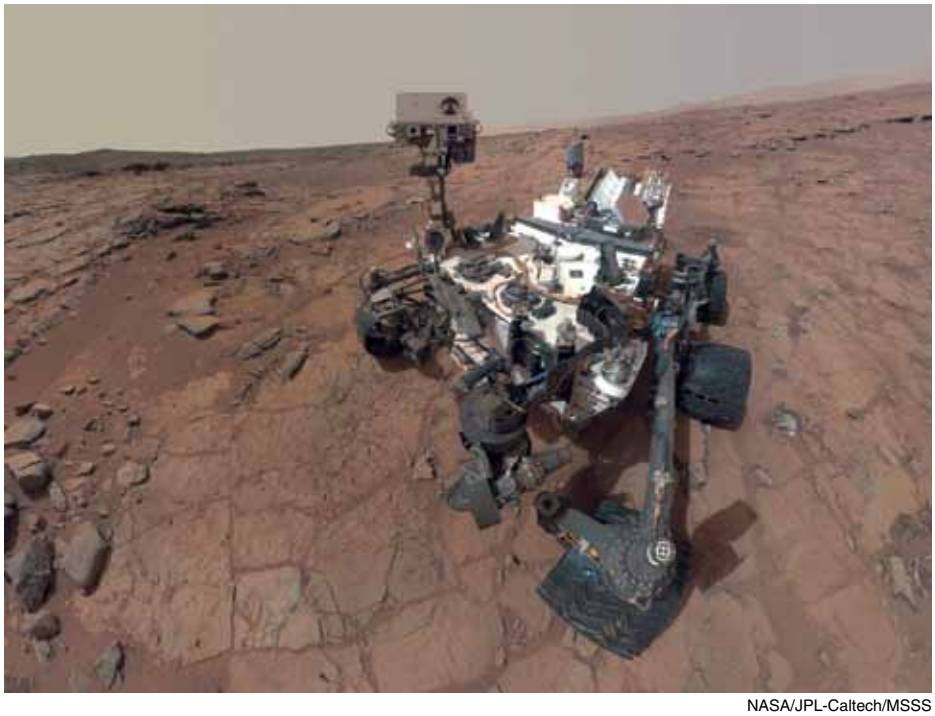
Curiosity Discovers Mars Could Have Supported Life

by Marsha Freeman

March 15—Scientists have taken a major step toward answering to question: did life exist anywhere in the Solar System, besides the Earth?

The most recent data sent to Earth from the Curiosity rover indicate that at least at some time in its past, Mars could have been a habitable planet. Curiosity is only in the seventh month of its minimally two-year mission, and still months away from its arrival at Mount Sharp—its ultimate destination—but it has already uncovered evidence of what scientists surmise is a region of Mars that could have supported microbial life.



NASA/JPL-Caltech/MSSS

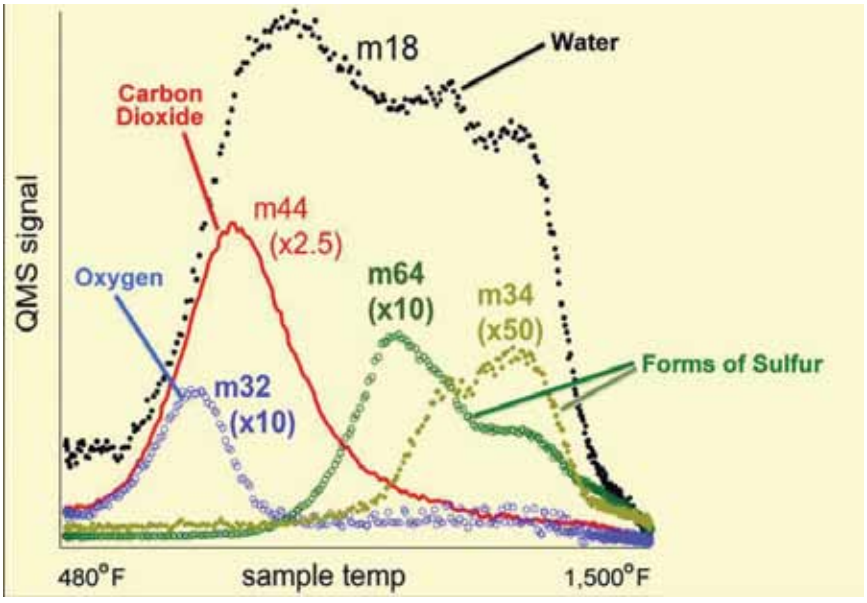
The Curiosity rover took this self-portrait photo during its 177th day on Mars, on Feb. 3. The rover is near the John Klein outcrop, where the rover carried out the first rock-drilling experiment on another planet.

At a March 12 press briefing at NASA headquarters, Michael Meyer, lead scientist for NASA's Mars Exploration Program said: "A fundamental question for this mission is whether Mars could have supported a habitable environment. From what we know now, the answer is 'yes.'"

Two key suites of scientific instruments on Curiosity provided the new data—Sample Analysis at Mars (SAM), and Chemistry and Mineralogy (CheMin). The new data come from the first-ever examination of material from inside a rock on another planet. Last month, Curiosity drilled a 2.5 inch hole into a rock outcrop called "John Klein," which resides in a region not far from where Curiosity landed on Aug. 7, 2012, dubbed

Yellowknife Bay. An aspirin-sized sample of the powdered rock was delivered to SAM and CheMin for analysis, and the results have been very rewarding.

FIGURE 1
Major gasses released from the bedrock called "John Klein" and analyzed by the SAM instruments



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As the temperature of the rock powder was increased, different gases were released, and then analyzed by the rover's Sample Analysis at Mars (SAM) instrument.

New Discoveries

Two new ground-breaking results were announced by scientists during the March 12 briefing.

First, on Earth, it is the case that, although life can be found in very extreme environments, such as inside nuclear power plants and in bone-dry deserts, some amount of water, even if very small, must be available for life to exist. Numerous Mars missions have observed from orbit the footprints of past water on Mars, in the form of dry river beds, deep-cut canyons carved from the landscape by flowing water, and signatures of chemicals, that, on Earth, form in watery environments. Opportunity has provided scientists with *in situ* confirmation that Mars had a wet past, adding ground truth to the orbital observations. But the evidence provided by Opportunity's investigations of the chemistry of the minerals it examined indicate that the past water in Meridiani Planum was acidic and salty.

However, Curiosity confirmed the presence of clays, first seen from orbit, with a chemical composition that indicated that they were formed in a neutral, or mildly alkaline, water environment. Asked at the briefing how he would characterize this finding in layman's terms, Curiosity chief scientist John Grotzinger said, "If this water were around, and you had been on the planet, you would have been able to drink it."

At least 20% of the rock sample, according to CheMin principal investigator David Blake, was made up of clay. He described the clay as produced through the reaction of relatively fresh water with igneous material. The presence of calcium sulfate also indicates a non-acidic watery environment.

Second, in addition to water, any life on Mars would have had to find an available source of the key chemical ingredients for life. Curiosity's CheMin and SAM instruments identified some of these in the rock sample, including sulfur, nitrogen, hydrogen, oxygen, phosphorus, and carbon (**Figure 1**). Paul Mahaffy, SAM principal investigator, reported that "the range of chemical ingredients we have identified in the sample is impressive, and it suggests pairings such as sulfates and sulfides that indicate a possible chemical energy source for micro-organisms." Dr. Grotzinger said these minerals are "effectively like batteries," that can be a source of energy for life.

In addition, scientists unexpectedly found a mixture of chemicals that were oxidized, less-oxidized, and even non-oxidized, inside the rock. (Iron on the surface that has been oxidized, or chemically combined with oxygen, is what gives Mars its red coloration). Photographs of the drill cuttings, before samples were delivered for chemical analysis, showed them to be gray, indicating the material had not been fully oxidized. These different levels of oxidation indicate a range of energy that microbes on Earth make use of.

The Road Ahead

The SAM instrument is also able to detect organic chemicals, which on Earth are created by life, but are also produced inorganically, through chemical reactions. These complex compounds, containing carbon

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This mosaic was assembled from dozens of images of Mt. Sharp, taken on Sept. 20, 2012.

and hydrogen, have long been assumed to be prerequites for life.

In the past, methane has been detected from orbit in the Martian atmosphere. This is intriguing because methane in the atmosphere would not be long-lived, since it is destroyed when exposed to radiation. If there is methane in the atmosphere of Mars today, it could mean that it is currently being produced there, either chemically or organically. But the orbital observations were spotty and the methane signature seemed temporary, so scientists are anxious for ground truth.

So far, the scientists reported, Curiosity's instruments have not detected any complex organic compounds. The search will continue. "What we can do now," Grotziner stated, "with the issue of habitability in the bag, we can undertake a more systematic search for a brighter carbon signal."

But the scientists also cautioned that, even if no organics are found, it does not mean that life was never resident on Mars. Complicated compounds, such as organics, degrade over time, it was pointed out, especially under the constant bombardment of radiation on the Martian surface. It is possible that life, and organics, were present in Mars' past, but have been erased, at least from the surface, over time.

Grotzinger also stated that even if organic compounds are not found during this mission because they were not there in the past, the Gale Crater site could still have supported life, because inorganic carbon can be used as food by a microbe. "What we have learned in the last 20 years of modern microbiology," Grotziner said, "is that very primitive organisms … can derive energy just by feeding on rocks."

Following a month of conjunction throughout April, where the relative position of the Sun between the Earth and Mars prevents robust communications between the two planets, Curiosity is slated to start its multi-month trek to Mount Sharp. The 3-mile-high mountain was created when a meteorite struck the planet, excavating Gale Crater and throwing subsurface material up in to the center.

From orbit, and now, from stunning photos taken by Curiosity, it is clear that Mount Sharp has a story to tell. The base of the mountain will contain the oldest excavated material in the crater, and its sedementary layers, laid down through successive periods of flowing water, should reveal more of the chemical, geologic, hydrologic, and atmospheric history there. If Curiosity is able to climb up the side of Mount Sharp, eons of time of Mars' history will be revealed.