# New evidence for life-capable environments on Saturn’s moon Enceladus

**By Bryan Dyne**
**6 June 2017**

The Cassini spacecraft, now in the 13th and final year of its explorations in orbit around Saturn, has discovered molecular hydrogen in the plumes of gas and ice erupting out of the south pole of Saturn’s moon, Enceladus. This is further evidence of a mineral-laden and warm ocean benearth the moon’s ice-covered surface. It indicates for the first time that this ocean likely has hydrothermal vents and thus, similar to Earth, the geochemical energy necessary to support communities of microbial life.

To be clear, this is not evidence that Enceladus is inhabited even by the smallest of life-forms. None of Cassini’s twelve 12 instruments would be able to detect the life that exists on Earth if the satellite were orbiting planet Earth, much less on an icy moon more than one 1 billion kilometers away. What the spacecraft has shown is evidence that Enceladus is yet another Solar System body—alongside Jupiter’s moon Europa, potentially the dwarf planet Pluto and others—which has all three ingredients that astrobiologists think Earth-like life needs: liquid water, chemicals such as carbon, nitrogen, oxygen and hydrogen and a source of energy.

Cassini has conducted 21 flybys of Enceladus as part of its broader mission to study Saturn and its system of 62 moons. The moon was initially targeted by astronomers after data sent back by both Voyager spacecraft suggested that one of Saturn’s rings was the result of material being vented from Enceladus’ surface. This hypothesis was verified during Cassini’s first three flybys, which confirmed the initial observations of Voyager that a great deal of material—mainly water vapor—is erupting from geyser-like plumes at the moon’s southern polar region.

Those initial results also revealed that certain parts of the moon’s south pole were more than 80 degrees Celsius hotter than the surrounding ice, much too warm to be explained by any external heating from the Sun or Saturn, indicating that parts of Enceladus are heated from the moon’s interior. The most likely sources of warmth are from the tidal friction generated between Enceladus and Saturn or (less likely) some radioactive source in the moon’s core.

What the surface temperatures also hinted at, and which has now been confirmed, is the presence of a liquid water ocean several kilometers below the surface of Enceladus. At first, it was thought that the ocean was only located near the moon’s south pole, but gravity mapping by Cassini has shown that the ocean covers the entire moon. This was the first indication that Enceladus might have the possibility of supporting Earth-like life.

As a result of those initial measurements, Enceladus became a priority target for Cassini flybys, second only to Saturn’s largest moon Titan, which has been the target of 127 flybys and of the Huygens lander, and Saturn itself.

The data sent back to Earth from the Enceladus flybys has built up more and more evidence that the moon has the necessary ingredients to support life. Observations by Cassini’s spectrometer over the course of seven flybys revealed that in addition to water, Enceladus’ southern plumes consist of trace amounts of hydrocarbons such as methane, propane, acetylene and formaldehyde—similar to the composition of most comets.

The most recent piece of the puzzle was uncovered in 2015, during Cassini’s last flyby of Enceladus. Rather than analyzing the plumes from a distance, the spacecraft was directed to undertake the more dangerous path of flying directly through the plumes to analyze the erupting particles directly. Thanks to this

manueuver, astronomers discovered that the plumes also contain molecular hydrogen.

This led directly to a new question: What on Enceladus could make molecular hydrogen inside an ocean? In Earth's oceans, it is produced through interactions between the salty ocean, rocky minerals and hot hydrothermal vents. After months of testing and ruling out other possibilities, it was determined that this is also the most likely scenario for Enceladus as well. The hypothesis fits both the amount of molecular hydrogen found on the moon as well as the geological activity that is likely making hot spots on the moon's surface.

The similar chemical and thermal properties of the oceans of Enceladus and Earth do not tell us that there is life on another world. Rather, it shows that the conditions required to produce life are not that uncommon. On Earth, the microbes around hydrothermal vents form the root of our planet's tree of life.

On Enceladus, these are places that deserve careful study in the search for extraterrestrial life.

Since 2006, there have been 11 proposed missions have been proposed to follow-up and deepen Cassini's observations, the most recent being the Enceladus Life Finder. These are alongside the proposals to have a mission to study Jupiter's moon Europa, which was last visited in the late 1990s. As a result of budget cuts, NASA has been forced to choose between the two mission concepts, ultimately focusing on developing the Europa Clipper mission, which is slated to launch in 2022. Both missions combined would cost less than one of the US Navy's new aircraft carriers.

Until a new Saturn mission is launched, there will be no new up-close data of Enceladus. Cassini's 2015 flyby of the moon was the spacecraft's last, as part of the final series of flybys of every object it has studied before it runs out of fuel and crashes into Saturn. That event is scheduled for September 15 of this year and will mark the end of a remarkable era of planetary exploration.

---