

# The Jovian Satellites

## Jupiter's Moons

Jupiter has four *large* moons (the Galilean satellites): Io, Europa, Ganymede and Callisto, plus dozens of small moons. The *Galileo Mission* (launched 1989, arrived 1995, ended in 2003) has been the premier mission to Jupiter. At the end of its mission, *Galileo* was purposely destroyed so that it would not accidentally crash into Europa.

**Io:** Most geologically active object in the Solar System. The energy for the activity comes from Jupiter's gravity: Io's non-circular orbit causes tides and friction that heat the interior. Volcanoes spew lava and sulfur dioxide (SO<sub>2</sub>).

**Ganymede and Callisto:** These are very large moons, covered in an icy surface with embedded organic material (hydrocarbons). Ganymede is the largest moon in the Solar System - larger than Mercury or Pluto!

## Europa

A little smaller than the Earth's Moon. Its surface is covered in ice (water ice!) and crisscrossed with long ridges ("cracks"). There are very few craters. Minerals and probably some organic material are embedded in the ice.

The *Galileo* spacecraft images show fracture patterns and frozen flood areas. Comparing Voyager and Galileo image reveal that motion (ice flows) have been detected. Tidal stresses from Jupiter keep the interior warm and melt the ice. There may be *liquid* water a few km under its frozen surface!

We are not certain how thick the ice crust is: a few hundred *meters* or few hundred *kilometers*. *Some* liquid water is present, but how much, and how deep, is unknown. For example, if the crust were *very* thin, then craters could not last very long – yet we do see a few.

Europa contains:

***Liquid water, a source of energy, and a supply of organic material:  
these are the 3 key ingredients necessary for life!***

**Europa is a prime candidate for extraterrestrial life.**

NASA has plans for an Europa Exobiology Explorer (E<sup>3</sup>) mission to drill (or melt) its way below the ice. (Practice first on Lake Vostok). What will the probe find??

Lake Vostok: discovered 1996. Coldest temperature ever recorded on Earth, -89.2 C (-128.6 F), was measured at Vostok Station on July 21, 1983. Vostok is comparable in size and depth to Lake Ontario. About 150 miles long and 31 miles across. Lake Vostok has been sealed under 2.5 miles of ice for over a half million years! An ideal place to test techniques & equipment for the search for life on Europa.

## Titan, a Satellite of Saturn

**Titan** is the 2nd largest moon in the Solar System. Discovered in 1655 by Huygens. Larger than Mercury (and Pluto); Surface temperature is VERY COLD: ~ 85 K

**Titan** has a *dense atmosphere* (1.6 times denser than Earth's).

It is the only satellite with an atmosphere. The atmosphere contains mostly N<sub>2</sub> and methane (CH<sub>4</sub>). But it is also rich in **organic** material. In particular, ethane C<sub>2</sub>H<sub>6</sub> is very abundant. (Also contains propane, acetylene, HCN, etc...) It is almost impossible see surface features because the atmosphere is so full of organic "smog"!

The atmospheric temperature and pressure are such that there could be clouds of nitrogen and methane, liquid nitrogen rain, and possible lakes or seas of ethane!  
And perhaps continents made of water ice.

Given the **very rich concentration of organic material, and a suspected ocean of ethane, Titan is a candidate for extraterrestrial life.**

But the lack of liquid water means that any life on Titan will be *very* different from life on Earth.

Launched together in 1997, the *Cassini* spacecraft is now investigating Saturn while the *Huygens* probe studied Titan's atmosphere and surface properties. *Huygens* arrived at Titan on 2005 Jan 14. The Huygens science instruments/experiments included:

- atmospheric structure: accelerometer, thermometer, electrical conductivity
- Doppler wind meter
- imager & spectrometer
- gas chromatograph/mass spectrometer
- surface package: acoustic sounder; impact meter; liquid density, conductivity, temperature, etc.

Still being studied, the data show that Titan has surface features similar to Earth:

- dendritic river channels (probably cut by liquid methane)
- erosion due to wind and rain (liquid methane)
- tectonic features & perhaps cryo-volcanism
- almost no craters
- atmosphere contains methane clouds and fog
- a surprising lack of ethane (liquid or gas)
- relatively dry – although muddy, there were no lakes, springs, rain, etc., at the landing spot at that time

*Cassini* has also found what appear to be lakes of ethane or methane or some other hydrocarbon on Titan.