A Week on Mars

Rear window: The view from Viking's second camera brings the panorama full circle from last week's 300° section. The back yard is dominated by a 3-meter-wide boulder.

"Light winds from the east in the late afternoon, changing to light winds from the southwest after midnight. Maximum wind was 15 miles per hour. Temperature range from −122°F just after dawn to −22°F, but we believe that was not the maximum. Pressure steady at 7.70 millibars."

Meteorologist Seymour L. Hess of Florida State University reported the weather for July 20, a straightforward enough reading—until one looked at the numbers. For the Project Viking scientist had just made the first weather report for another world. It was the beginning of the Viking lander's first week on the planet Mars.

A day later, the measured temperature extremes had varied by scarcely 2°, and the timing of wind-direction changes produced a data curve barely distinguishable from the earlier readings. "The two of them are so alike," said Hess, "that if one of them were the Dow-Jones average and the other were my predictions, I'd be a wealthy man." He theorized that the apparently dominant air movements from the southwest might be "downslope winds" pouring past the lander into Chryse basin, while the other directional oscillations could represent those same winds "sloshing back and forth." Yet the mere familiar presence of a weather station, a far cry from the spacecraft's esoteric other instruments (or those of any other interplanetary mission to date), seemed to give Viking a "settled-in" feeling, as it began what should be the months or years of its intensive study.

Scientifically auspicious, it was nonetheless not a trouble-free start. The sensors in the lander's seismometer refused to budge from their safety-locked position, and although flight controllers were not giving up, a week after the landing they began planning how to reapportion the instrument's precious allotment of data "bits." The craft's transmitter inexplicably turned itself on with only 1 watt of power instead of 30 watts for two days running, and although it later resumed its planned power, officials remained concerned, since the reduced power could limit the amount of time available for picture transmissions as the Viking orbiter passed overhead each day. One of the lander's two receivers developed a 90-percent reduction in sensitivity, although the other receiver can take its place. And the telescoping, scoop-equipped arm designed to sample the surface caused fears, later allayed, when a pin provided to hold it in place during landing at first refused to fall free. (When an extra extension of the arm finally allowed the pin to drop to the ground, scientists promptly examined the resulting soil depression for indications of grain size and bearing strength. "Indian," quipped one, "use every part of buffalo.") This week the scoop turned to its primary task of delivering soil samples to the probe's biological and other instruments.

But the wonder of Mars kept the scientists spellbound day after day. Various observers, hoping for signs of Martian life, scanned the lander's remarkable photos rock by rusty rock, jokingly pointing out such "artifacts" as a Volkswagen, a castle (complete with walls and parapet), a beer can (alias "the drain pipe" and "the Midas muffler"), a tire, footprints, a Polaroid film wrapper and one particular stone (debunked with great care by Viking geologist Alan Binder) said by some to bear the numbers 1, 2, 3 and 4 and the letters C, A, B and G. (Binder, in a sort of skeptic's class-action suit, debunked only the B.)

One observation drew the opposite reaction. Lander photo-team member James A. Pollack of the NASA Ames Research Center drew a round of geochauvinistic hisses when it was announced that: "The sky of Mars is *not* blue." In fact, he said, it is more of a pinkish-orange. Because the Martian atmosphere is so thin, its light-scattering properties, which determine its color, are dominated by the relatively large dust particles (about 0.0005 inch, Pollack says) that hang suspended in it for months or years, replenished by the huge dust storms that annually blanket the planet. In fact, Pollack calculates, the atmosphere would seem about 99-percent darker if it were not for the particles.

Before the landing, Pollack says, he feared it would be years—if ever—before it could be determined whether it was dust or water-ice crystals giving the Martian sky its color. Fortunately, the sky seems to be an almost perfect match for the soil. Painstaking color-balancing of the lander's color photos, conducted by the imaging team headed by Thomas A. Mutch of Brown University, finally revealed that the "Red Planet" is, if not lipstick-red, at least the color of an embarrassed brick, and the obvious source of the dominant coloring agent in the Martian firmament. The likeliest mineral to account for the ruddy color, says Binder, is a hydrated iron oxide called limonite, common on earth and formed by the action of water on two other minerals, an orange one called hematite (Fe_2O_3) and a yellow one known as goethite ($HFeO_2$). (Binder's early estimate of the Martian color suggests a hematite/geothite proportion of about 2 to 1.) The limonite could be a "fossil stain," Binder points out, formed in an ancient past amid lots of water. Robert L. Huguenin of MIT, however, has recently determined that ultraviolet light can do the trick with only a little water around. Indeed, limonite is common in the less-than-drenched desert of Arizona.

It is not the rocks of Mars themselves that are red, Binder says; rather, it is coating, as hard as the rocks and similar to the earthly phenomenon known as "desert varnish," formed when traces of water seep into porous rocks and begin the color-causing mineralogical reactions from the inside outward. What really excites Binder and his colleagues, however, is the discovery that, despite the overall reddish cast, at least six distinct lithological rock types are visible in the few kilometers covered in the color images: Besides the predominant, apparently basaltic rocks, there are darker, bluish ones in the middle distance; two types of light-colored, bedrock-like formations (fractured and less-fractured), both seemingly scoured nearly sand-free by the wind; some particularly course-grained basalts in the immediate foreground, and a surprising few of what Binder calls "erratics"—small, smooth, light-colored rocks that seem to have moved in from elsewhere. (Planners at NASA are considering automated sample-returns and robot rovers among possible future Mars missions, but so many Viking scientists have begun wishing that the lander had wheels that the conclusion seems nearly foregone.)

The dust that lies under, over and among the rocks (and helps to map wind patterns by forming neat "wind tails" on many of the rocks' leeward sides) plays numerous roles in the Martian environment. It could even protect Martian lifeforms against the sun's ultraviolet radiation. (Perhaps, Pollack suggests, possible Martians may even prefer to come out in the dust storms to avoid a fatal dose of UV.) The suspended dust particles, says Pollack, also directly heat the atmosphere by absorbing sunlight, thus amplifying diurnal temperature changes and in turn contributing to the wild (and abrasive-loaded) winds.

Despite such heating mechanisms, Mars is well established as a chilly world, yet it seems to be the cold, rather than the warmth, that is raising the most intriguing questions. Hugh H. Kieffer of UCLA, head of the team that is mapping Martian temperatures from the Viking 1 orbiter (soon to be joined by number 2—see related story), had already reported surprising south-pole readings well below the condensation temperature of carbon dioxide, dominant constituent of the atmosphere, when the instrument recorded "fantastic," unexpected cold in the region of 27,000-kilometer-high Arsia Mons, southernmost of the three great volcanic peaks that mark the Tharsis ridge. Some Viking researchers feel that the chill south-polar readings may have reflected a high-altitude ice cloud rather than the surface, and the temperatures at Arsia Mons, measured just before dawn, may be due to the same phenomenon. In any event, says Kieffer, the region would soon warm up, since the low thermal inertia of the thin atmosphere would permit the temperature to rise "tens of degrees" in a few short hours as soon as the sun rose. Partial evidence for ice cloud readings came from the Capri region, one of the now-abandoned "supersafe" landing sites, where atypically low temperatures were accompanied by overall reflectivity measurements of as much as 40 percent compared to the estimated Martian average of about 25 percent—a sign of the presence of suspended ice particles.

The surface composition of the atmosphere that encourages such exotica was measured for the first time over the (earth) weekend by the lander's mass spectrometer. Besides an expected 95 percent carbon dioxide, the device recorded 0.3 percent oxygen, and reinforced a separate instrument's earlier measurement (made during the descent on July 20) of argon and, gratifyingly, nitrogen, vital to life (at least on earth). The surface data showed 2 to 3 percent molecular nitrogen and 1 to 2 percent argon 40, with an argon-36-to-argon-40 ratio of 1: 2,750 ± 500.

As the atmospheric data begin to be analyzed, competing planetary-evolution theories are reemerging to clash horns again. Tobias Owen of the State University of New York holds that the low argon-isotope ratio (about one-ninth the argon 36 proportion of earth) so far offers "no compelling evidence" to support notions of an early, thick atmosphere on Mars. The ratios of carbon dioxide and nitrogen to argon 36, he says, suggests that the maximum surface atmospheric pressure on the planet was never more than 10 times its present value. This is at odds with the opinion of Michael B. McElroy of Harvard University, who traces back the present nitrogen abundance and escape rate to deduce a primordial atmosphere some 7 times thicker than Owen's.

A major part of the controversy is whether the presumed thicker atmosphere—a necessary condition for flowing water—was a one-time thing or a cyclic reoccurance. Earth-based measurements of Martian oxygen-18-to-oxygen-16 ratios, says McElroy, suggest that at least 1,000 millibars of oxygen must recycle down into the planet and back again every billion years, which could be a sign of an overall atmospheric pressure pulsation. But this question—and a new world of others—remains open. □

Viking: #1 down, #2 to go

Elated by the treasure trove of data from the Viking 1 orbiter and lander, mission scientists have repeatedly proclaimed "an embarrassment of riches." At the same time, however, they are having to contend with a similarly bountiful embarrassment of spacecraft. Only five days after the first lander made its safe touchdown on Mars, flight controllers at JPL had to be ready with instructions for the computer aboard Viking 2 which would adjust the spacecraft's path so that it would reach orbit on August 7 at a proper Martian latitude to photograph desirable sites for its lander.

Emboldened by the success of lander 1, the flight team voted to abandon the low southern latitude containing the "supersafe" sites that had been chosen in case the first descent ended in disaster. Instead, they decided to aim for a band at 46°N that skirts the fringes of the Martian north polar hood, including the original primary and backup sites in the Cydonia tableland (10°W) and the huge, 700-kilometer saucer known as Alba Patera (110°W). No confirming radar will be available at this high a latitude, however, so the site areas to be studied will be expanded into 1,500-kilometer-wide swaths, and supplemented with an additional 2,500-kilometer track across the plains of Utopia (centered at 230°W).

The reason for the northward choice, as it had always been, was water. That far up in the summer hemisphere there may be as much as 5 to 10 times as much water vapor in the atmosphere, and says Crofton B. Farmer of JPL, subsurface water may even condense out overnight as frost. Furthermore, what excites the water-watchers also excites the biologists. "If I were an organism that had found myself at the 'A' latitudes [the lander 1 site, only half as far from the equator]," says Viking scientist and Nobel laureate Joshua Lederberg, "I think I'd head north."

The biology team has an additional reason for preferring the northern region. If Viking's life-hunting instruments find no positive results by the time solar conjunction cuts off communication with the spacecraft for about six weeks beginning in early November, the biologists would like to turn off the instruments' heaters after conjunction for a lengthy period of "cold incubation" at Martian ambient temperatures. This would test for microorganisms that could thrive only in the planet's extreme cold, but it's hard to achieve such temperatures in the biology instrument because certain spacecraft equipment that must remain "on" warms the instrument's mounting plate. The northern sites promise resultant temperatures as low as −10° to 0° C, says the biology team's assistant leader for engineering, Ronald I. Gilje of TRW. This could be up to 45° cooler than would be attainable in the rejected "supersafe" sites (barely 5° south of the equator) and as much as 25° cooler than even the lander I site in the Chryse basin.

Geologically, the 46° band is fascinating, with much of the prime Cydonia site criss-crossed by a network of linear depressions that have given the terrain the nickname "elephant hide." But all three site areas include both smooth and rough regions, with distinct boundaries visible even in Mariner 9 photos.

Signs of water are eloquent. A 25-kilometer-wide crater named Arandas, near Cydonia, has a smooth ejecta blanket which most closely resembles laboratory test craters made by impacts in "waterlogged ground." Presumably the water either mixes in to give the outflowing material a runnier texture or simply vaporizes in the heat and floats the whole load along on a cushion of steam. Also, the angle between Chryse and Cydonia would let a single orbiter handle communications for both landers while the other orbiter would be free to explore the planet. The most tempting section of the strip, however, to Harold Masursky, site-selection chief, is Alba Patera, the backup. Signs of trickling and flowing water, he says, are younger there than anywhere else on Mars. Some apparent mountain tributaries, he suggests, may be even younger than the roughly 100-million-year minimum that some feel crater-count dating can detect. □