Orbiting Mars and preparing for landing

On the 19th of June, 314 million kilometers from earth, a rocket engine suddenly burst into life, fired for exactly 37 minutes 36 seconds, and just as abruptly cut off again. When it was over, the planet Mars had acquired its newest satellite: the Viking 1 spacecraft.

Because of a fuel leak, the orbit achieved on June 19 (with a cheer from the control room at the Jet Propulsion Laboratory in Pasadena), left Viking circling the planet once in 42 hours 21 minutes, compared with the planned 24 hours 36 minutes that would match the length of the Martian day.

Two days later another firing brought the orbit down to the desired period (24.661 hours), so that the lowest point in the orbit, 1,514 kilometers above the surface, will always be directly above the prime landing sight in the Chryse region of Mars. The burn changes necessitated by the leak ended up costing the Viking 1 orbiter about 20 to 25 percent of its main-engine propellent for the rest of the mission, which could last as long as two years. Plenty of margin was provided, however, and project scientist Gerald Soffen said the shortage will have no impact whatsoever on the mission, unless scientists should decide to add presently unscheduled experiments involving fuel-consuming orbital maneuvers.

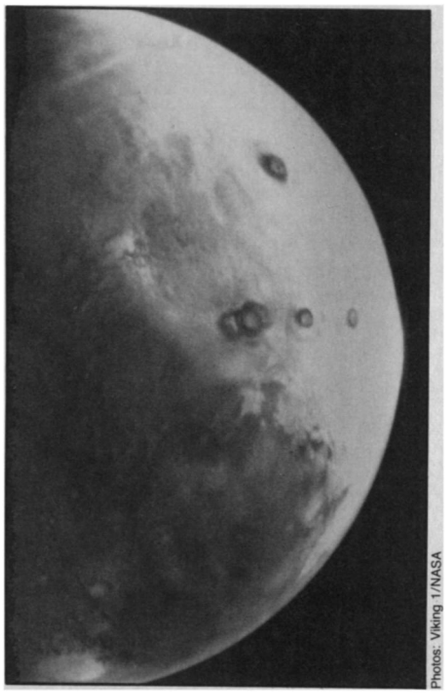
Even before the craft reached Mars, researchers on its huge scientific team were already beginning to reap benefits. Strikingly clear photos and other data gathered during the last few days of Viking's approach sent ripples of excitement through the Viking horde at JPL.

Perhaps the most significant finding, at least to those drawn by the lure of possible life on Mars, has been the discovery of unexpectedly large amounts of water in the atmosphere and on the surface. Before Viking was even launched, Crofton B. Farmer of JPL, in charge of the Viking orbiter's water detector, calculated that there may be conditions under which water can exist as frost or ice on some places on Mars even through the Martian day. "It is tempting to observe," he later wrote in the planetary science journal ICARUS (28:279), "that a black Martian organism would find little difficulty in obtaining a supply of liquid by merely locating itself directly on the surface of exposed frost or ice during daylight."

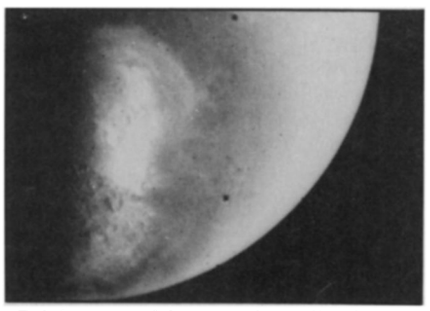
Even before orbit was reached, the detector on Viking had revealed traces of water in the Martian stratosphere. Photos revealed bright deposits apparently on the floor of the huge Hellas basin (even through the seeming frost they showed more detail than the best of Mariner 9's images), as well as in the smaller Argyre impact basin, which Farmer and others felt might be water ice. Similar brightness was seen in a long surface fracture known as Memnonia Fossae, which is barely 20° south of the Martian equator, another likely water spot according to orbiter imaging team leader Michael H. Carr of the U.S. Geological Survey. The last water detector readings before reaching orbit showed about 6 microns of water in the atmosphere over the morning southern hemisphere, where the dry Martian winter is just beginning, and about twice that much in the warmer northern hemisphere. The latter readings, however, primarily measured only the water above the widespread layer of haze that blanketed much of the northern regions. With that amount of water above the haze layer, far more must be below it, Farmer says. Earth-based observations have indicated an average of about 50 microns of precipitable water from Mars during the warmer seasons (July 4 will be the Martian summer solstice in the northern hemisphere), and Farmer, gesturing at a map region slightly north of the equator, says, "I wouldn't be surprised at numbers which are three or four times the earth-based numbers for certain places. And that's wet."

The haze layer is likely to include a substantial proportion of water, since it has been seen late enough in the day for CO_2 crystals already to have turned to invisible gas. Denser clouds also appeared, and some Viking scientists such as Bradford Smith of the University of Arizona, feel that the photos show shadows suggesting that the brightness around Memnonia Fossae is actually just such clouds, perhaps one or two kilometers overhead. None of the hazes are expected to pose problems for the July 4 touchdown of the Viking lander, presently attached to the orbiter, and lander scientists, in fact, are looking forward to the possibility of even seeing early-morning wisps of ground fog, perhaps dissipating before the cameras' very eyes.

Now that Viking is safely circling Mars, the orbiter's infrared thermal mapping device is also getting down to the tasks that may be related to the presence of water. When the sensor looks at the sinuous channels that may be the remnant beds of ancient rivers, it may reveal progressively higher cooling rates toward the downstream ends of the channels, says Hugh Kieffer of the University of California. This would be strong evidence that long ago rivers did indeed flow through them, with the larger sediment particles settling out first, leaving the smaller, faster-cooling particles to settle farther downstream. But like the other orbiter instruments, the heat-mapper began its work days before reaching orbit, revealing a surface temperature range for the planet's morning quarter (the only part visible during Viking's approach) of from −30°F near the equator and northward during the late morning down to −193°F in the south polar region. The atmospheric temperatures measured from a 15-micron channel responsive to carbon dioxide (the atmosphere's main constituent), ranged from −153°F to −187°F.



Four volcanoes: Giant Olympus Mons plus three cones of Tharsis ridge, including sidelobed Arsia Mons. White area at left seems to be water frost or ground fog.



Bright area of frost marks Hellas basin.

All of the early measurements, and even the photo interpretations, are likely to be refined as the mission progresses. The hyperactive Martian winds have been at work since Mariner 9 was on duty—a huge volcano called Arsia Mons, east of Memnonia Fossae on the Tharsis rise, seems to have acquired a pair of striking ringlike lobes that Mariner never saw—possibly from dust transport. Meanwhile, the center of attention is now the certification of the Chryse landing site, although even Harold Masursky of the U.S. Geological Survey, for many months the chief worrier about the safety of the chosen spot, seemed from the early photos to be optimistic about the success of the first U.S. landing on the planet Mars. □