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# Spectral characteristics of lunar impact melts and inferred mineralogy

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**Abstract**–Two suites of lunar impact melt samples have been measured in NASA's Reflectance Experiment Laboratory (RELAB) at Brown University. Suite 1 comprises seven Apollo 17 crystalline impact melt breccias and seven quenched glass equivalents. Suite 2 is made up of 15 additional impact melt samples (from Apollo 12, 15, 16, and 17) which exhibit a range of textures and compositions related to cooling conditions and glass abundance. A few of these samples have cooled slowly and fully crystallized, and thus have the same spectral properties as igneous rocks of similar texture and composition; they cannot be uniquely distinguished without geologic context. However, most of the impact melts and melt breccias contain either quantities of quenched glass and/or have developed microcrystalline nonequilibrium textures with well-defined, diagnostic spectral properties. The microcrystalline textures are associated with a distinctive 600 nm absorption feature, apparently due to submicroscopic ilmenite inclusions in a transparent host (typically fine-grained plagioclase). The reflectance properties of these lunar sample suites contribute to and constrain the identification and characterization of impact melts in remote sensing data.

## INTRODUCTION

Numerous studies of the distribution and composition of impact melt at terrestrial craters have been used to study aspects of the cratering process. Mixing within the melt, depth of excavation, and timing of melt emplacement are among the specific questions that have been addressed (Phinney and Simonds 1977). Although no large-scale craters remain in pristine state on Earth, models for the entire sequence of events from melt generation to cooling have also been developed (Grieve et al. 1977a; Cintala and Grieve 1994). Lunar impact melt generated through the cratering process is expected to be generally similar to terrestrial melt (but more pristine), while important differences occur related to scaling effects between the Earth and Moon. For example, Cintala and Grieve (1994) predict the proportion of clasts entrained by impact melt to be higher on the Moon than on the Earth. Therefore, direct observations of lunar impact melt are also important in their own right. Impact melts in lunar craters may have been homogenized by turbulent flow within the transient cavity (Grieve et al. 1977a, 1977b). The melt should consist of lithic fragments (unmelted clasts of target material), glass, and recrystallized melt, although the exact proportions are currently not predicted by such models. Thus far, estimations of lunar melt distribution have provided abundant clues to many aspects of the impact process, such as impact angle and the timing of melt emplacement (Hawke and Head 1977). However, knowledge of the composition and extent of impact melts may answer a different set of questions entirely, including mixing in the melt and the depth of excavation.

Models of lunar crater formation processes rely considerably on the distribution and morphology of impact melt deposits at lunar craters (e.g., Schultz 1976; Hawke and Head 1977), but lack additional information on the compositional characteristics that might extend the spatial context of such deposits. A better