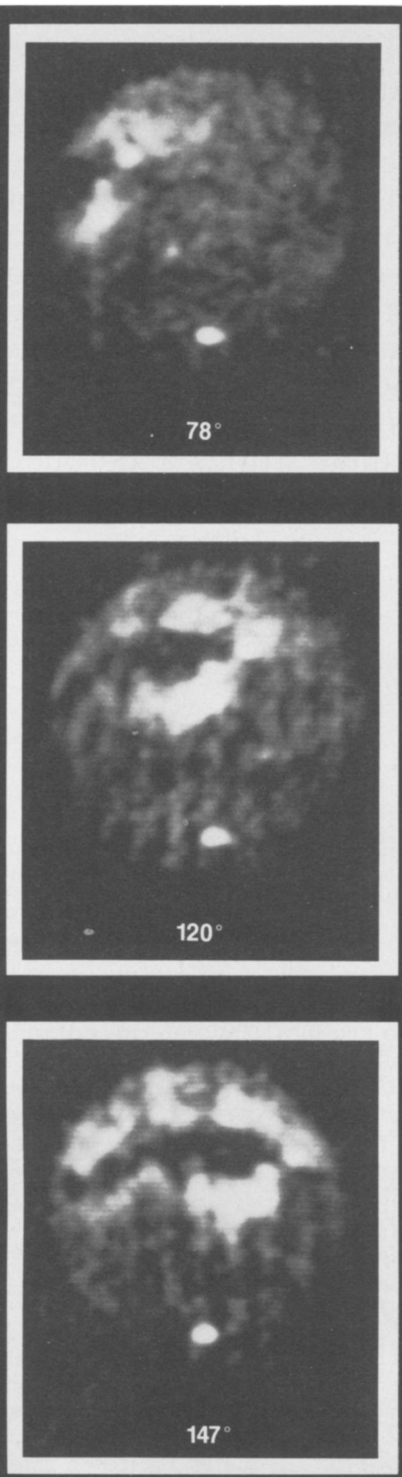
A DIFFERENT VIEW OF MARS

By JONATHAN EBERHART



Muhleman et al.

The radar face of Mars, shown at three longitudes as the planet rotates (the latitude of the point directly facing Earth is 23.7°S), differs from its photographic appearance. The bright spot at the bottom of each image is the south polar cap, but the smaller spot about half an inch up from it has no obvious photographic equivalent. Similarly, much of the large black feature near the equator in these images has been informally dubbed "Stealth," since it shows no radar return whatever.

Hidden by its blanket of cloud, Venus has been mapped only by radar, with none but the cameras of a few Soviet landing craft having actually taken its picture. Mars poses no such problem except for the occasional dust storm, and in the late 1970s the two U.S. Viking spacecraft photographed virtually the entire Martian surface. Radar is more than just a fog-cutter, however, and the latest radar maps of Mars present a strange view of the terrain, with conspicuous features where none are known from the photos and with some well-known surface details simply missing.

The maps were made possible by an unusual hookup in which radar signals sent from NASA's Goldstone tracking station in California were bounced off the Martian surface and received by 26 of the 27 radio telescopes in the Very Large Array (VLA) near Socorro, N.M. The VLA has no transmitters, but it has been linked with one at Goldstone to help with communications when the Voyager 2 spacecraft flies past Neptune this summer (SN: 9/10/88, p.170). Voyager's signals will be at a wavelength of 3.6 centimeters (called the X-band), which the Goldstone station could already transmit and which the VLA is now equipped to receive.

Duane O. Muhleman of the California Institute of Technology in Pasadena and his colleagues first used the system 19 months ago to "image" the rings of Saturn, then aimed it at Mars in a successful test last Sept. 12 and operated it again on Oct. 22. Rather than using a single, huge dish as its "ear," the VLA provides a "synthetic aperture" by combining radar echoes from 325 "baselines" between pairs of its antennas. Scientists are still analyzing the data, but Muhleman presented an initial look last month at the 4th International Conference on Mars in Tucson, Ariz.

"We see four discrete types of features," he reports, and all pose questions. The icy Martian south polar cap is prominent, as "radar bright" as Ganymede, the ice-covered moon of Jupiter that Muhleman says is the brightest radar object in the solar system, some eight times brighter than most of Mars. Yet the southern hemisphere is relatively featureless, revealing "no clear indication" even of the huge Hellas basin or the vast plain named Argyre Planitia. Says Muhleman, "It is tempting (but dangerous) to say that this type of radar echo, whose physics is poorly understood, is primarily coming from relatively 'fresh' lava flows, except for the south pole." A great deal about Mars is yet to be learned, however, and Muhleman is not about to assert that the radar maps contain evidence for recent volcanic activity.

The northern hemisphere shows the "shields" presumably produced by eruptions from three huge volcanoes on an elevated region called the Tharsis rise. There is a region west of Tharsis, however, that produces no radar echo at all. "We call it Stealth," Muhleman says. The likeliest explanation, he adds, is "very, very deep deposits of light stuff, a density way below 1 gram per cubic centimeter." In fact, he notes, "this has implications for future landing missions, though we don't know what it means yet."

Then there are regions that give similar echoes to the known Tharsis shields, but that fail to match corresponding photos from the Viking spacecraft at all. Maybe the features producing the radar return are buried, Muhleman suggests. Also conspicuously absent are signs of the huge canyon called Valles Marineras – as long as the United States is wide – and of the caldera of Olympus Mons, a volcano several times the height of Mt. Everest.

Overall, Muhleman calls the radar map "a high-resolution way of looking at the subsurface" of Mars. But when are the radar returns produced through ice, or through layers of dust, or through other aspects of the terrain that await additional information from planned U.S. and Soviet spacecraft?

"What that tells me," says Muhleman, "is that it's a tragedy that they took the radar off the Mars Observer mission," which is scheduled to go to Mars in 1992. For cost-cutting reasons, says NASA Program Manager Marius Weinreb in Washington, D.C., "we decided that we had to de-scope some of the science," so they replaced the radar altimeter that would have been used in orbit around the planet with a laser altimeter. Either instrument would be primarily to measure surface elevations, but the radar version would also yield information about roughness as well as possibly penetrating the ice and dust and making other measurements that could be compared with photographs and infrared data. "The potential of this new technique for Mars is enormous," Muhleman says, calling the decision to drop it from the spacecraft a case of "one more damn experiment that looks at the upper half-inch of Mars' surface instead of penetrating." □