### Telescopic Near-Infrared Spectra

Completely crystalline melt rocks may have the same mineralogy as volcanic or plutonic rocks of the same composition, and are thus not easily identifiable as a distinct lithology by remote spectroscopic measurements alone. The impact melts specifically targeted by this study are melts emplaced on the surface, equivalent to suevite breccias at terrestrial impact craters. These are most likely to comprise impact glasses and glassy melt breccias, which should be spectroscopically distinct from each other and from nonmelt rocks.

Near-infrared telescopic spectra for single integrated 5–10 km regions of pooled impact melt at three craters (Copernicus, Tycho, and Aristillus) were presented in Smrekar and Pieters (1985). Such low-resolution single ''point'' remote measurements indicated that despite different geologic settings and locations, the melt rocks are notably similar spectrally. Observations of the more crystalline peaks and walls indicate that the target compositions among the craters are quite different. However, the spectra from areas with large areas of pooled impact melt are broadly similar to each other: the shape and position of the mafic absorption bands near 1 μm suggest the presence of significant amounts of Fe-bearing glass mixed with lithic fragments and/or recrystallized melt. The impact melt spectra of these three craters also all appear to exhibit a 1.2 μm absorption feature. Smrekar and Pieters (1985) suggested recrystallization of plagioclase crystals to explain the presence of the absorption band. While this is still a working hypothesis, the feature could also be due the nonequilibrium rapid crystallization of pyroxene discussed above which results in disproportionate Fe partitioning into the M1 pyroxene site (e.g., see Klima et al. 2008).

### Multispectral Image Data

Multispectral images of the Moon from the Galileo and Clementine missions have been used to evaluate characteristics in a spatial context in and around lunar impact craters (e.g., Belton et al. 1993; Pieters et al. 1994). The wavelengths for these images are sensitive to spectral variability across the ultraviolet to visible portion of spectrum, and to the presence of mafic absorption bands near 1 μm. Two characteristics have been recognized in multispectral data of impact melts that often allow the melts to be distinguished from surrounding materials within a multispectral image. Both Galileo SSI observations during the Earth-Moon encounters and Clementine (UVVIS) ultraviolet-visible camera images indicated that melt halos around many impact craters are observed to have high spectral ratio values between 0.76 and 0.41 μm (i.e., a strong red slope) (McEwen et al. 1993), and lower albedo values than surrounding materials. These characteristics of melts only occur in a relative sense: while impact melts may be observed to be redder and darker than local soils, they are not necessarily redder and darker than soils at other locations on the Moon.

## LABORATORY SPECTRA OF LUNAR IMPACT MELT SAMPLES

### Sample Descriptions

#### *Suite 1*

The Suite 1 Apollo 17 samples were originally selected by Graham Ryder to be part of a separate effort to characterize the compositional homogeneity of the Serenitatis melt sheet (Ryder, personal communication). The seven samples span a range in composition, grain size, and texture (see Table 1). At least six of these samples are believed to have been melted as part of the Serenitatis basin formation and then recrystallized. The seventh sample is distinct in petrography, chemistry, and inferred origin. These well-characterized samples were selected for spectral analysis to allow comparison with chemical and petrographic characteristics. Glass versions of the samples were prepared to simulate quenched impact melt glass.

One sample (76015) was used to create mass fraction mixtures between the original crystalline melt breccia and the compositionally equivalent prepared quench glass material. Mass fraction mixtures of glass and crystalline material of different proportions provide a first order comparison for mixtures that might occur in a natural event. Comparable mixtures were also calculated from the endmember spectra using the BDR equations of Hapke (1981) and compared to the actual mixtures.

#### *Suite 2*

The 15 naturally occurring impact melt samples were identified from the samples collected at the Apollo 12, 15, 16, and 17 landing sites (see Table 2). They have a range of textures, mineralogical compositions, and glass abundance. Although the history of these samples is not known (including the scale of the impact event), they are still impact melt rocks produced in the lunar environment, and provide a unique sample database to develop an understanding of lunar impact melt characteristics.

### Laboratory Procedures

The Suite 1 crystalline samples were received as fine-grained powder, and no coarse particles were