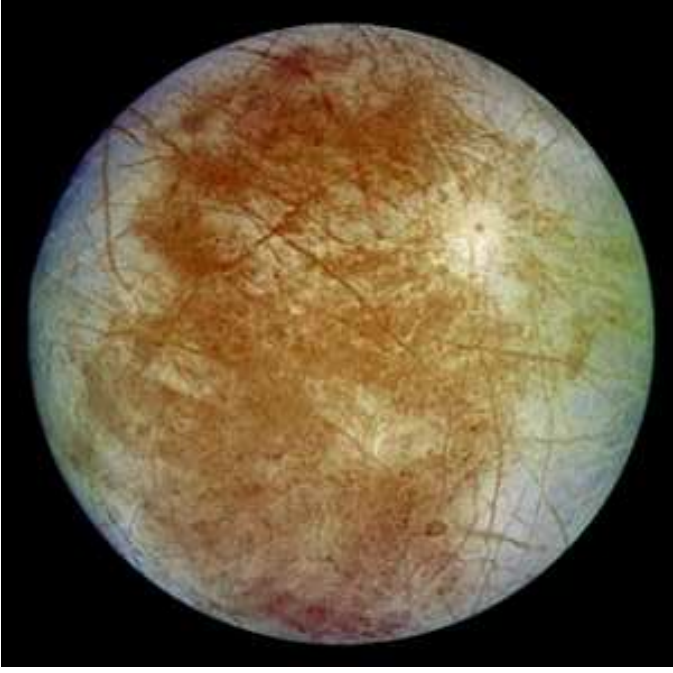
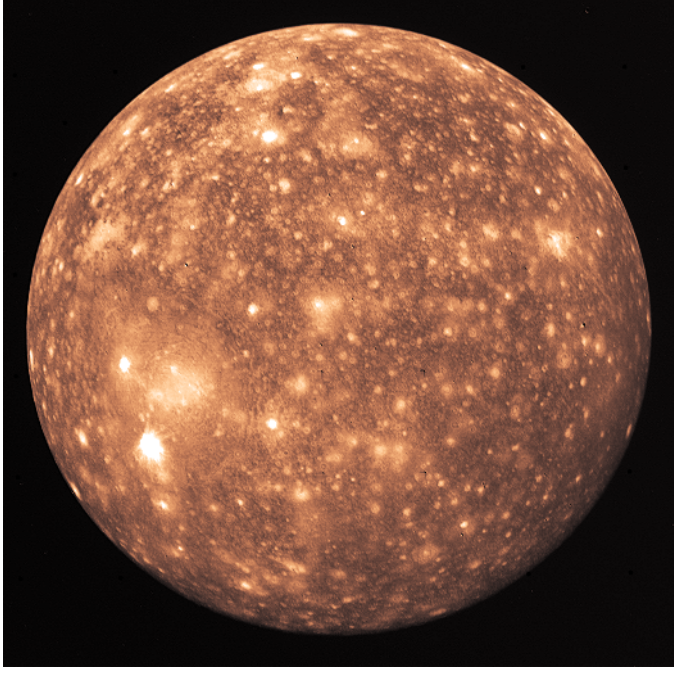


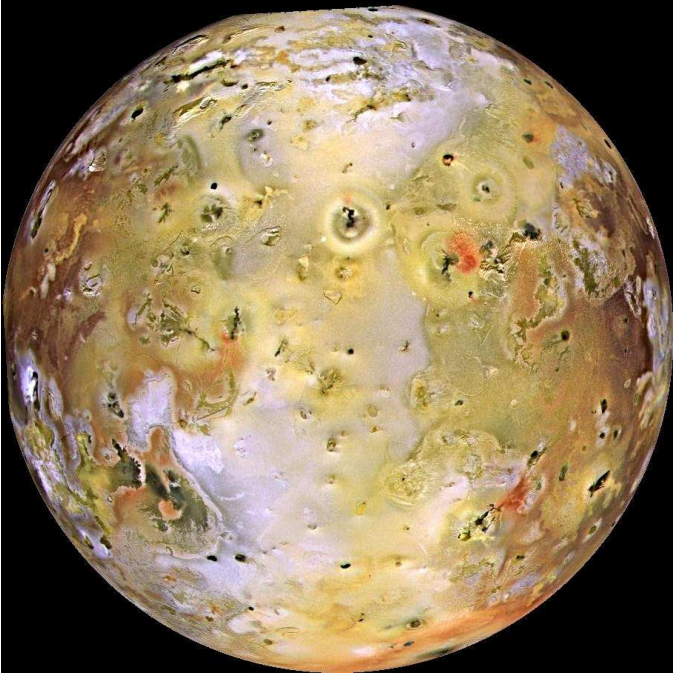
**Europa,  
“Ice  
Ball”**



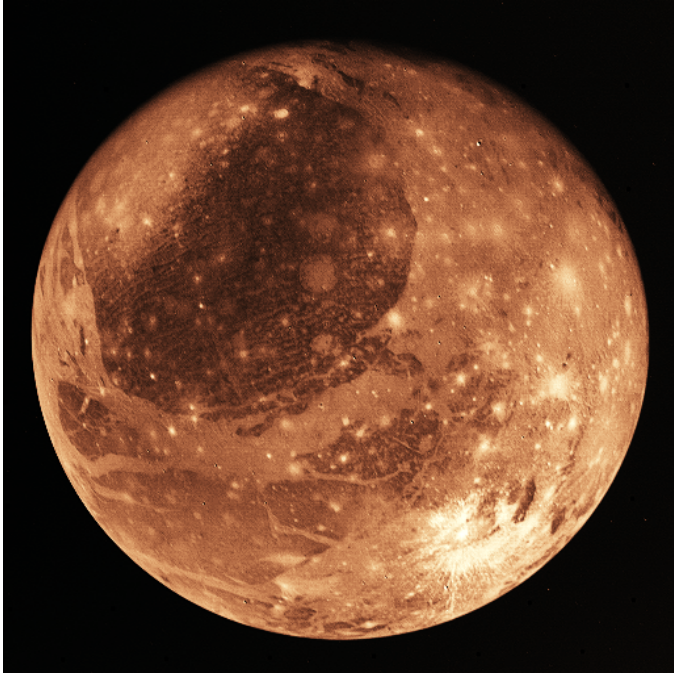
**Callisto,  
“Crater  
Moon”**



**Io,  
“Volcano  
Moon”**



**Ganymede,  
“Planet  
Moon”**



# What We Will Learn Today

- What are the main moons of the Solar System?
- Is our Moon unique in its synchronous rotation?
- What is the three-object resonance in our Solar System?
- How are the Galilean Moons interesting?

# Solar System's Seven Dwarfs

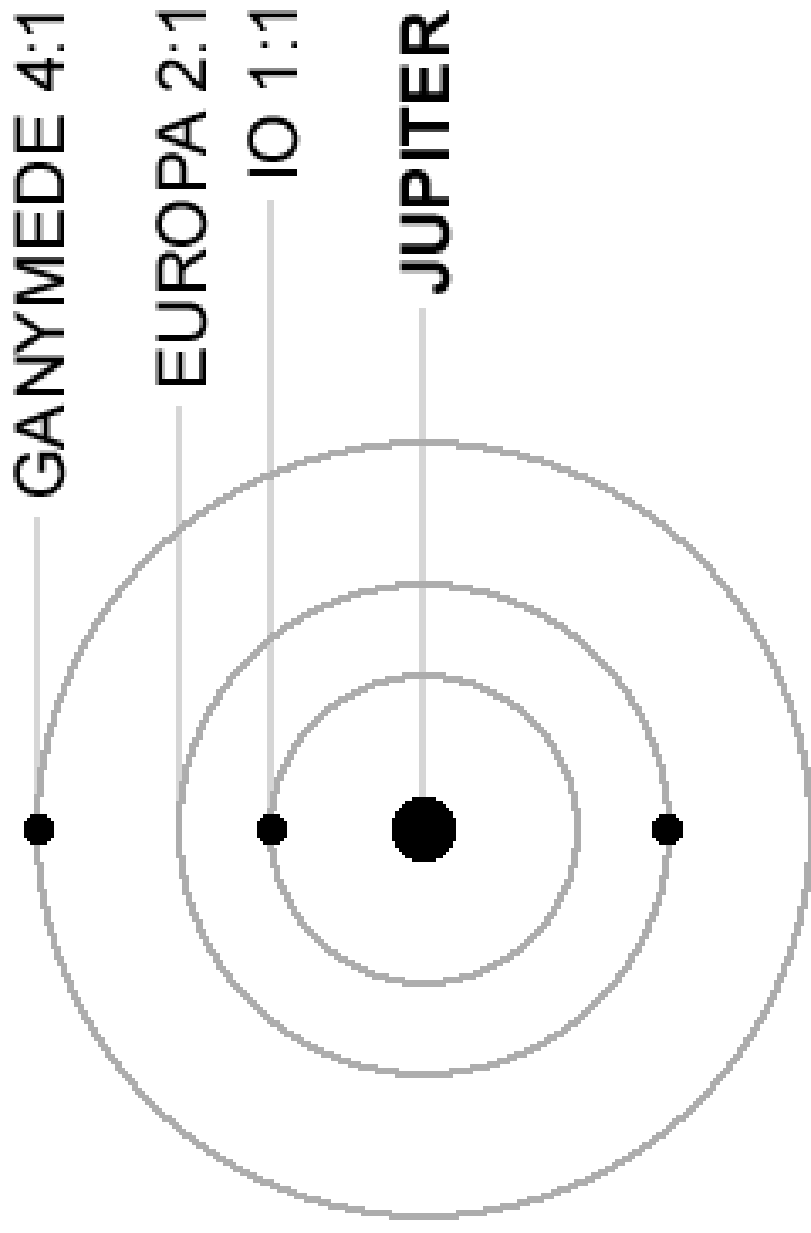
- Largest to smallest
  - Ganymede (Jupiter)
  - Titan (Saturn)
  - Callisto (Jupiter) ← Mercury
  - Io (Jupiter)
  - Moon (Earth)
  - Europa (Jupiter)
  - Triton (Neptune) ← Pluto



# Details of the Moons

| Moon         | Radius<br>(km) | Planet Dist<br>(10 <sup>3</sup> km) | Orbital Period<br>(Earth Days) | Rotation Period<br>(Earth Days) | Density<br>(g/cc) |
|--------------|----------------|-------------------------------------|--------------------------------|---------------------------------|-------------------|
| Io (J)       | 1,821          | 421.6                               | 1.77                           | 1.77                            | 3.57              |
| Europa (J)   | 1,565          | 670.9                               | 3.55                           | 3.55                            | 2.97              |
| Ganymede (J) | 2,634          | 1,070.0                             | 7.16                           | 7.16                            | 1.94              |
| Callisto (J) | 2,403          | 1,883.0                             | 16.69                          | 16.69                           | 1.86              |
| Moon (E)     | 1,738          | 384.4                               | 27.3                           | 27.3                            | 3.34              |
| Titan (S)    | 2,575          | 1,221.9                             | 15.95                          | 15.95                           | 1.88              |
| Triton (N)   | 1,353          | 354.6                               | -5.88                          | -5.88                           | 2.0               |

# Resonance of Inner Galilean Moons



# Io, The Volcano Moon

- Io's internal is continuously heated
  - Eccentric orbit
  - Strong tidal force from Jupiter



Cassini image of Io & Jupiter's clouds

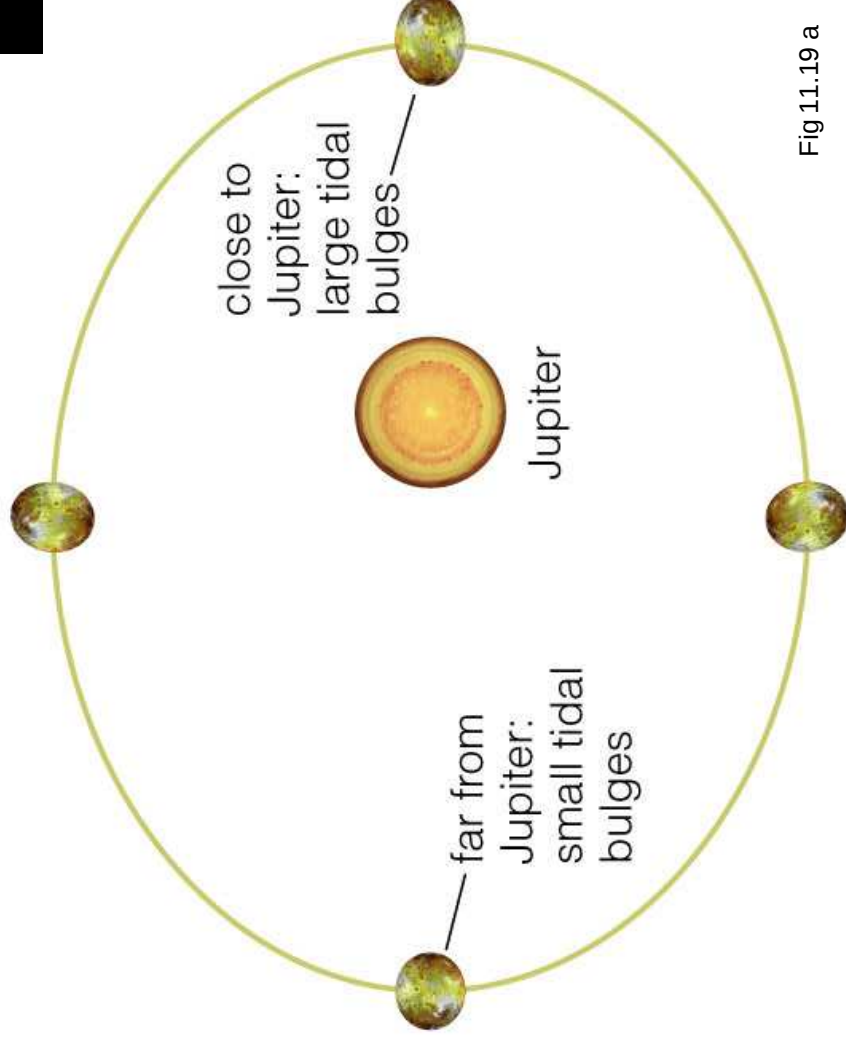
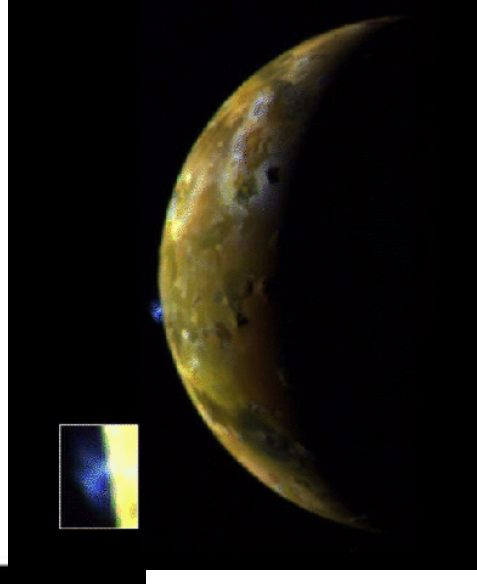
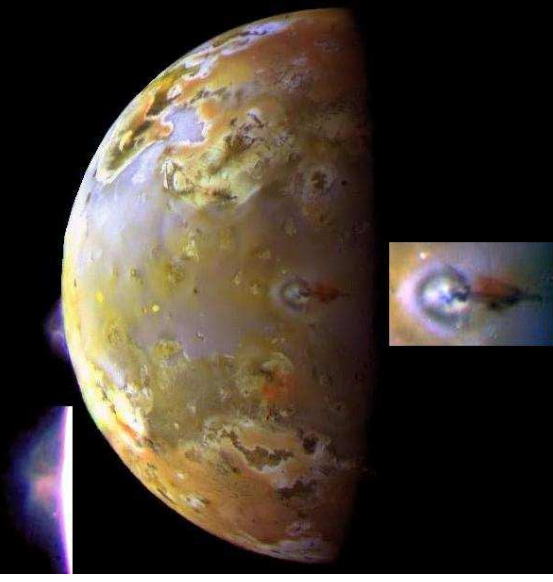
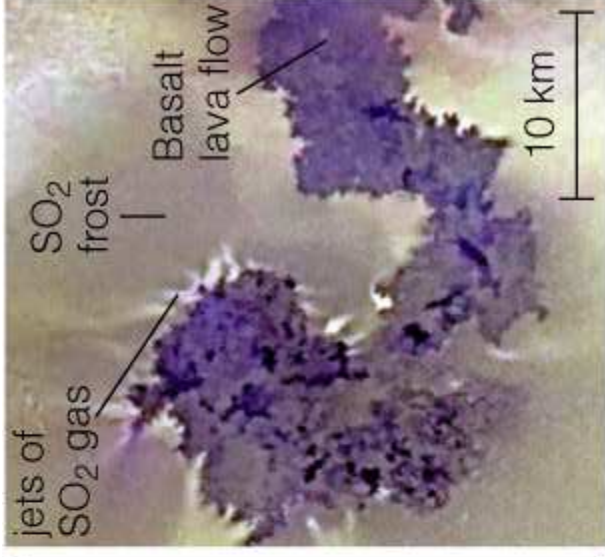
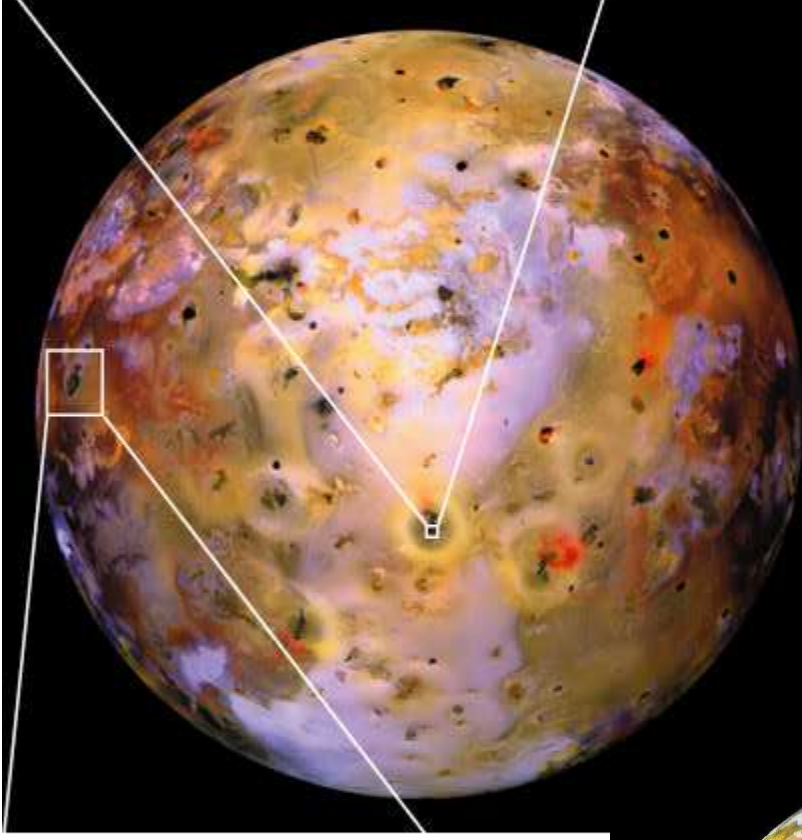


Fig 11.19 a

# Io: Youngest surface in SS

No impact craters on Io, surface *always* under construction



Galileo images of active volcanoes

Fig 11.17

# Europa, The Ice Moon

- Very few craters
- Water-ice surface repaved by flowing water/ice
- Observed features
  - Jumble of icebergs
  - Double-ridged cracks

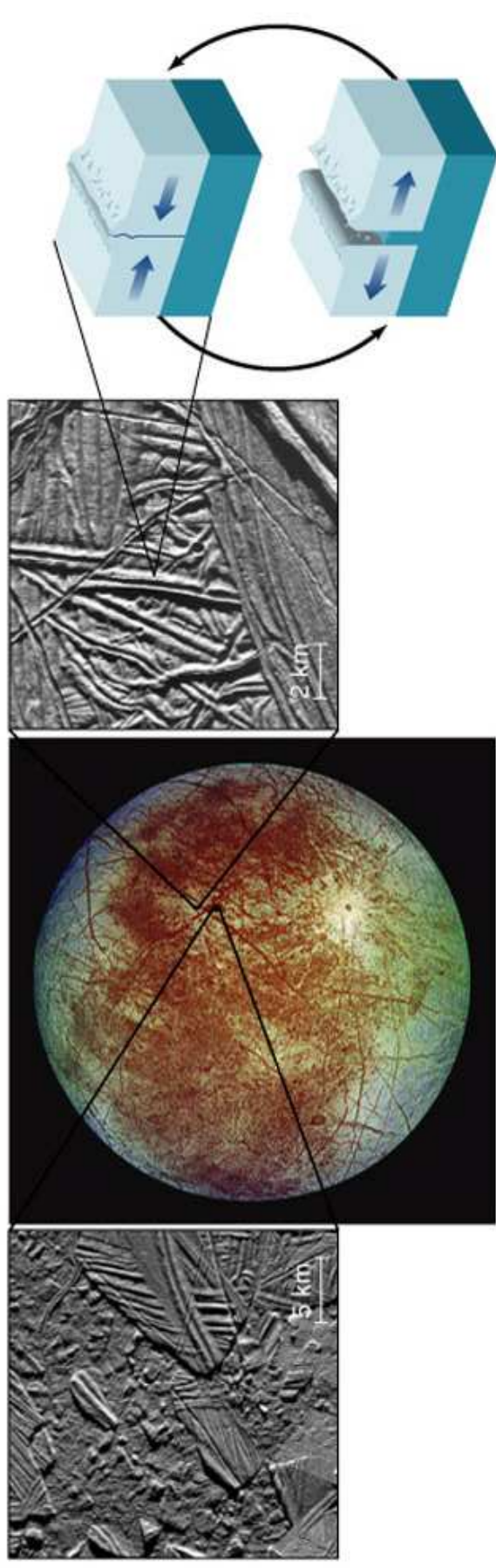


Fig 11.20

# Europa's Interior

- Determined based on detailed gravity study
- Europa has a magnetic field
  - Induced by Jupiter's magnetic field, changes with Jupiter's rotation
  - Argues for salty water ocean
- Liquid water in Europa may be twice as much on Earth

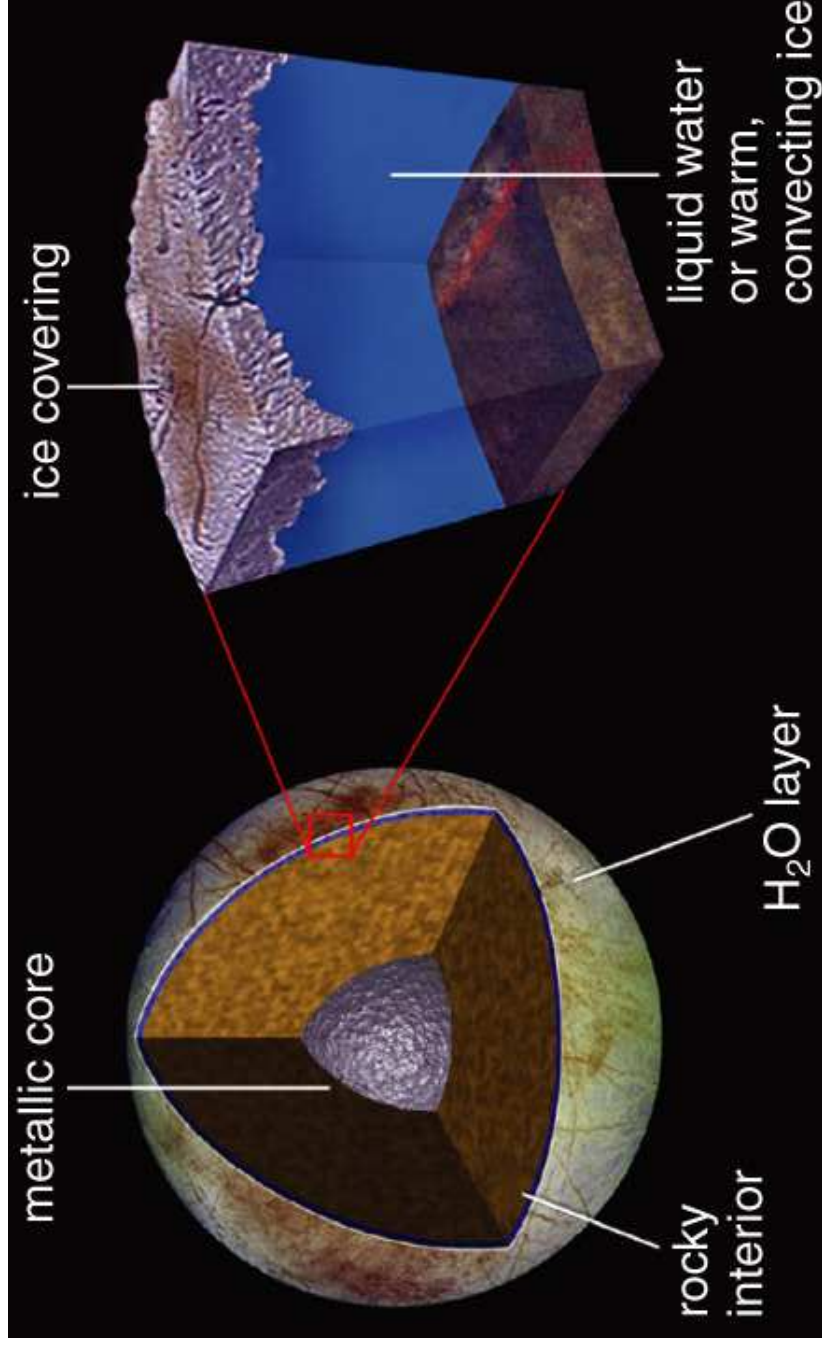


Fig 11.21

# Ganymede, The “Planet” Moon

- Largest moon in the Solar System
- Dark, cratered regions
- Light crater-free regions
  - Frozen water on surface
- Possible water ocean beneath surface
- Past plate tectonic activity suspected

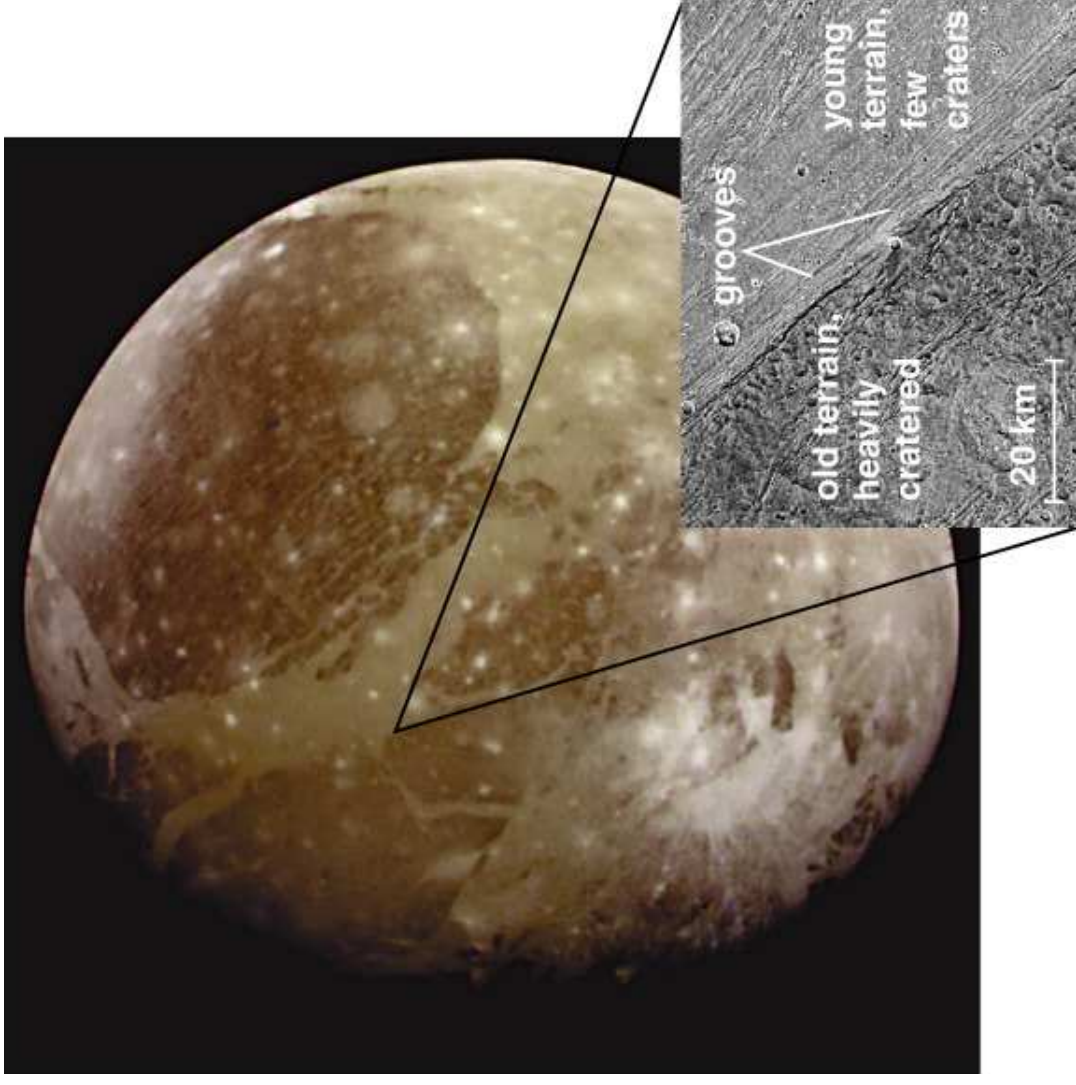
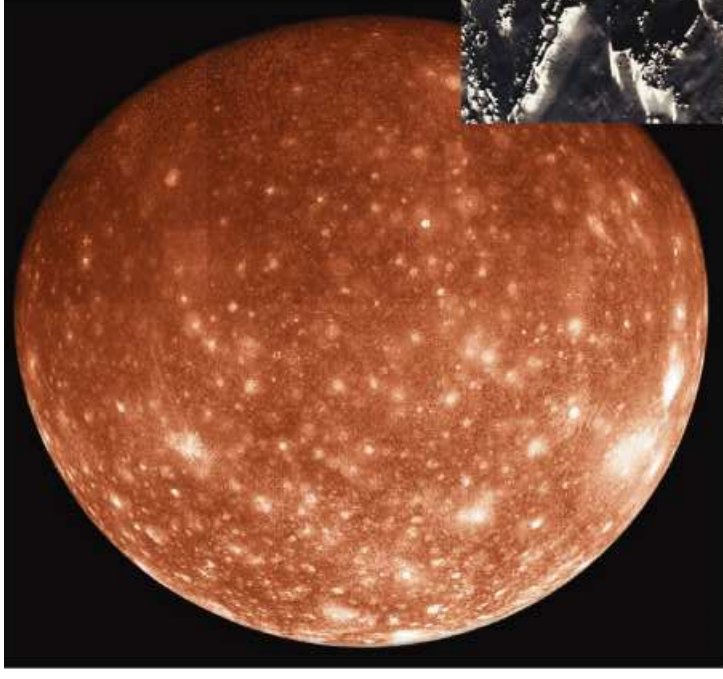


Fig 11.23

# Callisto, The Crater Moon

- Lots of craters
- Dark powder in the craters
  - Leftover material after water sublimated away
- No internal heat source
  - No evidence of past tectonics or volcanism
- Never differentiated!
  - No tidal heating
  - No orbital resonance



Callisto is heavily cratered, indicating an old surface that nonetheless may hide a deeply buried ocean.



Close-up photo shows a dark powder overlaying the low areas of the surface.

Fig 11.24

# Unique Features of Galilean Moons

- Io
  - Constant volcanos
  - Youngest surface in the Solar System
- Europa
  - Water ice, possible water ocean beneath surface
  - Possible life near ocean vents!
- Ganymede
  - Largest moon in the Solar System
  - Past plate tectonics
- Callisto
  - Heavily cratered
  - No differentiation