FAR-ULTRAVIOLET LUNAR MAPPING FROM APOLLO 17, R. L. Lucke, R. C. Henry, and W. G. Fastie, Physics Dept., Johns Hopkins University, Baltimore, Md. 21218

A far-ultraviolet (1200-1650 Å) spectrometer, described by Fastie (1), collected data on the local reflectivity of the moon as it viewed the lunar surface from the Apollo 17 Service Module. The field of view of the instrument was, approximately, a 30km x 30km square, or about one square degree on the moon's surface. The moon's rotation caused the spectrometer to scan different portions of the surface as the instrument was carried across the sunlit hemisphere once each orbit. Spectra were accumulated for a total of 38 hours, spread over a six-day period.

The light intensity received by the spectrometer was low near the terminator, increased to a maximum value at that point on the bright side at which the instrument looked most nearly down-sun, and then decreased again toward the other terminator. Superimposed upon this large-scale behaviour were numerous fluctuations from this general trend. Large fluctuations occurred near the terminators, largely due to local topography. Crater walls and mountainsides will either cast long shadows or catch direct sunlight near dawn and sunset, depending on which way they face. More interesting are fluctuations that occur far from the terminators. Analysis shows that mare material has, with a possible small wavelength dependence, a 5-10% higher reflectivity in the far ultraviolet than does highland material. This is in contrast to the visible, where the highlands reflect about 30 to 40 percent more than do the maria.

Evidence for this is given in Figure 1, where two 1470 Å scans across the sunlit hemisphere are shown. The gross behaviour of the light curve has been artificially removed to permit the fluctuations to be shown on an expanded scale. Two successive orbits, for which the spectrometer viewed nearly the same points on the moon, are shown to demonstrate the reproducibility of the fluctuations. Fluctuations due to photon-counting statistics are only slightly greater than the width of the line. The lower of the two straight lines in Fig. 1 is an approximate average of the reflectivity of the highland regions crossed during orbit 29, normalized to unity. The upper line represents a 10% higher reflectivity. It is seen that all of the regions of mare material - the flat bottom of the large crater Neper, Mare Crisium, Palus Somni, and Mare Serenitatis - have reflectivities from at least five to about ten percent higher than highland regions. Similar lines clearly could be drawn for orbit 28. At Mare Marginis, seen several orbits earlier (not shown), the difference in reflectivity between mare and highland is about 8%, and at Mare Smythi, several orbits later, the difference is about 12%. In addition to terrain-correlated differences, Fig. 1 also shows fluctuations within the same type of terrain.

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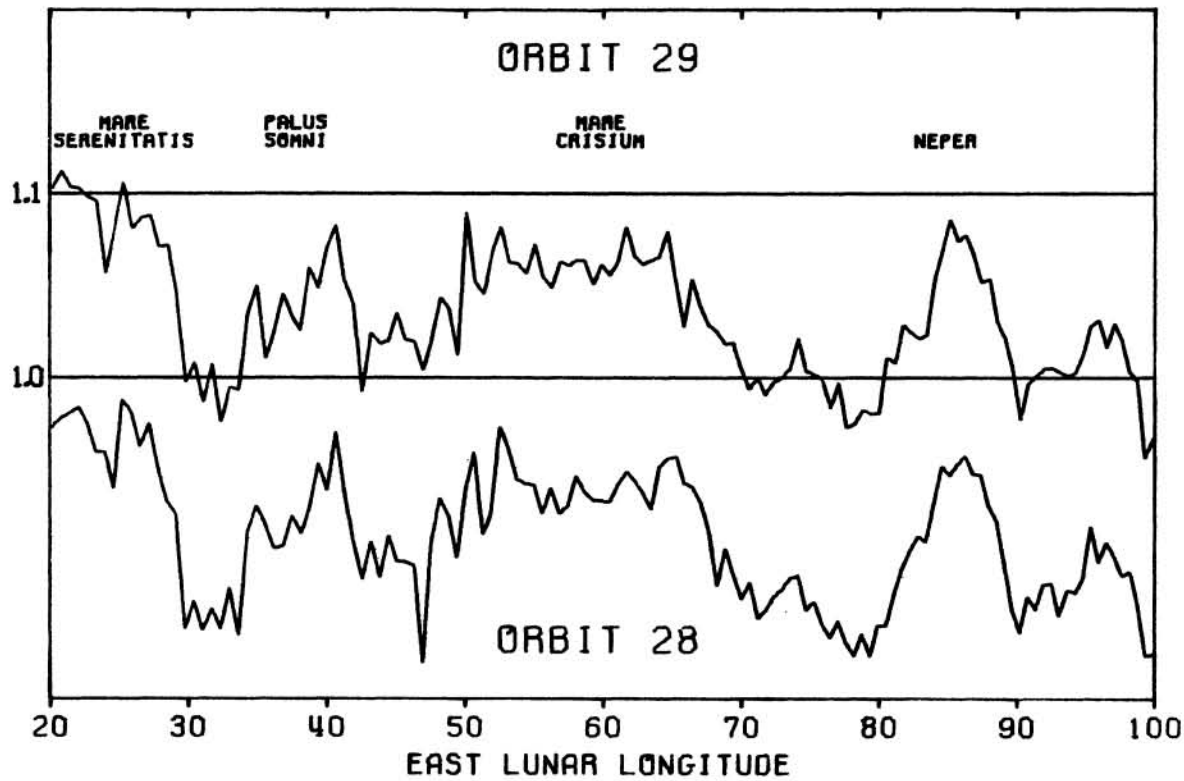

Fig. 1. -- Relative far-ultraviolet (1470 Å) brightness of the moon, as a function of lunar longitude, along part of the path of two Apollo 17 orbits. Low-frequency components have been arbitrarily removed to permit identification of higher-frequency components with lunar features. Mare areas are seen to have a higher ultraviolet reflectivity than highland areas.

The well-known darkness of the lunar surface (in visible light) compared to, for example, freshly ground rock powders, has been attributed to various mechanisms (2, 3) which create an amorphous, iron-rich coating on grains of lunar soil. Glassy spheroids are also present. The formation of this coating gives an age-darkening effect which accounts for the brightness of fresh surface material (e.g. from young craters) relative to material that has been on the surface a long time. A reasonable explanation of the (visible) darkness of maria with respect to highlands was suggested by Adams and McCord (4), who pointed out that the basaltic maria have a higher iron content

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available for inclusion in a glassy surface layer than do the more anorthositic highlands, and that it is primarily iron that produces absorption in such a coating. These two effects-surface age and mineralogical composition - can probably also account for the moon's ultraviolet reflectance properties. Since far ultraviolet radiation is very non-penetrating, its reflectance is primarily a surface phenomenon, dependent on the (complex) index of refraction of the surface of the reflecting object and essentially independent of its bulk properties. This should make ultraviolet reflectance more sensitive to a thin coating than visible reflectance is, and may mean that an ultraviolet map of the moon could give better age and/or composition discrimination on the surface than a visible map. Such an ultraviolet map is in preparation. The higher albedo of the maria may be explainable in terms of the effect a higher iron content could have on the index of refraction of the soil grain's surface coating.

Laboratory studies made on powdered terrestrial rock samples show that the reflectivity of basaltic material is, like the moon and unlike granitic material, nearly independent of wavelength throughout the 1200-1650 Å range. The relative importance of mineralogical composition in determining the ultraviolet reflection properties of lunar surface material (5) is the subject of on-going study.

(1) Fastie, W. G., The Moon, 7, 49 (1973).
(2) Hapke, B., The Moon, 7, 342 (1973).
(3) Nash, D. B., and Conel, J. E., The Moon, 8, 346 (1973).
(4) Adams, J. B., and McCord, T. B., Science, 171, 967 (1971).
(5) Lucke, R. L., Henry, R. C., and Fastie, W. G., The Astronomical Jour., 78, 263 (1973).