2nd rover is treated with kid gloves

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bigger crater almost 2,000 feet wide beckons, targeted for exploration after scientists investigate

Cover story

the local soil and the bedrock outcrop already in view.

It is a setting dramatically different from the butterscotch-colored hills, covered with churned up rock and sand, in the Gusev Crater where Spirit landed Jan. 3.

"Holy smokes!" said rover science chief Steve Squyres of Cornell University as he viewed the first images from the landing site. "I'm just blown away by this." He noted that the slab-like look of the bedrock outcropping resembles layered rocks laid down by lakebeds and by lava on Earth.

"Planetary scientists have been especially intrigued by this area for several years," said William Hartmann, a senior scientist at the nonprofit Planetary Sciences Institute in Tucson. "The new images are the most exciting of any received so far on Mars."

A landing site like no other

"What an amazing landing site. It is completely different than I imagined — much smoother with a silty texture, with way fewer blocks, and the bonus of an outcrop in the background," said geophysicist F. Scott Anderson of the University of Hawaii at Manoa, who participated in NASA's landing site selection process.

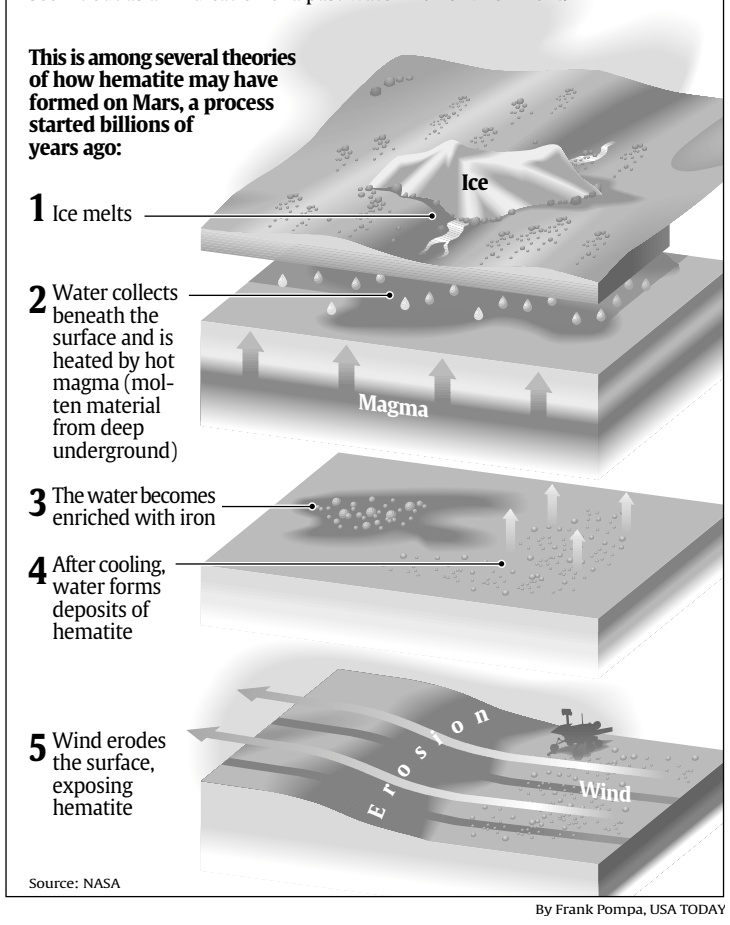
"It has really paid off in that we have not been to an area that looked so dark in color in the orbital data, and the results are clear: This region looks tremendously different than the other places we have landed."

Meridiani Planum is covered with a layer of gray hematite, a mineral usually found near hot springs on Earth.

During the next three months, the rover will turn its science instruments on this metallic gray rock in an attempt to determine its origins. Scientists believe the plain might harbor remnants of an ancient lake, hot springs or volcanic activity.

Hunting for hematite

The surface of Meridiani Planum, where the Opportunity landed, is one of three regions on Mars thought to be rich in a mineral called gray hematite. On Earth, this mineral usually forms in association with water. The rover will seek it out as an indication of a past water-rich environment.



By Frank Pompa, USA TODAY

Interactive graphics

USA TODAY .com Explore U.S. space missions to Mars and to the moon in interactive graphics at **usatoday.com**

"We're on Mars, everybody," Rob Manning of the Jet Propulsion Laboratory said early Sunday morning as whoops filled a jammed control room.

The landing touched off a locker room-style celebration, marked by a marching, chanting and cheering landing team. Team leaders drank champagne, which was poured into plastic cups by their boss, NASA chief Sean O'Keefe.

'What a night'

Rover team members serenaded O'Keefe with a chorus of *Happy Birthday* and presented him with a Lego rover. O'Keefe has headed NASA in bad times — during last year's explosion of the space shuttle Columbia — and good times, the current period of Martian exploration.

The drama of a live landing drew politicians such as former vice president Al Gore and California Gov. Arnold Schwarzenegger, who observed the proceedings from a balcony vantage, to JPL's control room to offer congratulations.

"What a night," O'Keefe said. "This team is the best in the world, no doubt about it."

The success capped a roller-coaster weekend for space agency engineers, who managed to stave off a "funeral" for Spirit, in NASA science chief Ed Weiler's words.

Spirit took itself out of engineering intensive care Saturday. After refusing to shut down or follow instructions since Wednesday, the rover Saturday obeyed commands that bypassed the computer memory now thought to be at fault.

Spirit's return to obedience occurred within the same 24-hour period as Opportunity's arrival on Mars.

"We are moving to a guarded condition," said Mars Exploration Rover project manager Pete Theisinger of JPL. A problem in the rover's "flash memory" software seems to have triggered the communication bug plaguing Spirit.

Flash memory, which is used in digital cameras, stores data aboard the rover overnight and holds its morning wake-up instructions. The faulty flash memory blocked the probe from shutting down at night, which drained the batteries.

Engineers suspect that a sequence of moves initiated by Spirit's arm last week perhaps tripped up the rover's software. More than 100 computer resets took place over the past week as Spirit struggled with the fault.

Theisinger suggested at least three weeks of testing and repair would be needed, in the best case, before Spirit could begin exploring again. Spirit landed on Jan. 3 and is designed for a three-month lifespan. NASA chief scientist Ed Weiler said he expects the rover will exceed that performance by at least a month and still meet most of its science goals, despite the setback.

Good start for second rover

It could be two weeks before Opportunity drives off its lander. Mission controllers are avoiding some tests of the second rover's instruments and flash memory software to ensure it doesn't suffer the communication breakdown that plagued Spirit.

The fact that Opportunity landed on a side "petal" flap was not a problem because the craft was designed to land on any of its sides and tip itself right-side up.

"We did land on a rear petal, and that's good in many ways," said Matt Wallace, mission manager. "It allowed us to retract the airbags in front of the lander. That front path is beautifully clear." Spirit drove down the back of its lander after airbags blocked its path.

Once Opportunity drives off the lander, the smooth floor of Meridiani looks especially amenable to rover driving, offering few obstacles. "We are really going to be able to motor," Squyres says.

Public interest in the Mars rovers remains high. NASA has reported more than 4 billion Mars rover Web site hits since Spirit's landing on Jan. 3, more than the space agency recorded on its Web site for all of 2003.

Rovers roll with the bounces after they touch down

Bouncing to a landing, wrapped in 24 interconnected airbags, NASA's Mars Exploration rovers know how to make an entrance.

"All systems worked perfectly at Gusev for Spirit," says landing chief Rob Manning of NASA's Jet Propulsion Laboratory. And with the sterling landing achieved by Opportunity, bouncing landings look all the more attractive.

The landings proved two experimental ideas valuable — the use of three small stabilizing rockets to steady the lander and a downward-looking camera that measures airspeed to prevent crashes. About the size of quarts of soda, the rockets each pumped out 281 pounds of force per second and likely prevented Spirit from bouncing into a small crater. Opportunity's landing was so seamless that the rockets never needed to fire.

That success has inspired some scientists, such as Tracy Gregg of the State University of New York at Buffalo, to call for more adventuresome balloon landings for future rovers.

Geologists savor the possibility of exploring Olympus Mons, the largest volcano in the solar system, a lava pile 400 miles across that rises 13 miles above the Martian plain, or Valles Marineris, a canyon rift 600 miles long and 13,000 feet deep.

No chance, says Manning. "On a quarter-ton vehicle like the rover, you don't want more bounces" that canyon cliffs and volcano slopes provide in abundance, he says.

"We'd all love to go to those exciting, steep and dangerous places," says landing expert Paul Withers of Boston University. But he suggests that a variety of lander types will be used in coming decades, rather than adopting one technique as the "best."

And in fact, NASA's planned Mars landings in this decade, larger and heavier efforts, call for the use of landing rockets:

- **Phoenix Mars Scout.** An arctic lander, Phoenix will arrive in 2008 near surface ice deposits fingered from orbit by NASA's Mars Odyssey mission. A weather station and chemistry lab combo, the lander will look for signs of life, like the carbon molecules found in organic chemistry, on Northern Mars.
- **Mars Science Laboratory.** A nuclear-powered rover designed to roam freely over three-quarters of Mars' terrain. Departing from Earth in 2009, the mission will start its efforts at a site deemed most hospitable for life on the Red Planet.

By Dan Vergano