Mars's Tough Organic Molecules and Mysterious Methane

The Curiosity rover recently found new evidence preserved in rocks on Mars that suggests the planet could have supported ancient life as well as evidence in the Martian atmosphere that relates to the search for current life on the Red Planet. While not necessarily evidence of life itself, these findings are encouraging for future missions exploring the planet's surface and subsurface.

The new findings—"tough" organic molecules in 3-billion-year-old sedimentary rocks near the surface—appeared in two papers published in the June 8 edition of the journal *Science*.

Organic molecules contain carbon and hydrogen, and also may include oxygen, nitrogen, and other elements. While commonly associated with life, organic molecules can also be created by nonbiological processes and are not necessarily indicators of life.

This is not the first time that organic molecules have been found on the Red Planet. The Sample Analysis at Mars (SAM) instrument suite on Curiosity made the first definitive detection of organic molecules on Mars in 2013 at Gale Crater. This new detection finds larger and more complex molecules, and indicates organic carbon concentrations on the order of 10 parts per million or more, about 100 times greater than prior detections.

"With these new findings, Mars is telling us to stay the course and keep searching for evidence of life," says Thomas Zurbuchen, associate administrator for the Science Mission Directorate (SMD) at NASA Headquarters, in Washington.

Although the surface of Mars is inhospitable today, there is clear evidence that, in the distant past, the Martian climate allowed liquid water—an essential ingredient for life as we know it—to pool at the surface. Data from Curiosity reveal that billions of years ago, a water lake inside Gale Crater held all the ingredients necessary for life, including chemical building blocks and energy sources.

"The Martian surface is exposed to radiation from space. Both radiation and harsh chemicals break down organic matter," says Jen Eigenbrode of NASA's Goddard Space Flight Center in Greenbelt, Maryland, who is lead author of one of the two *Science* papers. "Finding ancient organic molecules in the top five centimeters of rock that was deposited when Mars may have been habitable bodes well for us to learn the story of organic molecules on Mars with future missions that will drill deeper."

In the second paper, scientists describe the discovery of seasonal variations in methane in the Martian atmosphere over the course of nearly three Mars years, which is almost six Earth years. This variation was also detected by the SAM instrument suite on Curiosity.

Water-rock chemistry might have generated the methane, but scientists cannot rule out the possibility of biological origins. Methane previously had been detected in Mars's atmosphere in large, unpredictable plumes. This new result shows that low levels of methane within Gale Crater repeatedly peak in warm summer months and drop in the winter.

These latest results give scientists confidence that NASA's Mars 2020 rover and the European Space Agency's ExoMars rover will find even more organics, both on the surface and in the shallow subsurface.

"There's always been a nagging concern that organic molecules might be destroyed by geological processes on Mars. But the fact that we're finding them still present in surface rocks makes it more likely that—if there is indeed a record of ancient life on Mars—it may have been preserved, and that we may be able to find and sample it," says Ken Farley, project scientist for Mars 2020 and W. M. Keck Foundation Professor of Geochemistry at Caltech.

Mars 2020 is the first part of a proposed campaign to collect, cache, and ultimately return samples of rocks from Mars.

"Are there signs of life on Mars?" asks Michael Meyer, lead scientist for NASA's Mars Exploration Program at NASA Headquarters. "We don't know, but these results tell us we are on the right track."

The Jet Propulsion Laboratory, managed by Caltech for NASA, oversees the Mars Science Laboratory Project for NASA's SMD and built the project's Curiosity rover.

This self-portrait of NASA's Curiosity Mars rover (created by stitching two images together and removing the rover's arm) shows the vehicle at the site from which it reached down to drill into a rock target called "Buckskin" on lower Mount Sharp.