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 life-forms 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 micro-organisms 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 "water-logged 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. □