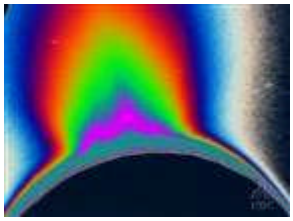
Liquid water on Saturn moon could support life

Cassini spacecraft sees signs of geysers on icy Enceladus



Geysers found on Saturn moon

NASA / JPL / SSI
An enhanced-color image of Enceladus, based on data from the Cassini spacecraft, highlights dark "tiger stripes" in the south polar region. Those stripes are actually fissures that appear to be the source of the Saturnian moon's geysers.

By Alan Boyle Science editor
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Scientists have found evidence that cold, Yellowstone-like geysers of water are issuing from a moon of Saturn called Enceladus, apparently fueled by liquid reservoirs that may lie just tens of yards beneath the moon's icy surface.

The surprising discovery, detailed in Friday's issue of the journal Science, could shoot Enceladus to the top of the list in the search for life elsewhere in our solar system. Scientists described it as the most important discovery in planetary science in a quarter-century.

"I think this is important enough that we will see a redirection in the planetary exploration program," Carolyn Porco, head of the imaging team for the Cassini mission to Saturn, told MSNBC.com. "We've just brought Enceladus up to the forefront as a major target of astrobiological interest."

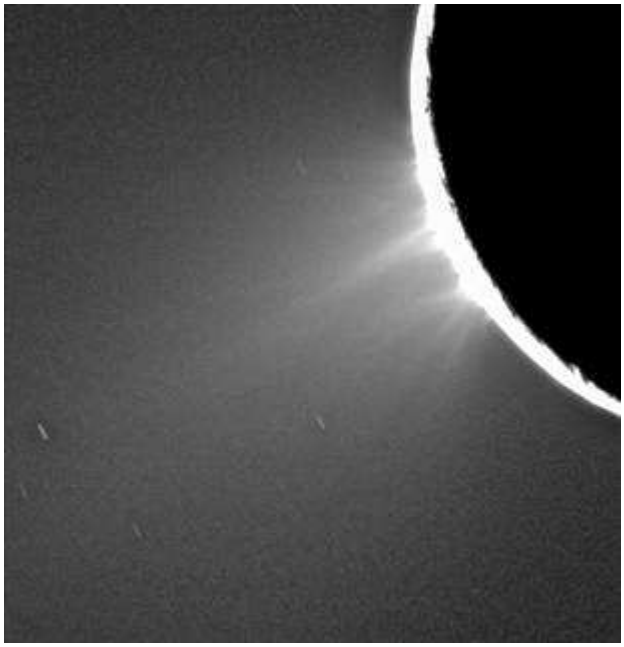
The readings from Enceladus' geyser plumes indicate that all the prerequisites for life as we know it could exist beneath Enceladus' surface, Porco said.

"Living organisms require liquid water and organic materials, and we know we have both on Enceladus now," she said. "The plumes through which Cassini flew last July contain methane, contain CO2, propane — they contain several organic materials."

The third necessary ingredient — energy for fueling life's processes — could exist around hydrothermal vents around the bottom of Enceladus' water reservoirs, just as it does around Earth's deep-ocean hydrothermal vents.

The results impressed University of Colorado planetary scientist Robert Pappalardo, who has studied Enceladus and other icy moons but was not involved in the newly published research.

"I think the discovery of activity on Enceladus is about the most exciting discovery in planetary science since the volcanoes of Io," he said, referring to the detection of volcanic activity on Jupiter's moon by the Voyager probe in 1979.



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The white streaks in this image are backlit geysers of water ice, rising hundreds of miles into space from Enceladus' dark disk.

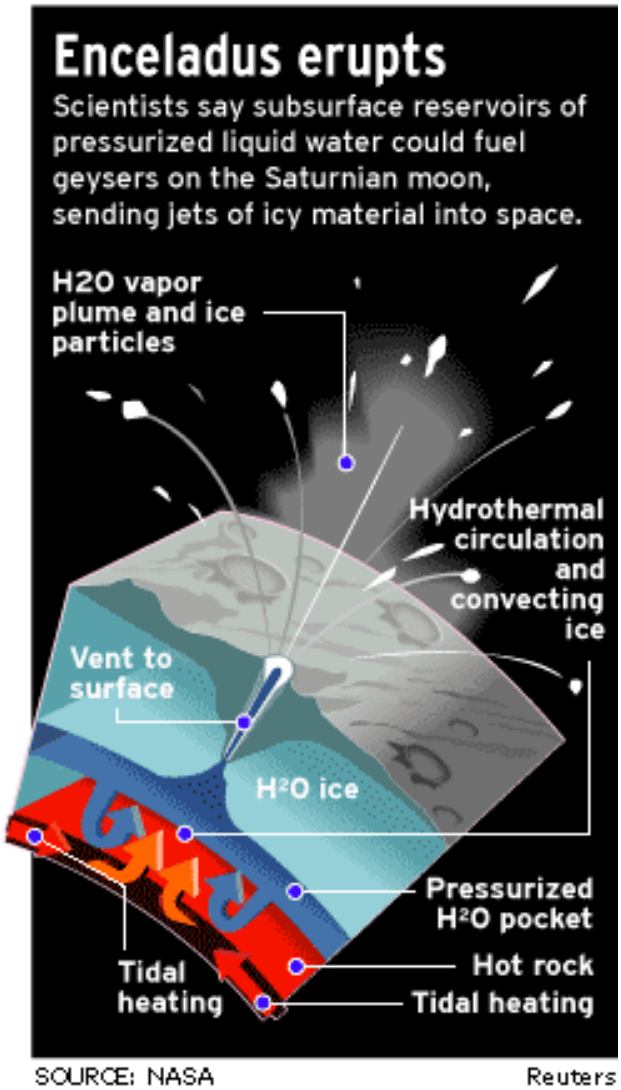
The findings unveiled Thursday are based on imagery as well as temperature readings from Cassini, a U.S-European spacecraft that has been studying the ringed planet and its moons since 2004.

The precise sources of the geysers could not be spotted directly, because Cassini's camera isn't quite good enough to spot the bright spray of water and ice crystals against the bright ice on Enceladus' surface, said imaging team member Andrew Ingersoll, an atmospheric scientist at the California Institute of Technology.

However, Cassini's camera repeatedly recorded the spray of ice crystals and water vapor from Enceladus' south polar region, backlit by sunlight. That imagery allowed researchers to trace the source back to the mysterious dark "tiger stripes" previously seen on Enceladus.

Researchers investigated several possibilities for the origin of the geysers, including the idea that the contents were driven by warm ice turning directly into vapor, or consisted of a cometlike slurry of ice and dirt.

The Cassini team found that the spray from the geysers was composed of equal proportions of ice and water vapor. That ruled out the "warm ice" model as well as the "comet" model, Porco said. The best remaining model was that the geyser was driven by liquid water beneath the surface.



"We arrived at our last model, and in some ways somewhat reluctantly, because this is a pretty extraordinary result," she said. "Like [the late astronomer] Carl Sagan was fond of saying, 'Extraordinary claims require extraordinary evidence.'"

The imaging team's conclusion was supported by the temperature readings from Cassini's infrared spectrometer: Although the surface temperatures were far below freezing, the readings showed relatively warm spots in the south polar region, centering on the tiger stripes. Scientists traced the internal heating patterns that could create such

warm spots, and concluded that temperatures could be above freezing mere yards beneath the surface.

"It can be warm enough 10 meters or so beneath the surface," Porco explained, "and there's enough pressure to keep liquid water stable at that depth."

Still more supporting evidence came from an analysis of the ice surrounding the "tiger stripe" cracks. That ice was amorphous and virtually crater-free, indicating that it welled up relatively recently.

Cassini's images showed that the geysers rose hundreds of miles above the surface. Based on the imagery, researchers concluded that most of the ice crystals fell back to the surface as snow. Some of the ice escaped Enceladus' gravity field to become part of a wide, thin ring of Saturn known as the E ring.

Boiling water beneath the surface?

The Cassini team theorized that water could be heated to the boiling point far beneath the surface, pushing up through the "tiger stripe" cracks, Porco said. The source of the heating could be molten rock, perhaps extending nearer to the surface in the south pole region, she said.

"If you have molten rock, then we really are playing the game of looking possibly at an environment that is conducive to living organisms," Porco said. "If this is correct, we've just hit the ball out of the park. It doesn't really get much more exciting than this. If this is all we did on Cassini, this would have made the mission worthwhile."

The types of living organisms Porco and astrobiologists have in mind aren't little green men or even little green fish. Rather, they're more likely to be microbes that have adapted to the type of sunless, chemical-fueled environment seen around Earth's hydrothermal vents. For years, scientists have theorized that such environments might exist beneath the similarly icy surface of Europa, a moon of Jupiter, or beneath the surface soil of Mars.

Years of further research

It will literally take years to follow up on Cassini's findings about Enceladus: Although the spacecraft made three close flybys of the moon in 2005, the next close encounter isn't scheduled until 2008. Porco said the Cassini team is already working to change the probe's orbit to get closer to the moon, and she said it would be imperative for the Cassini mission to get an extension beyond 2008 for even more encounters.

"It would be insanity to think that we wouldn't get it, based on this discovery," she said.

Ingersoll said observations need to be repeated to solidify the case for liquid water on Enceladus. "I'd be perfectly happy to do this again, just to see how much variability there is," he said.

One of the big unanswered questions has to do with why so much heat is emanating from such a little moon. The Saturnian system is about 890 million miles (1.4 billion kilometers) from the sun, so sunlight isn't much of a factor. Moreover, Enceladus is just 309 miles (500 kilometers) wide, compared with Europa's diameter of 1,940 miles (3,138 kilometers).

On Europa, internal heat is thought to be generated by a molten core as well as tidal flexing. But on Enceladus, the calculations for such effects fall short by a factor of 10, Porco said.

Some scientists have theorized that Enceladus is an asymmetric moon, with a small molten core that's off-center. That could explain why the warm spots are concentrated in the south polar region, and why Enceladus might have regional reservoirs of liquid water rather than a global subsurface ocean. However, scientists would have to explain how the core came to be off-center in the first place.

New scientific frontiers

Pappalardo said the research related to Enceladus' geysers suggested many more scientific questions yet to be answered.

"I think it certainly elevates the priority of further Enceladus exploration, by the Cassini spacecraft first off," he said. "We really need to understand what's going on there. What kind of plumbing is there on Enceladus? What could be maintaining the liquid, if there really is a reservoir of liquid water within?"

Like Pappalardo, Brown University planetary scientist James Head ranked the results from Enceladus alongside the 1979 discovery of Io's volcanoes. Head, an expert on Europa, said the findings could help reverse NASA cutbacks in space science missions. For example, NASA recently put a proposed mission to Europa and Jupiter's other icy moons on hold.

"People are really striving to try to reverse that, because it is such a clear imperative," he told MSNBC.com.

Porco said that the evidence for liquid water could well put Enceladus ahead of Europa as a priority for further exploration, but Head said one icy moon shouldn't be pitted against another.

"These are the kinds of exciting results that exploration is all about," he said. "I wouldn’t say it would change the ranking on Europa vs. Enceladus. What it really says that we need to get off our butts and explore Europa — because the same kind of exploration is going to give us hundreds of insights about comparable things."