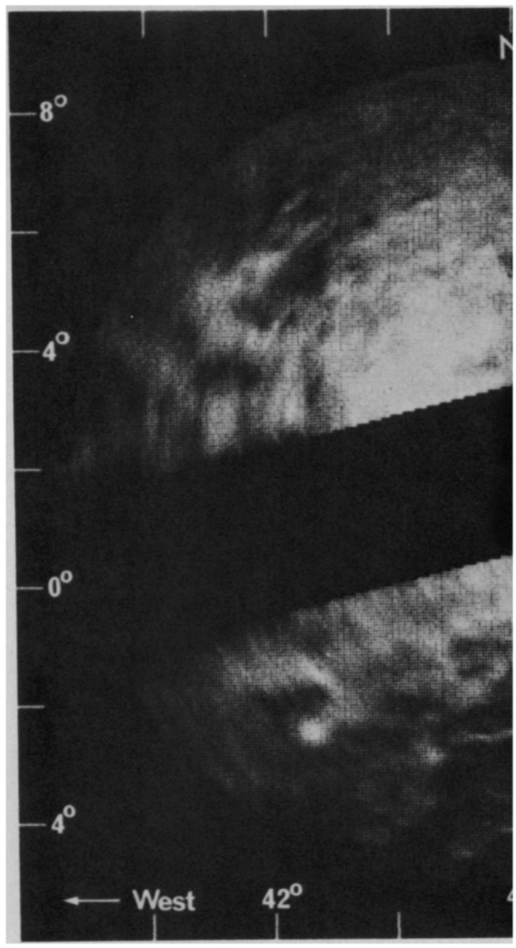
Our cratered sister planet

A ground-based radar map of Venus reveals craters on the equator as large as 100 miles in diameter



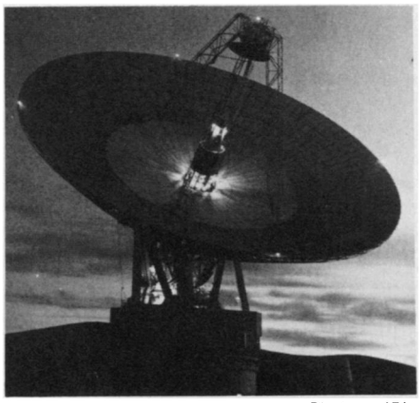
Craters on surface of Venus show as dark

by Everly Driscoll

A new radar map of Venus—the most detailed such map ever obtained—shows that the surface of the cloud-covered planet is pocked with craters.

Or at least one swatch is—an area 910 miles across, about the size of Alaska. The region contains a dozen large craters ranging from 21 miles across to one 100 miles across and possibly many smaller craters invisible to the radar. The craters are all relatively shallow. The 100-mile-wide crater is only a quarter of a mile deep.

"This area of Venus appears to be as crater-infested as the moon," says Richard M. Goldstein, head of the radar mapping team that produced the map at the Jet Propulsion Laboratory (JPL) in Pasadena. The whole area itself is basically flat, says Howard C. Rumsey, the team member who devised the computer techniques for making the map. The area may vary by no more than about 3,300 feet in altitude. "The surprising thing is to discover any craters at all," he says.



Photos: JPL

Goldstone 210-foot dish sent signals.

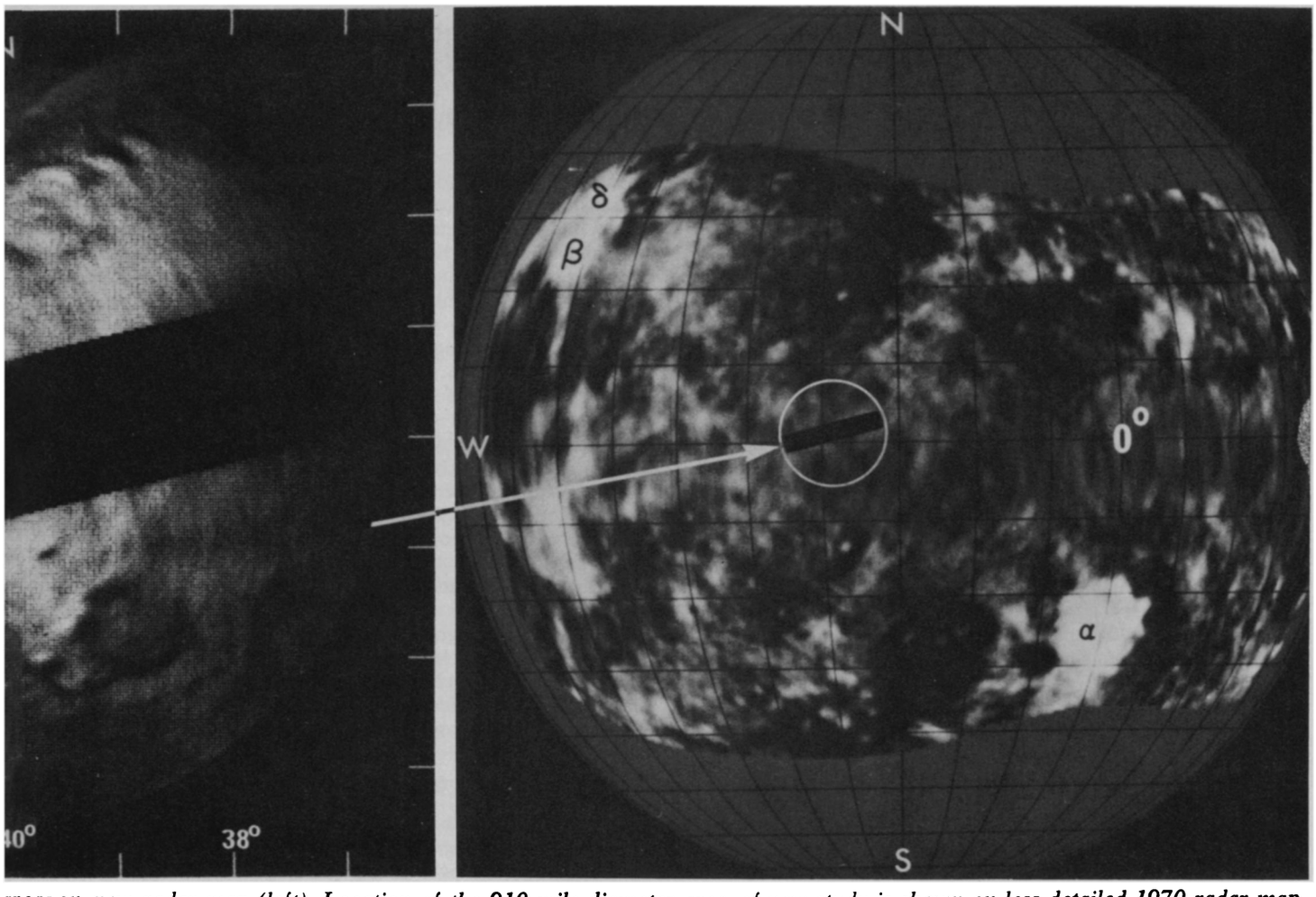
Why are the large craters so shallow? "That question," says Goldstein, "is bound to be important relative to the internal and external processes that have gone on [and may still be going on] on Venus." The shallow craters could be the result of preatmospheric bombardment of the planet and then subsequent isostatic readjustment. Extensive internal degassing may have flooded the craters with a fill such as lava. Or subsequent erosion on the surface could have filled the craters with dust.

"The shallower the craters are," says Harold Masursky of the U.S. Geological Survey, "the more dynamic the crust of a planet is." He, along with many others who have been studying the craters on the earth, moon and most recently Mars, is ecstatic about the craters on Goldstein's map. "Several of us are convinced that the surface of Venus will help us understand the earth's crust and the dynamics that lead to continental drift." He suggests that Venus' crust may be even more mobile than the earth's crust, because Venus is still hot.

But to determine whether the craters were made shallow by isostatic readjustment or by lava fill, much-higher-resolution radar maps of Venus' surface would be needed. Masursky suggests that these might be obtainable from a spacecraft placed into orbit around Venus equipped with a radar altimeter and side-looking radar. NASA has been studying such a mission.

Certainly "seeing" through to the surface of a cloud-shrouded planet from earth—such as Goldstein's group has done—was no easy task. It took radar, an array of sophisticated computer techniques and signal-processing equipment and a year of painstaking work, just now completed. The results are images of the surface with a resolution of about six miles—five times better than the map of Venus the team produced in 1970.

The JPL scientists used two antennas—the 210-foot dish and the 85-foot dish at the Goldstone site near Pasadena. The 210-foot dish beamed a series of



areas on new radar map (left). Location of the 910-mile-diameter area of new study is shown on less detailed 1970 radar map.

radar signals at Venus June 20, 1972, to pierce the 13-mile-thick cloud bank that covers the surface. At that time Venus was 30 million miles from the earth. The radar beam made the round trip in a little over 5 minutes.

The return echoes were then received by both the 210-foot and the 85-foot dish, 14 miles away. "This, in effect," says Goldstein, "gave us stereo reception and enabled us to pinpoint each area touched on Venus."

The team scanned 500,000 square miles of the planet for four hours and was able to determine brightness and elevation differences of as little as 650 feet in an area of Venus previously unknown. This information they determined from the time-of-flight differences, the Doppler shift (the changes in the frequency of the radio waves caused by the rotation of Venus), and from the small time difference between reception at the two antennas.

The information was fed into the digital-processing computers (especially designed for this project), which can make 50 million additions and substractions per second. Two hydrogen maser clocks, one at each antenna, timed the reception of the returned echoes to an accuracy equivalent to one second in one million years. □

Next radar probes to coincide with Venus flyby

The Goldstein team plans to make more radar probes of Venus about the time the Mariner Venus-Mercury spacecraft (to be launched in November 1973) flies by Venus six months from now on Feb. 5, 1974.

The spacecraft will carry seven instruments including two television cameras. "It will be a very exciting mission with tremendous exploration yields," says Bruce Murray of the California Institute of Technology. Murray has been working on the mission for several years now and is head of the imaging team.

"There is no way we expect to see the surface, however," says Murray. "I think it would be a miracle if we did." What the scientists will see are clouds that cover Venus and the cloud structure itself near the terminator. The radar information of the surface could then be correlated with the cloud formations and structure. "We hope it will be helpful," says Goldstein of the radar surface maps.

The television cameras on the Mariner spacecraft—almost identical to the ones carried on Mariner 9 to Mars in 1971—have been improved. They are now equipped with 1,500 millimeter Cassegrain telescopes that will yield 150-foot resolution. They have also been equipped with ultraviolet sensors. These will help resolve the ultraviolet markings that have been observed to rotate around the planet about every four or five days.

The instruments on the spacecraft will take measurements of the planet for 17 days, according to N. William Cunningham, program manager of the mission at NASA headquarters. Venus will rotate under the cameras and other instruments as the spacecraft swings by on its way to Mercury.

"We are probably going to photograph some of the area Goldstein has been covering," says Cunningham.

"We sure hope we see a break in the clouds as we go by," he adds. But Cunningham admits he is a little bit more hopeful about space miracles than Murray.