observed. The TF is a function of both the optical constants of the minerals present as well as their particle size (Mustard and Hays 1997). Because our impact melt Suites are fine-grained particulate samples (<125 μm), we highlight features of our FTIR data that allow the presence (but not abundance) of individual minerals to be identified.

The spectra of Figs. 8 and 9 are for the exact *same* samples as studied with BDR and provide additional information about the mineral constituents present. This independent information helps to constrain interpretations that might be derived from the near-infrared spectra. Arrows highlighting specific features of plagioclase (blue arrows) and olivine (green arrows) in Figs. 1b and 1c are transferred to Figs. 8 and 9 for the discussion below. Considerably more information can be extracted from these spectra than is discussed here and the data for all samples listed in Appendix are available through the RELAB data collection (http://www.planetary.brown.edu/relab/).

Microcrystalline Plagioclase and Olivine

From the micrographs of Fig. 3 and the spectra of Figs. 8 and 9, it is clear that the Suite 1 Apollo 17 melt breccias and many of the Suite 2 samples contain abundant microcrystalline components and very little quenched glass. The smooth almost featureless character of quenched glass seen in Figs. 8b and 9b is uncommon among our other samples, although samples such as 12032 and 12033 (2C3) and certainly 64455 and 67095 (2B) may be the exceptions. Most melt breccia and impact melt samples exhibit features in Fig. 8 that are indicative of crystalline plagioclase and minor olivine present. The presence of microcrystalline plagioclase is also clearly indicated in the mid-infrared spectra of Fig. 9 (arrows) among many superimposed other features. It is not possible to interpret individual spectra here, but the preponderance of features indicating the presence of abundant microcrystalline plagioclase is clear. Although olivine appears regularly in the spectra of Fig. 8 where few other features exist (see Fig. 1b), we interpret olivine to be a minor component simply because olivine features are not prominent elsewhere.

In a nonequilibrium situation such as rapid crystallization and cooling after formation of an impact melt, the optically active iron and titanium can be incorporated into crystal sites where they do not normally reside. The feature observed near 1.2 μm can either be accounted for by small amounts (≤0.5%) of FeO captured within the plagioclase microcrystals (e.g., Adams and Goulland 1978) or a significant amount of the FeO within crystallized pyroxene being incorporated into the M1 site instead of the M2 (Klima et al. 2008). We tentatively prefer the plagioclase interpretation for these samples because microcrystalline plagioclase is an abundant phase and also appears to be a carrier of the ilmenite component discussed below.

Microcrystalline Ilmenite

An absorption near 600 nm is observed ubiquitously in both the melt breccias and the impact melt samples of Figs. 1d and 1f. A broad generally similar feature tentatively assigned to Ti^{3+} in augite has been observed in Apollo 17 mineral separates (Pieters et al. 2008; Isaacson, in preparation), but the feature observed in our impact melt samples is not correlated with the presence of pyroxene absorption features. A Ti^{3+} feature was observed near 500 nm in the Ti-bearing prepared quenched glasses of Bell et al. (1976), but this Ti^{3+} glass feature is very weak and too faint to detect when Fe^{2+} is also present creating the strongly dominant Fe–Ti charge transfer absorption across the visible. The preponderance of evidence summarized below now indicates that the 600 nm feature observed in these special lunar materials is due to submicroscopic ilmenite within a semitransparent matrix.

The 600 nm absorption and overall nature of the continuum observed in our impact melt samples are similar to those caused by the unusual microcrystals of ilmenite found in the pyroclastic black beads of Apollo 17 seen in Fig. 2. Ilmenite in most circumstances is normally so strongly absorbing that it is effectively opaque and this characteristic 600 nm feature is rarely observed except in laboratory mineral separates (e.g., Cloutis et al. 2008; Cloutis 2010). However, when the ilmenite is very fine-grained or at least very thin across one axis and set in a transparent matrix, then the 600 nm feature can be observed. The ilmenite-bearing black glass spheres of Apollo 17 exhibit a prominent absorption at 600 nm (Fig. 2), which is attributed to the presence of a nonopaque silicate matrix in which thin layers of ilmenite are suspended (Weitz et al. 1999), allowing some radiation to be transmitted through and returned from the sample (Adams et al. 1974). Pieters and Taylor (1989) also observed this 600 nm feature in the presence of extremely fine-grained inclusions of ilmenite within plagioclase crystals. They suggested that in order for the ilmenite absorption to be detected, the abundance of ilmenite in a sample is less important than its petrographic characteristics. The presence of the 600 nm feature appears to depend upon ilmenite existing in a sufficiently thin or fine-grained form to allow selective absorption of light. The best situation would be for fine-grained ilmenite crystals to be disseminated throughout a matrix that allowed light