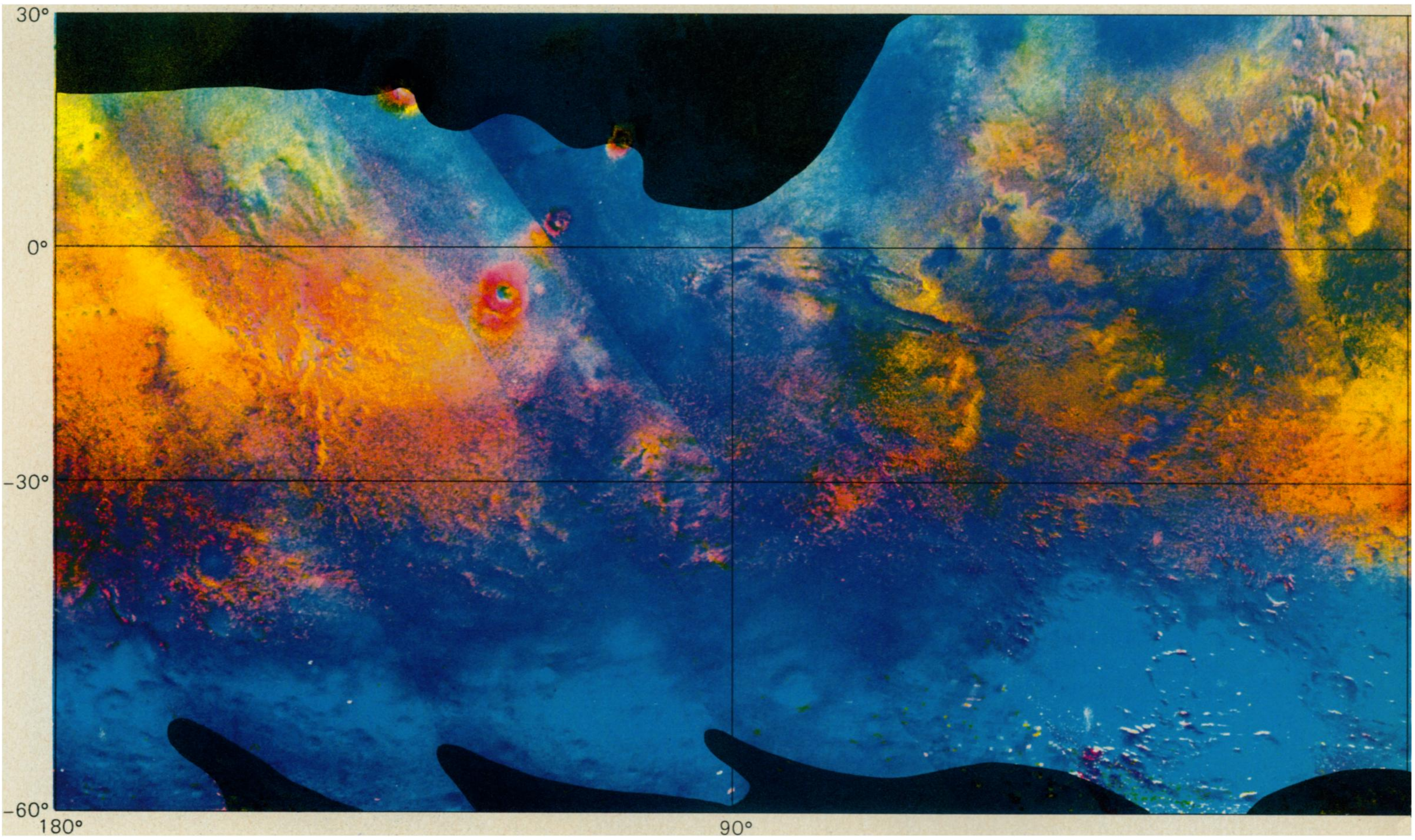


A MARS OF MANY COLORS

Repainting the red planet reveals details invisible to the naked eye.

BY JONATHAN EBERHART

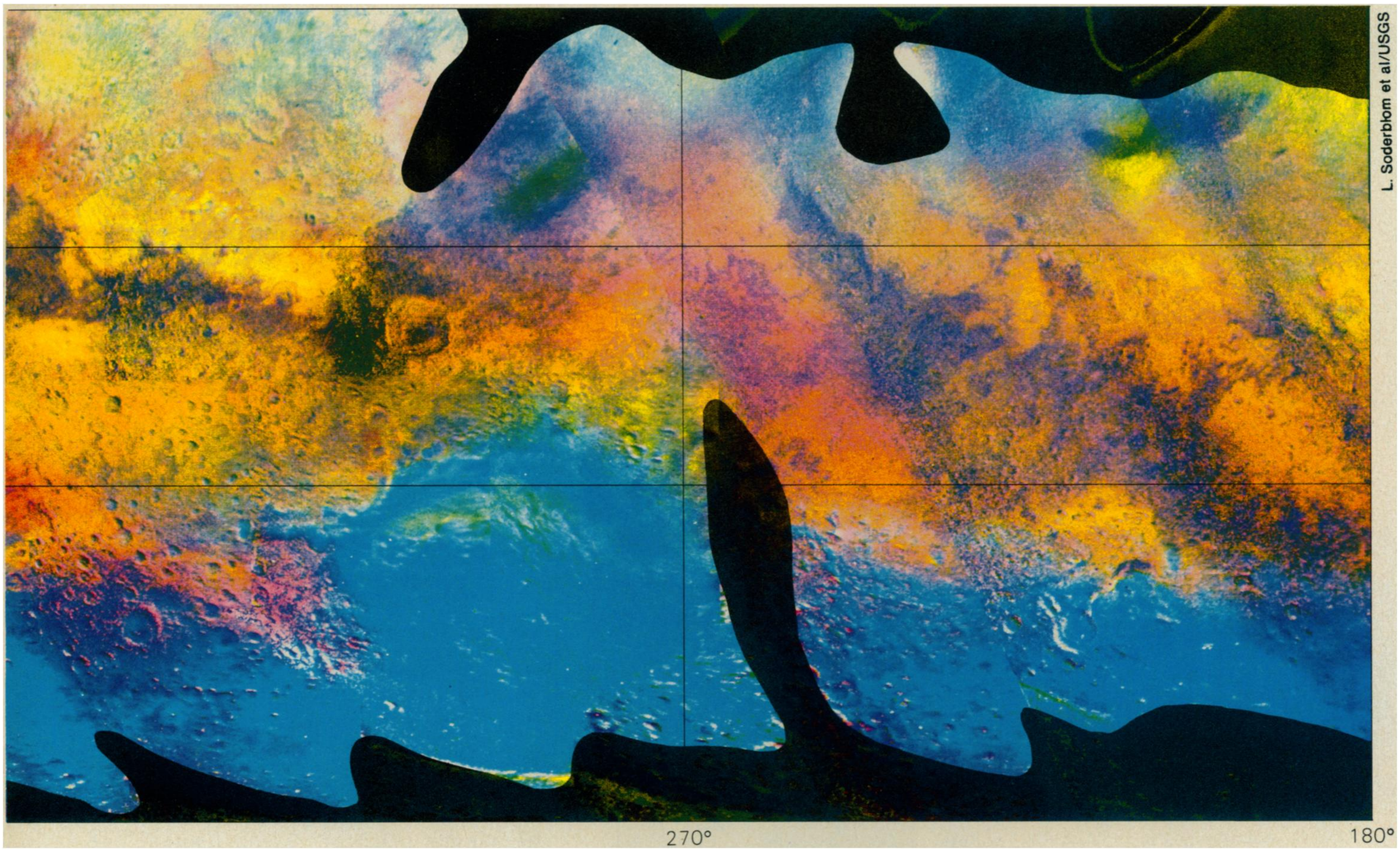
First you simply look up at the planet in the night sky, later interpolating a telescope. Next you shoot a spacecraft past the place, snapping some quick pix on the fly. Then you put one into orbit and go mapping. And finally, at long last, comes the landing. The quest seemingly is at its end; you've sent your vision off from a little spot on your world to a little spot on another. But it is only a little spot. To really appreciate its value, you must step back from it, take the global view again and transform what could otherwise become myopia into perspective on the scale of an entire planet. It was the planet, after all, not any exclusive spot on it, that drew you onward in the first place.

Earth's moon, for example, has been probed at various sites by Rangers, Surveyors, Apollos and a variety of Soviet spacecraft. Yet scientists are now pressing for a Lunar Polar Orbiter, an unmanned craft designed to back up and survey the broad picture of the moon, tying together those isolated samplings of the surface.

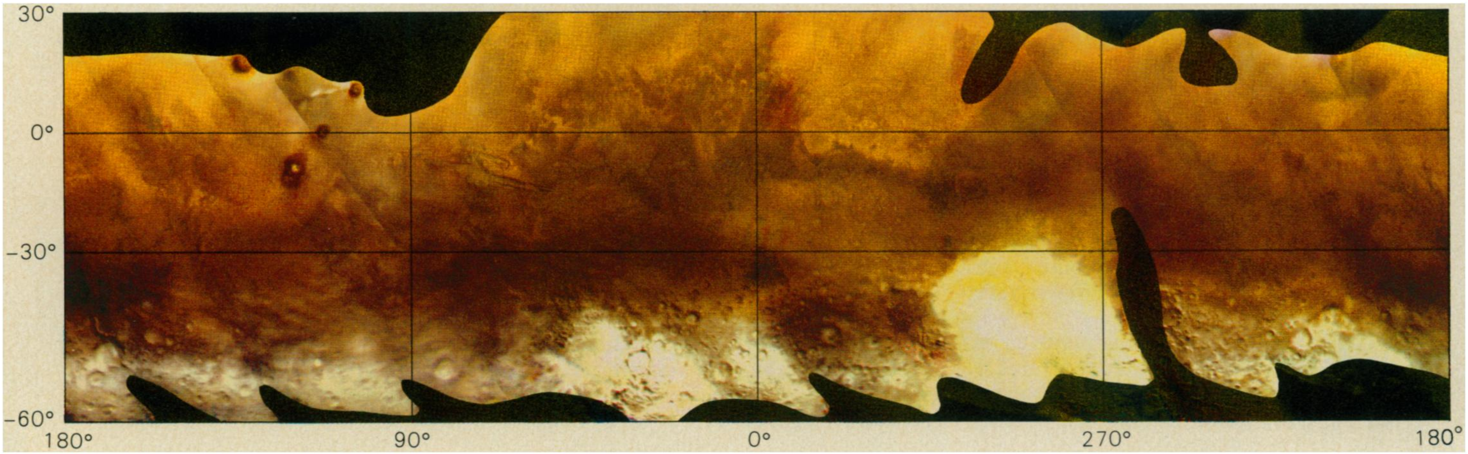
The need for the global view may be even greater for Mars, with its polar caps, planet-wide winds and diverse types of terrain. The Viking landers have sniffed, tasted, touched and listened to their little patches of Mars, but researchers continue to seek newer and better ways of understanding the broad-scale planet.

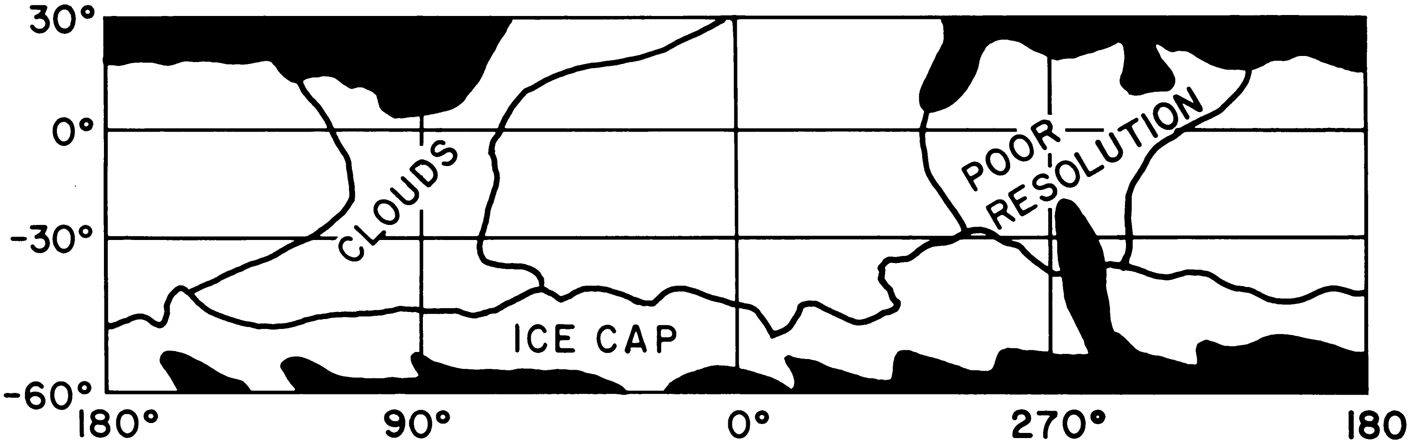
The colorful map shown here is the result of one such effort. Created from photos taken by Viking 2 shortly before it took up orbit around Mars in the summer of 1976, it makes different types of Martian terrain stand out in a way that closer views or natural colors cannot. It was produced by Lawrence A. Soderblom, Kay Edwards, Eric M. Eliason and colleagues from the U.S. Geological Survey in Flagstaff, Ariz., who have also been working on a "whole moon catalog" of comparative lunar data (SN: 5/7/77, p. 300).

The map began with 16 color photographs—actually 16 three-photo sets of



Global color variations on Mars are shown in this "false-color" composite (above) assembled from photographs taken by Viking 1 shortly before it entered its circum-Martian orbit. The original data consisted of 16 images, each photographed at three different wavelengths: 0.45 microns (violet), 0.53 microns (green) and 0.59 microns (red). The images were then processed in two ways: First, the round images of Mars were combined and reshaped by computer into a Mercator projection. Next, the color data were redistributed so that, in the finished product, blue shows the ratio between the brightnesses of the original violet and green; red shows the original red-to-green ratio, and the present green shows the planet's albedo (reflectivity) at 0.59 microns. The map shows the planet's full circumference from about 30°N to 63°S, with the blacked-out areas representing regions where the data were considered unreliable due to atmospheric distortions, data-transmission problems, high phase angles and other causes. Each "pixel," or picture element, represents 2.5 kilometers at the equator. The original, natural-color Mercator image (before being processed by the false-color scheme) appears below.





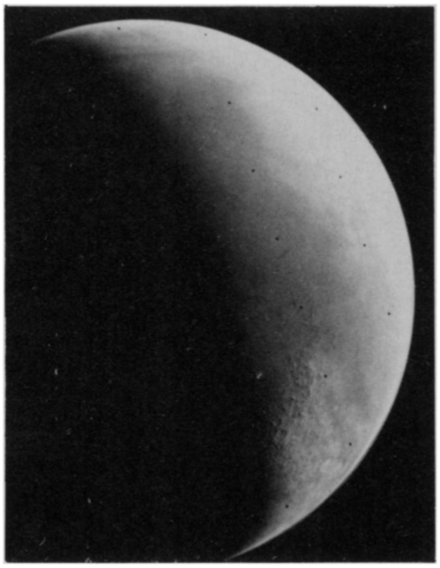
"Confidence key" to the color maps on pp. 326-327 shows where atmospheric effects and other factors may affect interpretation.

near-identical violet, green and red images—showing Mars as the round planet that it is, taken while the spacecraft was from 400,000 to 200,000 kilometers distant. The pictures were then combined and reshaped by a computer into a Mercator projection that shows the entire circumference of the planet from about 30°N to 63°S.

The colors are produced by recombining the brightnesses recorded through the three selected color filters in the Viking camera system. The violet image shows the planet at a wavelength of 0.45 microns ± 0.03; the green is 0.53 ± 0.05, and the red is 0.59 ± 0.05. Conventionally combined, they produce a natural color image, like the smaller map shown. The USGS group, however, wanted to show differences that the natural colors would not necessarily reveal. A similar task faces the researchers who process Landsat images of the earth, trying, for example, to bring out brown water next to brown soil. The key is that, although such features may have the same color to the naked eye, they reflect different amounts of light at different wavelengths. Thus Landsat—and Viking—carry cameras that can take pictures at several different wavelengths, so that proper choice of wavelengths can distinguish among different types of surface—wet, dry, rough, smooth, loose, hard-packed, etc.

The USGS "false-color" map thus combines three color bands, as does the original, but they use the color data in a different way. Blue, in the finished product, represents the ratio between the 0.45-micron brightness (the original violet channel) and the 0.53-micron brightness (the original green channel). Red now represents the ratio between 0.59 microns (the original red) and 0.53 microns. The remaining color, green, shows not a ratio, but albedo—simple reflectivity—at 0.59 microns. When the newly assigned colors are combined, the Mars that emerges is a very different one indeed.

The entire spectral band involved is only 0.14 microns wide, extremely limited compared to earth-based data, but the USGS group estimates a 50-fold advantage in spatial resolution. (The Viking orbiters are now compiling pole-to-pole coverage which promises to reveal details perhaps 15 times smaller still, since the photos in the present map were taken before the spacecraft had reached the planet.) There are other problems, however, such as atmospheric hazes that interfered with the surface entirely. Parts of the map have thus been masked off as misleading, while the accompanying key identifies regions where clouds or the icy southern cap are dominant.


Round image became Mercator component.

Some individual features stand out in the finished product, such as Olympus Mons and the other huge volcanoes on the Tharsis uplift, which appear as bright red spots. The large, light blue area at about 290° probably represents near-surface frosts in Hellas basin. More often, however, the color changes represent broader terrain shifts, many of which are prominent in the region from the equator to 30°S that is the USGS team's primary area of interest in the map.

This region, they say, seems to consist primarily of two general "provinces": an older, reddish unit rich in ridges, rugged plateaus, crater rims and other topographic "highs" and a younger region of intercrater plains suggestive of lunar maria. This younger terrain, by the conventions of the map, is "among the bluest lithologic units on Mars." (The "blue" is just a slight variation in spectral slope, of course; to the eye, virtually everything would show the characteristic reddish brown that has made the "red planet" famous.) The large Tharsis volcanoes, believed to be among the youngest features on the planet, apparently are an unusual exception to the old-red/young-blue pattern.

North of the south equatorial belt are some brighter regions which the researchers believe to represent mantles of wind-borne debris. In the belt itself, however, the color variations "are apparently directly related to the local lithology, not to random aeolian debris dispersed about Mars." One sign of this is that the color boundaries in the belt appear "systematically abrupt" along major age and terrain-type boundaries. Also, the color within each province seems uniform, rather than varying within the sharp-bounded areas.

In the more northerly regions apparently dominated by soils (as opposed to lava flows, for example) and aeolian material, there also seem to be two basic surface types: the darker regions show an older material with relatively little vertical relief or change in morphology, while the brighter soils—apparently the brightest on the planet—are stratigraphically higher, with the subsurface topography showing a "serrated" effect with a northeast-southwest "grain."

As for the big volcanoes on Tharsis, as well as for some of the ancient highlands, their dark red color remains an open question. The USGS researchers feel that these areas are prime targets for further earth-based spectral studies—which means telescopes. From the telescope followed the flyby spacecraft, the more sophisticated orbiter and the spectacular lander. Then it's back to the orbiter's broad-scale view, and then back to the terrestrial telescope, with its freedom to search wide spectral bands. The circle closes. □