

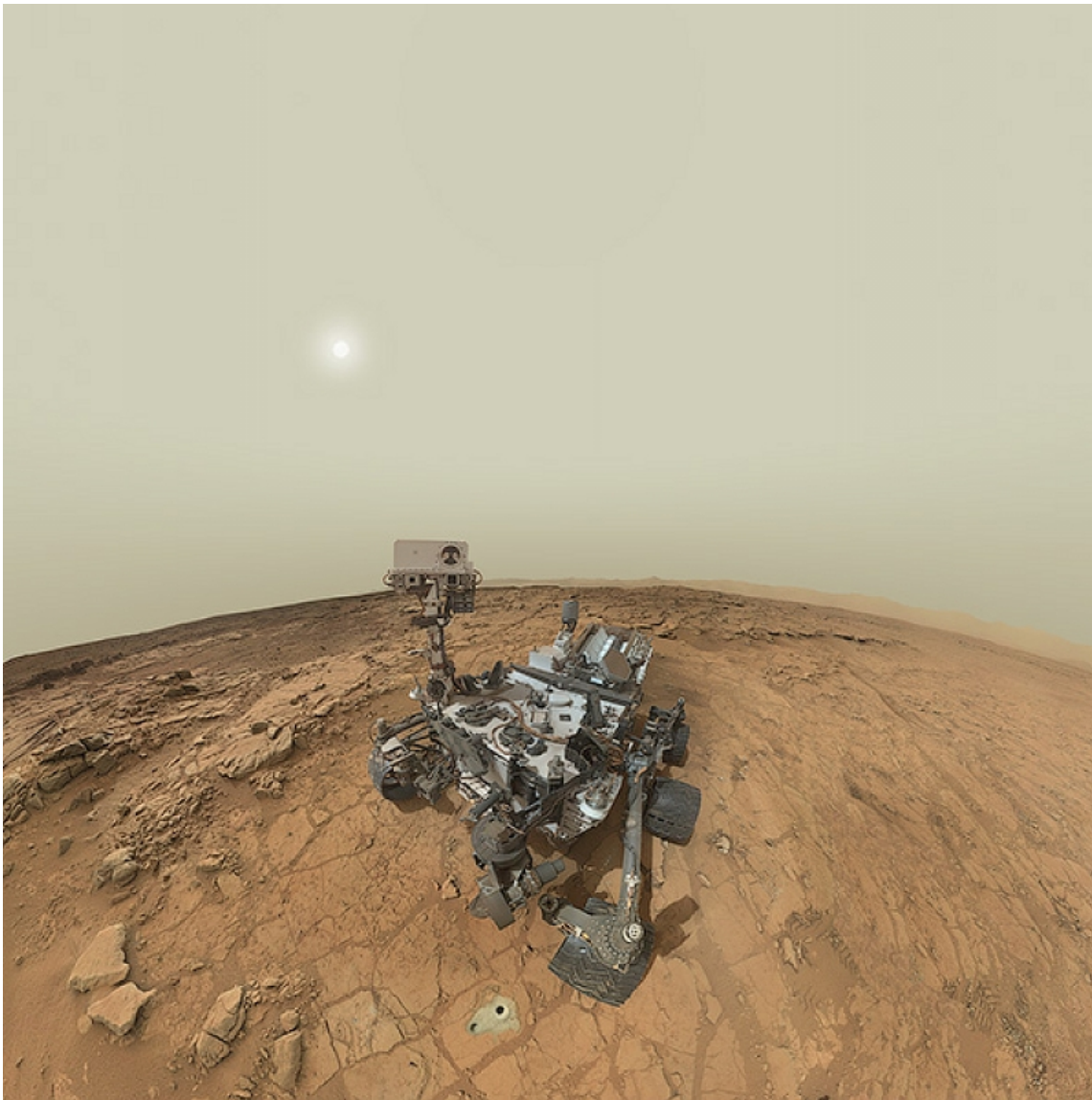
# ASTROBIOLOGY TOP 10: CURIOSITY'S ORGANIC DISCOVERY

By Aaron L. Gronstal - Jan 2, 2015

*As 2014 comes to a close, Astrobiology Magazine is counting down the 'Top 10' stories of the past year... and this year ended with big news. Topping the list at number 1 is the discovery of organic molecules on the surface of Mars.*

*NASA's Curiosity rover dominated this year's Top 10 with three entries on the list. The rover made a number of incredible discoveries for astrobiology on the red planet, the biggest of which is the first definitive finding of organics on Mars. The molecules were found in a sample drilled out of Cumberland rock in Gale Crater. The discovery could shape the future of Mars exploration. Now, astrobiologists are trying to determine if the organic molecules are biological or non-biological in origin.*

*Curiosity Detects Methane and Organic Molecules in Gale Crater was originally published on December 19, 2014.*



This self-portrait of NASA's Mars Curiosity Rover includes a sweeping panoramic view of its location in the Yellowknife Bay region of Gale Crater. The impressive mosaic was constructed using frames from the rover's Mars Hand Lens Imager (MAHLI) and Mastcam. Credit: NASA, JPL-Caltech, MSSS – Panorama by Andrew Bodrov

NASA's Curiosity rover has made two of its most important observations on Mars since arriving on the planet in 2012. The rover measured a spike in levels of the organic chemical methane in the local atmosphere of its research site. Additionally, Curiosity detected other organic molecules in drill samples from a mudstone that once sat at the bottom of the lake that filled Gale crater in Mars' ancient past.

The results were published in the journal *Scienceexpress*, and announced at the 2014 Fall Meeting of the *American Geophysical Union* (AGU).

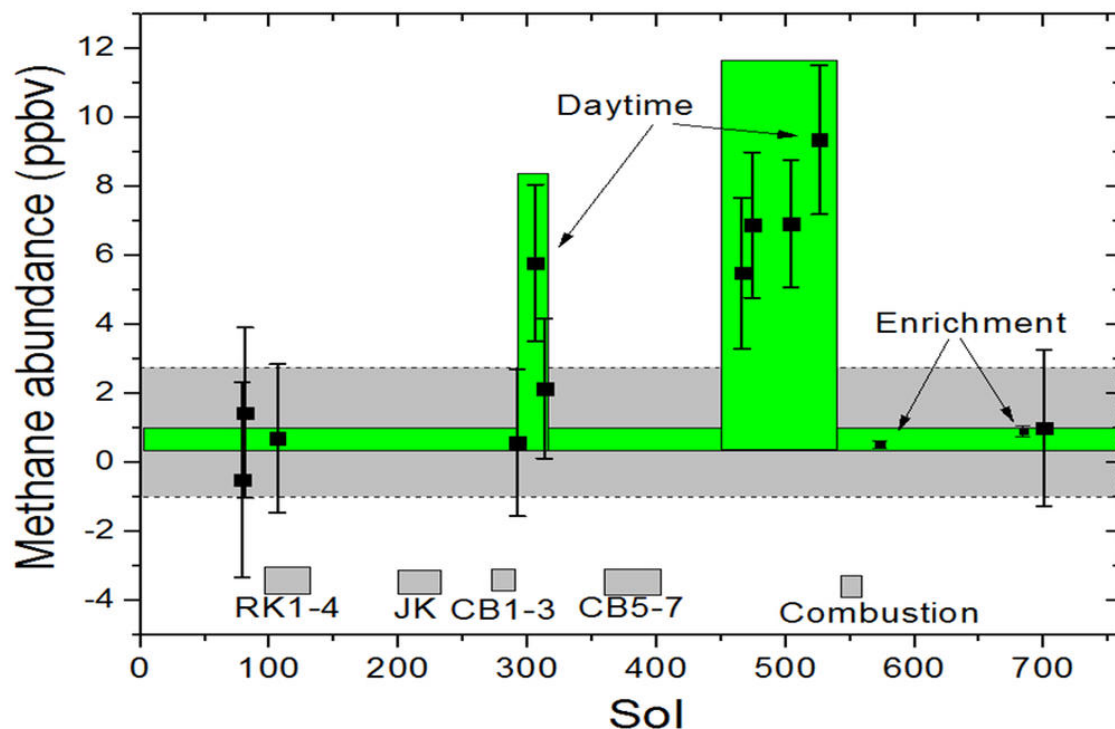
Credit: American Geophysical Union (AGU) on UStream

## The Scent of Methane

Methane has previously been **detected** in the martian atmosphere by Earth-based telescopes and **orbital** missions at the red planet. However, methane levels measured by **Curiosity** at Gale crater have shown only a small fraction of **methane** in the air.

The new measurements showed a tenfold increase in local methane levels. The methane was short-lived and decreased to previous levels shortly after it appeared.

“This temporary increase in methane – sharply up and then back down – tells us there must be some relatively localized source,” said Curiosity science team member, Sushil Atreya of the University of Michigan, in a recent **press release** from NASA JPL. “There are many possible sources, biological or non-biological, such as interaction of water and rock.”



This graphic shows tenfold spiking in the abundance of methane in the Martian atmosphere surrounding NASA's Curiosity Mars rover, as detected by a series of measurements made with the Tunable Laser Spectrometer (TLS) instrument in the rover's Sample Analysis at Mars (SAM) laboratory suite. Credit: NASA/JPL-Caltech

Methane is important because it is an organic molecule often produced by life on Earth. However, methane is not proof of life because it can also be produced by many different processes that do not involve living organisms. Even so, the finding proves that present-day Mars is an active world.

“At this point, we don't know the origin of this methane,” said Danny Glavin in a recent NASA interview. “It could be biological from, maybe methanogenic bacteria deep in the subsurface releasing methane. But there are non-biological explanations as well, such as water-rock interactions in the subsurface that could also produce the methane signals that we're seeing.”

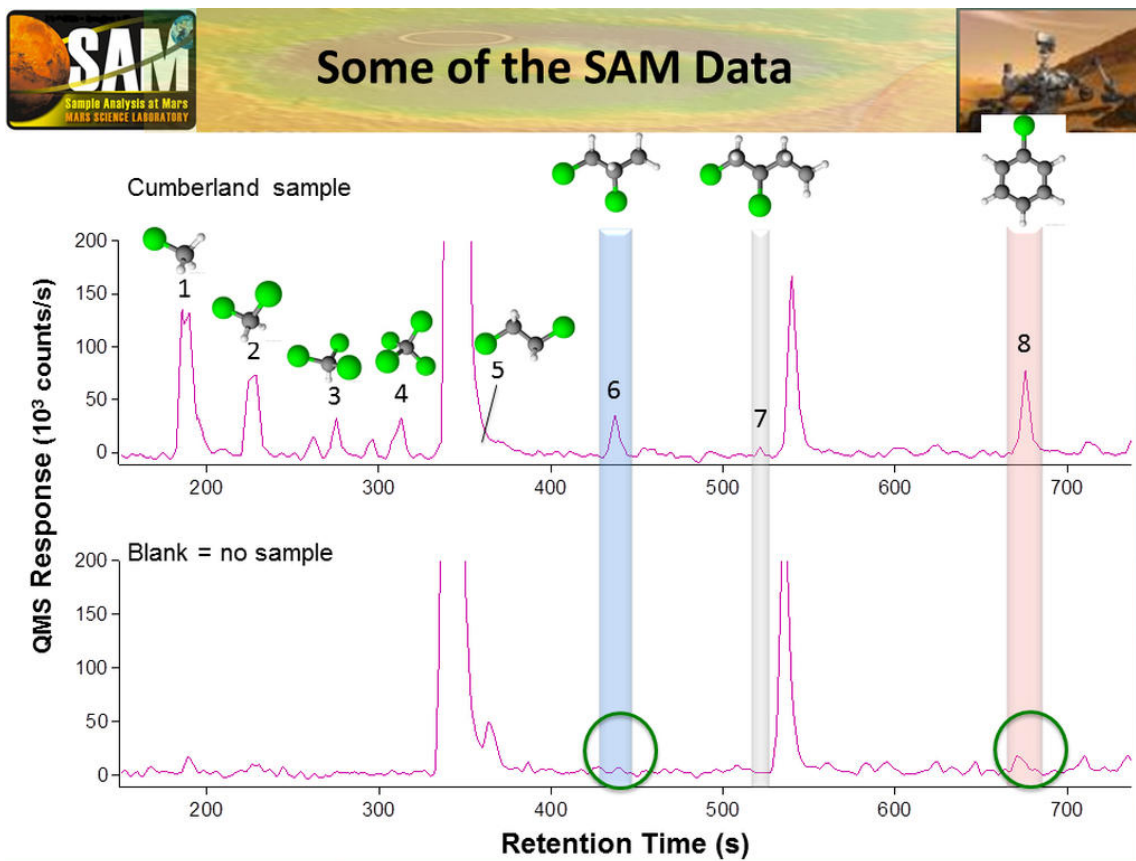


NASA's Mars rover Curiosity drilled into this rock target, "Cumberland," during the 279th Martian day, or sol, of the rover's work on Mars (May 19, 2013) and collected a powdered sample of material from the rock's interior. Analysis of the Cumberland sample using laboratory instruments inside Curiosity will check results from "John Klein," the first rock on Mars from which a sample was ever collected and analyzed. The two rocks have similar appearance and lie about nine feet (2.75 meters) apart. Curiosity used the Mars Hand Lens Imager (MAHLI) camera on the rover's arm to capture this view of the hole in Cumberland on the same sol as the hole was drilled. The diameter of the hole is about 0.6 inch (1.6 centimeters). The depth of the hole is about 2.6 inches (6.6 centimeters). Credit: NASA/JPL-Caltech/MSSS

## Drilling Organics

The second of Curiosity's big discoveries came when the rover drilled into a rock dubbed "Cumberland." Samples from the mudstone were analyzed by Curiosity's SAM instrument, which then provided the first definitive detection of organic molecules on the martian surface.

Previous data gathered by Curiosity has shown that Gale crater was once filled with a **lake** of liquid water that persisted for long periods of time. Cumberland sat on the lake bed of this ancient body of water.

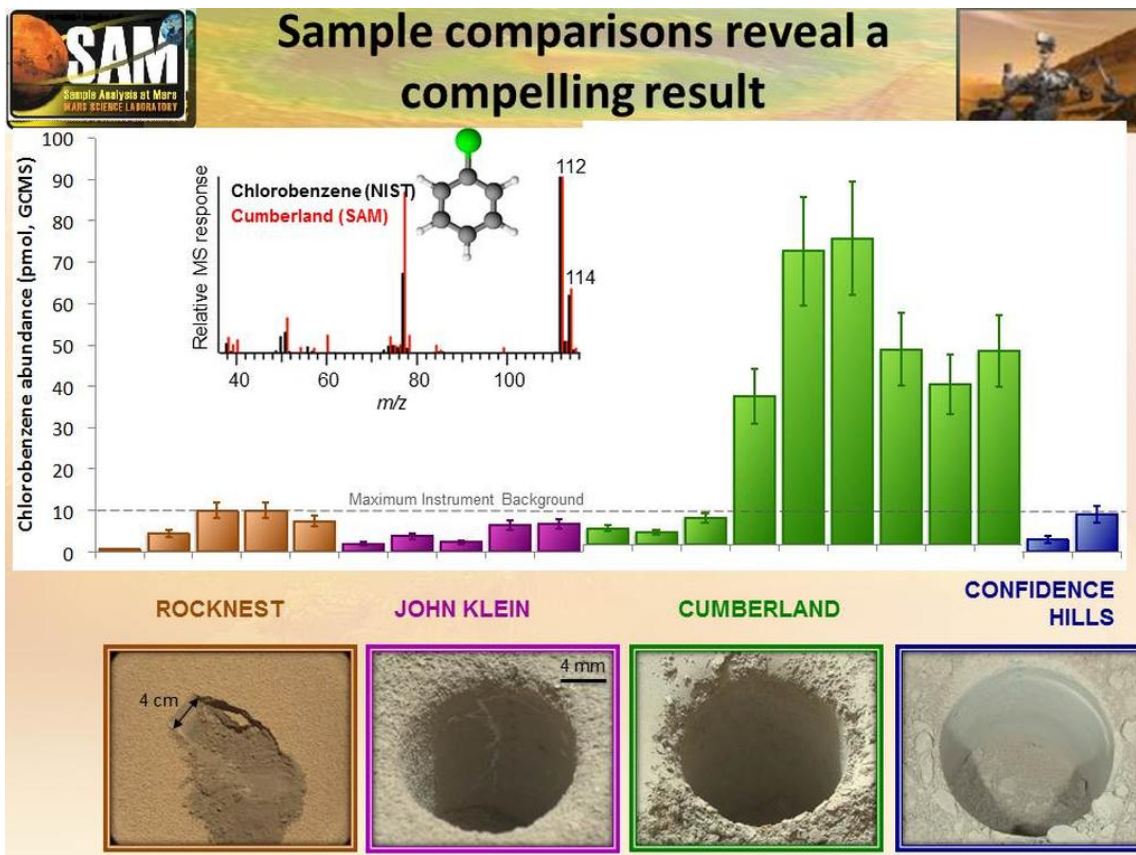


Data graphed here are examples from the Sample Analysis at Mars (SAM) laboratory's detection of Martian organics in a sample of powder that the drill on NASA's Curiosity Mars rover collected from a rock target called "Cumberland." Credit: NASA/JPL-Caltech

In the Cumberland samples, Curiosity found molecules that are not common on Earth, including chlorinated alkanes and chlorobenzene, which was the most abundant molecule detected. On our planet, chlorobenzene is used in manufacturing, but does not occur naturally.

Astrobiologists have been hunting for organic material on Mars for decades. Organic molecules are typically built from atoms of carbon, hydrogen and oxygen, and they are often referred to as the 'building blocks' for life as we know it. However, this does not indicate that the martian organic molecules are connected to life.

There is not enough information to determine whether or not the martian organics found by Curiosity are biological or non-biological in origin. Many non-biological processes on Mars could have produced them, including the delivery of materials by meteorites or geological reactions in the rock.



This graphic offers comparisons between the amount of an organic chemical named chlorobenzene detected in the “Cumberland” rock sample and amounts of the same compound in samples from three other Martian surface targets analyzed by NASA’s Curiosity Mars rover. Credit: NASA/JPL-Caltech

“Although at this point in the mission we can’t conclude that there was definitive life on Mars, the SAM discoveries have really shown us that all of the basic ingredient for life were there, including complex organic compounds, the building blocks of life,” said Glavin.

The findings raise hope that chemical evidence of ancient life could one day be found on Mars. Determining the origins of the newly discovered organics could help solve the age-old question of whether or not Mars was once **alive world**.

“We think life began on Earth around 3.8 billion years ago, and our result shows that places on Mars had the same conditions at that time – liquid water, a warm environment, and organic matter,” said Caroline Freissinet in a press release from NASA’s Goddard Space Flight Center. Freissinet is the lead author of an additional paper that has been submitted to the *Journal of Geophysical Research-Planets*.

Need To Know: Sample Analysis at Mars Findings. Credit: NASA Goddard (YouTube)

## **Astrobiology and SAM**

Curiosity's SAM instrument is one of the most complex analytical chemistry laboratories ever delivered to another planet. One of SAM's most important astrobiological goals is to search for evidence of ancient habitable environments in Gale crater that could have supported life in Mars' past.

For more information about astrobiology-related sessions at the 2014 Fall Meeting of the American Geophysical Union, check out this handy pdf of abstracts collated by the NASA Astrobiology

Program:<http://astrobiology.nasa.gov/articles/2014/12/14/astrobiology-related-sessions-at-agu/>