THE BENEFITS OF SAMPLE RETURN: CONNECTING APOLLO SOILS AND DIVINER LUNAR RADIOMETER REMOTE SENSING DATA.

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Introduction: 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. 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.

Laboratory Studies: It has been established that thermal infrared spectra measured in a simulated lunar environment (SLE) are significantly altered from spectra measured under terrestrial conditions [e.g. 1, 2]. The data presented here were collected at the University of Oxford Simulated Lunar Environment Chamber (SLEC). In SLEC, the lunar environment is simulated 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 [3]. A comprehensive suite of experiments were conducted 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. Thermal infrared measurements

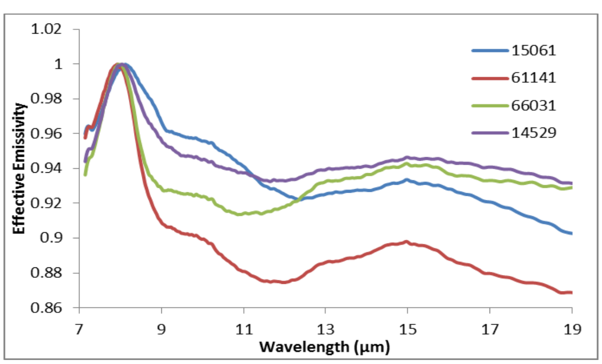

Figure 1: Subset of thermal infrared emission spectra measured in SLE as part of this study.

(Figure 1) in optimized SLE were made of 10084, 12001, 14259, 15071, 15601, 61141, 66031, 67701, and 70181. Table 1 lists soils available to this study.

Diviner Data: The Diviner Lunar Radiometer is a nine-channel, pushbroom mapping radiometer. Diviner measures broadband reflected solar radiation with two channels, and emitted thermal infrared radiation with seven infrared channels [4]. The three shortest wavelength thermal infrared channels near 8 μm were specifically designed to characterize the mid-infrared "Christiansen Feature" emissivity maximum, which is sensitive to silicate composition [5]. The Diviner dataset includes all six Apollo sites at approximately 200 m spatial resolution.

Table 2: Apollo Soils currently available to SLEC.

Apollo Site	Station	Soil	Mass	Is/FeO
Apollo 11	LM	10084	5 g	78
Apollo 12	LM	12001	5 g	56
Apollo 14	LM	14259	3.5 g	85
Apollo 15	LM	15021	3.5 g	70
Apollo 15	Sta. 1	15071	5 g	52
Apollo 15	Sta. 7	15411	3.5 g	43
Apollo 15	Sta. 9a	15601	3.5 g	29
Apollo 16	Sta. 1	61141	5 g	56
Apollo 16	Sta. 6	66031	3.5 g	102
Apollo 16	Sta. 11	67701	3.5 g	39
Apollo 17	LM	70181	5 g	47
Apollo 17	Sta. 2	72501	3.5 g	81
Apollo 17	Sta. 9	79221	3.5 g	81

Results: We find that analyses of Diviner observations of individual sampling stations and SLE measurements of returned Apollo soils show good agreement, while comparisons to thermal infrared reflectance under terrestrial conditions do not agree well, which underscores the need for SLE measurements and validates the Diviner compositional dataset. Future work includes measurement of additional soils in SLE and cross comparisons with measurements in JPL Simulated Airless Body Emission Laboratory (SABEL).

References: [1] Logan L.M. *et al*. (1973) *JGR*, *78*, 4983. [2] Salisbury J.W. and Walter L.S. (1989) *JGR*, *94*, 9192. [3] Thomas I.R. et al. (2012) Rev.Sci.Inst., 83 (12), 124502. [4] Paige D.A. *et al*. (2010) *SSR*, *150*. [5] Greenhagen B.T. *et al*. (2010) *Science*, *329*, 1507.