Fifty Years of Exploration –

MISSIONS TO MARS

By Henry M. Holden

NASA'S VIKING Project found a place in history when it became the first US mission to land a spacecraft safely on the surface of Mars and return images of the surface.

Two identical spacecraft, each consisting of a Lander and an Orbiter, were built. The orbiters photographed the surface of Mars from orbit, and the Landers studied the planet from the surface. The orbiters also served as communication relays for the Landers once they touched down.

NASA's Viking Project was the conclusion of a series of missions to explore Mars that began in 1964, with Mariner 4, and continued with the Mariner 6 and 7 flybys in 1969, and the Mariner 9 orbital mission in 1971 and 1972.

After studying orbiter photos, the Viking site certification team considered the original landing site proposed for Viking 1 unsafe. The team examined nearby sites, and Viking 1 landed on Mars in July 20, 1976, on the western slope of Chryse Planitia (the Plains of Gold)

The site certification team also decided the planned landing site for Viking 2 was unsafe after it examined high-resolution photos. Certification of a new landing site took place in time for a Mars landing, on September 3, 1976, at Utopia Planitia.

The Viking missions were planned to operate for 90 days after landing, but each orbiter and lander operated far beyond its design lifetime. Viking Orbiter 1 exceeded four years of active flight operations, ending its mission on August 7, 1980.

On August 20, 1975, Viking 1 was launched by a Titan/Centaur rocket from Complex 41 at Cape Canaveral Air Force Station, in Florida, to begin a half-billion mile, one-month journey through space to explore Mars. The four-ton spacecraft went into orbit around the red planet in mid-1976. (Photo: NASA)

The Viking Project's primary mission ended on November 15, 1976, eleven days before Mars' superior conjunction (its passage behind the Sun), although the Viking spacecraft continued to operate for six years after first reaching Mars. After conjunction, in mid-December 1976, controllers re-established telemetry and command operations, and began extended mission operations.

The first spacecraft to cease functioning was Viking Orbiter 2, on July 25, 1978; the spacecraft had used all the gas in its attitude one - control system, which kept the craft's solar panels pointed at the Sun to power the orbiter. When the spacecraft drifted off the Sun line, the controllers sent commands to shut off power to Viking Orbiter 2's transmitter.

Viking Orbiter 1 began to run short of attitude control gas in 1978, but through carefully conserving the remaining supply, engineers found it possible to continue acquiring science data at a reduced level for another two years. The gas supply was finally exhausted and Viking Orbiter 1's electrical power was commanded off on August 7, 1980, after 1 489 orbits of Mars. The last data from Viking Lander 2 arrived at Earth on April 11, 1980. Lander 1 made its final transmission to Earth on November, 11, 1982. Controllers at JPL tried unsuccessfully for over six months to regain contact with Viking Lander 1. The overall mission came to an end on May 21, 1983.

VIKING ORBITERS

Each of the two orbiters, weighed 2 325 kilograms (5 125 pounds) with fuel. Each orbiter carried a lander, weighing 576 kilograms (1270 pounds), and their design was greatly influenced by the size of the landers.

The orbiters were a follow-on design to the Mariner class of planetary spacecraft with specific design changes for the 1976 surface mission.

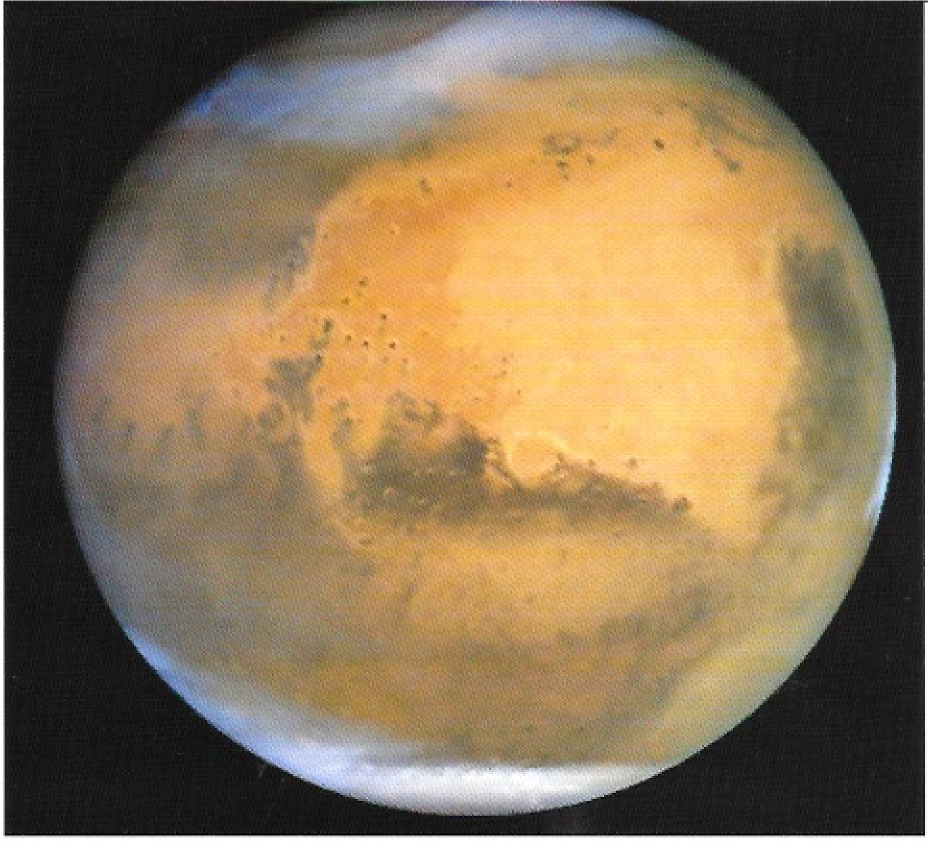
Operational lifetime requirements for the orbiters were 120 days in orbit and 90 days after landing. The combined weight of the orbiter and lander was one factor that contributed to an 11-month transit time to Mars, instead of the five months for Mariner missions. The longer flight time then dictated an increased design life for the spacecraft, larger solar panels to allow for longer degradation from solar radiation and additional attitude control gas.

The orbiter was 3,3 metres high and 9,7 metres across the extended solar panels. With fuel, the orbiters weighed in excess of 2 300 kilograms (5 000 pounds).

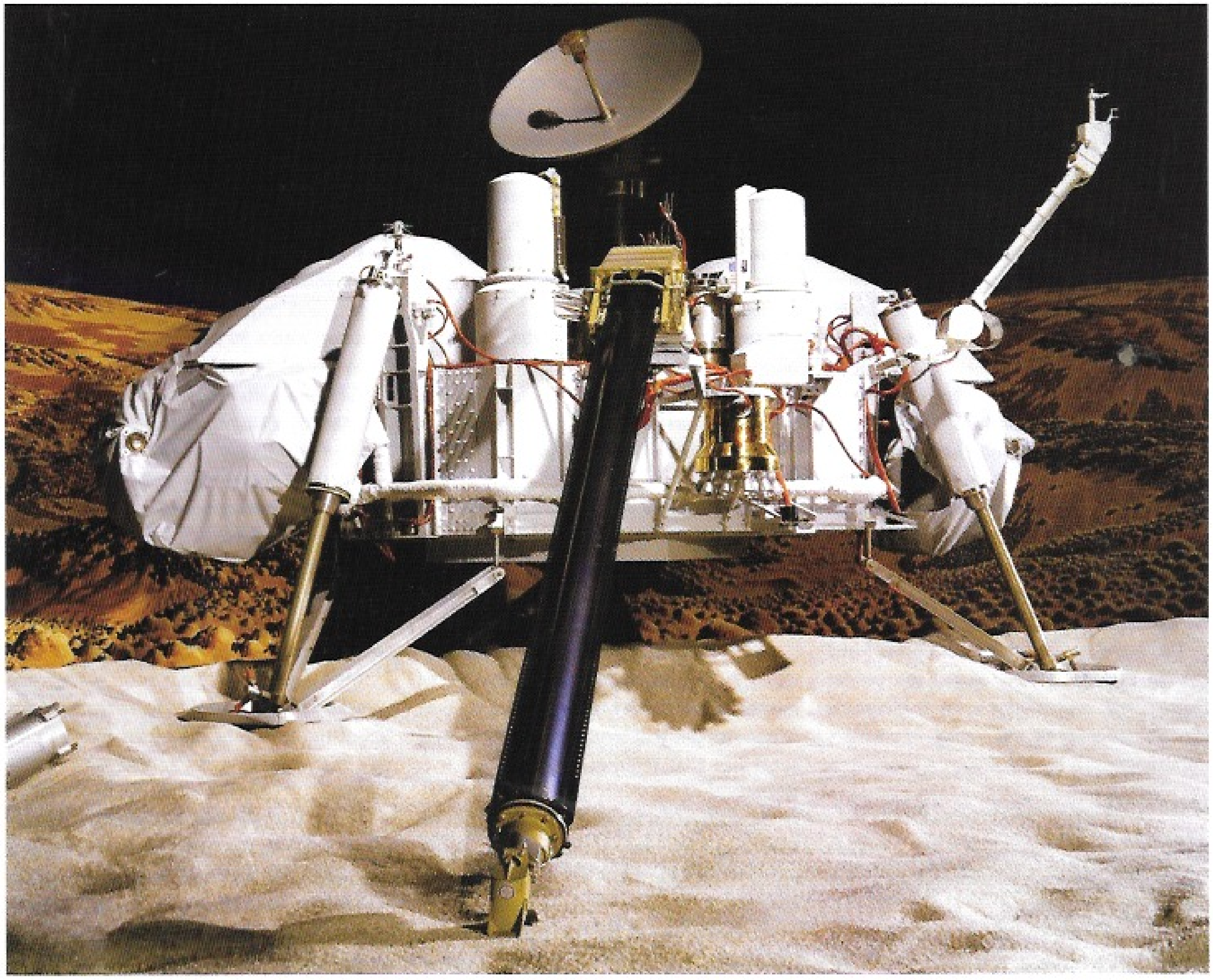
Combined area of the four panels was 15 square metres, and they provided both regulated power and unregulated direct current power for the radio transmitter and the Lander.

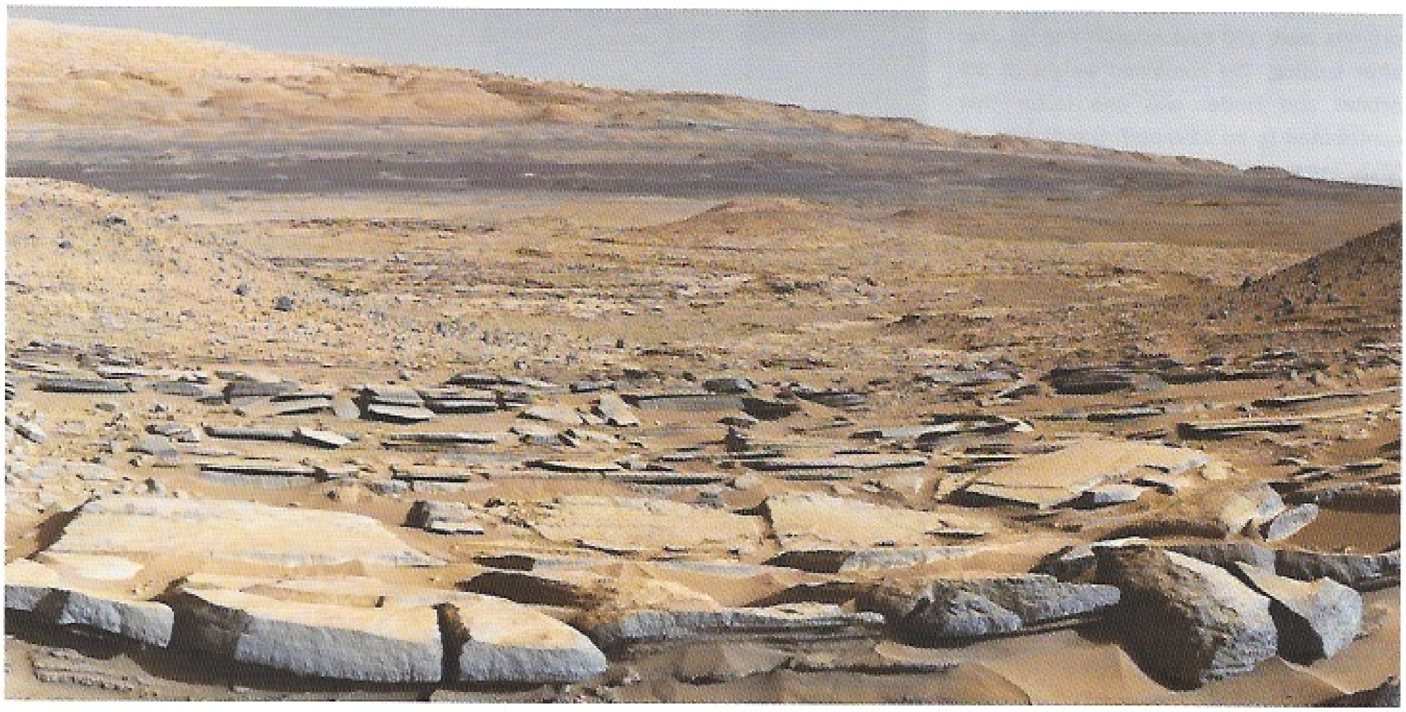
Two 30-amp-hour, nickel-cadmium, rechargeable batteries provided power when the spacecraft was not facing the Sun during launch, correction manoeuvres and Mars occultation.

The orbiter was stabilised in flight by locking on to the Sun for pitch and yaw references and on to the star Canopus for roll reference.



Above: *NASA's Hubble Space Telescope took the picture of Mars on June 26, 2001, when Mars was approximately 68-million kilometres from Earth — the closest Mars has ever been to Earth since 1988. Hubble can see details as small as 16 kilometres across.*
Below: *An artist's rendition of Viking 1 lander on Mars.* (Photos: NASA)





A view from the "Kimberley" formation on Mars taken by NASA's Curiosity rover. The strata in the foreground dip towards the base of Mount Sharp, indicating flow of water toward a basin that existed before the larger bulk of the mountain formed. (Photo: NASA/JPL-Caltech/MSSS)

VIKING LANDER

The Lander spacecraft was composed of five basic systems: the Lander body, the bioshield cap and base, the aeroshell, the base cover and parachute system, and Lander subsystems. The completely outfitted lander measured approximately three metres across and was about two metres tall. It weighed about 576 kilograms without fuel.

The Lander and all exterior assemblies were painted light gray to reflect solar heat and, to protect equipment from abrasion, the paint was made of rubber based silicone.

The body was a basic platform for science instruments and operational subsystems. It was a hexagon-shaped box built of aluminium and titanium alloys, and was insulated with spun fibreglass and Dacron cloth to protect equipment and to lessen heat loss.

The Lander body was supported by three landing legs, each 1,3 metres long. The legs gave the Lander a ground clearance of 220 mm.

Each leg had a main strut assembly and an A-frame assembly, to which was attached a circular footpad 305 mm in diameter. The main struts contained bonded, crushed aluminium honeycomb to reduce the shock of landing.

The two-piece bioshield was a pressurised cocoon that completely sealed the Lander from any possibility of biological contamination until the Viking left Earth's atmosphere.

SCIENCE EXPERIMENTS

With a single exception, the seismic instruments, the science instruments acquired more data than expected.

The seismometer on Viking Lander 1 would not work after landing, and the seismometer on Viking Lander 2 detected only one event that may have been seismic. However, it provided data on wind velocity at the landing site to supplement information from the meteorology experiment, and showed that Mars has very low seismic background

The three biology experiments discovered unexpected and mysterious chemical activity in the Martian soil, but provided no clear evidence for the presence of living micro-organisms in soil near the landing sites.

According to mission biologists, Mars is self-sterilising.

They believe the combination of solar ultraviolet radiation that saturates the surface, the extreme dryness of the soil and the oxidising nature of the soil chemistry prevent the formation of living organisms in the Martian soil.

The question of life on Mars at some time in the distant past remains open especially with the recent discovery of water on the planet.

OTHER SIGNIFICANT DISCOVERIES

Other significant discoveries of the Viking mission included: the Martian surface is a type of iron-rich clay that contains a highly oxidising substance that releases oxygen when it is wetted.

The surface contains no organic molecules that were detectable at the parts-per-billion level less, in fact, than soil samples returned from the Moon by Apollo astronauts.

Nitrogen, never before detected, is a significant component of the Martian atmosphere, and enrichment of the heavier isotopes of nitrogen and argon relative to the lighter isotopes implies that atmospheric density was much greater than in the distant past.

Changes in the Martian surface occur extremely slowly, at least at the Viking landing sites. Only a few small changes took place during the mission lifetime.

The greatest concentration of water vapour in the atmosphere is near the edge of the north polar cap in midsummer. From summer to fall, peak concentration moves toward the equator, with a 30 percent decrease in peak abundance.

Forty years after the first successful landing on Mars by Viking spacecraft, the ambitious mission continues to evoke pride and enthusiasm for future space exploration. Viking spacecraft continued collecting data for more than six years.

The Landers accumulated 4 500 up-close images of the Martian surface. The accompanying orbiters provided more than 50 000 images, mapping 97% of the planet.

The Viking team did not know the Martian atmosphere very well; they had almost no idea about the terrain or the rocks, and yet they had the audacity to try to soft land on the surface.

As Gentry Lee, Solar System Exploration chief engineer at NASA's Jet Propulsion Laboratory, recalls: "We were both terrified and exhilarated. All of us exploded with joy and pride when we saw that we had indeed landed safely."