Glass sample 77075 is shown for comparison with naturally occurring lunar quenched glasses of pyroclastic origin in Fig. 2. These prepared quenched glass samples are typically greater than twice as bright as the natural lunar pyroclastic samples, so all spectra are scaled at 2500 nm to allow spectral comparisons. Prominent differences between these lunar glasses are seen in the visible part of the spectrum. As documented with laboratory transmission spectra by Bell et al. (1976), the visible is dominated by Fe-Ti charge-transfer absorptions, and the slope of the spectrum at 500 nm depends on the combined FeO and TiO_2 abundance. For remote sensing applications, the slope of the spectrum near 500 nm is often approximated by the ratio of reflectance at 415 nm to that at 750 nm (selected because of these wavelengths' availability in Clementine multispectral images). Despite the limited range in FeO and TiO_2 abundance, the spectral ratio for Suite 1 glasses shown in Fig. 4 is clearly correlated to FeO*TiO_2, as predicted by Bell et al. However, it is important to note that this relationship is only apparent for the quenched glasses, and the crystalline samples exhibit a random relation.

Although dark "halos" of impact melt are often observed for fresh lunar craters (e.g., Tycho), Suite 1 samples exhibit no regular change of albedo with melting. This is illustrated in Fig. 5 in the form of a plot of the 415/750 nm ratio for Suite 1 materials measured in the laboratory against their albedo (at 750 nm). The Suite 1 crystalline samples could generally be comparable to fresh (immature) regolith on the Moon. With melting, an increased apparent reddening in spectral slope is observed for each glass sample relative to its crystalline counterpart, but there is no comparable trend with brightness. Some glass samples become darker, whereas others are brighter, most likely a result of the heterogeneous nature of their original lithology.

Because of the limited range in FeO and TiO_2 abundance, the Suite 1 samples represent a small subset of melt compositions expected on the Moon. However, they illustrate the difference in spectral variability among the glasses (homogenous melts of similar chemistry) relative to their crystalline counterparts. It should be apparent from Figs. 1e and 2, however, that the Clementine wavelengths miss the peak reflectance near 600 nm and are not particularly well suited to capture the principal variation of the charge transfer absorptions of quenched glasses.

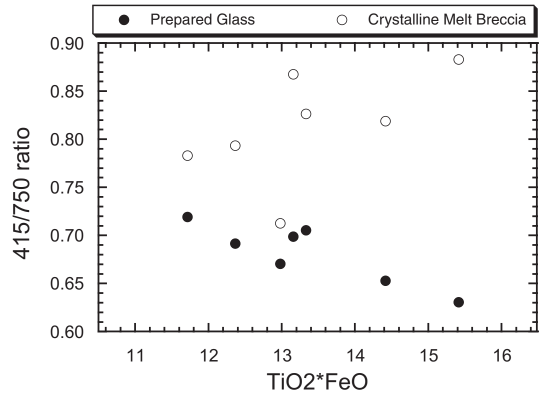

Fig. 4. Relationship between the slope of the visible spectrum (estimated by the ratio between 415 and 750 nm) and FeO*TiO_2 composition for Suite 1 materials. This spectral parameter is correlated to composition for the glass samples, but not for the equivalent crystalline samples.

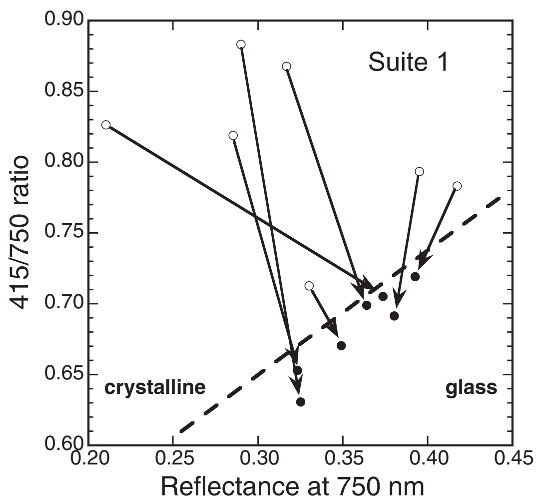

Fig. 5. Relationship between the 415/750 nm spectral parameter and albedo (reflectance at 750 nm) for Suite 1 materials. There is no consistent change in albedo between the crystalline and quenched glass of the same sample. For this general composition of materials, however, glass spectra appear "redder" than their crystalline counterparts at these wavelengths.

Glass and Crystalline Mixtures

It is anticipated that various proportions of glass and crystalline components will exist for melts produced under a range of conditions on the Moon. To examine the optical properties of such a range, mass fraction mixtures for crystalline and quenched glass samples of 76015 were prepared and their spectra are presented in Fig. 6a. These spectra are of physical mixtures prepared with the two forms of the sample and measured directly with the RELAB spectrometer. While these mixture spectra clearly define the overall character of such mixtures, the data should not be used for detailed quantitative estimates or modeling because the particle size is not strictly controlled. Due to the limited quantity of each sample, mass fraction mixtures were limited. Calculated mixture spectra based on the crystalline and