BASIC REFLECTANCE EXPERIMENTS: SCATTERING, ABSORPTION, PARTICLE SIZE, ETC. C.M. Pieters[1], D. Sandlin[2], C. Wells[2], T.V.V. King[3], [1] Brown Univ. Providence, RI, [2] Lockheed, Houston, [3] U. of Hawaii

The Laboratory. The Reflectance Experiment Laboratory (RELAB) is designed to measure the primary optical properties of surface reflection (reflectance, albedo, polarization) with high precision (~1/2%) and high spectral resolution (≥10Å; .4 - 2.7 μm) under geometric conditions comparable to those for earth-based or spacecraft reflectance measurements. The computer controlled instrument is a swinging arm goniometer with a practical range of phase angles from 10° to 120°. A phone line modem for long distance remote users has been installed. A summary of current basic research experiments is presented below. All data were taken at i = e = 15°.

Transmitted Component of Reflectance. Characteristic mineral absorption features in a reflectance spectrum are carried by a component of light transmitted through the particles of the surface. Quantification of this transmitted component and its relation to a scattered component of reflectance was performed using an isotropic glass (Schott BG-36) with multiple absorption bands. The transmission spectrum (%T) for 1 mm of this glass is shown in Fig. 1 (courtesy of R.L. Huguenin, U. of Mass.). Extinction coefficients for the continuum and absorption features relative to the continuum were measured for a strong band near .802 μm (α = 7.01 mm^{-1}) and a weak band near 1.07 μm (α = 0.091 mm^{-1}. The glass was ground and sieved to clean particle sizes. Directional reflectance spectra for four particle sizes are shown in Fig. 2. The mean optical path length (MOPL) through the particles was measured using an iterative process with the three extinction coefficients for each sample. This process also allows an estimation of the reflected scattered light and the relative proportion of the transmitted and scattered components of light interacting with such a particulate surface. The results are summarized below. Although the relative proportion of the transmitted component varies, the MOPL appears to vary regularly with particle size.

Part. Size	Transmitted Component	Scatter Reflected	Scatter Lost	mm MOPL	Absorption Strength 1.07 μm feature True	Absorption Strength 1.07 μm feature Apparent
A	.554	.304	.142	.52	.046	.028
B	.659	.242	.099	1.11	.097	.068
C	.781	.159	.060	1.75	.148	.120
D	.793	.094	.113	2.35	.194	.169

Particle Size Mixtures. For controlled particle size separates we have previously shown (King et al., LPS XII, 1981) that particle size has a strong (and once thought dominant) effect on the strength of absorption features in mineral mixtures involving orthopyroxene, ilmenite, and plagioclase. Since real soils contain a particle size distribution, we created samples from the same particle size range but in greatly different proportions. Some of the results are shown in Fig. 3 and Table 1. For such more realistic soils the range of parameter values (absorption strength, albedo, etc.) is considerably reduced. Large particles in a mixture do not dominate the spectral characteristics.

Reflectance Experiments

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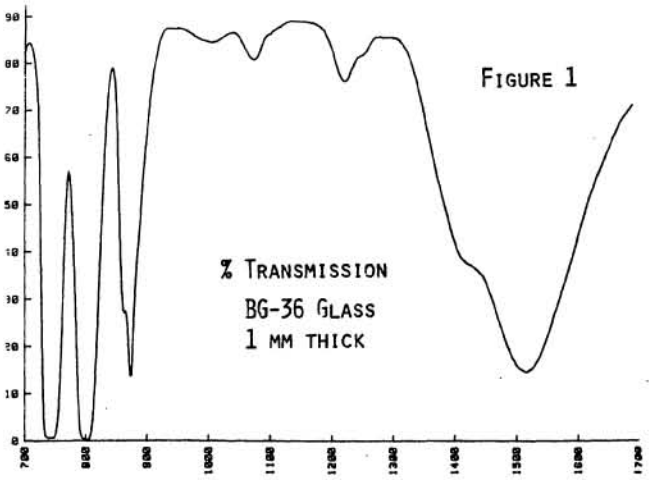

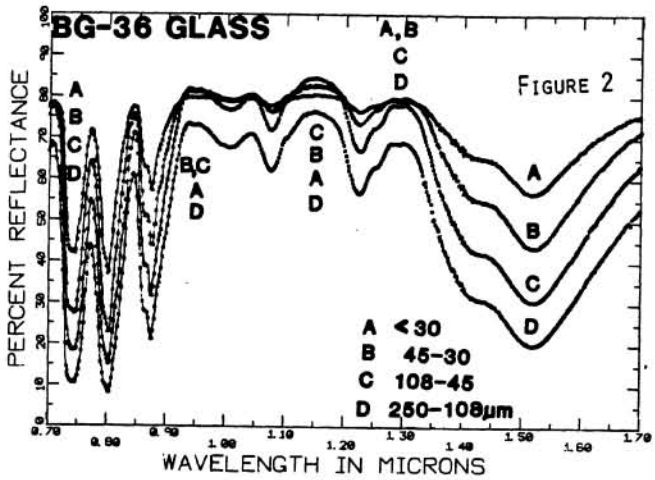

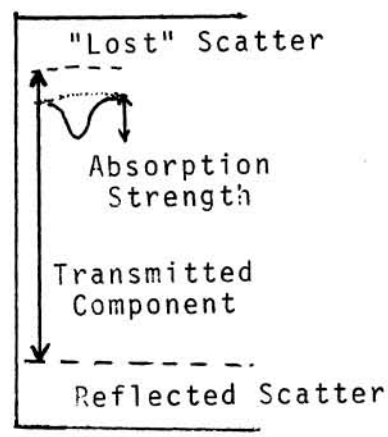

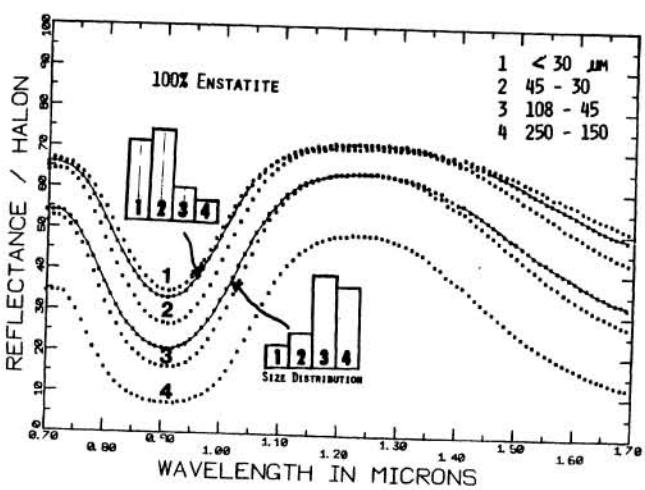

TABLE 1.

% OPX	% ILM	.91μm Abs. strength	1.2μm Max Albedo	% Particle size (μm) 250 -150	108 -45	45 -30	< 30
100		83	47	100			
100		73	65		100		
100		63	71			100	
100		50	72				100.
100		66	64	35	40	15	10
100		57	66	25	25	25	25
100		53	71	10	15	40	35
90	10	77	35	100			
90	10	66	45		100		
90	10	50	40			100	
90	10	27	40				100
90	10	53	35	35	40	15	10
90	10	37	38	10	15	40	35

Figure 3. Reflectance of 4 particle size separates of enstatite (data points) and of mixtures of these separates with two different size distributions (connected data points).