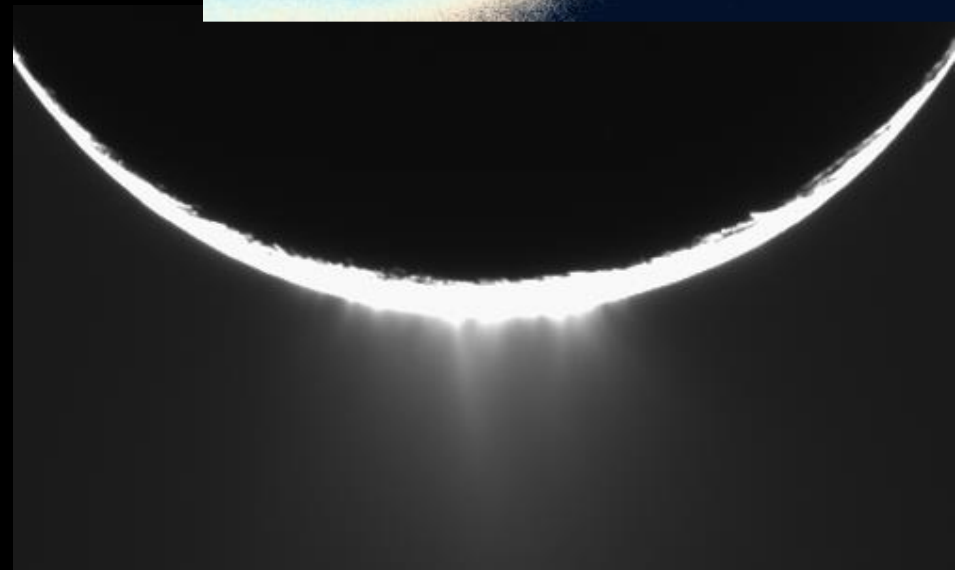
Enceladus



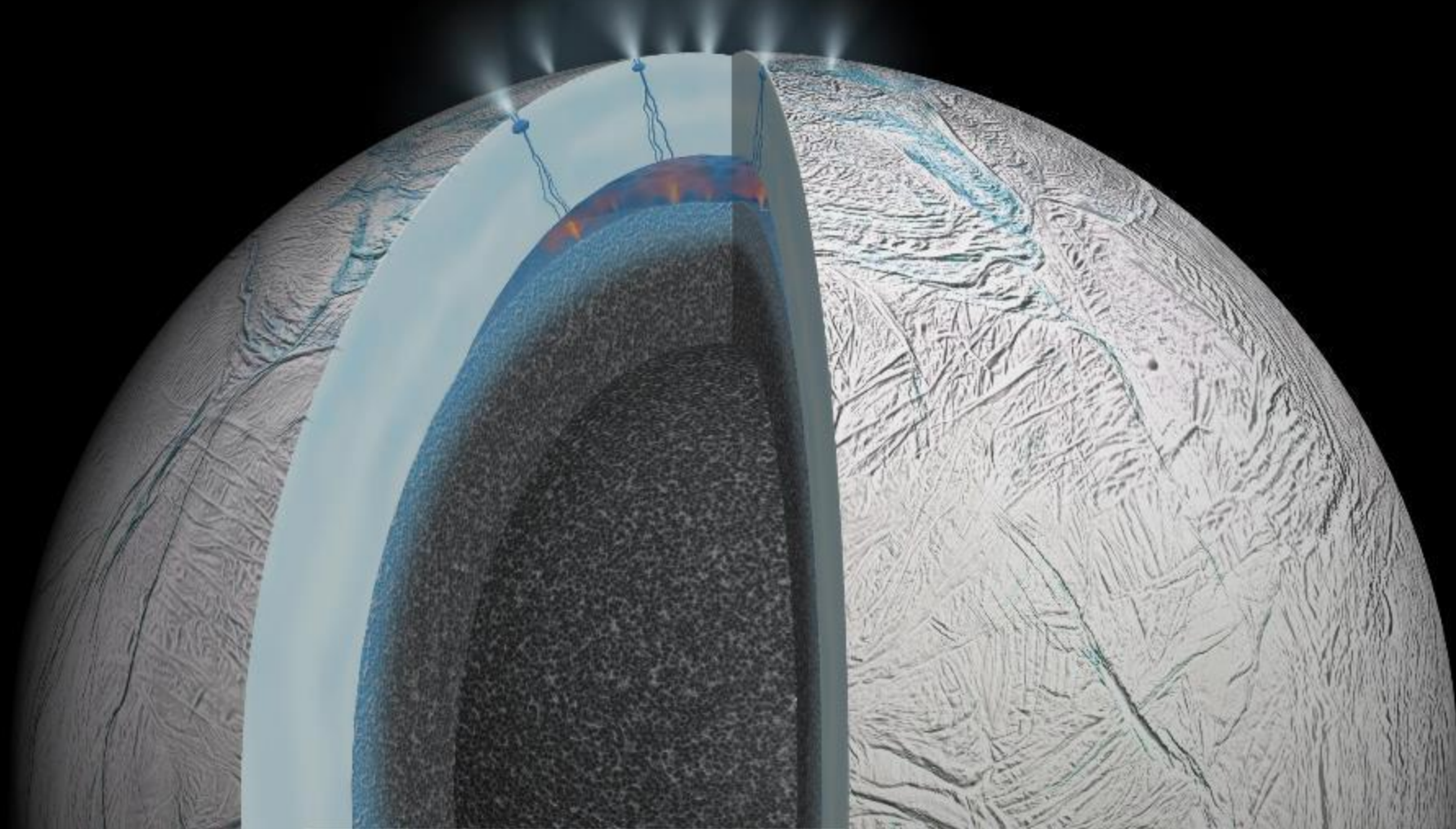
Enceladus



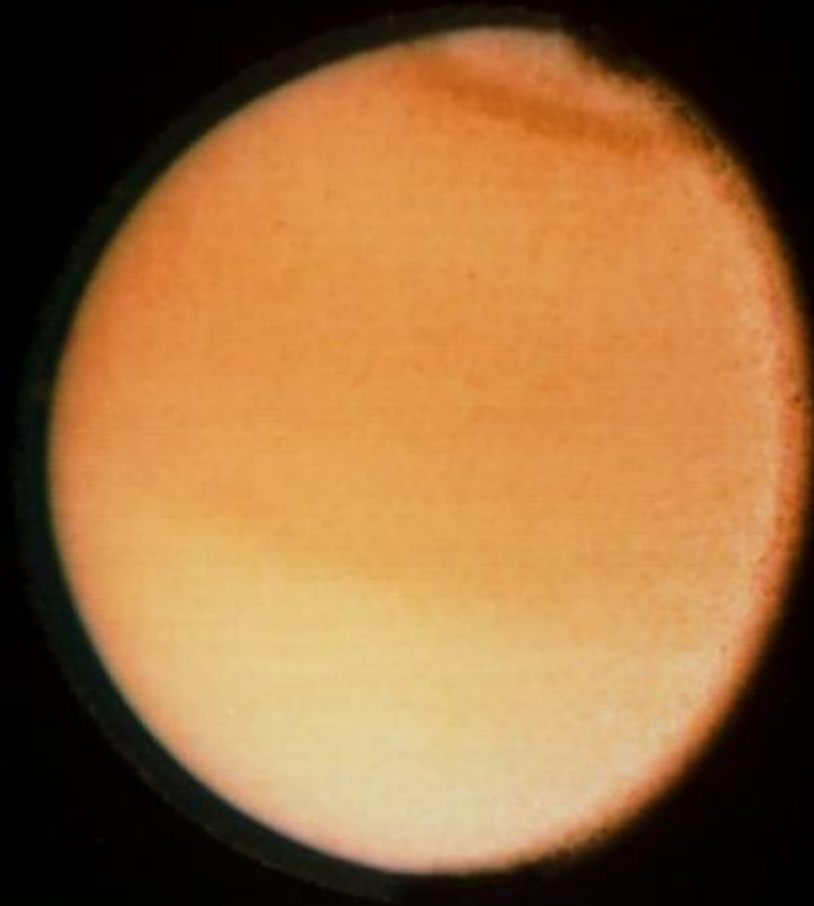
- Water is gushing out of south polar fractures!
- Tiny body should have a cold interior

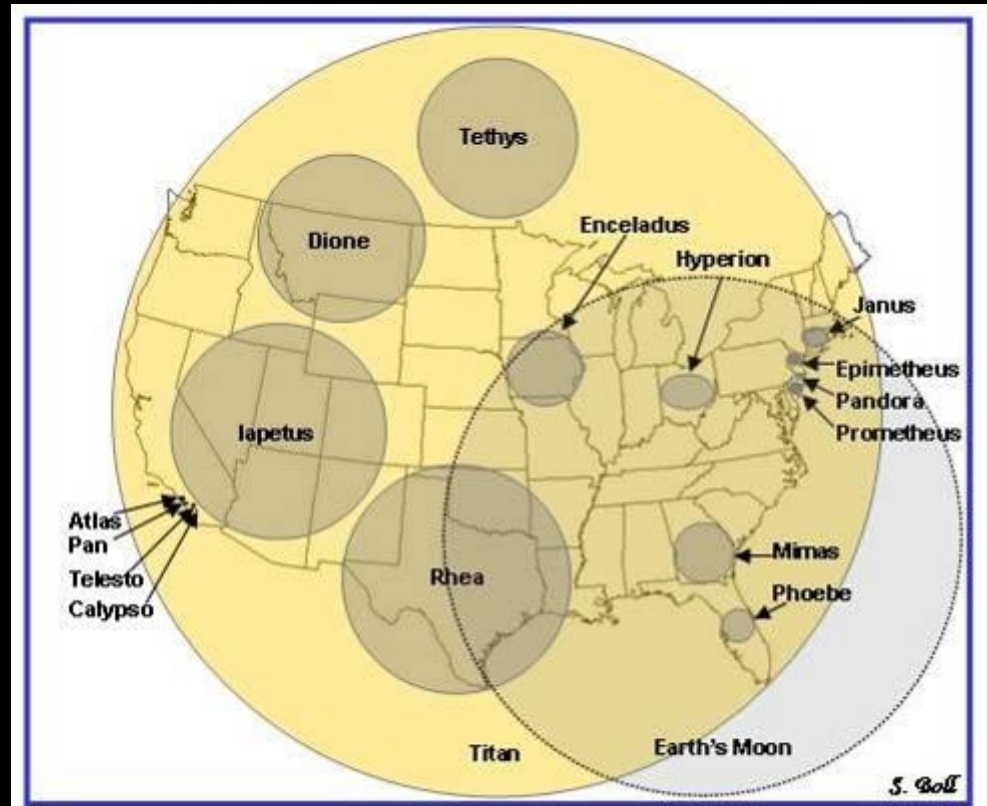


Water in contact with rocky core



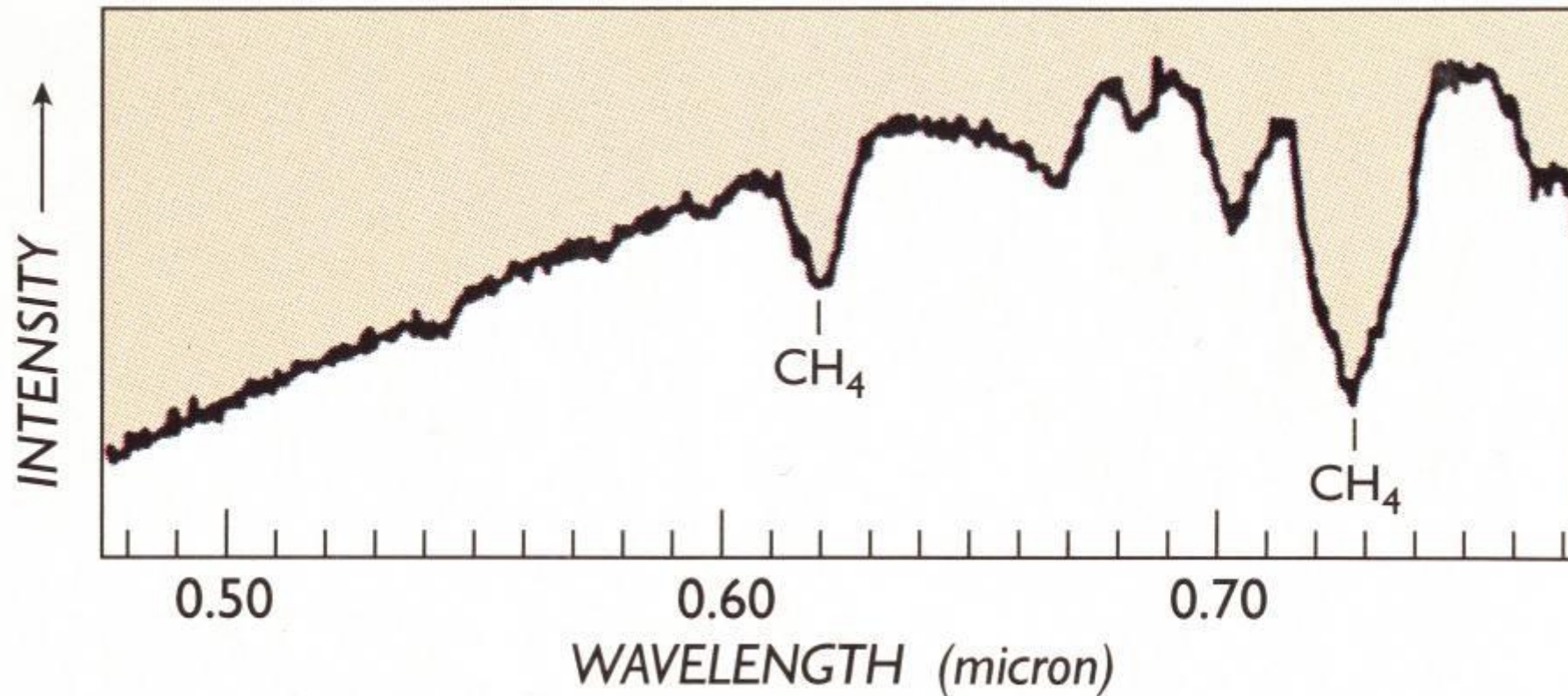
TITAN - most like Earth?



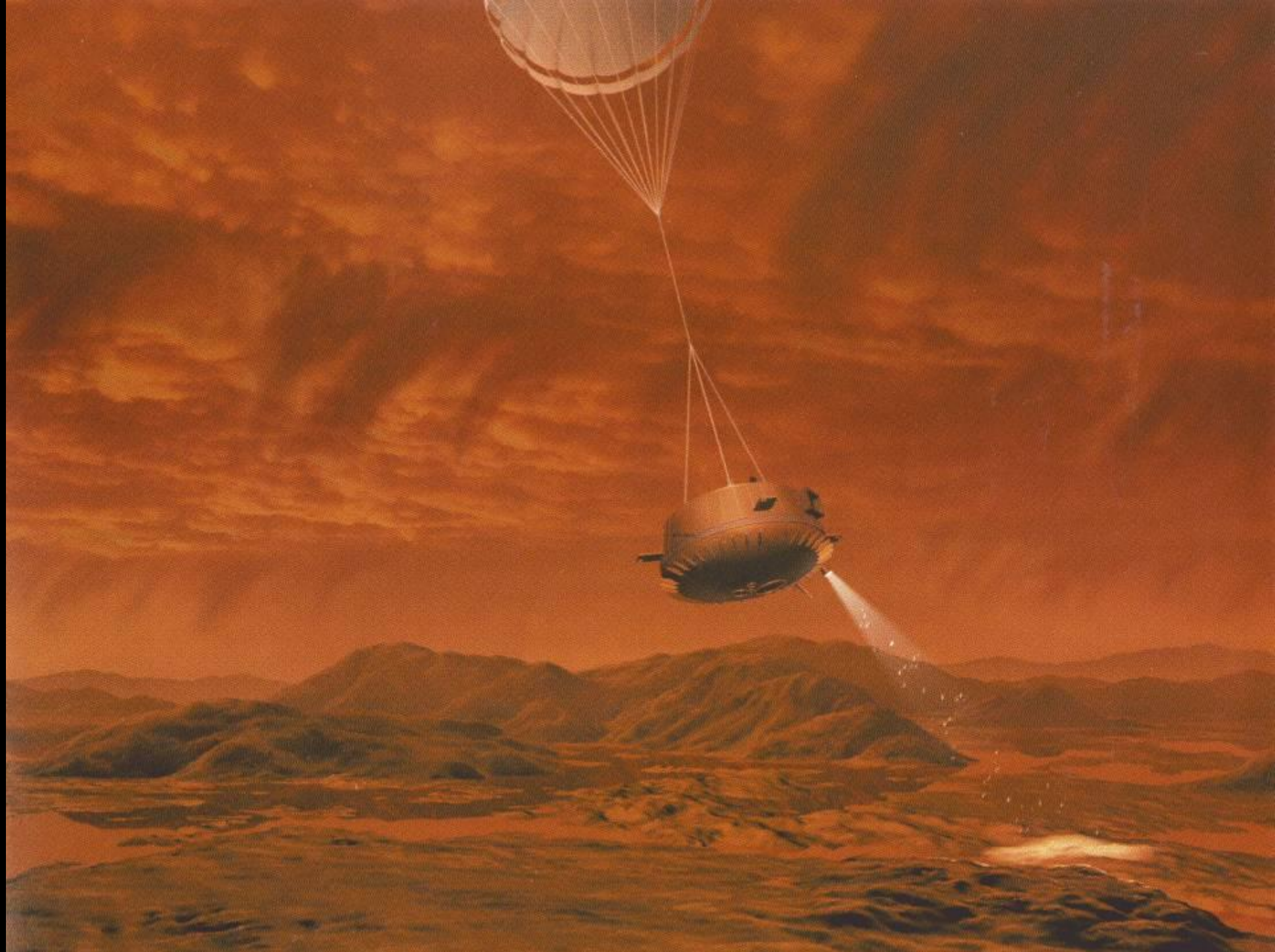


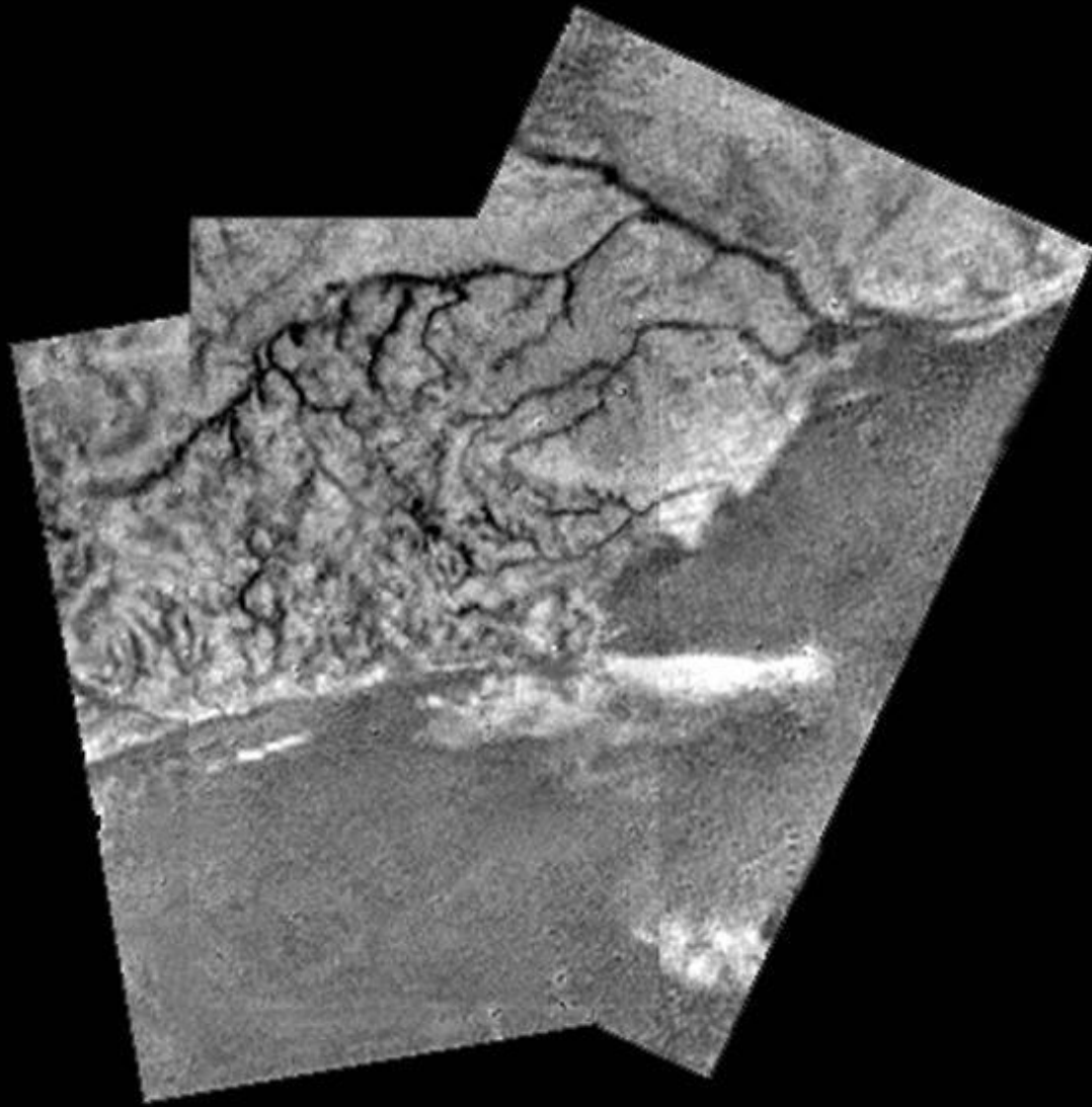
What did we know?

- Nitrogen-rich atmosphere!
- Also lots of methane







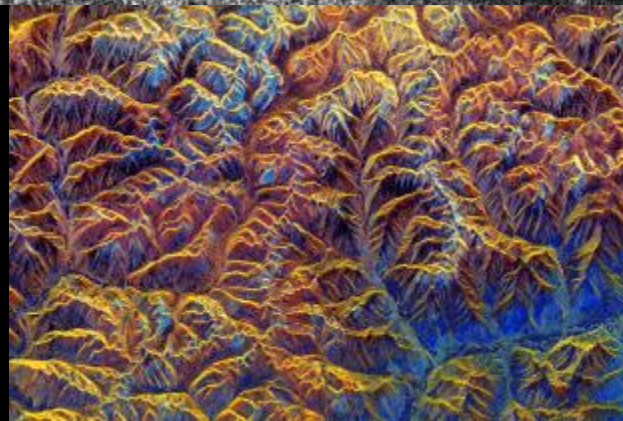
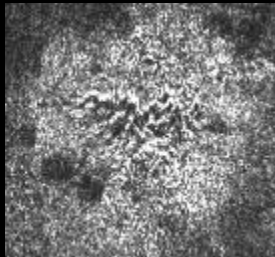
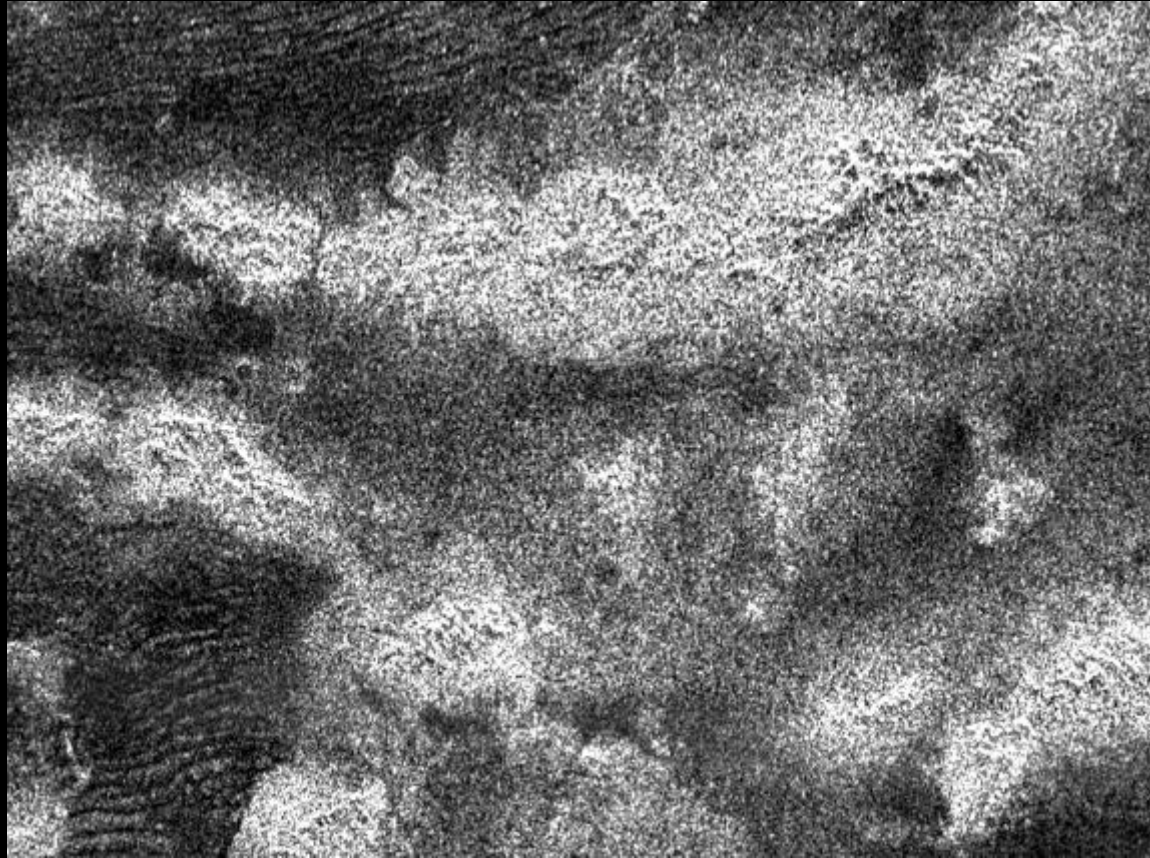


- Erosion
- Rounded cobbles in river bed!



Mountains

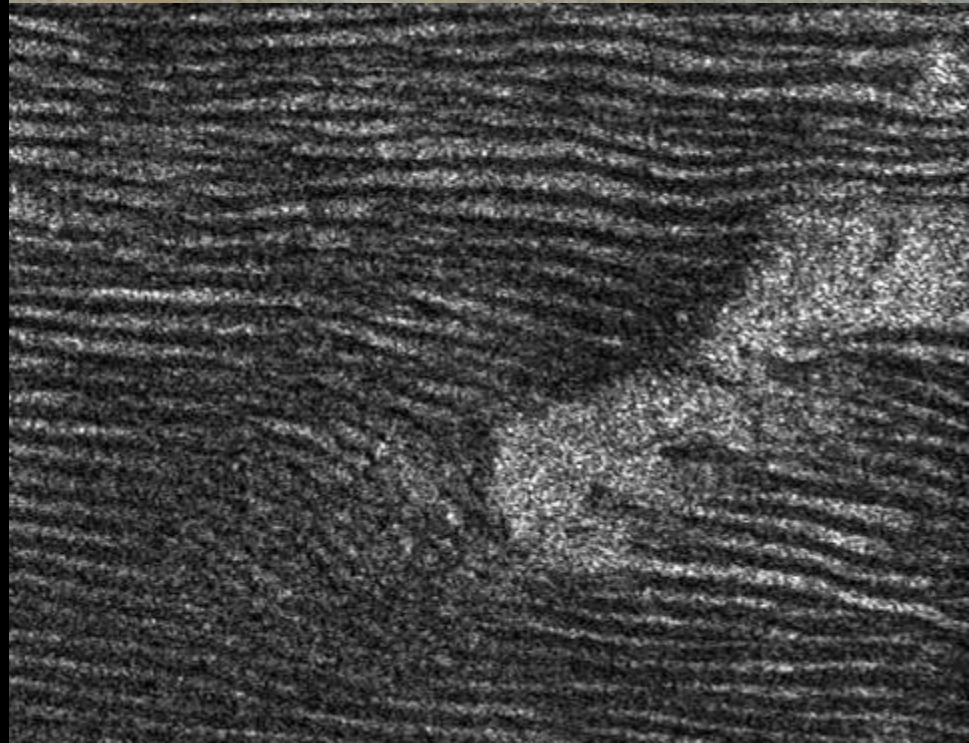
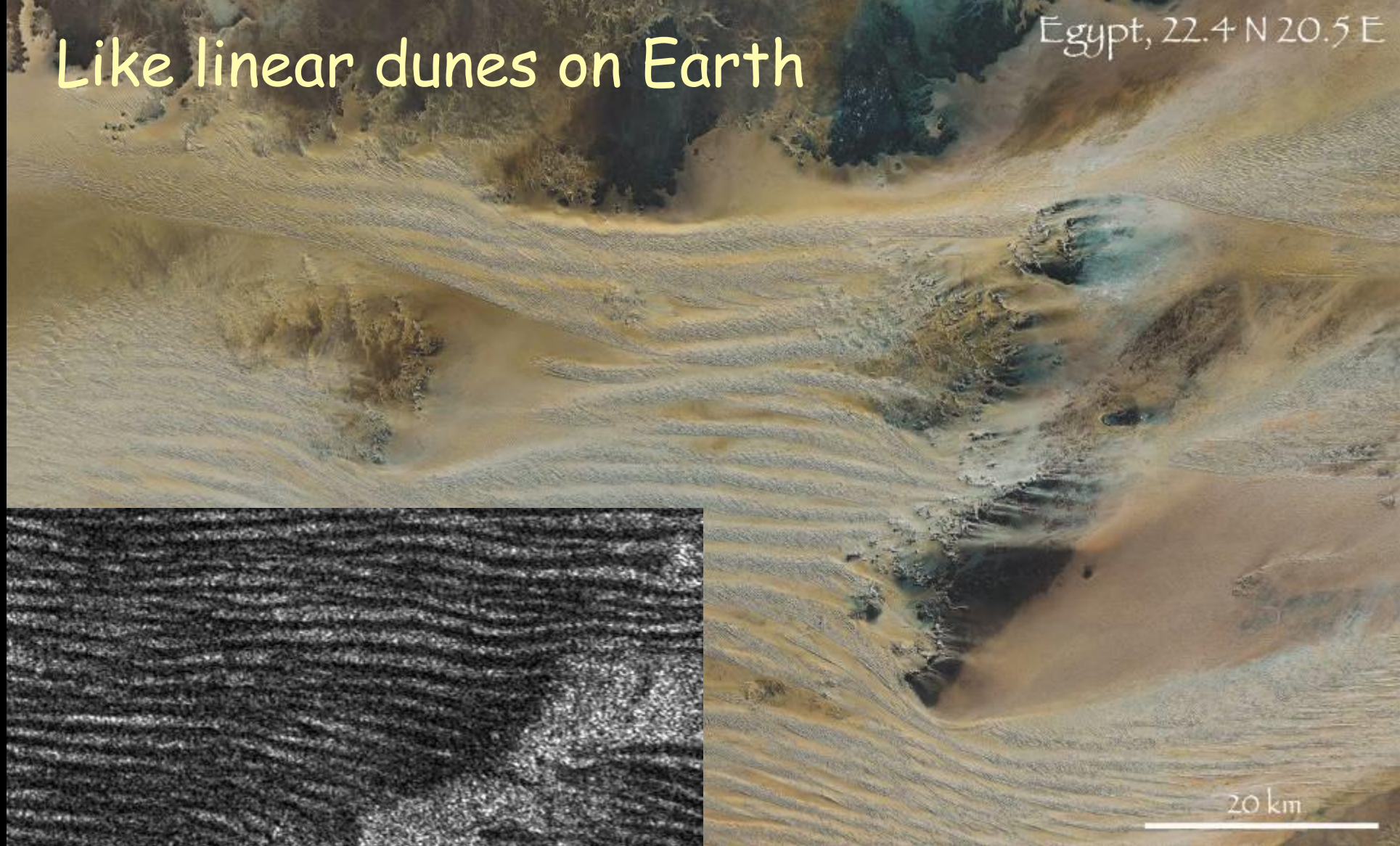
- In long belts and isolated blocks
- Heavily eroded



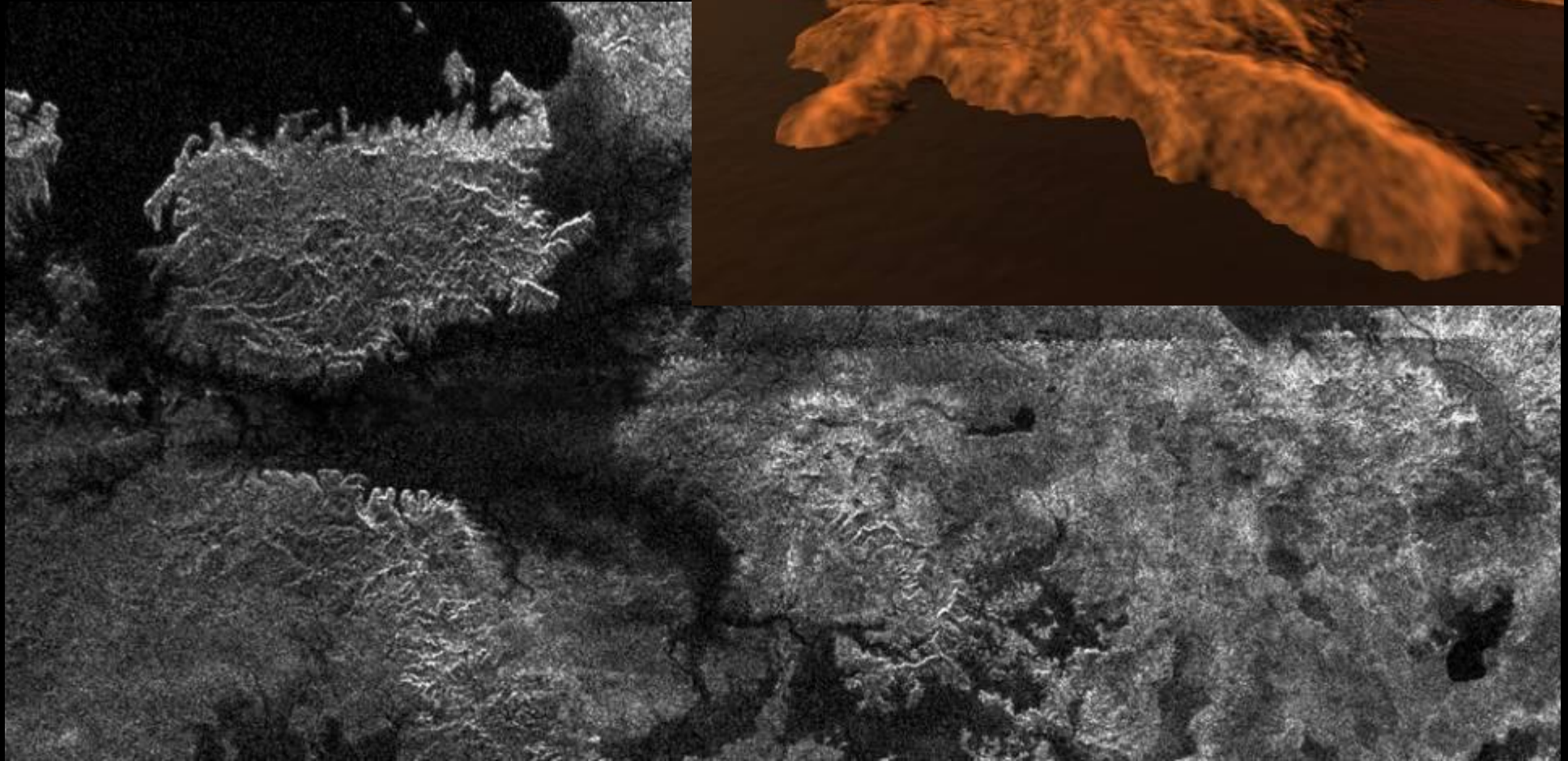
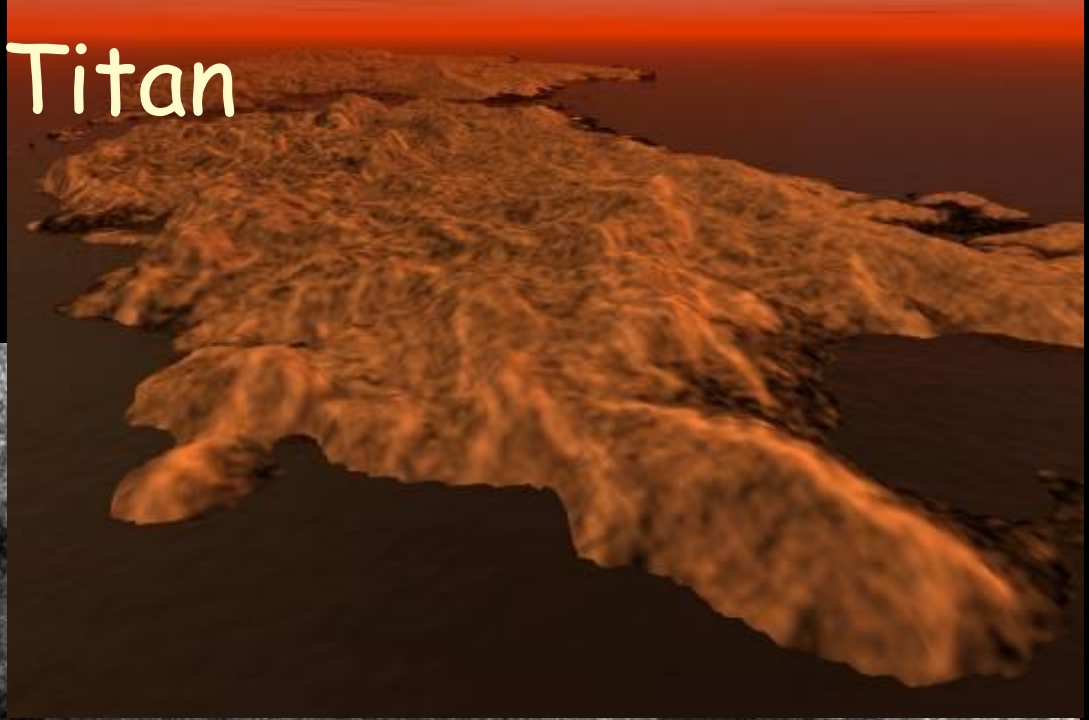
SIR-C/X-SAR of Tibetan plateau.

Like linear dunes on Earth

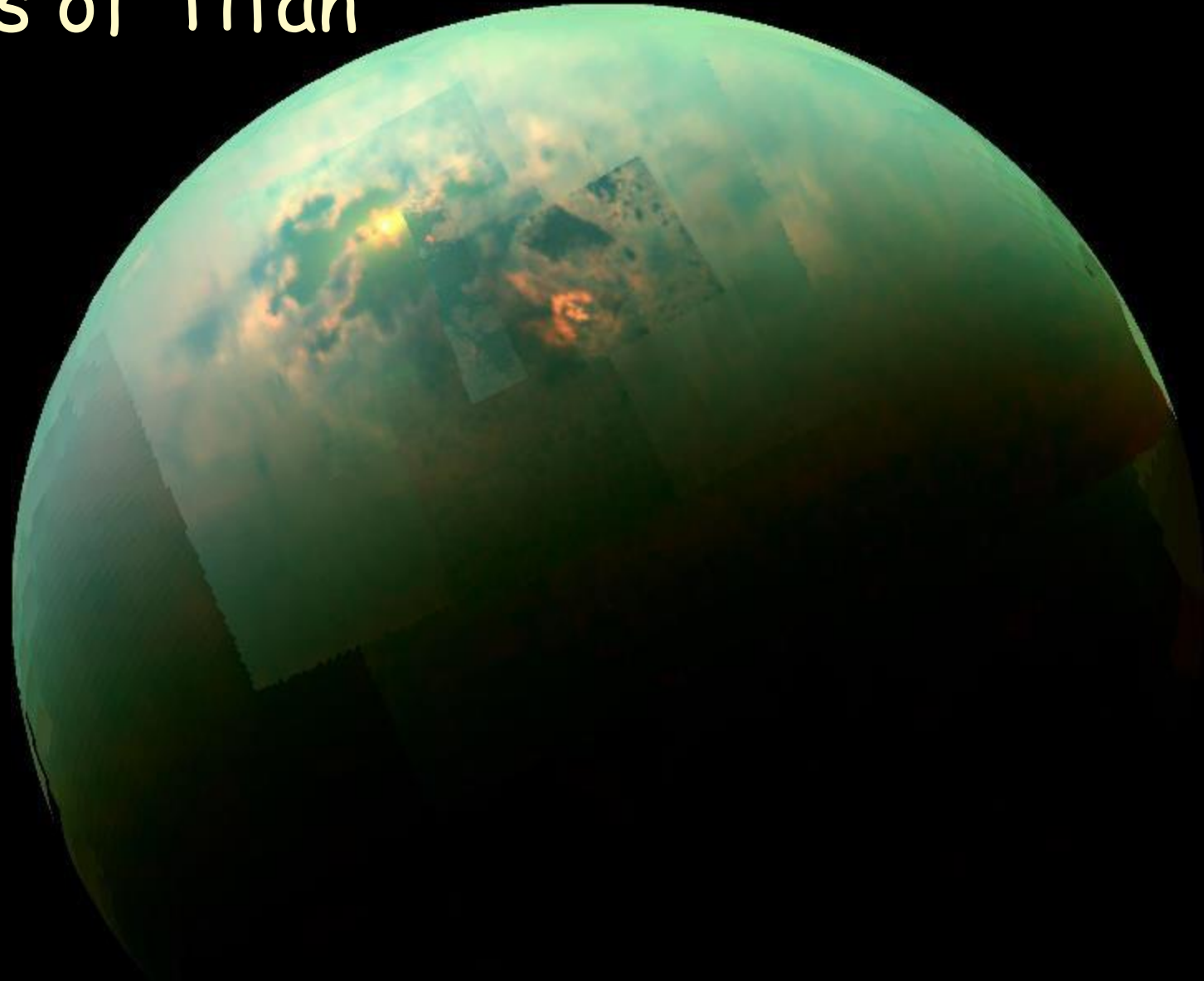
Egypt, 22.4 N 20.5 E



Methane Seas of Titan



Seas of Titan



- Glint off sea surface