

Lesson 10

Galilean Moons of Jupiter



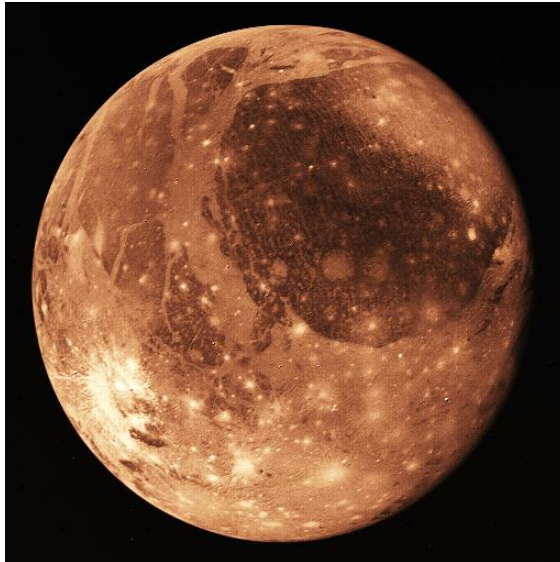
Jupiter has 79 satellites (2016)

- **Galilean satellites:** Four largest moons made of ice and rock (Ganymede, Callisto, Io, Europa)
- Galilean satellites were discovered by **Galileo Galilei** in 1610 using a first-generation refracting navigating telescope.
- Galilean moons are vastly different from each other in their surface appearance and activity.
- 6 with diameters 250 km to 50 km
- Most of the others are very tiny (2-10 km), mostly captured asteroids or captured comets with irregular shapes.



The Galilean Moons: Jupiter's 4 largest satellites

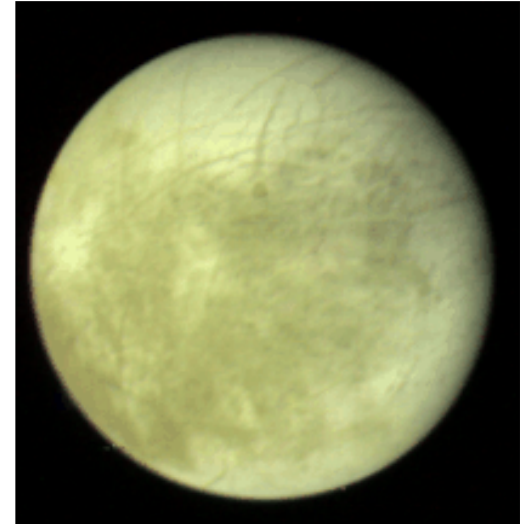
Ganymede



Callisto



Europa



Io

The Galilean moons are very large, spherical shaped, have atmospheres of some kind, and are visible from Earth's surface using low magnification telescopes

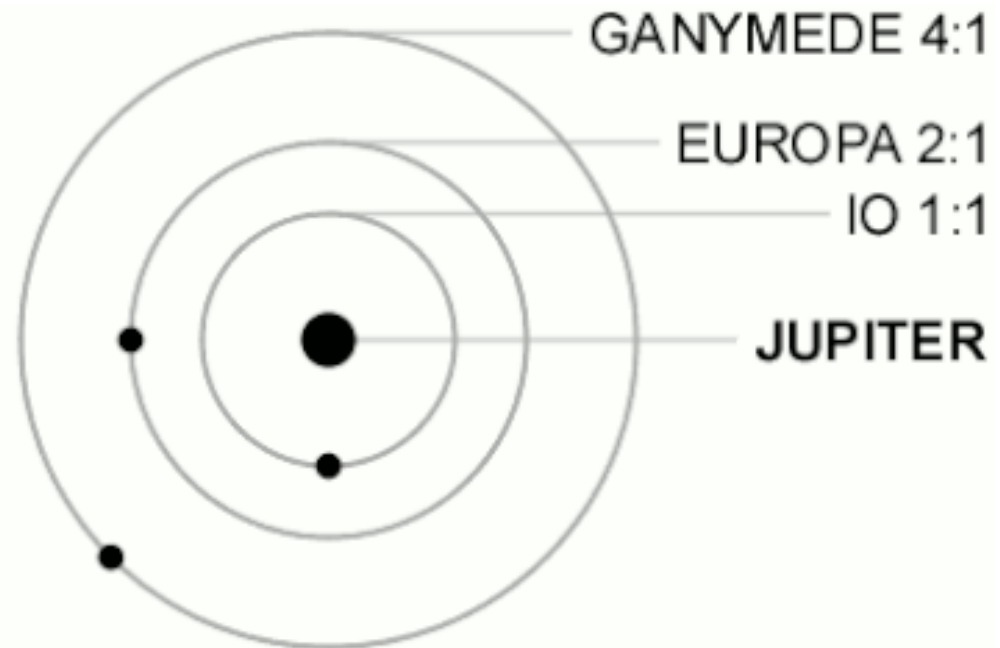


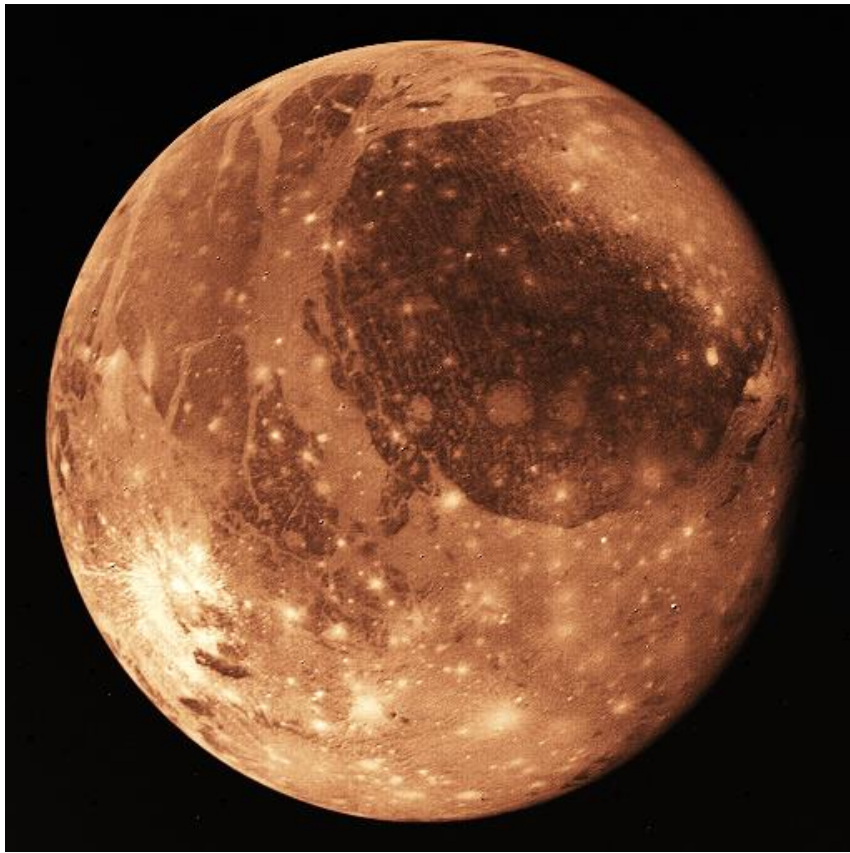
Galilean moons orbiting Jupiter as seen from Voyager II in 1979. The dark moving spots on Jupiter's atmosphere are shadows cast by the moons.



The orbits of the Galilean moons tend to be elliptical rather than approaching circles. This is because of the gravitational attraction of Jupiter (the strongest pull) and the weaker gravity of the other large moons interfering with each other's motions.

Ganymede, Europa, and Io are in **resonant orbits**. Their orbital periods are integer values of each other. For every 1 orbit of Ganymede, Europa orbits 2 times and Io orbits 4 times.





Ganimede is the largest moon in the solar system with a diameter of 5260 km diameter. Ganimede is larger than Mercury and Pluto.

It is covered by a very thin oxygen atmosphere.

Ganimede is the 7th satellite outward from Jupiter, and is the 3rd of the Galilean moons outward from Jupiter.



Ganymede's interior is thought to have a small iron core, surrounded by a small mantle of rock. The ice crust is very thick. Ganymede has a strong magnetic field suggesting a molten iron core.



Ganymede's surface has two types of landforms. About half of Ganymede's icy crust is covered with impact craters. The other half is crater-less terrain covered with linear groove valleys and ridges.

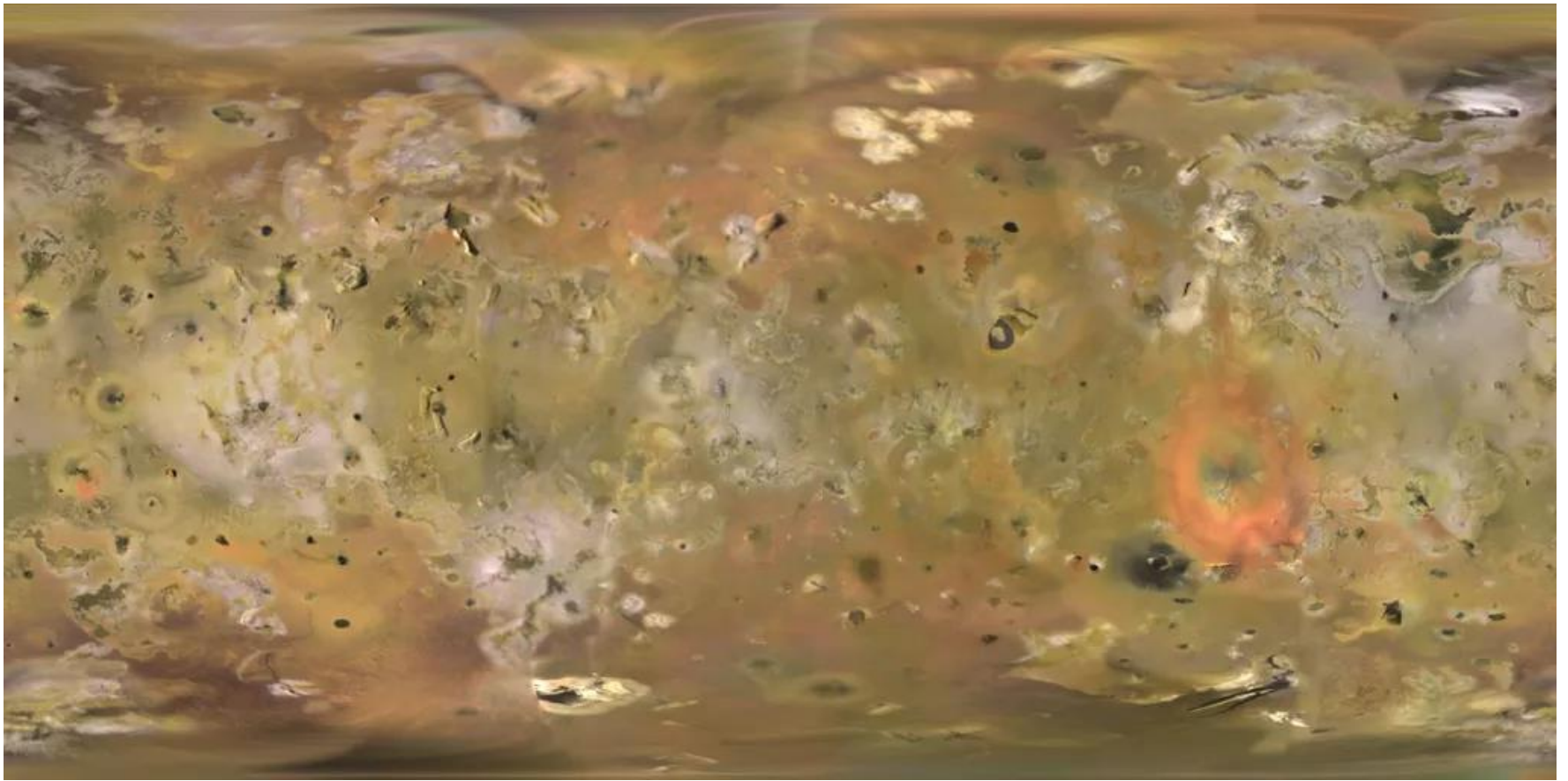




Io is the 3rd largest of the Galilean moons and orbits the closest to Jupiter. Io is a the most volcanically active body in the solar system. Io's surface is covered with hundreds of active volcanoes and geysers.

The multicolored surface of Io is the result of volcanoes blasting out lava mixed with molten rock (from Io's mantle), water ice, icy sulfur, and icy hydrocarbons from the crust.

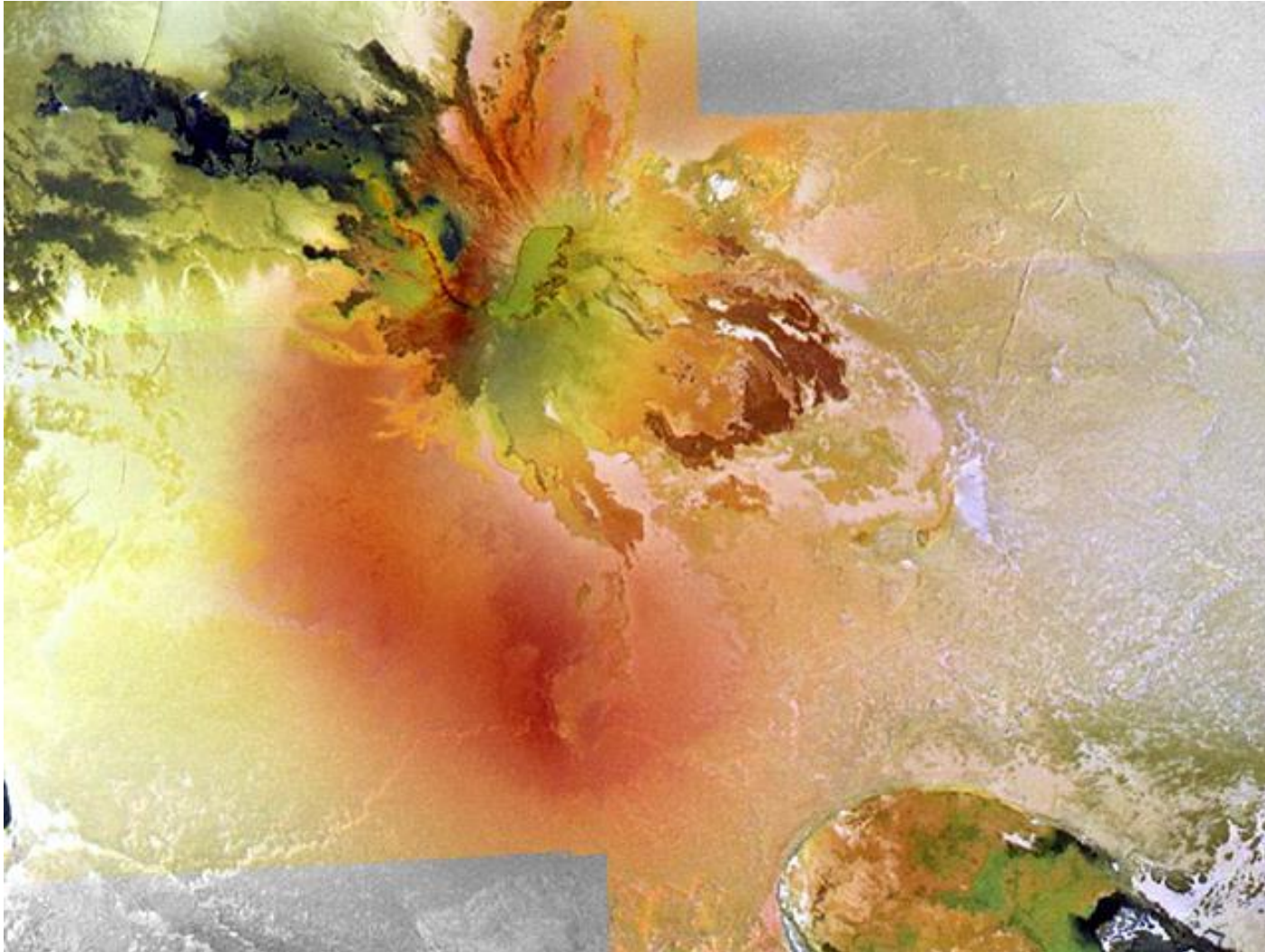




A Mercator map view of Io's crust. There are hundreds of volcanoes and geysers on Io's surface with overlapping lava flows. There are relatively few impact craters because the volcanism constantly destroys the old icy crust and covers the landscape with fresh lava.

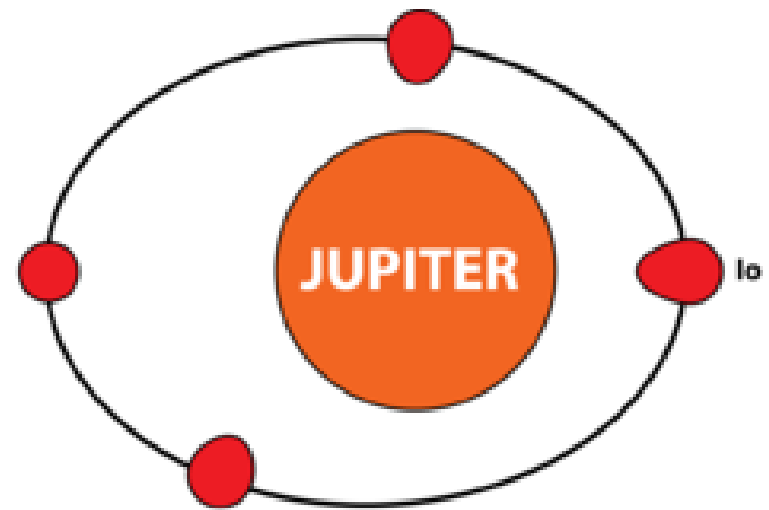


Culann is an active volcano that produces greenish yellow lava flows of molten rock mixed with sulfur.



Io is the closest moon and has a very elliptical orbit. **Tidal forces** caused by Jupiter's strong gravity field stretches and squeezes Io (**tidal deformation**). The force of stretching affecting Io at perigee is very strong.

As Io's mantle and crust stretch and squeeze. The rock and ice break and rub against each other. The friction by the rubbing and sliding creates extreme internal heat. The sulfur and water ices melt and boil from the heat. Rock in the mantle melts. The molten rock and steam blast out of the volcanoes.

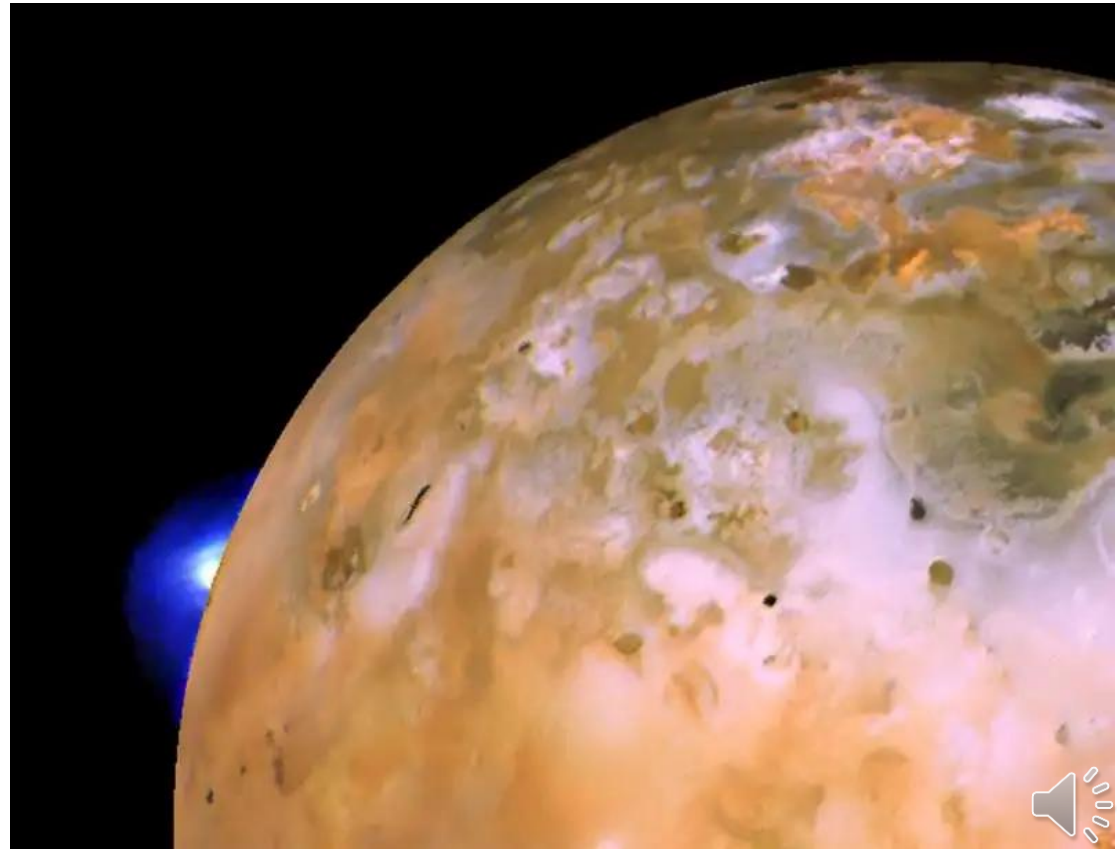


The diagram shows an exaggerated Io.



Io volcano erupts in 2013 sending plumes of lava and debris 50-100 km upward into space over Io's surface. The volcanic blasts are stronger than Io's weak surface gravity, so the plumes debris, steam, and lava fountains shoot very high upward.

Eventually, the lava and debris rain down onto the surface hundreds of km away from the volcano.





Callisto is the 2nd largest of Jupiter's moons and the 3rd largest moon in the solar system. Callisto's orbit lies the farthest from Jupiter. Callisto is the most densely cratered object in the solar system. The entire icy rocky surface is covered with impact craters.

Callisto is tidally locked with Jupiter. It takes Callisto 17 Earth days to orbit Jupiter and 17 Earth days to rotate once. The same side of Callisto faces Jupiter at all points in its orbit.

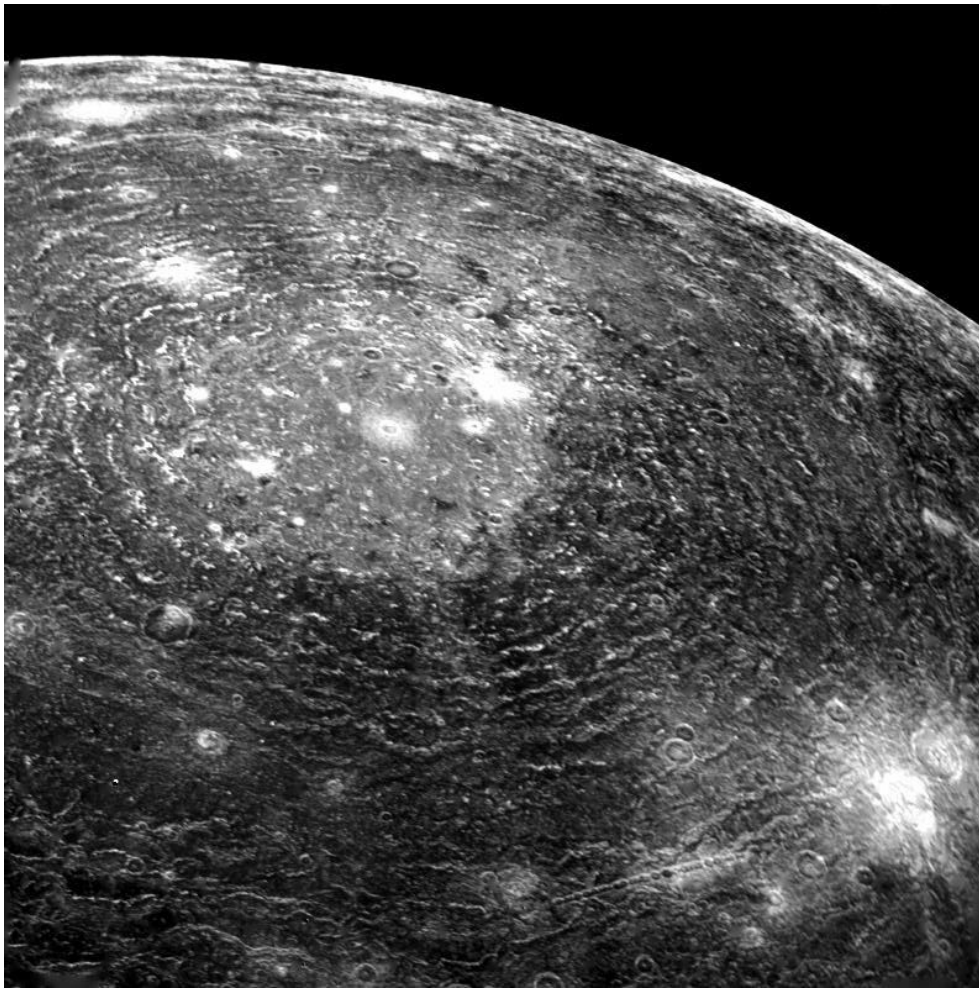




Callisto has a thick crust of mostly ice with some rock. There is a possible liquid water layer 200 km below the surface. The mantle and core of Callisto is thought to be made of rock and metal.

Callisto's surface has no evidence of volcanic activity that destroyed and renews the crust. The cratered surface is probably 4 billion years old. The white around the edges of the craters is thought to be icy frost from frozen water.



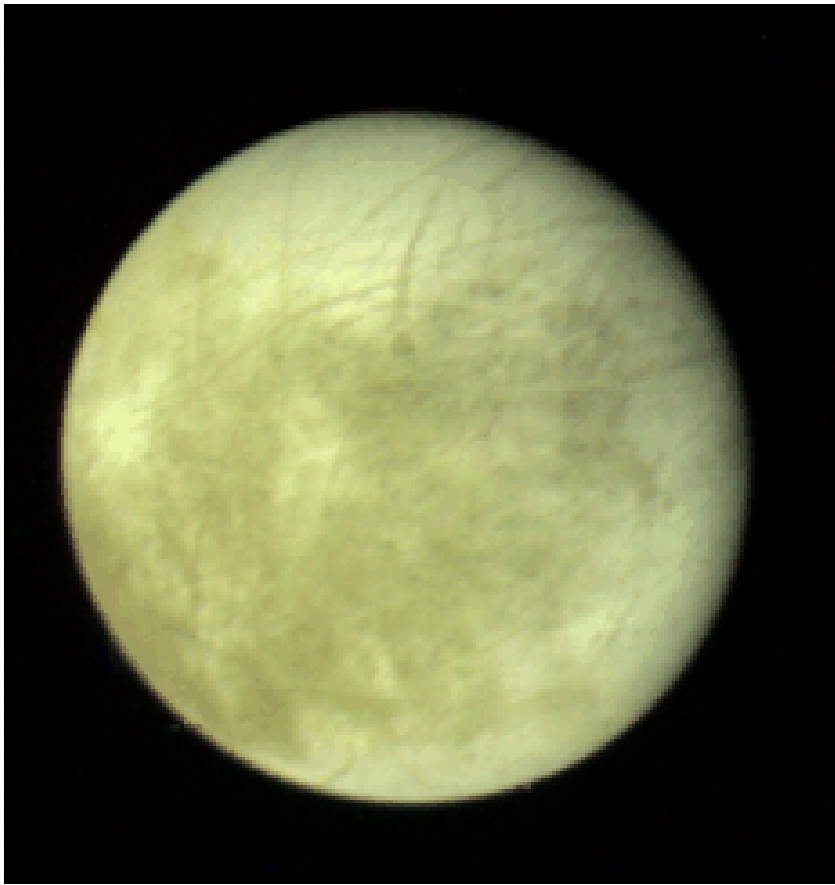


Valhalla, sometimes called the **Callisto Basin**, is centered at 18° N latitude on the surface.

Valhalla is a large impact crater, most likely caused by a comet collision.

The basin has dozens of concentric rings of ridges and valleys surrounding the central impact point. The icy crust was crumpled and deformed by the shockwaves and compression during the impact.

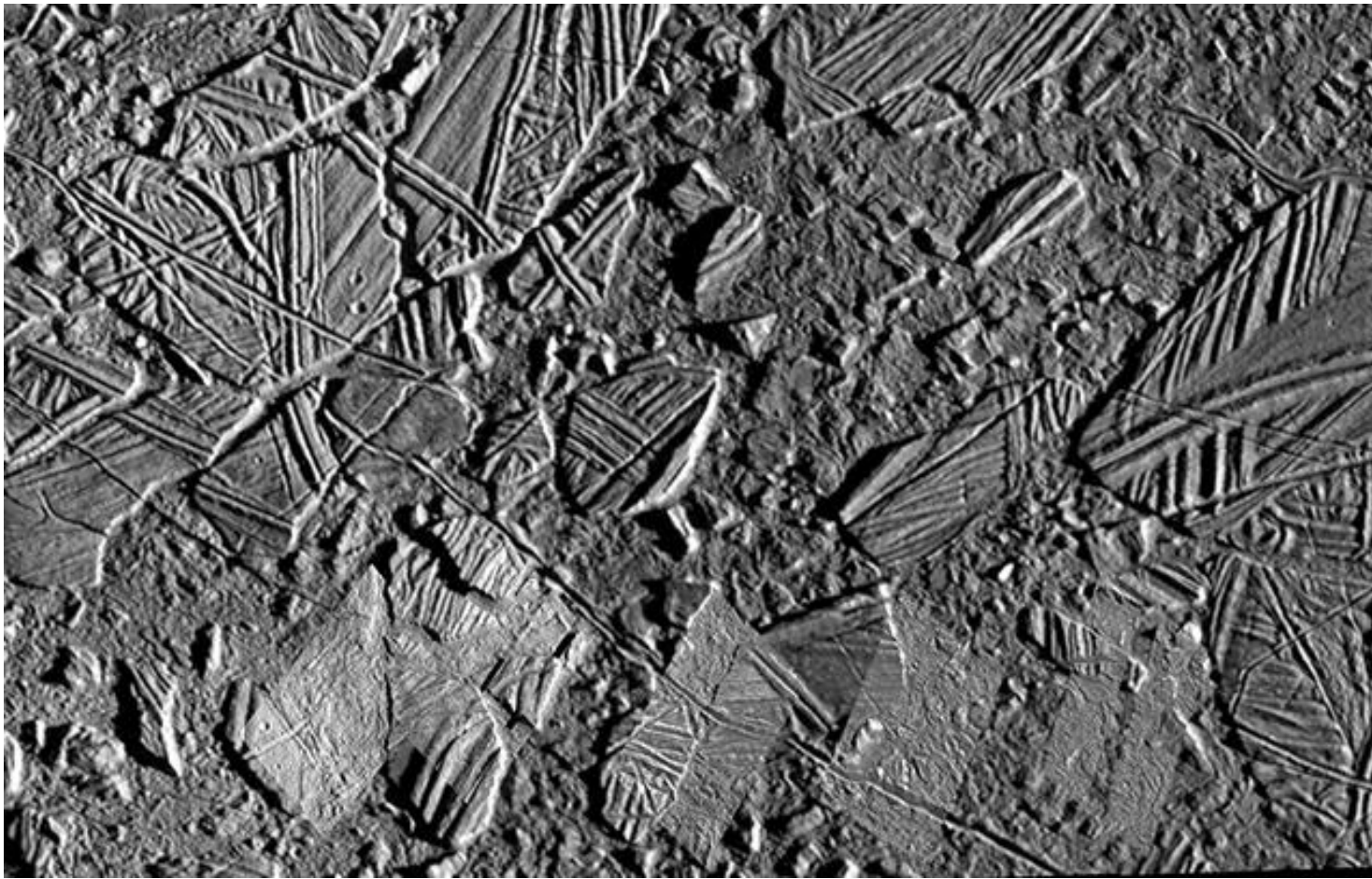




Europa is the smallest Galilean moon of Jupiter and is the 2nd closest of the Galilean moons to Jupiter. Europa has a very smooth and reflective ice crust possibly over a large liquid water 15-20 km below the crust.

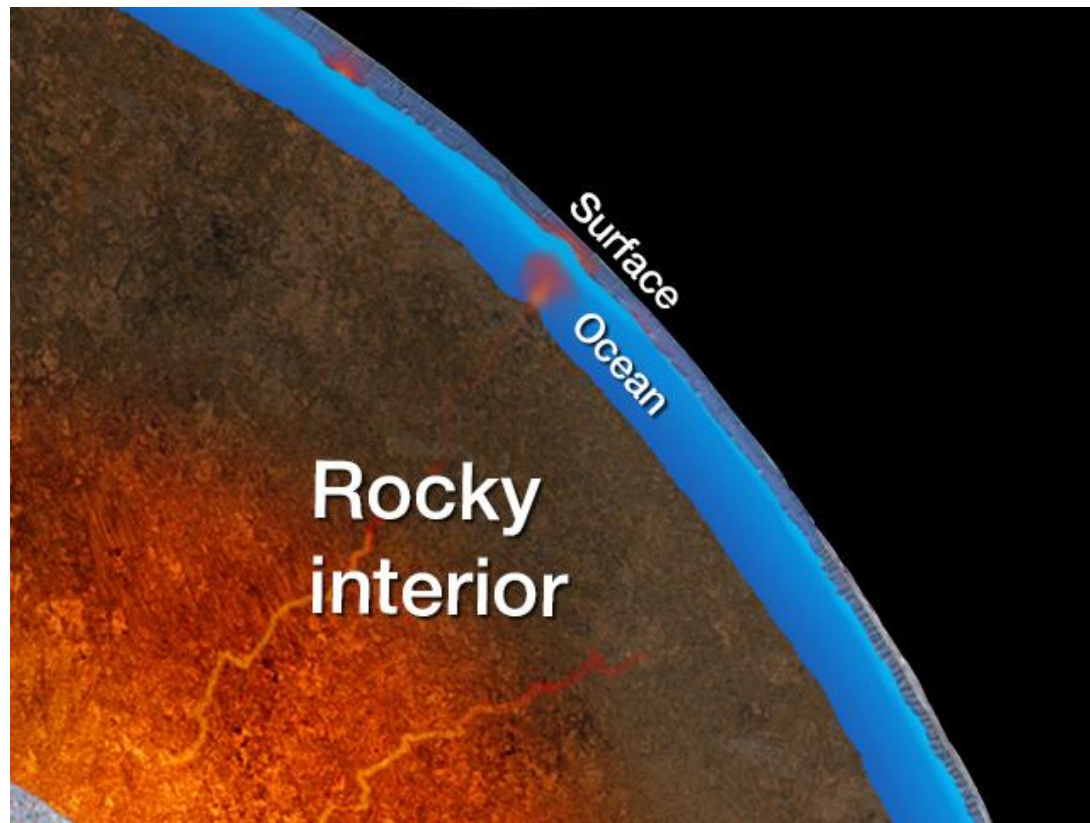
Europa's icy crust and surface is crisscrossed with large, deep cracks. This indicates that the water below the surface is relatively warm and in motion.





Conamara Chaos is an active region on Europa's surface. Large slabs of icy crust (similar to plates on Earth) have shifted, rotated, broken, and crushed into each other making a disordered system of ridges and valleys.





Just like Io, Europa is being squeezed and stretched by Jupiter's immense gravity field. The friction from the tidal deformation makes a lot of heat in Europa's rocky mantle. The heat warms the liquid water layer (ocean) which then moves the icy crust slabs.

