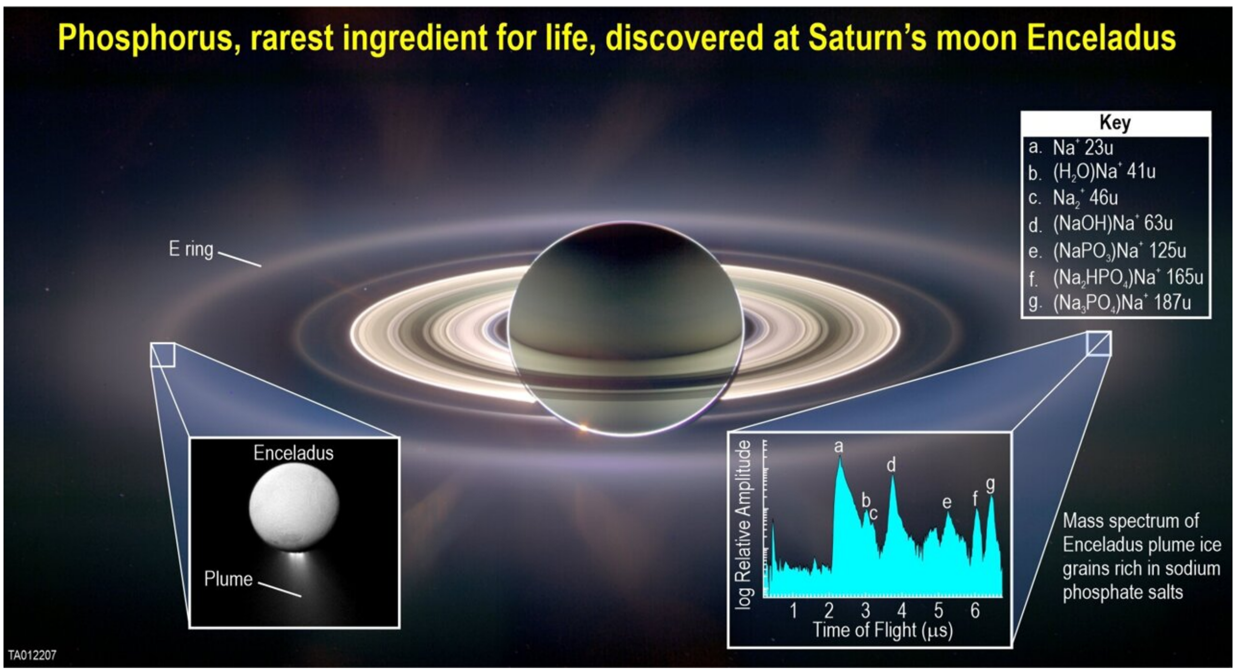
Key building block for life found at Saturn's moon Enceladus

June 14 2023

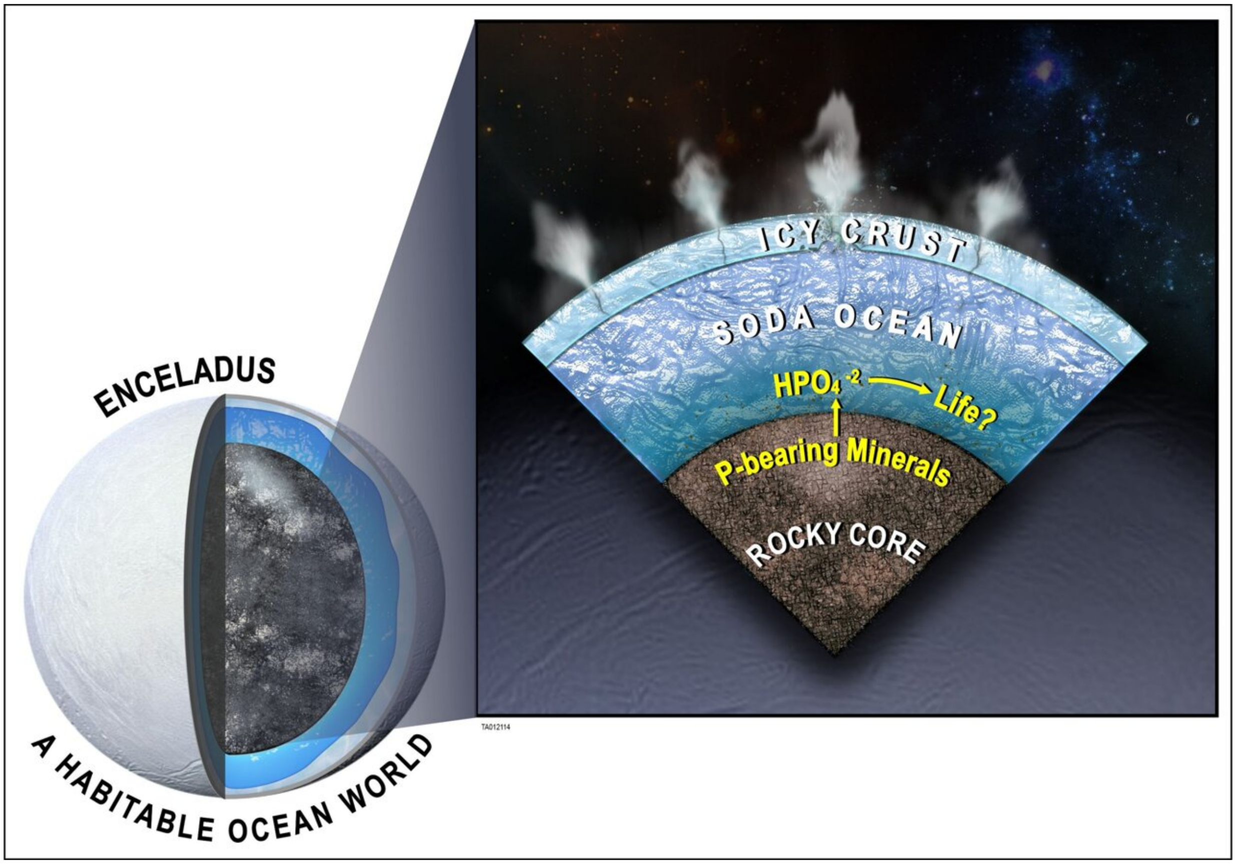


SwRI Lead Scientist Dr. Christopher Glein was part of a team that found phosphorus, a key building block for life, from the subsurface ocean of Saturn's small moon, Enceladus. Liquid water erupts from the moon's subsurface ocean, forming a plume that contains grains of frozen ocean water. Some of these ice grains go on to form Saturn's E ring. The team analyzed Cassini spacecraft data from ice grains in the E ring, which revealed fingerprints of soluble phosphate salts from Enceladus' ocean. Credit: Cassini Imaging Team/SSI/JPL/ SWRI/ Freie Universität Berlin

The search for extraterrestrial life in our solar system just got more exciting. A team of scientists including Southwest Research Institute's Dr. Christopher Glein has discovered new evidence that the subsurface ocean of Saturn's moon Enceladus contains a key building block for life. The team directly detected phosphorus in the form of phosphates originating from the moon's ice-covered global ocean using data from NASA's Cassini mission. Cassini explored Saturn and its system of rings and moons for over 13 years.

"In 2020 (published in 2022), we used geochemical modeling to predict that phosphorus should be abundant in Enceladus' ocean," said Glein, a leading expert in extraterrestrial oceanography. He is a co-author of a paper in the journal *Nature* describing this research. "Now, we have found abundant phosphorus in plume ice samples spraying out of the subsurface ocean."

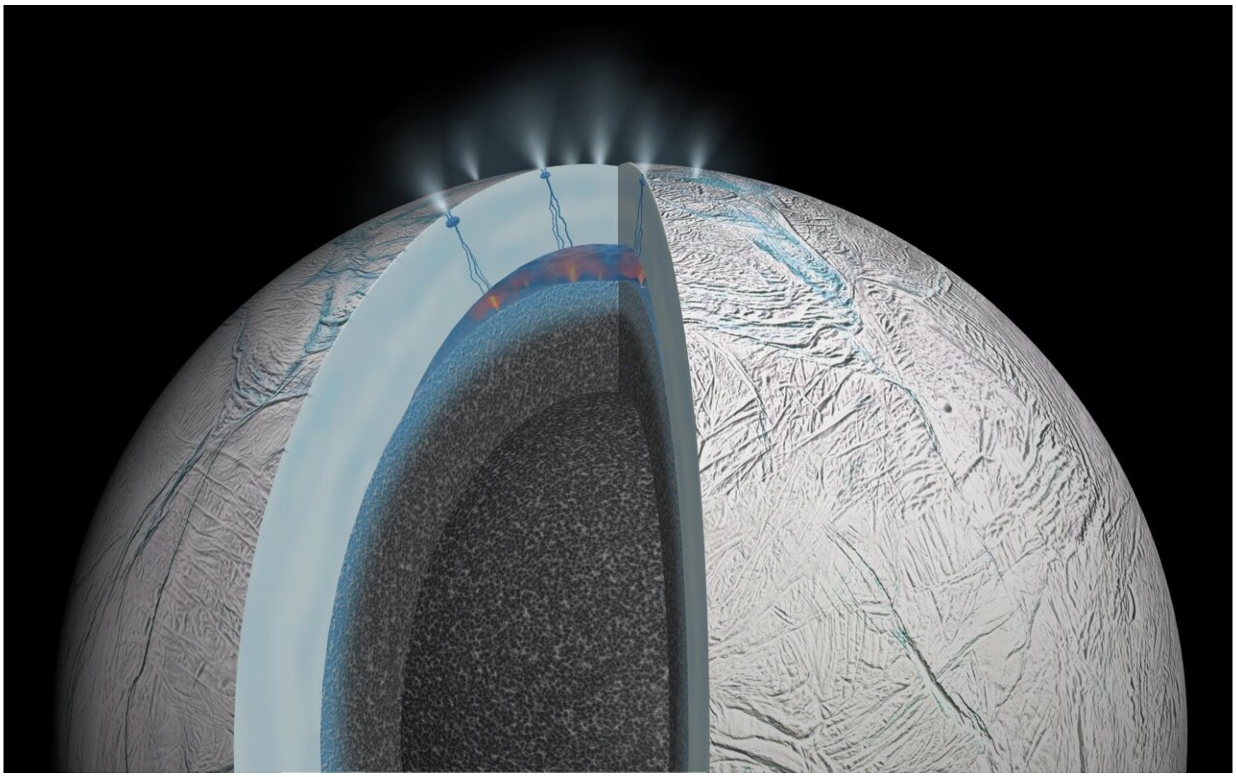
The Cassini spacecraft discovered Enceladus' subsurface liquid water and analyzed samples in a plume of ice grains and gases erupting into space from cracks in the moon's icy surface. Analysis of a class of salt-rich ice grains by Cassini's Cosmic Dust Analyzer showed the presence of sodium phosphates. The team's observational results, together with laboratory analogue experiments, suggest that phosphorus is readily available in Enceladus' ocean as phosphates.



Scientists have inferred that a soda or alkaline ocean (containing $NaHCO_3$ and/or Na_2CO_3) inside of Enceladus interacts geochemically with a rocky core. Geochemical modeling and laboratory experiments indicate that this interaction promotes the dissolution of phosphate minerals, making phosphate (e.g., HPO_4^{2-}) readily available to potential life in the ocean. The discovery of phosphates by Cassini strongly supports the paradigm that Enceladus' ocean is habitable. Credit: Southwest Research Institute

Phosphorus in the form of phosphates is vital for all life on Earth. It is essential for the creation of DNA and RNA, energy-carrying molecules, cell membranes, bones and teeth in people and animals, and even the sea's microbiome of plankton. Life as we know it is simply not possible without phosphates.

"We found phosphate concentrations at least 100 times higher in the moon's plume-forming ocean waters than in Earth's oceans," Glein said. "Using a model to predict the presence of phosphate is one thing, but actually finding the evidence for phosphate is incredibly exciting. This is a stunning result for astrobiology and a major step forward in the search for life beyond Earth."



An artist's rendition of Saturn's moon Enceladus depicts hydrothermal activity on the seafloor and cracks in the moon's icy crust that allow material from the watery interior to be ejected into space. Those ejected particles, clues to the subsurface ocean, were analyzed by instruments on board the Cassini space mission. New analysis finds evidence of phosphates, a key building block for life as we know it. Credit: NASA/JPL-Caltech

One of the most profound discoveries in planetary science over the past 25 years is that worlds with oceans beneath a surface layer of ice are common in our solar system. Such worlds include the icy satellites of the giant planets, such as Europa, Titan and Enceladus, as well as more distant bodies like Pluto.

Worlds like Earth with surface oceans must reside within a narrow range of distances from their host stars to maintain the temperatures that support surface liquid water. Interior ocean worlds, however, can occur over a much wider range of distances, greatly expanding the number of habitable worlds likely to exist across the galaxy.

"Geochemical experiments and modeling demonstrate that such high phosphate concentrations result from enhanced phosphate mineral solubility, in Enceladus and possibly other icy ocean worlds in the solar system beyond Jupiter," Glein said. "With this finding, the ocean of Enceladus is now known to satisfy what is generally considered to be the strictest requirement for life. The next step is clear—we need to go back to Enceladus to see if the habitable ocean is actually inhabited."

More information: Frank Postberg, Detection of phosphates originating from Enceladus's ocean, *Nature* (2023). DOI: 10.1038/s41586-023-05987-9. www.nature.com/articles/s41586-023-05987-9

Mikhail Yu. Zolotov, Phosphate discovery hints at geochemistry and origin of Enceladus, *Nature* (2023). DOI: 10.1038/d41586-023-01886-1

Provided by Southwest Research Institute