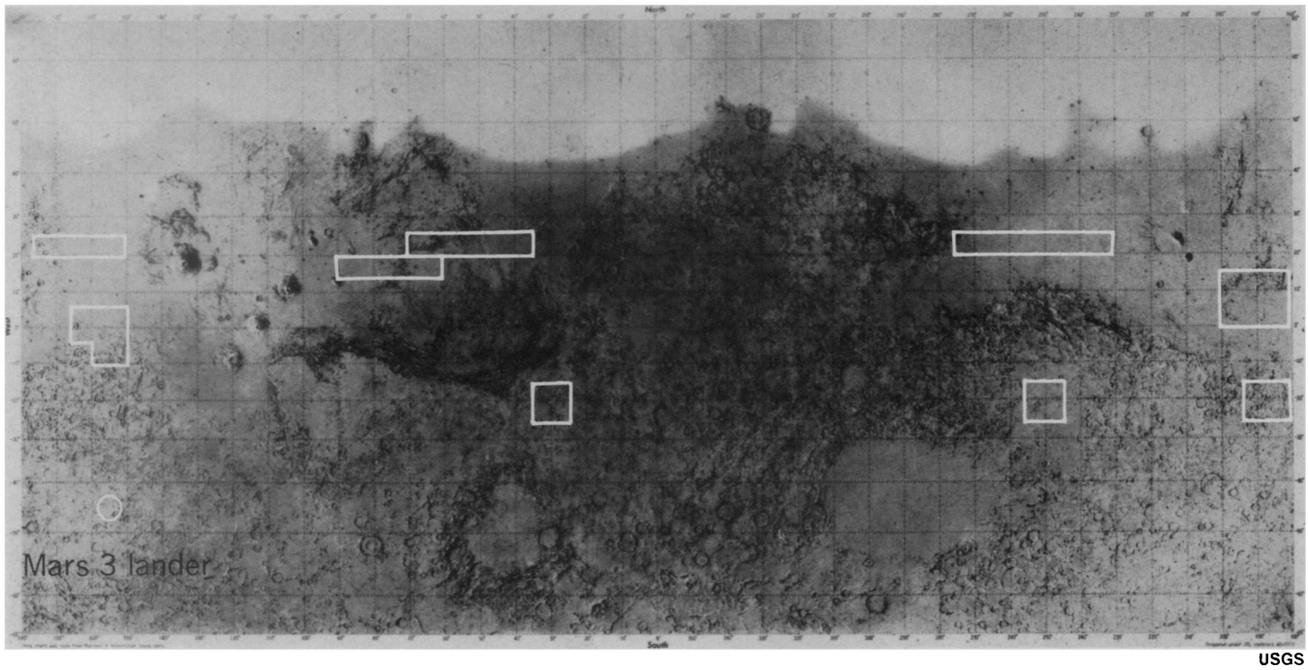


USGS

Where will we land on Mars?

Four landing sites will be chosen from the nine regions now under study

by Everly Driscoll

About this time last year Mariner 9 was nearing a dust-shrouded Mars. The planet that has been unveiled from beneath the dust since then has proved far more interesting than the dead, moon-like object postulated from the Mariner 6 and 7 fly-bys (SN: 8/12/72, p. 104). Mariner 9 has taken more than 7,000 pictures. It has measured, among other things, surface temperatures, atmospheric composition and pressures, and the gravity field.

These photos and measurements lay a solid foundation for the forthcoming Project Viking (SN: 2/26/72, p. 134). Two spacecraft, each carrying a lander and orbiter, will be launched between mid-August and mid-September 1975. The first craft will arrive at Mars in mid- or late-June 1976 and probably land, if all goes well, in time for the 200th anniversary of the United States —July 4, 1976. The second craft will arrive 10 to 30 days later, depending on the launch interval. The prime goal of Viking is the search for life or the lack of life on Mars (SN: 7/24/71, p. 64).

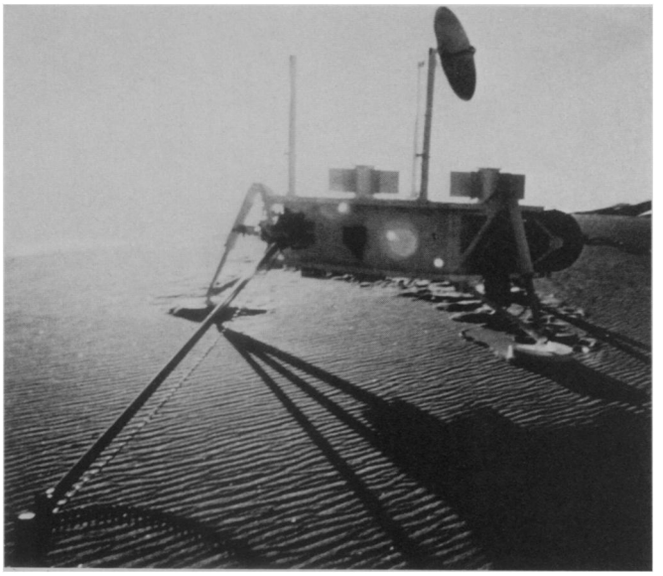
Just where the two Viking landers should touch down is now the subject of intensive research. The Viking Site Selection Working Group, composed of 15 scientists and program officials, are now in phase two of their task—a comprehensive study of nine regions from which they will choose two prime and two backup landing sites. On Dec. 4 they will recommend four sites to the Viking Science Steering Group, which will review the sites on Dec. 7 and send recommendations to NASA headquarters.

Between now and 1975 the group will continue to study the selected sites from ground-based radar, Mariner 9 findings and ground-based astronomy. But the final decision will not be made until June 1976, when the first Viking craft is in Martian orbit. Viking 1 and 2 can remain in orbit as long as 50 days before being committed to a landing—a flexibility that the Soviet Mars 3 did not have. Viking 1 will land north of the equator; Viking 2 to the south. "If everything is okay, and the primary site is acceptable, the craft can land right away," says Loyal Goff of NASA headquarters. If for any reason the close-up look reveals the primary site unacceptable, the craft can be maneuvered to survey and land at the backup site.

Each orbiter will carry two high-resolution (at best 70 meters) television cameras, an infrared spectrometer and an infrared radiometer. The landers will carry a gas chromatograph/mass spectrometer for detecting organic molecular building blocks of life in the soil; a biology instrument capable of performing three different life-detection experiments (SN: 5/27/72, p. 344); three meteorology sensors; a seismometer; an X-ray fluorescence spectrometer for inorganic analysis of surface material; two cameras for providing both color and stereo photographs and 360-degree panoramas of the site; and an automatic arm that will scoop up soil samples to be tested and analyzed.

"Viking is a very expensive mission and our first serious attempt to land on Mars," notes Carl Sagan of Cornell University, a member of the site selection group. "We have got to be mighty careful." Unlike the Soviet space program, there are no continuum commitments to Martian exploration after Viking in the NASA program.

There are several ways Viking could "come to grief in landing," as Sagan puts it. The craft could land on terrain that is too high, too rough, too soft, or too hard. Operational restrictions limit the landing zone to an equatorial band from 24 degrees north to minus 25 degrees south. Fortunately, some of the more interesting terrain on Mars is along this belt. The landing spot must be lower than the mean elevation of Mars so that there will be enough atmosphere between the point of entry and the landing for the parachute to slow the vehicle down. In addition, the craft must avoid obstacles larger than 22 centimeters that would interfere with the landing legs. It must also avoid areas of deep dust. But the craft shouldn't land on frozen lava either, says Sagan. "That would just wipe out



The Viking lander will weigh 1,262 pounds, almost twice the size of the Mars 3 craft.

NASA

all of the biology and organic chemistry experiments." (The sampler arm must be able to scoop up soil to be placed in the analyzers.)

Another problem could be the Martian weather—the winds. To ensure a safe landing, the winds cannot exceed 65 meters per second. Unlike the Mars 3 craft, however, Viking will be able to compensate for some horizontal winds it might meet during descent. The reaction control rockets can fire in the opposite direction to the cross winds to cancel out some of the horizontal velocity.

But even with this capability, the Martian winds could be serious. Sagan, Joseph Veverka and colleagues at Cornell are studying evidence in Mariner 9 photographs of what Sagan calls visual weather vanes and anemometers—white and black splotches and streaks that have changed shapes since they were first spotted. Some of them have disappeared altogether. By analyzing them, the Cornell group hopes to determine wind velocities at the surface. Other groups are working on numerical wind circulation models for the atmosphere.

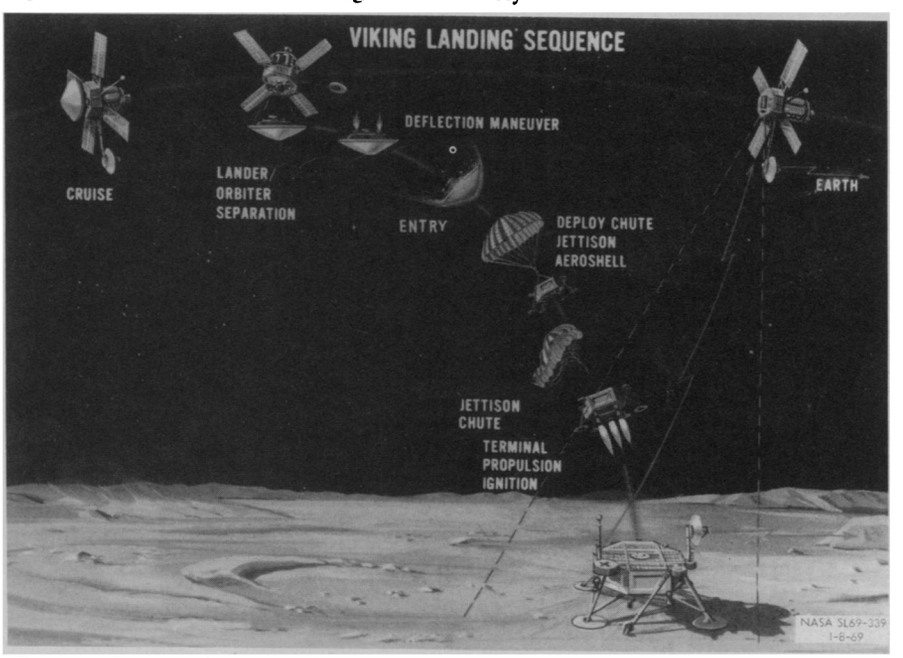
Another limitation of the landing site is the slope. It cannot be more than 19 degrees.

Could there be any scientifically desirable places left after all of these constraints? "By luck it turns out there are," says Sagan. The working group has singled out the nine areas outlined on the map for intensive research. From these areas they are now selecting the four sites. Each of the regions appears to be a plains area, says Harold Masursky of the U.S. Geological Survey, also a member of the selection group. Four types of plains are possibly represented: volcanic plains; alluvial plains made from material deposited by a flow of water at one time on Mars; plains consisting of windblown silt or sand (probably the most likely condition); and plains similar to the fringe areas or foothills of mountains on earth. The group is using several methods to study these regions in greater detail. In October, Mariner 9 photographed some of the Viking areas again and scientists are now reenhancing these photographs. The group is also using ground-based radar tracks taken of the southern hemisphere in 1971. The radar data do not cover the Viking zones, but geologists can compare the radar signatures to Mariner 9 photography of the same area, and extrapolate to the landing areas. Between now and 1975 during close approaches of the planet to earth, they hope to use the upgraded Arecibo telescope to do radar studies of the landing sites.

The group is using other methods as well. Mars is now in the same season (summer at the northern polarcap) that it will be in at landing time. The scientists are examining photographs for evidence of seasonal changes during the last few terrestrial weeks. They are also using recent photography to prepare geological maps. They are measuring the surface roughness by photogrammetry and other techniques. From this work they hope to interpret the geological processes on the surface.

Safe landing sites and scientifically interesting sites are sometimes conflicting. Since the chief purpose of Viking is the search for life, or the absence of it, the site-selection group would like to select a safe site, but also one with geological terrain and environment thought most conducive to life. These would be areas in which water could be produced (volcanic emanations), concentrated (as in stream flow) or stored (as permafrost). Several of the smooth areas appear to be flood plains at the base of tributaries—sinuous channels that appear to have been eroded by water (if indeed there was ever water on Mars). "At least two of the sites will have to be supersafe," says Masursky. "We can look for more scientific return in the backup sites." The concern for a safe landing is real. At a recent meeting of the NASA physical sciences advisory committee (SN: 10/7/72, p. 236), the members drafted a recommendation addressing this very problem. "It was the unanimous opinion of the committee that the choice of sites should be governed almost exclusively on the basis of a successful landing with all instruments operational. Any choice of a landing site should be completely discounted if there is a remote chance that it would jeopardize the landing."

After all its cautious planning, NASA agrees. Viking must land, and land safely.



Retrorockets and a parachute will slow Viking lander for soft touchdown.