Viking: Mars goes into hiding

Ice clouds in the north, dust clouds in the south—and somewhere beneath it all is Mars.

For many weeks, the Viking 2 orbiter has been circling the planet in a path that takes it as close as 800 kilometers to the surface. On March 11, its companion craft, orbiter 1, was sent even closer, following a deep-dipping orbit that brings it within as little as 298 kilometers of the rusty rocks below. The scientists on Viking's orbiter imaging team ought thus to be seeing the best photos yet from the two craft. Instead, says one team member, "we're seeing mush."

The orbiters have not gone haywire, and no one has been conducting X-ray tests in the JPL darkrooms. The culprit is Mars itself—or at least its atmosphere.

In the northern hemisphere, surface features are nearly invisible much of the time because of a discontinuous but widespread layer of haze in the way. The haze looks brighter in images taken through a violet filter than through a red one. This suggests that it consists primarily of condensates—probably ice crystals. The reasoning is that condensates reflect more strongly in the violet part of the spectrum, says James Cutts of Science Applications, Inc., while dust particles or the surface itself would dominate in the red. Further, the brightness grows in proportion to increasing north latitude, which is consistent with the haze being associated with the now-growing north polar cap.

In the southern hemisphere, meanwhile, visibility is just as bad—and possibly getting worse. Here the villain is dust. The Viking orbiters have photographed isolated dust storms in the area before, but now there is speculation among the team scientists that it may be the beginnings of the Great Dust Storm. A titanic dust storm blanketed the entire planet for several months before the arrival of Viking's 1971 predecessor, Mariner 9, and kept the surface hidden for more than two months after it got there. During the early months of the Viking mission, every passing mention of dust brought questions from reporters about whether another Great Dust Storm was at hand, but now, says Cutts, "this could be it."

The team members generally feel, according to Cutts, that the northern hemisphere is likely to clear up before the southern one does. But it is the north, nonetheless, that poses some special concern. The reason is straightforward: both of the Viking landers are there, and winter is coming.

The worry is centered around lander 2 (SN: 2/5/77, p. 84), which is less than 43° away from the pole itself. The winter solstice in the northern hemisphere occurs on May 31, and Viking officials forecast that by the end of June there may be frost on the ground—and perhaps on parts of the lander—all day long. "The lander," one mission scientist has predicted, "may find itself a part of the polar cap."

As a safeguard, lander 2 has been assigned a protector named Sam. Actually it's SAM—Survival Automatic Mission—a reduced operating schedule designed to keep the craft's scientific instruments and other equipment from freezing to death. The organic chemistry experiment (the gas chromatograph/mass spectrometer) is being switched off, along with the three biology instruments. The X-ray fluorescence spectrometer that analyzes the elements in the "soil" will be checked periodically to see if it has picked up any wind-blown dust, and occasional pictures will be taken. (The two cameras will be taking similar images, just in case one freezes up.) The only two experiments to be run on a regular basis will be the seismometer, prompted by two possible Marsquakes that it has already detected, and the meteorology package, since one of Viking's major goals is to observe Mars throughout all of its seasonal changes. The SAM plan will go into effect on April 17 and is scheduled to end in mid-October with a return to the normal schedule.

Even before SAM, however, the cold has been making itself felt. When the biology instrument's heaters were turned off recently for a planned "cold incubation" test (the test was canceled when the soil-sampling arm stuck temporarily), the nutrient solutions in two of the experiments promptly froze solid. □

'Attractive mystery' in superconductivity

The behavior of solids chilled to very low temperatures is a branch of physics that is endowed with less elegant theoretical understanding than most. Much of the theoretical formulation is ad hoc, and some kinds of behavior are simply mysterious. Bernd T. Matthias of the University of California at San Diego and Bell Telephone Laboratories reportedly regards his latest discovery of unusual cryogenic behavior as "an attractive mystery."

What he discovered and reported at the March meeting of the American Physical Society in San Diego is a metal, a compound of erbium, rhodium and boron that first becomes superconducting as it cools and then at a lower temperature becomes magnetic (specifically ferrimagnetic). Both superconductivity and the various magnetic states (ferromagnetism, antiferromagnetism or ferrimagnetism) tend to appear in metals as they are cooled to temperatures near absolute zero, but this is the first time that superconductivity has given way to a magnetic state as a result of cooling.

All of these states represent the imposition of some kind of order on characteristics of the substance that were disordered at higher temperatures. In superconductivity the electrons that carry electric currents form pairs with oppositely oriented spins. In this condition they are able to move through the metal without experiencing the resistance that characterizes normal conductivity. Hence, superconductivity. A current once started will flow, presumably forever, without needing a voltage to drive it. The three magnetic states represent different orderings of the magnetic moments or intrinsic magnetic fields of the atoms in the metal. In ferromagnetism, the moments line up parallel to each other and yield a bulk magnetism. In antiferromagnetism, alternate moments are antiparallel and cancel. In ferrimagnetism, alternate moments are almost but not quite antiparallel: There is a certain angle between their directions that gives an overall magnetism to the sample. One of the interesting questions about a particular metal is which of these four conditions, if any, represents its ground state (lowest energy or coldest condition). This is the first time that a metal has been found to enter a superconducting state at one temperature and then upon further cooling lose its superconductivity and enter one of the magnetic states.

The discovery was an incident in a general search by Matthias and a number of collaborators for substances that would go superconducting at higher and higher temperatures. Superconductivity has enormous technological potential, but the refrigeration techniques are cumbersome and costly. Finding substances that become superconducting at relatively high temperatures—so far the best are not much higher than 20°K—could make the refrigeration easier and cheaper.

Matthias worked for a long time with binary metal compounds, but a few years ago he decided that ternary compounds showed more promise. The current discovery came from a systematic investigation of the compounds of rhodium and boron with the rare earths (XRh_4B_4 where X is any rare earth). Going systematically through the rare earths, the investigation found that some do not form the compound, but of those that do, two become superconducting when cooled, and several become ferromagnetic. The one with erbium ($ErRh_4B_4$) becomes first superconducting at 8.6°K, and then upon further cooling to 0.9°K, loses its superconductivity and becomes ferrimagnetic. Matthias calls it an attractive mystery because he believes that an understanding of why it happens may lead to a better understanding of superconductivity and may possibly lead to the higher superconducting temperatures that many scientists and technologists would like to see. □