El Sistema Solar

Curso de Actualización en Geociencias
Centro Agustín Ferreiro
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Departamento de Astronomía

Instituto de Física

Facultad de Ciencias

FACULTAD DE CIENCIAS
UDELAR | fcien.edu.uy

- www.astronomia.edu.uy/sistemasolar
- photojournal.jpl.nasa.gov
- www.hubblesite.org

Nuestra galaxia

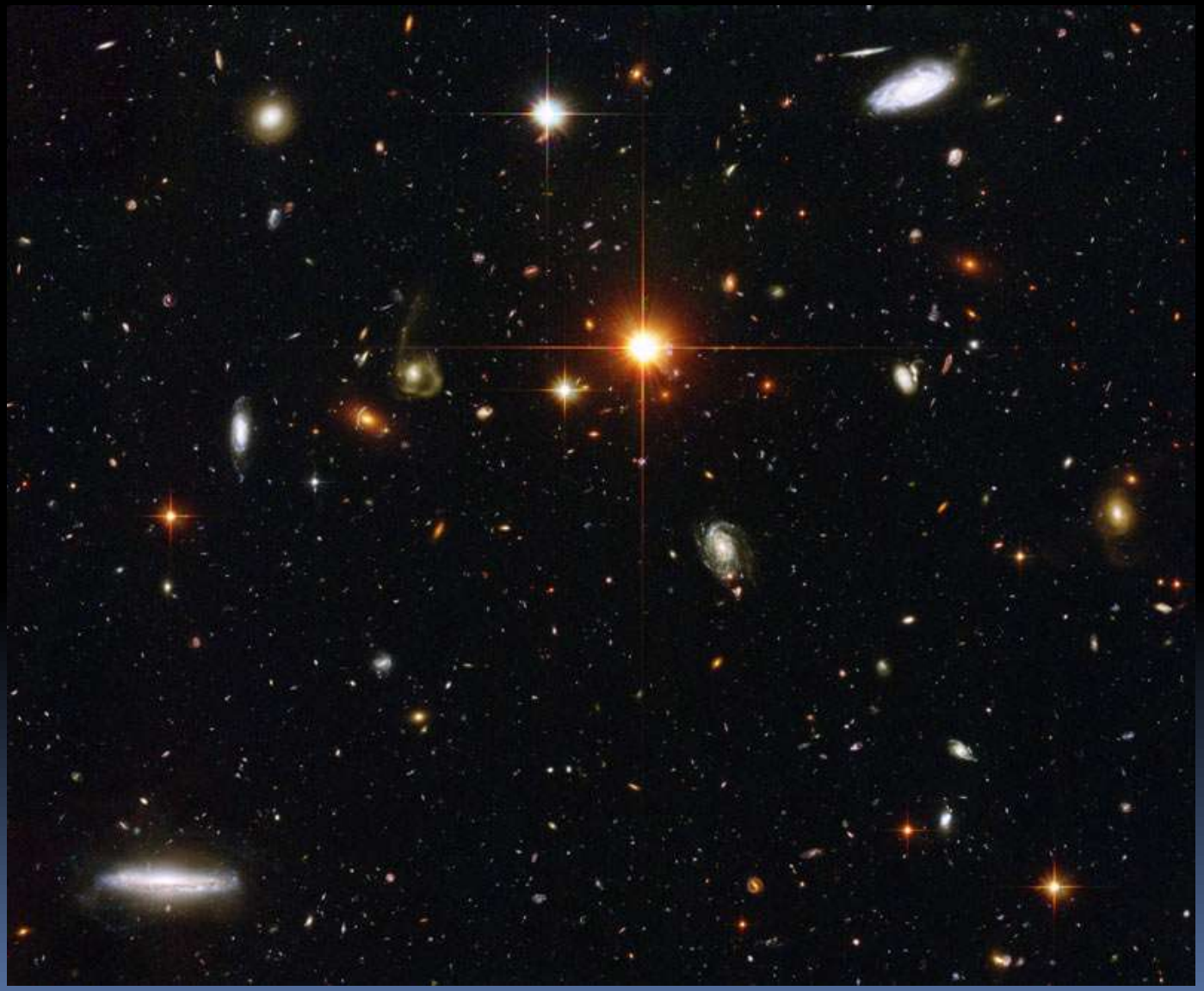
300.000 millones de estrellas

La Vía Láctea

Galaxia

Galaxias

2 billones de galaxias



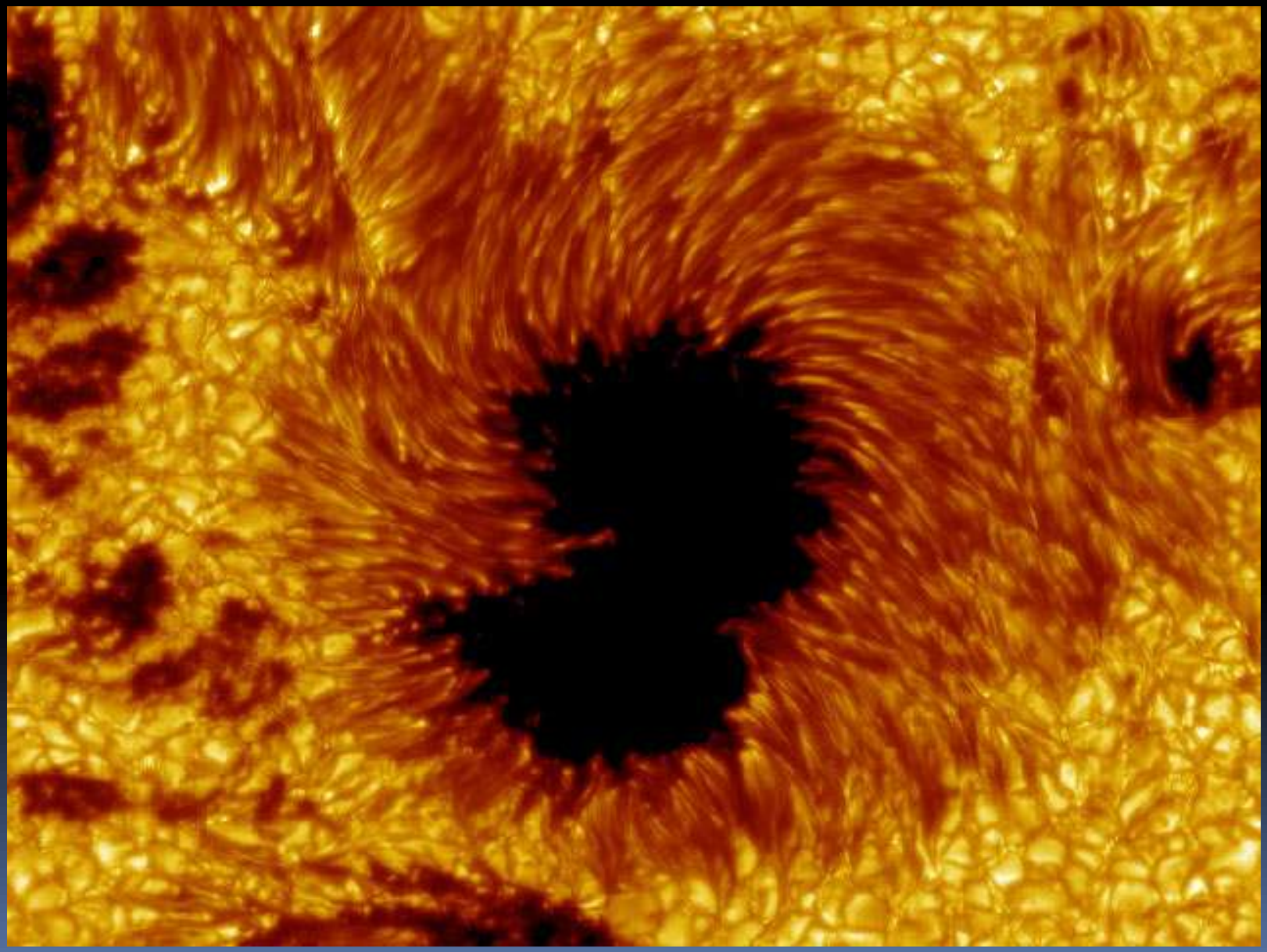
Temperatura sup = 5800 C
Temperatura int = 14.000.000
Presión = 250.000 millones de atm.

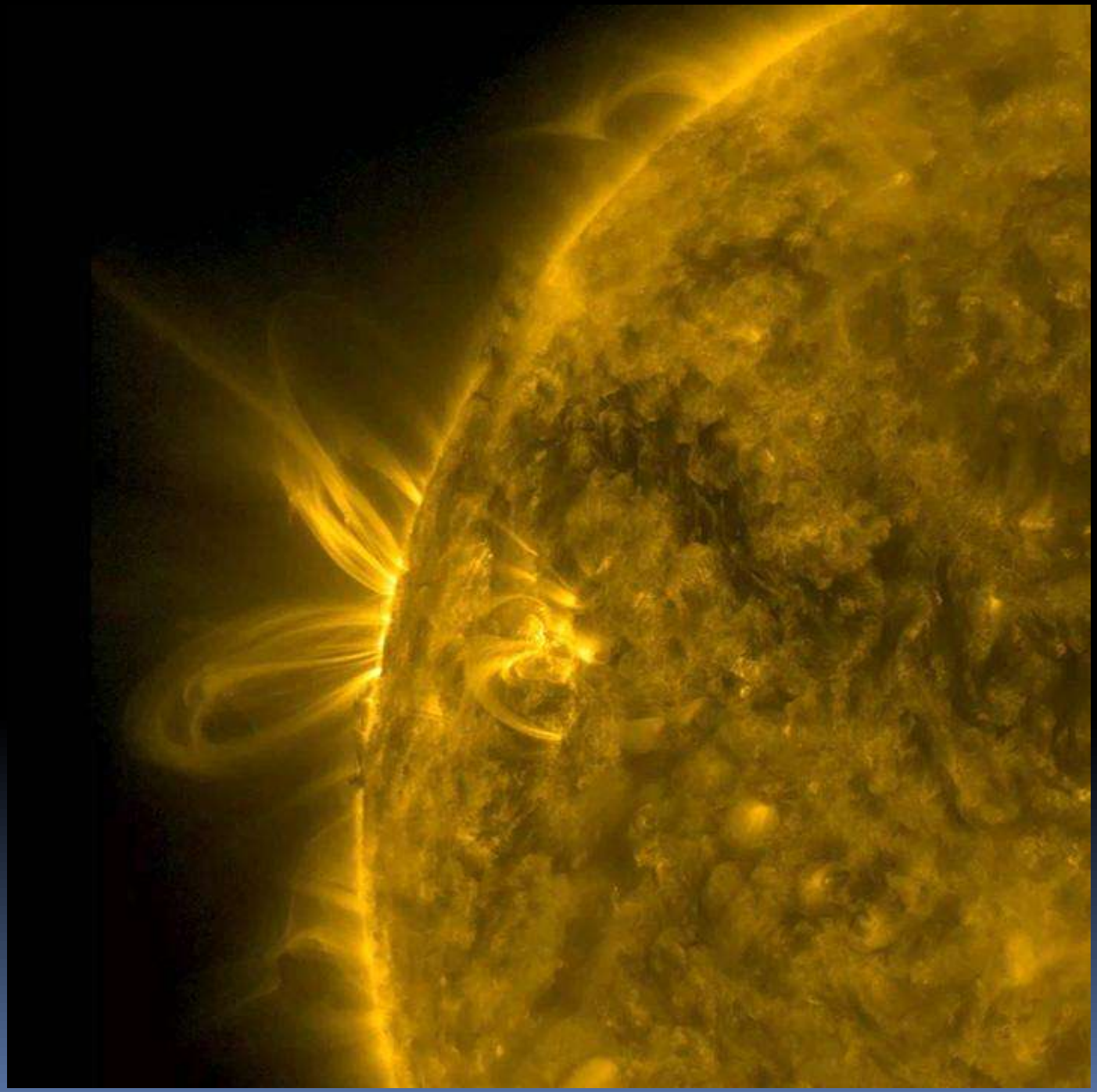
Equilibrio PESO – PRESION

Sol

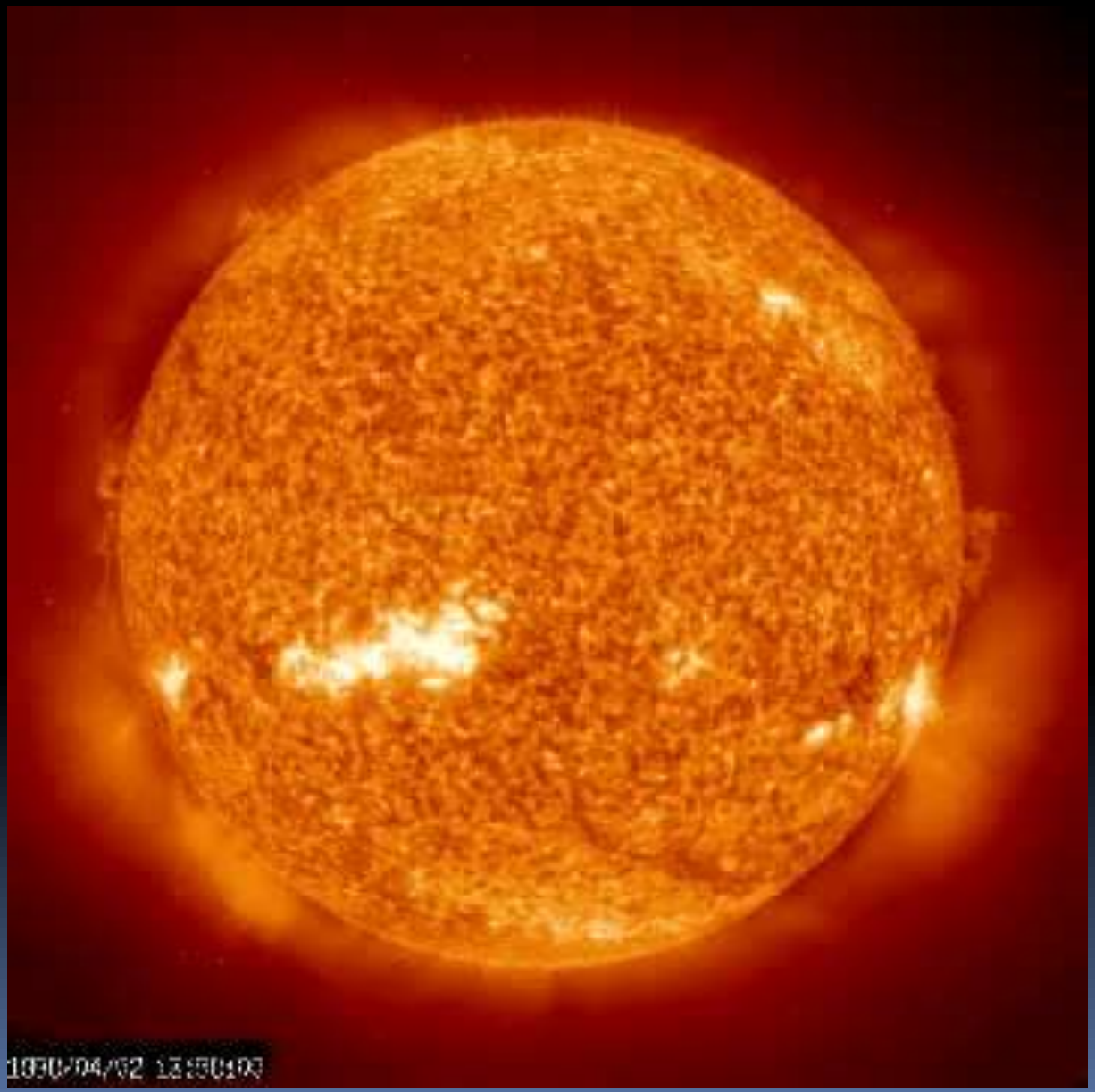
Masa = 1000 Jupiter
75% Hidrógeno

MANCHAS SOLARES: Campos magnéticos intensos



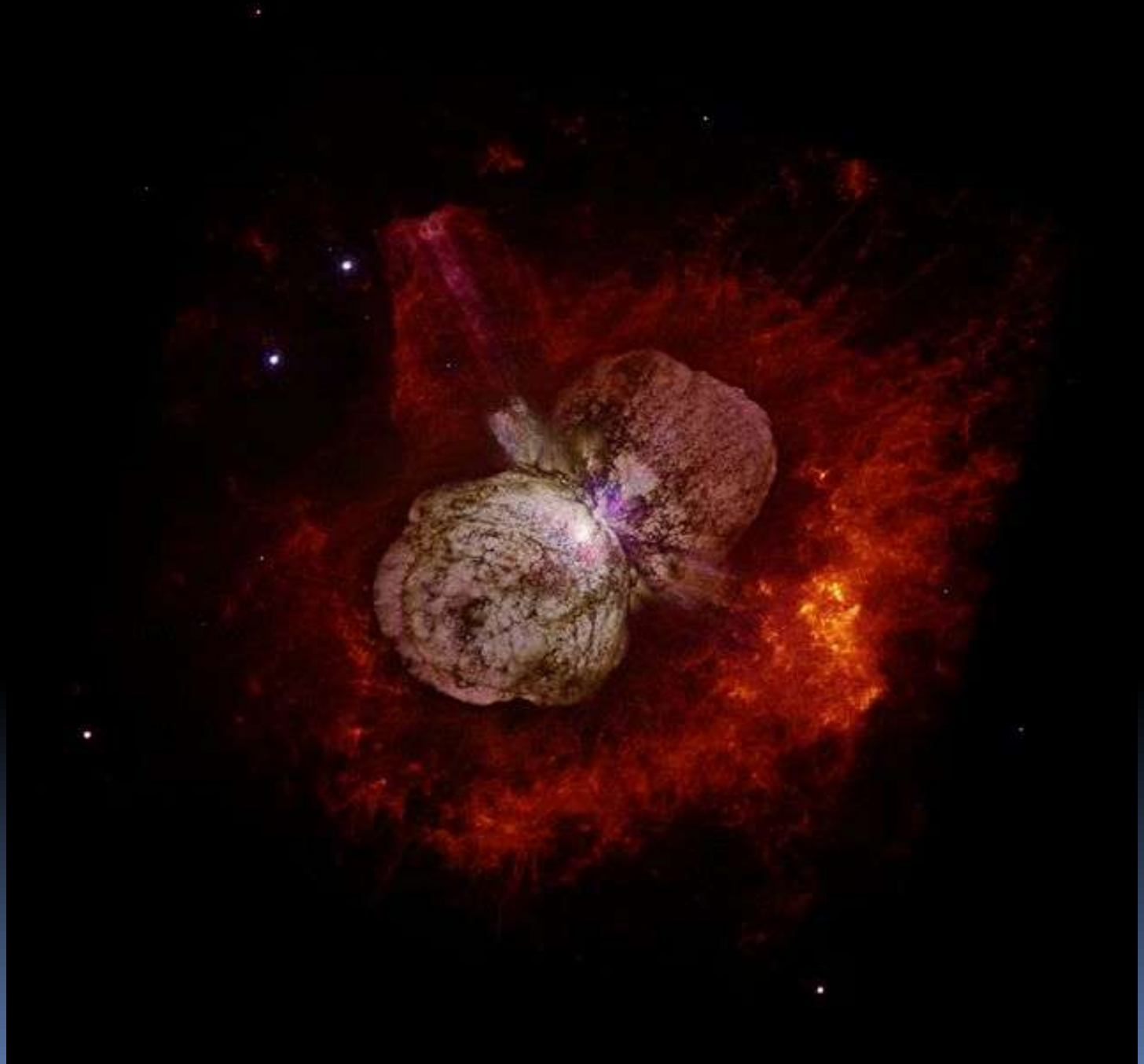


Sol: reactor de fusión nuclear



Muerte estelar

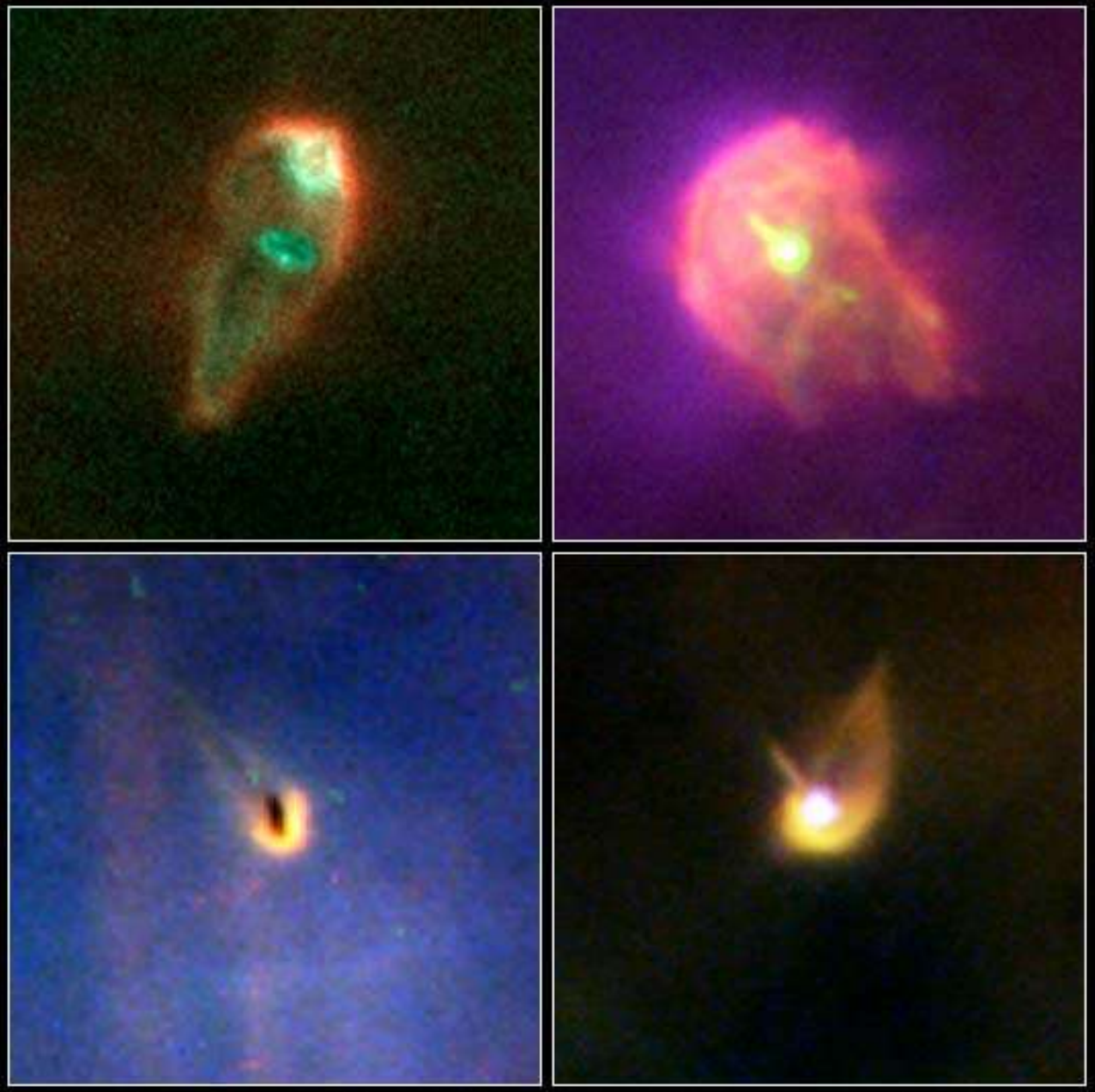

www.hubblesite.org



Medio interestelar enriquecido con “polvo” de estrellas.

Principales elementos en el polvo: CHON

Formación estelar

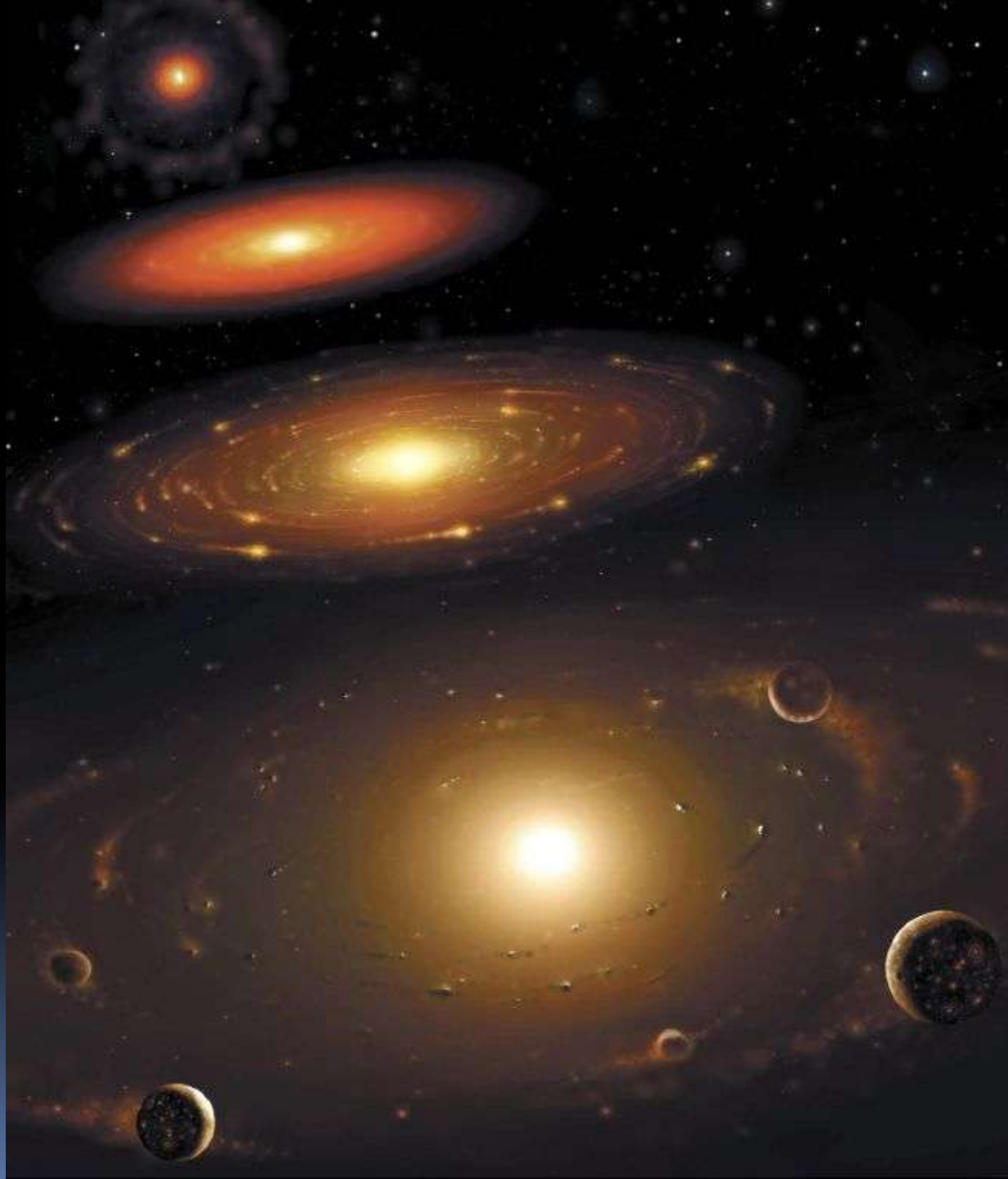


Protoplanetary Disks in the Orion Nebula **HST** • WFPC2

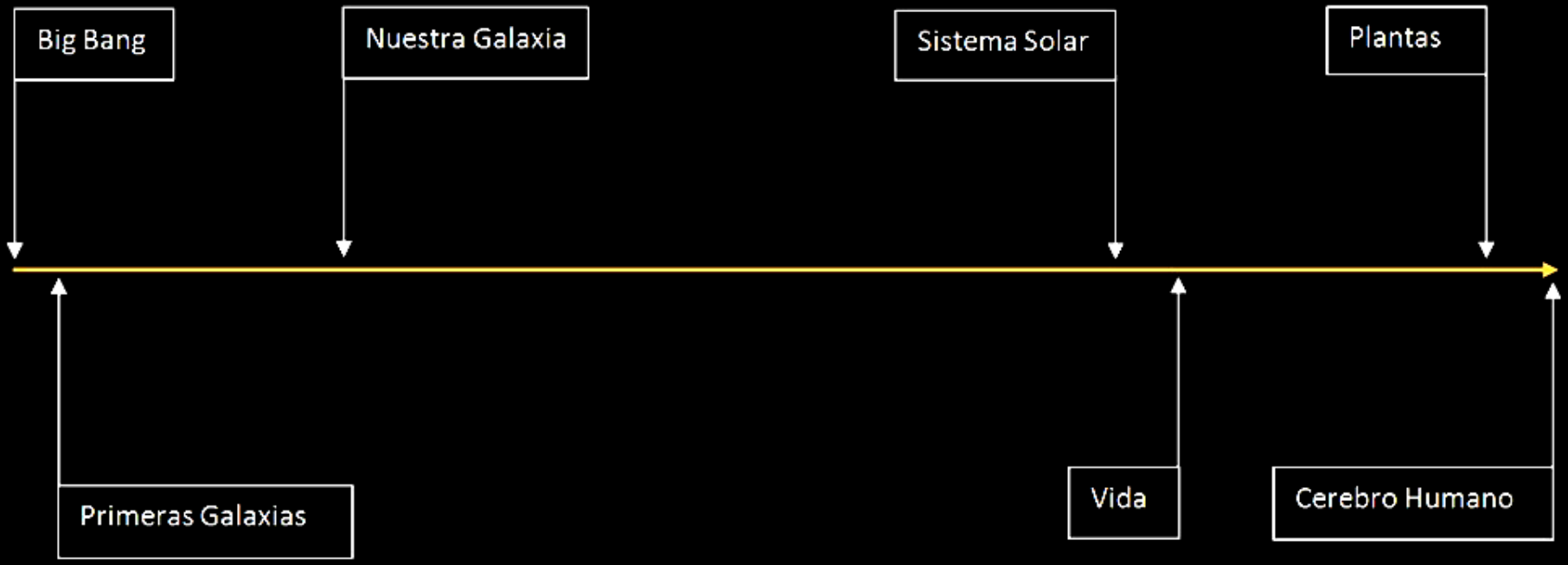
NASA, J. Bally (University of Colorado), H. Throop (SWRI),
and C.R. O'Dell (Vanderbilt University) • STScI-PRC01-13

Disco protoplanetario a 450 AL de la Tierra

Formación del Sistema Solar

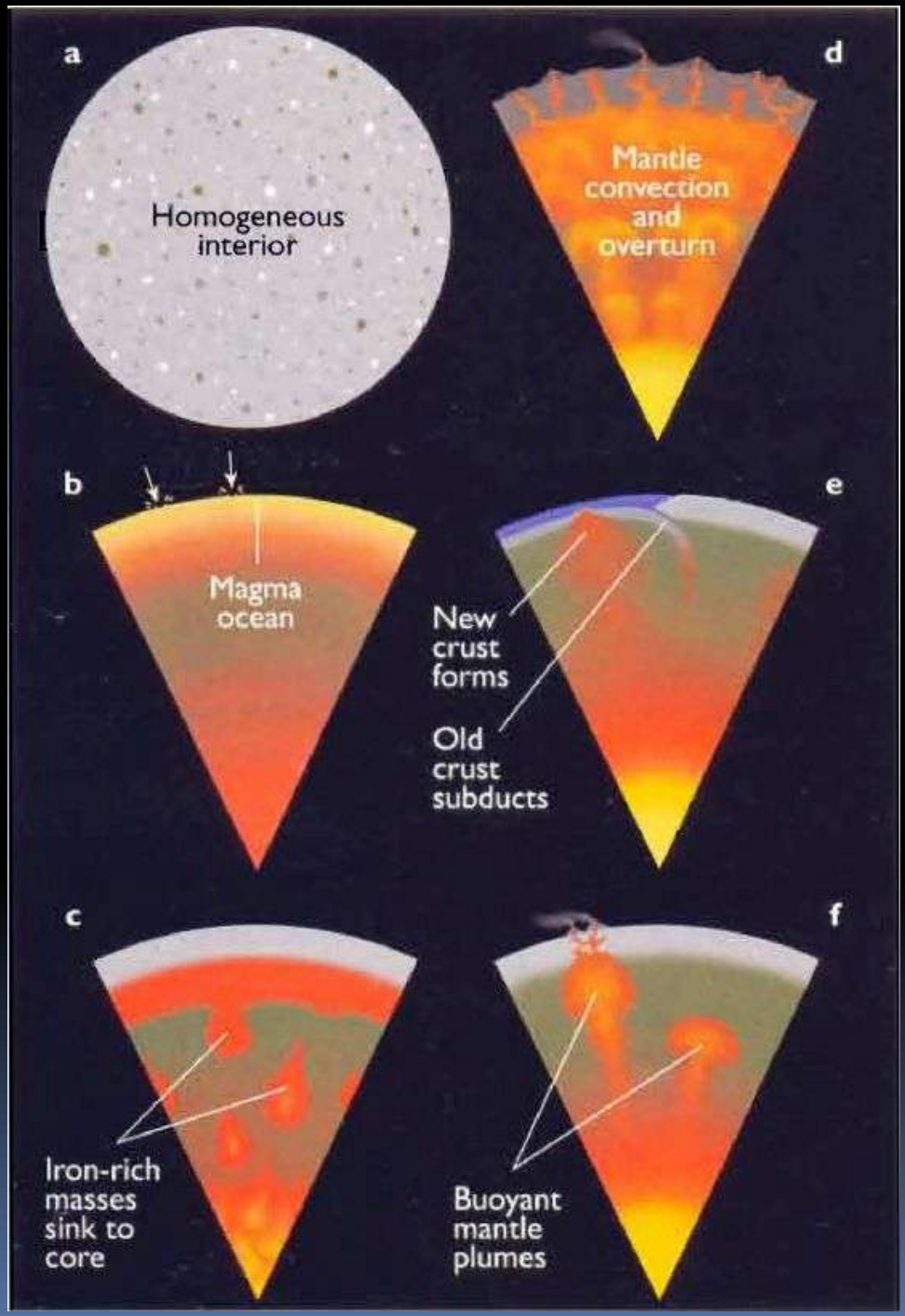


Cronología



Big Bang: hace 13.700 millones de años

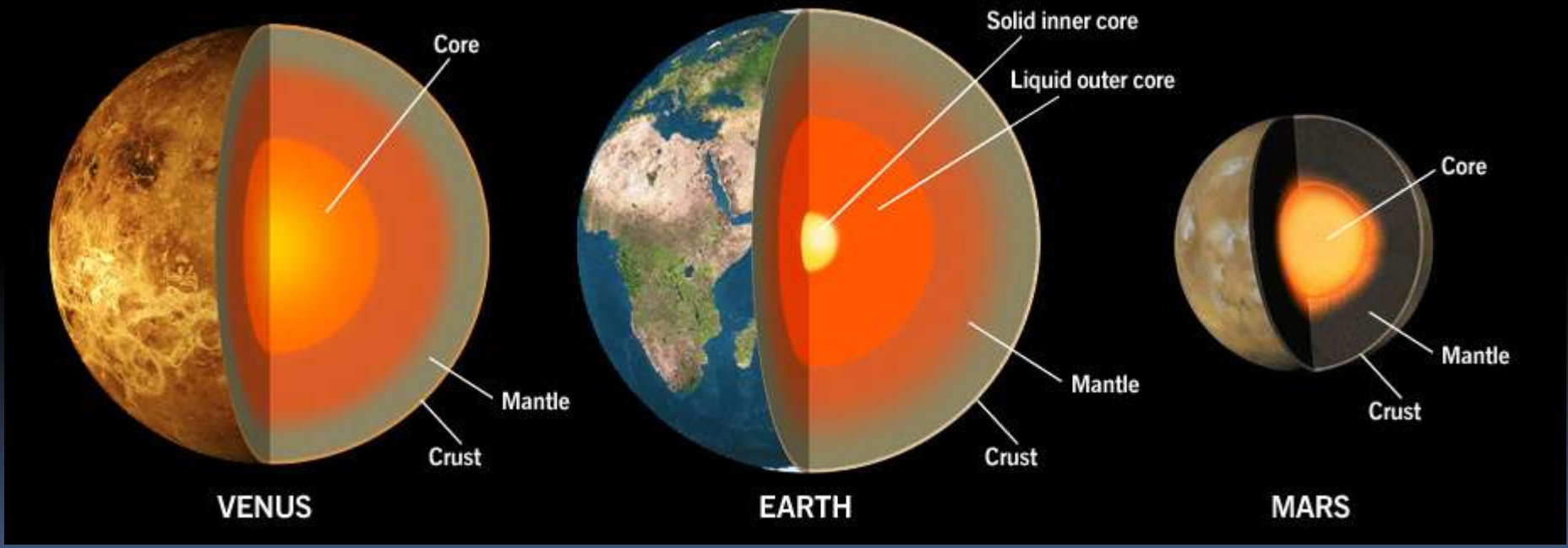
Evolución planetaria



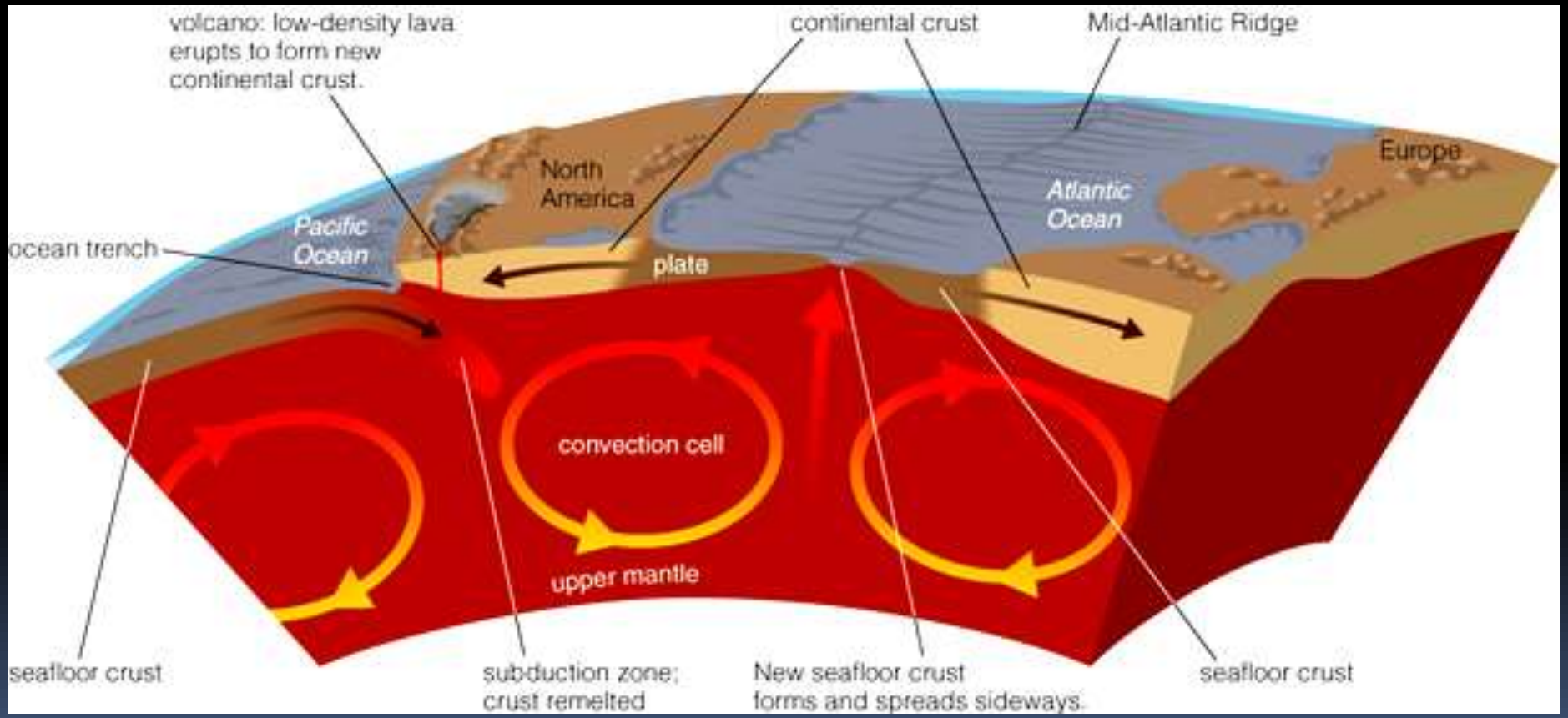
Meteorito: material primitivo

Meteorito de San Carlos

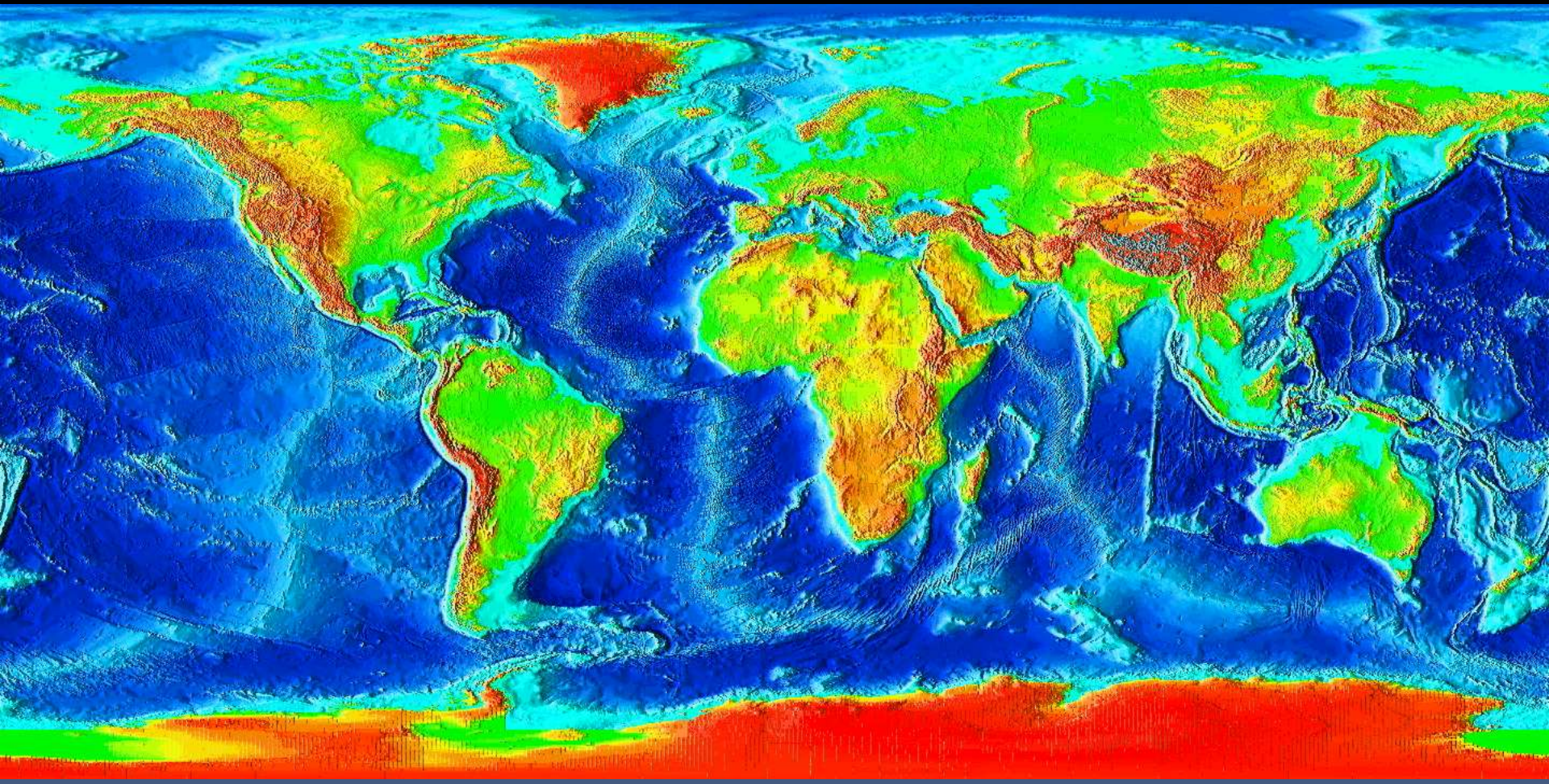
Evolución planetaria:
administración del calor interno



Tierra:
renovación superficie y atmósfera

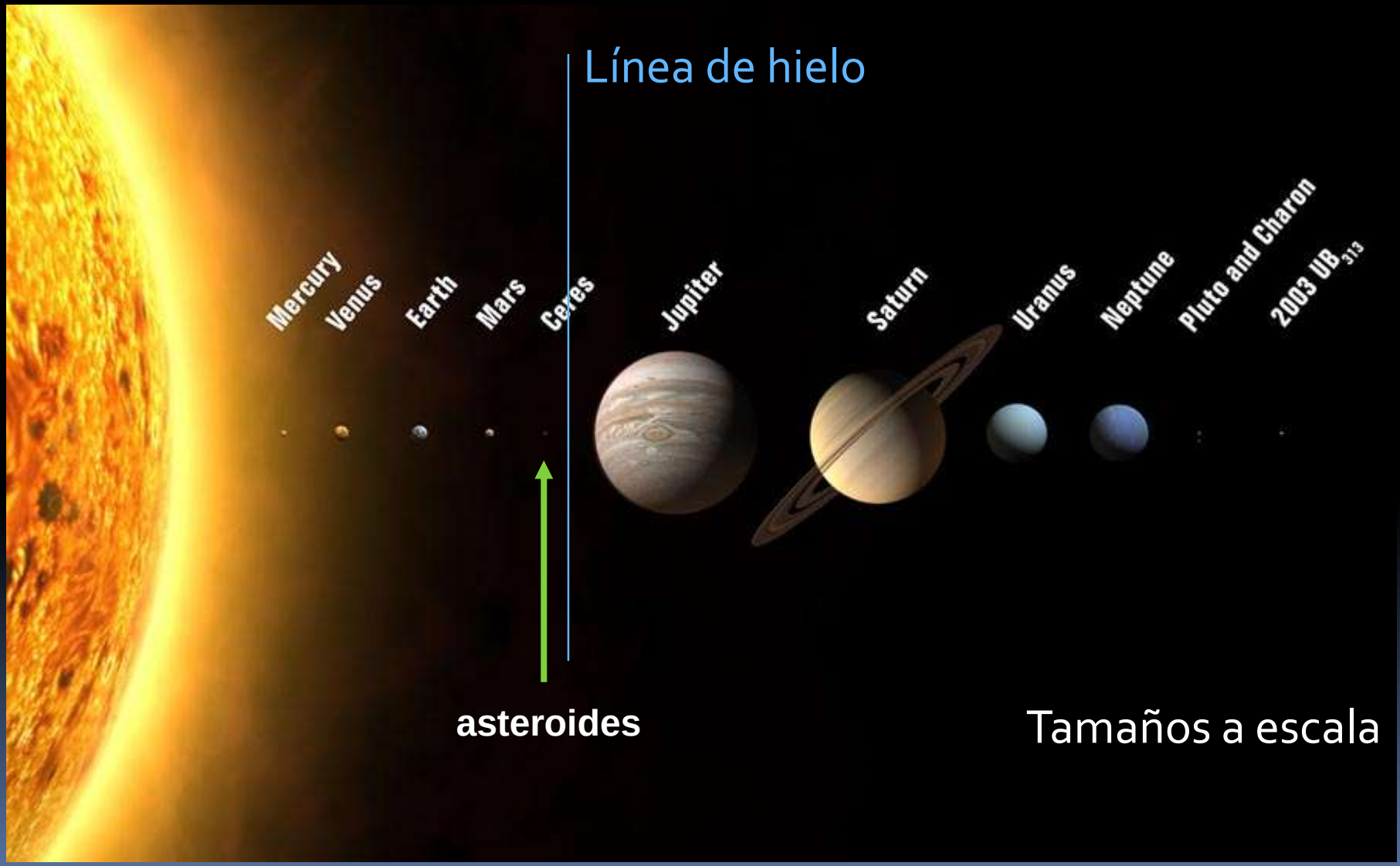


Tectónica



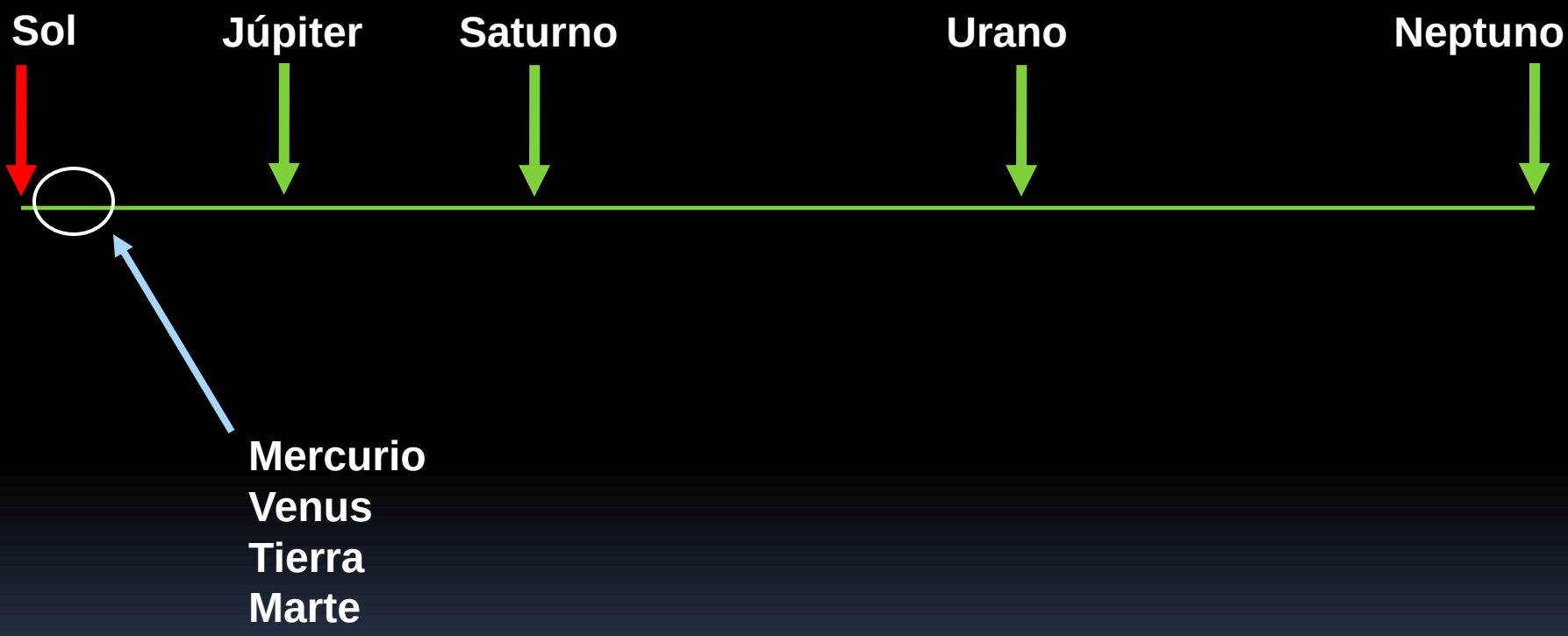
Sistema Solar

Mundos rocosos, gaseosos y helados



Sistema Solar

Distancias a escala



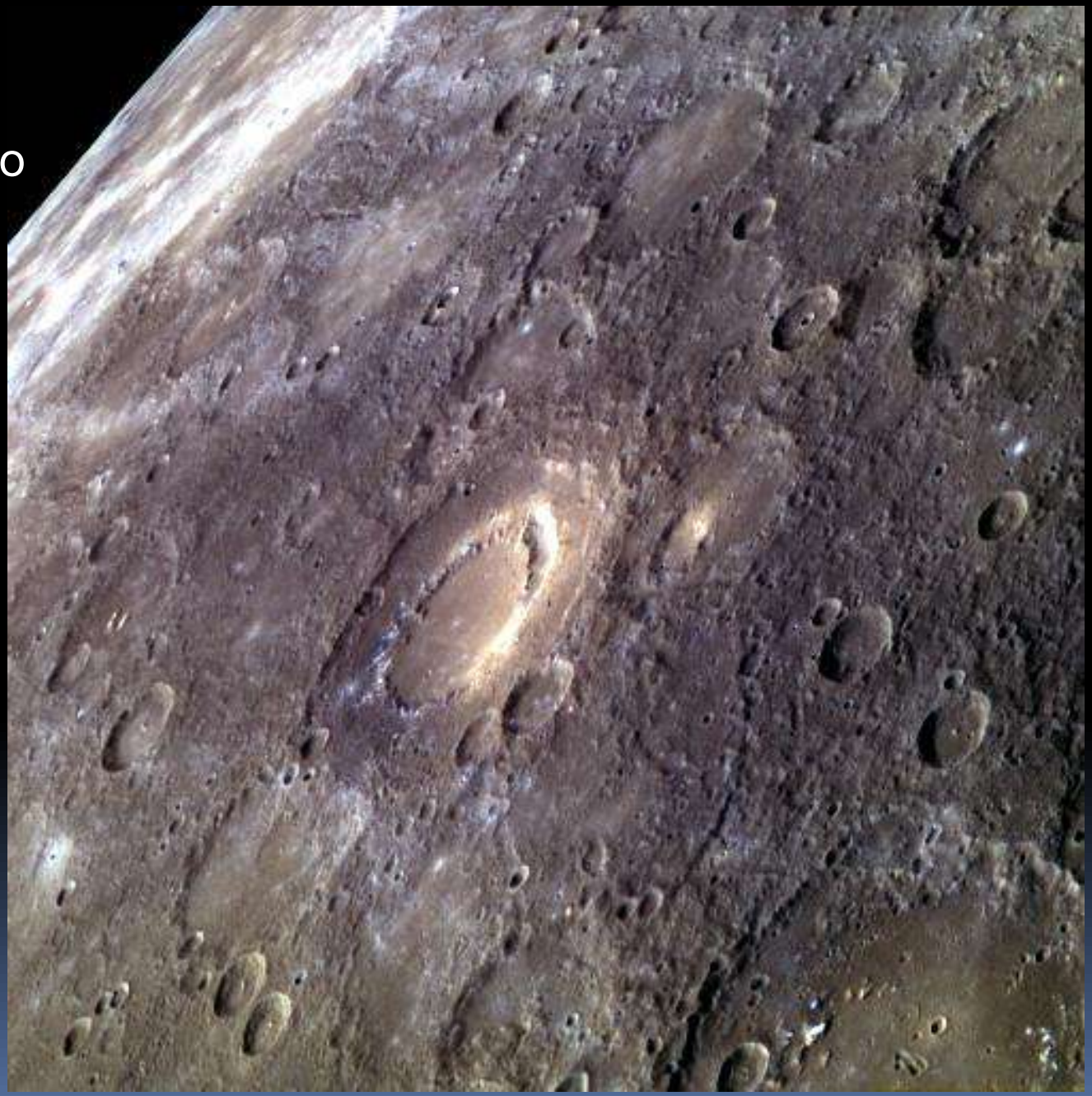
MUNDOS ROCOSOS

Mercurio: fosilizado y sin atmósfera

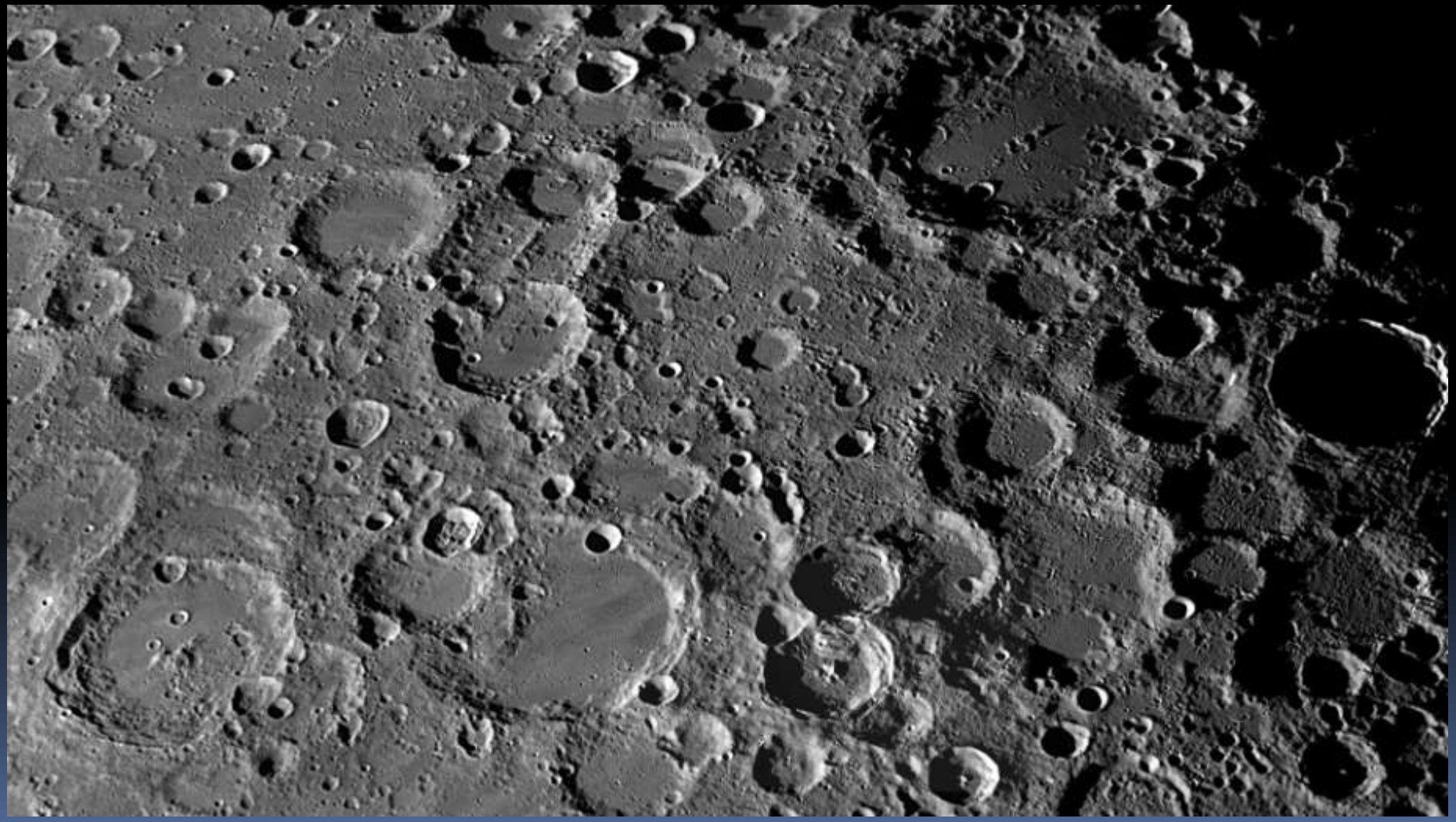
Día = 2 años mercurianos !
-170 C < Temperatura < 400 C

Mercurio

Cráteres de impacto



Cráteres lunares: bombardeo



Fractura en Mercurio

Venus: atmósfera

Temperatura media = 500 C
Presión = 90 atm.
CO_2
No hay agua

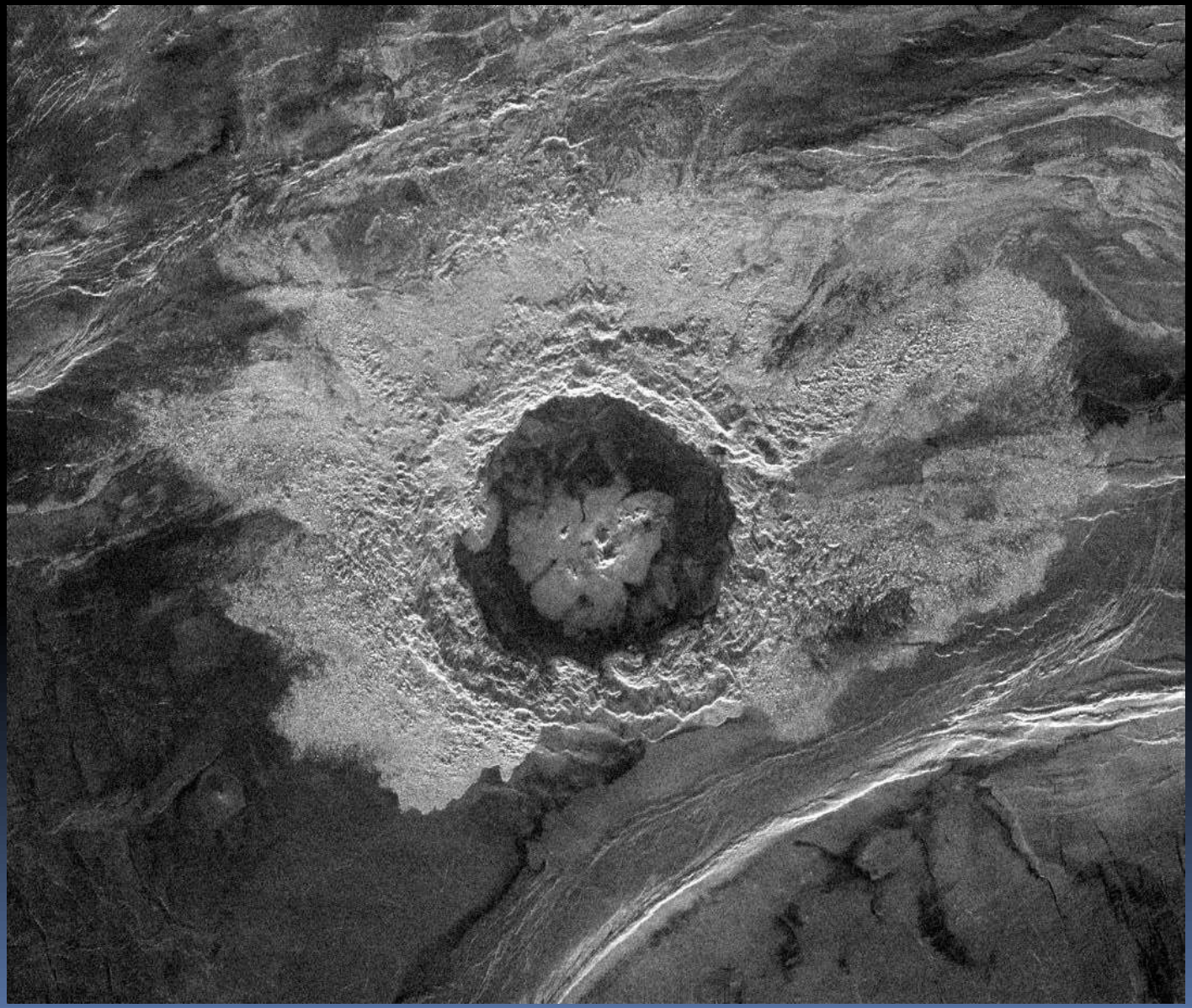
Venus: superficie

Miles de volcanes inactivos
Imágenes de radar

Venus

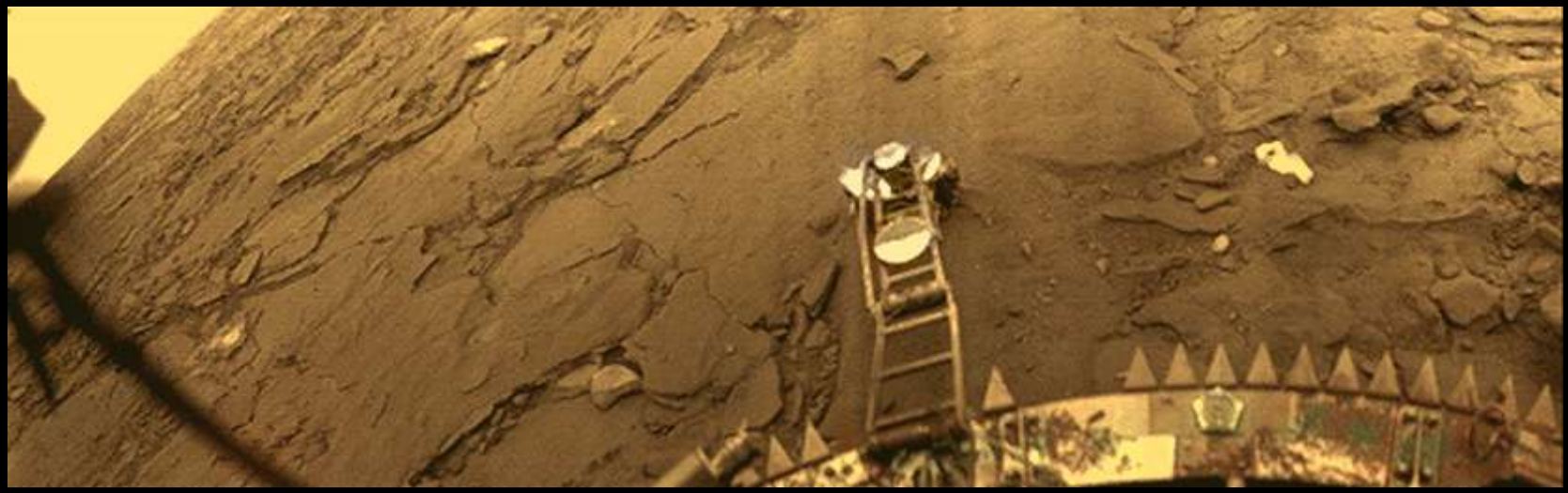
"panqueques" de lava muy viscosa

Cráter

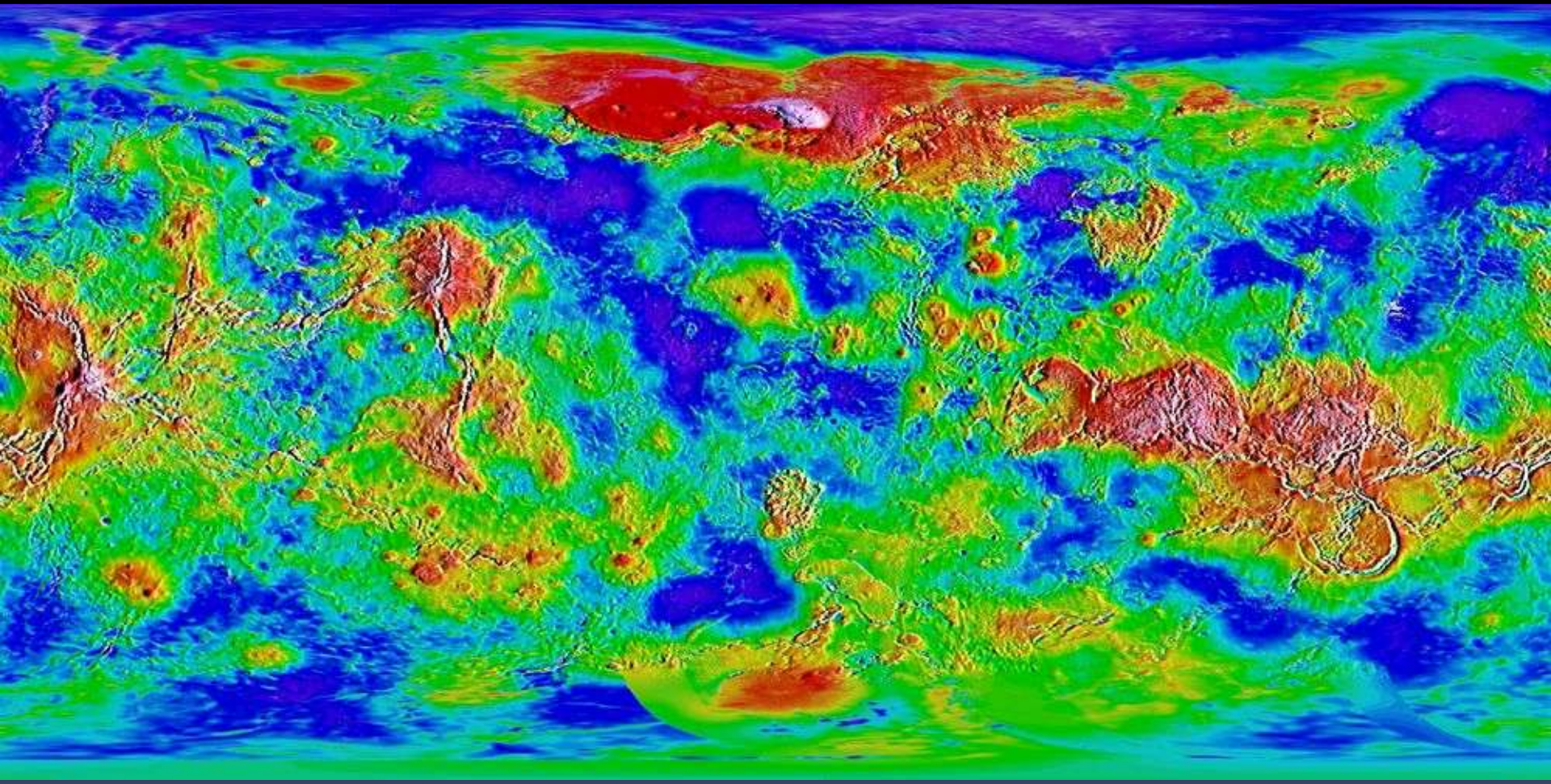


Venus

Roca sólida y seca (basaltos)



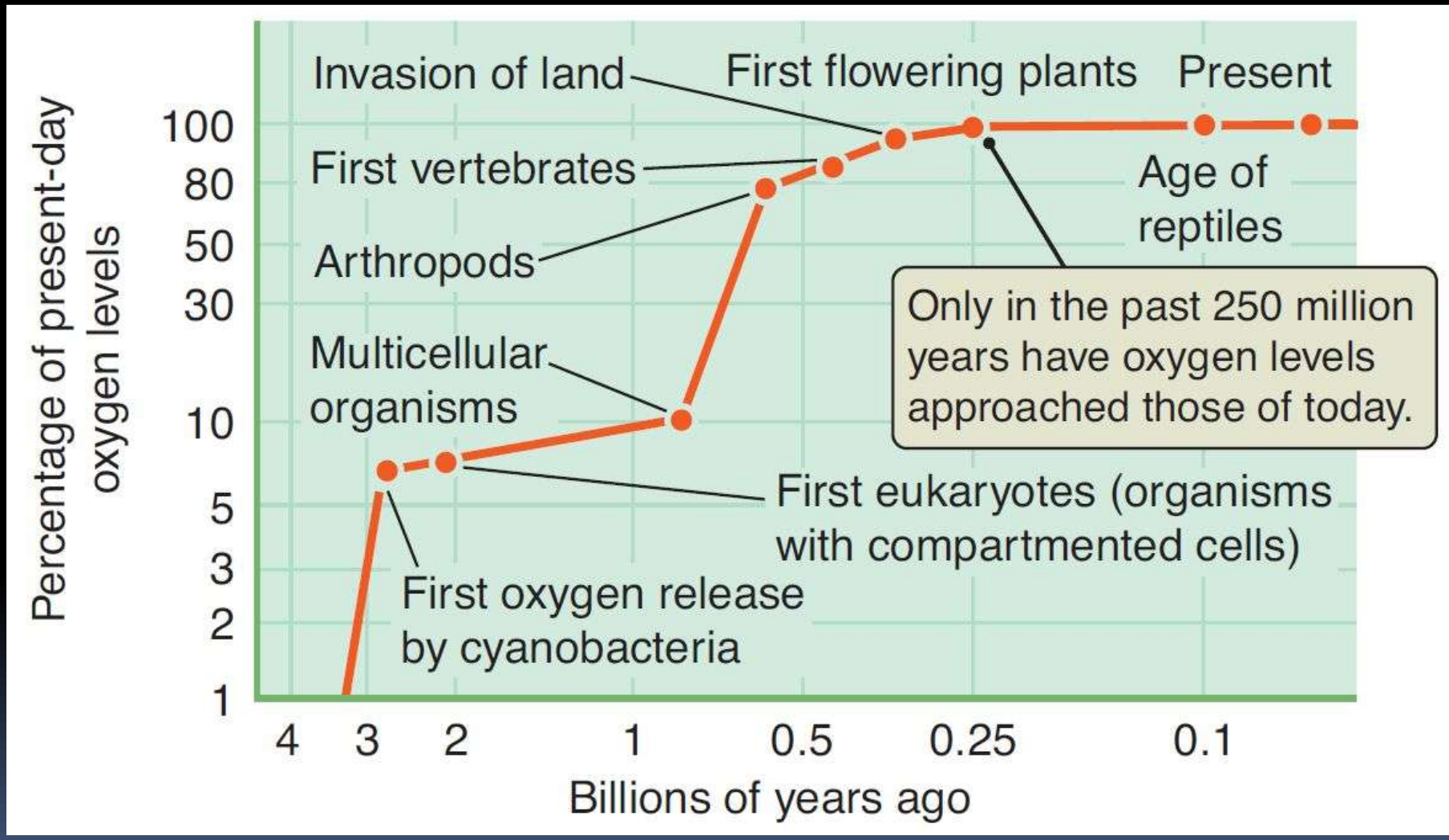
Mapa de Venus



Agua sólida, líquida y gaseosa.
Única atmósfera rica en Oxígeno: energía y protección UV.

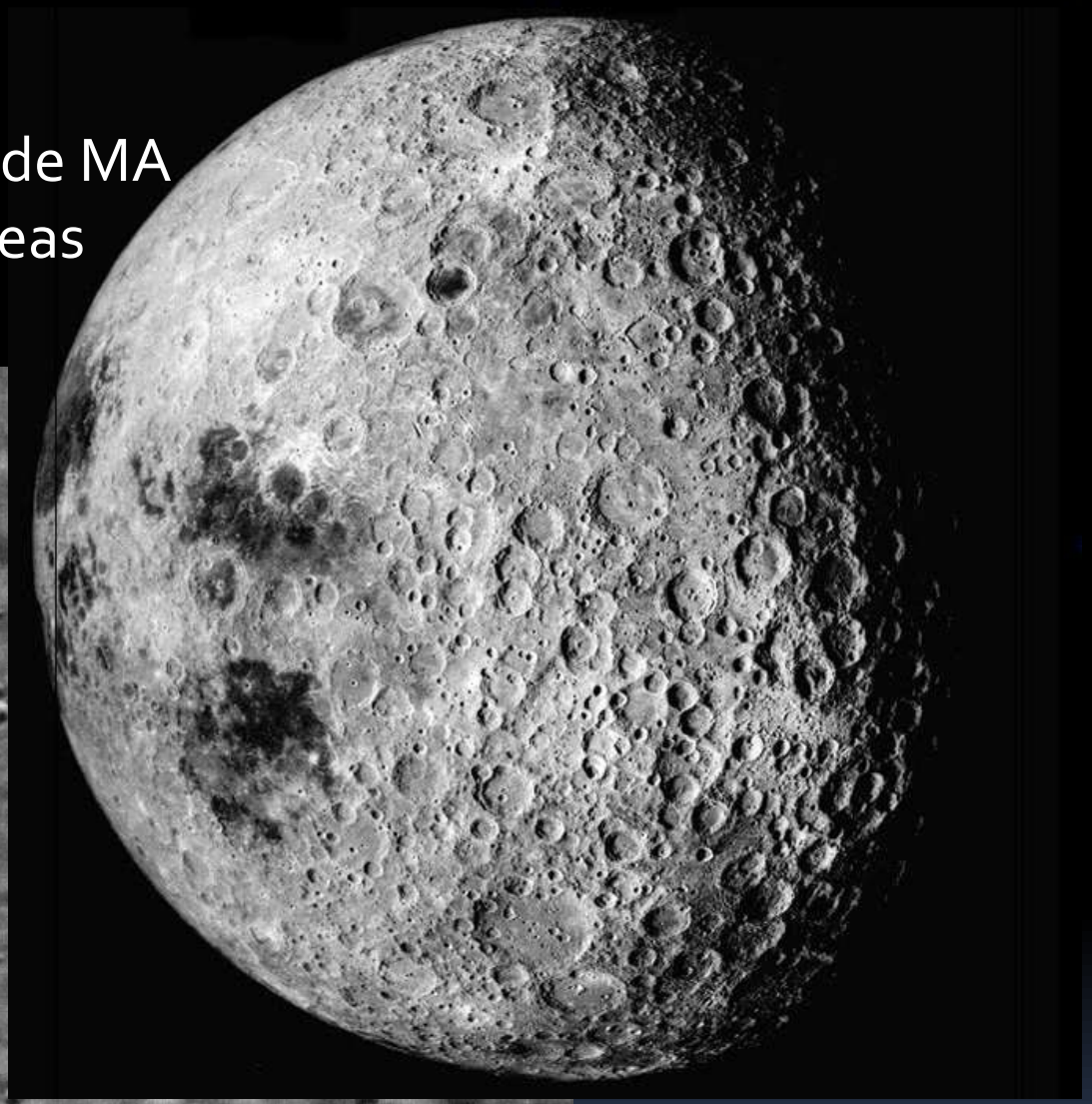
Preguntas…

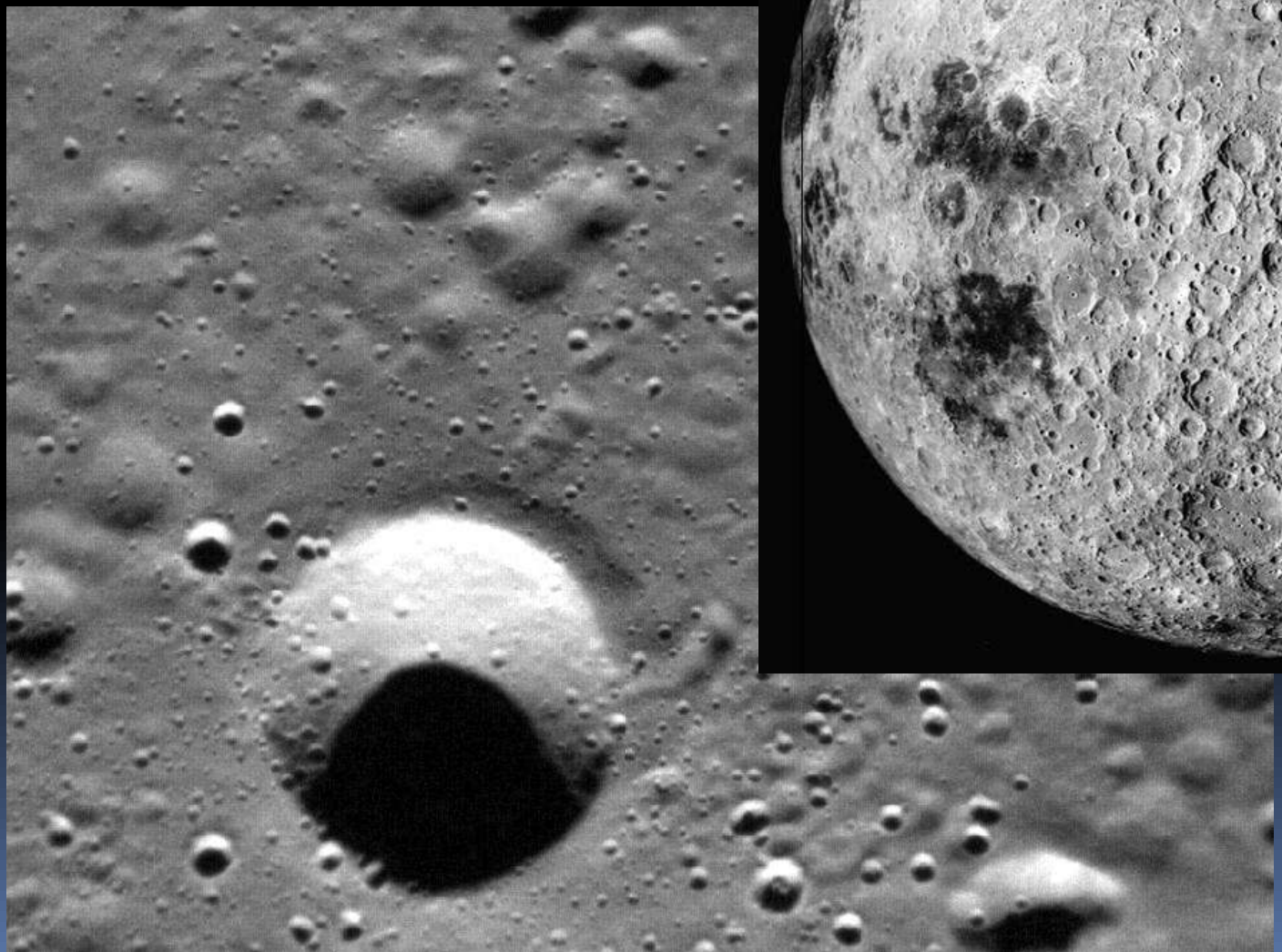
- ¿Origen del agua terrestre?
- ¿A dónde fue el agua de Venus y Marte?
- ¿Origen del Oxígeno terrestre?


Invasion of land
First flowering plants
Present
First vertebrates
Age of reptiles
Arthropods
Only in the past 250 million years have oxygen levels approached those of today.
Multicellular organisms
First eukaryotes (organisms with compartmented cells)
First oxygen release by cyanobacteria
Percentage of present-day oxygen levels
100
80
50
30
10
5
3
2
1
4
3
2
1
0.5
0.25
0.1
Billions of years ago

Luna

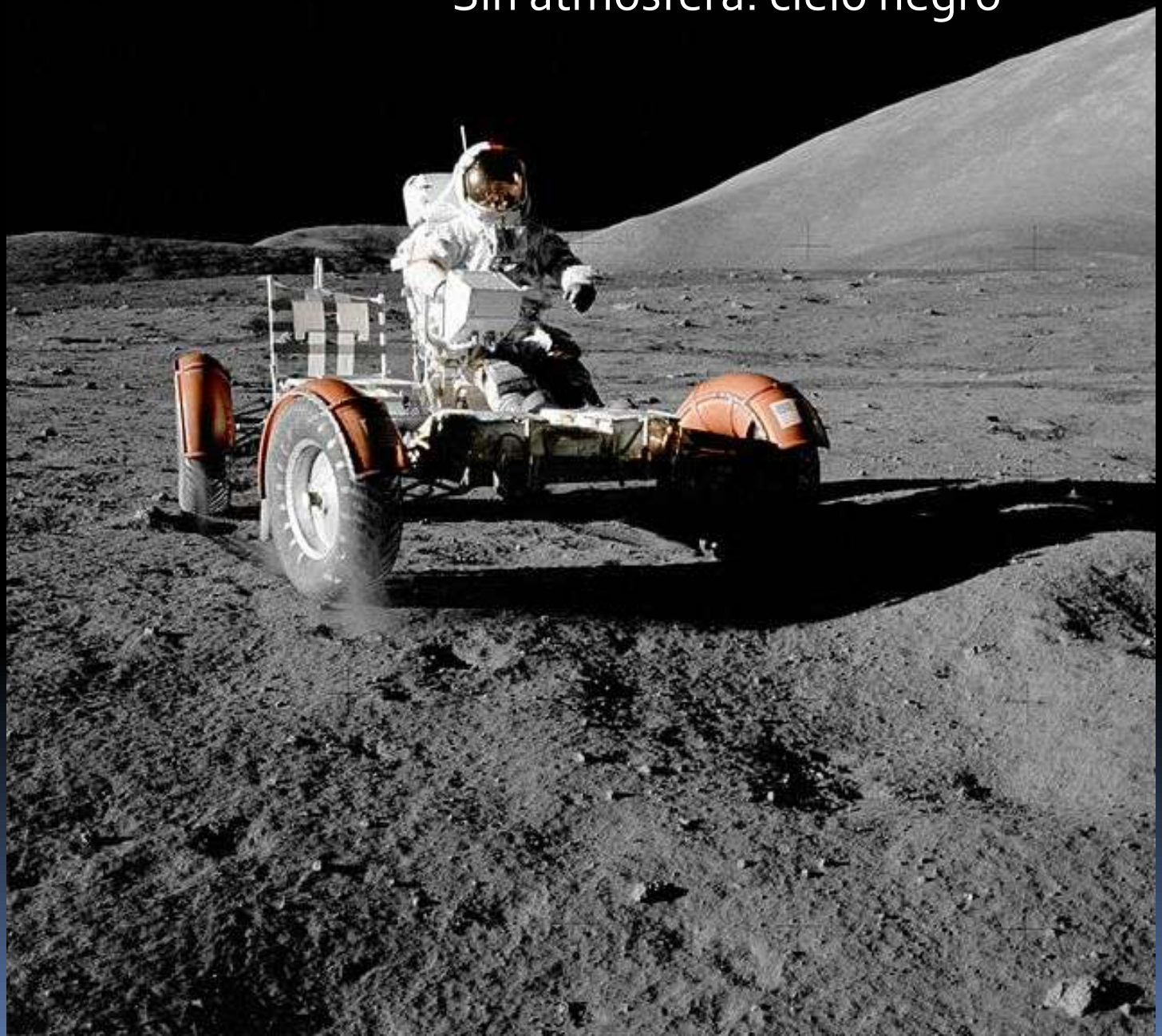
Fosilizada desde hace miles de MA
Rotación sincrónica por mareas
-170C <Temp < 130 C





Luna

Sin atmósfera: cielo negro

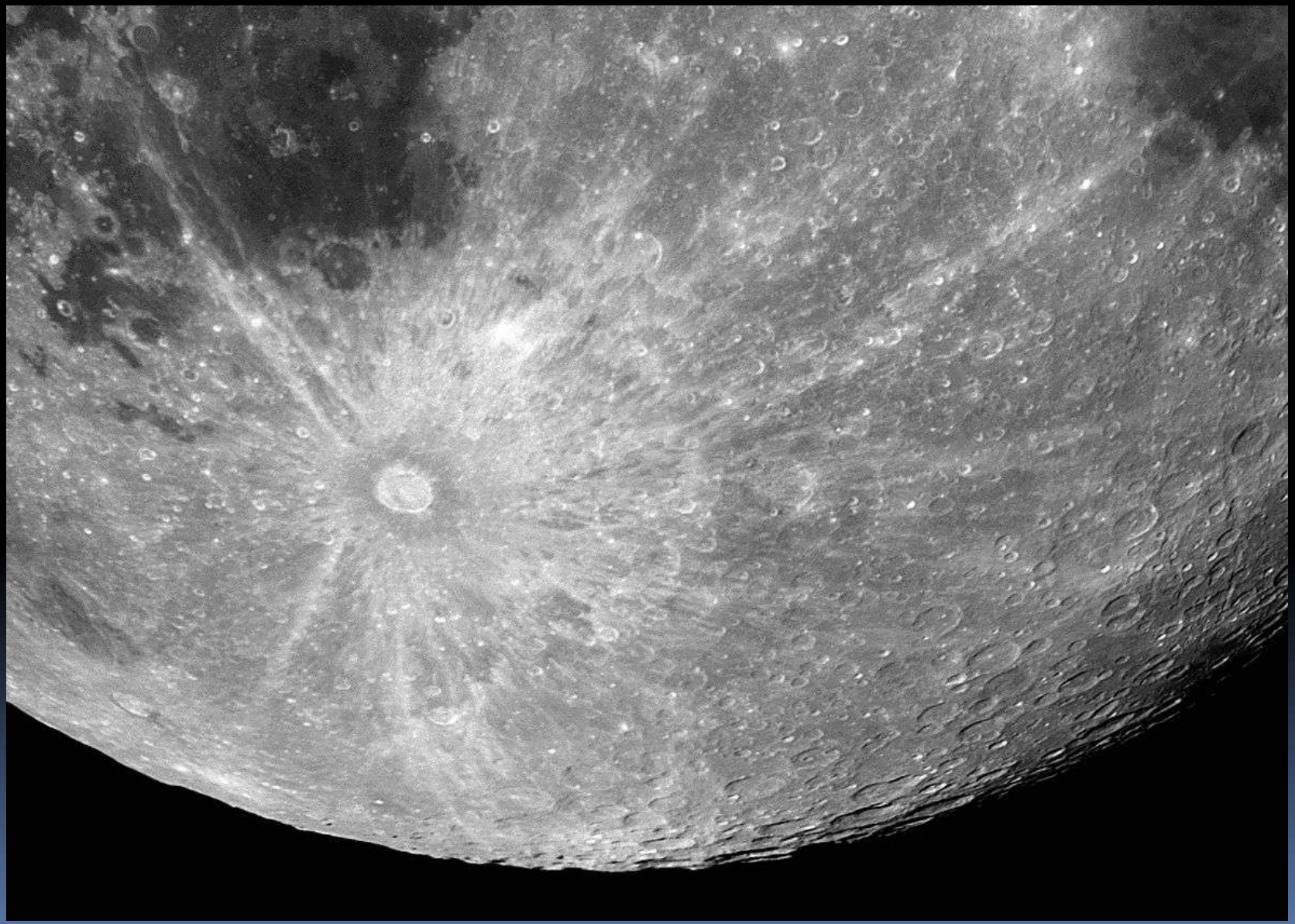


Luna

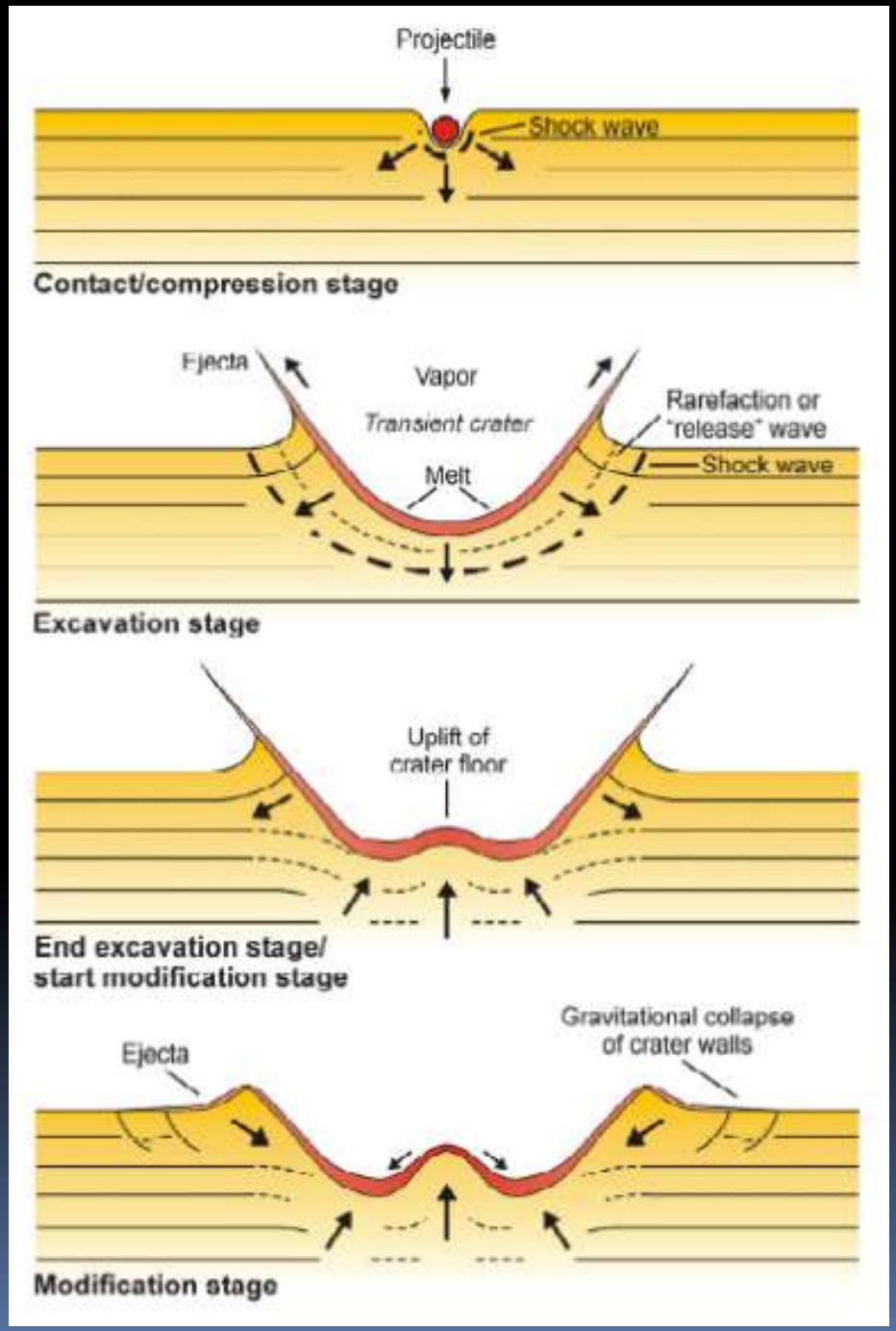
"Mares" de lava
(mas jóvenes)

Cráter Tycho

"Joven" gran cráter (100 MA)



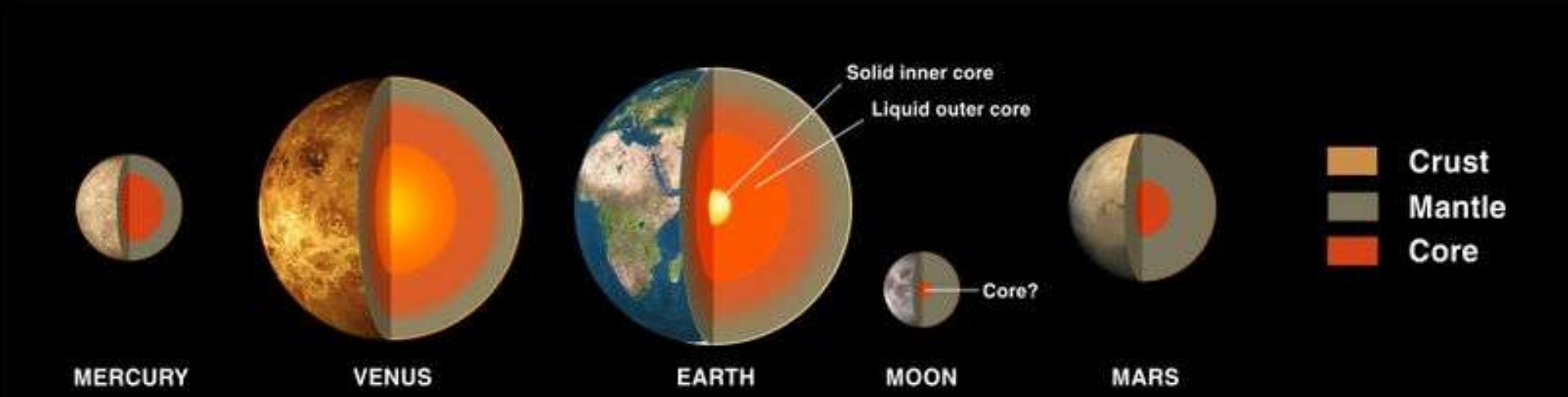
Cráter Arizona: hace 10.000 años


Projectile
Shock wave
Contact/compression stage
Ejecta
Vapor
Transient crater
Rarefaction or "release" wave
Melt
Shock wave
Excavation stage
Uplift of crater floor
End excavation stage/ start modification stage
Gravitational collapse of crater walls
Ejecta
Modification stage

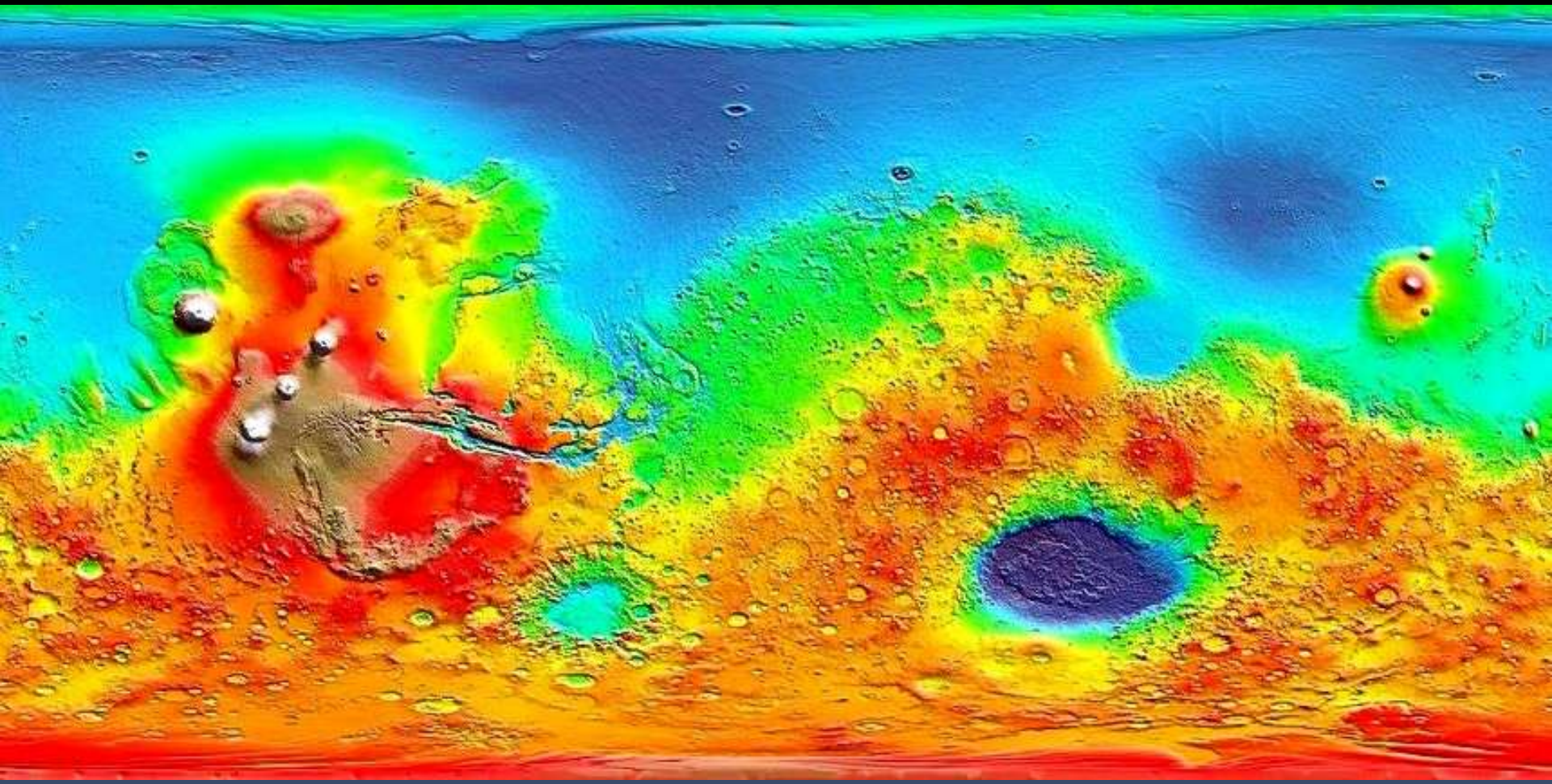
Marte

Marte

Volcanes fosilizados
Erosión por fluidos
Agua en el pasado

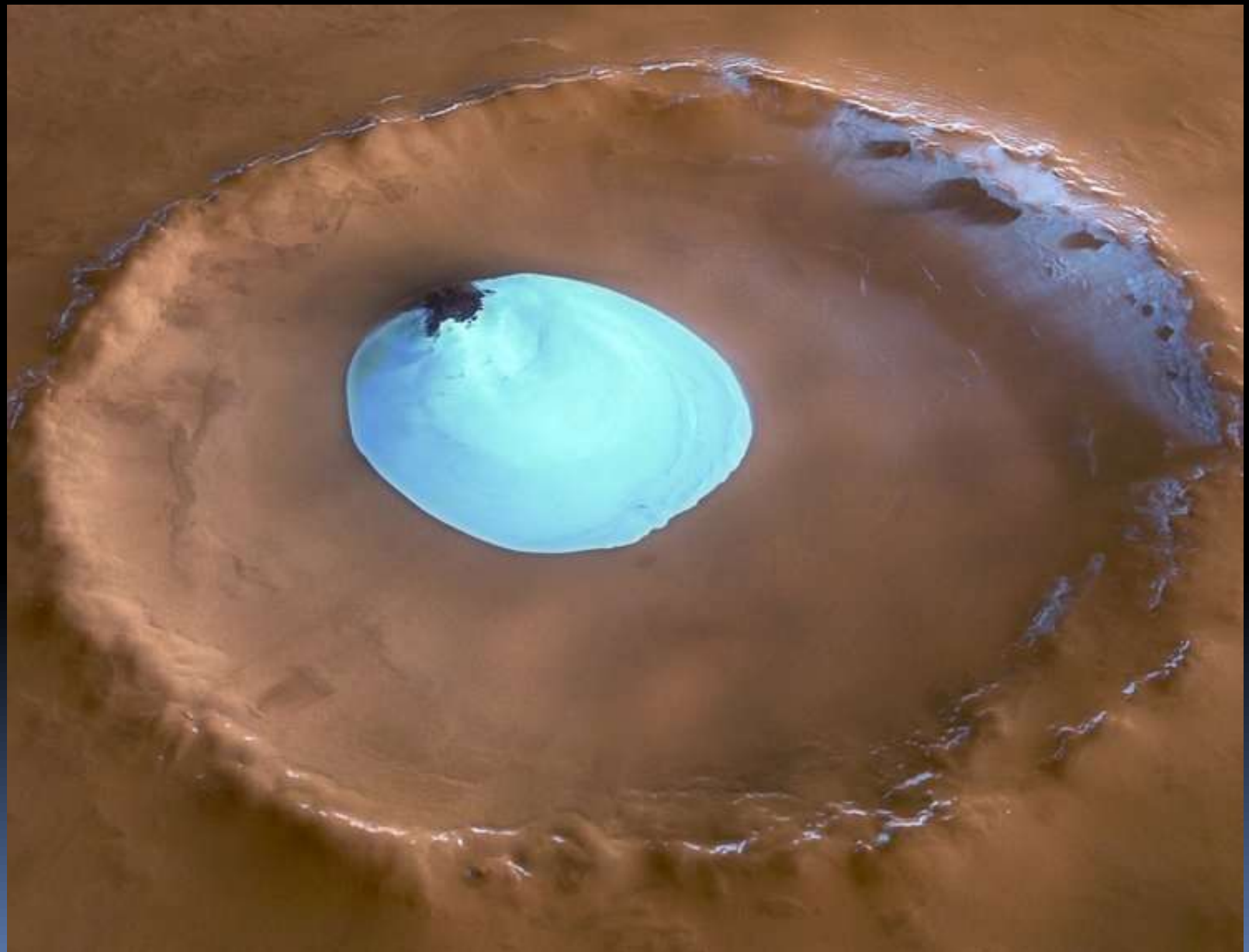

Solid inner core
Liquid outer core
Core?
Crust
Mantle
Core
MERCURY
VENUS
EARTH
MOON
MARS

Marte



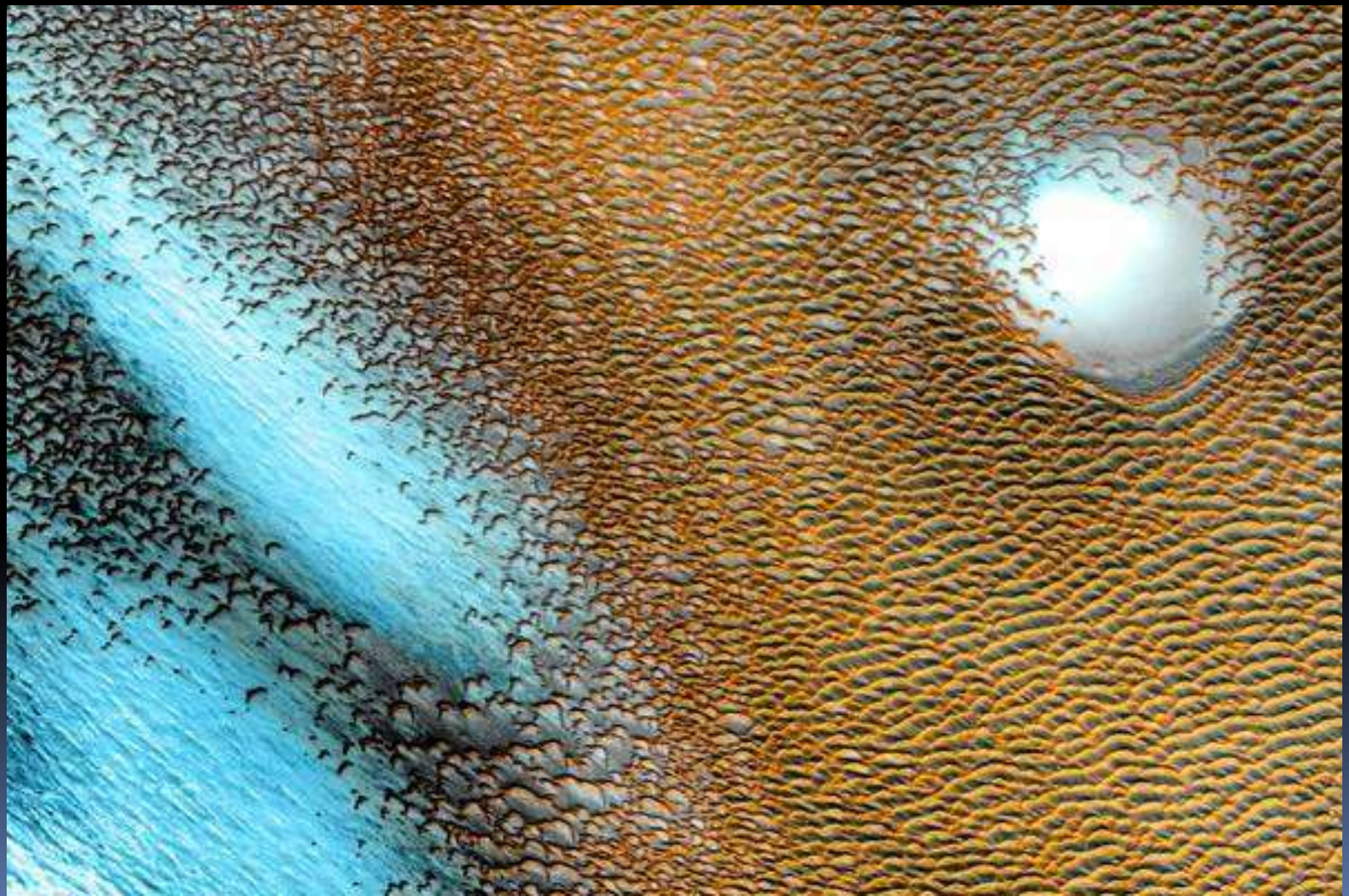
Marte

CO_2 sólido y gaseoso



Marte

Dunas



Marte

Dunas: actividad eólica

Marte

Tornados

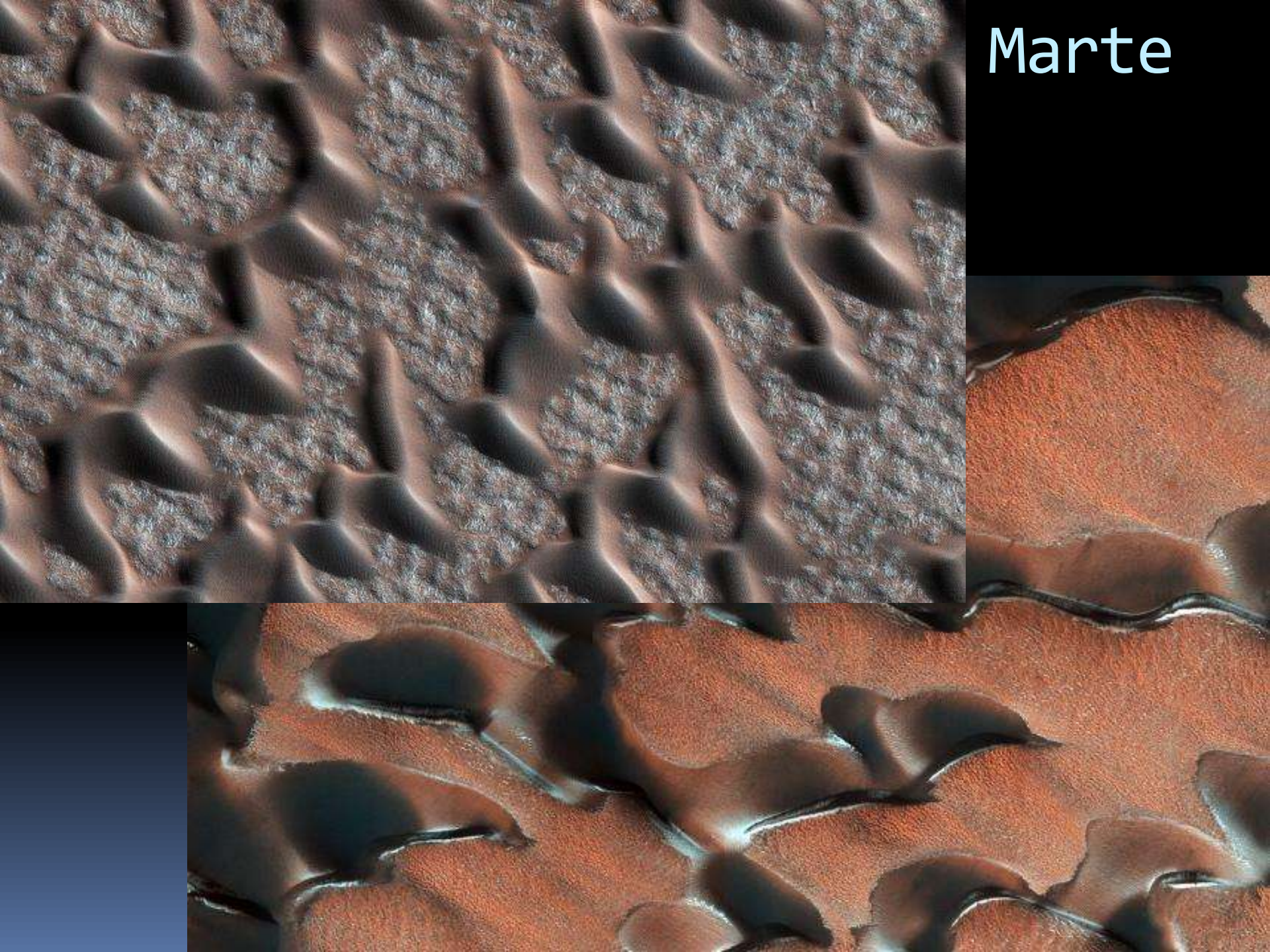
Tormenta de polvo

Marte

Dunas cubiertas de CO_2

Marte

Marte

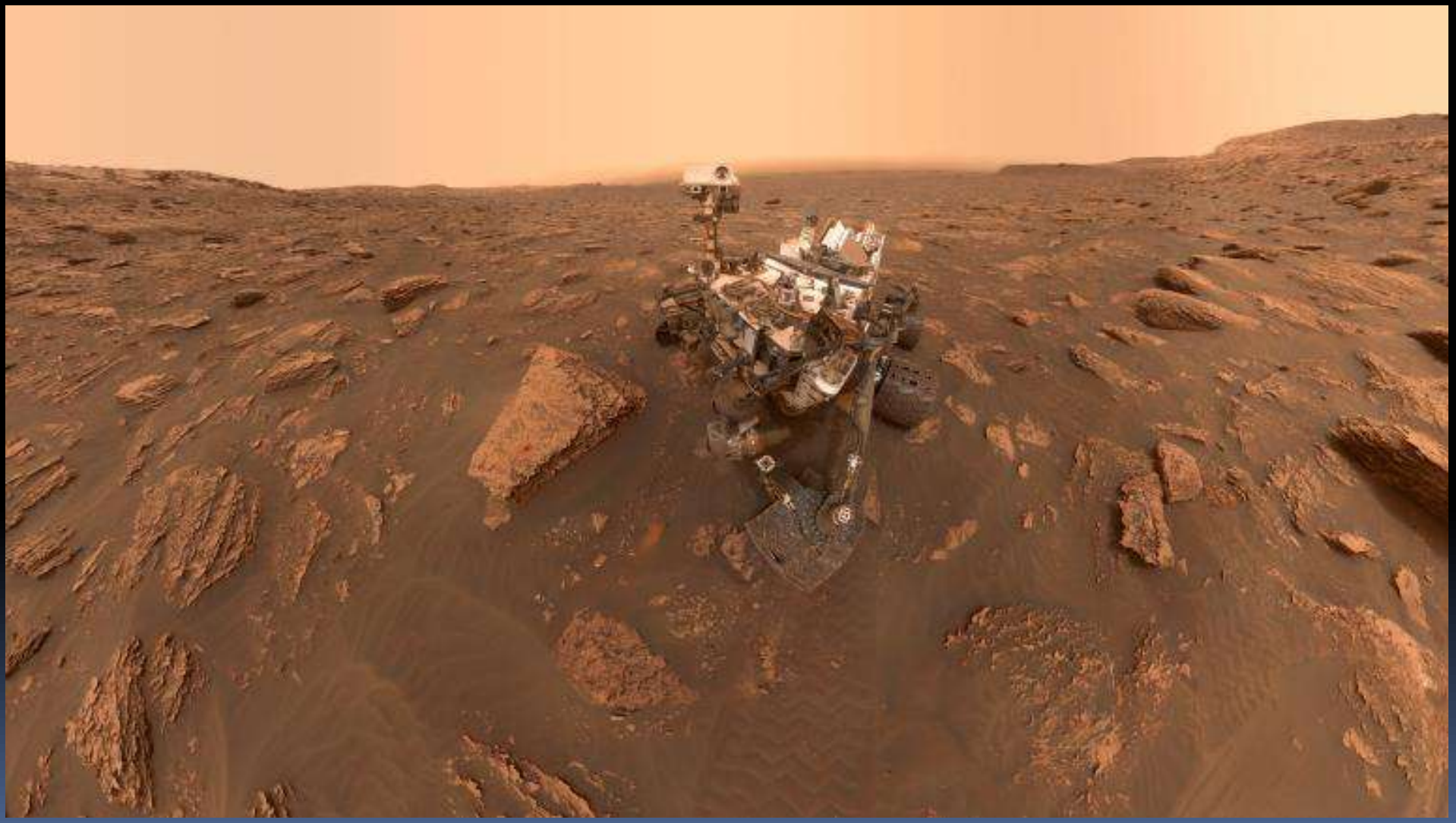


Marte

Sin agua superficial.

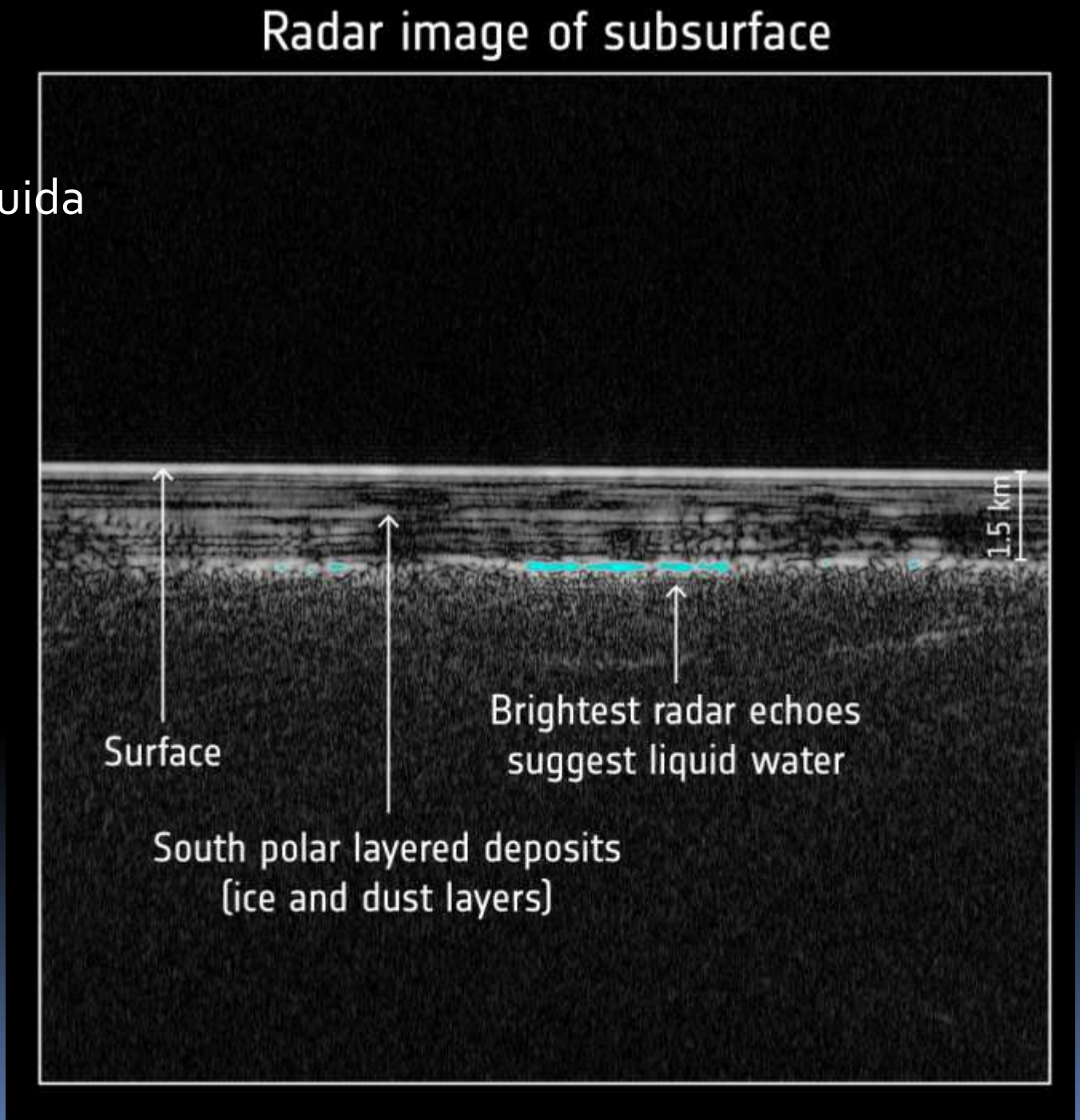
Hielo subsuperficial (permafrost)

Marte

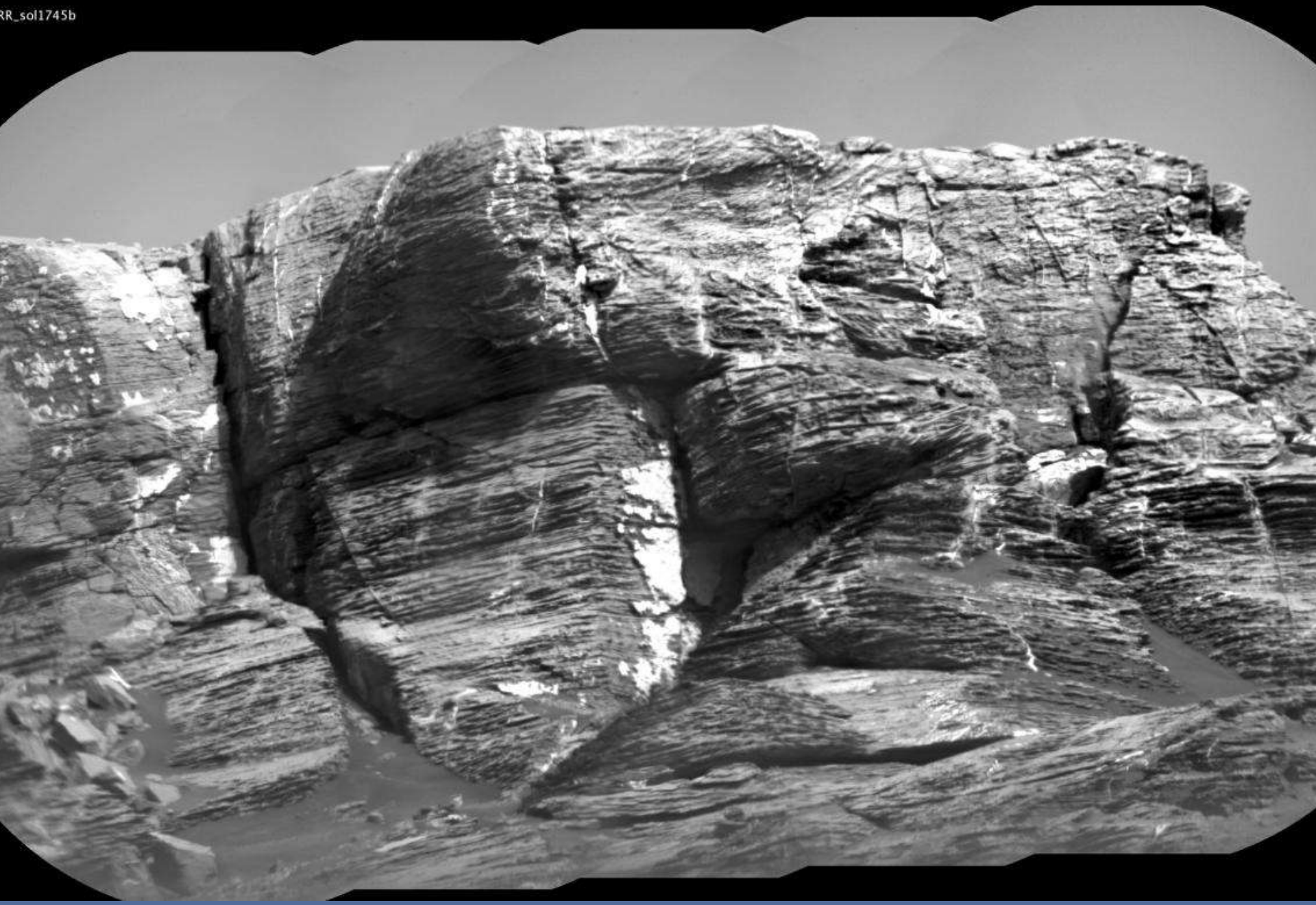


Marte

Tal vez agua líquida



Rocas sedimentarias en Marte



Deimos (satélite de Marte)

Fobos (satélite de Marte)

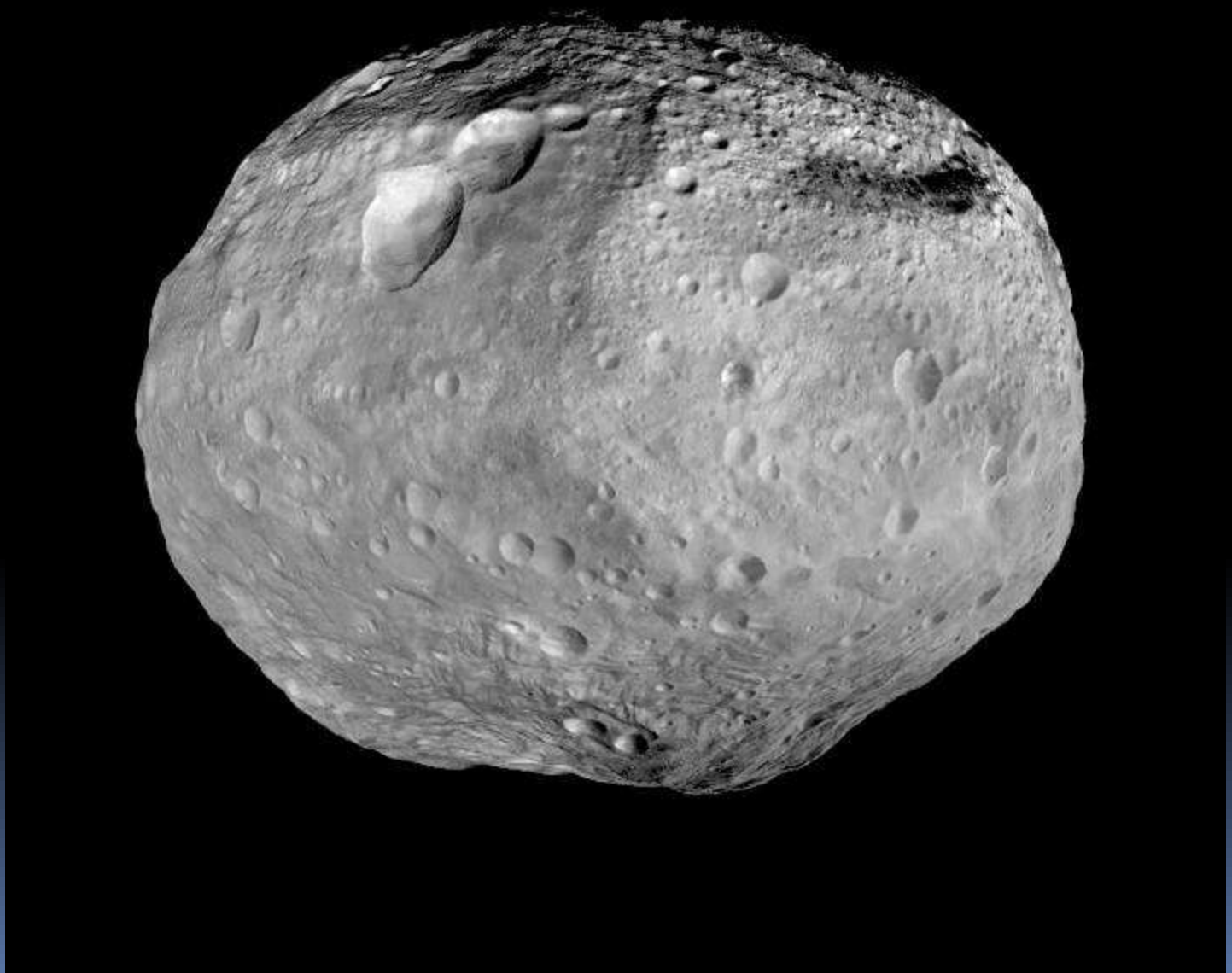
Asteroide Eros

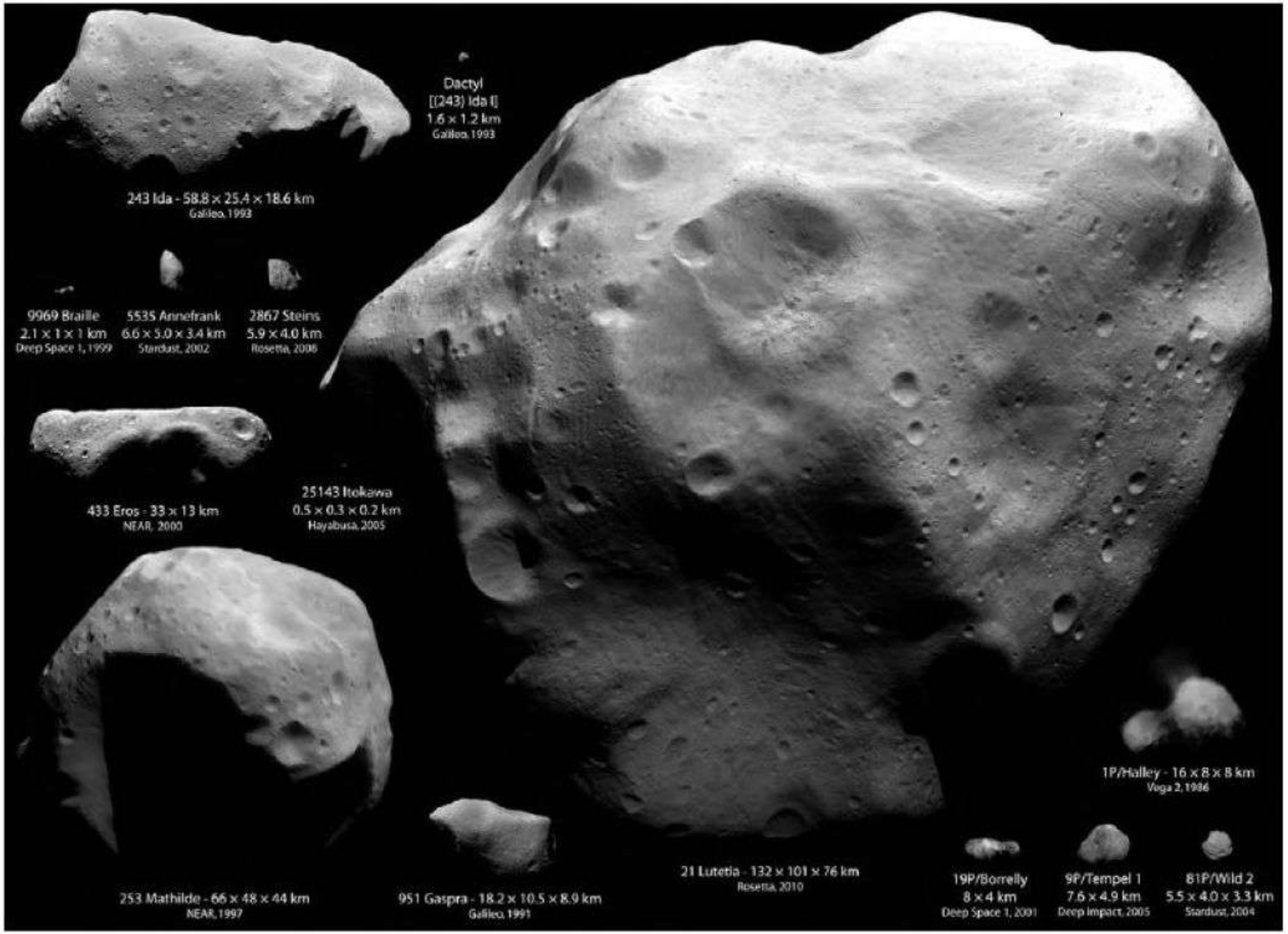
Itokawa

"Pila de escombros"

Ceres(planeta enano)

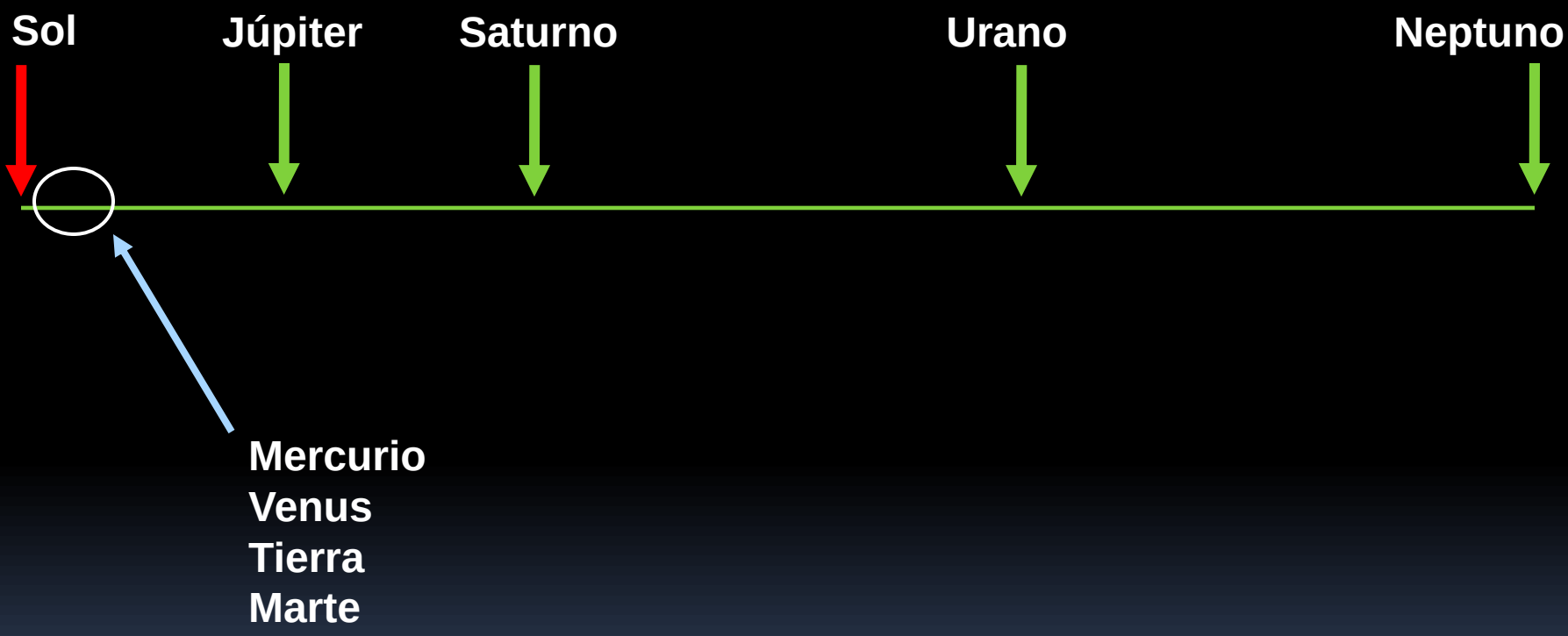
Vesta



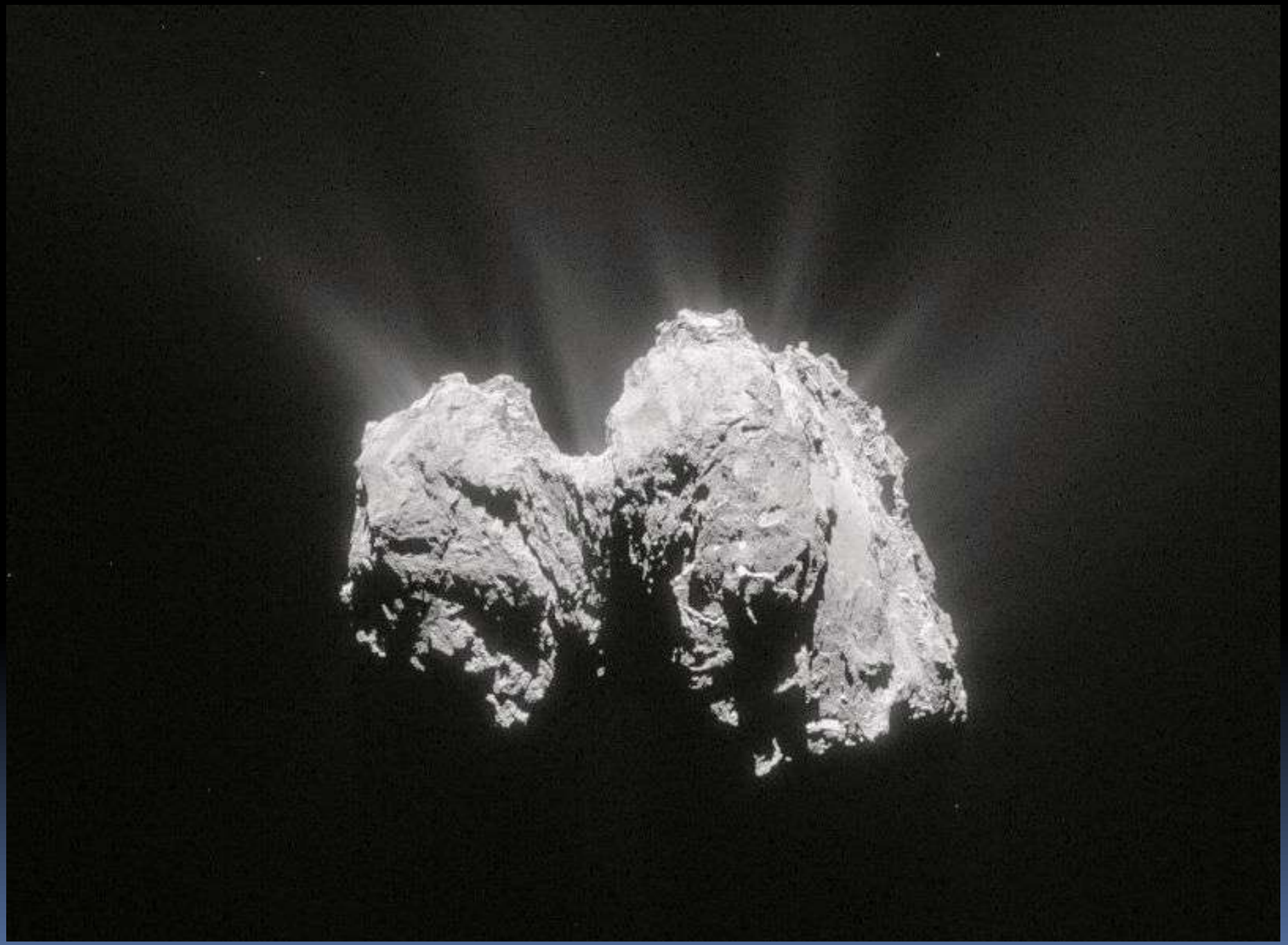

Dactyl
[(243) Ida I]
1.6 × 1.2 km
Galileo, 1993
243 Ida - 58.8 × 25.4 × 18.6 km
Galileo, 1993
9969 Braille
2.1 × 1 × 1 km
Deep Space 1, 1999
5535 Annefrank
6.6 × 5.0 × 3.4 km
Stardust, 2002
2867 Steins
5.9 × 4.0 km
Rosetta, 2008
433 Eros - 33 × 13 km
NEAR, 2000
25143 Itokawa
0.5 × 0.3 × 0.2 km
Hayabusa, 2005
253 Mathilde - 66 × 48 × 44 km
NEAR, 1997
951 Gaspra - 18.2 × 10.5 × 8.9 km
Galileo, 1991
21 Lutetia - 132 × 101 × 76 km
Rosetta, 2010
1P/Halley - 16 × 8 × 8 km
Vega 2, 1986
19P/Borrelly
8 × 4 km
Deep Space 1, 2001
9P/Tempel 1
7.6 × 4.9 km
Deep Impact, 2005
81P/Wild 2
5.5 × 4.0 × 3.3 km
Stardust, 2004

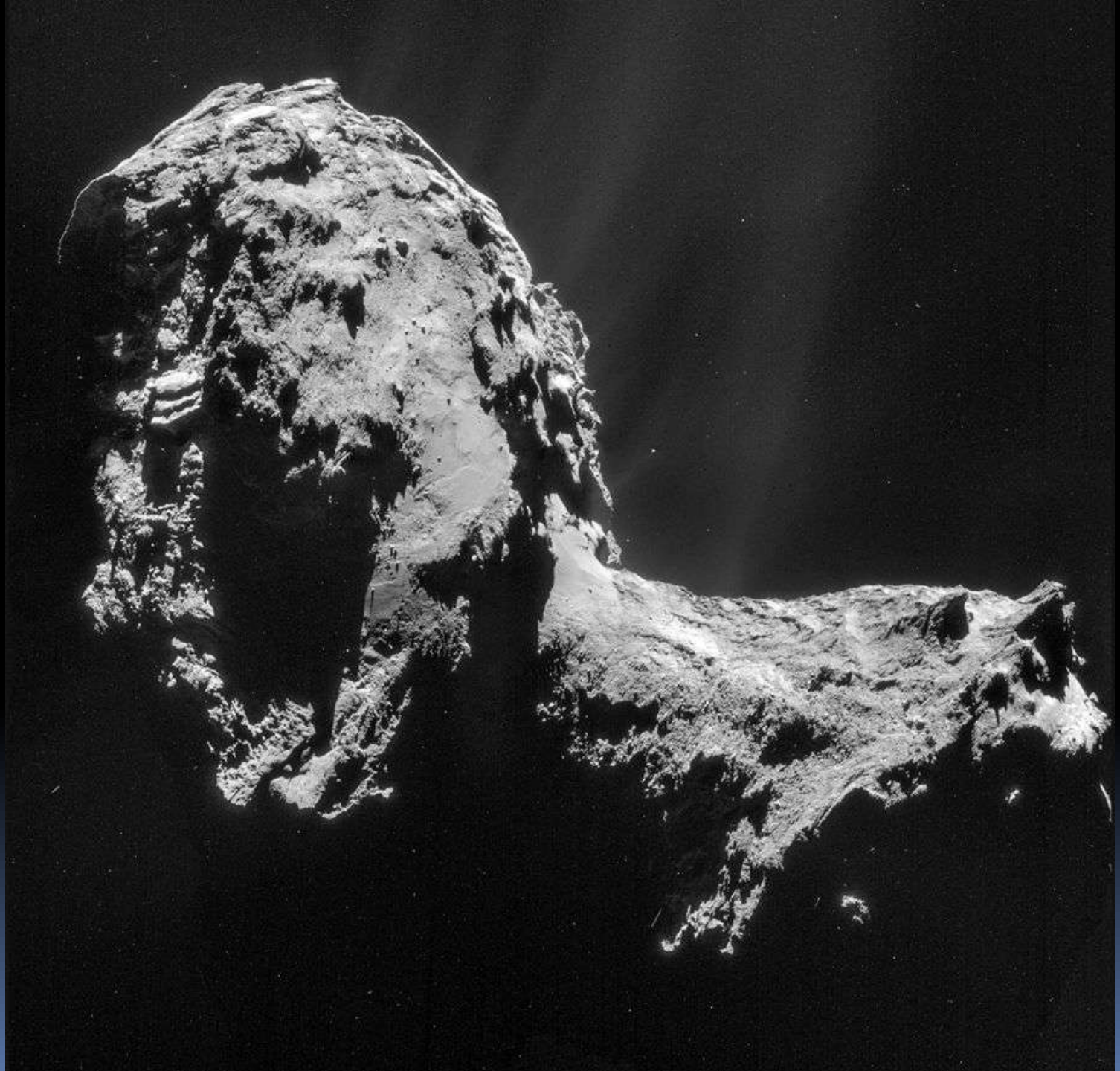
Sistema Solar

Distancias a escala



Núcleo cometario

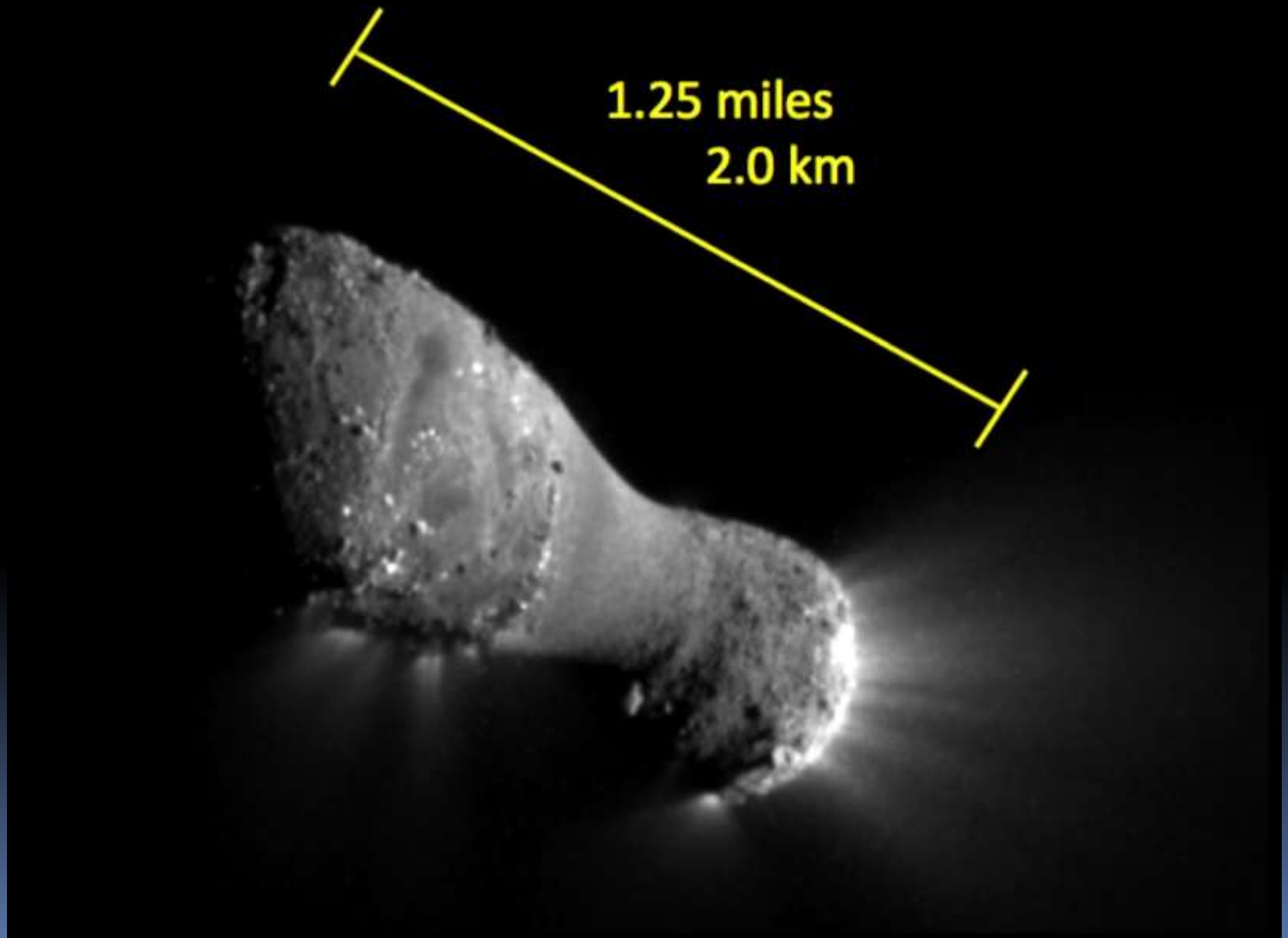


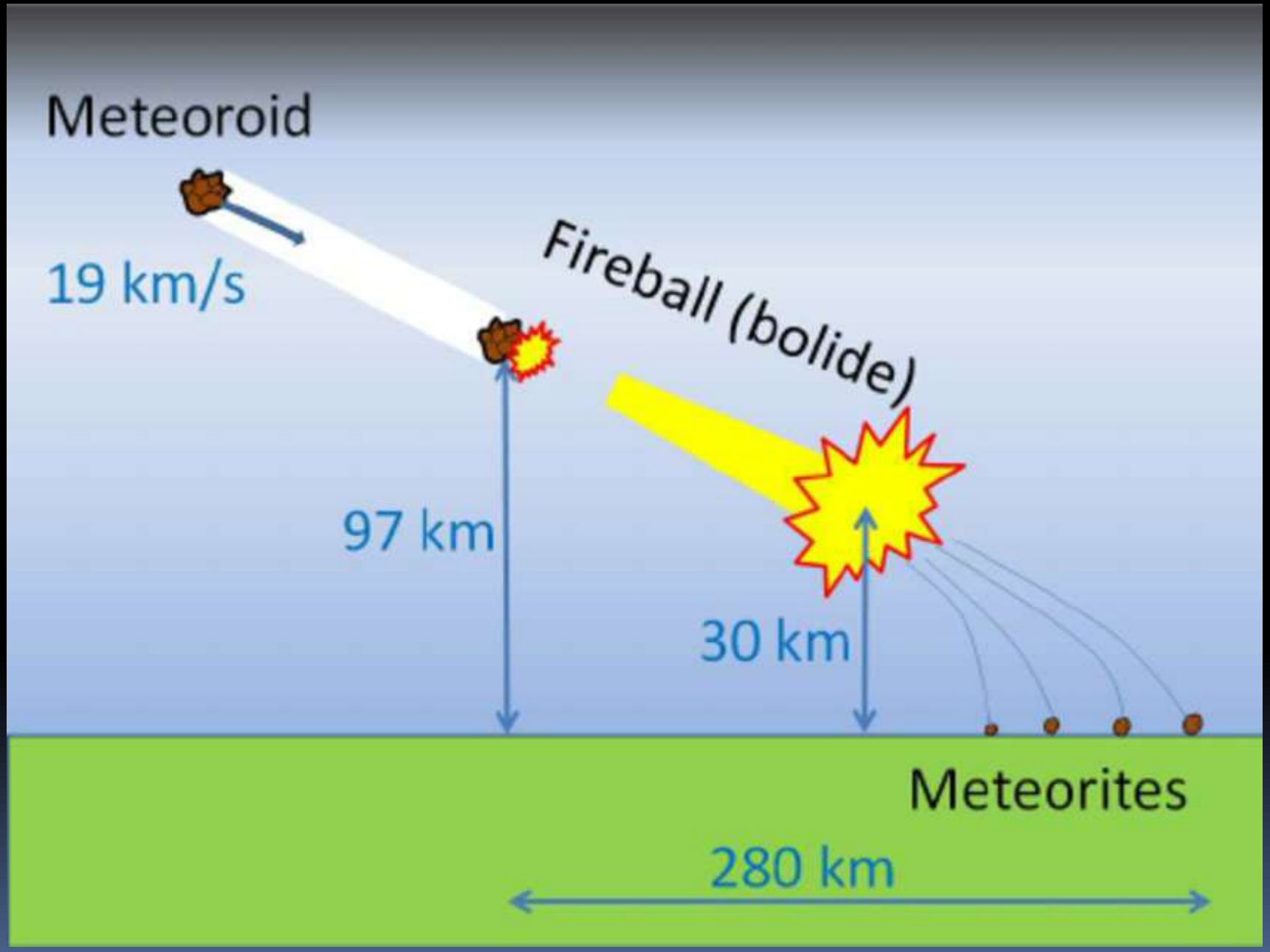


Núcleo cometario

Cometa

Núcleo cometario




Meteoroid
19 km/s
Fireball (bolide)
97 km
30 km
Meteorites
280 km

Tunguska 1908: 1000 bombas Hiroshima

Meteoritos

- Fragmentos de asteroides y cometas
- Fragmentos de Marte y Luna
- Sobreviven al ingreso en la atmósfera
- Metálicos, rocosos y carbonosos
- Se encontraron aminoácidos

Frecuencia de impactos actual

- Asteroide de 1km cada 1 millón de años
- Catástrofe regional
- “Invierno nuclear” durante algunos meses

MUNDOS GASEOSOS Y HELADOS

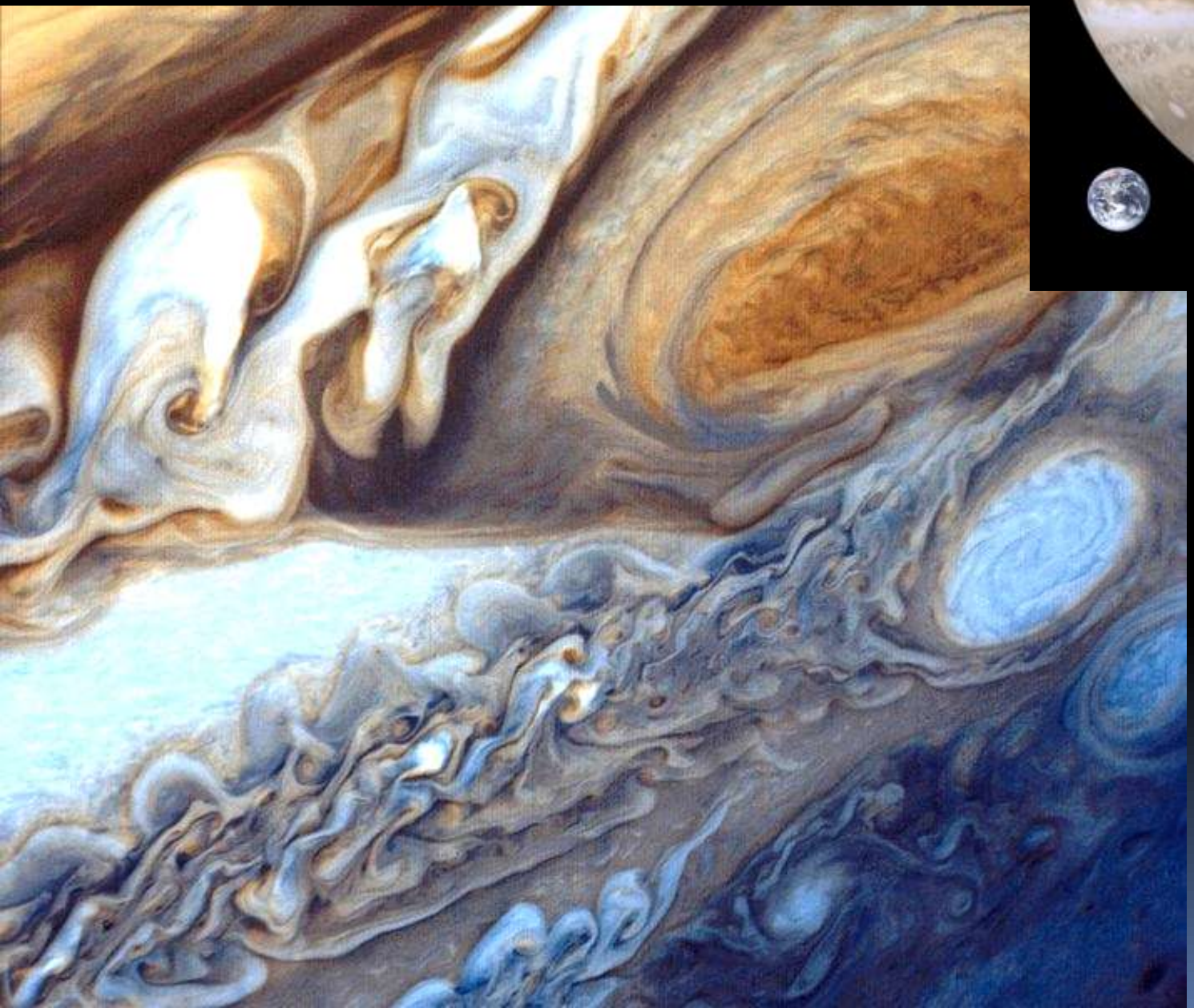
Júpiter

H + He

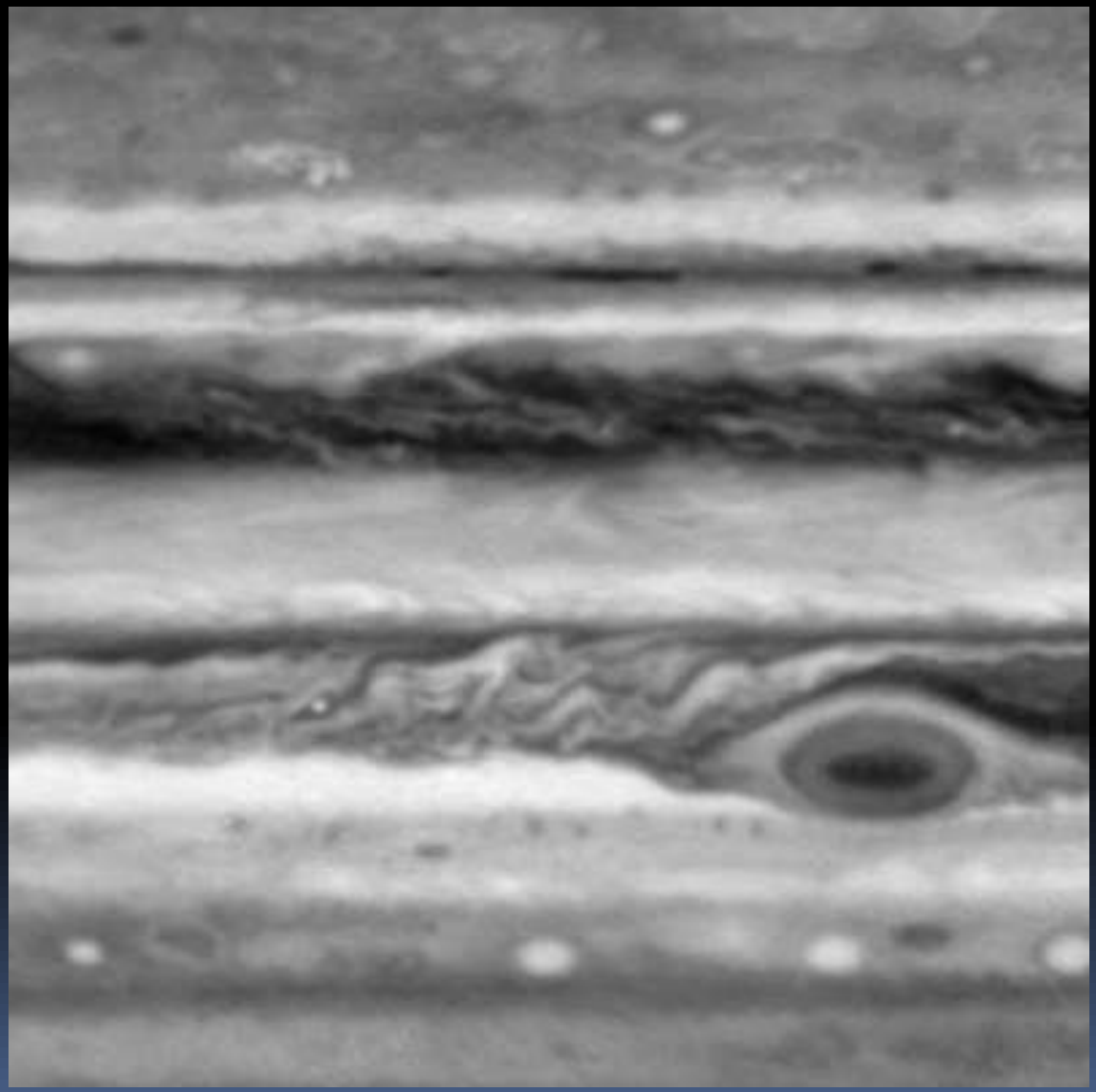
Temp.: -170 C

Masa≈ 300 Tierras

Júpiter

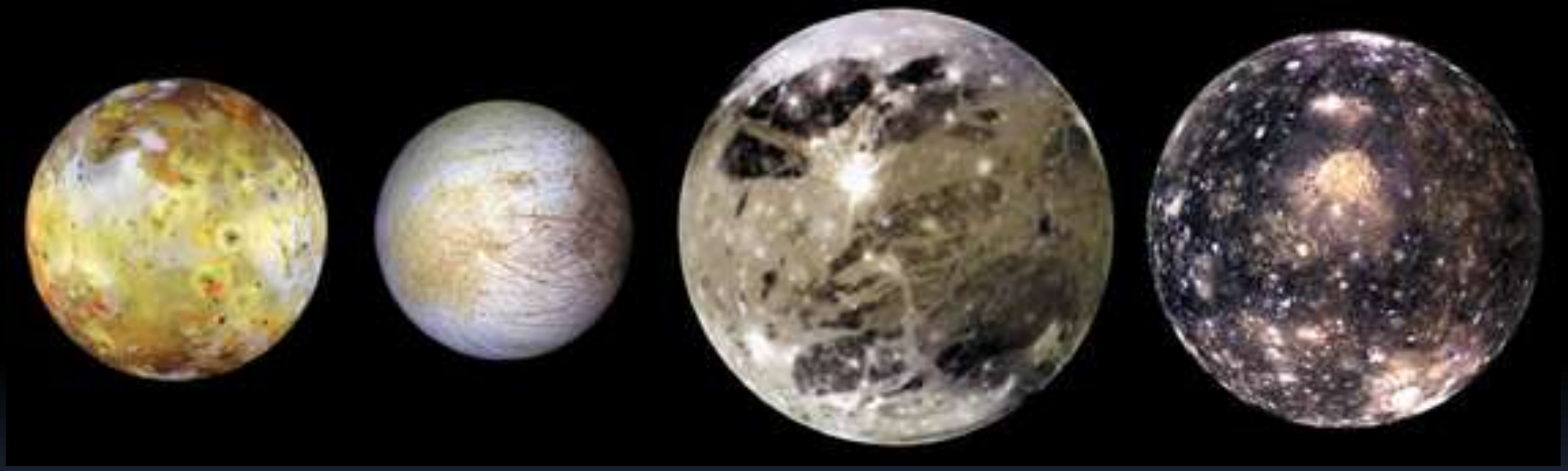


Júpiter



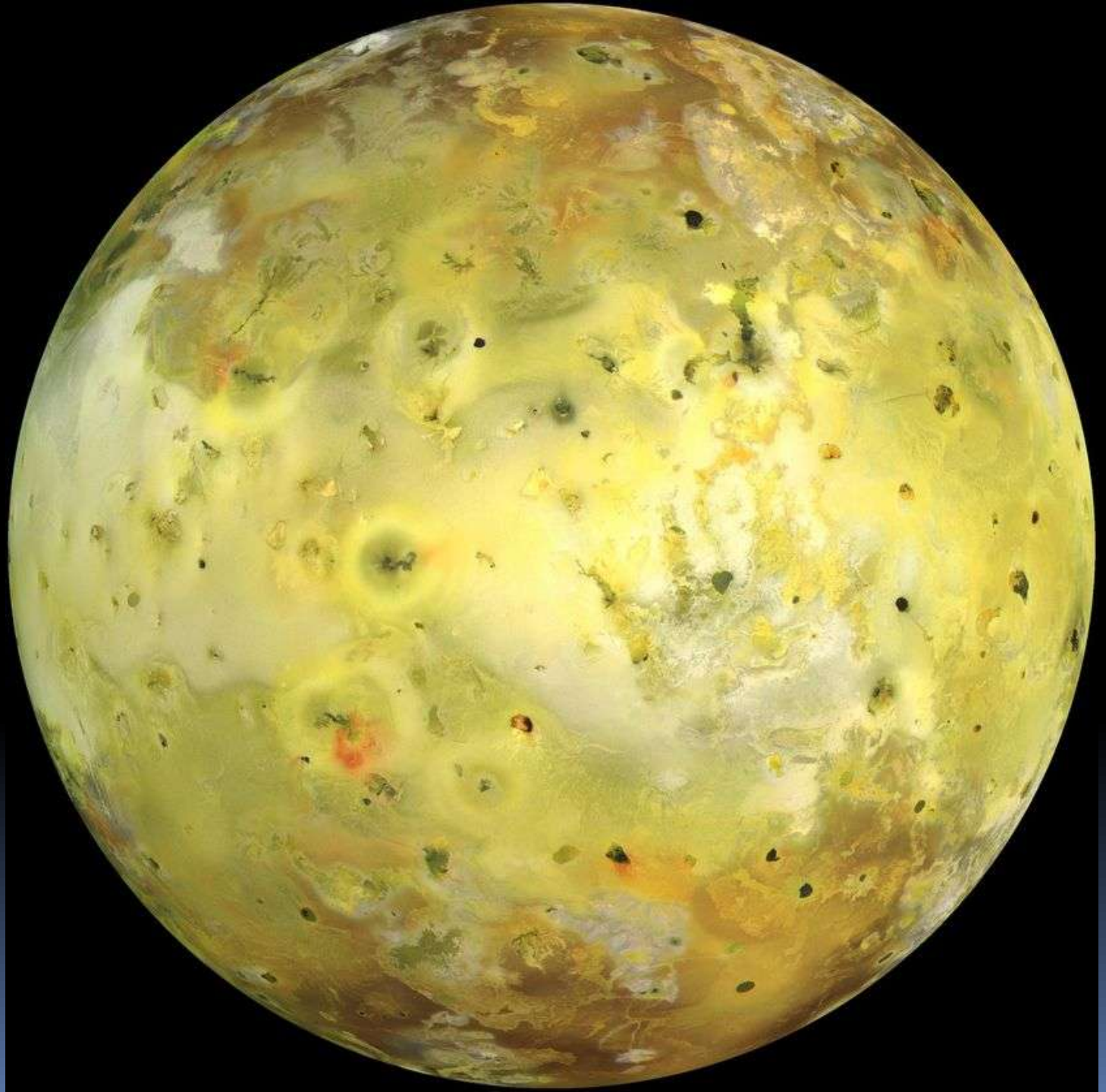
Júpiter

Satélites Galileanos



Io

volcanes



Io

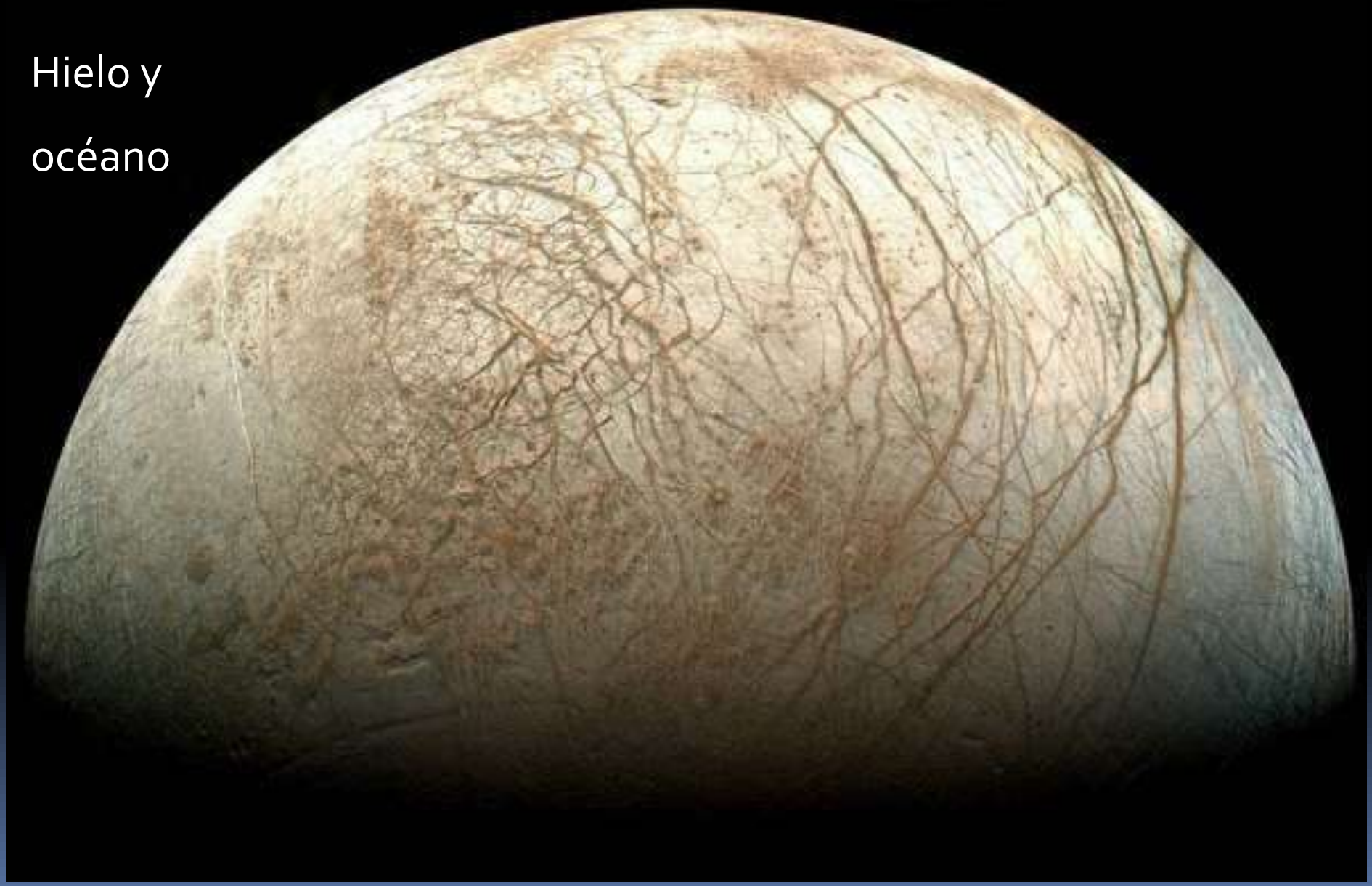
Volcanes activos

Mareas jovianas

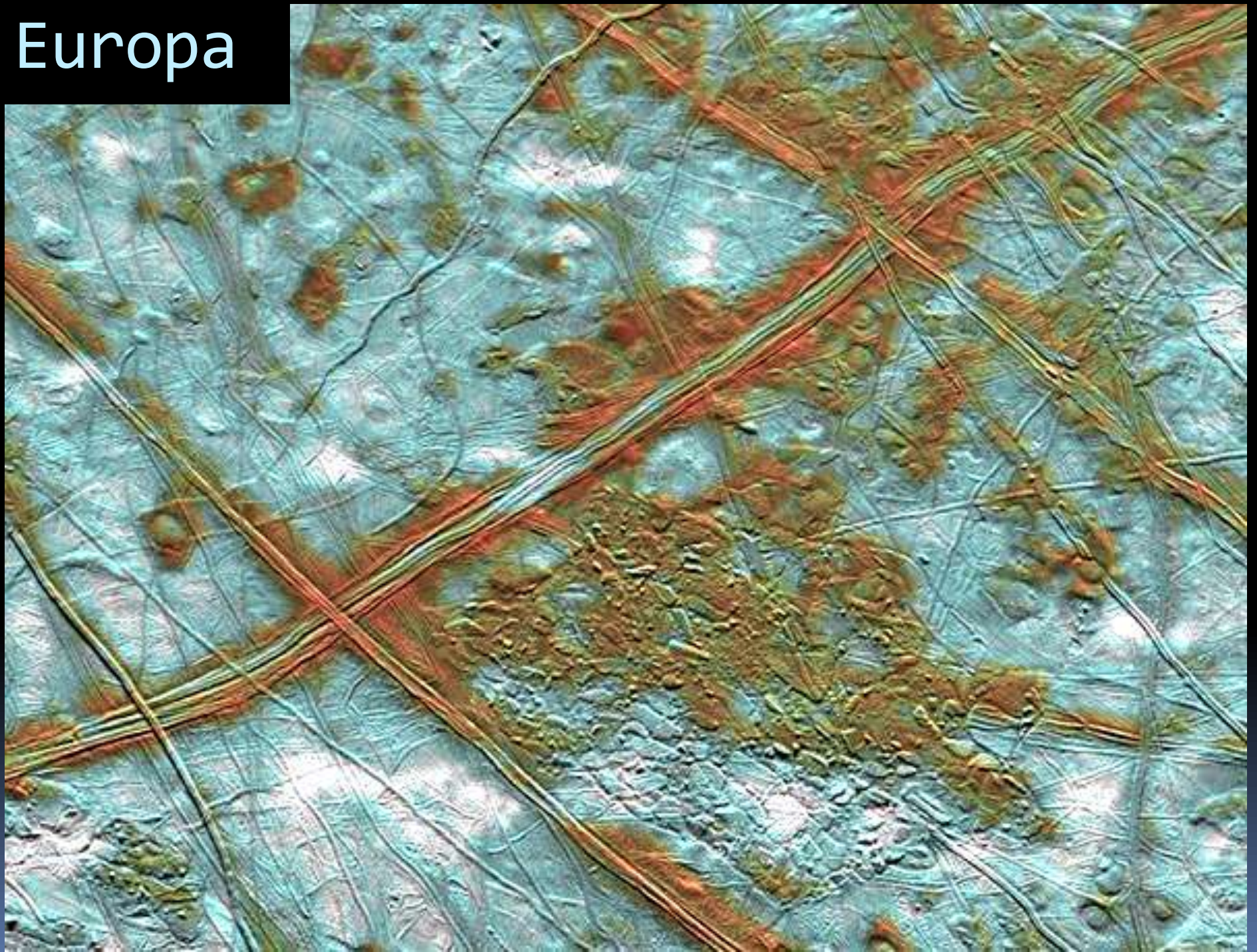
Europa (satélite)

Hielo y

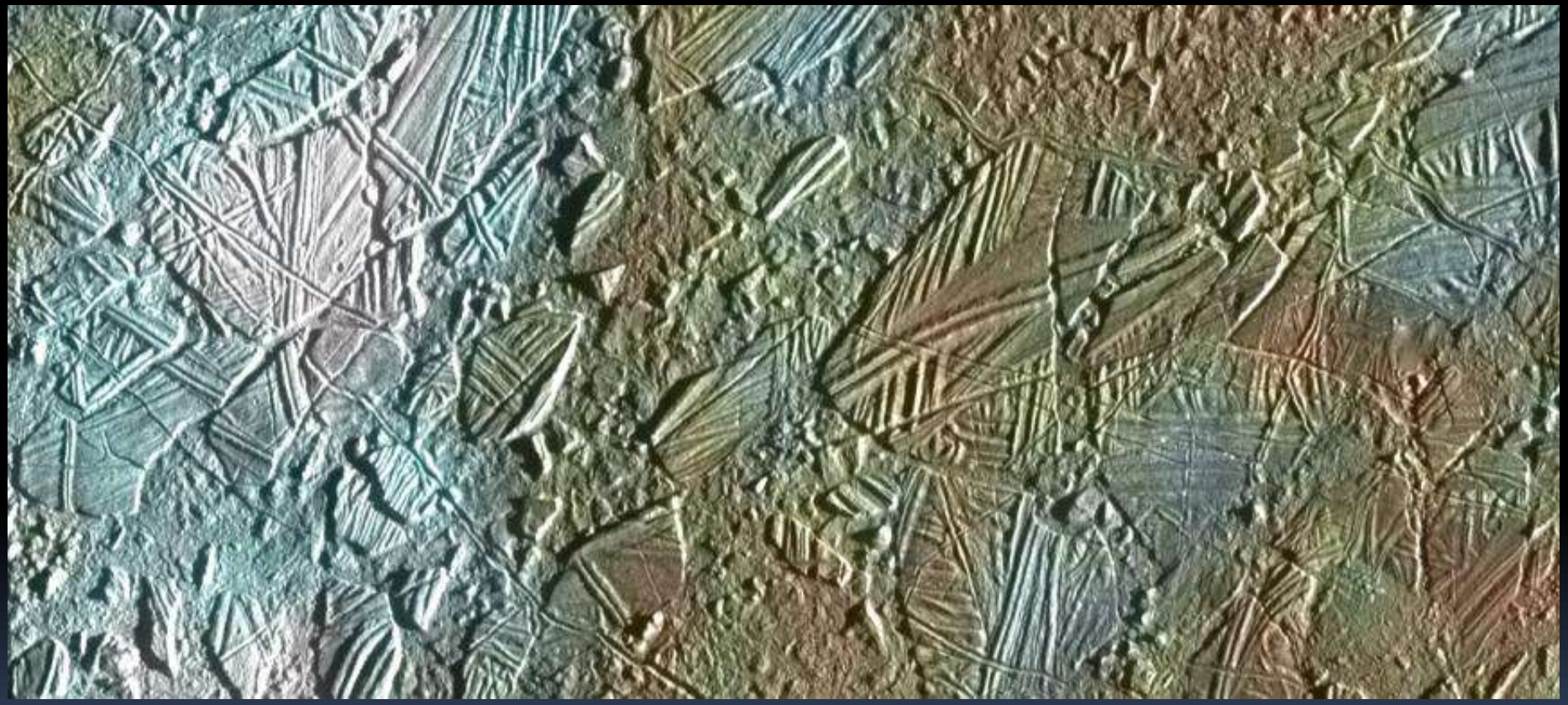
océano

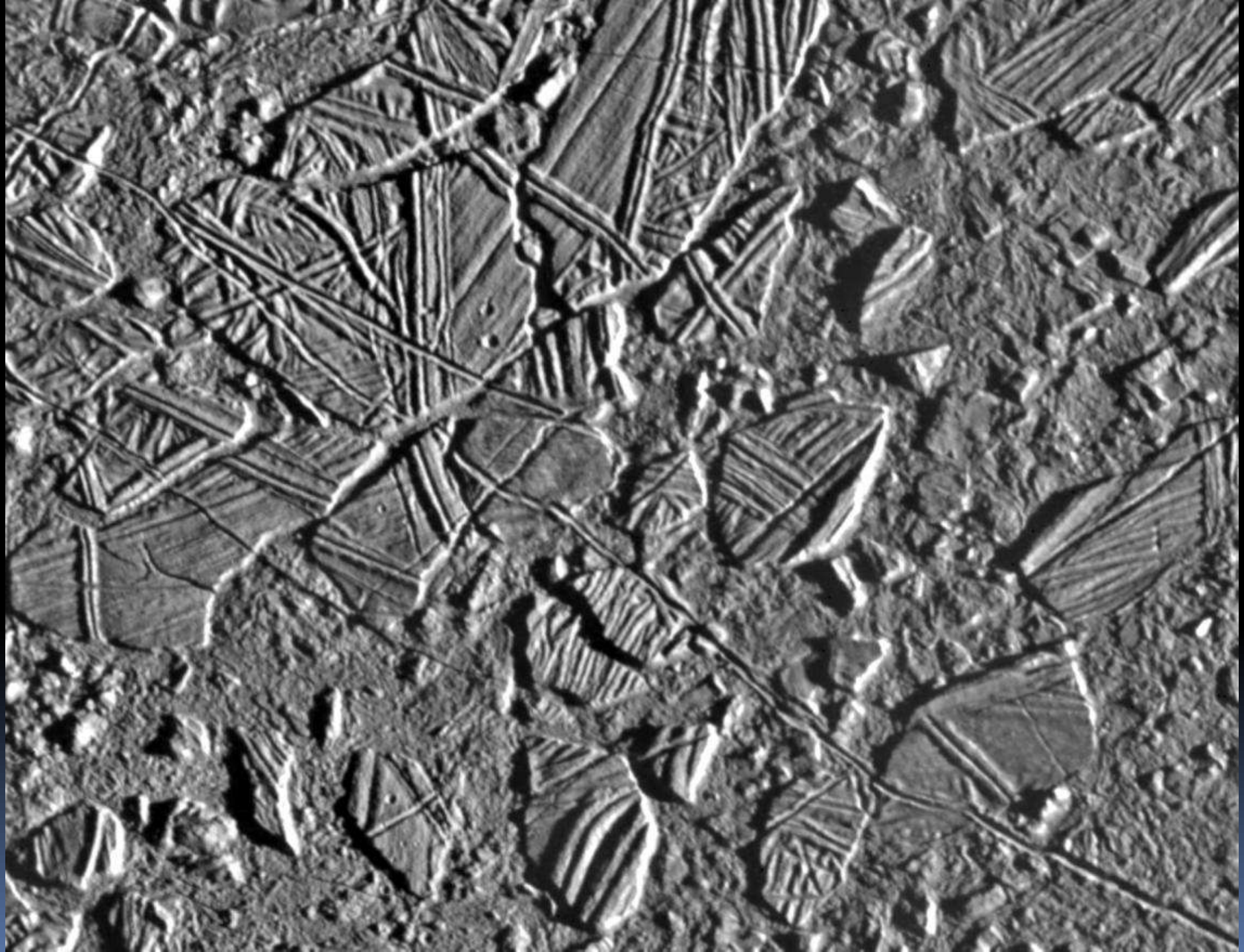


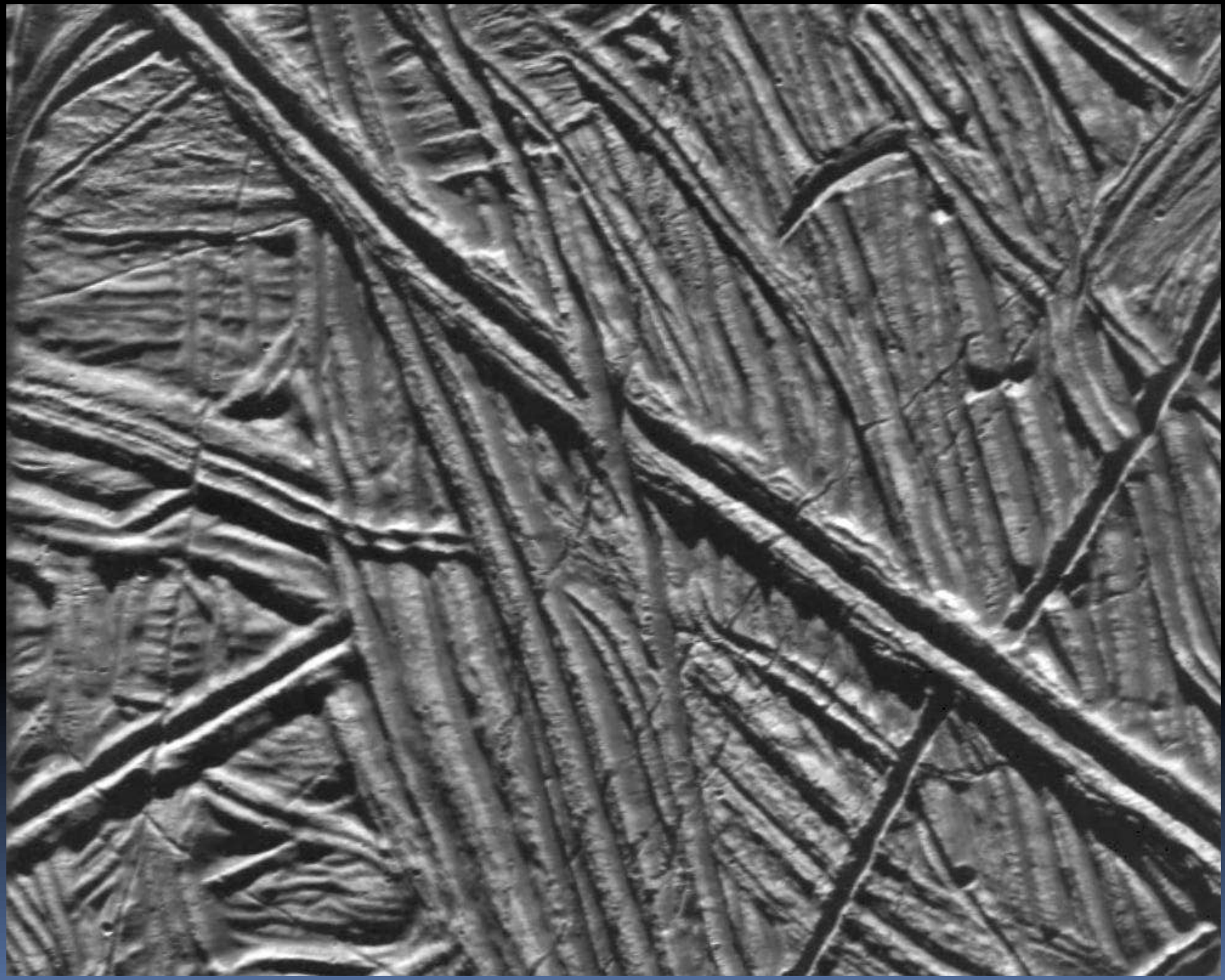
Europa



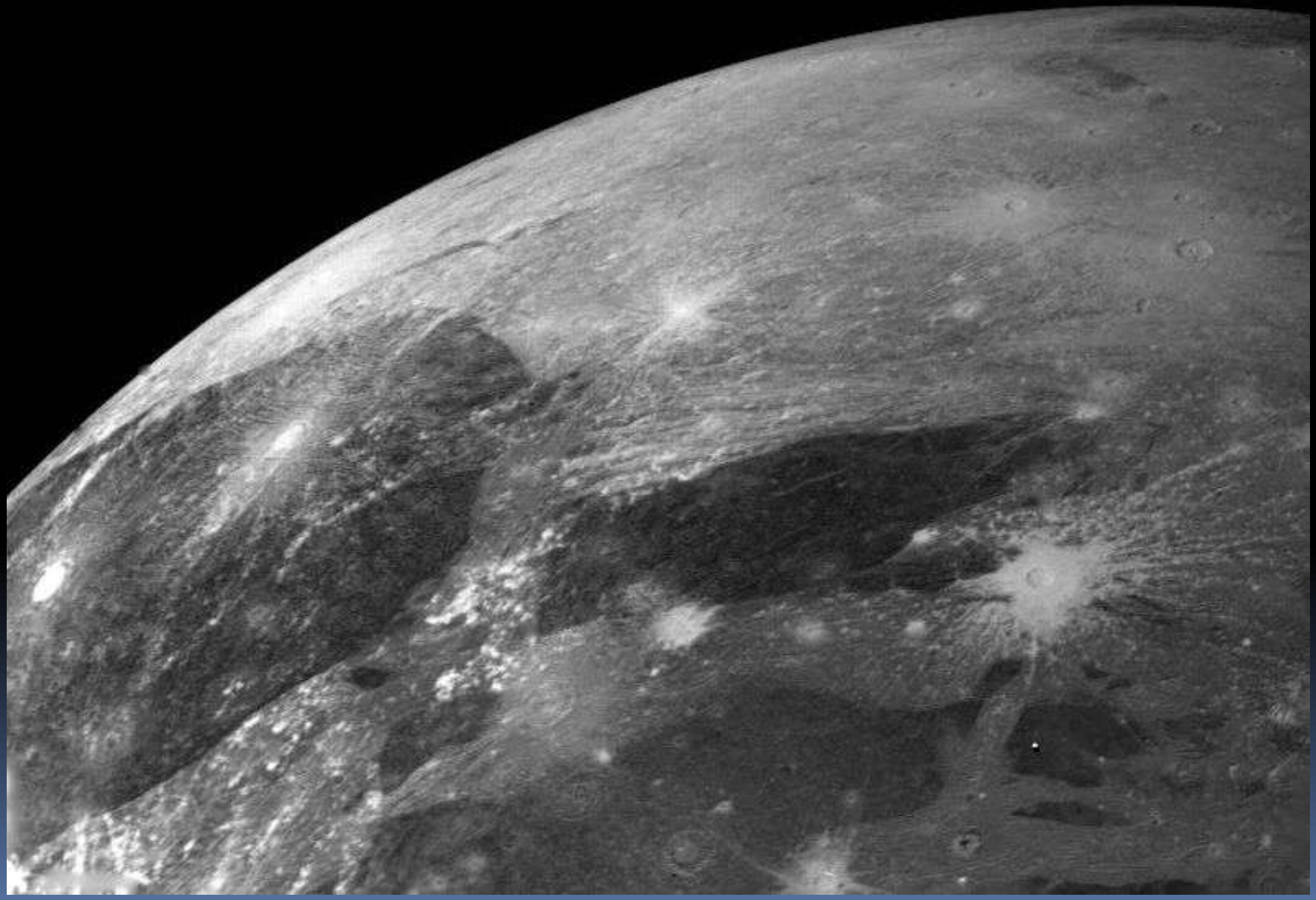
Europa



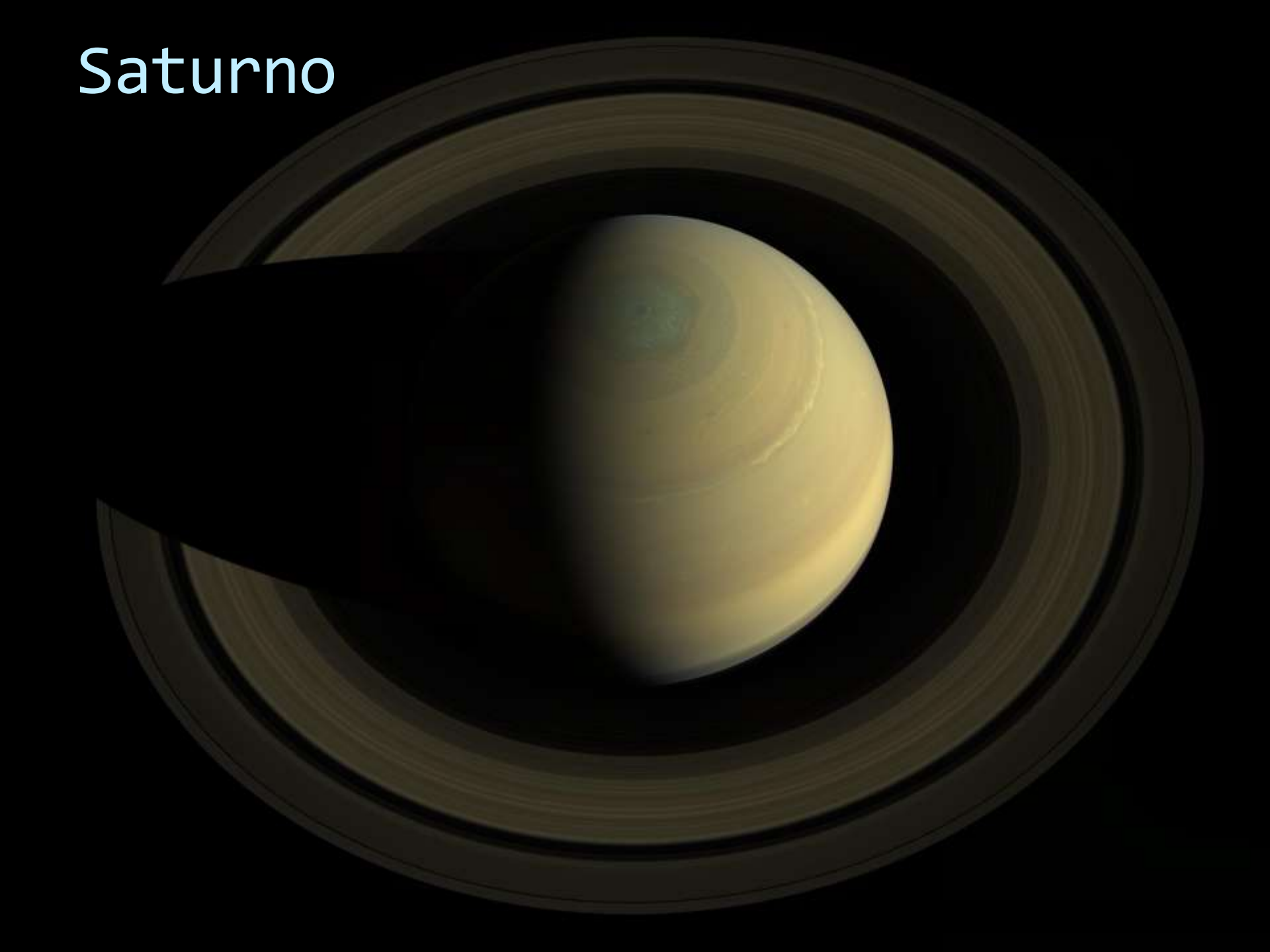




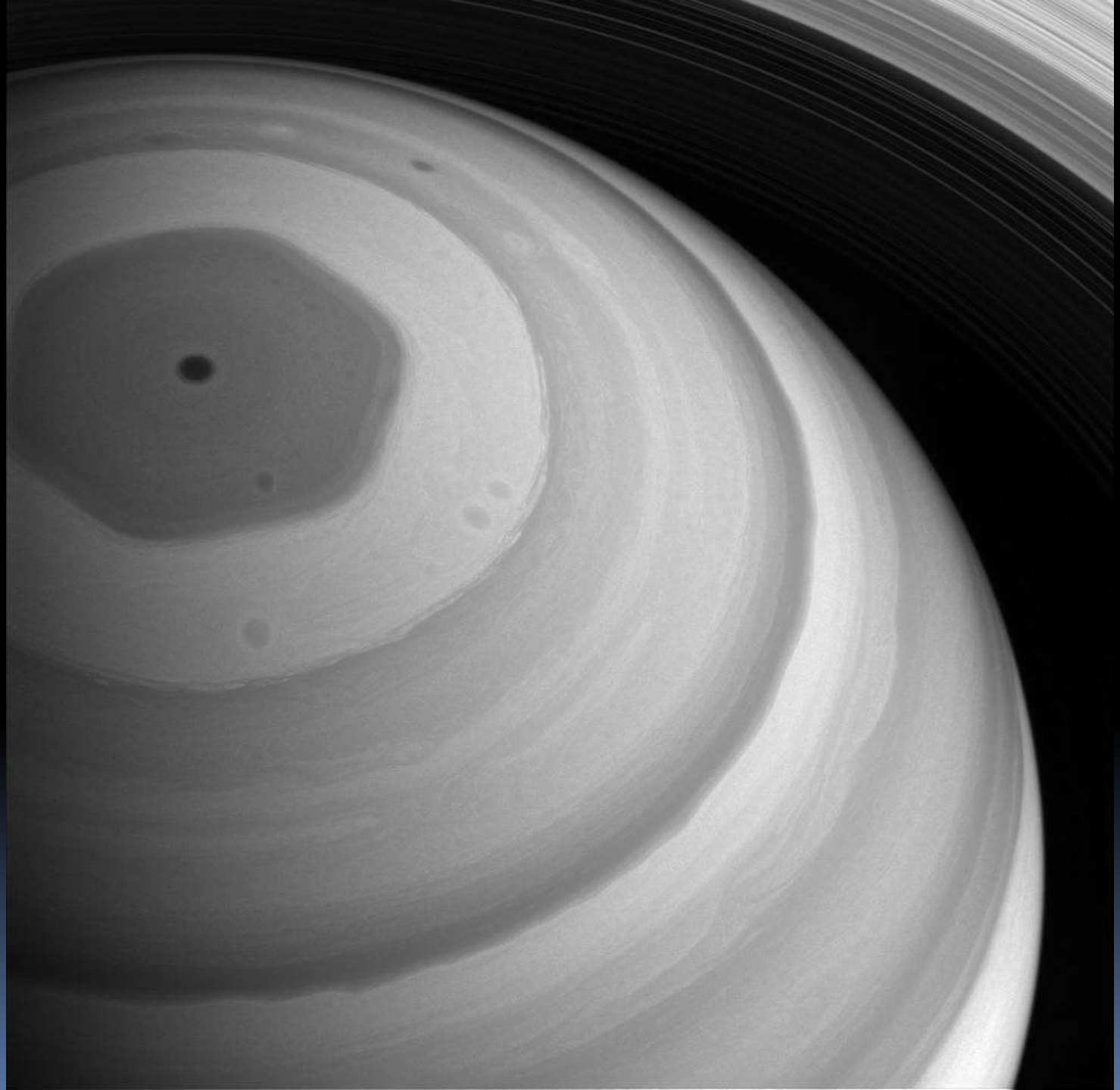
Ganímedes



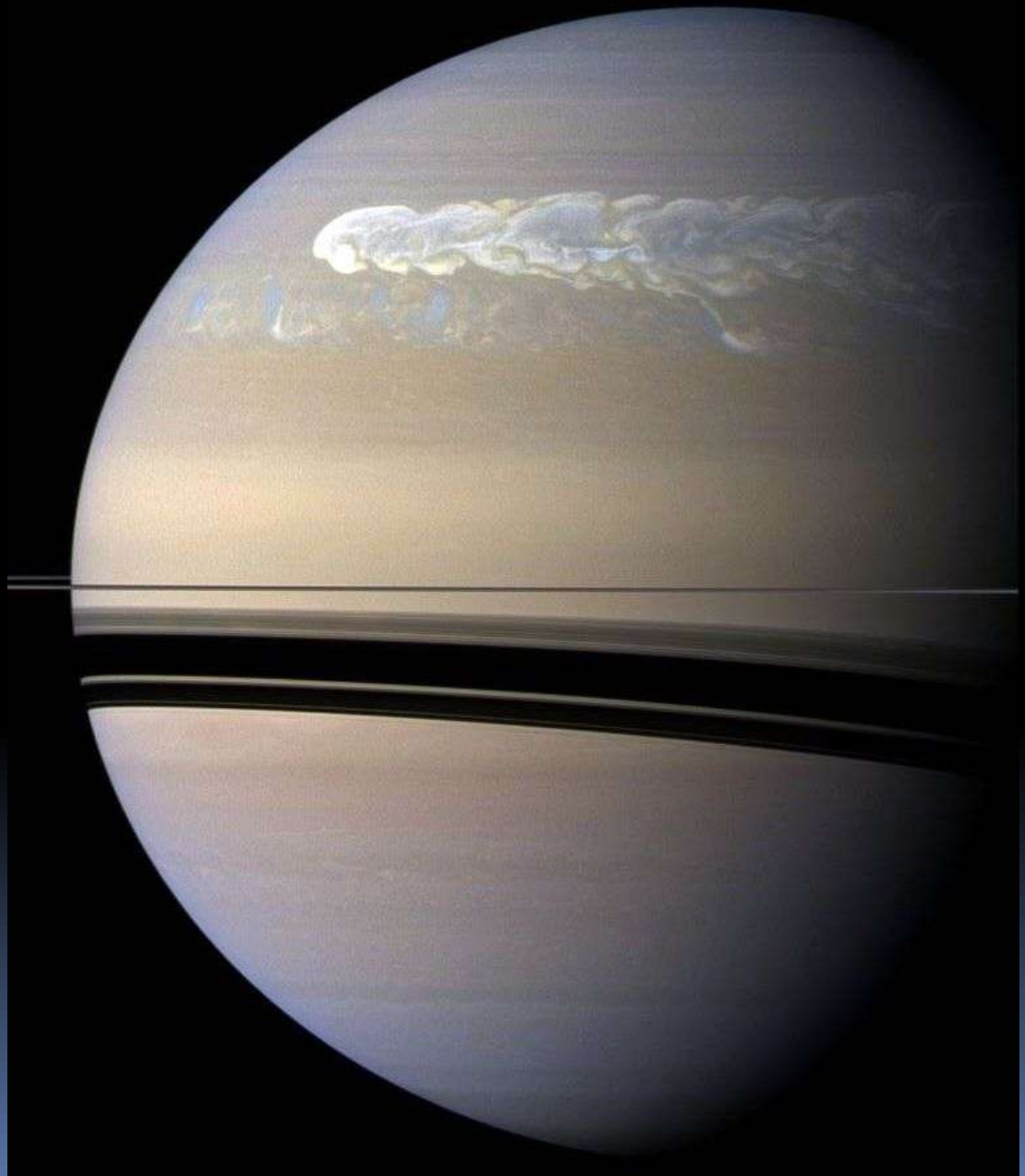
Saturno

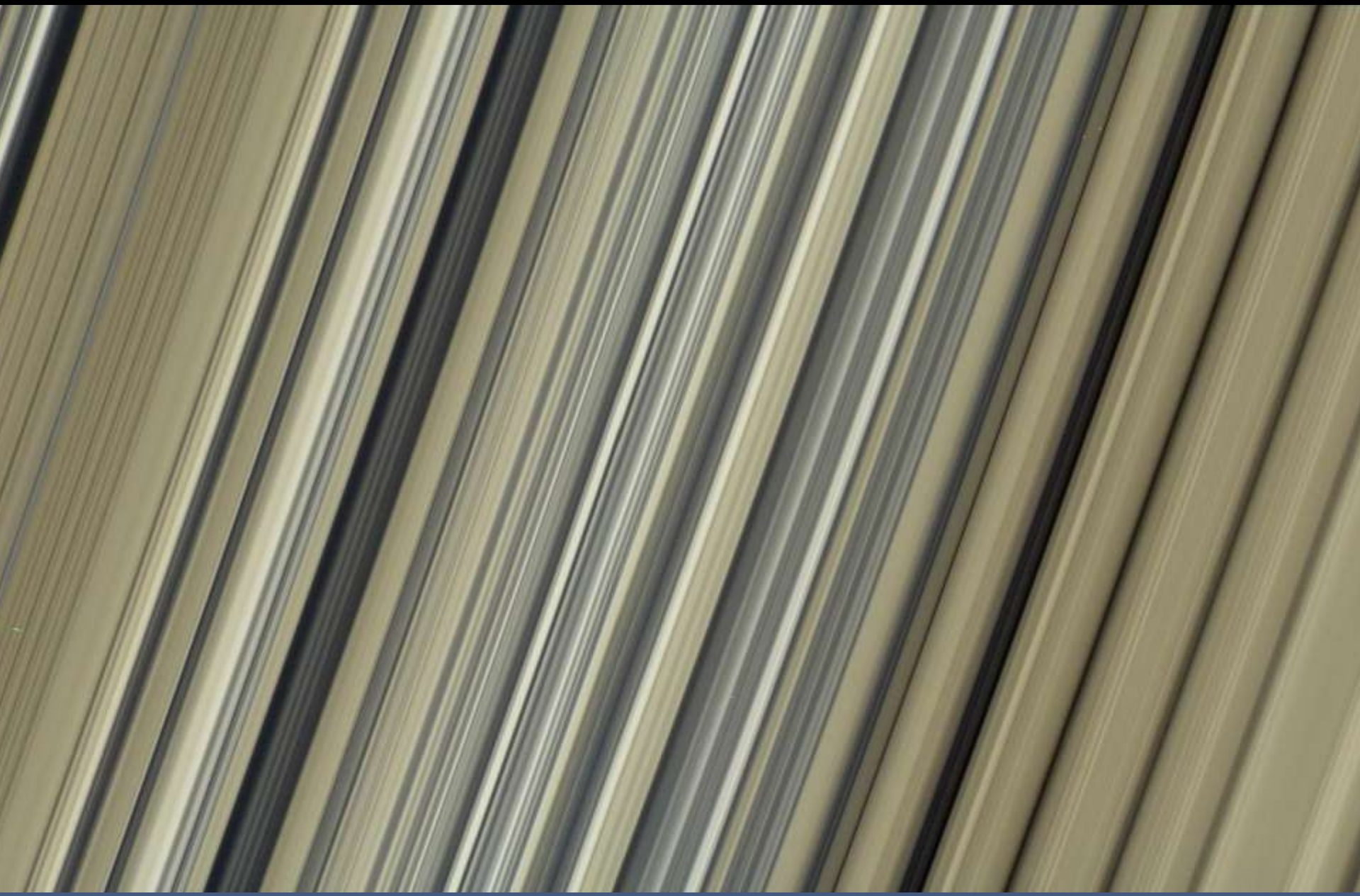


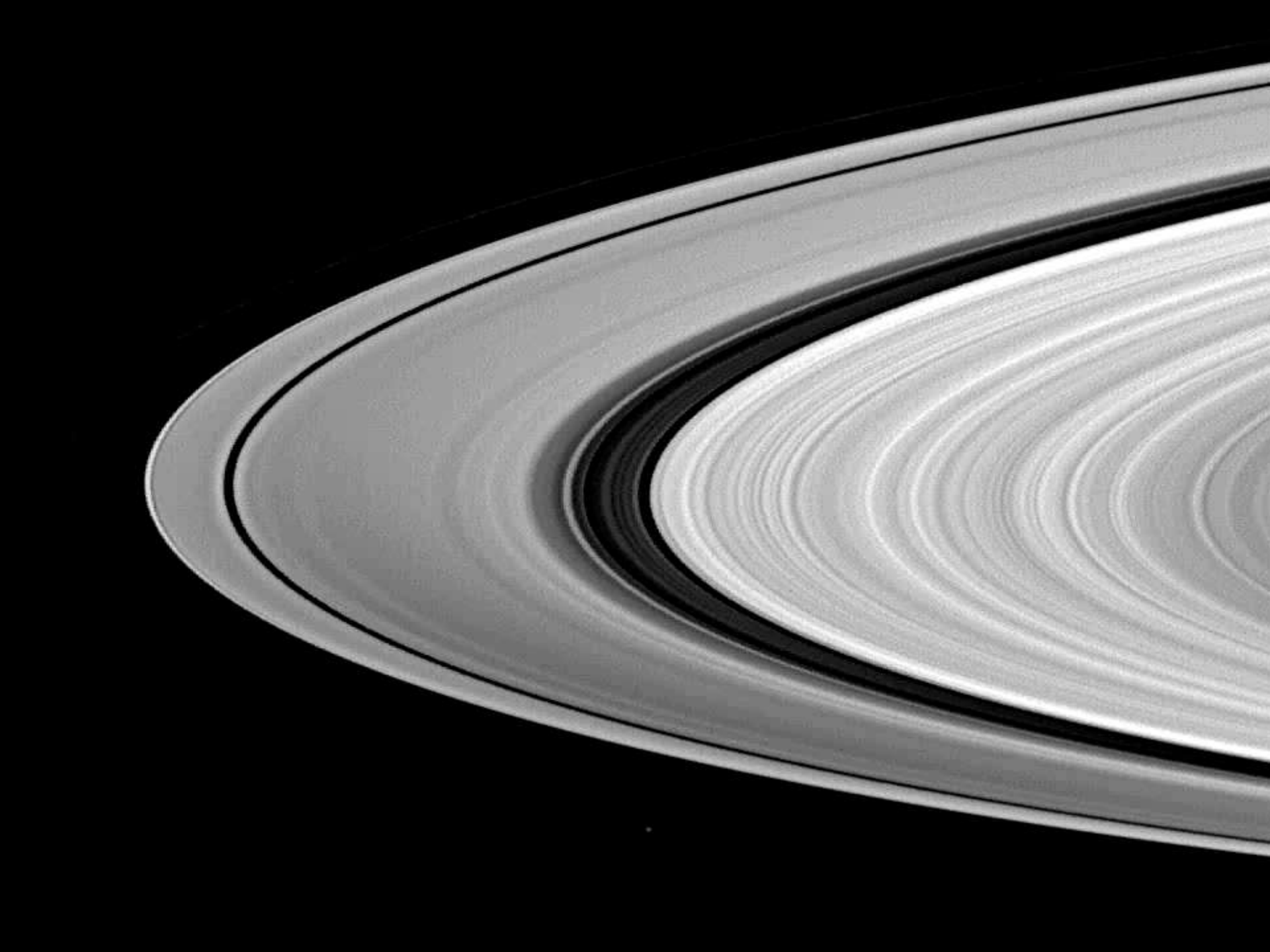
Saturno



Tormenta

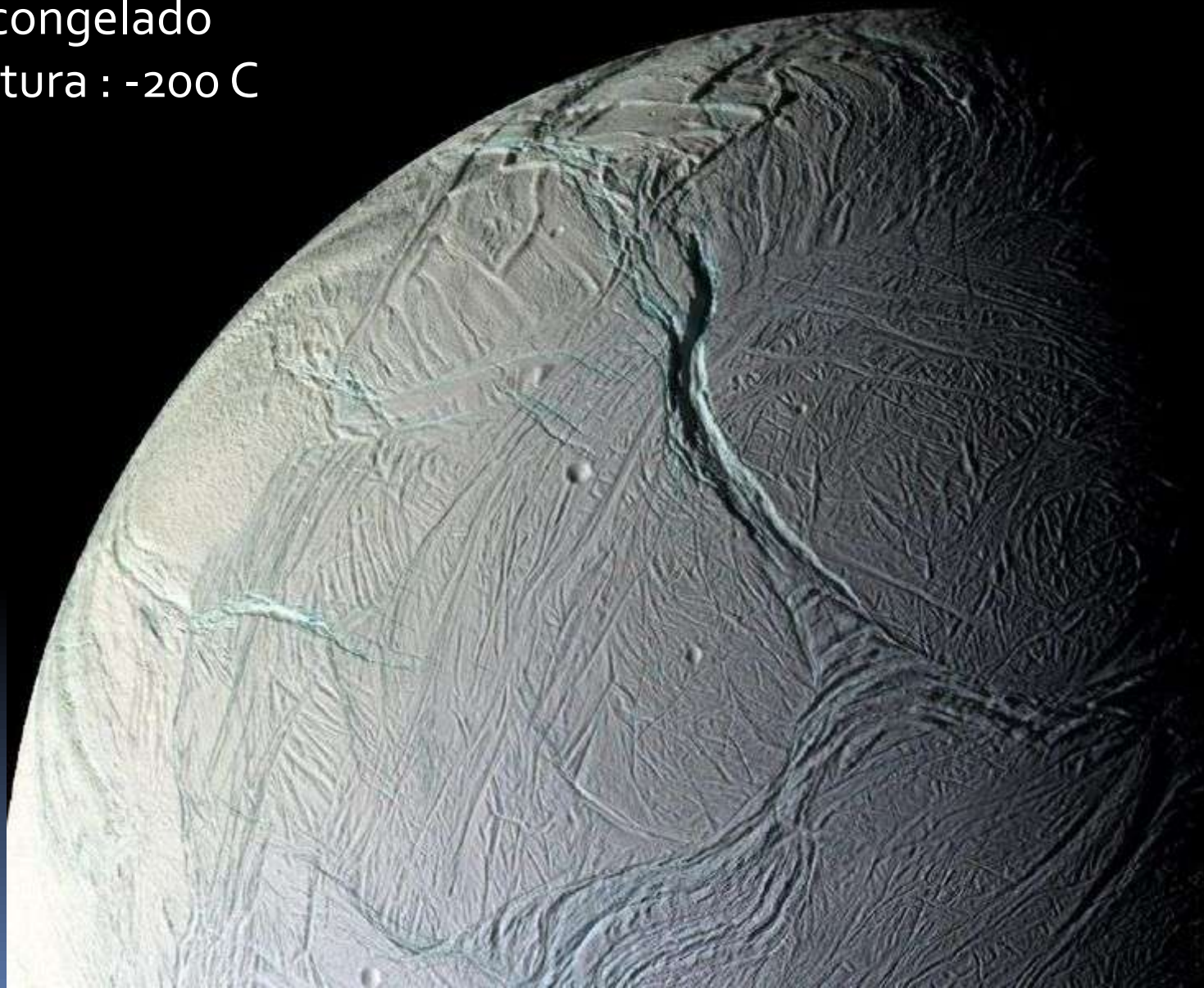






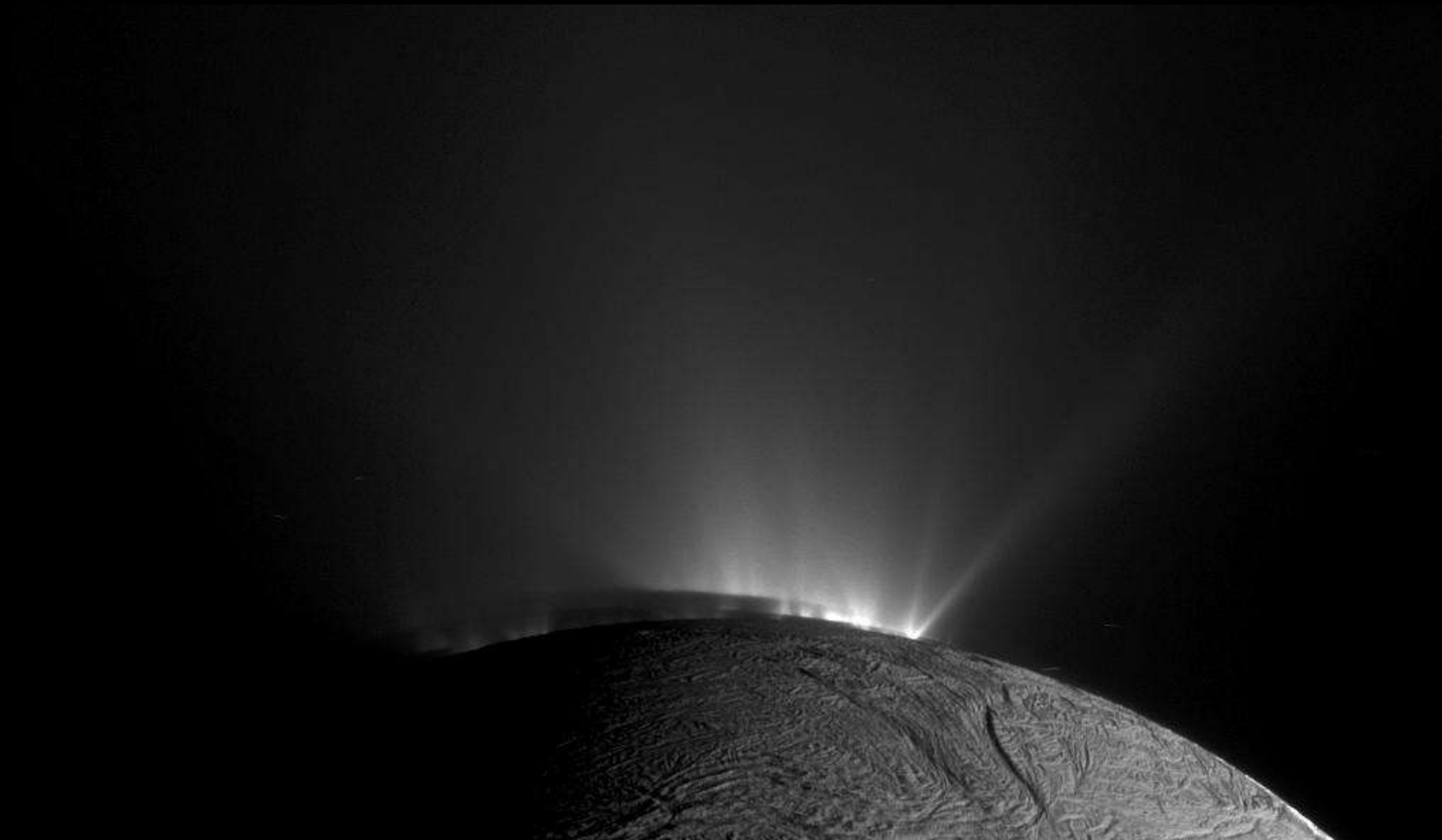
Encelado

Océano congelado
Temperatura : -200 C

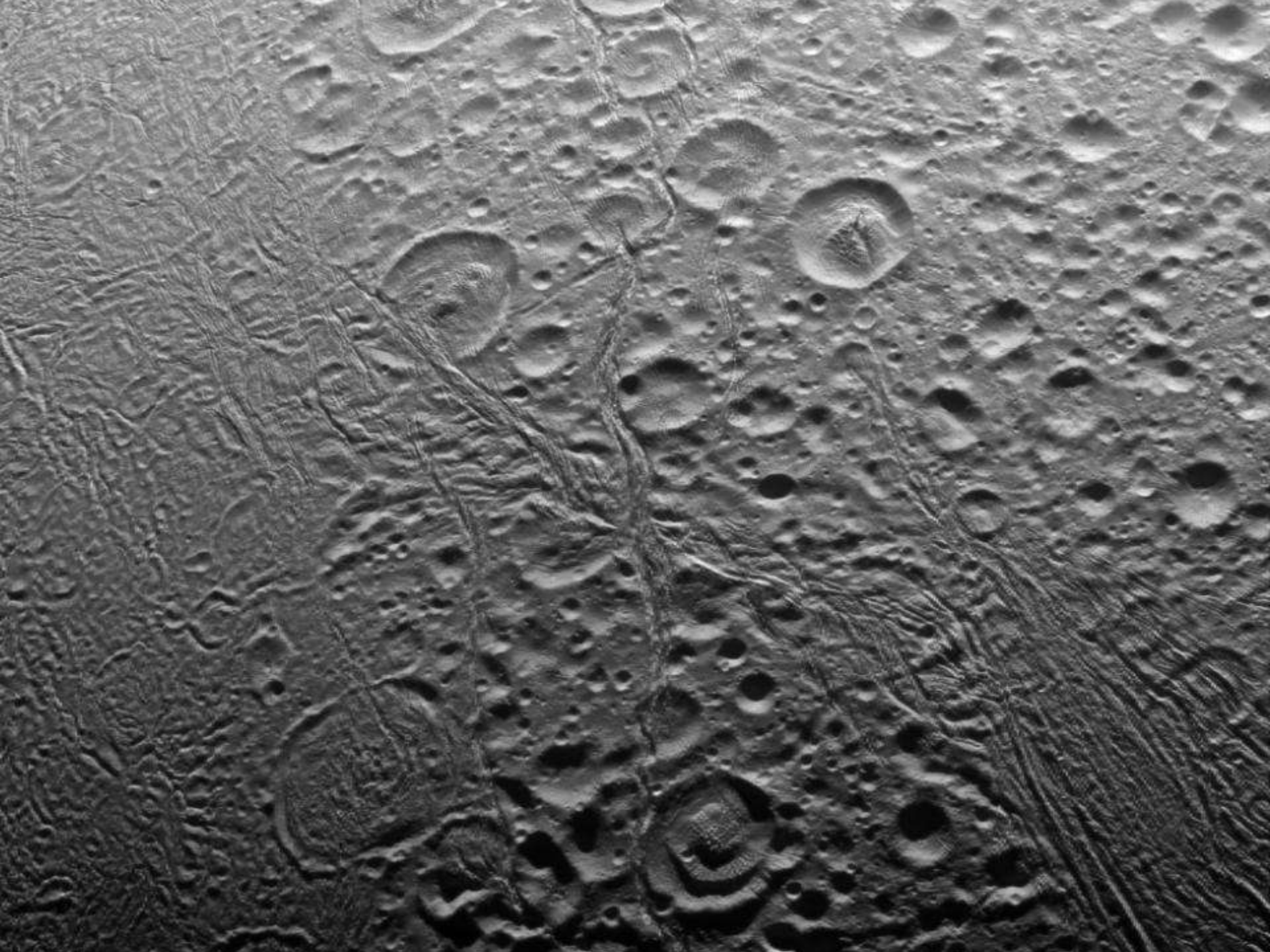


Encelado

Compuestos orgánicos



Encelado

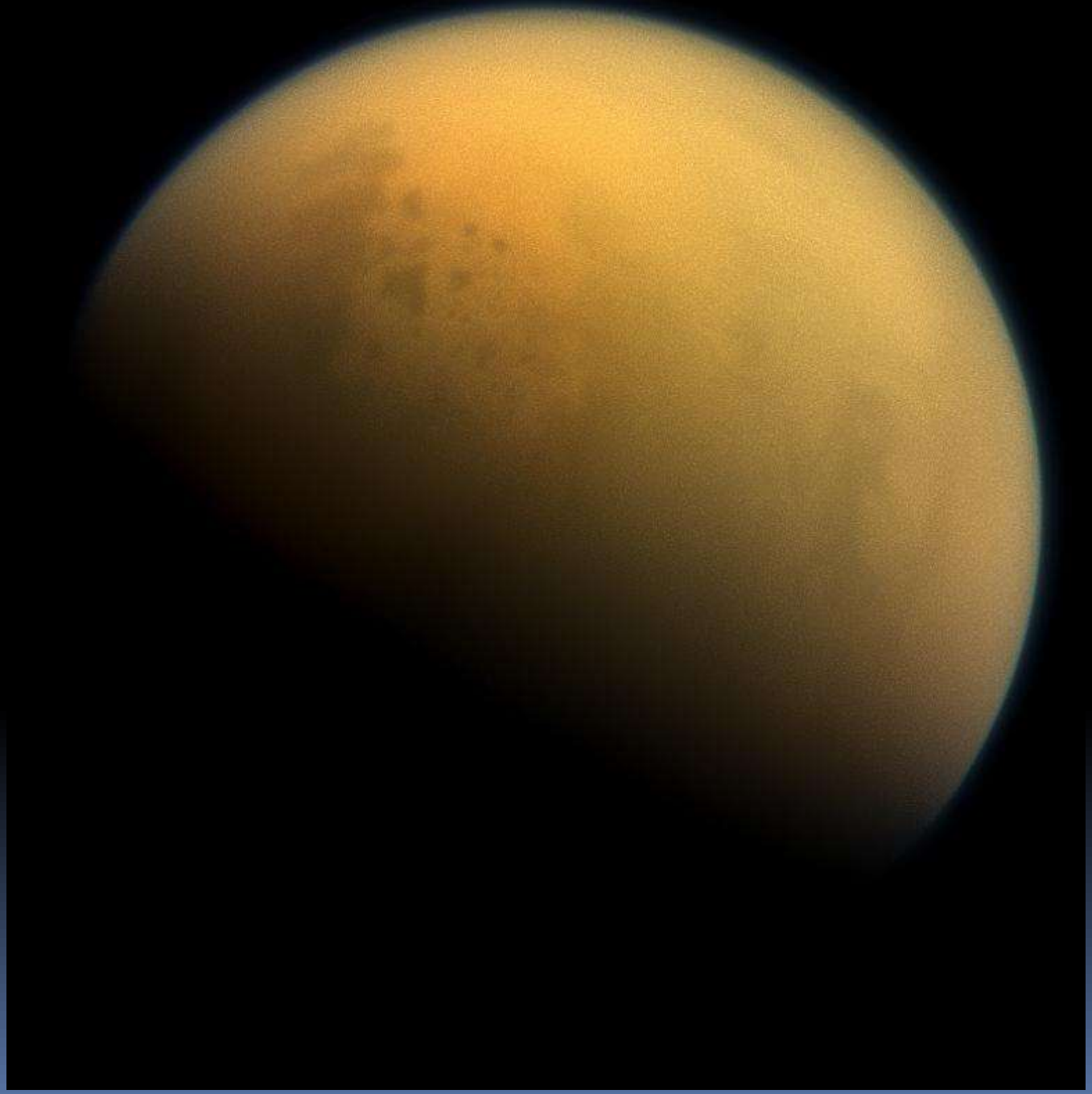


Glaciar terrestre

Titán

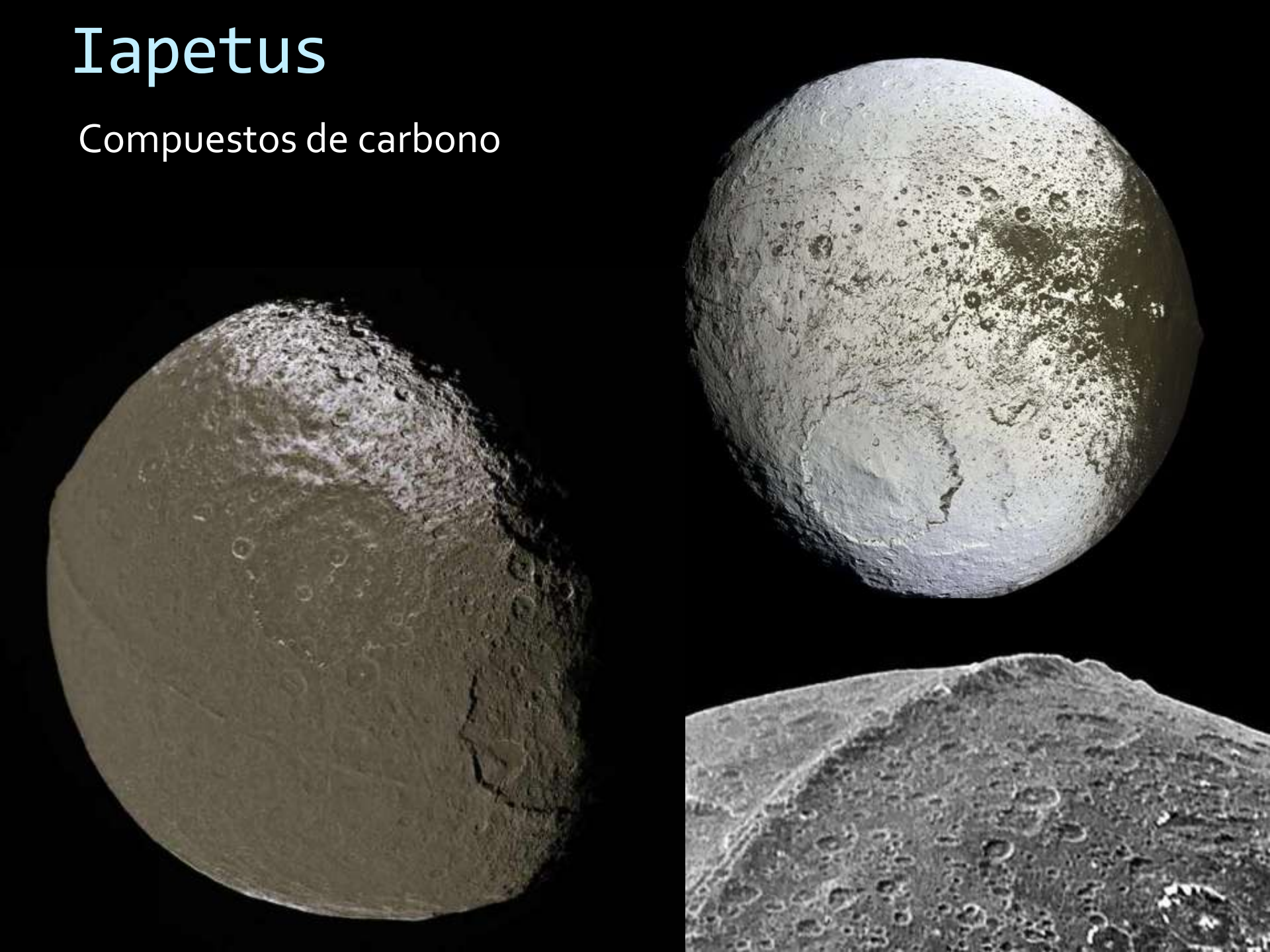
Atmósfera de Nitrógeno
Temperatura media = -170 C
Presión > 1 atm.
Metano sólido en superficie
Lagos de nitrógeno

Titán

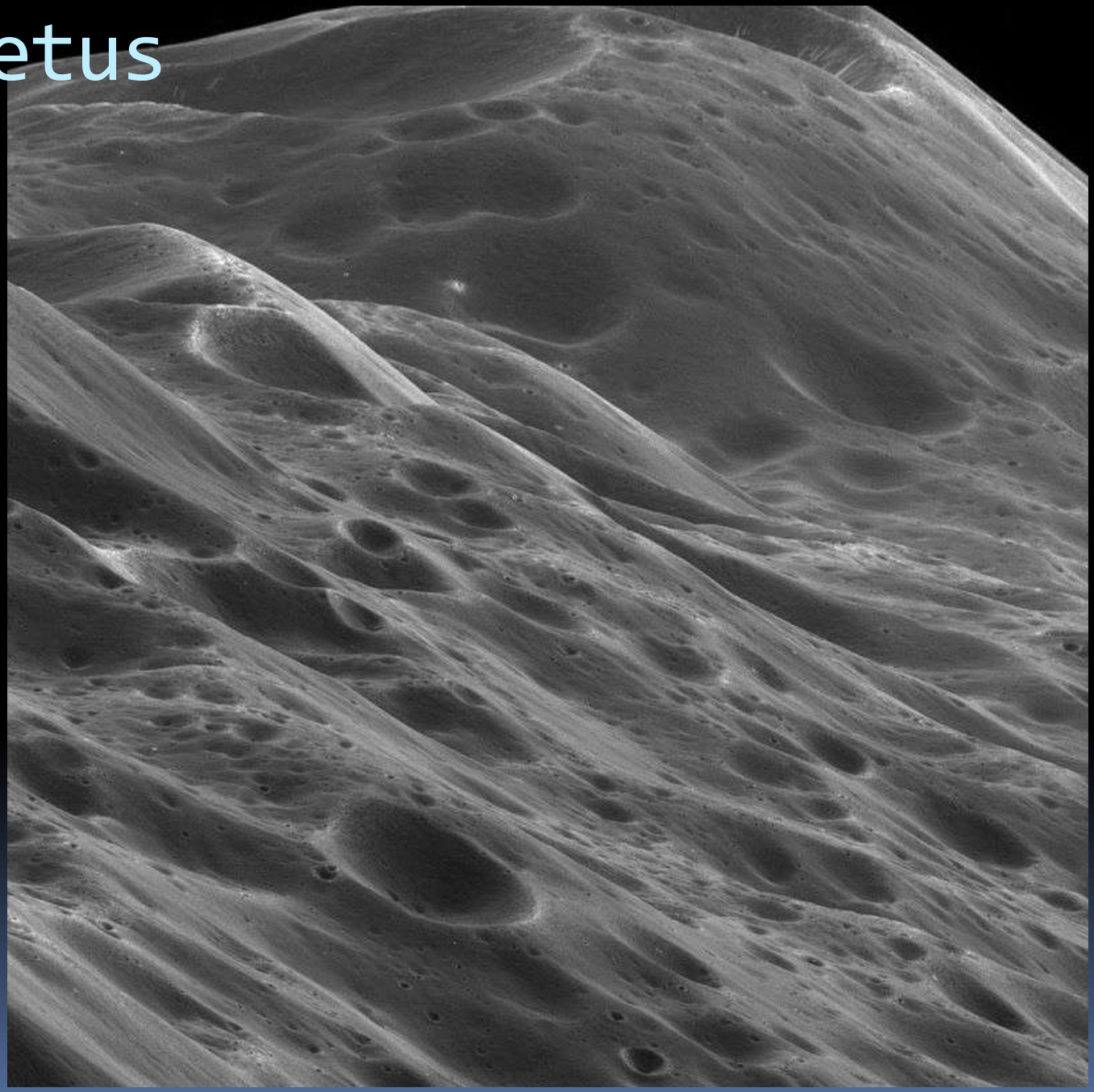


Iapetus

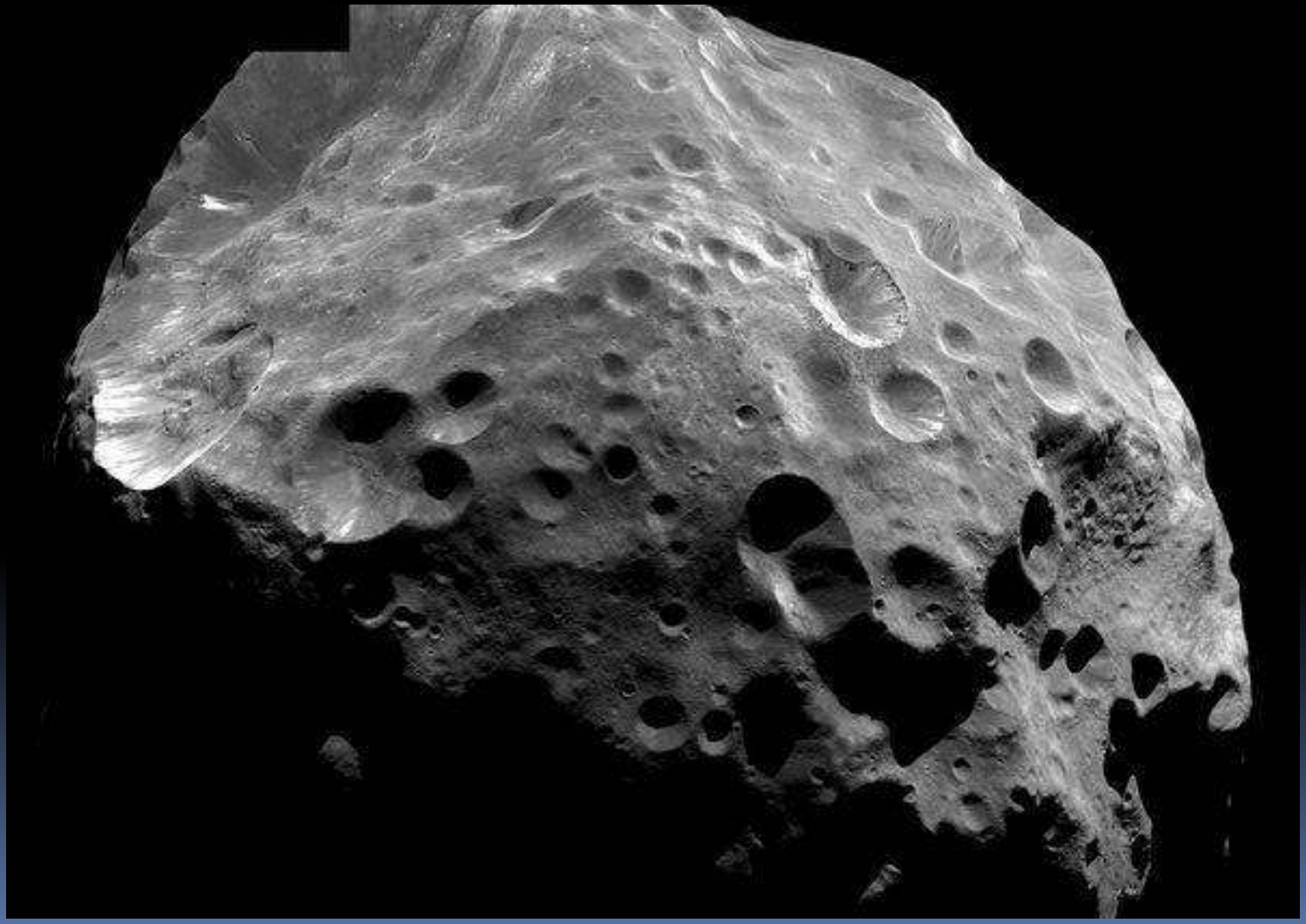
Compuestos de carbono



Iapetus



Phoebe

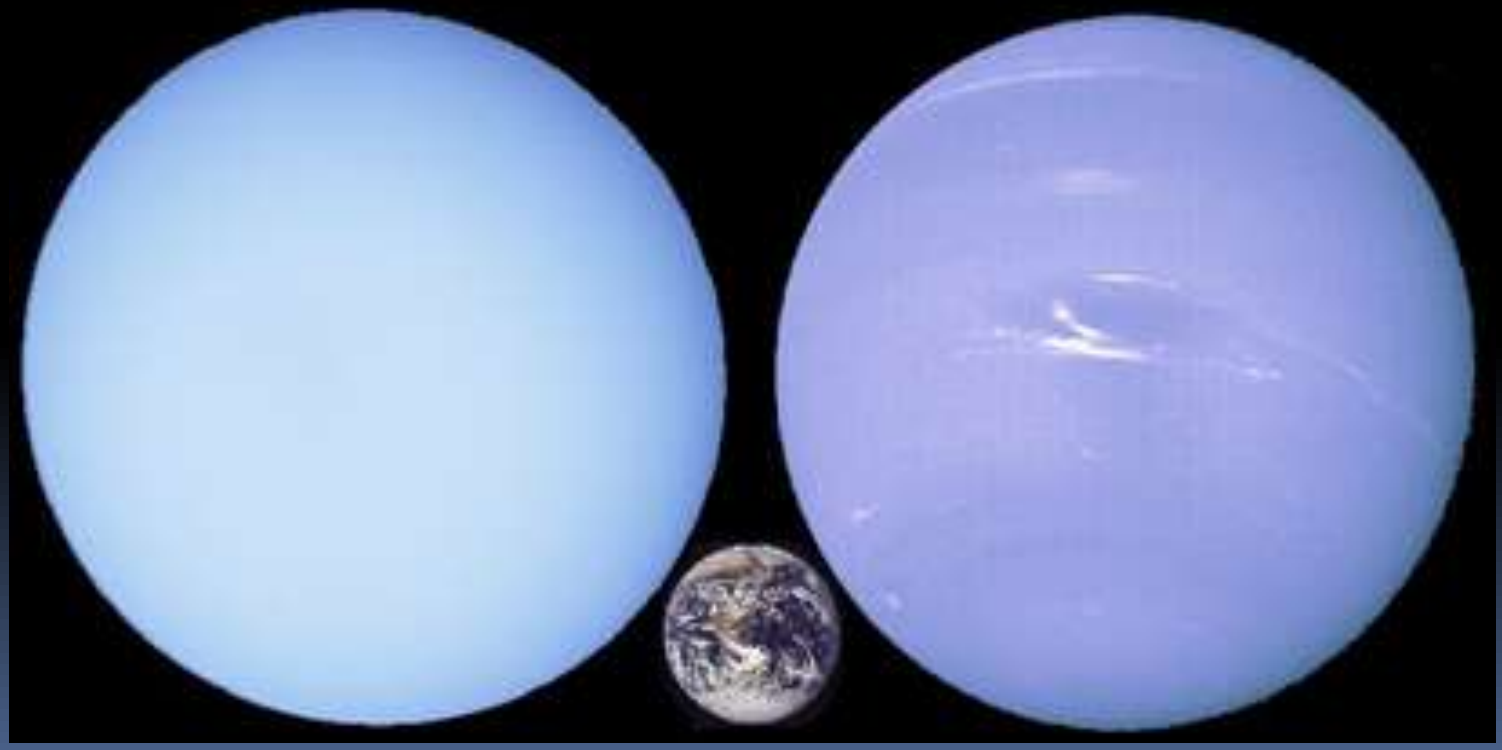


Hiperion

Alta porosidad

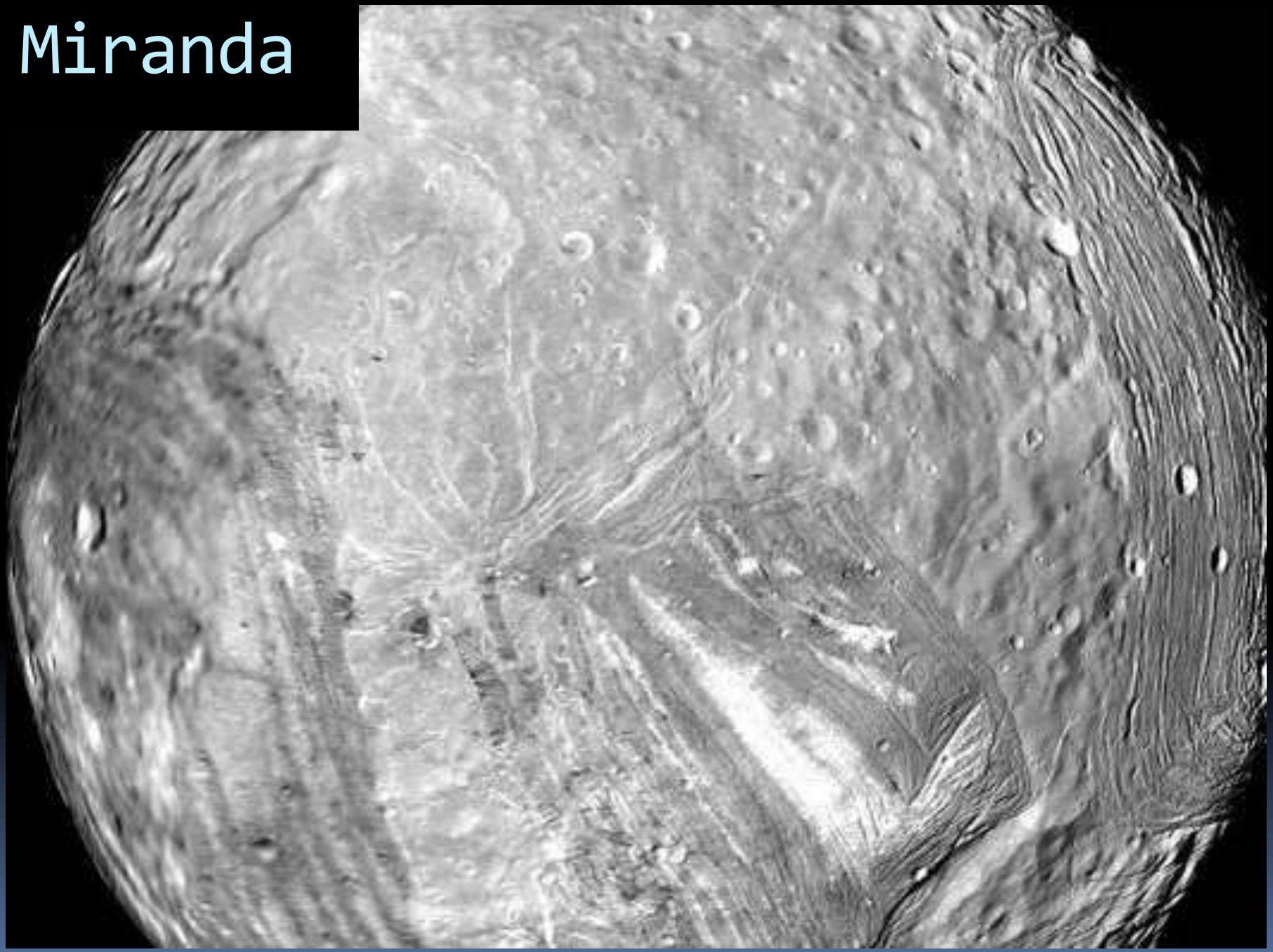
Urano y Neptuno

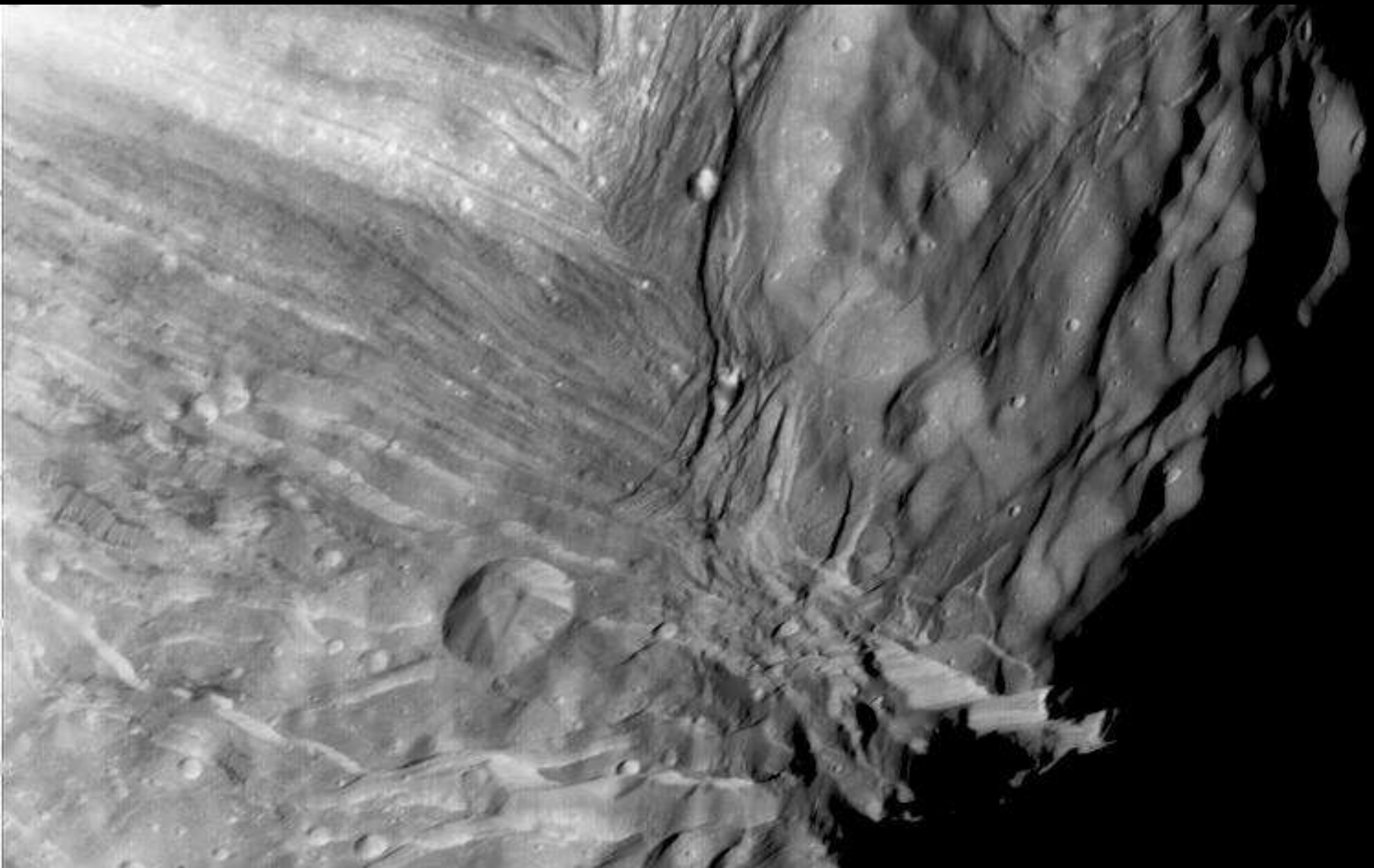
$CH_4 + NH_3$
Temp: -220 C

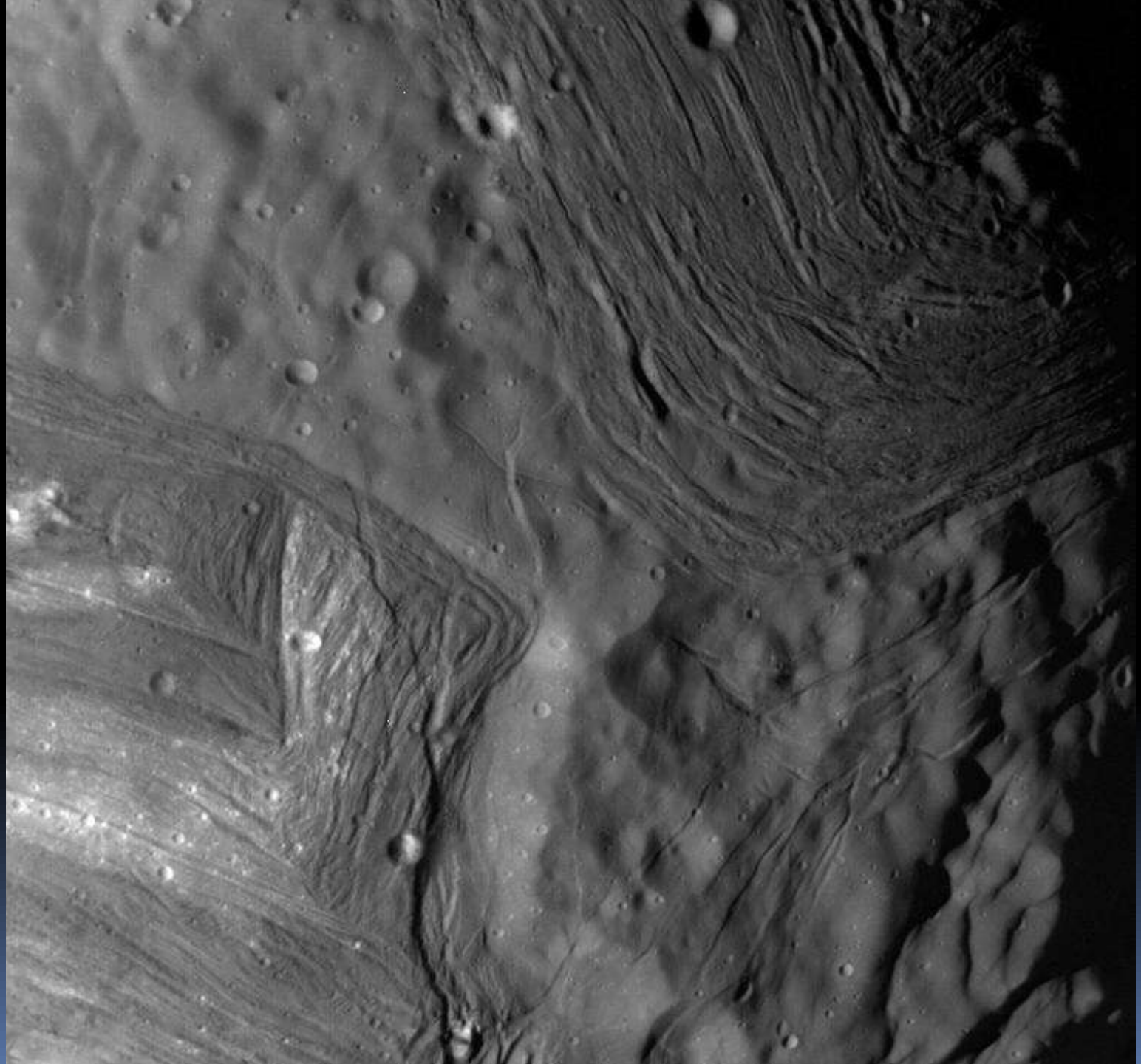


Ariel

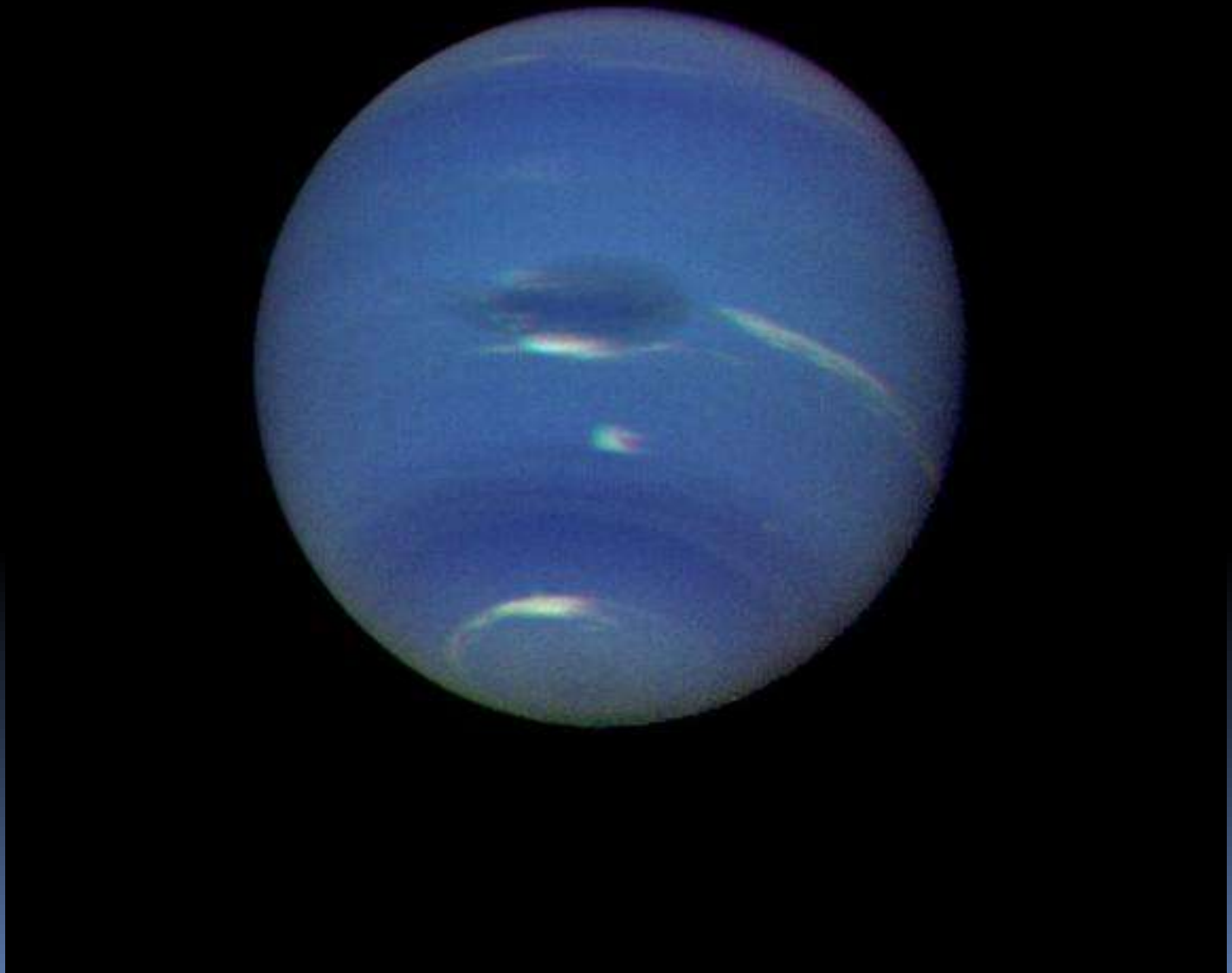
Miranda

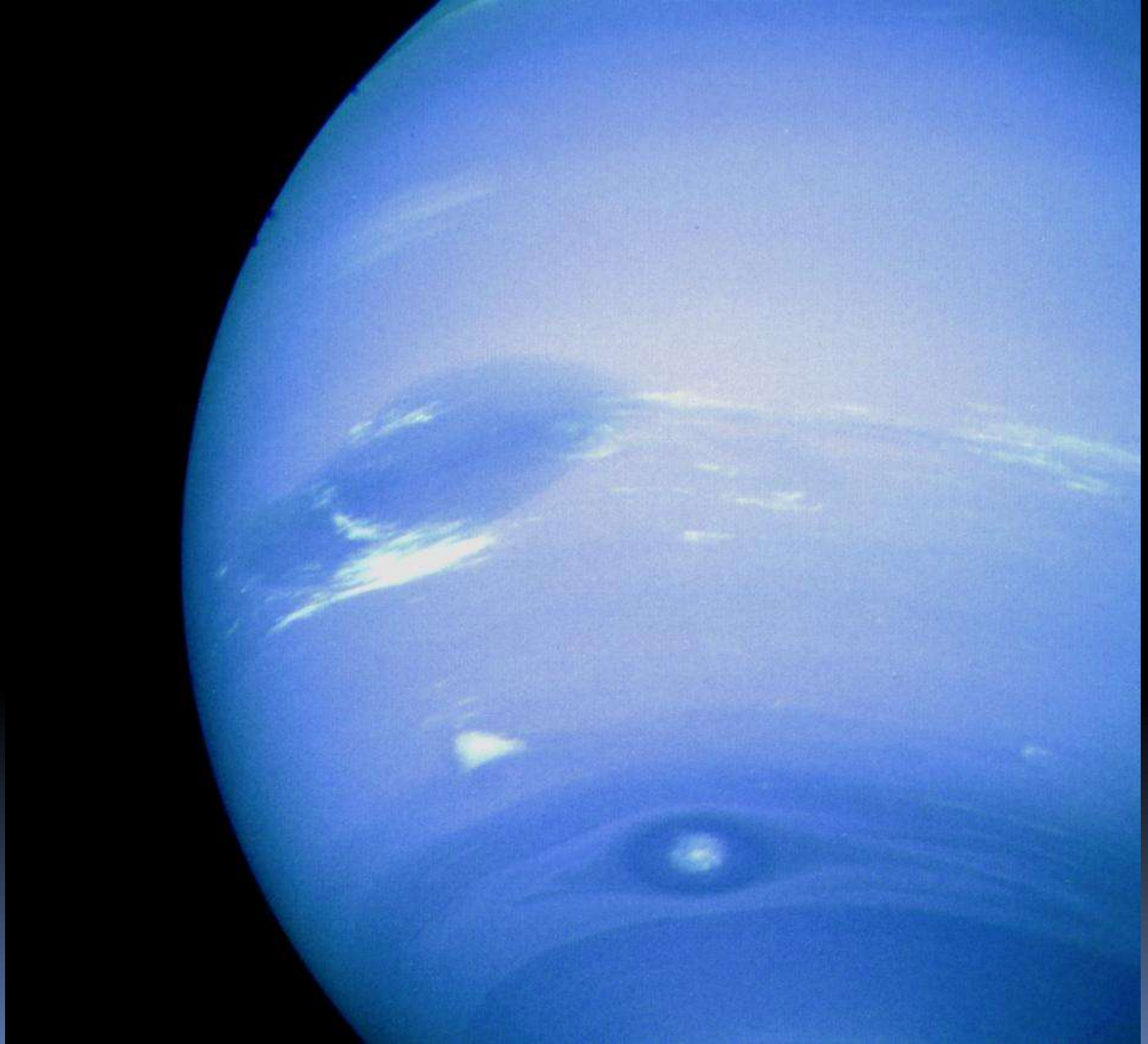




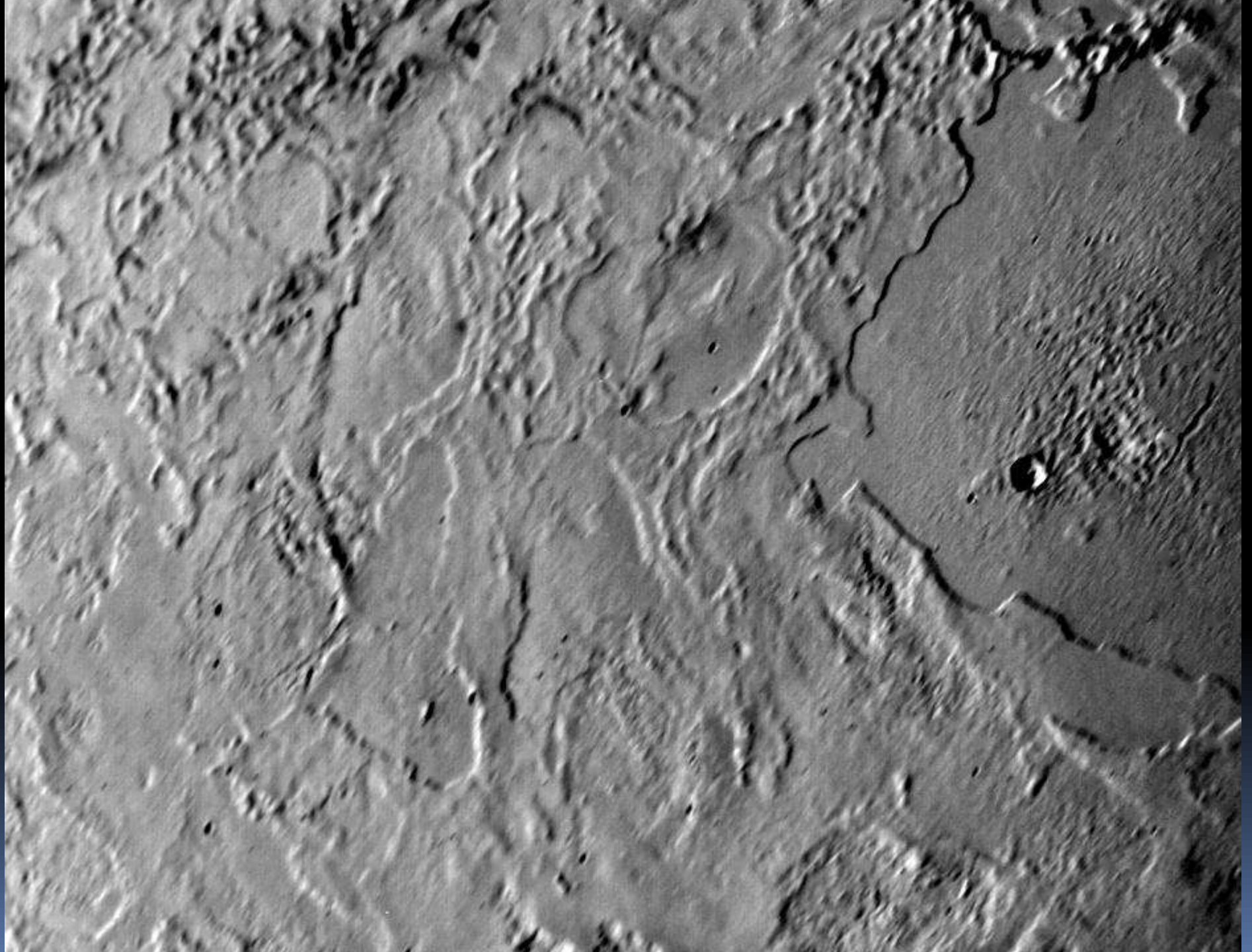


Neptuno





Tritón



Mayores satélites del SS

MAS ALLA DE NEPTUNO

Cinturón de Kuiper

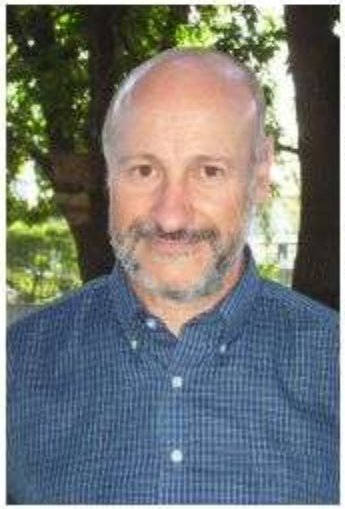
Julio Fernández

Division for Planetary Sciences
of the AMERICAN ASTRONOMICAL SOCIETY

MEETINGS | PUBLICATIONS | ADVOCACY | EDUCATION | CAREERS | MEMBERSHIP

2018 Prize Recipients

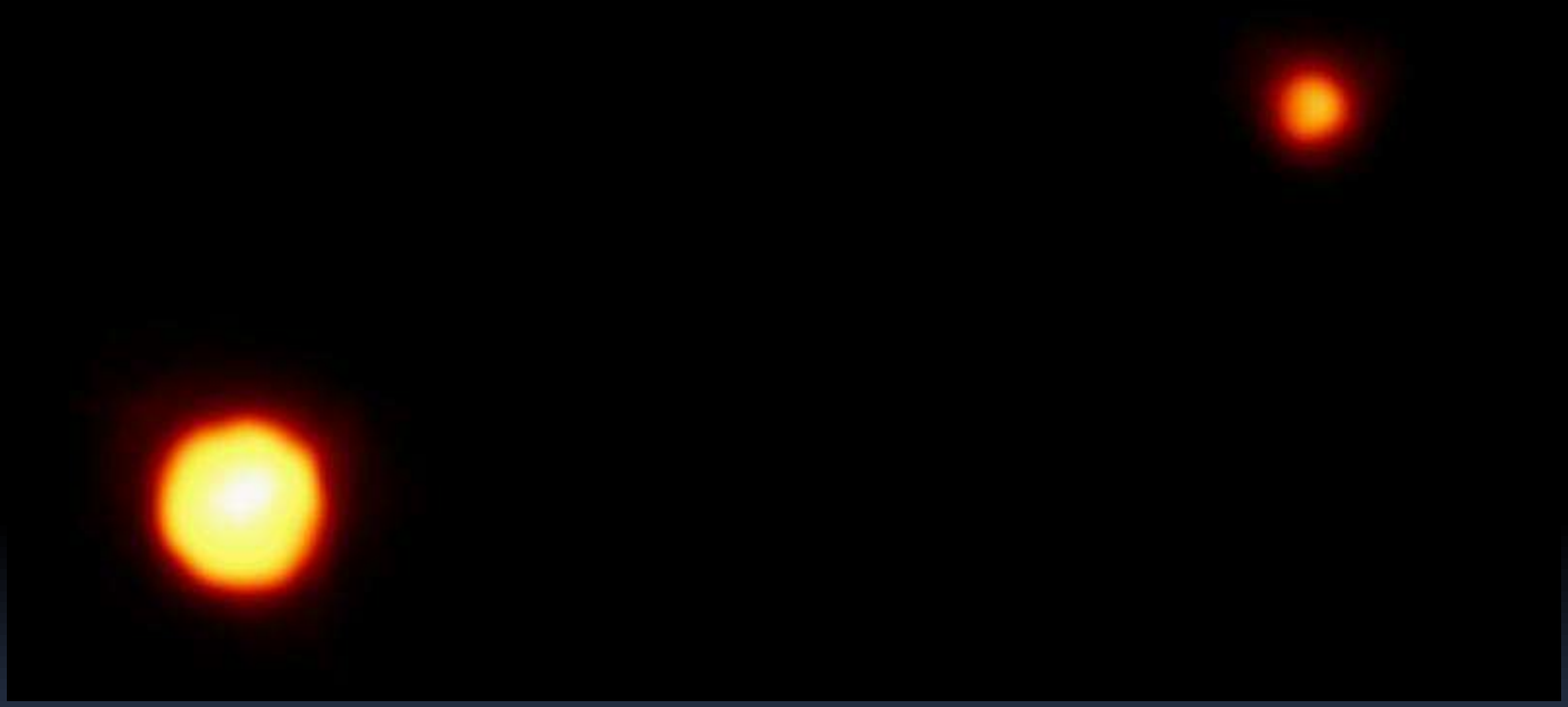
Julio Ángel Fernández Alves – 2018 Gerard P. Kuiper Prize



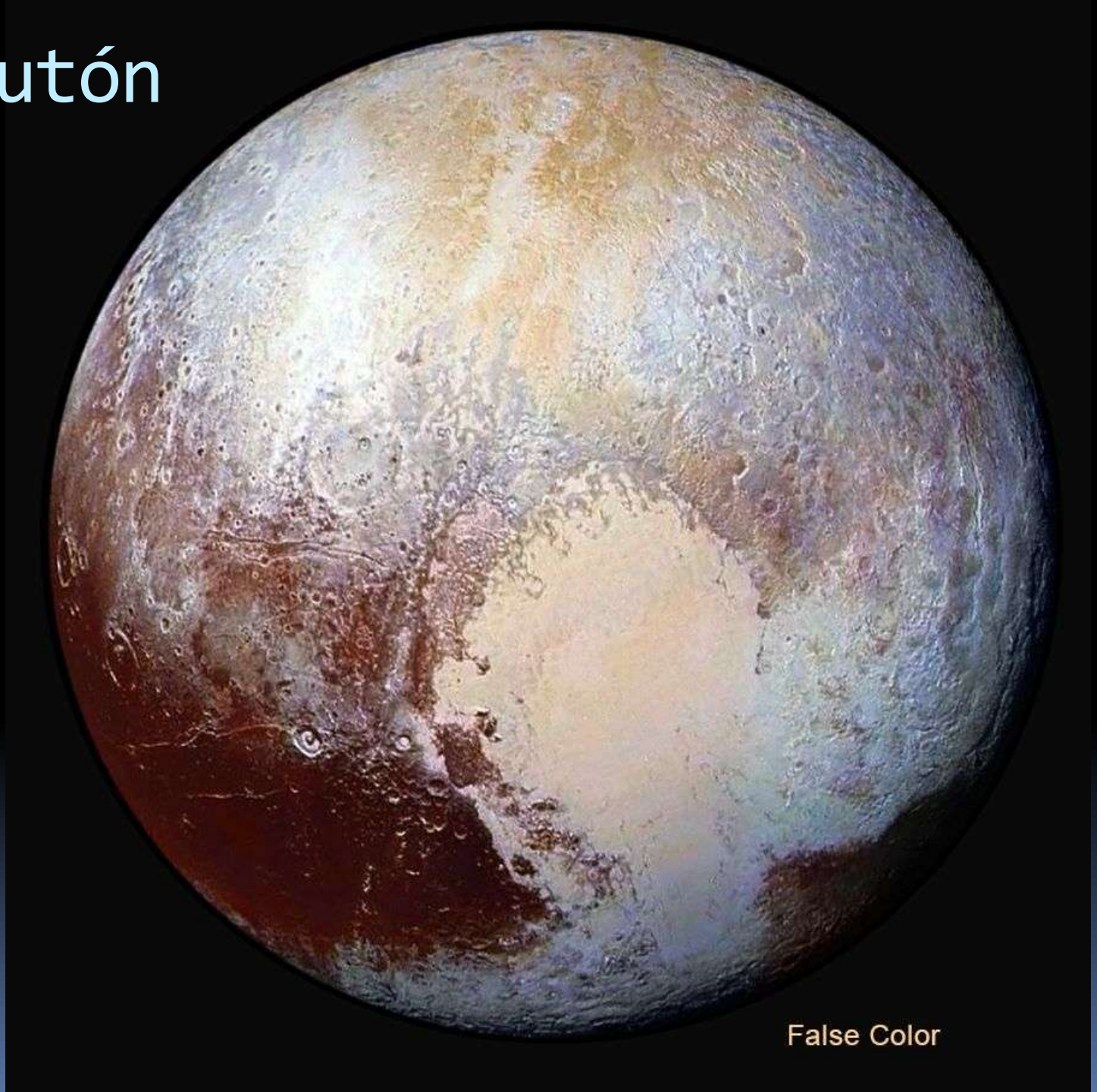
DPS awards the 2018 Gerard P. Kuiper Prize for outstanding contributions to the field of planetary s
de Ciencias, Universidad de la República, Montevideo, Uruguay) for his research focusing on the o
dynamical evolution of comets. Prof. Fernández's 1980 paper "On the Existence of a Comet Belt E
discovery of the Kuiper belt. In the same year he published another seminal paper showing that Oo
Uranus region, having been scattered by those planets' perturbations; this population of scattered c
seminal contribution introduced the fundamental concept behind the present formation models invo
early solar system. In addition to his scientific contributions, Dr. Fernández has been tireless in insp
integration of South American planetary scientists with colleagues around the world.

Plutón y Caronte

Plutón y Caronte desde Hubble



Plutón



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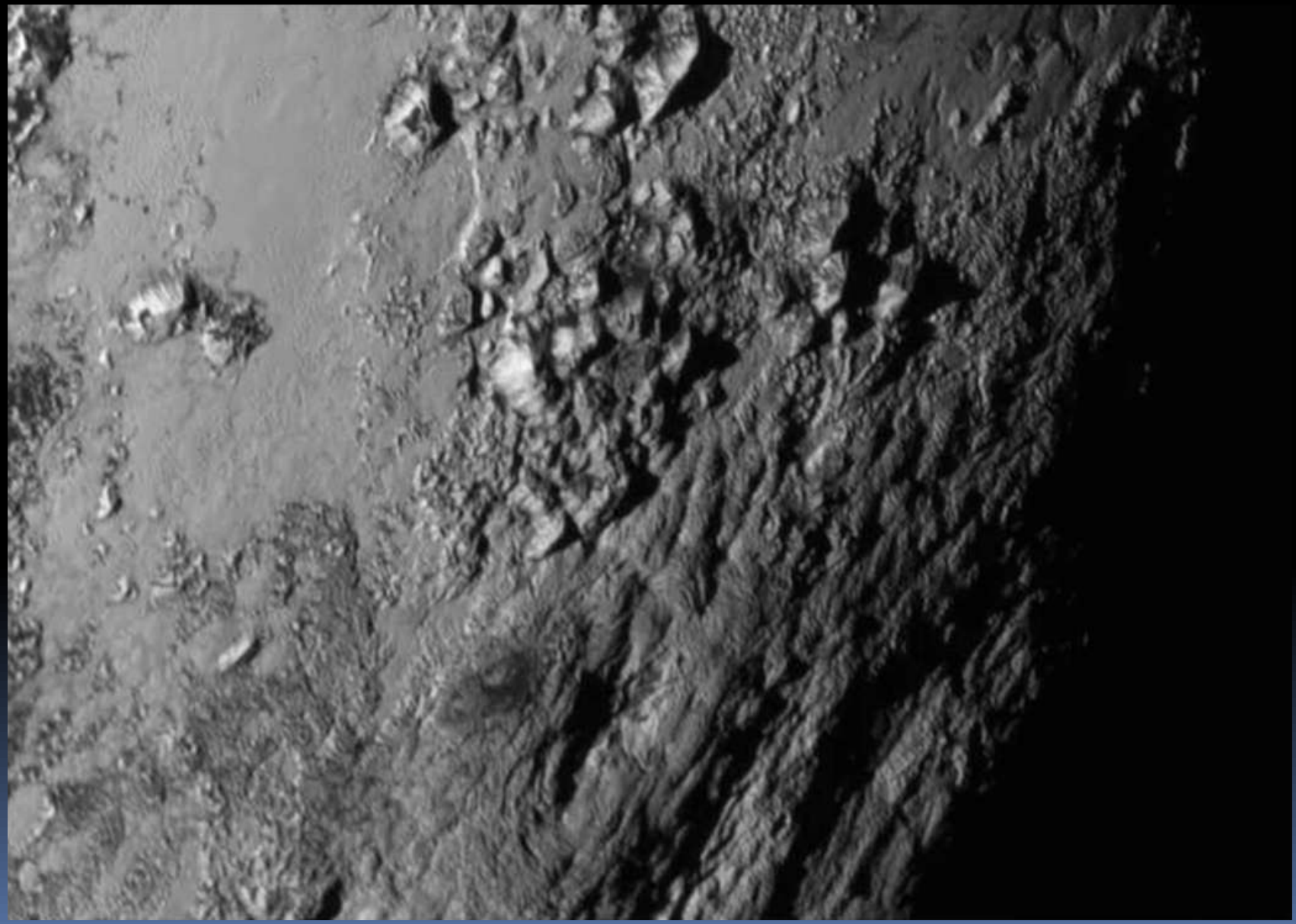
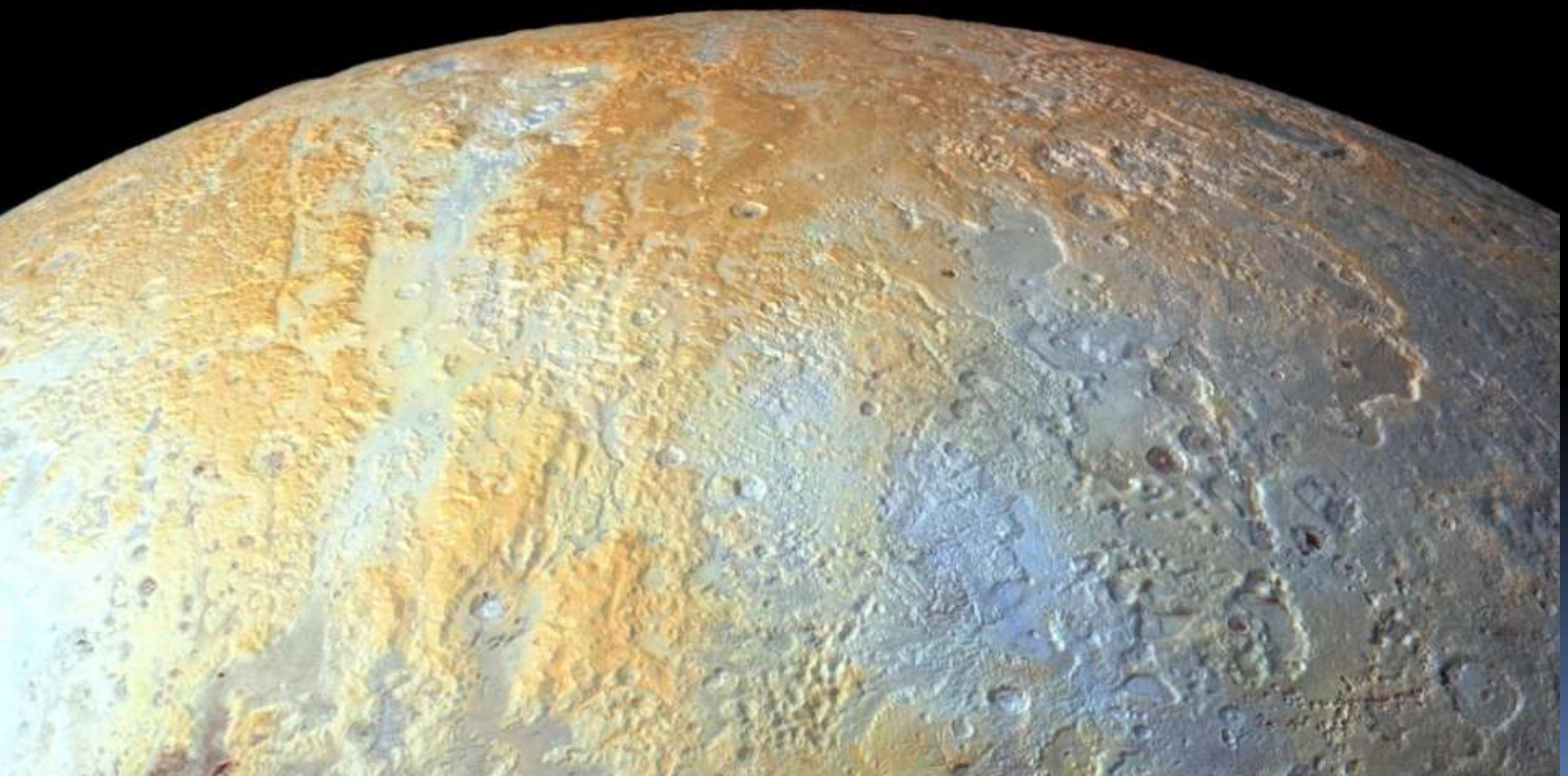
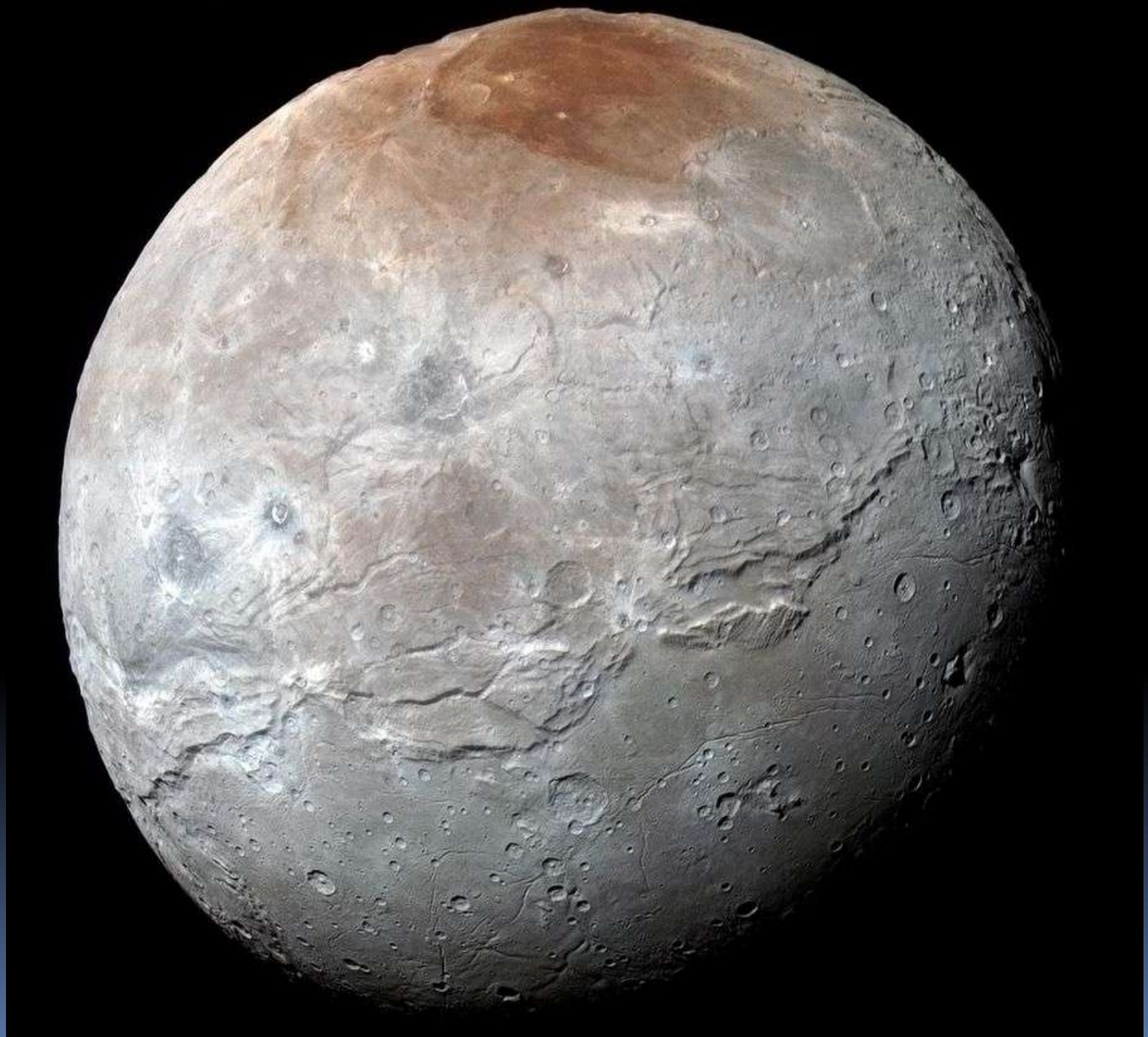


Jóvenes (100 millones de años…) montañas de hielo.

Plutón

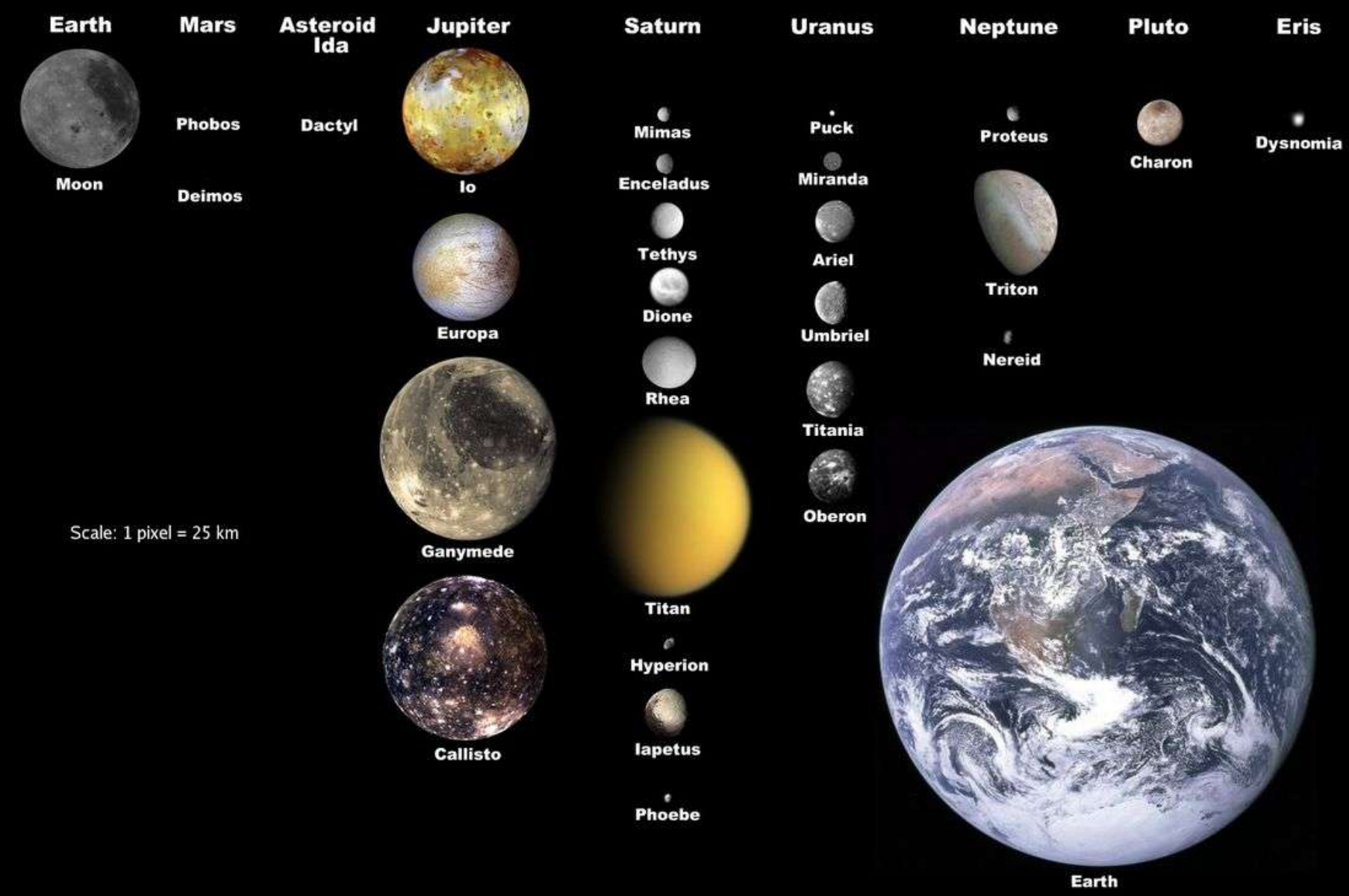


Caronte

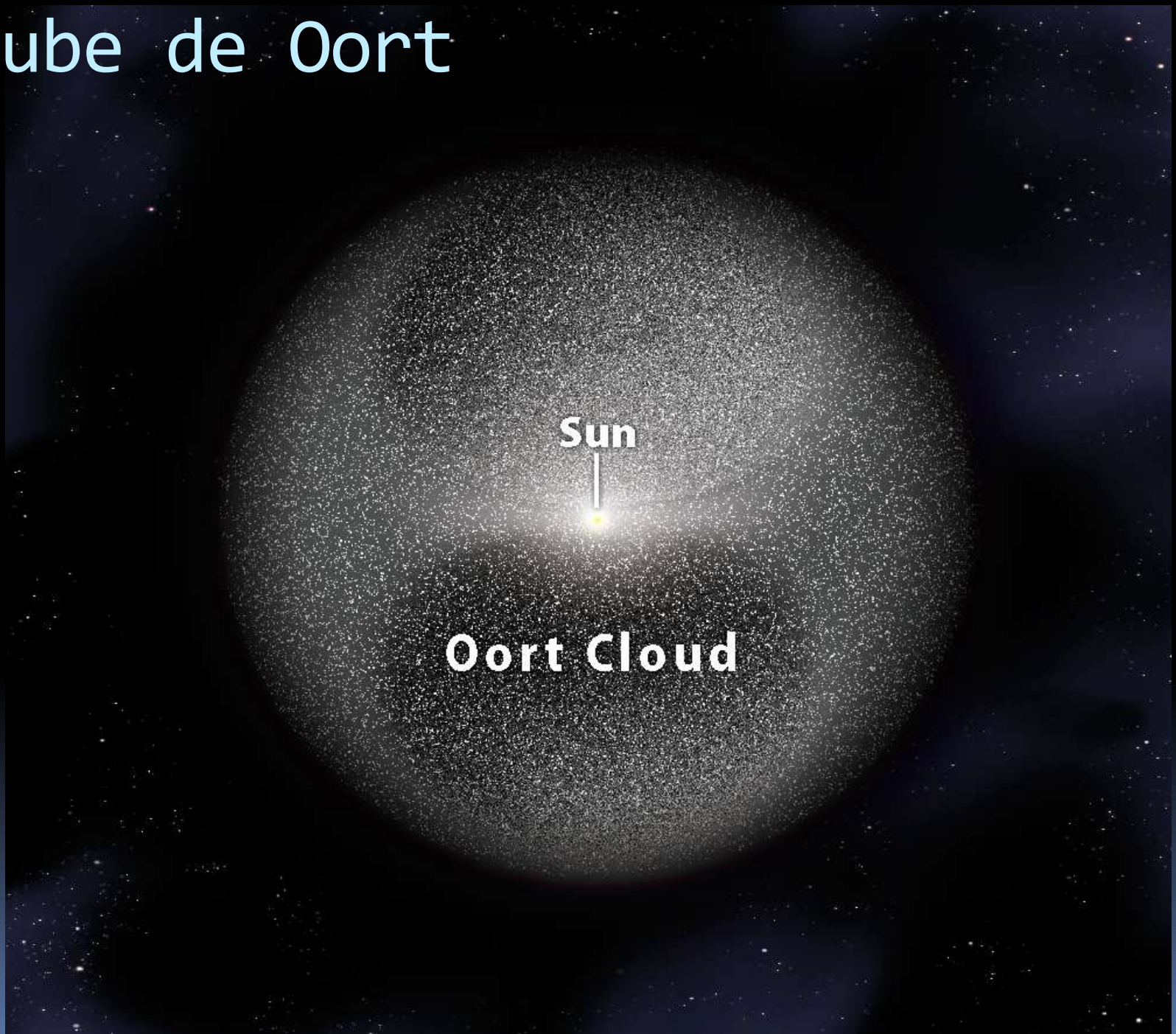


Largest known trans-Neptunian objects (TNOs)

Selected Moons of the Solar System, with Earth for Scale



Nube de Oort



El origen de todo…

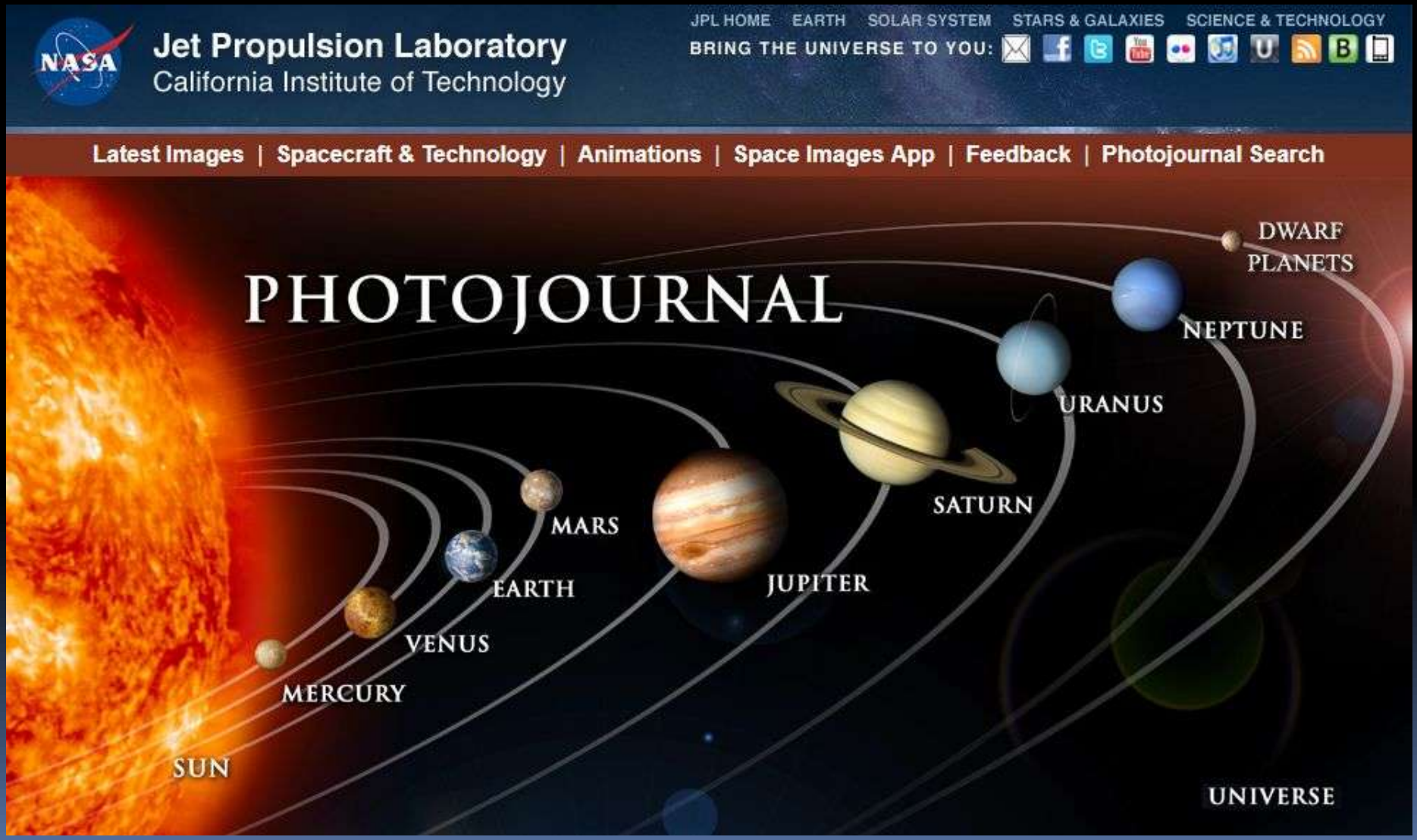
Posibles actividades

- Imágenes de photojournal
- www.astronomia.edu.uy/sistemasolar
- Trabajar distancias
- Tamaños y características
- Línea de distancias al Sol

Distancias planetarias a escala

Tome una cinta de papel de 1 metro o más.
En un extremo marque el Sol y en el otro Neptuno.
Dóblela en 3 partes iguales.
En la marca próxima al Sol está Saturno y en la otra Urano.
Doble a la mitad la sección Sol-Saturno. Allí está Júpiter.
Doble en 3 la sección Sol-Júpiter.
En la marca próxima al Sol está Marte.
Doble en 3 la sección Sol-Marte.
En la marca próxima a Marte está la Tierra.
Doble en 3 el tramo Sol-Tierra.
En la marca próxima al Sol está Mercurio y en la otra Venus.

photojournal.jpl.nasa.gov



Fin

Dudar de todo o creerlo todo
son dos opciones igualmente cómodas,
pues tanto una como otra
nos eximen de reflexionar.

Henri Poincaré.