Is there, was there, life on Mars?

by Marsha Freeman

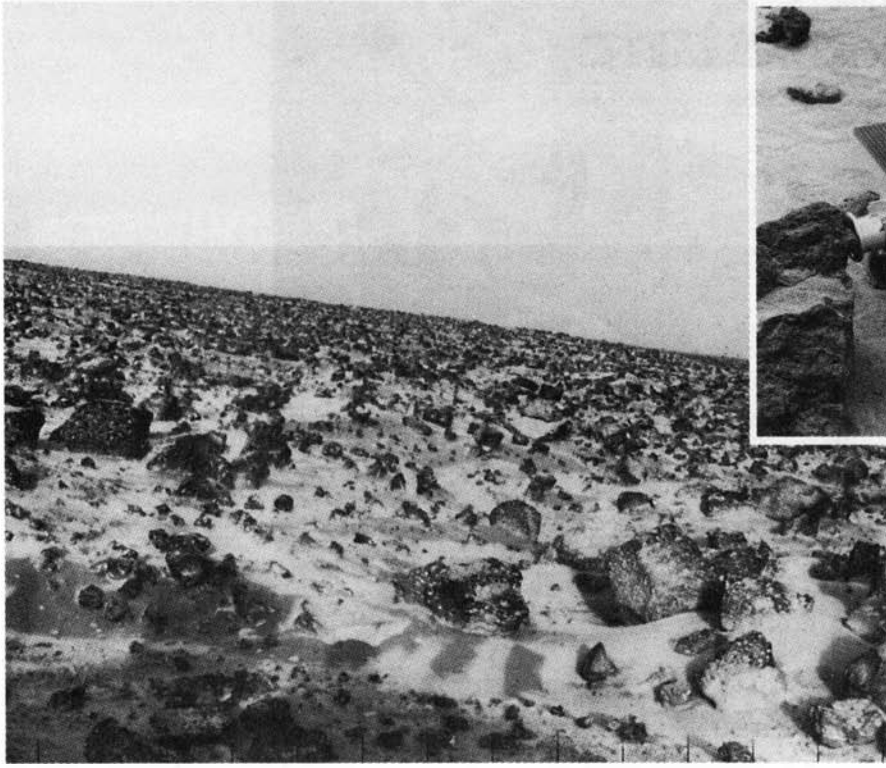
For over one hundred years, one of the most hotly debated questions in the world scientific community has been whether there was, and even could still be, life on Mars. In 1877, Italian astronomer Giovanni Schiaparelli pointed his telescope at Mars, and described features he saw on its surface as *canali,* by which he meant channels, but which was mistranslated as "canals." That error fueled the notion that sentient beings had constructed a series of waterworks on the red planet.

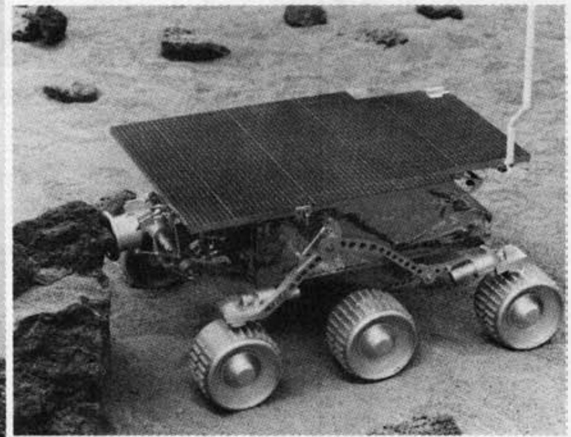
Even before that, there had been speculation that intelligent beings lived on Mars, and the great scientist Carl Gauss suggested one way to communicate with them, which was to plant trees in Siberia to form three squares, demonstrating to the Martians that the Earthlings understood the Pythagorean Theorem. Such speculation ended, however, when the Mariner 9 orbiter returned photographs of Mars, in 1971, showing no artifacts or other signs of intelligent life.

But the Mariner spacecraft revealed a fantastic planet that *could* have harbored life, in the past. Clear to any observer was evidence of a previously geologically active planet that had produced features such as volcanoes, including the largest one in the Solar System, Olympus Mons. Channels and dry lake beds, most likely formed by liquid water, indicated that in its past, Mars had been a wet, and, therefore, warmer planet, not all that different from the early Earth.

Over the decade following the arrival of the next visitors to Mars, the Viking landers and orbiters, in 1976, scientists continued to pore over the photographic evidence, as well as the results radioed back to Earth from the instruments aboard the four Viking spacecraft, to try to solve the mystery of whether there was life on Mars. Most experts closed the book on life on Mars when the Viking landers could not provide conclusive evidence that life exists on Mars today.

But in their paper on the evidence for early life on Mars from a meteorite, published in the Aug. 16 issue of *Science* magazine, the team of scientists led by David McKay and Everett Gibson, from the NASA Johnson Space Center, points out that no matter how one interprets the Viking results on the existence of life on





Scientists have determined that the only nonnegotiable prerequisite for life is water. This 1979 photograph of the Utopia Planitia region of Mars, taken by the Viking 2 lander, shows a thin coating of water ice on the rocks and the soil. The ice remained on the surface for 100 days. Inset: The 25-pound Sojourner rover will be the first vehicle to traverse another planet. The top of the vehicle is the solar panel that will power it.

Mars today, "the Viking results contained no information on possible fossils."

It is indeed ironic, that the Aug. 7 announcement by a team of scientists that they believe they have found evidence of life on Mars, was garnered from a piece of Mars that came here, rather than from spacecraft we have sent there.

There is general agreement, however, that the definitive answer to the question of whether there has been, and whether there is today, life on Mars, will require the transit of man to the planet, to search for himself.

Is there life on Mars today?

The initial investigations by researchers looking at the Viking data led to the conclusion that there is no life on Mars. Each of the two Viking landers had a pair of slow-scan cameras mounted about three feet apart. The cameras were capable of "seeing" objects big enough to be seen by the human eye, but in none of the hundreds of pictures relayed back to Earth could anyone discern any sign of life.

In 1984, two years after Viking stopped sending data back to Earth, NASA released its evaluation of the results, in a publication titled *Viking: The Exploration of Mars,* stating that "the cameras found nothing that could be interpreted as living."

Each lander also contained a Biology Instrument package, and a Gas Chromatograph/Mass Spectrometer (GCMS) to search for organic molecules, evidence of living things, in the Martian soil. Samples for the biology and chemical experiments were provided by the soil collector arm on Viking, which scooped up soil and delivered it to the chambers of the experiment.

Each sample was heated in a small oven, and the instruments measured the volatilized gases that were released, in a search for organic compounds—combinations of carbon, oxygen, hydrogen, and nitrogen—that are present in living matter on Earth. In its 1984 evaluation, NASA reported, that "to the surprise of almost every Viking scientist, the GCMS, which easily finds organic material in the most barren Earth soils, found no trace of any in the Martian sample."

But not every Viking scientist was satisfied with the conclusions drawn from the results. As exobiologist Penelope Boston wrote in 1993, "Is absence of evidence evidence of absence?" In the years since Viking ceased transmitting data, scientists have continued to use increasingly sophisticated processing technology to reevaluate the data. Similarly, the recent discovery of the tiny structures in the Martian meteorite was made when scientists used a new scanning electron microscope and other tools that became available only in the past few years.

On July 21-23, 1986, the NASA Mars Conference was held at the National Academy of Sciences in Washington, D.C., to commemorate the 10th anniversary of the Viking landing. Presentations that were given before more than 400 scientists and engineers, described the state of knowledge about Mars and the upcoming missions that were planned to further explore it, and also allowed scientists to air their

After the Mars Pathfinder lander is on the planet's surface, its air bags will deflate, and the three petals protecting the scientific instruments will open. Nestled on one of the petals will be the tiny Sojourner microrover (left petal), which will collect data and relay it back to the lander, for transmission to Earth.

differences in evaluating the Viking data.

In his highly controversial presentation on "A Reappraisal of Life on Mars," Dr. Gilbert Levin, a biochemist who had designed one of the instruments for the Viking landers, stated that he did not think that one of the tests, using the GCMS, which had produced negative results on organic material in the Martian soil, was adequate, or accurate. His, and colleague Dr. Patricia Straat's, Viking instrument, the Labeled Release experiment, had, in fact, indicated a partially positive response to the question of life on Mars. Their experiment took a sample of wetted Martian soil on Viking, labeled with a radioactive nutrient, and heated it to observe the evolution of gases emitted, to determine whether living organisms had ingested the food, and, one might say, "burped." The instrument yielded what Levin described as an "astonishing result."

On the other hand, Levin reported, he used an instrument similar to the GCMS to test soil samples from Antarctica, and this showed *no* signs of life, indicating that it was not as sensitive as scientists had believed. Therefore, Levin proposed, the possibility of there being life on Mars today cannot be ruled out; the Viking results were not conclusive.

Dr. Levin's departure from the mainstream on this issue of life on Mars helped encourage the following decade's search for the possibility that life *could* exist on Mars. Many exobiologists concluded that Viking was not necessarily looking in the right place.

In an article in the July/August 1996 issue of *Ad Astra* magazine, writer John Kross relates that a few years ago, there was a cartoon posted on a bulletin board at the Jet Propulsion Laboratory in California. It showed the Viking lander on the surface of Mars with its "electronic eyes vainly searching the horizon for signs of life. Nothing was to be seen. But out of view of the camera, a leafy vine curled unnoticed around the lander's leg."

While leafy vines are not to be expected, there are promising places to look for life on Mars.

The terrestrial analogues of Mars

During the Aug. 7 press conference on the finding of possible fossils in a Mars meteorite discovered in Antarctica, science team leader David McKay answered the question, what could have interrupted the evolution of the primitive life forms he thinks they have found, into higher forms of life? Dr. McKay responded: "Mars is a very inhospitable place right now, even for the kind of life forms that we think we see here. Such life forms could not exist on the surface. Mars lacks an atmosphere, except for about 7 millibars, a little bit of carbon dioxide atmosphere. There's no water on the surface."

"At some point in Mars' history," he said, "things went bad . . . in the sense that the atmosphere mostly disappeared, either into space, or it got locked up in carbonate rocks in the subsurface. And the water dried up, and some of that water went into space, some of it may still be there as ice, as permafrost, or even as a groundwater system. So the question is, what happened to this early life when things went bad? And it is one view that early life retreated under-ground, and may still be there."

NASA associate administrator for space science Wesley Huntress stated, at the same press briefing, that the discovery that life exists just about anywhere on Earth today "where there's a source of chemical energy and liquid water," leads one to ask, "why wouldn't it [life] have evolved also on other places in the early Solar System, where one might have had liquid water and sources of chemical energy?"

Today, Mars is a frozen planet, where the temperature stays below zero. The north and south poles are covered with water ice and frozen carbon dioxide, and the atmospheric pressure is so low, that when water evaporates from the polar caps, it does not become liquid, but sublimes directly into the atmosphere as a gas.

There are many theories about what happened to the once-plentiful flowing water on Mars, which has produced the channels, canyons, lake beds, and now-dry riverbeds that are visible today. Some of the water is clearly frozen at the poles. Some of it, undoubtedly, went into space. Ground ice, or permafrost, represents the greatest potential reservoir of water on Mars, and, according to some estimates, may indicate that there is liquid water deep within the planet.

While we are preparing for the more sophisticated unmanned, and then, manned, missions to go to the red planet for *in situ* research, there is another way that Earth-bound scientists can examine the history of life on Mars, beside investigating pieces of that planet that make their way to Earth.

Chris McKay, a physicist and exobiologist at the NASA Ames Research Center, has been approaching the question of whether primitive life developed earlier in the history of Mars, and whether or not it may still be there in some form, by looking for terrestrial, or Earth-based, analogues for the conditions that exist on Mars.

McKay has stated that when the results from Viking first came in, in 1976, he could not understand why, if the chemical ingredients for life were there, no life was found. He later determined that only one ingredient for life—water—is "nonnegotiable," and water was not present, at least not in the dry regions from which the Viking landers examined their samples. McKay has described water as a "metaphor for life."

McKay and his colleagues have been exploring places on Earth that share some of the extreme characteristics of Mars, in order to observe how life emerged, how it has survived in hostile environments, and what mechanisms can be used to discover more about Mars. This has taken him to Siberia, the Antarctic, and under the sea.

In 1990, McKay made his first expedition to northeastern Siberia, along with members of the Soviet Academy of Sciences, to explore what he termed the "best terrestrial analogue to the Martian permafrost." Freezing conditions have persisted in Siberia for over 3 million years, where temperatures fluctuate between 10 and 14°F.

Preserved in the ice, about 30 feet under the surface, the scientists found large numbers of bacteria, which, when thawed out, resumed their life functions. As McKay remarked in an interview with *Omni* magazine in 1992, "On Earth, wherever there's a niche that life can expand into, it

Meteorite trove in Antarctica

The first discovery that there were concentrations of meteorites in the Antarctic was made by Japanese scientists in 1969. Since that time, more than 16,000 pieces of meteorites have been collected in Antarctica, and since 1977, frozen meteorites have been returned to NASA's Johnson Space Center Meteorite Processing Laboratory for curation, and distribution to scientists for study. Scientists at the Johnson Space Center gained experience in extraterrestrial geology, by studying the rocks brought back from the Moon by the Apollo astronauts.

The meteorites, which are pieces of rock from space, have been preserved in the ice of Antarctica and are concentrated in areas characterized by stagnant, snow-free "blue ice." It is estimated that most of them fell to the Earth over the past 1 million years.

Most of the fragments are of asteroids, from the "belt" made up of pieces of an exploded planet between Mars and Jupiter. The two classes of meteorites that can definitely be classified by their origin are those from the Moon and Mars, because they can be matched against the rocks brought back from the former, and the chemical composition of the atmosphere of the latter, as determined by the Viking landers.

The annual hunt for meteorites in Antarctica is a joint endeavor by the National Science Foundation, the Smithsonian Institution, and NASA. The annual meteorite field visit to Antarctica by the United States is led by Dr. Ralph Harvey, a planetary geologist from the University of Tennessee.

Last year, Harvey noted that a Martian rock that he is studying—one of 12 found in Antarctica—contained carbonate, an unusual mineral for a meteorite. He said that the find had "staggering implications," in that the material would have been deposited by fluids travelling through the Martian crust. Such analyses can give scientists a new window on the development of the planet's climate, over billions of years. The Antarctic meteorites, Harvey said, provide "new and exciting ideas about our Solar System."—*Marsha Freeman* does." McKay and the other American members of the team proposed that even if the Martian climate today is unsuited for life, based on what they discovered in Siberia, the frozen soil could be a treasure trove, because it is "ideal for preserving frozen samples."

Teams of scientists have also made trips to one of the coldest place on Earth—Antarctica—in search of Martian conditions that could shed light on the possibilities of life on Mars. The largest ice-free expanses on the continent are the dry valleys, where the average temperature is –4°F, and where there is less precipitation than in the Gobi Desert. Several years can go by without there being as much as snow flurries. Nothing lives on the surface.

Although there did not initially appear to be any life in this region, closer inspection has revealed that below the surface, in crevices on the north-facing (sunny) side of sandstone rocks, there are layers of lichen and bacteria that receive sunlight through the translucent rocks. Minute amounts of water, generated from occasional snows, get trapped in the pores of the rock, and are used by the organisms.

The other major habitat for life in the Mars analogue in the Antarctic, is below the perennial 13- to 16-foot-thick ice cover of the floors of the dry valleys. The dry valley floor is ice, 60 to 120 feet thick, but under its surface are lakes that are 90 to more than 200 feet deep. Here, algae, diatoms, and other microbial life forms live in the water, under the ice, where they are protected from the cold, dry conditions above.

Microbes on Earth have been found living in boiling hot springs, on the sides of active volcanoes, in hydrogen sulfide-rich geothermal springs, in acidic pools of mine-tailings, in the depths of the oceans near hot vents, in deep aquifers under the Savannah River Nuclear Plant in South Carolina, and other extreme environments, which, until recently, would have been excluded from consideration in a search for life.

In October 1995, the Pacific Northwest Laboratory issued a press release titled, "SLiME at Hanford Hints at Potential for Microbes on Mars." It reports on the discovery of a microbial ecosystem, called a "subsurface lithoautotropic microbial ecosystem," or SLiME, found in groundwater samples, thriving on chemical energy in basalt rock, more than 3,000 feet below the surface, at the Department of Energy's Pacific Northwest Laboratory.

Commenting on the find, Chris McKay described these organisms, which use carbon dioxide and hydrogen as an

Pathfinder could find signs of a warmer Mars

In an interview with the editor of the German-language Fusion *magazine, Dr. Jonathan Tennenbaum, on July 18, Pathfinder project scientist Matthew Golombek described the region of Mars the Pathfinder rover will explore, after it arrives there on July 4, 1997:*

This will be the first rover to be on the surface of a different planet. There have been rovers on the Moon, of course, but never on Mars. The two previous [Viking] landers just had little arms that poked out, but no mobility.

The main goal of our mission is "ground truth." Imagine seeing a cornfield from orbit. In order to really know that it is corn, you need to go down there and look at it. We are going to go down, and we have a rover with a suite of instruments, designed to look at the rocks, basically. You may not think rocks are very interesting, but, in fact, rocks are like old blueprints of how they formed; what the environment was when that material formed. And so, we're landing at the mouth of a giant catastrophic outflow channel, [Ares Vallis], that could have a whole variety of rock types.

This is a location where enormous volumes of water coursed through the surface in a very short period of time. An analogy would be to take all the water in the Great Lakes and rush it to the ocean in about a two-week period. . . . This has happened on Earth, where large lakes have been dammed by loads of the ice sheet in the last ice age, and when the ice dam broke, the water drained in a very short period of time.

The idea is that there could be a whole variety of rock types there, and we have instruments [on the rover] that will go and look at the rocks and determine the environment, and how they formed. The areas that this channel came from is all the ancient heavily cratered terrain on the planet, and actually a whole variety of different terrains that we've seen from orbit. And the idea is that [on] early Mars, the environment could have been much more suitable—both warmer and wetter—for the formation of life.

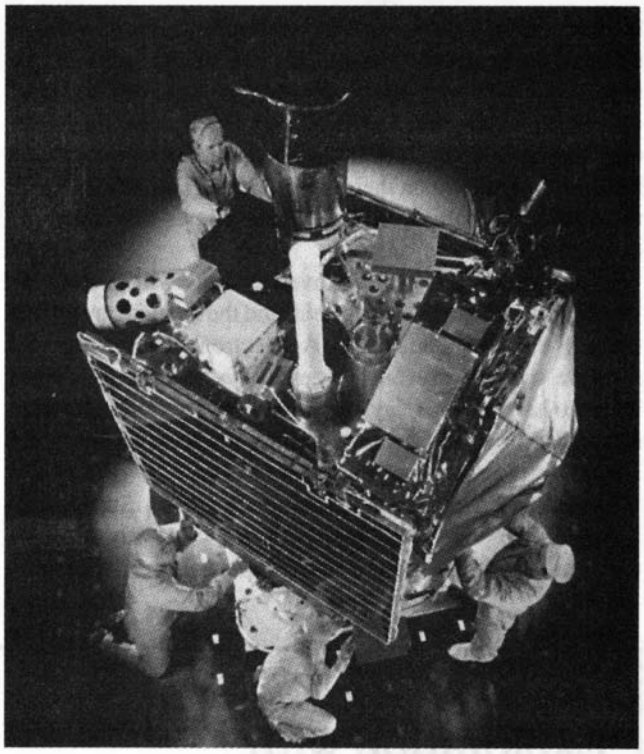
We hope to learn about the environment early on in the planet's history—how the planet differentiated, how the crust formed, how the weathering products have developed.

And if we find evidence of liquid water, that would be quite amazing, because it would indicate that at a time on the Earth when life got started, about 4 billion years ago, there could have been a similar environment on Mars. . . . Pathfinder won't give us all the answers, right away, but we're going to be able to address those questions, and, hopefully, over a series of missions, we can begin to address them and learn about it.

energy source, and live independently of the surface biosphere, as "exactly the system we have postulated for Mars." They can live below the surface, without light, in an oxygen-free environment.

"The basalt connection," the report states, "in theory, also indicates that microbes could exist in the Martian subsurface," assuming that there is liquid water there. "This does not mean there is life on Mars," the release cautions, "but if SLiME can exist here, then, in theory, it could exist on Mars, too."

John Rummel, director of Research Administration and Education Programs at the Marine Biological Laboratory at Woods Hole, Massachusetts, told writer John Kross, as reported in the current issue of *Ad Astra,* that there may well be liquid water below the permafrost on Mars. There are "a number of outflow features on Mars consistent with a meteorite impact piercing the permafrost layer and releasing large amounts of water," which would be evidence of subsurface water resources. "There is nothing in biological terms that precludes life on Mars existing below the surface," he concluded.



Because the Martian atmosphere is so thin, spacecraft hardware has to be tested in a vacuum chamber. Here, workmen ready the Mars Global Surveyor for testing. It will carry duplicates of five of the instruments that were on the Mars Observer, which failed just before orbiting the planet, in 1993.

The next small steps to Mars

The demoralization that resulted in much of the scientific community, when the Viking data seemed to indicate negative findings for life, has been dramatically reversed, through the new evidence of fossil remains from Martian meteorites.

NASA did not abandon the red planet after Viking, but turned the focus of its investigation away from life on the planet, and toward a more global understanding of Mars. The highly capable Mars Observer was launched on Sept. 25, 1992, but the spacecraft lost contact with Earth on Aug. 21, 1993, three days before its insertion into Mars orbit. Mars Observer was not going to land on Mars, but to orbit the planet as a kind of extraterrestrial Landsat remote-sensing system, to provide further detail on the topography and mineral distribution, as well as the global weather, on Mars.

In order to accomplish the scientific objectives of the Mars Observer, but within a very limited budget, NASA has scheduled a series of small Mars Surveyor missions, which will fly Mars Observer instrument spares, or similar equipment, on a series of spacecraft.

The first launch will be in November of this year, and is the Mars Global Surveyor. The scientific objectives involve high resolution imaging of the surface, studies of the topography and gravity, the role of water and dust on the surface and in the atmosphere of Mars, the weather and climate of Mars, the composition of the surface and atmosphere, and the existence and evolution of the Martian magnetic field.

The Mars Global Surveyor will arrive at Mars in September 1997 after a 10-month cruise phase. After four months, aerobraking (using the atmospheric drag of Mars) and thrusters will convert its elliptical capture orbit into a nearly circular two-hour orbit. Mapping operations will begin in January 1998.

The spacecraft will be in a polar, or "Sun-synchronous," orbit, so that each image will be taken with the Sun at the same mid-afternoon azimuth, similar to Earth-orbiting remote-sensing spacecraft. Data will be acquired for one Martian year, or approximately two Earth years. The spacecraft will also be used as a data relay for later U.S. and international missions over the following three years.

The Mars Global Surveyor includes six primary investigations. The Mars Orbital Camera will take high-resolution images, on the order of one meter, of surface features. It will also take lower resolution images of the entire planet over time, to enable research into the temporal changes in the atmosphere and on the surface.

The Thermal Emission Spectrometer is an interferometer that will measure the infrared spectrum of energy emitted by a target. This information will be used to study the composition of rock, soil, ice, atmospheric dust, and clouds. The Mars Orbital Laser Altimeter will measure the time it takes for a transmitted laser beam to reach the surface, reflect off the surface, and return. This time will allow the calculation of the distance, and hence the height, of objects on the surface. Combining these measurements will result in a topographic map of Mars.

The Radio Science Investigations will measure the

Doppler shift of radio signals sent back to Earth to allow the precise determination of changes in the orbit of the spacecraft. This will allow scientists to construct a model of the Mars gravitational field. As the spacecraft passes over the poles on each orbit, radio signals pass through the Martian atmosphere on their way to Earth. The way in which the atmosphere affects these signals allows determination of its physical properties.

The Magnetic Fields Investigation will determine whether Mars has a magnetic field, and the strength and orientation of the field, if one exists. An electron reflectometer will measure remnant crustal magnetization, and the spacecraft will also have a radio relay system to relay scientific data from the landers that will be deployed by the Russian Mars '96 mission, and future Mars Surveyor landers.

Less than a month after the Mars Global Surveyor is launched, the Mars Pathfinder will be on its way to Mars, taking a shorter path, and arriving before its orbital partner. The Pathfinder will be the first spacecraft to land on Mars in 20 years, and the first one to deploy a rover there.

Because, as part of NASA's Discovery Program, the cap on the cost of the mission is $150 million, new, and somewhat daring, techniques were incorporated into Pathfinder's mission. The mission is primarily an engineering demonstration of key new technologies and concepts, for use in future rover missions to Mars.

Upon arrival at Mars, the spacecraft will enter the Martian atmosphere, and deploy a parachute to help slow its descent. Then, four huge air bags will inflate to surround the lander, to cushion it during a relatively hard landing, which will be at about 35 miles per hour. At a height of about 330 feet, three solid rocket motors, placed inside the top half of the entry vehicle above the lander, will be fired to stop the descent, and the lander will fall to the ground, bouncing and rolling until it stops.

Within an hour of landing on the surface of Mars, the air

Exploration with humans and robots

In a series of interviews with Mars mission scientists, Jonathan Tennenbaum asked Dr. Steven Squyres, from Cornell University, about the limitations of robots in exploration, compared to sending humans. Dr. Squyres responded with an example from his own experience:

I think that the appropriate strategy to adopt is to let robots do what robots do best, and let humans do what humans do best. And have the two work together in . . . the most efficient fashion. What comes to my mind is an experience I had once when I was doing some field work in Antarctica.

I am interested in this problem of lakes on early Mars, and what those environments might have been like. And in the dry valleys of Antarctica, there is a region where there are some lakes that are covered with about four or five meters of ice year-round. So we were studying those lakes. It's a very hostile environment; a very cold place to work, and certainly trying to get into the water column to the bottom of the lakes is a very difficult thing to do.

We had two ways of exploring the bottom. Once we put holes through the ice, we could either put on scuba equipment and go down to the bottom and dive there ourselves, or we could use a small robotic vehicle which we had with us, and put that down and it could dive for us and explore the bottom. We could control it remotely from the surface. We had the opportunity for both human and robotic exploration open to us.

To put a human there is very, very costly and difficult. You have all the life support systems associated with scuba, you have to worry about tanks, you have to worry about compressors that compress the air—it's difficult, it's dangerous, it's time-consuming, and you don't want to do a lot of it if you don't have to. In contrast, the rover, the ROV—the remotely operated vehicle—was much easier to operate, but much less capable.

So once we put a dive hole in, the first thing would be to put the robot down the hole, and we would spend hours surveying the bottom, finding out, basically, what it looks like, making some simple, first-order measurements, doing a simple, basic reconnaissance without using the precious dive resources that we had. Then, once we had answered the simple, first-order questions, and we had really focussed on what the key difficult scientific questions were that the robot couldn't answer, then we put the humans down the hole.

You would answer the questions you went down there to answer, plus, you could look and you could see the environment around you, you could touch it, you could observe it, you could very rapidly formulate a hypothesis and test it right there on the spot, which a robot can't do or certainly can't do very well. And it was only by putting humans in the environment that we really understood it. If we had only the robots to go on, we would have made a lot of mistakes, we would have gotten a lot of things wrong. But, if we had tried to put the humans down first, without doing the robots before them, the humans would not have been able to use the time nearly as efficiently and we wouldn't have come away with this much.

bags will be deflated and partially retracted toward the lander. Pathfinder will then open its three metallic petals, stand itself right side up, if necessary, and then engineers will instruct the rover to drive off and begin exploring the immediate surroundings.

The diminutive rover is named Sojourner, after African-American Isabella Van Wagner, who, as Sojourner Truth, travelled around the United States during the Civil War, advocating the abolition of slavery as well as women's rights. Sojourner, which weighs a mere 25 pounds, will be deployed to roam across an ancient Martian flood plain, using an autonomous navigation system.

The primary mission of the rover, to be accomplished within the first seven days of deployment, is a combination of engineering try-out tasks and scientific requirements. Barring unforeseen inclement weather or other circumstances, the rover is planned for deployment between 10 a.m. and 2 p.m. (Mars time) each day, and will do more extended missions farther from the lander, for 30 days. Since it has solar panels, and, therefore, will not run out of fuel, scientists expect it to operate for a longer period of time. The communications range of the rover is about 1,640 feet (500 meters), a distance it would take it a few weeks to achieve.

The Sojourner rover has cameras fore and aft, and an Alpha-Proton X-Ray Spectrometer. The APXS will be capable of determining the elemental composition of rocks it encounters. Such information can yield the mineralogy of the rocks, and specially filtered cameras will aid in the identification of specific minerals. One thing scientists hope to find are aqueous deposits, or minerals that were deposited by standing bodies of water, to tell them about the history of water on Mars.

The lander will make atmospheric and meteorological observations during its descent through Mars' atmosphere, and will function as a weather station on the surface of the planet. Its Atmospheric Structure Instrument/Meteorology Package includes temperature, pressure, and wind sensors. The lander will also relay data to Earth from the microrover.

Cameras on the lander, which will "see" at about human eye-level above the surface, have filters to aid in geological studies. The cameras can be rotated, to provide a nearly complete view of the lander and the Martian surface.

NASA currently has plans for two spacecraft for each 26-month window of opportunity for launches from the Earth to Mars, with increasing sophistication and difficulty of tasks. The focus of the 1998 orbiter will be on Martian climate, for example, and include an ability to conduct active soundings into the atmosphere to measure pressure and temperature.

There is also a panoply of Russian, and one Japanese, Mars missions planned. The Europeans have long proposed an InterMarsNet series of landers to function as a global on-the-ground observation system.

In 1993, representatives of most of the world's space agencies met in Germany to discuss coordination of future Mars missions. At that time, the International Mars Exploration Working Group was formed. The InterMarsNet program it favored, was to include four stations on the surface, with three in the northern hemisphere of Mars, forming a triangle. The fourth would be farther north. Three of the landers would be provided by NASA, as part of its Mars Surveyor mission in the year 2003.

Each station would deploy a seismometer and a meteorological station, and would carry instruments for geochemical analysis of the surface, and panoramic cameras. The lifetime of the mission was two Earth years (one Mars year).

But, at the meeting of the European Space Agency's Space Science Advisory Committee in Paris last April, InterMarsNet was passed over for an astrophysics satellite. However, it is possible that InterMarsNet will be chosen as the science mission following that, for a launch possibly in the year 2005.

Currently, the future unmanned missions to Mars, which have been sketched out in general form by NASA scientists and mission planners, are undergoing scrutiny and may be revised, following the Aug. 7 announcement that life may have developed on early Mars. This finding certainly adds urgency to the task of finding out as much as possible, from robotic representatives of man's intelligence that we send to Mars, in preparation for going there ourselves.