

MARS

Of all the planets, Mars has long been considered the solar system's prime candidate for harboring extraterrestrial life. Astronomers studying the red planet through telescopes saw what appeared to be straight lines crisscrossing its surface. These observations (later determined to be optical illusions) led to the popular notion that intelligent beings had constructed a system of irrigation canals on the planet. In 1938, when Orson Welles broadcast a radio drama based on the science fiction classic *War of the Worlds* by H.G. Wells, enough people believed in the tale of invading martians to cause a near panic.

Another reason for scientists to expect life on Mars had to do with the apparent seasonal color changes on the planet's surface. This phenomenon led to speculation that conditions might support a bloom of martian vegetation during the warmer months and cause plant life to become dormant during colder periods.

So far, six American missions to Mars have been carried out. Four Mariner spacecraft, three flying by the planet and one placed into martian orbit, surveyed the planet extensively before the Viking Orbiters and Landers arrived.

Mariner 4, launched in late 1964, flew past Mars on July 14, 1965, within 9,846 kilometers (6,118 miles) of the surface. Transmitting to Earth 22 close-up pictures of the planet, the spacecraft found many craters and naturally occurring

channels but no evidence of artificial canals or flowing water. Mariners 6 and 7 followed with their flybys during the summer of 1969 and returned 201 pictures. Mariners 4, 6 and 7 showed a diversity of surface conditions as well as a thin, cold, dry atmosphere of carbon dioxide.

On May 30, 1971, the Mariner 9 Orbiter was launched on a mission to make a year-long study of the martian surface. The spacecraft arrived five and a half months after liftoff, only to find Mars in the midst of a planet-wide dust storm that made surface photography impossible for several weeks. But after the storm cleared, Mariner 9 began returning the first of 7,329 pictures; these revealed previously unknown martian features, including evidence that large amounts of water once flowed across the surface, etching river valleys and flood plains.

In August and September 1975, the Viking 1 and 2 spacecraft, each consisting of an orbiter and a lander, lifted off from Kennedy Space Center. The mission was designed to answer several questions about the red planet, including, is there life there? Nobody expected the spacecraft to spot martian cities, but it was hoped that the biology experiments on the Viking Landers would at least find evidence of primitive life - past or present.

Viking Lander 1 became the first spacecraft to successfully touch down on another planet when it landed on July 20, 1976, while the United States was celebrating its Bicentennial. Photographs sent back from Chryse Planitia ("Plains of Gold") showed a bleak, rusty-red landscape. Panoramic images returned by Viking Lander 1 revealed a rolling plain, littered with rocks and marked by rippled sand dunes. Fine red dust from the martian soil gives the sky a salmon hue. When Viking Lander 2 touched down on Utopia Planitia on

September 3, 1976, it viewed a more rolling landscape than the one seen by its predecessor, one without visible dunes.

The results sent back by the laboratory on each Viking Lander were inconclusive. Small samples of the red martian soil were tested in three different experiments designed to detect biological processes. While some of the test results seemed to indicate biological activity, later analysis confirmed that this activity was inorganic in nature and related to the planet's soil chemistry. Is there life on Mars? No one knows for sure, but the Viking mission found no evidence that organic molecules exist there.

The Viking Landers became weather stations, recording wind velocity and direction as well as atmospheric temperature and pressure. Few weather changes were observed. The highest temperature recorded by either spacecraft was -14 degrees Celsius (7 degrees Fahrenheit) at the Viking Lander 1 site in midsummer.

The lowest temperature, -120 degrees Celsius (-184 degrees Fahrenheit), was recorded at the more northerly Viking Lander 2 site during winter. Near-hurricane wind speeds were measured at the two martian weather stations during global dust storms, but because the atmosphere is so thin, wind force is minimal. Viking Lander 2 photographed light patches of frost, probably water-ice, during its second winter on the planet.

The martian atmosphere, like that of Venus, is primarily carbon dioxide. Nitrogen and oxygen are present only in small percentages. Martian air contains only about 1/1,000 as much water as our air, but even this small amount can condense out, forming clouds that ride high in the atmosphere or swirl around

the slopes of towering volcanoes. Local patches of early morning fog can form in valleys.

There is evidence that in the past a denser martian atmosphere may have allowed water to flow on the planet. Physical features closely resembling shorelines, gorges, riverbeds and islands suggest that great rivers once marked the planet.

Mars has two moons, Phobos and Deimos. They are small and irregularly shaped and possess ancient, cratered surfaces. It is possible the moons were originally asteroids that ventured too close to Mars and were captured by its gravity.

The Viking Orbiters and Landers exceeded by large margins their design lifetimes of 120 and 90 days, respectively. The first to fail was Viking Orbiter 2, which stopped operating on July 24, 1978, when a leak depleted its attitude-control gas. Viking Lander 2 operated until April 12, 1980, when it was shut down due to battery degeneration. Viking Orbiter 1 quit on August 7, 1980, when the last of its attitude-control gas was used up. Viking Lander 1 ceased functioning on November 13, 1983. Despite the inconclusive results of the Viking biology experiments, we know more about Mars than any other planet except Earth.

* Mars ground-based observations detected water vapor on Mars in 1964.

* Mariner 4 flew past Mars in 1965 and photographed a heavily cratered, moonlike surface.

* Mariner 4 found that the Martian atmosphere is thin, with less than 1 percent

the pressure of the Earth's atmosphere, and is composed largely of carbon dioxide.

* The Mariner 6 and 7 flybys took place in 1969. Instruments on these spacecraft found that nitrogen is virtually absent from the atmosphere and that solid carbon dioxide ("dry ice") occurs in the clouds and near the polar caps.

* Mariner 6 and 7 found that the dust particles in the Martian atmosphere probably consist of silicate materials derived from the planetary surface.

* The first soft landing on Mars was executed by the USSR Mars 3 spacecraft in 1971; the spacecraft ceased operating 20 seconds after the landing.

* Mariner 9 became the first Mars-orbiting spacecraft in 1971. It obtained over 7300 photographs. Among the results of this mission were:

* Mars is actually a two-part world, with an ancient cratered surface in the Southern Hemisphere and a geologically younger surface, with volcanoes, canyons, and dry river channels, in the Northern Hemisphere.

* The Martian volcanoes include a few huge ones, rising to heights of as much as 25 kilometers (16 miles), with fresh-looking lava flows.

* Mars has a huge valley (Vallis Marineris), about 5000 kilometers (over 3000 miles) long.

* Sinuous channels, with braided and streamlined formations, appear to be former river beds.

* Landforms resembling lava flows occur in flat regions.

- * There are layered deposits in the Martian polar regions, perhaps indicating glacial periods in past times.
- * Solar ultraviolet light is not absorbed by the atmosphere and hence reaches the surface of Mars.
- * Periodic global dust storms were observed in detail.
- * The two small moons of Mars were photographed and found to be very dark and to have irregular shapes and cratered surfaces.
- * The Viking 1 and 2 landers and orbiters reached Mars in 1976. Among their many findings were:
 - * The highly oxidized soil produced unique chemical reactions in the life detection instruments (see Appendix section on Exobiology).
 - * The reddish color of the soil is due to oxidized iron.
 - * The soil is fine-grained and cohesive, like firm sand or soil on Earth.
 - * The surface rocks resemble basalt lava, and the soil chemistry is like that of weathered, altered basalt.
 - * There are water and sulfur compounds in the soil.
 - * The sky is not blue but pink, its color caused by fine suspended particles of red dust.
 - * The polar caps are largely made of water ice.
 - * The winds at the surface of Mars are light, about 24 kilometers per hour (15

miles per hour).

- * The surface temperature ranges from about -84°C (-120°F) at night to -29°C (-20°F) in the afternoon.
- * Fog and clouds occur despite the fact that the water content of the atmosphere is less than 0.1 percent that of the air on Earth.
- * The surface pressure of the atmosphere, only about 0.8 percent that of the Earth's atmosphere, varies seasonally in accord with the evaporation of the polar caps.
- * The isotopic ratios of carbon and oxygen in the Martian atmosphere resemble those of the Earth's atmosphere.
- * The atmosphere has been modified over time by the escape of nitrogen to space; this has produced nitrogen isotopic ratios that differ from those on Earth.
- * Mars may have had a much denser atmosphere in the past, and could have had liquid water on its surface.
- * The abundances of rare gases such as argon and neon suggest that Mars has a lower volatile content than either the Earth or Venus.
- * The Martian moons are grooved, indicating that fracturing may have occurred; they may be asteroids that were captured by Mars.
- * Mars is the Roman god of war.
- * This planet has a red color to it.

- * Mars is the fourth planet from the Sun.
- * Mars has two moons, Phobos, 16.7 miles in diameter and Deimos, 9.3 miles in diameter.
- * Mars travels around the Sun every 687 Earth days.
- * One Martian day is 24 hours and 37 minutes long.
- * Mars' gravity is about one-third (.38) that of Earth.
- * The diameter of Mars is 4,212 miles.
- * There have been six U.S. missions to the planet Mars.
- * The first American soft landing on the surface of another planet was on July 20, 1976, by the Viking spacecraft.
- * There are strong winds (200-300 mph) on the surface of Mars.
- * The high and low surface temperature at Vikings 1 and 2 landing sites ranged from -17° F (maximum high) to -191° F (maximum low).
- * Evidence indicates that there was surface water on Mars in the past.
- * Mars' atmosphere is primarily carbon dioxide (thin).
- * The planet has ice caps of frozen carbon dioxide (dry ice).
- * The long valley on Mars' surface, Valles Marineris, is 3,100 miles long and 310 miles across.
- * Mars' high mountain, Olympus Mons, has a base the size of Missouri.

* Mars has a rocky interior that's low in metal (iron sulfide).

Source: NASA