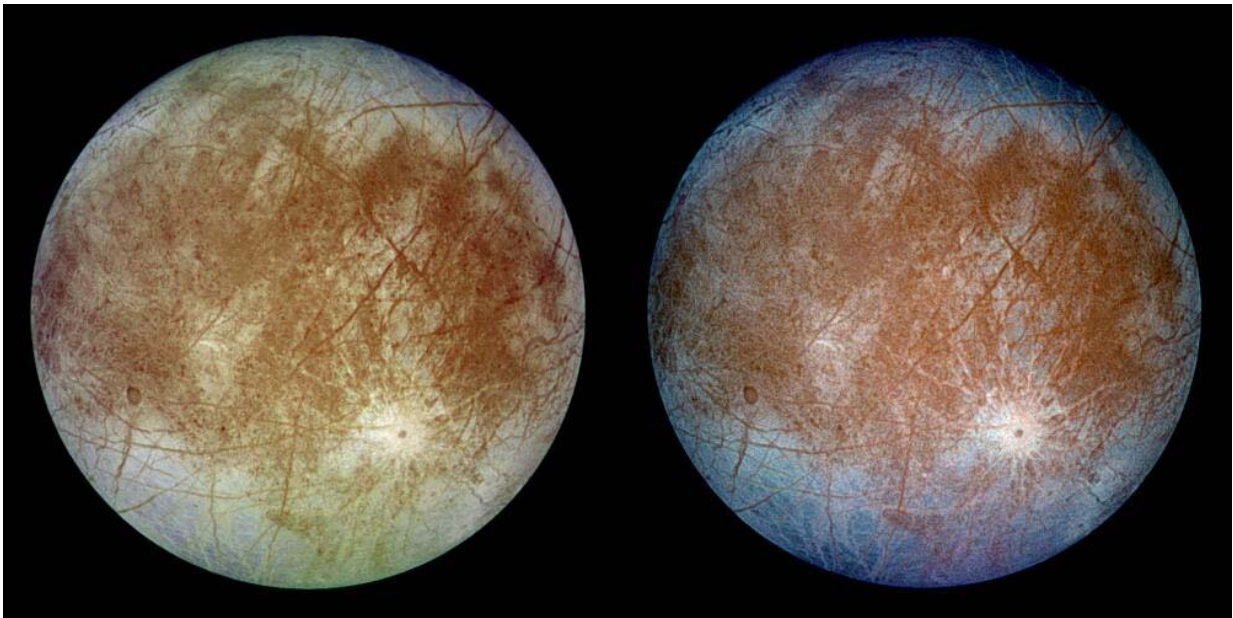


# Experiments measure freezing point of extraterrestrial oceans to aid search for life

May 3 2022, by Hannah Hickey

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This image, taken by the Galileo spacecraft in 1996, shows two views of Jupiter's ice-covered satellite, Europa. The left image shows the approximate natural color while the right is colored to accentuate features. Europa is about 3,160 kilometers (1,950 miles) in diameter, or about the size of Earth's moon. Credit: NASA Jet Propulsion Laboratory

Researchers from the University of Washington and the University of California, Berkeley have conducted experiments that measured the physical limits for the existence of liquid water in icy extraterrestrial worlds. This blend of geoscience and engineering was done to aid in the

search for extraterrestrial life and the upcoming robotic exploration of oceans on moons of other planets.

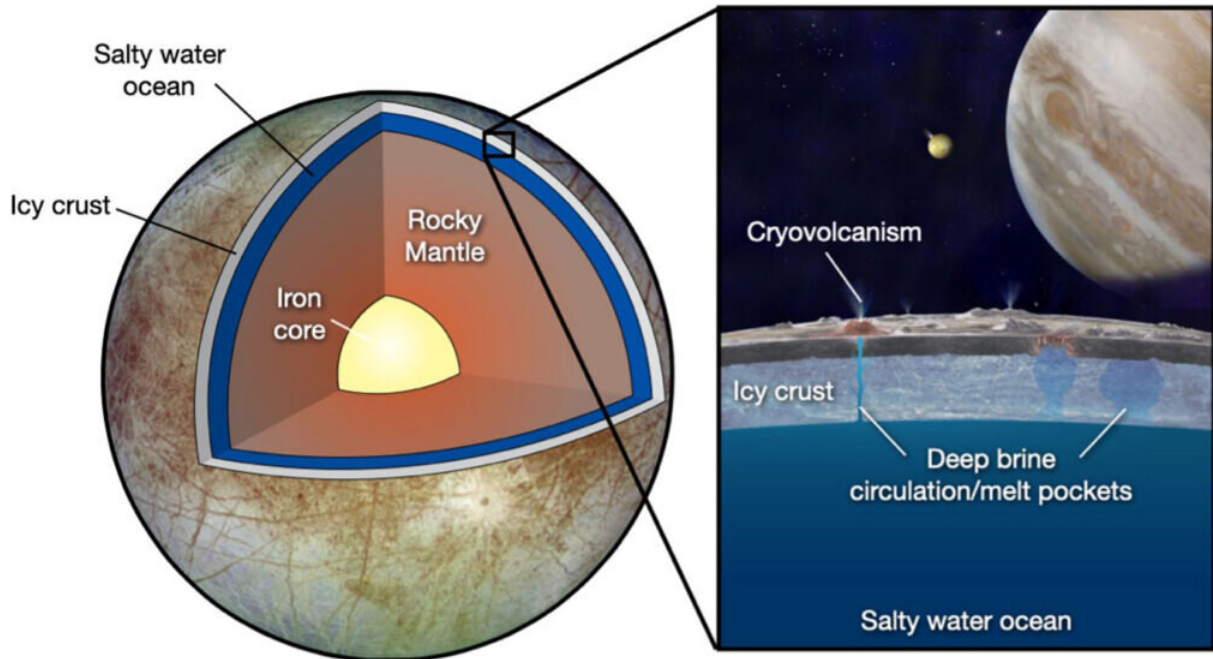
The results were recently published in *Cell Reports Physical Sciences*.

"The more a liquid is stable, the more promising it is for habitability," said co-corresponding author Baptiste Journaux, an acting assistant professor of Earth and space sciences at the UW. "Our results show that the cold, salty, high-pressure liquids found in the deep ocean of other planets' moons can remain liquid to much cooler temperature than they would at lower pressures. This extends the range of possible habitats on icy moons, and will allow us to pinpoint where we should look for biosignatures, or signs of life."

Jupiter and Saturn's [icy moons](#)—including Europa, Ganymede and Titan—are leading candidates within our solar system for hosting [extraterrestrial life](#). These ice-encrusted moons are thought to harbor enormous liquid oceans, up to several dozen times the volume of oceans on Earth.

"Despite its designation as the 'blue marble,' Earth is remarkably dry when compared to these worlds," Journaux said.

The oceans on these moons may contain various types of salts and are expected to range from about 100 miles deep, on Europa, to more than 400 miles deep, on Titan.



The left panel's gray and blue layers show the deep, ice-covered ocean on Europa, a moon of Jupiter that could host extraterrestrial life. This ocean is thought to be much deeper than oceans on Earth. New research hints at where liquid water might be found in these environments. Credit: NASA/JPL-Caltech, with modifications by Baptiste Journaux

"We know that water supports life, but the major part of the oceans on these moons are likely below zero degrees Celsius and at pressures higher than anything experienced on Earth," Journaux said. "We needed to know how cold an ocean can get before entirely freezing, including in its deepest abyss."

The study focused on eutectics, or the lowest temperature that a salty solution can remain liquid before entirely freezing. Salt and water are one example—salty water remains liquid below the freezing temperature of pure water, one of the reasons people sprinkle salt on roads in winter

to avoid the formation of ice.

The experiments used UC Berkeley equipment originally designed for the future cryopreservation of organs for medical applications and for food storage. For this research, however, the authors used it to simulate the conditions thought to exist on other planets' moons.

Journaux, a planetary scientist and expert on the physics of water and minerals, worked with UC Berkeley engineers to test solutions of five different salts at pressures up to 3,000 times atmospheric pressure, or 300 megapascals—about three times the pressure in Earth's deepest ocean trench.

"Knowing the lowest temperature possible for [salty water](#) to remain a liquid at high pressures is integral to understanding how extraterrestrial life could exist and thrive in the deep oceans of these icy ocean worlds," said co-corresponding author Matthew Powell-Palm, who did the work as a postdoctoral researcher at UC Berkeley, also co-founder and CEO of the cryopreservation company BioChoric, Inc.

Journaux recently started working with NASA's Dragonfly mission team, which will send a rotorcraft in 2027 to Saturn's largest [moon](#), Titan. NASA also is leading the Europa Clipper mission in 2024 to explore Europa, one of the many moons orbiting Jupiter. Meanwhile, the European Space Agency in 2023 will send its JUICE spacecraft, or Jupiter Icy Moons Explorer, to explore three of Jupiter's largest moons: Ganymede, Callisto and Europa.

"The new data obtained from this study may help further researchers' understanding of the complex [geological processes](#) observed in these icy [ocean](#) worlds," Journaux said.

**More information:** Brooke Chang et al, On the pressure dependence

of salty aqueous eutectics, *Cell Reports Physical Science* (2022). DOI: [10.1016/j.xcrp.2022.100856](https://doi.org/10.1016/j.xcrp.2022.100856)

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