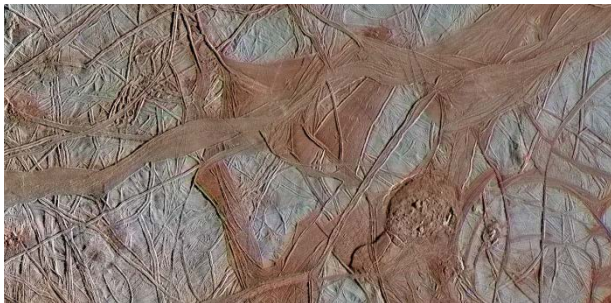


Investigating Ocean Worlds

Ocean Worlds of the Solar System

What is an Ocean World?

An “ocean world” is a planet or moon that is believed to have a liquid ocean on it. Earth is an ocean world because water covers 71% of its surface. There are also moons and dwarf planets in our solar system where oceans exist. Many of these oceans are covered with frozen ice shells.



This enhanced-color image of Jupiter's moon Europa shows geologic features that may form when a crack in the surface opens and closes repeatedly due to tidal interactions. The colors represent different chemical compositions (light blue/white: relatively pure water ice; pale red: salts). Credit: NASA/JPL-Caltech/SETI Institute

Maintaining a Liquid Ocean

The ocean worlds in the outer solar system, far away from the heat of the Sun, are outside the traditional “habitable zone,” which is a region that is not too close to the star and thus too hot, nor is it too far and thus too cold. But we now know that even these worlds can have liquid water.

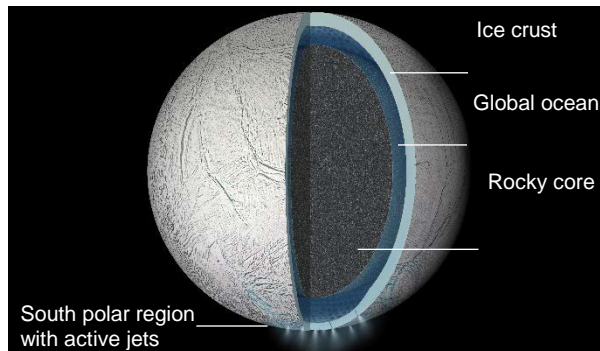
If not from the Sun, where does the heat for liquid water come from on worlds such as Europa, which is a moon of Jupiter and one of NASA's primary targets in the search for life beyond Earth? Heat on Europa is created by tidal energy, as the moon is stretched and squeezed by Jupiter's gravity while it orbits the planet.

This process heats the moon's ocean and prevents it from freezing, thus enabling it to sustain a liquid ocean.

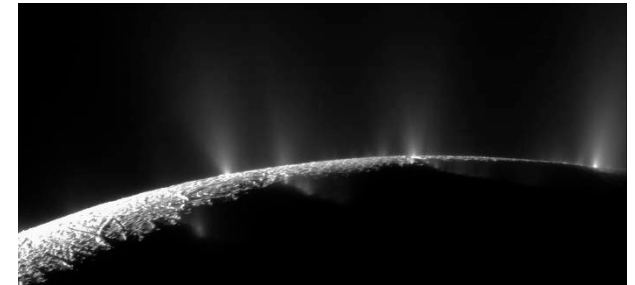
Diversity of Worlds

No two ocean worlds are the same.

- Some, such as Europa and Saturn's moon Enceladus, have icy crusts covered with cracks. Global oceans course beneath the ice. Tidal tugging causes these cracks to form, similar to what happens to the shell of a hardboiled egg when it is rolled between a hand and a table. These cracks are intriguing because organics from the interior could escape through them which orbiting spacecraft could then detect.
- Saturn's moon Titan is thought to have either a thin, salty subsurface ocean sandwiched between layers of ice, or one thick subsurface ocean that extends all the way down to the moon's rocky interior.
- Others may have multiple layers of liquid ocean between multiple layers of ice. Jupiter's moon Ganymede is one such example.



This illustration demonstrates how the interior of Saturn's moon Enceladus might look. A global liquid water ocean is shown between the moon's rocky core and icy crust. The thickness of layers shown here is not to scale. Credit: NASA/JPL-Caltech



The Cassini spacecraft took this image in 2010 showing the Sun illuminating jets of water ice erupting through the surface of Enceladus. Credit: NASA/JPL-Caltech/SSI

Life in the Oceans?

Life on Earth is made possible by its oceans. Liquid water is one of life's three most important ingredients; the other two are energy and certain elements, such as carbon and hydrogen. Given that there are liquid oceans on other worlds, it is natural to wonder whether life can exist there. By probing the ocean worlds in the outer solar system, astrobiologists hope to find out whether there's life beneath the icy surfaces.

On Earth, hydrothermal vents deep in the oceans have bustling ecosystems that dot the ocean floor. When Earth's ocean water interacts chemically with rocks on the ocean floor (such as at hydrothermal vents), we see a wealth of simple organisms which feed on the nutrients released by hydrothermal vents. Future missions to explore ocean worlds such as Europa will investigate whether simple organisms might live there too.

For More Information

- <https://astrobiology.nasa.gov/>
- <https://www.nasa.gov/specials/ocean-worlds/>