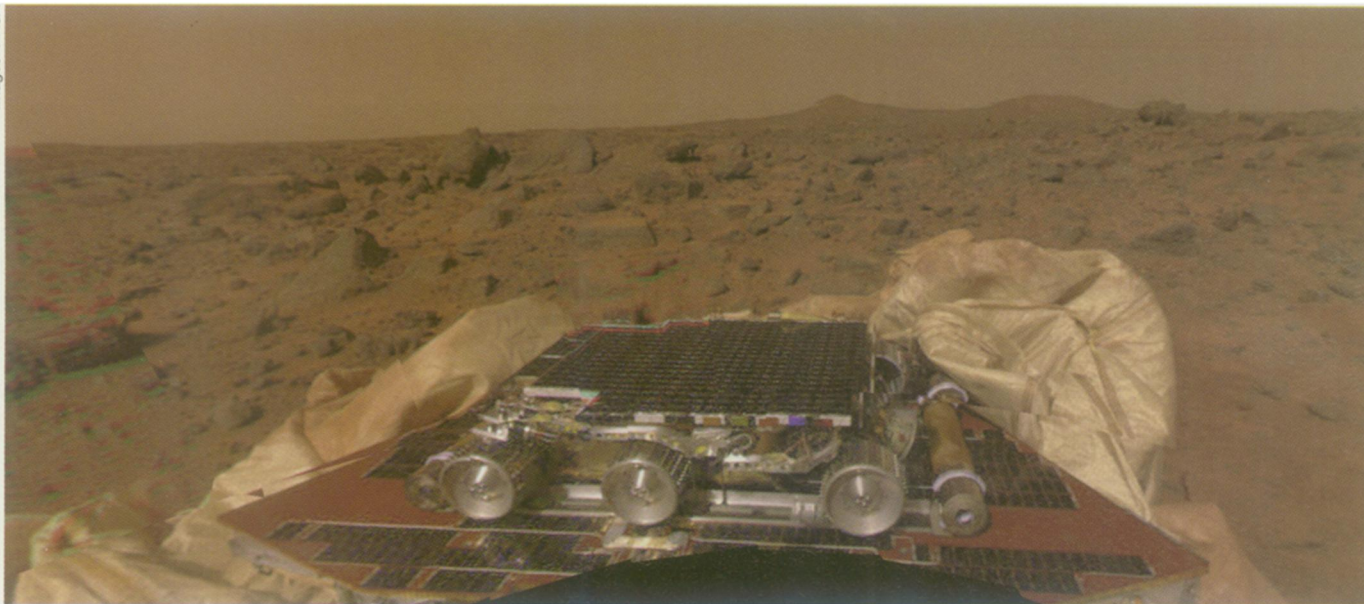


# Postcards from the Red Planet

Images: NASA



The journey was 7 months long, the landing bumpy. But right on schedule, the spacecraft Pathfinder struck the surface of Mars this July 4, bounced at least 16 times, and landed upright in the chilly darkness.

Soaking up the energy from the earliest light of a Martian dawn, the craft awakened and soon beamed to Earth the first close-up images of an alien landscape—distant hills and nearby rocks that provide the most compelling evidence to date that the bone-dry terrain was once awash in water.

Next, the craft's six-wheeled rover, Sojourner, made its Martian debut. After an obstructive airbag had deflated fully and a communications problem with the mother ship had been cleared up, this tiny field geologist rose to its full height—30 centimeters—and inched down a ramp. At 1:38:55 a.m. Eastern Daylight Time on July 6, the steel-cleated tires of the first rover on Mars left their tracks in the powdery red soil.

Meanwhile, 191 million kilometers away, Pathfinder scientists and engineers at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif., hugged, cried, and gave each other high-fives.

The reception was no less enthusiastic on the Internet, where Web sites containing the new images received some 100 million hits in 5 days—a world record, according to NASA. Little wonder about all the hoopla: After a gap of 21 years, a representative of Earth had once again arrived on the Red Planet.

Last Monday, Sojourner nestled up to a rock called Barnacle Bill, placing its spectrometer squarely against the rock's intriguingly bumpy surface. The spec-

troscopy provided further proof that the 12 meteorites believed to have fallen to Earth from the Red Planet had really done so. Several chemical fingerprints, including the ratio of iron to magnesium, were similar to those found in the group of 12. Yet the rock is richer in silica than any of the dozen and in this respect resembles a class of volcanic Earth rocks found in the Andes Mountains.

One way rocks produce silica is by undergoing repeated cycles of heating and cooling. The abundance of silica in Barnacle Bill suggests that ancient rocks on Mars were exposed to more prolonged heating than scientists had thought.

Even the first images taken by Pathfinder's camera "had scientists salivating," says project scientist Matthew P. Golombek of JPL. Those images reveal that the landing site, the mouth of a dried-up flood plain called Ares Vallis, displays a cornucopia of colors, rock shapes, and soil textures far exceeding what scientists had hoped for (SN: 6/28/97, p. 402). For instance, although much of Mars has rusted, tinted red by oxidizing gases in the atmosphere, the rocks at Ares Vallis

*Flat Top (arrow) is part of the rocky terrain seen by the Pathfinder camera on July 7, after the camera was extended to its full height.*

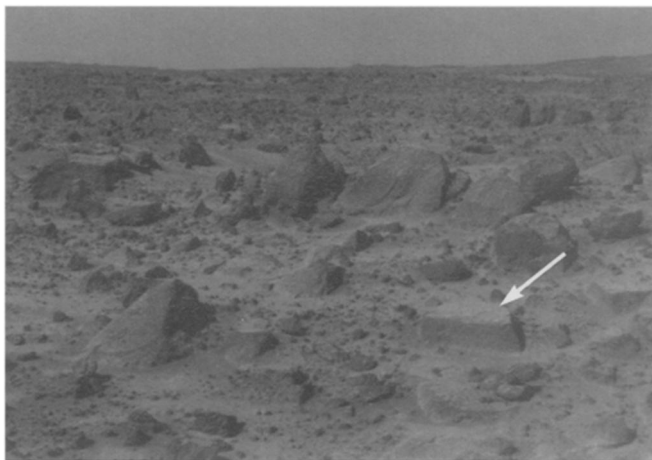
*View from the Pathfinder camera in its original position shows Sojourner and ramps before they were deployed.*

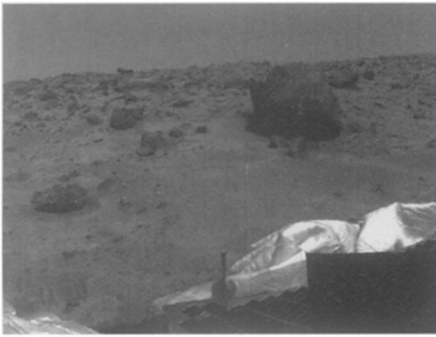
sport a variety of red hues, ranging from dark to light.

"This is just an absolutely wonderful surprise," says Pathfinder investigator James F. Bell of Cornell University. Viewing the rocks through all 12 of the camera's color filters may help to identify their composition, he adds.

Researchers had selected Ares Vallis as a landing site because of its watery history. Torrents of water equal in volume to 1,000 times the flow of the Amazon River are believed to have swept boulders from Mars' ancient southern highlands into this floodplain several billion years ago, giving Pathfinder the chance to view some of the planet's oldest rocks.

In addition, says Pathfinder investigator Daniel Britt of the University of Ari-





zona in Tucson, an asteroid or meteorite that gouged a small crater just a kilometer or so from the craft brought buried rocks to the surface. Rubble scattered around a larger crater, some 50 km distant, forms yet another population. Thus, three distinct sets of rocks populate the landing site.

In comparison, the landing sites for the two Viking craft that touched down on Mars in 1976 were "dreadfully flat," uniform in color, and not nearly as interesting geologically, notes Golombek. "There are many wondrous things to see and many wondrous things to go and do," he adds.

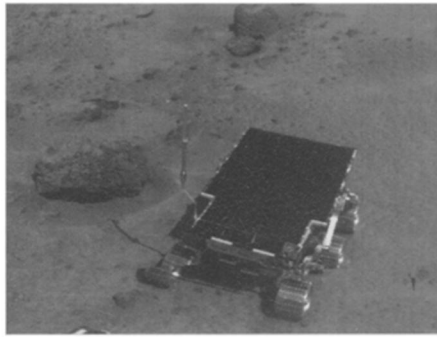
During the first week of the mission, members of the science team devised their own nomenclature as they sought familiarity with a panoply of intriguing landforms. A wall-size panoramic view of the region recorded by Pathfinder's camera was soon dotted with yellow stick-on tags labeling nearby rocks with such fanciful monikers as Yogi (because it resembles the back of a bear), Chimp, Flat Top, Casper, Scooby Doo, and the more distant Couch boulder and Twin Peaks.

Sojourner, whose mission is expected to continue for several weeks, can crawl only to the closest of these. Its travel path is plotted by researchers who don 3-D goggles to analyze stereo views of the terrain. If it strays farther than 500 meters from Pathfinder, the rover will lose contact with the mother ship, which relays the marching orders from Earth.

Several features in the pictures speak volumes about the region's watery past. Stereo images transmitted by Pathfinder reveal that the craft touched down at the edge of a channel marked by undulating ridges and valleys. This pattern may have been generated by helical flows of water that swept sediment away from the center of a rushing stream and deposited it on either side, notes Ronald Greeley of Arizona State University in Tempe.

If water was indeed the architect, then measuring the spacing between the ridges and valleys, as well as the depth of the channel, could provide a gauge of the depth of the inundation that once flowed over Ares Vallis.

As it drained away, water from a flash flood is likely to have collected in small depressions and formed ponds. Some of the ponds may have been rich in mineral salts, which would have precipitated as the water evaporated, forming a crust.



Michael Malin of Malin Space Science Systems in San Diego says the crusts at Ares Vallis appear similar to the scumlike coverings he has encountered during austral summers in Antarctica, when ice melts briefly and creates ponds. The rover's spectrometer should be able to identify salt deposits if they exist.

Other indications of the action of water come from one of the two hills known as Twin Peaks. This hill appears to display four or five horizontal layers of rock. Such layers, like the multihued striations in the Grand Canyon, could be generated by erosion or could represent deposits pushed up against the hill. Either way, the process required the action of water over an extended period.

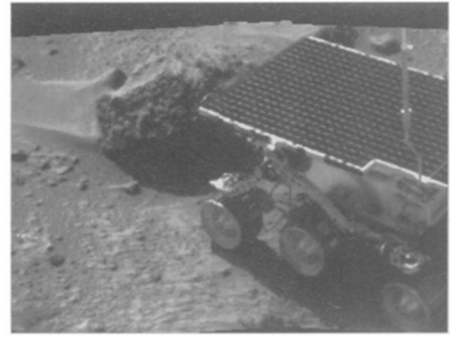
"The point is that we see evidence of several floods, not just one catastrophic event," says Greeley.

That's intriguing, he adds, because the longer the water persisted in a particular region, the more likely it is that some form of life thrived there.

The rounded shape of many of the rocks littering the landing site may also have been sculpted by water, he says. Across the site, Greeley adds, rocks are oriented in one general direction. That orientation matches the direction of water flow indicated by the huge channels seen in Viking images of the area.

Greeley says he's particularly taken by Stripe, a rock named for the whitish swath down its side. At first, scientists figured this marking was simply a fracture that had been filled in by bright dust. Now, images taken with the Pathfinder camera extended to its full 3-meter height show that the swath extends onto the top of the rock. Greeley speculates that it represents a vein of minerals deposited in the rock, possibly by liquid water percolating through and leaving behind a mineral sediment.

Just such a process has been suggested by several researchers to explain how ALH84001, the famous Martian meteorite thought to contain fossils of bacteria, acquired its carbon-rich compounds (SN: 8/10/96, p. 84). If his hypothesis pans out, Greeley says it would be the "first confir-

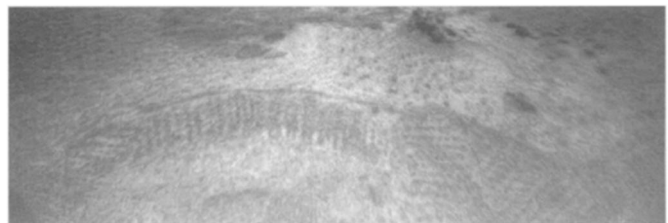


*The smaller rock at left is called Barnacle Bill; the larger one at right is Yogi (left image). Sojourner leaves Pathfinder (center) and applies its spectrometer to the surface of Barnacle Bill (right).*

mation of that kind of activity on Mars."

Pathfinder also managed to record several images of the smaller of Mars' two moons, Deimos. "I'm pleased to report that the only astronomical observatory on Mars is open for business," says Nicholas Thomas of the Max Planck Institute for Astronomy in Katlenburg-Lindau, Germany.

Addressing meteorology as well as astronomy, Pathfinder's instruments provide a daily weather report. The winds at Ares Vallis blow a gentle 5 meters per second, and temperatures have ranged from a low of about -90°C at night to a high of about -10°C during the day, says Tim



*Tracks left by Sojourner as it moved toward Barnacle Bill.*

Schofield of JPL.

Another set of measurements, which analyzed how quickly Pathfinder decelerated as it entered the Martian atmosphere, will be critical for planning maneuvers with the next craft to visit the Red Planet. Those measurements reveal that above 60 km, the craft encountered an atmosphere only one-fifth as dense as the Viking craft experienced at the same altitude. At lower altitudes, Pathfinder also recorded a lower density than Viking did, but the difference was not as great.

Mars Global Surveyor, launched last fall, is expected to enter orbit around Mars in September, but it won't begin monitoring the planet's climate until March. Surveyor will use atmospheric resistance—rather than a costly propulsion system—to move into a lower orbit.

With luck, Pathfinder and Sojourner will still be operating when Surveyor arrives. Even if they aren't, the July 4 landing is one for the history books. Message to Mars: We're back! —R. Cowen