A Violent Venus Seen from a Troubled Magellan

Scientists and engineers who had gathered at the Jet Propulsion Laboratory in Pasadena last week to revitalize planetary exploration tasted both the bitter and the sweet. The sweet was a technological triumph that returned the sharpest views ever of the cloud-shrouded surface of Venus; Magellan, NASA's first new planetary mission in a decade, looked like it was going to be a much needed success.

But even as Magellan was returning those revealing views, NASA experienced, yet again, the bitterness of technical imperfection. After the *Challenger* explosion, the shuttle hydrogen leaks, and the myopia of the Hubble Space Telescope, engineers were wrestling with a schizophrenic spacecraft whose erratic behavior threatened this crucial radar mapping mission to Earth's sister planet.

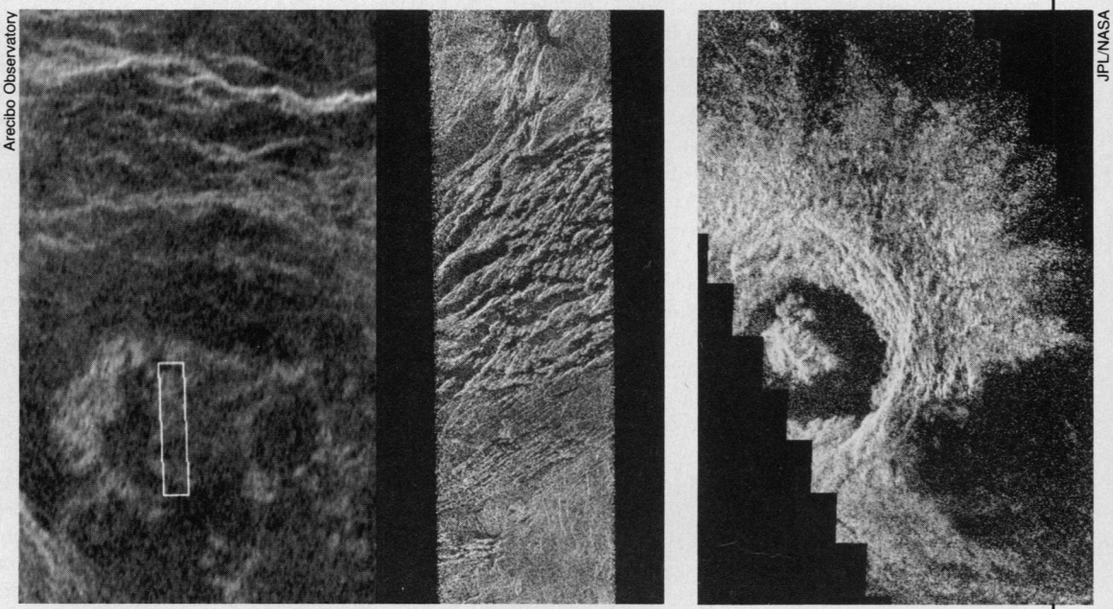
It all began with a missing heartbeat, the signal from the spacecraft's attitude control system that 90 times per minute reassures the spacecraft's brain, the command and data system, that all is well. When attitude control skipped a beat on 16 August, even as radar data were being returned, onboard computers played it safe by switching to backup components and beginning a search for Earth. This was a routine programmed into the craft. But the routine pointed Magellan away from its home planet because a backup memory contained incorrect data due to an earlier partial failure.

Bad became worse after the craft next went into a preprogrammed countdown toward a new search strategy. But before that could happen, it experienced a "computer transient"—something a computer does that it is not supposed to do at that time. Fortunately, this transient only caused a temporary pause in the countdown. But 13 hours after first losing contact, another computer transient serendipitously caused a switch from the faulty backup memory to the prime memory and instituted another search strategy that, much to the surprise of worried controllers, reestablished contact.

Within hours of an upbeat press conference about this episode and Magellan's prospects, disaster struck again: On 23 August, Magellan's signal faded away as if it had slowly turned away from Earth. This time it took 21 hours for JPL to reestablish firm contact with the balky craft. Once again, Magellan had somehow slipped into its backup search strategy as if following a whim.

Though JPL controllers have deciphered what Magellan has been up to, they still do not know what sets off its erratic behavior. At first they offered the possibility that a passing cosmic ray flipped a single bit in the computer to cause the missing heartbeat, but even before the second episode that seemed insufficient. As this issue went to press, engineers were considering the possibility that the separation of Magellan's spent rocket motor had somehow damaged the spacecraft.

Planetary scientists watching all this felt especially frustrated. Their technology had worked perfectly. Magellan's big radar antenna had beamed microwave signals at the hidden surface, received the echoes, and beamed records of them back to JPL. There, the echoes were processed into images of the Venusian terrain with a resolution of 120 meters. That is a level of detail ten times greater than two Soviet radar mappers managed in the mid-1980s. For the first time, geologists can begin to identify the processes that formed many of the features identified by earlier mapping. So the goal is in sight: radar maps of most of Venus enabling researchers to decide how the Venusian crust is created and deformed and whether there is any role for plate tectonics on Venus (*Science*, 17 August, p. 742).



A sharper view. *The Magellan spacecraft's radar mapper returned images of a 75-kilometer strip of Venus's surface showing parallel mountains and lava-filled valleys (center image) that were a smudge in the box shown on an Earth-based radar image (left). A 34-kilometer impact crater (right), also lava-filled, stands out as well.*

The sliver of a map 60 kilometers wide and 7000 kilometers long deciphered from Magellan's first look will not permit geologists to make any grand pronouncements. But it did produce one surprise. Looking just east of Beta Regio, a region previously known to contain huge volcanoes and a long rift torn in the crust, Magellan mapped ridges, valleys, fractures, and lava flows. Such features had been seen on the less detailed maps made before, noted Stephen Saunders of JPL, the Magellan project scientist, but he added: "I am somewhat surprised at the degree and pervasiveness of fracturing, even on some of the lava flows that are presumed to be rather young. My supposition is that Venus is much more violent than I thought before."

The test of that supposition will come when, or if, Magellan looks at other areas around the Venusian globe and breaks the jinx that has plagued NASA.

■ **Richard A. Kerr**