The other thing that impressed me was that because of the connections, this management of the Tennessee River also helps to manage the Ohio and Mississippi rivers.

The Tennessee River forms in Knoxville from the French Broad, the Little, and the Holston rivers. It goes down, doesn't touch Georgia—Georgia wants some of this water—Alabama, Mississippi, back up east of Memphis, all the way to Paducah, Kentucky, and runs in to the Ohio River. The Ohio runs in to the Mississippi, and that goes to Memphis. So the coordination with all those rivers, and the Army Corps, is all pretty important.

How do you interface with the Army Corps of Engineers? If the decision were made to break up the TVA, would the Army Corps have to pick up operation of the dams?

They would certainly be a likely candidate, but you'd find private enterprise to do that, too; private river-management companies. We interface very closely with the Corps because we control the river, we control the shoreline, so any appurtenances you'd want to build, boat docks, we control all of that. The Corps controls navigation. So we provide the water for navigation but they control the navigation, and they run the locks. There are a lot of locks.

You know, when TVA was formed in 1933, you could not travel the length of the Tennessee River. You would get down to the shoals, which is a big, muddy flat spot. Today, there are a lot of locks, and we are in communication in real time with the Corps. How much water do you need in the Mississippi? How much do you want in Huntsville? That's a pretty daily occurrence. [Today, the Tennessee River] is a very heavily used transportation conduit, maybe the most heavily transported river, or second behind the Mississippi. The savings from using river transportation, versus other forms, is hundreds of millions [of dollars] every year, which also helps with economic development.

In the 1960s, at the same time that President Kennedy was at Muscle Shoals to celebrate the 30th anniversary of the TVA, there was a program put forward, and developed by the Ralph M. Parsons Company, called the North American Water and Power Alliance, or NAWAPA, which would have built on the TVA model, and moved it west. The Great American Desert, with such rich soil, but a serious lack of water, could have become a breadbasket for the country. But this was never built. We have resurrected and improved and expanded the NAWAPA program, as a great infrastructure project that must be built. The success of the TVA is an important precedent for taking on such a large-scale infrastructure project.

Thank you for taking the time to discuss the past and future of TVA.

It's been a pleasure.

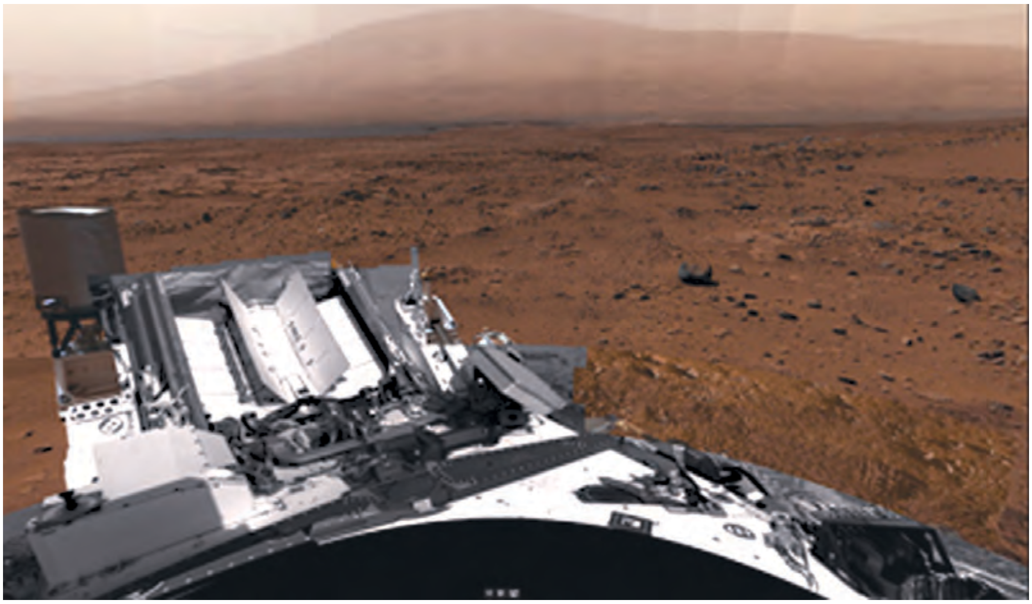
SPACE

Curiosity Opens Many Windows To the Solar System

by Marsha Freeman

As we mark the one-year anniversary of the successful landing of NASA's Curiosity rover on Aug. 6, planetary scientists are reaping the early results of a set of scientific experiments never before carried out on Mars. The highly sophisticated, nuclear-powered rover will help both uncover the evolutionary history of the planet, and describe in detail where it is in that process today. But the success of the mission is not only important based on what the Curiosity will find, but the precedent it sets for the missions of the future exploration of Mars.

The question of whether there was, or is, life on Mars has been the prime motivation for the series of missions in NASA's Mars exploration program. The question of whether life presents itself uniquely on Earth, or is a universal characteristic of all of Creation, has occupied the greatest minds in science for generations. While Curiosity is not expected or designed to provide a definitive answer to that question, it will extend and enrich our understanding of crucial aspects of the pathway of development of the planet, through its geological, chemical, and hydrologic history, and provide more insight into whether that pathway has included life.



NASA/JPL-Caltech/MSSS

This full-circle view, which includes the Curiosity rover and distant Mount Sharp, toward which it is headed, was created by combining nearly 900 images, taken by the rover between Oct. 5 and Nov. 16, 2012.

But Curiosity also has "a higher calling." Strategically located between our planet and the main belt of asteroids, the rover, complemented by a set of spacecraft in orbit around Mars, has a bird's-eye view of stray debris left over from the creation of the Solar System, some of which has, and will, threaten our planet. Curiosity can be thought of as a pathfinder for what must be a series of sentinels, helping to keep watch over the safety of the Earth. In this regard, telescopes and other scientific infrastructure located on or near Mars provide a new perspective on the activities in our celestial neighborhood.

The technological breakthroughs required for the next steps in exploring Mars, including most emphatically, the deployment of fusion energy, will also create the ability to interfere with any potential extraterrestrial threats to Earth. From this unique vantage point, in the future, we will be able to not only find and, when needed, disable individual asteroids and comets, but discover the generating principles that created these seemingly wayward objects, and the Solar System, itself.

From the orbit of Mars, we will be able to gain new insight into the development of the Solar System, as well as a new perspective of the Earth. This is not because we will be able to "see" the Earth from Mars, but because we will discover new generating principles in the creation of life and the galactic processes within which they occur.

The End of 'Curiosity'?

The truly astounding event, however, over this past year, has not been the performance of Curiosity, but the intention to have this magnificent scientific laboratory be the last one of its kind. The Mars exploration program has been savagely attacked by the Obama Administration, as future missions have been cancelled, delayed, and de-scoped.

Since the mid-1970s, when the Viking landers and orbiters revealed a planet that had a geologically dynamic past, and a history of flowing water, various missions had been proposed, and some were even approved, to bring to bear on Mars the kind of infrastructure deployed on our planet and in near-Earth space, to gain a detailed understanding of what once may have been a more Earth-like world.

Proposals were considered for Mars airplanes, for in situ study of the atmosphere; weather stations to help guide safe landings on the surface; networks of seismic stations to determine the interior structure and composition of the planet's core; fleets of communications satellites in Mars orbit, for uninterrupted exchanges with Earth; an interplanetary Internet, to manage and transfer huge amounts of data; robotic systems on the planet's surface that could be operated remotely from Earth, or one of Mars's moons; and telescopes with an array of scientific instruments for a new age in the exploration of space. Using the indefensible excuse that there is not enough money for space exploration, the Obama Administration has put Mars on the chopping block.

We must decide now if we plan to have a future as a nation, as a civilization, as life on Earth. The threats are immediate, in terms of the current worldwide descent into barbarism through an existential economic collapse; unknowable, in terms of the threat to Earth from space; and long-term, since, at some point in the distant future, we know that our Sun will no longer provide us with the means for life on Earth.

While it is not the case that a space exploration program meets these challenges in itself, there will not be a resolution to any of them without one.

Mars: A Habitable Planet

In March, scientists announced a major step forward toward answering the question of whether Mars could possibly have supported life. Curiosity's instruments revealed the groundbreaking results.

Although numerous previous orbital missions, and the still-operating Opportunity rover, have confirmed that there once was flowing water on Mars, the chemical composition of the minerals that Opportunity examined indicated that past water in Meridiani Planum was acidic and salty, not conducive to supporting life. However, data gathered from orbiting satellites had indicated the presence of clay minerals in Curiosity's region of Mars, which held the possibility for a different chemistry.

Curiosity found that the composition of the clay, examined from a drilled sample inside a rock named "John Klein," afer the mission's deputy project manager, who died in 2011, indicated that it formed in water that was neutral, or mildly alkaline.

If you were on the planet, you would have been able to drink it, was the way Curiosity chief scientist John Grotziner described it during a March 12 press briefing.

Second, a detailed analysis of the chemicals in the rock sample identified sulfur, nitrogen, hydrogen, oxygen, phosphorus, and carbon—all key ingredients for life. Combinations of pairs of some of the chemicals could provide the energy source for microorganisms, the scientists reported.

Last month, scientists released findings from the Sample Analysis at Mars (SAM) suite of instruments, which measures the abundance of different isotopes of elements in the atmosphere. How, why, and how quickly the atmosphere of Mars has escaped into space will help reveal aspects of the geologic, chemical, hydrological, and potentially, biological history of the planet. A thicker atmosphere, which would indicate a warmer climate, would have allowed liquid water to exist on the surface of Mars.

Curiosity scientists reported that as heavier isotopes would tend to remain near the ground, or, for a longer period of time, in the atmosphere, as lighter isotopes more easily escape, determining the ratio between them sheds light on Mar's atmospheric history. The enrichment of heavier isotopes as measured by the instruments verifies the expected process of evolution of the atmosphere.

Curiosity has spent a highly productive half (Earth) year exploring an area within 500-yards of its initial landing site. On July 4, the mobile laboratory began the five-mile trek to its ultimate goal—the three-mile-high layered mountain in the center of Gale Crater, in which the rover landed one year ago. The drive to Mount Sharp will be done slowly and deliberately, and will take more than the rest of this year to accomplish. The mound in the center of the crater was formed as a result of an impact on the surface of the planet, likely more than 3 billion years ago.

Over time, a sequence of deposits was laid down, most likely through the action of flowing water, forming sedimentary layers. Each layer of the stratified structure encases a different period in the geological and chemical history of Mars.

This is similar to the way the geological history of Earth can be read through the stratified layers of formations such as found in the Grand Canyon. Scientists hope to read this history in order to map the evolutionary changes in the planet, over billions of years.

Vernadsky on the Cosmic Origins of Life

In tackling the question of the origin of life on Earth, the great 20th-Century Russian-Ukrainian scientist Vladimir Vernadsky proposed that the Earth's continual interaction and exchanges with the rest of the cosmos had to be taken into account, in considering the appearance of life. If this is so, he posited, there is every possibility that there is life elsewhere in the cosmos.

In creating the science of biogeochemistry, Vernadsky explained that although there are geological and chemical prerequisites required for life, it was life's creation of the biosphere that evolved Earth's geology and chemistry. Vernadsky made these discoveries through the study of basic processes of the planet, and his ability to conceive of a higher-order process. He was the first to initiate an intensive study of the chemical and atomic—that is, isotopic—properties of life, examining the distinguishing earmarks of life in the Earth's biosphere, we well as a similar examination of meteorites.

Finding life on Mars, therefore, is not simply a question of looking intensively for microbes, or their remains, but applying Vernadsky's concepts and methods to discover the underlying principles of how life developed on Earth and may have developed on Mars.

Curiosity is the first step in this investigation, as it advances the detailed examination of the geochemical history and the current state of Mars. In the future, advancements will be made by applying Vernadsky's most critical breakthrough—the deployment of man's unique creative thought, to planetary exploration. New platforms of technology that are man's tools, and the passion and commitment to create a future for humanity, will lead to the answers to some of mankind's most profound questions.