Crater mound a prize and puzzle for Mars rover

Curiosity scientists seek to solve the mystery of Mount Sharp.

Eric Hand

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The object of desire for scientists with the Mars Science Laboratory (MSL) mission rises mysteriously from the centre of Gale Crater: it is Mount Sharp, a 5.5-kilometre-tall mound of layered sediments that time and pressure have squeezed into a mountain of rock. If all goes well with the mission landing, set for 05:31 GMT on 6 August, NASA's Curiosity rover will spend its working life climbing up the lower part of the mountain, which is named after Robert Sharp, a pioneer of planetary geology who died in 2004. Researchers hope that as the compact-car-sized rover ascends Mount Sharp, it will unpack the hundreds of millions of years of Martian history that are hidden in the mountain's layers.

The making of Mount Sharp

Gale Crater's central mound, nearly two-thirds the height of Mount Everest, features several distinct layers of rock spanning hundreds of millions years. Some of these layers seem to have been laid down at very different times, leaving a mysterious gap in the geological record. Here is one way to account for the formation of Mount Sharp and its associated features.

Rivers and lakes deposit sediments.

SOURCE: EDGETT, K. S., SUMNER, D. Y., MILLIKEN, R. E. & KAH, L. C. GALE CRATER. PAPER GIVEN AT THE 3RD MSL LANDING SITE WORKSHOP (2008); GO.NATURE.COM/B3WPDV

The team will also be trying to understand how the mound got there in the first place. There are other craters on Mars with large central mounds, and nothing like them exists on Earth. "The question is, how did Mount Sharp form?" says John Grotzinger, MSL project scientist and a geologist at the California Institute of Technology in Pasadena. "The short answer is, we don't know." Dawn Sumner, a mission co-investigator and a geologist at the University of California, Davis, calls it a "scientific enigma".

The top of Mount Sharp is slightly taller than the rim of the crater wall, suggesting that, in the past, the crater was submerged in sediments and then later exhumed by wind erosion. One scenario favoured by many of MSL scientists is that the crater was subject to two distinct epochs of both deposition and erosion (see 'The making of Mount Sharp').

Researchers are most interested in the earlier epoch of deposition, which would have created the lower part of the mound. There, the rocks show a clear signature, detected by orbiting satellites, of water-altered minerals: a thin layer of clays and a layer of sulphates.

But it is unclear precisely how watery and hospitable a period the deposits represent. Michael Malin, principal investigator for the MSL Mast Camera project and the president of Malin Space Science Systems in San Diego, California, says that the minerals could have been formed in a playa-like environment, in which layers are built up over time as wind-carried sediments fall into a shallow or intermittent desert lake infused by groundwater. But he says that it's also possible that Gale Crater once contained a deeper lake, with water carrying in more sediment and depositing it in thicker layers.

Another area of interest will be the sediments in the area where Curiosity is expected to touch down: deposits from an 'alluvial fan', a delta-like feature that was created when water spilled into a portion of the crater and deposited sediments there. On the basis of the sharp edges of the channels in the fan, Sumner believes that it was created after the mound. Even though the most recent geological epochs on Mars have been the driest, Sumner says, there still could have been occasional bursts of watery activity. Malin, on the other hand, believes that the fan came first, and that parts of it underlie the mound. The fan would have been buried while the mound was

forming and then later uncovered by wind erosion. In that case a possible cementing of the fan's sediments would have allowed it to resist the wind's erosive effects. Sumner is not concerned about these differences of opinion; that's what the mission is for, she says. "We have a million different opinions among 250 people."

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