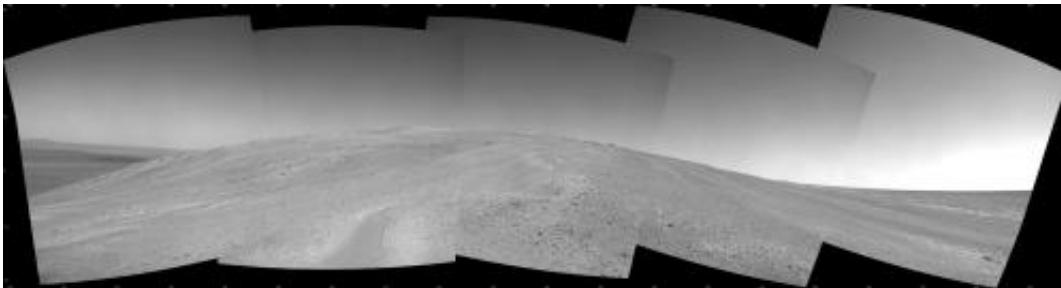


NASA team hacks Opportunity to treat Mars Rover's amnesia

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NASA's Mars Exploration Rover Opportunity captured this southward uphill view after beginning to ascend the northwestern slope of "Solander Point" on the western rim of Endeavour Crater. Credit: NASA/JPL-Caltech

NASA's Mars rover Opportunity has been working well into its golden years - after nearly 11 years roaming the Red Planet, it has survived more than 40 times past its warranty. But now, this trusty veteran explorer is experiencing some worrisome memory loss.

The long-lived [rover](#) has been having some senior moments, according to John Callas, project manager for the Mars Exploration Rover mission (as Opportunity and its defunct twin Spirit are formally known). The episodes of amnesia stem from faulty flash memory - the kind of memory in your digital camera that allows your pictures to stay saved even after your device is turned off.

But flash memory doesn't last forever - and the seventh, final bank in the

flash memory appears to be malfunctioning.

"Flash memory has a limited lifetime," Callas said. "It only allows so many read-write cycles before it starts to wear out some of the cells. And after 11 years of operation on Mars, we now suspect we're seeing a wear-out of some of those cells."

This leads to a pair of problems. Since the rover can't use the seventh memory bank, it uses its random-access memory - or RAM, the kind of memory your computer uses when it's on for temporary data storage. The problem is, as soon as the rover (or your computer) is switched off, the information stored in RAM is lost. So if the rover turns off before sending all of its at-risk data back to its handlers at the Jet Propulsion Laboratory in La Canada Flintridge, then those data are lost forever.

That's an annoying, but manageable, issue, Callas said. The second snag is that the flash memory issue also causes the rover to reboot - and when it reboots, it stops the long-term activities the team had planned for the rover and simply waits for further instructions on the ground. On weekends and over the holiday season, when people are out of the office, these unexpected hang-ups can put the team days behind schedule, Callas said.

"It's like you're taking a family trip and your car stalls, and every time your car stalls you have to call triple-A - but now it's stalling every 20 miles," Callas said. "You're not going to make much progress."

The researchers do have a clever little fix, Callas added. They plan on modifying the software so that the rover thinks it only has six banks' worth of flash memory - which should make it skip faulty bank No. 7, since that's at the very end. (They're lucky the faulty segment wasn't right in the middle of the [flash memory](#) module, Callas added - that would make a fix much more complicated.)

"You have a piece of lettuce you want to put on your sandwich and the edge of the lettuce is a little bit brown, and you just cut it off and you put the rest in your sandwich and you go," Callas said by way of analogy. "Maybe you have a little less lettuce, but it doesn't have any brown on it."

Opportunity, which along with its twin Spirit arrived at the Red Planet in early 2004, set out to find signs of past water on Earth's dry, dusty next-door neighbor. It did that and more, even finding evidence of past habitable environments in its later years that complemented the findings from its descendant, NASA's 2012 rover Curiosity.

Opportunity was never meant to last this long, and it's picked up a number of scars along the way. It's been described as arthritic, with a gimpy elbow and a somewhat disabled front wheel, but that hasn't kept the robot from logging roughly 26 miles on the Red Planet.

It's unclear how long Opportunity will last, said Callas, who compared the aging rover to an elderly parent (one in good health, who still plays tennis every day).

"With each passing day we get one day closer to that end ... but until that time, we're going to keep going, keep exploring," Callas said.

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