Optical Environment in Gemini Space Flights

In their report [*Science* **153**, 297 (1966)] Ney and Huch give a detailed discussion of the scattering mechanisms they think may be responsible for the inability of orbiting astronauts to see stars in the daytime. They overlook an additional cause of the difficulty—scattering in the observer's eye. The intensity of ocular scattering is sufficient by itself to make impossible the observation of first-magnitude stars if the level of illumination on the face of the observer exceeds about 1000 lux (100 ft-c). Unless the viewing window of the space capsule is protected by a conical sunshade it will be difficult to reduce the interior illumination below this critical figure, even if the other window is obscured by a blind, as 1000 lux is only about 1 percent of the outdoor daylight level.

This fogging effect of ocular scattering is often experienced by city-dwelling astronomers who find that it is impossible to see the Milky Way within about 90 deg of the direction of a single street lamp that produces an ambient light level only about 0.01 percent that of daylight. That ocular scattering, rather than atmospheric scattering, produces the observed loss of contrast in the visual image of the sky can be shown by stepping into the shadow of the lamppost. The Milky Way can be seen immediately.

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Martian and Lunar Craters

In the next decade, it seems, the study of Mars may include as much prejudice and diversity of unqualified opinion as interpretation of the moon has suffered in the past. With the imminent advent of manned exploration of the moon, the interpretation of the lunar surface is approaching a definitive phase, and it would seem a pity if the same unfounded prejudices and fallacies regarding the lunar surface were transferred to Mars prior to direct exploration of the planet. Diversity of opinion, however, is to be welcomed as a stimulus to new fields, provided individual opinions are schooled with a variety of experience and provided the explanations for a given set of observations are scientifically acceptable. This approach is now particularly important in the field of planetary science, which calls for a combination of many different disciplines—for example, astronomy, physics, geology, and meteorology.

With these points in mind we wish to comment on a paper by Öpik (*1*) in a recent issue of *Science*.

Citing Fielder (*2*), Öpik states that attempts to ascribe a volcanic origin to Martian features can be "ignored completely." Such a statement made in connection with the evaluation of photographs that are so recent as the Mariner photographs is surprising! Decades of study of lunar photographs of a similar type have not resulted in lunar volcanism's being disregarded by impact-hypothesis adherents of even Baldwin's (*3*) standing. Indeed, as far as the moon is concerned, the general tendency is for opinion to be swaying over to admit an increasing proportion of endogenic features among features previously considered impact phenomena (*4*, *5*).

Öpik goes on to say that the presence of volcanic formations on the moon or Mars remains to be proved. Many authors, ourselves included, would dissent from this view. The evidence for lava flows and volcanic craters on the moon is indisputably strong (see, for example, *5*).

Fielder's note (*2*) on Martian volcanism was based on the following argument (*6*). Many years of study have shown that the moon is partly volcanic; the ring structures, craters, and lineaments of Mars are remarkably like those of the moon; therefore Mars has probably been shaped in part by volcanic forces. This view contrasts with Öpik's categorical statements (*1*) against volcanism, which are not adequately backed, in his articles, by destructive or even critical arguments.

Öpik's next statement is equally misleading: "The lunar and Martian craters bear close resemblance to terrestrial meteor craters and are very different in structure from terrestrial volcanoes and calderas." First, he fails to recognize that the lunar craters and rings cannot be grouped together as one type; there are many different types, and Öpik is clearly displaying strong prejudice in assuming that the craters are virtually all impact phenomena. The vast majority of lunar craters and rings and Martian rings do not bear a close resemblance to proved terrestrial meteoritic craters. Second, there is a strong morphologic similarity between certain lunar and Martian rings, on the one hand, and terrestrial volcanic features on the other; this statement is contrary to Öpik's and is based on a protracted study reported in *Lunar Geology* (*7*), from which we may quote, concerning a terrestrial volcanic ring: "This caldera is much more lunar than any known meteoritic crater."

Öpik ends his paragraph or arguments against lunar and Martian volcanism with the comment that meteor craters are an observational fact. We feel tempted to ask if volcanic craters are not even more of an observational fact!

Regarding Mars, Öpik states that "the evidence of 'leeward clouds' occurring on the maria borders . . . would appear rather dubious to anyone who has systematically observed the planet. . . ." If Öpik is referring to the observations' being dubious, then his statement is erroneous, since the observations Wells has discussed elsewhere (*8*) were originally made by some of the most systematic astronomers who have ever observed the planet—Lowell and Douglass (*9*), Antoniadi (*10*), Dollfus (*11*), and Focas (*12*), the latter two observers having contributed the most recent observations which originally led to the comparison with lee-wave clouds.

In a similar manner Öpik regards as improbable the suggestion that the Martian maria are highlands, simply because the "darkish" dust covering them would be continuously wandering into the lowlands and thus blurring the observed sharp boundaries of the maria. Also he assumes that the reappearance of the dark maria after being covered with light-colored dust from the deserts is only attributable to some "peculiar" property of the maria—that is, to plants shaking off the dust covering.

It is, in fact, not necessary to the hypothesis for dark dust to be moved about on the surface. A variation in the size of grains making up the maria would produce the observed albedo changes. Fractionation of grain sizes in relation to elevated areas and its effect on the maria have been discussed by Rea (*13*). If the maria