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FAR-ULTRAVIOLET PROSPECTING OF THE ENTIRE LUNAR REGOLITH; Richard C. Henry, W. G. Fastie, and R. L. Lucke, Physics Department, Johns Hopkins University, Baltimore, MD 21218; B. W. Hapke, Earth and Planetary Sciences Department, University of Pittsburgh, Pittsburgh, PA 15260, and W. R. Hunter, Naval Research Laborabory, Washington, DC 20375.

The mining of large quantities of industrial materials from the surface of the moon requires meticulous care in the selection of mining locations. Identification from lunar orbit of regions that differ in composition or in physical state is an economic imperative. Only a limited number of physical or compositional parameters are accessible from orbit, however. We propose that a generally useful parameter is the index of refraction of the regolith, and we propose that it be measured for the entire lunar regolith by survey of the far-ultraviolet reflectivity of the moon.

The far-ultraviolet reflectivity of the moon depends strictly on the lunar index of refraction, in a way that the visible-light reflectivity does not. In the visible, considerable penetration by light into the particles that make up the lunar surface occurs. This light is absorbed selectively by wavelength, and is scattered, a good amount of it leaving the particle and becoming part of the reflected beam. Thus, minor impurities in the interior of the surface particles can have a profound effect on the optical reflectivity. In the far ultraviolet, in contrast, this effect is negligible, as ultraviolet photons will not significantly penetrate the grains. The reflectivity coefficient will be determined virtually entirely by the index of refraction of the grain as a whole.

Data obtained with the Far-Ultraviolet Spectrometer Experiment (1,2) carried on Apollo 17 have been analysed (3,4,5) and show that substantial index-of-refraction differences do occur from place to place on the lunar regolith. The Apollo 17 spectrometer had a 1000 km^2 field-of-view, and therefore no fine-scale compositional/physical state survey was possible, even for the 3% of the moon that was observed; but a multi-channel orbital far-ultraviolet photometer has been described (5) which is capable of mapping the entire regolith with 1 km^2 resolution. This photometer has been proposed for the Lunar Polar Orbiter mission. The ground resolution it will provide is probably adequate for large-scale surface mining operations.

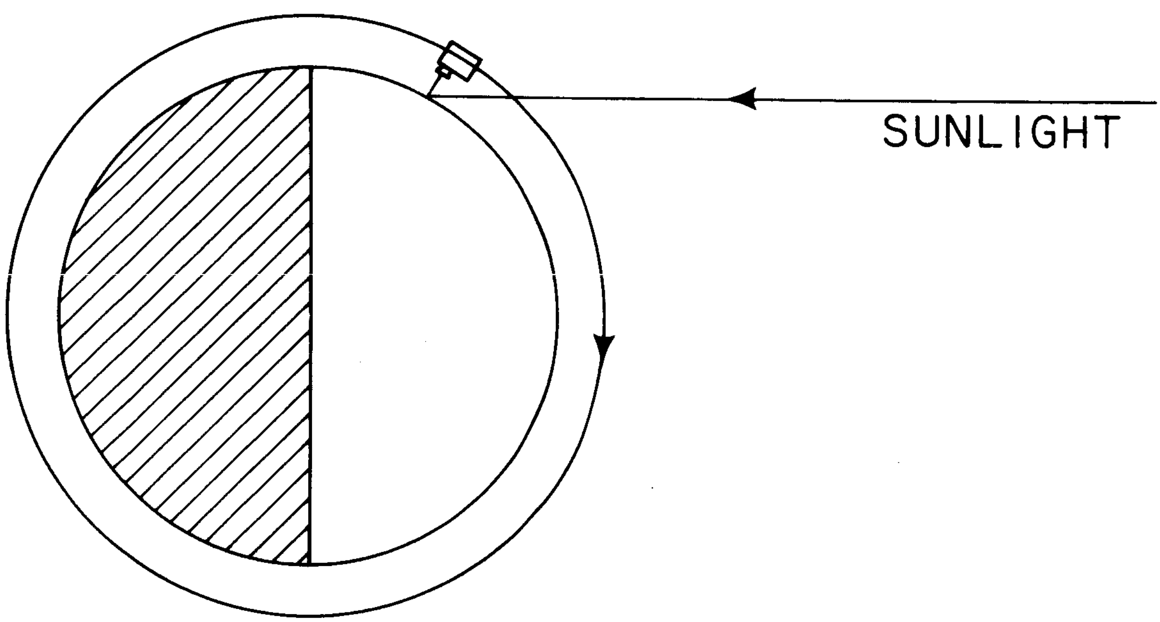

Figure 1 shows schematically the method of acquisition of data. The photometer is a three-channel device, which allows verification of the absence of any influence of body scattering on the reflectivity observed. The angle of incidence of the sunlight must be taken into account in computing the index of refraction, but techniques for doing this are well developed (4,6).

The result of these measurements will be a refractive index map of the moon. The refractive index is determined by the composition and the physical state of the material. Measurement of the refractive index does not, of course, determine the composition. However, differences in refractive index from place to place certainly indicate differences in composition or in physical state. If detailed measurements in the laboratory of the composition of samples taken at a certain site on the moon have been made, then the lunar refractive index map can be used to safely infer that the composition of contiguous regions containing the sample site and differing negligibly in refractive index is substantially the same. Also, one of us (B.W.H.) is currently carrying out NASA-supported laboratory research to determine, among other things, the effect of composition on refractive index. The refractive index map, used in close conjunction with optical photographs and other orbitally-obtained composition-dependent parameters, will be a powerful tool in the selection of lunar mining sites. The choice of sites is critical: for example (7), the Apollo 11 and Apollo 12 sites differ by a factor 3 in their titanium abundance. With 1 km^2 resolution, the refractive index maps might reveal comparatively small, highly anomalous regions, which could prove exceptionally rich in desirable minerals.

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