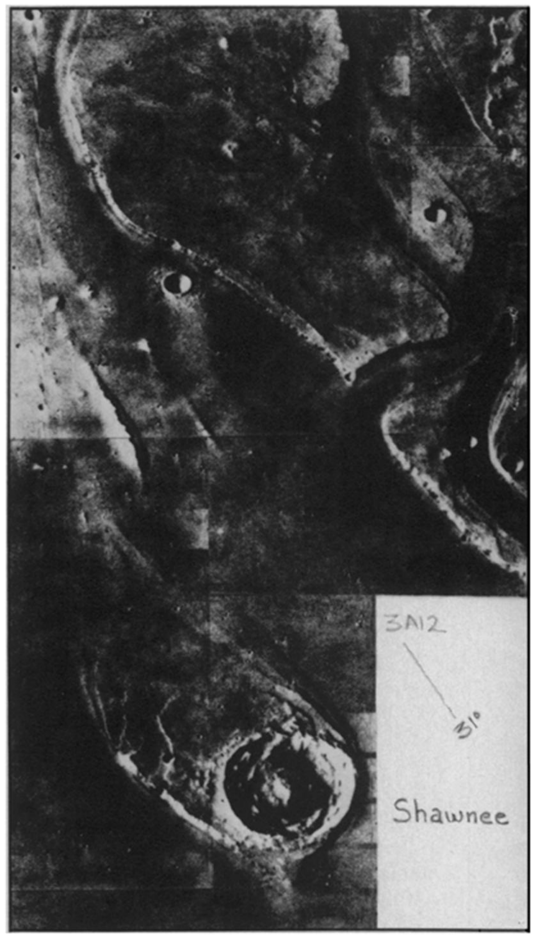
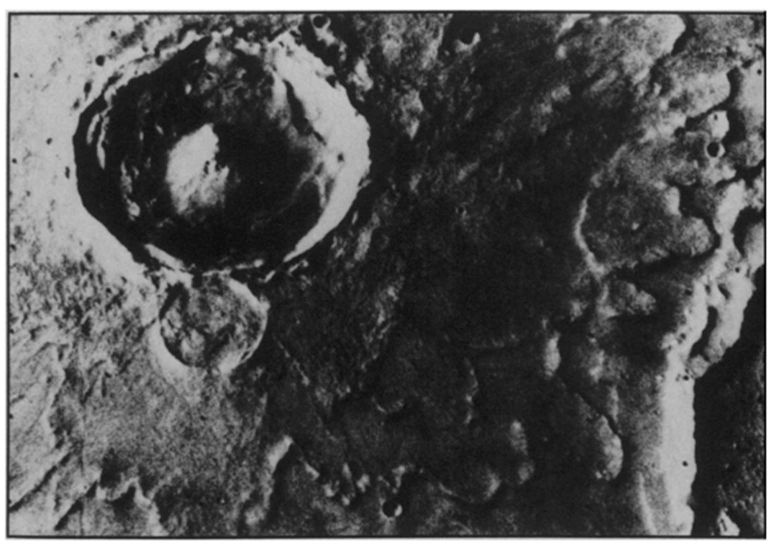
A stunning, wondrous, water-sculptured planet





Above right, meandering, intertwining, northward-flowing channels believed cut by running water on Mars in its geologic past. Right, the crater Yuty, 18 kilometers across, with its central peak and avalanche-like flows of debris. The entire area has been worn down by wind and possibly water erosion.

"I think we should stop messing around and get down there," said a scientist on the huge Project Viking flight team at the Jet Propulsion Laboratory in Pasadena.

"We believe we must continue to look at other areas of the planet," said Project Manager James S. Martin, who had to make the final decision.

And so, after endless meetings, 20-hour workdays and the combined labors of the largest workforce ever to shepherd a probe to another planet, the Big Day was scrapped. The ultimate Bicentennial punctuation mark—the first U.S. landing on Mars—would not be written on the Fourth of July. Instead, it may be delayed as late as July 22, or longer, while scientists look for a safer spot—if there is one.

The culprit was Mars itself, abetted by the stunning, almost too-revealing photos taken by Viking's versatile cameras. "Depending on who you talk to," says Viking science planning director B. Gentry Lee, "you're seeing between 2 and 20 times the resolution of the Mariner 9 pictures." The 1971 spacecraft took more than 7,000 pictures of Mars during nearly a year in orbit, but Viking's superb camera systems have revealed a wealth of detail that Mariner never even knew was there. The difference, says planetary astronomer Bradford Smith of the University of Arizona, came to many of the landing planners as "a severe shock."

The pictures have revealed so many small features—knobs, holes, rough spots—that officials fear the possibility of still smaller features, potentially dangerous to a landing attempt, that not even Viking can detect. These same views, however, have put a new face on the fascinating world.

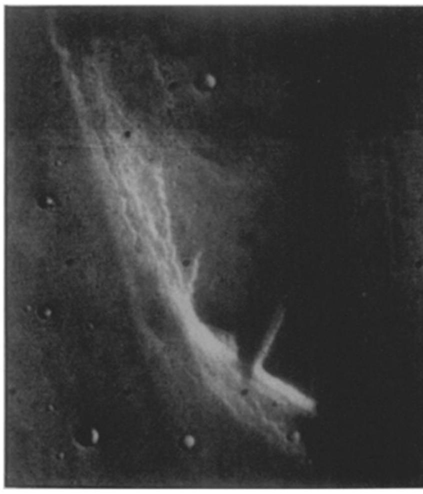
One of the most baffling features is a kind of deeply etched terrain described by various Viking researchers as "deflation hollows" or simply "the pits." It's common in the Chryse region originally targeted for the landing—one photo shows about 1,000 square kilometers of it—but as to its origin, says Harold Masursky of the U.S. Geological Survey, "we haven't a clue." One possibility is that it was formed when the surface collapsed following the rapid melting of permafrost underneath. There are large such regions on earth, Masursky points out, such as near Irkutsk in Siberia. The strange terrain could also be another effect of erosion by the powerful Martian winds, or soil chunks plucked from the once smoother surface by water. Many of the pits have sharp angles and other alignments within their perimeters, however, which suggests, according to Masursky, that their shape (and perhaps their triggering) may be controlled by fractures in the ground, an argument in favor of birth by surface collapse. It is almost impossible to be sure from the height of Viking's orbit, and it makes the landing planners nervous. If the pits are visible to Viking, which can see features only a bit smaller than a football field, what perils might they represent on the Volkswagen-sized lander's scale?

Then there are the "knobs," believed by some of the Viking scientists to be bumps on the Martian bedrock sticking up through the volcanic and sedimentary deposits on the surface. They range from the size of major mesas down to . . . what? The landing planners wish they knew. A secondary problem, points out Masursky, is that, as on the moon, "mass wasting" caused by seismic jarring is likely to have sent material from the tops and vertical faces of the knobs tumbling down to lie strewn about their bases. Another hazard.

The knobs, however, also serve as markers for the most exciting of all Martian phenomena to date: the apparent presence, tens or hundreds of millions of years ago, of large quantities of water. If present signs are indeed due to water—and it would take a remarkable theory to explain them away otherwise—then it was not merely water in some esoteric sense that only a scientist would notice. Viking's images have revealed vast "floodplains" scores of kilometers across, "rivers" equal to the largest on earth and "islands" far larger than Manhattan. Several of the island-like features show distinct strata, either deposited by successive flooding episodes or laid down by repeated volcanic and aeolian visitations and later sectioned by a continuous flow. One "island," measured by stereoscopic study of Viking photos, towers 500 meters above the surrounding flats and is divided into at least seven separate strata.

As Mariner 9 previously revealed, though in less detail, many of the knobs and other obstructions in the flow beds have pronounced wakes, teardrop-shaped tails of raised lands that point distinctly "downstream" (roughly northward near the original Chryse site). Viking, however, has added dramatic evidence of what Masursky sees as the water's "turbulent, high-velocity flow": deep grooves along the obstructions' leading edges, suggesting the power of the long-vanished current and evoking images of river whitewater scoring the bottom as it pounds the rocks in its way. Another landing concern is that

Braided channels cut by past water flows.



Photos: Viking 1/NASA

Mars "Island" with seven laminated layers.

such strong flows may have plucked whole boulders from their beds, leaving the holes (which show in the photos by their much larger rims of dark sediment) and the boulders themselves to threaten the descending spacecraft.

There is a counter-theory (one of many in Viking's huge scientific staff), although it appears to be a declining view, that even the large flow features need not have been caused by "castastrophic" flooding episodes. Substantial erosion by small, gradual trickles certainly is common on earth, and a less torrential water supply would fit more comfortably with the present Martian climate (Mars also shows signs of slow water erosion), but evidence for strong flows is compelling, and it, too, has its terrestrial counterparts. Masursky notes, for example, that in Washington State during the retreat of the last major ice age, an event called the Spokane Flood took place when an ice dam burst and released the waters of Lake Missoula, apparently cutting a major river in three and a half days (SN: 10/19/74, p. 250).

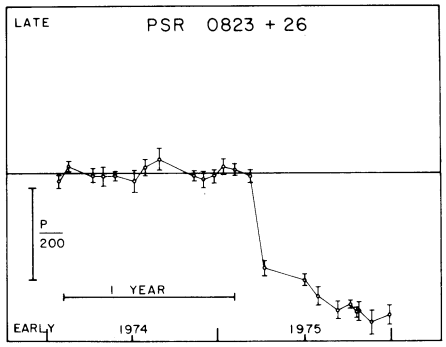
For some reason, Mars is still occasionally referred to as "moonlike," a generalization that becomes less applicable with each new Viking photograph. The Red Planet does have its craters, however, including such classics as Yuty (named after a village in Honduras), an 18-kilometer-wide ring with the characteristic central peak of an impact feature and ejecta blanket whose steep outer edges are further testimony to the erosive power of water. A difference from lunar crater fields may turn out to be that the smallest-size impact craters are absent on Mars, since even the present thin atmosphere would have destroyed most small meteoroids. A thick, primordial atmosphere, in fact, might have had a similar effect on larger projectiles, and if, as many researchers believe, much of the solar system's meteor bombardment was concentrated in a single early episode, Viking's mission becomes all the more important. It could prove necessary to recalibrate crater-counting as virtually the only method available for dating planetary surface features, at least on Mars, without sampling them.

With so many unknowns in its equations, the Viking team expanded its landing site search to include an area to the northwest of the original prime site and closer to the center of Chryse basin. Because the "Northwest Territory" is farther from the channels that open onto the original site, the hope was that only finer sediments would have settled there, perhaps providing a less rugged surface. The previously planned backup site at Tritonis Lacus, more than 12,000 kilometers around the planet, was also being considered, as well as an area near it called Isidis Planitia, and even a possible return to the prime site. Landing dates would range from July 9 for the prime site to July 21 for the backup site to July 22 for the Northwest Territory and even later for Isidis. The calendar is tight, because there's a lot of mission to be run before solar conjunction cuts off communication for a month beginning in early November. And—just to keep the pressure on—Viking 2, due in orbit Aug. 7, is on its way. □

Anti-glitch snags pulsar theories

Astronomers are unveiling a whole new can of worms in pulsar behavior which is guaranteed to give any theorist in the field gray hairs. In 1968, when pulsars were first observed, theorists instantaneously assigned the phenomenon to spinning neutron stars. They envisaged the pulsing to be a lighthouse effect caused by a cone of radiation emitted by the star. In 1969, the Crab and Vela pulsars (among the most studied pulsars) exhibited sudden increases in their pulsing frequency, later dubbed "glitches." After some momentary head-scratching, theorists decided that glitches are probably caused by "starquakes." Following a starquake, they reasoned, the star would settle down, under the influence of its own gravity, to a smaller diameter. The effect on the spin rate would be the same as for a spinning ice skater who suddenly pulls in his arms. In fact, this explanation has successfully described, in impressive detail, most of the pulsar glitches since observed.

Nature, however, seems to have reaffirmed its supremacy over the mortal deliberations of the theoretical scientist. Gordon E. Gullahorn and John M. Rankin of Cornell University reported at the meeting of the American Astronomical Society last week in Haverford, Pa., observations using the Arecibo radio telescope that show some anomalous pulsar behavior. They have seen several examples where a pulsar frequency suddenly decreases. This is totally contrary to the established quake model. The observation seems to suggest (if one maintains the starquake picture) that the star suffers a physical change that increases its effective diameter. Under the effect of a pure gravitational field, such a distortion is not energetically preferred.



Gullahorn and Rankin

Suddenly, a pulsar sends signals early.

The same two observers also report that the pulsar PSR 0823+26 not only has "anti-glitched," as described, but also has undergone a sudden "phase jump," so that suddenly, one day, its pulses began to arrive earlier than expected (see diagram). The anomalies don't even stop there, however, because whatever caused this pulsar's sudden phase jump has left its frequency unchanged. By the admission of several experts in the field, these observed peculiarities may portend the death of the standard starquake model.

If you were playing the stock market, "you'd begin to sell this [theory] short," says Malvin A. Ruderman of Columbia University, a recognized pulsar expert and creator of the standard starquake theory. In his opinion, the theory, however, was in trouble with the Vela pulsar long before these latest revelations. The history of the Vela pulsar is in dramatic contrast to the past records of other known pulsars, which glitch infrequently and when they do, have their spin rates changed by only