Water hints on both sides of Mars
By Gay Webster

Above: This microscopic image of “Plate rock,” taken on Opportunity’s 43rd sol on Mars, is representative of the science team’s goal at the rock outcrop under investigation at Meridiani Planum. Below: Spirit used its panoramic camera to capture this view of the rocky terrain just to the left of straight shaft after finishing a drive to the northeast on March 5.

JPL’s Spirit rover has found hints of a water history in a rock at Mars’ Gusev Crater, but it is a very different type of rock than those in which Opportunity found clues to a wet past on the opposite side of the planet.

A dark volcanic rock dubbed “Humphrey,” about 2 feet tall, shows bright material in interior crevices and cracks that looks like minerals crystallized out of water. Dr. Ray Arvidsson of Washington University, St. Louis, reported at a March 5 news briefing at JPL. He is the deputy principal investigator for the rovers’ science instruments.

“If we found this rock on Earth, we would say it is a volcanic rock that had a little fluid moving through it,” Arvidsson said. If this interpretation is correct, the fluid—water with minerals dissolved in it—may have been carried in the original magma that formed the rock or may have interacted with the rock later, he said.

The clues appear in an interior exposure of Humphrey where Spirit’s rock abrasion tool scraped away the rocks’ surface to a depth of 0.08 inch. To gain more confidence that the bright material seen in cracks and pores is not dust that has intruded from the surface over the millennia, scientists intend to have Spirit grind more deeply into another dark rock, not yet selected. The bright material is not debris from the grinding process, said Stephen Gorevan of Honeybee Robotics, New York, lead scientist for the abrasion tool.

The amount of water suggested by the possible crystals in Humphrey is far less than what is indicated by the minerals and structures that Opportunity has revealed in rocks at Meridiani.

On March 2, NASA announced scientists have concluded the part of Mars that Opportunity is exploring was soaking wet in the past. Evidence the rover found in a rock outcrop led scientists to the conclusion: Clues from the rocks’ composition, such as the presence of sulfates, and the rocks’ physical appearance, such as niches where crystals grew, helped make the case for a wet history.

“Liquid water once flowed through these rocks. It changed their texture, and it changed their chemistry,” said Dr. Steve Squyres of Cornell University, principal investigator for the science instruments on the rovers. “We’ve been able to read the tell-tale clues the water left behind, giving us confidence in that conclusion.”

The rover found a very high concentration of sulfur in the outcrop with its alpha particle X-ray spectrometer, which identifies chemical elements in a sample.

“The chemical form of this sulfur appears to be in magnesium, iron or other sulfate salts,” said Dr. Benton Clark of Lockheed MartinSpace Systems. Denver. “Elements that can form chloride or even bromide salts have so far not been selected.”

At the same location, the rover’s Moessbauer spectrometer, which identifies iron-bearing minerals, detected a hydrated iron sulfate mineral called jarosite. Germany provided both the alpha particle X-ray spectrometer and the Moessbauer spectrometer. Opportunity’s miniature thermal emission spectrometer has also provided evidence for sulfates.

On Earth, rocks with as much salt as this Mars rock either have formed in water, or after formation, have been highly altered by long exposures to water. Jezero may point to the rocks wet history having been in an arid lake or an arid hot springs environment.

The water evidence from the rocks’ physical appearance comes in at least three categories, said Dr. John Grotzinger, sedimentary geologist from the Massachusetts Institute of Technology, interpretations called “vugs,” spherules and cross bedding.

Pictures from the rover’s panoramic camera and microscopic imager reveal the target rock, dubbed “El Capitan,” is thoroughly pock-marked with indentations about 0.4 inches long and one-fourth or less as wide, with apparently random orientations. This distinctive texture is familiar to geologists as the sites where crystals of salt minerals form within rocks that sit in briny water. When the crystals later disappear, either by erosion or by dissolving in less-salty water, the void left behind are called vugs, and in this case they conform to the geometry of possible former evaporite minerals.

On Opportunity’s 44th sol, ending at 12:10 p.m. PST on March 9, the rock abrasion tool ground a hole of just over one-tenth of an inch in the rock. On March 8, diagnostic testing determined a voltage adjustment was necessary to overcome some mechanism “stickiness” in the routine during which the rock abrasion tool finds the “stickiness” in the routine during which the rock abrasion tool finds the highest point in the target area.

Spirit completed another 94 feet of its drive toward the rim of Bonneville crater on sol 64, bringing its total odometry to 1,600 feet—45.9 feet past the minimum mission success criterion.

The rover had some difficulty finding a way around an obstacle during the last portion of a direct drive that safely maneuvered it through a field of rocks. Spirit is climbing up a very steep part of Bonneville now, and ended this sol’s drive tilted at a forward pitch of about 15 degrees.

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Voyager 1 Jupiter flyby anniversary observed

On March 5, as Jupiter made its closest approach to Earth, the Voyager Flight Team reflected on this date 25 years ago when Voyager 1 flew closest of the solar wind and the transition to interstellar space. “Voyager also discovered a ring around the planet and observed auroral active volcanoes had been seen on another body in the solar system,” he said.

Ed Massey, current manager of the Voyager and Ulysses projects. “It was the first time noes on the satellite Io was the greatest surprise, according to Ed Massey, revealed. Engineers and scientists and JPL, building on an idea by Voyager team member DR. FRANK. LOW of the University of Arizona, solved this cooling problem with a clever redesign of past telescopes housed in large “thermos bottles” that store the thermalite to hold for the time when the instruments and the coolant, and planned for the first-ever Earth-approaching object, which takes Voyager farther away from Earth than in any other mission. “This innovative main launch” architecture allows the chill-in-the-empty space to do most of the cooling.”

Launched in August 2001, Voyager 2 is the fourth of NASA’s Great Observatories, a program that also includes the Hubble Space Telescope. See the Voyager 2 observation.

Section 353 hour at forum
Several members of Section 353 recently received honors at a national technology conference:

- The Space Technology & Applications International Forum was held Feb. 8-11 in Albuquerque, N.M. The forum is organized by the Institute for Space and Nuclear Power Studies at the University of New Mexico. Attendance was up almost 30% year due to increased interest in nuclear power applications through Project Prometheus and the Jupiter and Moon Orbiter. See the forum’s Conference on Thermo- nucleic Reactors in Mereologics. Section 353 staff members KIRK NOVACK, GINES FELIPPE, GUILLERMO GONZALEZ, KIKO MUÑOZ and MICHAEL PALSKE were awarded Outstanding Paper for 2001 for publication of “Development of a Thermal Control Architecture for the Mars Exploration Rovers.”

Voyager 1 Jupiter flyby anniversary observed

Dr. Michael Werner

Voyager team members celebrate Dr. Michael Werner on Feb. 16.


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A ballon-shaped robot explorer that one day could search for evidence that water existed on other planets has survived some of the most trying conditions on planet Earth during a 40-mile, wind-driven trek across Antarctica.

The tumbleweed rover, which is being developed at JPL, left the National Space Science and Engineering Center in southwest Washington, D.C., on Jan. 24, and spent the next eight days rolling across Antarctica's polar plateau.

Along the way, the beach ball-shaped device, roughly 6 feet in diameter, used the global Internet's satellite network to send information on its position, the surrounding air temperature, pressure, humidity and light intensity to a ground station at JPL.

The test was designed to confirm the rover's long-term durability in an extremely cold environment, with an eye towards eventually using the devices to explore the Martian polar caps and other planets in the solar system.

The final tumbleweed rover is envisioned as a lightweight, rough ground device that can serve multiple roles as an independent robotic explorer. The rover's design will allow it to act in turn as a parachute while descending through an atmosphere: an airbag on landing; and, ultimately, an unmanned vehicle equipped with a package of scientific instruments.

The tumbleweed rover is based on concepts going back to the 1970s and has been pursued by several investigators at JPL. Dr. Alberto Behar, a robotics researcher in the Robotic Vehicles Group, recently deployed this prototype at the South Pole. "We are testing a new mode of rover transportation that uses the available environmental resources to give us an added edge to cover more ground using fewer on-board resources," he said.

"This gives us the ability to use the precious cargo (on Earth) or payload (in space) mass for more applicable science instrumentation." Even though the average external temperature during the rover's deployment was recorded to be on average -22 degrees Fahrenheit, the rover kept its internal instrument payload at an average temperature of roughly 86 degrees Fahrenheit. The rover was able to stay warm by self-heating due to running electronics and an internal air pump.

The ultra-durable ball reached speeds of over 10 mph over the Antarctic ice cap, and traveled at an average speed of about 3.7 mph. The winds at the South Pole were unusually low during the test. As a result, there were several periods during its deployment when the rover did not move at all. Even taking those lulls into account, the rover managed an average speed of 0.8 mph over the course of the deployment.

Behar said the rover's design is especially well suited for polar missions to use instrument packages to look for water beneath a surface desert or an ice sheet, a task that cannot be done accurately from orbit. Plans to construct the next-generation tumbleweed rover are already underway at JPL.

Future refinements of the design are likely to focus on reducing the rover's weight and rolling resistance to the minimum winds needed to enable it to travel further and the adaptation of the payload to include a ground penetrating radar to conduct terrain and ice surveys.

Behar says he hopes an updated version of the rover will be deployed again later this year, and the design may one day find itself rolling on the polar areas of Mars.

Behar, who oversaw the design, construction, testing and deployment of the project, credited a number of JPLers who made significant contributions: Frank Carey, science and design; Jack Jones, design consultant; John Tauri, Northeastern; design, contact and test; Fabien Nicaise, ground station operator; Aaron Simo, ground station operator; Juam-Jeng (Jay) Wu, design consultant; and Evelyn Reed, administrative.

He also recognized the contributions of Waleed Abdalati of NASA's National Snow and Ice Data Center, as well as science officer Vladimir Tupschitzki and logistics officer Brian Stone; both from the National Science Foundation.

The tumbleweed rover project is managed by JPL and was supported jointly by NASA's Office of Space Science and the National Science Foundation.

For more information on the tumbleweed rover, visit http://robotics.jpl.nasa.gov/~behar/southpole/tw.htm.

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**A Sweeping Airborne Expedition**

By Alan Buss

An international team of scientists from NASA and other research institutions has embarked on a three-week expedition of discovery that will take them from the lush, dense rain forests of Central America to the frigid isolation of Antarctica.

Aimed with a unique radar instrument, the team will survey selected sites in Costa Rica and Patagonia to help unravel Earth's environmental secrets, and to preserve resources and biological and cultural diversity. Then the scientists are off to South America's Patagonia ice fields and Antarctica to conduct topographic surveys of ice to better gauge the effect of climate change.

Despite these harsh, exotic locales, this expedition won't encounter a single snake or spider, and parkas are definitely not required. That's because the team's survey tour guide is an all-weather imaging tool, the Airborne Synthetic Aperture Radar, or AirSar, developed and managed by JPL. Carried aboard a NASA DC-8 laboratory, AirSar can penetrate clouds and also collect data at night. Its high-resolution sensors operate at multiple wavelengths, polarizations and in interferometric modes. This means they "see" beneath treetops, and through thin sand and snow pack.

The sensors can produce topographic models.

Drs. Ron Blom, Eric Rignot and Sassan Saatchi of JPL are leaders of the campaign's terrestrial science, cryospheric, and ecology and conservation science teams. Respectively, they've used NASA's Dryden Flight Research Center's DC-8 bound for southern Mexico and Central America.

Rignot will continue on to Chile to survey Patagonian ice fields, and the Antarctic Peninsula.

Much of the archaeological evidence needed to understand Pre-Columbian societies in Central America comes from identifying and documenting features remaining on the landscape. Difficult terrain and logistics have limited ground-data collection. Pervious remote-sensing techniques were unable to penetrate the forest canopy. AirSar is expected to detect features such as fortifications, causeways, walls and other evidence of advanced civilizations hidden beneath the forest. Images will shed insights into how modern humans interact with their landscape, how ancient peoples lived and what became of them.

In South America and Antarctica, AirSar will collect imagery and high-precision topography data to help determine the contribution of Southern Hemisphere glaciers to sea level rise due to climate change. In Patagonia, a recent study by NASA and others found the contribution more than doubled from 1955 to 2000 compared to the previous 25 years. AirSar will make it possible to determine whether that trend is continuing or accelerating.

Not much is known about the poorly mapped glaciers in the Antarctic Peninsula, an area larger than Patagonia. The region experiences rapid atmospheric warming, triggering a widespread retreat of floating ice shelves, reducing permanent snow cover and lengthening the melt season. AirSar will provide reliable information on ice shelf thickness to measure the contribution of the glaciers to sea level rise. It will also provide a precise topographic reference for comparison with satellite laser altimetry data from NASA's Icesat satellite and previous airborne data.

AirSar's 2004 campaign is a collaboration of many U.S. and Central American institutions and scientists, including NASA's National Science Foundation. The Smithsonian Institution; National Geographic; Conservation International; the Organization of Tropical Studies; the Central American Commission for Environment and Development, and the Inter-American Development Bank.

For more information about AirSar and NASA's DC-8, visit http://airsar.jpl.nasa.gov and http://www.dfrc.nasa.gov/Research, respectively.
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Katherine Batkin, retired from Section 661; and Dr. B. Katin, retired at JPL for 28 years. He is survived by his wife, Patricia.

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JPL’s ONLINE NEWS SOURCE

Visit the previous issues of Universe at http://universe.jpl.nasa.gov.

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E. Lee Brubaker, retired from Section 311, died 2/25. Brubaker worked at JPL for 27 years. He is survived by his wife, Maria

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Advice to Advertisers

To my friends and colleagues: The kindness and generosity that you showed me and my family during our father’s death are much appreciated. The flowers, phone calls and notes really meant a lot to me during the difficult time. I hope this sympathy card can help my brother whenever he needs assistance.

My sincere appreciation to my JPL and Caltech colleagues for your kindness and condolences on the passing of my father. Thanks also to everyone for the beautiful flowers.

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