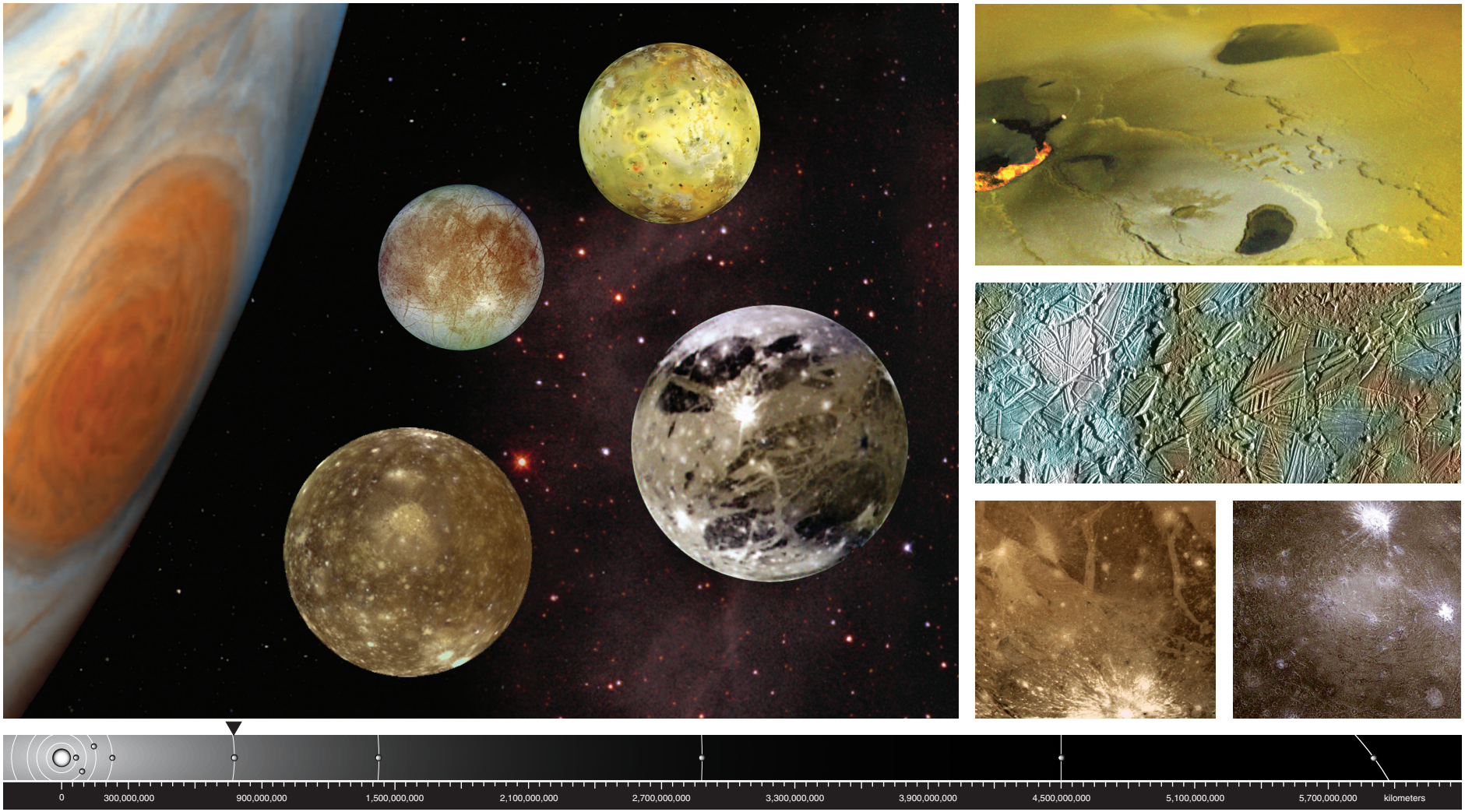



Galilean Moons of Jupiter

The planet Jupiter's four largest moons, or satellites, are called the Galilean moons, after Italian astronomer Galileo Galilei, who observed them in 1610. The German astronomer Simon Marius apparently discovered them around the same time. The names Marius proposed for the moons in 1614 (suggested to him by a fellow astronomer, Johannes Kepler) are the ones we use today — Io, Europa, Ganymede, and Callisto.

Io is the most volcanically active body in the solar system. Its surface is covered by sulfur and lava in many colorful forms. As Io travels in its slightly elliptical orbit, Jupiter's immense gravity causes "tides" in Io's solid surface 100 meters (300 feet) high, generating enough heat to give rise to the volcanic activity and drive off most water. Io's volcanoes are driven by hot silicate magma.

Europa's surface is mostly water ice, and the icy crust is believed to cover a global water ocean. Europa is thought to have twice as much water as does Earth. This moon intrigues astrobiologists because of its potential for having a "habitable zone." Life forms have been found thriving near underwater volcanoes on Earth and in other extreme locations that are possible analogs to what may exist at Europa.

Ganymede is the largest moon in the solar system (larger than the planet Mercury), and is the only moon known to have its own internally generated magnetic field. Callisto's surface is extremely heavily cratered and ancient — a record of events from the early history of the solar system. However, at a small scale, Callisto shows very few craters, suggesting that landslides are active today.

The interiors of Io, Europa, and Ganymede have a layered structure (as does Earth). Io has a core, and a mantle of at least partially molten rock, topped by a crust of solid rock coated with sulfur compounds. Europa and Ganymede each have an iron-rich core; a rock envelope around the core; a thick, soft ice layer; and a thin crust of impure water ice. Layering at Callisto is less well defined and appears to be mainly a mixture of ice and rock. Like Europa, Ganymede and Callisto have oceans, but they are deeper and less accessible than Europa's, and sandwiched between ice layers rather than in contact with their mantles.

Three of the moons influence each other in an interesting way. Io is in a tug-of-war with Ganymede and Europa, and Europa's orbital period (time to go around Jupiter once) is twice Io's period, and Ganymede's period is twice that of Europa. In other words, every time Ganymede goes around Jupiter once, Europa makes two orbits and Io makes four orbits. The moons all keep the same face towards Jupiter as they orbit, meaning that each moon turns once on its axis for every orbit around Jupiter.

Voyagers 1 and 2 offered striking color views and global perspectives from their flybys of the Jupiter system in 1979. From 1995 to 2003, the Galileo spacecraft made observations from repeated elliptical orbits around Jupiter, making numerous close approaches over the surfaces of the Galilean moons and producing images with unprecedented detail of selected portions of the surfaces.

Close-up images taken by the Galileo spacecraft of portions of Europa's surface show places where ice has broken up and moved apart, and where liquid may have come from below and frozen on the surface. The low number of craters on Europa leads scientists to believe that a subsurface ocean has been present in recent geologic history and may still exist today. The heat needed to melt the ice in a place so far from the Sun is thought to come from inside Europa, resulting primarily from the same type of tidal forces that drive Io's volcanoes. The possibility of life existing on Europa in a subsurface ocean is so compelling that scientists plan to send another spacecraft in 2020, the Jupiter Europa Orbiter, to study this intriguing moon.

## FAST FACTS

| Satellite | Distance from Jupiter |
|---|---|
| Io | 422,000 km (262,200 mi) |
| Europa | 671,000 km (417,000 mi) |
| Ganymede | 1,070,000 km (665,000 mi) |
| Callisto | 1,883,000 km (1,170,000 mi) |

| Satellite | Mean Radius |
|---|---|
| Io | 1821.6 km (1,131.9 mi) |
| Europa | 1,560.8 km (969.8 mi) |
| Ganymede | 2,631 km (1,635 mi) |
| Callisto | 2,410 km (1,498 mi) |

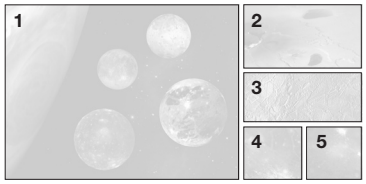
| Satellite | Orbital Period (Earth Days) |
|---|---|
| Io | 1.769 |
| Europa | 3.551 |
| Ganymede | 7.155 |
| Callisto | 16.689 |

| Satellite | Density ($g/cm^3$) |
|---|---|
| Io | 3.528 |
| Europa | 3.013 |
| Ganymede | 1.942 |
| Callisto | 1.834 |

## SIGNIFICANT DATES

1610 — Galileo Galilei and Simon Marius independently discover four moons orbiting Jupiter. This discovery, among others by Galileo, helped change the way people thought about the heavens. The prevailing idea of the time was that all heavenly bodies orbit the Earth: a planet with its own small orbiting bodies did not conform to this geocentric model.
1979 — Voyager 1 photographs an erupting volcano on Io: the first ever seen anywhere other than Earth.
1979–2000 — Using data from the Voyager and Galileo spacecraft, scientists gather strong evidence of an ocean beneath the icy crust of Europa; Galileo data indicate oceans within Ganymede and Callisto.
2003 — The Galileo mission ends with the spacecraft deliberately descending into Jupiter's atmosphere and being vaporized. Mission controllers purposely put Galileo on a collision course with Jupiter to eliminate any chance that the spacecraft would crash into Europa and contaminate that moon with terrestrial microbes.

## ABOUT THE IMAGES




1 A comparison "portrait" of Jupiter's four Galilean moons Io, Europa, Ganymede, and Callisto, each with different characteristics. (In this image composite, Jupiter is not at the same scale as the satellites.)

2 During one flyby of Io in 2000, the Galileo spacecraft photographed Tvashtar Catena, a chain of giant erupting volcanoes. White and orange at the left of the image show newly erupted hot lava, seen in the false-color image because of infrared emission.

3 This false-color image of Europa shows the icy crust broken up into blocks that appear to have "rafted" into new positions.

4 Fresh, bright material was thrown out of an impact crater on Ganymede.

5 Ice on Callisto excavated by younger impact craters contrasts with darker, redder coatings on older surfaces.

## FOR MORE INFORMATION

*solarsystem.nasa.gov/jupiter*

*solarsystem.nasa.gov/planets/profile.cfm?Object=Jupiter&Display=Moons*

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