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Carbonate Finally Found On Mars

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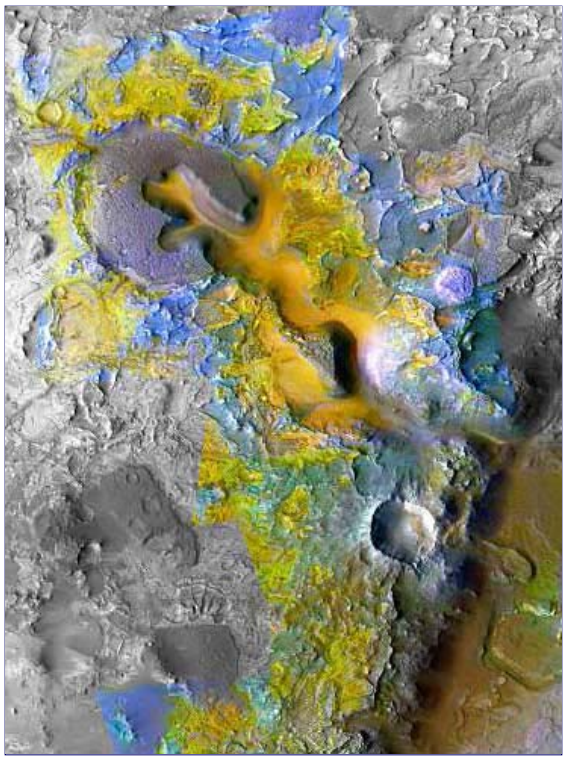
but how frequently have the conditions been hospitable for life?
We can say pretty confidently that when water was present in the places
we looked at, it would have been a happy, pleasant environment for life."
- John Mustard, Ph.D., Geological Sciences, Brown University



NASA's Mars Reconnaissance Orbiter has finally found carbonate minerals on Mars that show up as green in the above image of a 12-miles-wide region in Nili Fossae on the edge of the Isidis impact basin. Scientists hypothesize the carbonates might have formed at the surface when olivine-rich rocks were exposed and altered by running water. Image courtesy NASA/JPL/JHUAPL/MSSS/Brown University.

December 20, 2008 San Francisco, California - At the annual American Geophysical Union Fall 2008 meeting held in San Francisco from December 15 to December 19, Brown University graduate student, Bethany Ehlmann, reported finding the mineral carbonate on Mars, increasing the chances that life might have existed on the red planet in the past when there was a less acidic watery surface. Carbonates result from carbon dioxide dissolved in water.

On Earth, carbonates are usually marine sediments like limestone and chalk. "Primitive life would have liked it," said Bethany Ehlmann, a Brown graduate student and lead author of the paper that appears in the December 19, 2008, edition of the journal, *Science*. "It's not too hot or too cold. It's not too acidic. It's a 'just right' place."

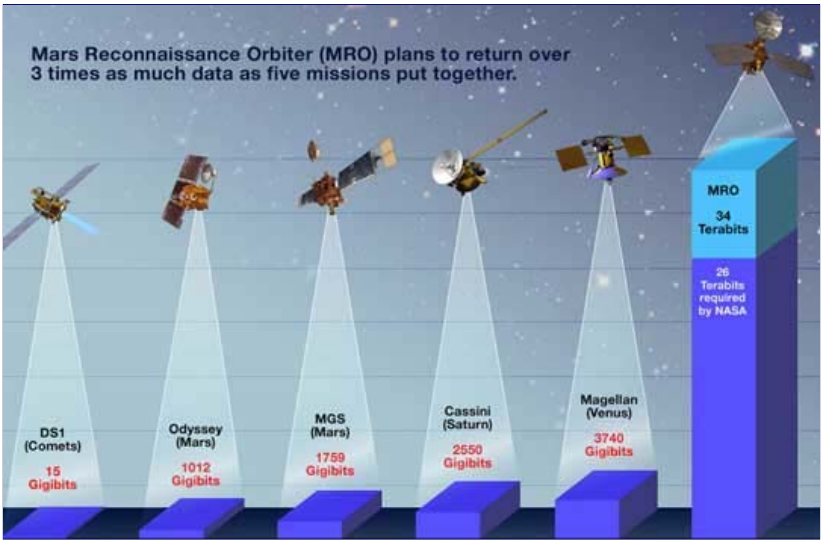
Brown University graduate student, Bethany Ehlmann, found the carbonate mineral on Mars by analyzing Mars Reconnaissance Orbiter (MRO) data. Image credit: John Abromowski, Brown University.

Until now, the mineral picture of more modern Mars, based on data from the Martian rovers, Spirit and Opportunity, and orbiting spacecraft, has been salt-rich and acidic waters. Since carbonates dissolve quickly in low pH solutions, it is possible that many large carbonate formations created on early Mars might have disappeared by now. That could explain why it's taken so long to find a carbonate signature, which is now clear in the Nili Fossae on the edge of the Isidis impact basin.

“This is opening up a range of environments on Mars,” said John “Jack” Mustard, Ph.D., a Brown Professor of Geological Sciences and a co-author with Bethany Ehlmann on the *Science* paper. “This is highlighting an environment that to the best of our knowledge doesn’t experience the same kind of unforgiving conditions that have been identified in other areas. We know there’s been water all over the place, but how frequently have the conditions been hospitable for life?” Mustard said. “We can say pretty confidently that when water was present in the places we looked at, it would have been a happy, pleasant environment for life.”

NASA Background On Important Carbonate Discovery

Mars Reconnaissance Orbiter (MRO) illustrated in an elliptical, low-planet orbit around Mars. MRO entered Mars orbit on March 10, 2006. Image courtesy NASA/JPL.



NASA: “Researchers using a powerful instrument aboard NASA's Mars Reconnaissance Orbiter (MRO) surveyed intact bedrock layers with the Compact Reconnaissance Imaging Spectrometer for Mars, or CRISM. Scientists found carbonate minerals, indicating that Mars had neutral to alkaline water when the minerals formed at these locations more than 3.6 billion years ago. Carbonates, which on Earth include limestone and chalk, dissolve quickly in acid. Therefore, their survival until today on Mars challenges suggestions that an exclusively acidic environment later dominated the planet. Instead, it indicates that different types of watery environments existed. The greater the variety of wet environments, the greater the chances one or more of them may have supported life.

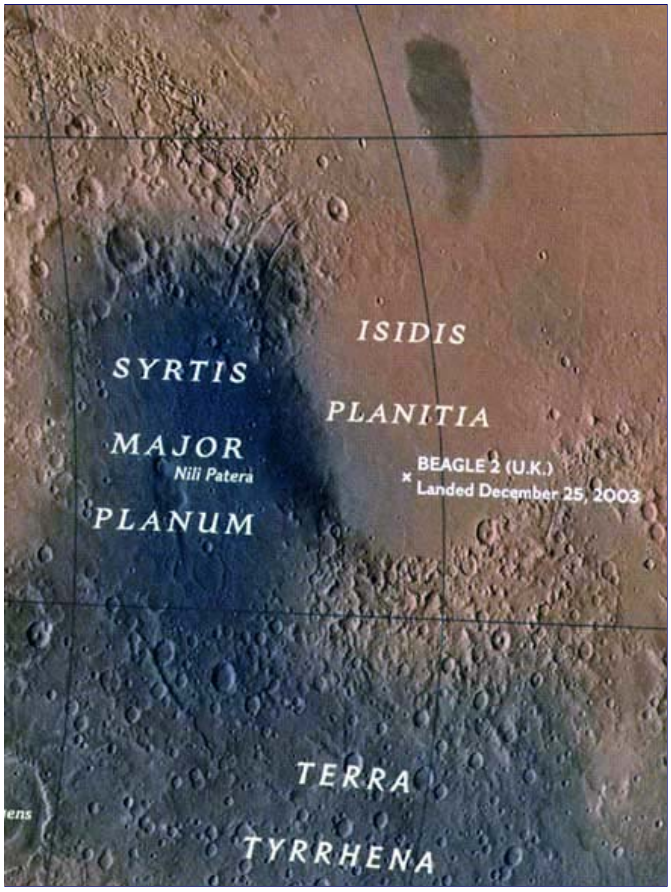
“We're excited to have finally found carbonate minerals because they provide more detail about conditions during specific periods of Mars' history,” said Scott Murchie, Principal Investigator for the MRO instrument at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland.

Carbonate rocks are created when water and carbon dioxide interact with calcium, iron or magnesium in volcanic rocks. Carbon dioxide from the atmosphere becomes trapped within the rocks. If all of the carbon dioxide locked in Earth's carbonates were released, our atmosphere would be thicker than that of Venus. Some researchers believe that a thick, carbon dioxide-rich atmosphere kept ancient Mars warm and kept water liquid on its surface long enough to have carved the valley systems observed today.

“The carbonates that CRISM has observed are regional rather than global in nature, and therefore, are too limited to account for enough carbon dioxide to form a thick atmosphere,” said Bethany Ehlmann, lead author of the article and a spectrometer team member from Brown University, Providence, Rhode Island.

“Although we have not found the types of carbonate deposits which might have trapped an ancient atmosphere,” Ehlmann said, “we have found evidence that not all of Mars experienced an intense, acidic weathering environment 3.5 billion years ago, as has been proposed. We've found at least one region that was potentially more hospitable to life.”

Isidis Impact Basin and Nili Fossae



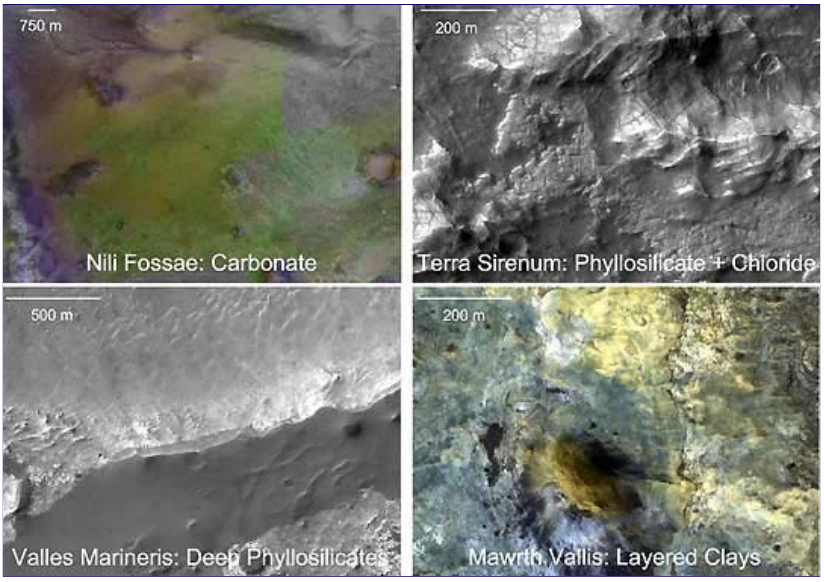
Isidis Planitia is near the Martian equator between Arabia Terra and Elysium Planitia.

The researchers report clearly defined carbonate exposures in bedrock layers surrounding the 1,489-kilometer-diameter (925-mile) Isidis impact basin, which formed more than 3.6 billion years ago. The best-exposed rocks occur along a trough system called Nili Fossae, which is 666 kilometers (414 miles) long, at the edge of the basin. The region has rocks enriched in olivine, a mineral that can react with water to form carbonate.

“This discovery of carbonates in an intact rock layer, in contact with clays, is an example of how joint observations by CRISM and the telescopic cameras on the Mars Reconnaissance Orbiter are revealing details of distinct environments on Mars,” said Sue Smrekar, Deputy Project Scientist for the MRO at NASA's Jet Propulsion Laboratory in Pasadena, California.

NASA's Phoenix Mars Lander discovered carbonates in soil samples. Researchers had previously found them in Martian meteorites that fell to Earth and in windblown Mars dust observed from orbit. However, the dust and soil could be mixtures from many areas, so the carbonates' origins have been unclear. The latest observations indicate carbonates may have formed over extended periods on early Mars. They also point to specific locations where future rovers and landers could search for possible evidence of past life.

Discovery of Four Types of Deposits from Wet Conditions on Early Mars



Each of these four panels shows a close-up view of a different type of geological deposit formed with the involvement of water, based on observations by NASA's Mars Reconnaissance Orbiter. All four date from the earliest period of Martian history, called the Noachian Period. Image credit: NASA/JPL/JHUAPL/University of Arizona/Brown University.

The upper-left panel shows carbonates overlying clays in the Nili Fossae region of Mars. The view combines color-coded information from infrared spectral observations by the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) with an underlying black-and-white image from the High Resolution Imaging Science Experiment (HiRISE) camera. Beneath a rough-textured capping rock unit (purple) lie banded olivine-bearing layers (yellow), which in some places have been partially or wholly altered to carbonate (green).

The upper-right panel shows phyllosilicates and chlorides in the Terra Sirenum region, observed by CRISM and HiRISE. Medium-toned, finely fractured rocks containing chloride salts either underlie higher-standing, light-toned phyllosilicates or fill in low spots between them. Both sit on dark, eroded volcanic material.

The lower-left panel shows the upper portion of canyon wall in Coprates Chasma, observed by HiRISE and CRISM. The chasm rim cuts across the middle of the image. The wall slopes down to the top of the image and continues outside the region shown, exposing multiple phyllosilicate-bearing layers in a section of rock 7 kilometers (4 miles) thick. Two of the layers shown here are finely fractured aluminum clays that dominate the lower half of the image, underlain by thin beds of iron-magnesium clays at the top of the image. The dark material is a remnant of an overlying layer of basaltic sand that has been partly eroded away by the wind.

The lower-right panel shows phyllosilicates with vertically layered compositions in Mawrth Vallis, observed by HiRISE (presented in enhanced color) and CRISM. The brown-colored knob in the middle of the scene is a remnant of cap rock that overlies aluminum clays (blue-gray), which in turn overlie iron-magnesium clays (buff)."

Other News On Mars - Rovers Are Awake from Martian Winter Hibernation

December 17, 2008 Update: Both Spirit and Opportunity started coming out of hibernation from solar conjunction and Martian winter this week and the Mars Rover team had its first planning session on Monday, December 15, to lay out rover missions in 2009. The prognosis right now is good for both rovers, but Spirit really needs a good dusting off by one of the Martian dust devils. And one of its front wheels is stuck and slows Spirit down.

Both rovers are near the Martian equator; Spirit is on one side of the red planet and Opportunity is on the opposite side.

Spirit is at the strange round region called Home Plate. Scientists hope to get it to move to the top of the Home Plate rim, but if it can't make the 30-degree slope, the rover will go down and around. Scientists hope Spirit can make it south 300 meters to what might be volcanic vents to explore.

Right now, Opportunity is moving out of Victoria Crater going south toward Endurance crater and distant outcroppings. If Opportunities wheels and energy keep up and it doesn't become too dusty and lose solar power, it will take Opportunity all of 2009 to reach the distant outcropping.

But the fact that January 2009 will be the 5th Earth year of the rovers on Mars is astounding. Opportunity landed on Mars January 24, 2004. The little rovers have long outlived their expected lives and everyone wonders how much longer can they keep going?

Mystery "Log" Photographed By Opportunity Rover On May 24, 2004

"The image is the edge of a long, rectangular, natural, Martian flat polygonal stone."

This is *not* a "log" on Mars. It's a polygonal stone turned on edge near Endurance crater, surrounded by dozens of flat polygonal stones that have not been thrust up from Martian soil by impacts such as the meteorite that created Endurance crater (upper right). More polygonal stones are sliding like "logs" into the crater after impact disturbances. NavCam image taken by Opportunity looking south from the rim of Endurance crater on Sol 118, May 24, 2004.
See May 24, 2004: **OpportunityNavCam.**

Interview:

Larry Crumpler, Ph.D., Science Team Member and Long Term Planning Lead, Mars Exploration Rover Program and Research Curator, Volcanology and Space Sciences, New Mexico Museum of Natural History and Science, Albuquerque, New Mexico:
"This so-called 'log' image is a NavCam image taken by Opportunity looking more or less south from the south southwest rim of Endurance crater way back on Sol 118, on May 24, 2004. Out on the horizon is a bright, white object, which is the heat shield where the Opportunity lander impacted the surface. You're looking at the reflective, thermal blanket on the heat shield reflecting the sun. We saw that for a long time and eventually Opportunity went out there and looked at it.

In the foreground of the image there is a slope going up to the west and it's the rim of Endurance crater, which Opportunity circled to the south and east and turned around and looked across the southern rim and into the crater to the east.

On the rim there are a lot of polygonal-shaped rocks and they are layers of the Meridiani Planum sediments that are fairly uniformly embedded in the Martian soil in very thin sheets that have broken up almost like flagstones that have broken up under the impact of a meteorite that made the impact crater, Endurance.

Then littered on top of the polygonal rocks are darkish lumps, some of which look quite elongated and they almost look like logs sticking out of the Martian dirt. The one in the image is just an upended flagstone that looks like a log.

It turns out that the edges of all these so-called flagstones are made of thin sheets that impart a roughness when combined with the angle of the sun making the face toward the camera a little darker than the lighter flat stones embedded in the soil. So, the image is the edge of a long, rectangular, natural, Martian flat polygonal stone.

In the crater rim, you can see a bunch of them that have slumped and rotated, sliding down into Endurance crater. There are some out there on the rim that might have been blasted out of the crater originally from meteorite impact and the wind has exposed the blocks of flagstones."

More Information:

For further reports about Mars exploration, please see **Earthfiles Archive** reports below:

- 08/05/2008 — Perchlorate Discovery by Phoenix Lander Does Not End Search for Life On Mars
- 05/29/2008 — Phoenix Robotic Arm Preparing to Dig Into Martian Permafrost
- 12/16/2005 — MARSIS Radar Looking Below Surface of Mars
- 07/30/2005 — Astronomers Report 10th Planet Far Beyond Pluto
- 02/26/2005 — Mars Spirit Rover Discovered Boundary Between Gusev Lava and Older, Water-Soaked Rocks in "Columbia Hills"
- 12/17/2004 — Is Our Solar System's Red, Mysterious Sedna An Alien Planetoid?
- 07/22/2004 — Is Physicist Vittorio Formisano's Mars Data Being Suppressed by ESA?
- 02/23/2004 — Is There Liquid Water on Martian Surface?
- 02/10/2004 — Part 1 - Opportunity Investigating Bedrock and Spirit's Headed for Bonneville Crater
- 01/31/2004 — Is There Living Green Algae in the Gusev Crater on Mars?
- 01/24/2004 — Updated - Spirit Alive, But in "Critical" Condition. Mars Express Sees Water Ice and Ancient River Channel
- 01/09/2004 — Robotic "Geologists" on Mars
- 12/18/2003 — Beagle 2 Spacecraft Will Land on Mars Christmas Day.
- 08/26/2003 — Mars At Its Closest August 27, 2003, At 2:51 a.m. PDT / 5:51 a.m. EDT.
- 06/02/2003 — Mars Express Radar Will "See" 3 Miles Into Red Planet's Crust
- 11/10/2001 — The Orion Constellation and the Pyramids of Giza
- 04/08/2001 — A Martian Southern Hemisphere Mystery - What are these?
- 03/18/2001 — Can Earth Plants and Bacteria Grow On Mars?
- 03/11/2001 — Are the "Tubes" On Mars from Lava, Water, or Wind?
- 02/25/2001 — A New Martian Mystery
- 06/26/2000 — 250 Photographs of Mars Show Signs of Water
- 12/01/1999 — Six More Planets Discovered 60 to 190 Light Years Away

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Websites:

NASA Jet Propulsion Lab: **http://mars.jpl.nasa.gov/mro/newsroom/pressreleases/20081218a.html**

Bethany Ehlmann, Brown University: **http://news.brown.edu/pressreleases/2008/12/mars**

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