Connecting Returned Apollo Soils and Remote Sensing: Application to the Diviner Lunar Radiometer

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The Diviner Lunar Radiometer, onboard NASA's Lunar Reconnaissance Orbiter, has produced the first global, high resolution, thermal infrared observations of an airless body. The Moon, which is the most accessible member of this most abundant class of solar system objects, is also the only body for which we have extraterrestrial samples with known spatial context, returned Apollo samples. Here we present the results of a comprehensive study to reproduce an accurate simulated lunar environment, evaluate the most appropriate sample and measurement conditions, collect thermal infrared spectra of a representative suite of Apollo soils, and correlate them with Diviner observations of the lunar surface.

It has been established previously that thermal infrared spectra measured in simulated lunar environment (SLE) are significantly altered from spectra measured under terrestrial or martian conditions. The data presented here were collected at the University of Oxford Simulated Lunar Environment Chamber (SLEC). In SLEC, we simulate the lunar environment by: (1) pumping the chamber to vacuum pressures (<10-4 mbar) sufficient to simulate lunar heat transport processes within the sample, (2) cooling the chamber with liquid nitrogen to simulate radiation to the cold space environment, and (3) heating the samples with heaters and lamp to set-up thermal gradients similar to those experienced in the upper hundreds of microns of the lunar surface. We then conducted a comprehensive suite of experiments using different sample preparation and heating conditions on Apollo soils 15071 (maria) and 67701 (highland) and compared the results to Diviner noontime data to select the optimal experimental conditions. This study includes thermal infrared SLE measurements of 10084 (A11 – LM), 12001 (A12 – LM), 14259 (A14 – LM), 15071 (A15 – S1), 15601 (A15 – S9a), 61141 (A16 – S1), 66031 (A16 – S6), 67701 (A16 – S11), and 70181 (A17 – LM).

The Diviner dataset includes all six Apollo sites at approximately 200 m spatial resolution We find that analyses of Diviner observations of individual sampling stations and SLE measurements returned Apollo soils show good agreement, while comparisons to thermal infrared reflectance under ambient conditions do not agree well, which underscores the need for SLE measurements and validates the Diviner compositional measurement technique.