3Q: The next Mars rover's destination

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This artist concept features NASA's Mars Science Laboratory Curiosity rover, a mobile robot for investigating Mars' past or present ability to sustain microbial life. Curiosity is being tested in preparation for launch in the fall of 2011. Credit: NASA/JPL-Caltech

When the next-generation Mars rover, dubbed Curiosity, touches down on martian soil next summer, its cameras will likely capture a scene similar to what the first explorers of the Grand Canyon witnessed: towering layers of rock and sediment rising up from a dusty valley.

On Friday, NASA officials announced that Curiosity will land in a region named Gale Crater, a large depression with a massive, finely stratified mountain at its center. For two years, the rover will explore and sample sediments from the crater's valleys and cliffs, seeking signs of habitability.

Maria Zuber, the Earle A. Griswold Professor of Geophysics and Planetary Science and head of MIT's Department of Earth, Atmospheric and Planetary Sciences, says Gale Crater may reveal clues about Mars' past. She spoke with MIT News about a future in which humans might explore the Red Planet.

Q. What makes Gale Crater an ideal landing site?

A. Gale is a large, ancient crater — about 154 kilometers [96 miles] in diameter — in the equatorial region of Mars that formed somewhere in the range of 3.5 to 3.8 billion years ago. At the center of the crater is a five-kilometer-high [16,400-foot] mountain that contains hundreds of fine layers and grades in composition from the bottom up. Such a sequence of rocks, called a stratigraphic section, is a treasure trove of information for geologists. It preserves a temporal record, in which you're essentially looking back in time as you progress down the column.

Gale's mountain is the remnant of sediments that once filled the crater and were subsequently eroded. At the base of this mountain are clays, which form in water-rich conditions at elevated temperatures possibly associated with impact or hydrothermal conditions. The geologic context of the clay minerals will hopefully allow the origin to be distinguished. Further up the column the mineralogy transitions to reveal sulfate-rich rocks. The crystallization of sulfates also requires a substantial quantity of water, and some sulfates recognized on Mars require acidic conditions to form. This sequence implies a change in the aqueous chemistry of early Mars, conceivably indicating a significant change in environmental conditions.

The Curiosity rover will be able to ascend at least the lower layers of the central mountain, systematically studying the chemistry and geology and providing information that scientists will use to reconstruct just how the environment changed.

Q. What would this area have looked like during an age when there might have been water, and possibly life, on the planet?

A. Gale has had a complex history but it seems certain that water played a role in shaping the crater. There may have been a large amount of water on the floor, and water may have played a role in depositing the sediments that compose the central mountain. Several channels, likely carved by flowing water, cut the mountain, underscoring that water was present in multiple episodes of the crater's history.

Q. One of the goals of the Curiosity mission is to "prepare for human exploration." What does this mean, and how will the rover tackle this objective?

A. This mission will demonstrate the ability to deliver a large and heavy spacecraft to the surface of Mars. That's a step … that needs to be taken if you want to eventually send a human there: When humans go to Mars, the landed mass will be significant. The Curiosity lander is about as heavy as a small car and more than 300 kilograms heavier than the Mars exploration rovers; to deliver such a massive robotic explorer to the surface of Mars is real progress.

The precision landing system to set the rover on the martian surface, called "Sky Crane," is genuinely new, and increases the flexibility in selecting landing sites. When we used to evaluate landing sites on Mars, the engineers would always want to land at low elevation, with a lot of atmosphere above it — for parachuting in — and somewhere flat with no large rocks that would cause the rover to tip over or limit mobility. And the scientists would always want to go to the rocky, hazardous, mountainous places because those are the most interesting geologically. Because this landing system is so robust, Curiosity can land in many places on Mars that would not have been possible in the past. The fact that a site may be rocky, or have a mountain or cliff nearby, need no longer necessarily be a showstopper.

This guided entry and the ability to do precision landing is extremely helpful for future human exploration, because humans will want to land in the best, safest place on Mars.

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