errors in the Russian data and their interpretation, the lunar surface is a very unlikely source for tektites. If, as some workers believe, K was volatilized during tektite formation, then larger concentrations of this element would be required in the parent material, leading to an even more severe disagreement with the Luna-10 observations. Further experiments will no doubt shortly resolve these problems.

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Slopes on the Moon

O'Keefe, Lowman, and Cameron (*1*) argue that the slopes of the Flamsteed Ring could not be produced by mass wastage, but are the fronts of coulées or very viscous acid lava flows. Several of their points call for comment.

The slopes of the Flamsteed Ring are lower than the angle of repose of broken rock and do not have the profile of terrestrial talus slopes. Does this mean that all processes of mass wasting can be eliminated from consideration? The angle of repose is the angle at which fragmental material will stand when gravity is the only accelerating force and rolling of fragments on the surface is the principal mechanism of slope modification. But if there are any other disturbing forces, such as shaking by earthquakes, the mechanics are different and the stable slope will be gentler than the angle of repose. Seed and Goodman (*2*) have investigated the stability of slopes of dry sand subjected to horizontal accelerations. They found, for example, that for sand with an angle of repose of about 40°, a horizontal acceleration of $0.5g$ causes visible slippage and one of $0.8g$ causes failure on slopes as low as 21°. Moreover, their work provides a basis for explaining the convex bulge at the toe of many lunar slopes, one of the most striking and unexpected features of the Orbiter photographs (*1*, fig. 1). Seed and Goodman found that even a small shear strength (which can arise merely from the interlocking of grains and does not imply cohesion) has a very significant effect on the nature of sliding. First, it causes sliding to occur on a critical surface which lies some distance beneath the surface of the slope. This introduces a secondary effect of the passive resistance of the base to the sliding mass at the toe of the slope. The resultant pattern of sliding thus can be very complicated, but a typical slope (*2*, fig. 17) has a convex bulge at the toe. The effect of shear strength is an inverse function of the length of the slope and would be small for slopes of sand greater than 15 meters. On the other hand, shear strength is a direct function of particle size (*2*). The profiles of the walls of Flamsteed Ring are thus not inconsistent with their being slides of noncohesive boulder-sized fragments activated by moonquakes (*3*).

Talus slopes on Earth have a different profile because they are controlled by processes occurring at the surface, such as rain wash or rolling of frost-heaved boulders, rather than by ground accelerations from infrequent seismic events. Where slopes of similar profile are found terrestrially, they are produced by processes involving internal cohesion, such as solifluction in permafrost regions. Some cohesion of the materials on lunar slopes is probably indicated by the fine-scale patterning of the ground.

If the slopes of the Flamsteed Ring are underlain by fragmental debris, this, of course, says nothing about the origin of the Ring itself and does not preclude its being a ring of coulées. Loney (*4*) has mapped a coulée at Mono Craters, California, and found that the front of the flow as it advanced was covered by a talus slope of blocks. The interpretation of the Flamsteed Ring as the surface expression of a ring dike seems dubious, however. The comparison with the ring of volcanoes in the Valles Caldera (*1*) is misleading. At Valles the volcanoes are but one feature within a complex structure dominated topographically by the outer caldera rim and the uplifted center. There is no terrestrial example to compare with a ring of volcanoes standing isolated on a plain that is level both inside and outside the ring.

Finally, the extreme velocities calculated for a basalt flow having the depth of the Flamsteed Ring (*1*) were derived erroneously. The conditions indicate a Reynolds number of 90,000 or more, at which the laminar flow formula (*1*, eq. 1) would of course be completely inapplicable.

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References and Notes

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Positions of Quasi-Stellar Objects with Large Red-Shifts

Strittmatter, Faulkner, and Walmsley (*1*) have presented evidence that all known quasars with red-shift $z > 1.5$ are contained within two areas, in antipodal directions occupying 6 percent of the sky. I think it appropriate to point out that the directions defined by quasars with $z > 1.5$ coincide with the direction of the Virgo cluster of galaxies ($l^{II} \approx 287°$; $b^{II} \approx +75°$) which, according to de Vaucoleurs (*2*), is the center of the supergalaxy, and with the antipodal direction ($l^{II} = 107°$; $b^{II} = -75°$). These coincidences suggest that quasars are a phenomenon related to the supergalaxy rather than to our galaxy, as suggested by Strittmatter *et al.*

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