is identified, noting that "we'll take as long as necessary to isolate the cause."

Although frustrated by the delay, astronomers have not criticized NASA's decision to play it safe. Unlike the Hubble Space Telescope, Chandra cannot be rescued by astronauts because it will orbit far beyond the shuttle's operating range. However, the delay may cause Chandra to lose its place in NASA's queue because Columbia, the only shuttle equipped to launch Chandra, is due for a major overhaul later this year. If the error isn't found before the Columbia is taken out for refurbishing, "it could delay the launch for at least a year," says Fred Wojtalik, Chandra program manager at NASA's Marshall Space Flight Center in Huntsville, Alabama. In the meantime, Chandra costs NASA $6 million a month while it cools its heels in a warehouse at the Kennedy Space Center in Florida.

The silver lining in Chandra's cloudy life is that the delays haven't jeopardized its scientific mission. Chandra may miss out on time-dependent observations such as peeking at a comet due to make its appearance later this year or a coobservation of Jupiter together with the Galileo spacecraft, says Harvey Tananbaum, director of the Chandra X-ray Center at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. "But the results will be just as spectacular," he promises, when it's finally lofted into orbit.

–MICHAEL HAGMANN

With reporting by David Malakoff.

PLANETOLOGY

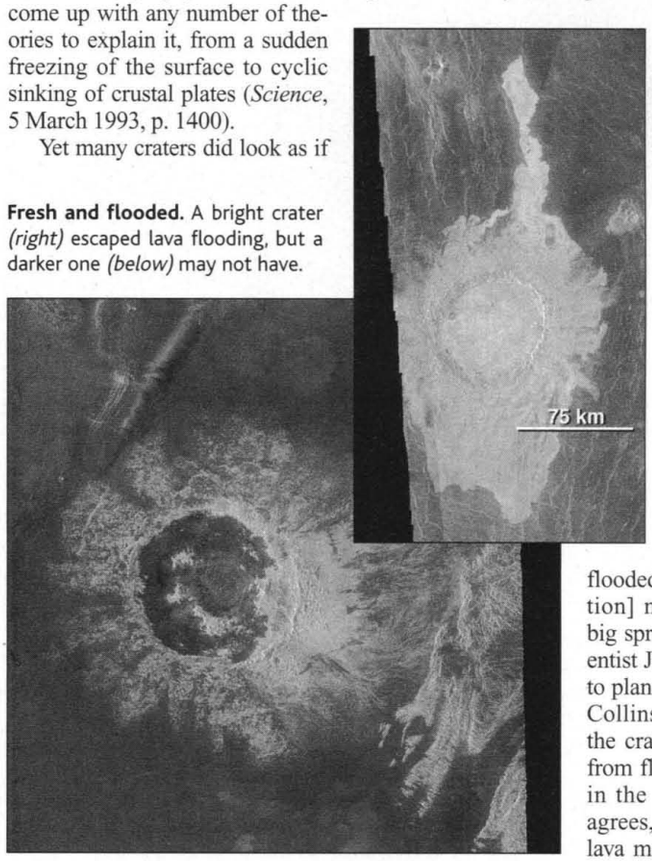
Craters Suggest How Venus Lost Her Youth

For a planet, volcanism is the secret to a youthful appearance, because it smooths the surface with fresh lava. Venus stopped getting these fiery beauty treatments long ago, and after the Magellan spacecraft flew by the planet in the early 1990s, some researchers concluded that the end was abrupt. Magellan's cloud-penetrating radar saw half a billion years' worth of impact craters pocking the plains created by earlier lava flows. Almost all of those craters looked like bare, raw scars untouched by any later lava flows, implying that the volcanic outpourings had shut down in a geological moment. Some researchers found it hard to swallow the idea that Venus had given up its volcanic activity so suddenly, however, and now they may have new reason to wonder.

A new analysis of Magellan radar images by planetary geologists Robert Herrick of the Lunar and Planetary Institute in Houston and Virgil Sharpton of the University of Alaska, Fairbanks, suggests that many venusian craters have in fact been altered by later lava flows, reopening the possibility that Venus was active after the supposed shutdown. The idea that global volcanic activity shut off in just 10 million or even 100 million years "is clearly wrong," says Herrick. Most researchers aren't so convinced, but "it's exciting," says planetary radar specialist Ellen Stofan of University College London and the Jet Propulsion Laboratory (JPL) in Pasadena, California. "I think they're on the right track."

Earlier analyses of the Magellan images seemed to show that only 5% to 10% of craters had been flooded by lava, suggesting that the Venusian volcanoes had shut off like a faucet. Entire planets weren't supposed to do that, but geophysicists soon managed to come up with any number of theories to explain it, from a sudden freezing of the surface to cyclic sinking of crustal plates (*Science*, 5 March 1993, p. 1400).

Yet many craters did look as if lava had smoothed the crater floors, making them dark in radar images. That lava was usually presumed to be rock melted during the impact, but, in work presented at the recent Lunar and Planetary Science Conference in Houston, Herrick and Sharpton decided to test that assumption by measuring how deeply lavas might have flooded outside the craters as well as inside them. On a limited number of orbits, the Magellan radar imaged the same crater from two different angles, so the pair of images could create a three-dimensional stereo image. That allowed the researchers to measure, for 70 craters, the relative heights of each crater's rim, floor, and surrounding terrain.



Fresh and flooded. A bright crater *(right)* escaped lava flooding, but a darker one *(below)* may not have.

CREDIT: JPL/NASA

With this 3D perspective, Herrick and Sharpton say they can see lava not only filling crater interiors but also flooding around seemingly pristine craters. On average, both the crater floors and surrounding terrain were higher, relative to crater rims, than the floors or surroundings of bright-floored craters. "That must mean these things are not only being filled on the inside, but they're being surrounded on the outside too," says Herrick, implying that Venus's volcanoes did indeed ooze lava during the past 500 million years. "It's going to change thinking about the whole planet."

Other researchers are not quite so sure, but many are impressed with the analysis. "It's clearly a significant finding," says planetary geologist Maribeth Price of the South Dakota School of Mines and Technology in Rapid City. Stofan's inspection of Magellan images is also suggesting that more of the craters are flooded by lava than had been thought, she says. "It seems some of [the stereo] data are pointing the same way."

But other scientists note that venusian craters of variable elevations may be masquerading as lava-flooded craters. "Their [elevation] numbers show a pretty big spread," says planetary scientist Jeffrey Plaut of JPL. And to planetary geologist Geoffrey Collins of Brown University, the craters look very different from flooded craters elsewhere in the solar system. Herrick agrees, but says that venusian lava may have been more viscous and less voluminous than that found on, for example, the moon, which might make venusian flooding less obvious.

A closer look around the craters may help settle the debate, says planetary geologist George McGill of the University of Massachusetts, Amherst. He inspected Magellan images of 17 of Herrick and Sharpton's supposedly flooded craters and says he spotted telltale surface features, such as tiny craters from impact ejecta, near some of them. These nearby features must have been there when the original crater formed, he notes, and would have been obliterated by any flooding. A more complete count of such features may reveal whether the onset of Venus's old age was jarringly abrupt or more graciously measured.

–RICHARD A. KERR