Eyes on Venus: A new dimension

To the outsider, the atmospheric veil of Venus conceals all, transparent only to the blind probings of radar. The planet hides her secrets well, and the penalty for looking directly upon her face is death. A handful of Soviet Venera landing craft have been sent to steal a glimpse (no U.S. probes have tried), only to succumb after an hour or two in the intense heat and pressure. Yet a few brief, attempted glances have been successful, each adding a tiny but significant fleck to the barely begun portrait of earth's eminently non-identical, Hadean "twin."

And now there is one "fleck" in color.

The first photo ever taken of the surface of Venus was made by Venera 9 on Oct. 22, 1975. Touching down on the planet at about 32°N by 291°, it survived just 53 minutes, but in that time it managed to transmit a single image, black and white, distorted, low in resolution—but unique (SN: 11/1/75, p. 276). The camera's first revelation, in fact, was the fact that it could see at all, since there had been no proof that enough sunlight for photography even reached the ground.

It was less than six and a half years ago, yet knowledge of the planet's surface was virtually nonexistent. Remarkably sharp-edged, young-looking rocks filled the scene. "This seems to knock the bottom out of the existing hypothesis by which the surface was expected to look like a desert, covered with sand dunes because of constant wind and temperature erosion," said Venera scientist Boris Nepoklonov. "Even the moon does not have such rocks. We thought there couldn't be rocks on Venus—they would all be annihilated by erosion—but here they are, with edges absolutely not blunted. This picture makes us reconsider all our concepts of Venus."

Venera 10 landed three days later, about 2,200 kilometers away at 16°N by 291°, and provided another tiny glimpse of a rock-strewn surface (SN: 6/19/76, p. 388). In addition, gamma-ray spectroscopy from both landers indicated radionuclide abundances typical of basalt, supporting U.S. earth-based radar studies that some researchers believed to be showing major volcanic features. The two craft had landed just off the northeastern and southeastern flanks of a region known from the radar maps as "Beta," already suspected of being a vast volcanic construct and now thought to be perhaps the likeliest spot on Venus to have eruptions still in progress.

Still, there were only the two photos, taken by panoramic cameras at downward angles that gave them the exaggerated curvature of a funhouse mirror. It was a year and a half before Soviet researchers provided corrected versions (SN: 4/16/77, p. 252), and the next two Veneras, in December of 1978, provided no photos (and little other surface data) at all.

Last month, however, Veneras 13 and 14 reached the planet and abruptly tripled the size of the Venus photo gallery. Each was equipped with a pair of cameras, angled down opposite sides of the landers' bulbous bodies, and together the twin craft imaged four more bits of the heretofore unseen terrain (SN: 3/20/82, p. 197, and this issue, p. 245). The cameras show far sharper resolution than their 1975 predecessors, but they also came equipped to make a dramatic addition: color.

Soviet accounts suggest that the camera systems were designed to provide color by scanning their scenes successively through red, blue and green filters. (The cameras of the U.S. Viking landers on Mars worked instead by focusing the light onto a series of photodiodes, each sensitive to a different part of the spectrum.) Only one color Venus photo has so far been released, presented to U.S. researchers at the recent Lunar and Planetary Science Conference in Houston, and it remains unclear whether the other three images were taken in color or only black and white.

The sole example, shown above, was taken by Venera 13 only minutes after its March 1 landing on Venus at 7°30′S by 303°, just east of a region known as Phoebe (see cover). The image is still in preliminary form, and like the black-and-white photos it still shows the geometric distortion caused by the oblique, wide-angle close-up. This is expected to be corrected in processing, transforming the frame into a cup-like shape.

It is not known how additional processing will affect the color

Enduring the hot, dense atmosphere of Venus, a Soviet spacecraft has provided the first look at the planet's surface in color

balance. The checked strip at right is a color-test chart, which, says Harold Masursky of the U.S. Geological Survey, probably includes what under earthly lighting would be shades of blue and green as well as the apparent red-orange hues. The Soviets have reported that the planet's sky is "orange," as seems to show in light reflected from the spacecraft's landing ring in the foreground. (The jagged "teeth" around the ring are "spoilers," designed to keep the lander from swinging as it hung from its parachute lines during its descent. Several years ago, the Soviets provided the U.S. Viking project with data on such descent-aerodynamics, based on experience with Soviet Mars landers in the early 1970s. The other piece of hardware in the color Venera photo, just left of center, is the jettisoned protective cover for the camera's viewing window.) James Pollack of the NASA Ames Research Center has suggested that an orange-ish sky over Venus would not be unexpected, since the dense atmosphere would distort and absorb the blue wavelengths of incoming sunlight. What appear to be patches of sky at the photo's upper corners show only a pale orange tint, but this could be due to lighting and exposure effects.

The brownish hue of the surface, while it could be that of a gray-black terrain (like that of earth's moon) seen through the Venus atmosphere, is what some researchers would expect to result from highly oxidized material. The color of Mars, for example, is essentially that of rust — oxidized iron. (The similar though paler color of the Martian sky — a much thinner and thus less blue-absorbing atmosphere than that of Venus — has been attributed to suspended particles of surface dust.) Free oxygen is almost non-existent in the Venus atmosphere, but recent analysis of deuterium:hydrogen measurements from the U.S. Pioneer Venus mission has indicated to the University of Michigan's Thomas M. Donahue and colleagues that the planet once had a veritable ocean's worth of water (SN: 12/12/81, p. 372). The water would have long since dissociated in the heat, letting its hydrogen escape into space, but the heavier oxygen could have stayed behind to oxidize the crust. Furthermore, notes Jeffrey L. Warner of the NASA Johnson Space Center, although the present Venus atmosphere has a far smaller percentage of water than earth's, it also has a far greater total pressure, so that the partial pressure of water on the two planets is about the same. The fact that Venus is also hotter than earth by more than 400°C, he says, means that water there has a greater "activity," or potential for such reactions as oxidation and erosion.

The overall appearance of the scene, says Masursky, "fits perfectly" with expectations based on earlier studies. Radar maps from the Pioneer Venus orbiter and from the Arecibo and Goldstone on earth showed the topography and roughness of the region (and indeed of much of the planet) to be typical of basaltic lava flows. Soviet analyses of X-ray fluorescence spectroscopy conducted by both Veneras 13 and 14 indicate the presence of tholeitic basalt, "the commonest kind on earth and the moon." Such basalts, he says, often form in layered flows, and U.S. and Soviet researchers alike have noted the layered appearance of the landing sites. Also typical of such floodlike "effusive" flows is the lack of large vesicles, or remanent gas bubbles, such as might have powered more explosive eruptions.

Both of the Venera 13 photos show abundant small particles on the surface (the Venera 14 site appears much "cleaner"), and scientists have suggested that physical and chemical erosion could be particularly active on Venus. Winds near the surface are slow, however, and James Garvin of Brown University points out the lack of "wind tails" — accumulations of fine particles on the lee sides of the larger chunks. On the other hand, some observers have said that the "fines" appear concentrated around the lander, as though they were formed by the spacecraft's impact, so that there might simply have been no time for wind tails to form.

The rush of recent U.S. and Soviet data from Venus had enabled major advances in addressing the planet's mysteries, but as the photos indicate, numerous questions remain. All six successful Venera cameras, after all, have photographed perhaps the equivalent acreage of a modest park. — JONATHAN EBERHART