One year of the Mars rover Curiosity

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The Mars rover Curiosity, the most advanced robotic probe ever to land on another world, has now spent one year on the surface of Mars, a little more than half of its predicted lifetime of 23 months. During that time, the rover has produced impressive scientific results, including its main goal of providing strong evidence that Earth-like microbial life could have existed in the ancient Martian environment.

Since its landing in Gale Crater on August 6, 2012, Curiosity has sent back a 190 gigabits of information from Mars, including more than 36,700 full images and 35,000 thumbnail images, used its laser to study the chemical makeup of potential targets, made a detailed analysis of two rocks, and driven more than a mile. It now is being directed towards its main target of *Aeolis Mons*(Mount Sharp), a rock formation thought to be the product of natural processes on Mars rather than collision with an external object like a meteorite. It thus contains a geological history that could span two billlion years.

Although Curiosity's main goal is Mount Sharp, it first traveled to another target, dubbed Yellowknife Bay, when the rover detected pebble deposits that had the character of a streambed. Using data from the rover as well as orbital observations, the scientists guiding Curiosity decided to follow the streambed, finding both veins and concretions (small, round deposits of minerals) in the rocks, further suggesting that liquid water once flowed in the area. Yellowknife Bay is where the prehistoric river led.

Once there, Curiosity used its five-centimeter drill to feed material into the Sample Analysis at Mars (SAM) and Chemistry and Mineralogy (CheMin), two of the rover's biochemical analysis instruments. Based on the data radioed across tens of millions of miles, scientists found the rocks contained oxygen, hydrogen, carbon, nitrogen, phosphorus and sulfur.

Continued analysis showed that 20 percent of the sample consisted of clay, something not before observed on Mars. Such clay is a product of a reaction of fresh water with rock formed from the cooling of lava, such as olivine. This could have happened within the deposit itself, during the transport of the minerals to the area or where the minerals first originated. Calcium sulfate was also found, suggesting that the soil has a neutral pH or is mildly alkaline.

Geologists working with Curiosity then discovered a mixture of oxidized, less-oxidized and non-oxidized chemicals, which microbes on Earth require to live. All of these are critical ingredients for terrestrial life and their discovery provides strong evidence that, at the very least, microscopic life similar to what developed on Earth existed on Mars hundreds of millions or billions of years ago.

Curiosity spent several weeks at Yellowknife Bay while teams of researchers studied the first sample, ordered drilling for one additional sample to confirm the results and took a great many images of the area. Now, the rover is beginning a journey of at minimum 5 miles (8 kilometers) to the base of Mount Sharp. In an attempt to speed up the process, computer scientists for Curiosity are installing new software called autonav, for autonomous navigation. If successful, autonav will allow Curiosity to drive along the Martian surface at a much faster speed, significantly cutting down the expected travel time of one year.

Another factor that could slow down the rover is rough terrain, though to date that has not been a problem for Curiosity.

More breakthroughs are expected closer to the base of Mount Sharp. The areas there are exposed layers of sedimentary rock that formed billions of years ago when Mars was a warmer and wetter planet and more hospitable to microscopic life.

Another one of Curiosity's goals is to understand why the climate of Mars has changed so much over the

past billion or two years. The leading hypothesis is that the planet at one time had a much thicker atmosphere which could hold in heat and moisture but that has since blown off into space. In one of its atmospheric studies, Curiosity found evidence that the processes which caused Mars to lose its atmosphere occurred near the atmosphere's outermost edge. This has given more direction to the next spacecraft to Mars, NASA's Mars Atmosphere and Volatile Evolution (MAVEN) satellite, which will look at the Martian atmosphere from orbit and focus on determining what caused the water and air of Mars to be lost.

Curiosity also studied radiation levels, both on the trip to Mars and on the surface, as part of the ongoing research into designing future human missions to the planet.