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1. NASA Finds Ancient Organic Material, Mysterious Methane on Mars

NASA’s Curiosity rover has found new evidence preserved in rocks on Mars that suggests the planet could have supported ancient life, as well as new 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 a good sign for future missions exploring the planet’s surface and subsurface.

The new findings – “tough” organic molecules in three-billion-year-old sedimentary rocks near the surface, as well as seasonal variations in the levels of methane in the atmosphere – appear 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 also can be created by non-biological processes and are not necessarily indicators of life.

“With these new findings, Mars is telling us to stay the course and keep searching for evidence of life,” said Thomas Zurbuchen, associate administrator for the Science Mission Directorate at NASA Headquarters, in Washington. “I’m confident that our ongoing and planned missions will unlock even more breathtaking discoveries on the Red Planet.”

“Curiosity has not determined the source of the organic molecules,” said Jen Eigenbrode of NASA’s Goddard Space Flight Center in Greenbelt, Maryland, who is lead author of one of the two new Science papers. “Whether it holds a record of ancient life, was food for life, or has existed in the absence of life, organic matter in Martian materials holds chemical clues to planetary conditions and processes.”

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,” said Eigenbrode. “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.”

Seasonal Methane Releases

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 detected by Curiosity’s Sample Analysis at Mars (SAM) instrument suite.

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’ 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 every year.

“This is the first time we’ve seen something repeatable in the methane story, so it offers us a handle in understanding it,” said Chris Webster of NASA’s Jet Propulsion Laboratory (JPL) in Pasadena, California, lead author of the second paper. “This is all possible because of Curiosity's longevity. The long duration has allowed us to see the patterns in this seasonal 'breathing.'”

Finding Organic Molecules

To identify organic material in the Martian soil, Curiosity drilled into sedimentary rocks known as mudstone from four areas in Gale Crater. This mudstone gradually formed billions of years ago from silt that accumulated at the bottom of the ancient lake. The rock samples were analyzed by SAM, which uses an oven...
to heat the samples (in excess of 900 degrees Fahrenheit, or 500 degrees Celsius) to release organic molecules from the powdered rock.

SAM measured small organic molecules that came off the mudstone sample – fragments of larger organic molecules that don’t vaporize easily. Some of these fragments contain sulfur, which could have helped preserve them in the same way sulfur is used to make car tires more durable, according to Eigenbrode.

The results also indicate organic carbon concentrations on the order of 10 parts per million or more. This is close to the amount observed in Martian meteorites and about 100 times greater than prior detections of organic carbon on Mars’ surface. Some of the molecules identified include thiophenes, benzene, toluene, and small carbon chains, such as propane or butene.

In 2013, SAM detected some organic molecules containing chlorine in rocks at the deepest point in the crater. This new discovery builds on the inventory of molecules detected in the ancient lake sediments on Mars and helps explains why they were preserved.

Finding methane in the atmosphere and ancient carbon preserved on the surface gives scientists confidence that NASA’s Mars 2020 rover and ESA’s (European Space Agency’s) ExoMars rover will find even more organics, both on the surface and in the shallow subsurface.

These results also inform scientists’ decisions as they work to find answers to questions concerning the possibility of life on Mars.

“For are there signs of life on Mars?” said 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.”

This work was funded by NASA’s Mars Exploration Program for the agency’s Science Mission Directorate (SMD) in Washington. Goddard provided the SAM instrument. JPL built the rover and manages the project for SMD.

For video and images of the findings, visit:

https://www.nasa.gov/mediaresources

Information on NASA’s Mars activities is available online at:

https://www.nasa.gov/mars

Source: NASA
2. Magnetic Fields Could Hold the Key to Star Formation

Astronomers have discovered new magnetic fields in space, which could shed light on how stars are formed and uncover the mysteries behind one of the most famous celestial images.

For the first time, extremely subtle magnetic fields in the Pillars of Creation – a structure made famous thanks to an iconic image taken by the Hubble Space Telescope – have been discovered and mapped.

The structure consists of cosmic dust and cold, dense gas that have nurseries of stars forming at their tips. This innovative research has shown that the magnetic fields that run along the lengths of the Pillars are at a different angle to the regions surrounding the Pillars, revealing the reason behind their unusual structure.

This ground-breaking discovery suggests that the Pillars have evolved due to the strength of the magnetic field and that the Pillars are held up thanks to magnetic support, suggesting that stars could be formed by the collapse of clumps of gas being slowed down by magnetic fields, and resulting in a pillar-like formation.

The discovery was made by a global team of researchers known as BISTRO and led by astronomers from the University of Central Lancashire (UCLan) who made measurements at the James Clerk Maxwell Telescope in Hawaii. Using an instrument on the telescope known as a polarimeter, the researchers showed that the light emitted from the Pillars is polarised, indicating the direction of the magnetic field.

Professor Derek Ward-Thompson, Head of the School of Physical Sciences and Computing at UCLan, said: "The technology employed to view the minutiae of the magnetic fields is truly remarkable, and the fact that we have been able to observe the incredibly weak magnetic field with this sensitive instrument will help us to solve the mystery of the formation of stars."

Explore further: Pillars of destruction: Colourful Carina Nebula blasted by brilliant nearby stars


Source: Phys.org
3. Juno Solves 39-Year Old Mystery of Jupiter Lightning

Ever since NASA's Voyager 1 spacecraft flew past Jupiter in March, 1979, scientists have wondered about the origin of Jupiter's lightning. That encounter confirmed the existence of Jovian lightning, which had been theorized for centuries. But when the venerable explorer hurtled by, the data showed that the lightning-associated radio signals didn't match the details of the radio signals produced by lightning here at Earth.

In a new paper published in Nature today, scientists from NASA's Juno mission describe the ways in which lightning on Jupiter is actually analogous to Earth's lightning. Although, in some ways, the two types of lightning are polar opposites.

“No matter what planet you're on, lightning bolts act like radio transmitters -- sending out radio waves when they flash across a sky,” said Shannon Brown of NASA’s Jet Propulsion Laboratory in Pasadena, California, a Juno scientist and lead author of the paper. “But until Juno, all the lightning signals recorded by spacecraft [Voyagers 1 and 2, Galileo, Cassini] were limited to either visual detections or from the kilohertz range of the radio spectrum, despite a search for signals in the megahertz range. Many theories were offered up to explain it, but no one theory could ever get traction as the answer.”

Enter Juno, which has been orbiting Jupiter since July 4, 2016. Among its suite of highly sensitive instruments is the Microwave Radiometer Instrument (MWR), which records emissions from the gas giant across a wide spectrum of frequencies.

“In the data from our first eight flybys, Juno’s MWR detected 377 lightning discharges,” said Brown. “They were recorded in the megahertz as well as gigahertz range, which is what you can find with terrestrial lightning emissions. We think the reason we are the only ones who can see it is because Juno is flying closer to the lighting than ever before, and we are searching at a radio frequency that passes easily through Jupiter’s ionosphere.”

While the revelation showed how Jupiter lightning is similar to Earth’s, the new paper also notes that where these lightning bolts flash on each planet is actually quite different. “Jupiter lightning distribution is inside out relative to Earth,” said Brown. “There is a lot of activity near Jupiter’s poles but none near the equator. You can ask anybody who lives in the tropics -- this doesn’t hold true for our planet.”
Why do lightning bolts congregate near the equator on Earth and near the poles on Jupiter? Follow the heat.

Earth’s derives the vast majority of its heat externally from solar radiation, courtesy of our Sun. Because our equator bears the brunt of this sunshine, warm moist air rises (through convection) more freely there, which fuels towering thunderstorms that produce lightning.

Jupiter’s orbit is five times farther from the Sun than Earth’s orbit, which means that the giant planet receives 25 times less sunlight than Earth. But even though Jupiter’s atmosphere derives the majority of its heat from within the planet itself, this doesn’t render the Sun’s rays irrelevant. They do provide some warmth, heating up Jupiter’s equator more than the poles -- just as they heat up Earth. Scientists believe that this heating at Jupiter’s equator is just enough to create stability in the upper atmosphere, inhibiting the rise of warm air from within. The poles, which do not have this upper-level warmth and therefore no atmospheric stability, allow warm gases from Jupiter’s interior to rise, driving convection and therefore creating the ingredients for lightning.

“These findings could help to improve our understanding of the composition, circulation and energy flows on Jupiter,” said Brown. But another question looms. “Even though we see lightning near both poles, why is it mostly recorded at Jupiter’s north pole?”

In a second Juno lightning paper published today in Nature Astronomy, Ivana Kolmašová of the Czech Academy of Sciences, Prague, and colleagues, present the largest database of lightning-generated low-frequency radio emissions around Jupiter (whistlers) to date. The data set of more than 1,600 signals, collected by Juno’s Waves instrument, is almost 10 times the number recorded by Voyager 1. Juno detected peak rates of four lightning strikes per second (similar to the rates observed in thunderstorms on Earth) which is six times higher than the peak values detected by Voyager 1.

“These discoveries could only happen with Juno,” said Scott Bolton, principal investigator of Juno from the Southwest Research Institute, San Antonio. “Our unique orbit allows our spacecraft to fly closer to Jupiter than any other spacecraft in history, so the signal strength of what the planet is radiating out is a thousand times stronger. Also, our microwave and plasma wave instruments are state-of-the-art, allowing us to pick out even weak lightning signals from the cacophony of radio emissions from Jupiter.”

NASA’s Juno spacecraft will make its 13th science flyby over Jupiter’s mysterious cloud tops on July 16.

NASA’s Jet Propulsion Laboratory, Pasadena, California, manages the Juno mission for the principal investigator, Scott Bolton, of the Southwest Research Institute in San Antonio. Juno is part of NASA’s New Frontiers Program, which is managed at NASA’s Marshall Space Flight Center in Huntsville, Alabama, for NASA’s Science Mission Directorate. The Microwave Radiometer instrument (MWR) was built by JPL. The Juno Waves instrument was provided by the University of Iowa. Lockheed Martin Space, Denver, built the spacecraft.

More information on Juno can be found at [https://www.nasa.gov/juno](https://www.nasa.gov/juno) and [https://www.missionjuno.swri.edu](https://www.missionjuno.swri.edu).

More information about Jupiter can be found at [https://www.nasa.gov/jupiter](https://www.nasa.gov/jupiter).

The public can follow the mission on Facebook and Twitter at [https://www.facebook.com/NASAJuno](https://www.facebook.com/NASAJuno) and [https://www.twitter.com/NASAJuno](https://www.twitter.com/NASAJuno).

Source: NASA
The Night Sky

Friday, June 8

• *Double stars in Lyra.* Vega is the brightest star very high in the east after dark. Just lower left of it is 4th-magnitude Epsilon Lyrae, the Double-Double. Epsilon forms one corner of a roughly equilateral triangle with Vega and Zeta Lyrae. The triangle is less than 2° on a side, hardly the width of your thumb at arm's length.

Binoculars easily resolve Epsilon. And a 4-inch telescope at 100× or more should resolve each of Epsilon's wide components into a tight pair.

Zeta Lyrae is also a double star for binoculars; much tougher, but plainly resolved in any telescope.

Delta Lyrae, below Zeta, is a much wider and easier pair. Notice its colors.

Saturday, June 9

• For much of the spring at mid-northern latitudes, the Milky Way lies right down out of sight all around the horizon. But watch the east now. The rich Cepheus-Cygnus-Aquila stretch of the Milky Way is rising up all across the east late these nights, earlier and higher every week. A hint for the light-polluted: It runs horizontally under Vega, right through the Summer Triangle.

Sunday, June 10

• In twilight this evening and tomorrow evening, Venus in the west almost perfectly lines up with Pollux and Castor to its right. The two stars come into view as night approaches, long after Venus is easy.

Monday, June 11

• Spot the Big Dipper very high in the northwest after dark. The middle star of its bent handle is Mizar, with tiny little Alcor right next to it. On which side of Mizar should you look for Alcor? As always, on the side toward Vega! Which is now the brightest star in the east.

Source: Sky & Telescope
ISS Sighting Opportunities

For Denver:

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Sighting information for other cities can be found at NASA's Satellite Sighting Information

NASA-TV Highlights
(all times Eastern Daylight Time)

**Friday, June 8**

4 p.m., Replay of the ISS Expedition 56-57/Soyuz MS-09 (Prokopyev, Aunon-Chancellor, Gerst) Docking and Hatch Opening Activities (all channels)

6 p.m., Replay of the ISS Expedition 56-57/Soyuz MS-09 (Prokopyev, Aunon-Chancellor, Gerst) Docking and Hatch Opening Activities (all channels)

8 p.m., Replay of the ISS Expedition 56-57/Soyuz MS-09 (Prokopyev, Aunon-Chancellor, Gerst) Docking and Hatch Opening Activities (all channels)

**Tuesday, June 12**

11 a.m., ISS Expedition 56 In-Flight News Conference for ESA for European Media with Flight Engineer Alexander Gerst of ESA (starts at 11:25 a.m.) (all channels)

Watch NASA TV on the Net by going to the NASA website.
Space Calendar

- Jun 08 - [Jun 01] World Oceans Day
- Jun 08 - Comet 212P/NEAT At Opposition (3.758 AU)
- Jun 08 - Comet P/2016 WM48 (Lemmon) At Opposition (3.852 AU)
- Jun 08 - Apollo Asteroid 4660 Nereus Closest Approach To Earth (1.743 AU)
- Jun 08 - Asteroid 20403 Attenborough Closest Approach To Earth (2.222 AU)
- Jun 08 - Kuiper Belt Object 2010 KZ39 At Opposition (45.036 AU)
- Jun 08 - 100th Anniversary (1918), Discovery of Nova Aquila
- Jun 09 - Comet C/2018 K1 (Weiland) Closest Approach To Earth (1.021 AU)
- Jun 09 - Comet P/2012 TK8 (Tenagra) At Opposition (4.125 AU)
- Jun 09 - Amor Asteroid 2009 SK104 Near-Earth Flyby (0.081 AU)
- Jun 09 - Asteroid 881 Athene Closest Approach To Earth (1.326 AU)
- Jun 09 - Apollo Asteroid 4197 Morpheus Closest Approach To Earth (1.770 AU)
- Jun 09 - Asteroid 130 Elektra Closest Approach To Earth (2.560 AU)
- Jun 09 - Asteroid 2069 Hubble Closest Approach To Earth (2.589 AU)
- Jun 10 - Comet 263P/Gibbs At Opposition (1.732 AU)
- Jun 10 - Comet P/2001 T3 (NEAT) Perihelion (2.486 AU)
- Jun 10 - Comet C/2015 VL62 At Opposition (2.940 AU)
- Jun 10 - SkeptiCal 2018 Conference, Berkeley, California
- Jun 10 - 15th Anniversary (2003), Mars Exploration Rover A (Spirit) Launch
- Jun 10 - 45th Anniversary (1973), Explorer 49 Launch (Moon Orbiter)
- Jun 11 - IGS Radar-6 H-2A Launch
- Jun 11 - Comet P/2007 T2 (Kowalski) Closest Approach To Earth (0.502 AU)
- Jun 11 - Comet P/2017 G2 (PANSTARRS) At Opposition (2.989 AU)
- Jun 11 - Amor Asteroid 2018 EJ4 Near-Earth Flyby (0.015 AU)
- Jun 11 - Amor Asteroid 2015 DP155 Near-Earth Flyby (0.023 AU)
- Jun 11 - Apollo Asteroid 2008 LA Near-Earth Flyby (0.071 AU)
- Jun 11 - Asteroid 26733 Nanavistor Closest Approach To Earth (1.370 AU)
- Jun 11 - Asteroid 6827 Wombat Closest Approach To Earth (2.023 AU)
- Jun 11 - Neptune Trojan 2013 KY18 At Opposition (29.046 AU)
- Jun 11 - Kuiper Belt Object 174567 Varda At Opposition (45.762 AU)
- Jun 11 - DORIS Analysis Working Group meeting (AWG) of the International DORIS Service, Toulouse, France
- Jun 11 - 5th Anniversary (2013), Shenzhou 10 CZ-2F/H Launch (Chinese Manned Launch to Tian Gong1 Space Station)
- Jun 11 - 70th Anniversary (1948), V-2 Blossom Launch (Carried Albert I the Rhesus Monkey)
- Jun 11 - Johann Georg Palitzsch's 295th Birthday (1723)

Source: JPL Space Calendar

Johann Georg Palitzsch
Food for Thought

Are There Enough Chemicals on Icy Worlds to Support Life?

For decades, scientists have believed that there could be life beneath the icy surface of Jupiter’s moon Europa. Since that time, multiple lines of evidence have emerged that suggest that it is not alone. Indeed, within the Solar System, there are many “ocean worlds” that could potentially host life, including Ceres, Ganymede, Enceladus, Titan, Dione, Triton, and maybe even Pluto.

But what if the elements for life as we know it are not abundant enough on these worlds? In a new study, two researchers from the Harvard Smithsonian Center of Astrophysics (CfA) sought to determine if there could in fact be a scarcity of bioessential elements on ocean worlds. Their conclusions could have wide-ranging implications for the existence of life in the Solar System and beyond, not to mention our ability to study it.

The study, titled “Is extraterrestrial life suppressed on subsurface ocean worlds due to the paucity of bioessential elements?” recently appeared online. The study was led by Manasvi Lingam, a postdoctoral fellow at the Institute for Theory and Computation (ITC) at Harvard University and the CfA, with the support of Abraham Loeb – the director of the ITC and the Frank B. Baird, Jr. Professor of Science at Harvard.

In previous studies, questions on the habitability of moons and other planets have tended to focus on the existence of water. This has been true when it comes to the study of planets and moons within the Solar System, and especially true when it comes the study of extra-solar planets. When they have found new exoplanets, astronomers have paid close attention to whether or not the planet in question orbits within its star’s habitable zone.

This is key to determining whether or not the planet can support liquid water on its surface. In addition, astronomers have attempted to obtain spectra from around rocky exoplanets to determine if water loss is taking place from its atmosphere, as evidenced by the presence of hydrogen gas. Meanwhile, other studies have attempted to determine the presence of energy sources, since this is also essential to life as we know it.

In contrast, Dr. Lingam and Prof. Loeb considered how the existence of life on ocean planets could be dependent on the availability of limiting nutrients (LN). For some time, there has been considerable debate as to which nutrients would be essential to extra-terrestrial life, since these elements could vary from place to place and over timescales. As Lingam told Universe Today via email:

“The mostly commonly accepted list of elements necessary for life as we know it comprises of hydrogen, oxygen, carbon, nitrogen and sulphur. In addition, certain trace metals (e.g. iron and molybdenum) may also be valuable for life as we know it, but the list of bioessential trace metals is subject to a higher degree of uncertainty and variability.”

For their purposes, Dr. Lingam and Prof. Loeb created a model using Earth’s oceans to determine how the sources and sinks – i.e. the factors that add or deplete LN elements into oceans, respectively – could be
similar to those on ocean worlds. On Earth, the sources of these nutrients include fluvial (from rivers), atmospheric and glacial sources, with energy being provided by sunlight.

Of these nutrients, they determined that the most important would be phosphorus, and examined how abundant this and other elements could be on ocean worlds, where conditions as vastly different. As Dr. Lingam explained, it is reasonable to assume that on these worlds, the potential existence of life would also come down to a balance between the net inflow (sources) and net outflow (sinks).

“If the sinks are much more dominant than the sources, it could indicate that the elements would be depleted relatively quickly. In other to estimate the magnitudes of the sources and sinks, we drew upon our knowledge of the Earth and coupled it with other basic parameters of these ocean worlds such as the pH of the ocean, the size of the world, etc. known from observations/theoretical models.”

While atmospheric sources would not be available to interior oceans, Dr. Lingam and Prof. Loeb considered the contribution played by hydrothermal vents. Already, there is abundant evidence that these exist on Europa, Enceladus, and other ocean worlds. They also considered abiotic sources, which consist of minerals leached from rocks by rain on Earth, but would consist of the weathering of rocks by these moons’ interior oceans.

Ultimately, what they found was that, unlike water and energy, limiting nutrients might be in limited supply when it comes to ocean worlds in our Solar System:

“We found that, as per the assumptions in our model, phosphorus, which is one of the bioessential elements, is depleted over fast timescales (by geological standards) on ocean worlds whose oceans are neutral or alkaline in nature, and which possess hydrothermal activity (i.e. hydrothermal vent systems at the ocean floor). Hence, our work suggests that life may exist in low concentrations globally in these ocean worlds (or be present only in local patches), and may therefore not be easily detectable.”

This naturally has implications for missions destined for Europa and other moons in the outer Solar System. These include the NASA Europa Clipper mission, which is currently scheduled to launch between 2022 and 2025. Through a series of flybys of Europa, this probe will attempt to measure biomarkers in the plume activity coming from the moon’s surface.

Similar missions have been proposed for Enceladus, and NASA is also considering a “Dragonfly” mission to explore Titan’s atmosphere, surface and methane lakes. However, if Dr. Lingam and Prof. Loeb’s study is correct, then the chances of these missions finding any signs of life on an ocean world in the Solar System are rather slim. Nevertheless, as Lingam indicated, they still believe that such missions should be mounted.

“Although our model predicts that future space missions to these worlds might have low chances of success in terms of detecting extraterrestrial life, we believe that such missions are still worthy of being pursued,” he said. “This is because they will offer an excellent opportunity to: (i) test and/or falsify the key predictions of our model, and (ii) collect more data and improve our understanding of ocean worlds and their biogeochemical cycles.”

In addition, as Prof. Loeb indicated via email, this study was focused on “life as we know it”. If a mission to these worlds did find sources of extra-terrestrial life, then it would indicate that life can arise from conditions and elements that we are not familiar with. As such, the exploration of Europa and other ocean worlds is not only advisable, but necessary.

“Our paper shows that elements that are essential for the ‘chemistry-of-life-as-we-know-it’, such as phosphorous, are depleted in subsurface oceans,” he said. “As a result, life would be challenging in the oceans suspected to exist under the surface ice of Europa or Enceladus. If future missions confirm the depleted level of phosphorous but nevertheless find life in these oceans, then we would know of a new chemical path for life other than the one on Earth.”
In the end, scientists are forced to take the “low-hanging fruit” approach when it comes to searching for life in the Universe. Until such time that we find life beyond Earth, all of our educated guesses will be based on life as it exists here. I can't imagine a better reason to get out there and explore the Universe than this!

Further Reading: arXiv

Source: Universe Today
Complex Jupiter

Explanation  How complex is Jupiter? NASA’s Juno mission to Jupiter is finding the Jovian giant to be more complicated than expected. Jupiter’s magnetic field has been discovered to be much different from our Earth’s simple dipole field, showing several poles embedded in a complicated network more convoluted in the north than the south. Further, Juno’s radio measurements show that Jupiter’s atmosphere shows structure well below the upper cloud deck -- even hundreds of kilometers deep. Jupiter’s newfound complexity is evident also in southern clouds, as shown in the featured image. There, planet-circling zones and belts that dominate near the equator decay into a complex miasma of continent-sized storm swirls. Juno continues in its looping elliptical orbit, swooping near the huge planet every 53 days and exploring a slightly different sector each time around.

Image Credit: NASA, Juno, SwRI, MSSS; Composition: David Marriott