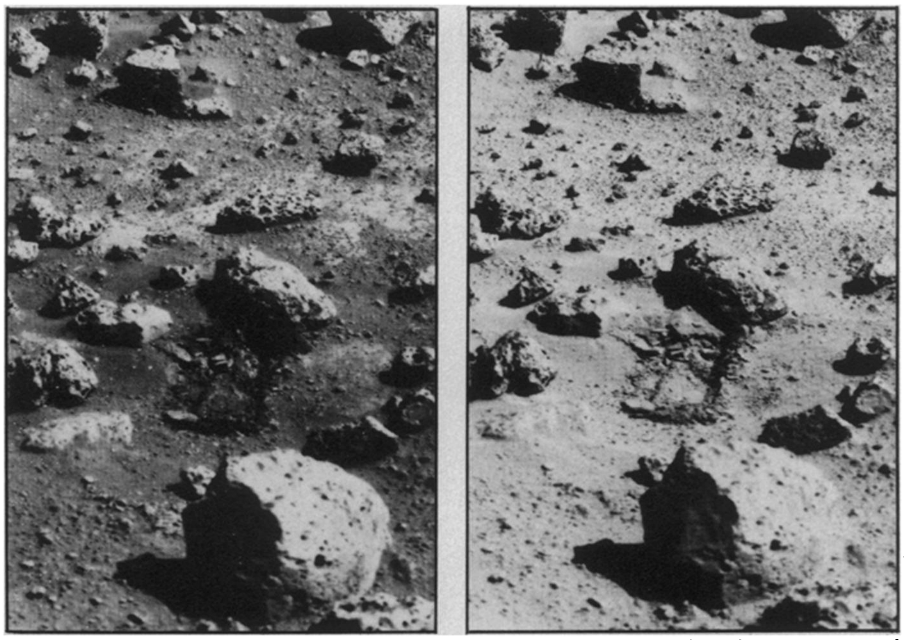
Mars: How little we really know



E. Guinness, K. Jones

Viking lander 2 site became lighter and less contrasty (right) after dust storms and transient ground frost, suggesting that water may have nucleated on dust grains, frozen and descended to surface, then vanished to leave a whole new complexion to the site.

Many of the more than 500 scientists gathered at California Institute of Technology last week for the Second International Colloquium on Mars had previously served as part of the Viking project, which sent two orbiting craft and two landers to the planet in 1976. Most are now back at their respective universities and other institutions, but Viking lives on. Designed to operate for mere months, all four craft made it through a full, 688-day Martian year, and three are still at work. Said Gerald Soffen, the mission's original project scientist, "It has outlasted us all."

True enough. Yet although Viking represented a giant leap among interplanetary spacecraft, it was but a small step in the comprehension of an entire world, especially one as surprising and varied as Mars. The data continue to come in, new hypotheses abound, yet for every researcher with a new "fact" to report, there are probably ten to interpret it, and still more to think of myriad questions raised by the one answer. As the colloquium clearly showed — though it should come as no surprise — the mysteries of Mars are far from solved.

The point was made right from the first day, when discussion focused on the huge dust storms that have sometimes wrapped the entire planet. From orbit, at least when they are not simply hiding *everything* (as they did from the Mariner 9 spacecraft for weeks in 1971), the storms often show the roiling, billowing structure that characterizes the dramatic, hide-behind-your-camel storms of some terrestrial deserts. The tenacious Viking landers, however, have now been through two global storms and several smaller ones (merely the size of, say, Brazil), and the difference in the surface view is surprising.

Photos from the landers, says Kenneth Jones of Jet Propulsion Laboratory, show hardly any sign that a storm is there at all — a slight darkening of the sky. Meteorologist Jack Ryan of McDonnell Douglas Astronautics adds that it sometimes takes not only optical data, but temperature and pressure measurements as well to tell that a storm has passed across the site. Large changes in the atmosphere's daily cycle of tides, for example, he says, are a typically subtle clue to when one of the storms is on its way to global status. In the landers' two and a half earth years on the Martian surface, there has been nothing even close to a photo of a horrendous, towering wall of advancing dust.

Or is it all dust? Lander 1's now-classic surface panorama, photographed only days after its arrival at Chryse basin, shows beautiful dune-like features receding into the distance, which earthly experience says should be made of sand, far larger than the dust of the storms. Indeed, there is some sand on the planet, says Ron Greeley of Arizona State University, but apparently not at the lander sites. Laboratory studies by Greeley and colleagues have suggested an explanation: that the dust storms generate "temporary sand" when electrostatic charges caused by the colliding particles cause the grains to lump into sand-sized pieces.

The size of Martian dust grains might seem mere scientific esoterica, but Greeley proposes that it may be the larger sizes of the aggregate grains that cause them to settle out and perhaps help bring the huge storms to an end. Perhaps even more important, they may explain why the admittedly weathered Martian surface seems markedly *less* eroded than expected from some pre-Viking researches. Massive erosion rates as high as centimeters per year — "enough to wear the planet down to a billiard ball in its lifetime," says one hindsighted geophysicist — had been proposed, but Edward Guinness of Washington University in St. Louis proposes that the erosion may be more like one millimeter per million years. The electrostatically bound dust grains may be a clue, says Greeley, since the energy released when they hit the surface may be dissipated in breaking up the clumps, rather than in carving up the rocks.

Another Martian mystery is the polar caps. The residual northern cap was discovered early in the Viking mission to consist almost entirely of water ice, but scientists waited in vain to see vapor given off from the north freeze out in the south as the seasons reversed. Last week, colloquium participants reported that the residual southern cap seems to be dominated by frozen carbon dioxide. Scientists are developing hypotheses to explain the difference, but they are complex: Water ice is left at the residual northern cap when the temperature gets below the freezing point of water but remains above that of CO_2, but why does the southern cap, which gets colder in the winter, keep primarily CO_2 without the water as well? In any event, says Hugh H. Kieffer of the U.S. Geological Survey, "there can be only one permanent polar cap composed of the major atmospheric component [CO_2]." As the planet's axis of rotation shifts with time, bringing alternate poles nearest the sun at perihelion, "the assymetry," says Kieffer, "reverses every 50,000 years."

The major Martian controversy, however, involves the possibility of far more water than remains in the permanent polar caps. Water — or something else — cut numerous channels in the planet's surface, ranging from little tributaries to vast features far larger than earth's mightiest rivers. Water is still the leader, though lava, wind, fracturing and other factors are variously cited candidates. Victor R. Baker of the University of Texas at Austin asserts that only a flood "similar to water" can explain all the channel forms seen on Mars, but the water had to go somewhere. One possibility is a thick layer of subsurface ice, or permafrost, but finding out from existing data is perhaps the toughest problem facing the Mars-watchers. A key factor could be the early state of the Martian atmosphere, and although atmospheric analyses are thought to be among Viking's most reliable data, they are only components in building a picture of five billion years of evolution. An early, thicker atmosphere may have allowed the existence of water as a liquid (impossible now), but there are signs that different channels may vary widely in age. "Mars," said one participant in a triumph of understatement, "is a toughie." □