ULTRAVIOLET SPECTRAL REFLECTANCE MEASUREMENTS FOR LUNAR AND TERRESTRIAL SAMPLES

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When a sample is illuminated normal to its surface and observed almost normal (at 5° from incident beam), the ratio of the intensity to that given by a perfectly white sample (MgO) gives the normal albedo A. Its variation with λ gives the reflectance spectrum. Such spectra were measured for large varieties of terrestrial, meteoritic and lunar samples, usually between λ=0.35 to 2.5 μm, for instance by HUNT, SALISBURY et al., (series of papers cf. 1974), MCCORD et al. (cf. 1973), ADAMS et al. (cf. 1973), NASH et al. (1974), GAFFNEY (1974), etc. Some measurements were extended to 0.20 μm, often with a limited accuracy, for example by ROSS et al. (1969), ANTIPOVA-KARATAIEVA (1973), CARVER et al. (1975), etc.

However, a strong absorption band exists for almost all the silicates around 0.23 μm, which offers diagnosis for remote sensing but was not studied.

We have collected high-accuracy measurements in the domain 0.20–0.65 μm for 15 pulverized rocks and meteorites, 12 lunar fines, 7 lunar rocks and breccias. Figs. 1, 2 and 3 reproduce some curves.

a) Around λ=6500 Å, the albedo of silicates is dominantly controlled by the amounts of silica and magnesium: the albedo increases when grain-size decreases; for small grains (< 25 μm), an albedo lower than 0.35 is diagnostic of mafic, carbonaceous, or metallic material, while albedo larger than 0.35 usually indicates acidic samples. Ultra-mafic rocks generally give A(6500 Å) > 0.30.

b) Faint and broad absorption bands are seen in the visible and near U.V. on some samples. They are produced by electronic transitions from constitutional or impurity cations between energy levels modified by the crystal field, and from charge transfer from one ion to another.

Lunar sample 67455.3 shows features which are amplified in the second derivative curve and corresponds rather well with the crystal field transitions of Mn^{2+} (see fig. 1). Ignimbrite (fig. 1) shows a large absorption feature which could result from both Mn^{2+} and Fe^{2+} crystal field transitions, and also from charge transfer bands Fe^{2+}→Ti^{4+} and Ti^{3+}→Ti^{4+} as computed by Loeffler et al. (1974).

Sulphites and sulfates have sharp conduction bands. Metals behave differently.
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c) The spectra in deeper U.V. display for all the silicates a deep absorption with a minimum near \( \lambda = 2300 \) A. Accumulations of charge transfer bands occur in this range, involving transitions between oxygen and cations such as \( \text{Fe}^{2+}, \text{Fe}^{3+}, \text{Ti}^{3+}, \text{Ti}^{4+} \) and Chromium; some of these bands are indicated fig. 1.

In fig. 4 we plot \( A(2300 \ \text{A}) \) against \( A(6500 \ \text{A}) \) in log scales for lunar fines and for rocks pulverized with grains 25 \( \mu \)m. The lines of equal ratio \( A(6500)/A(2300) \) are indicated; they express the intensity of the 2300 A band. Increases of grain-size move the dots parallel to these lines. The terrestrial samples 1 to 6 and stony meteorites C to G show ratios \( A(6500)/A(2300) \) varying from 3.3 to 10 while carbonaceous meteorites A and B give 2.7 and 3.0, basaltic glass 7 produces an exception at 1.7 and Imenite 8 has \( R \) near unity like a metal.

Conversely, the twelve fines from the lunar regolith follow a very regular trend with a constant ratio \( 2.67 \pm 0.28 \), which is lower than any ordinary terrestrial silicaceous sample. Exposed surfaces of lunar rocks (not shown) give still lower ratios, around 1.5, while non-exposed surfaces for the same rocks give around 2.6.

These first results already indicate that for asteroids, satellites and planets, extension of reflection spectroscopy to wavelengths near 2000 A, which is now feasible with spaceborne telescopes, will help to clarify problems of mineralogic compositions such as discriminations between stony and metallic objects, carbonaceous and silicaceous bodies, etc.

REFERENCES

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