Strongest evidence yet indicates Enceladus hiding saltwater ocean

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This image shows icy spray spewing from Saturn's moon, Enceladus. Credit: NASA/JPL/Space Science Institute

(PhysOrg.com) -- Samples of icy spray shooting from Saturn's moon Enceladus collected during Cassini spacecraft flybys show the strongest evidence yet for the existence of a large-scale, subterranean saltwater ocean, says a new international study led by the University of Heidelberg and involving the University of Colorado Boulder.

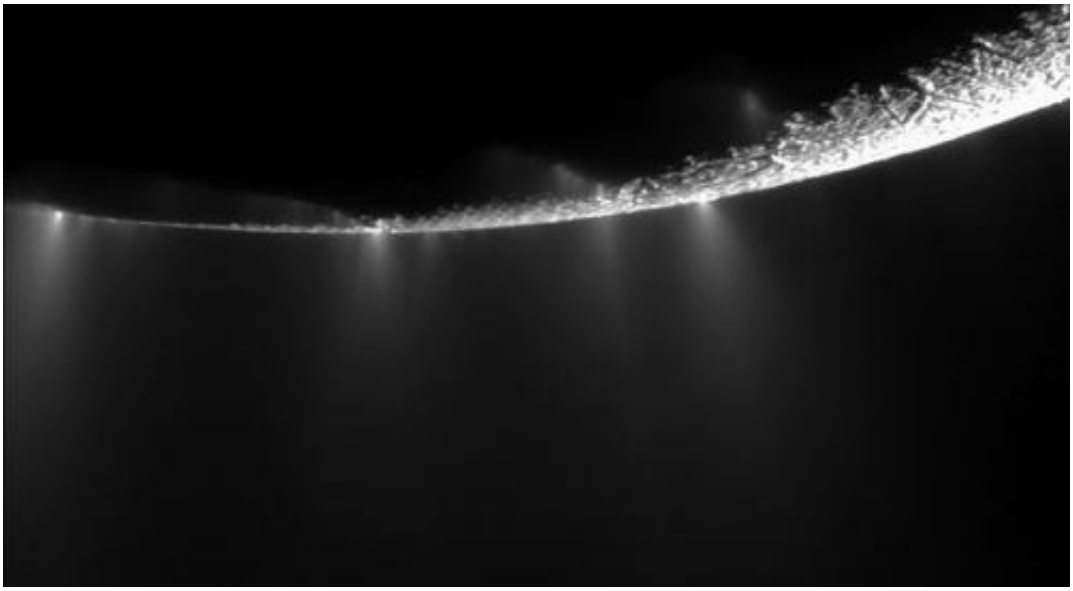
The new discovery was made during the Cassini-Huygens mission to Saturn, a collaboration of NASA, the European Space Agency and the Italian Space Agency. Launched in 1997, the mission spacecraft arrived at the Saturn system in 2004 and has been touring the giant ringed planet

and its vast moon system ever since.

The plumes shooting water vapor and tiny grains of ice into space were originally discovered emanating from Enceladus -- one of 19 known moons of Saturn -- by the Cassini spacecraft in 2005. The plumes were originating from the so-called "tiger stripe" surface fractures at the moon's south pole and apparently have created the material for the faint E Ring that traces the orbit of Enceladus around Saturn.

During three of Cassini's passes through the plume in 2008 and 2009, the Cosmic Dust Analyser, or CDA, on board measured the composition of freshly ejected plume grains. The icy particles hit the detector's target at speeds of up to 11 miles per second, instantly vaporizing them. The CDA separated the constituents of the resulting vapor clouds, allowing scientists to analyze them.

The study shows the ice grains found further out from Enceladus are relatively small and mostly ice-poor, closely matching the composition of the E Ring. Closer to the moon, however, the Cassini observations indicate that relatively large, salt-rich grains dominate.



Dramatic plumes, both large and small, spray water ice out from many locations along the famed "tiger stripes" near the south pole of Saturn's moon Enceladus. The tiger stripes are fissures that spray icy particles, water vapor and organic compounds. Image credit: NASA/JPL/Space Science Institute

"There currently is no plausible way to produce a steady outflow of salt-rich grains from solid ice across all the tiger stripes other than the salt water under Enceladus' icy surface," said Frank Postberg of the University of Germany, lead author of a study being published in *Nature* on June 23. Other co-authors include Jürgen Schmidt from the University of Potsdam, Jonathan Hillier from Open University headquartered in Milton Keynes, England, and Ralf Srama from the University of Stuttgart.

"The study indicates that 'salt-poor' particles are being ejected from the underground ocean through cracks in the moon at a much higher speed than the larger, salt-rich particles," said CU-Boulder faculty member and study co-author Sascha Kempf of the Laboratory for Atmospheric and Space Physics.

"The E Ring is made up predominately of such salt-poor grains, although we discovered that 99 percent of the mass of the particles ejected by the plumes was made up of salt-rich grains, which was an unexpected finding," said Kempf. "Since the salt-rich particles were ejected at a lower speed than the salt-poor particles, they fell back onto the moon's icy surface rather than making it to the E Ring."

According to the researchers, the salt-rich particles have an "ocean-like" composition that indicates most, if not all, of the expelled ice comes from the evaporation of liquid salt water rather than from the icy surface

of the moon. When salt water freezes slowly the salt is "squeezed out," leaving pure water ice behind. If the plumes were coming from the surface ice, there should be very little salt in them, which was not the case, according to the research team.

The researchers believe that perhaps 50 miles beneath the surface crust of Enceladus a layer of water exists between the rocky core and the icy mantle that is kept in a liquid state by gravitationally driven tidal forces created by Saturn and several neighboring moons, as well as by heat generated by radioactive decay.

According to the scientists, roughly 440 pounds of water vapor is lost every second from the plumes, along with smaller amounts of ice grains. Calculations show the liquid ocean must have a sizable evaporating surface or it would easily freeze over, halting the formation of the plumes. "This study implies that nearly all of the matter in the Enceladus plumes originates from a saltwater ocean that has a very large evaporating surface," said Kempf.

Salt in the rock dissolves into the water, which accumulates in a liquid ocean beneath the icy crust, according to the Nature authors. When the outermost layer of the Enceladus crust cracks open, the reservoir is exposed to space. The drop in pressure causes the liquid to evaporate into a vapor, with some of it "flash-freezing" into salty ice grains, which subsequently creates the plumes, the science team believes.

"Enceladus is a tiny, icy moon located in a region of the outer Solar System where no liquid water was expected to exist because of its large distance from the sun," said Nicolas Altobelli, ESA's project scientist for the Cassini-Huygens mission. "This finding is therefore a crucial new piece of evidence showing that environmental conditions favorable to the emergence of life may be sustainable on icy bodies orbiting gas giant planets."

The Huygens probe was released from the main spacecraft and parachuted through the atmosphere to the surface of Saturn's largest moon, Titan, in 2005.

The Cassini spacecraft is carrying 12 science instruments, including a $12.5 million CU-Boulder ultraviolet imaging spectrograph designed and built by a LASP team led by Professor Larry Esposito.

Provided by University of Colorado at Boulder

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