EFFECTS OF SPACE WEATHERING ON THERMAL INFRARED EMISSIVITY SPECTRA OF BULK LUNAR SOILS MEASURED UNDER SIMULATED LUNAR CONDITIONS. K. L. Donaldson Hanna1,2, N.E. Bowles1, C. M. Pieters2, B. T. Greenhagen2, T. D. Glotch4, and P. G. Lucey3. 1Atmospheric, Oceanic and Planetary Physics, University of Oxford, Oxford, UK (Kerri.DonaldsonHanna@physics.ox.ac.uk), 2Dept. of Earth, Environmental and Planetary Sciences, Brown University, Providence, RI, USA, 3Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA, 4Dept. of Geosciences, Stony Brook University, Stony Brook, NY, USA, and 5Hawaii Institute of Geophysics and Planetology, University of Hawaii, Honolulu, HI, USA.

Introduction: Understanding the spectral effects of space weathering on thermal infrared (TIR) observations of the lunar surface is an important consideration for the interpretation of current and future remote sensing datasets as the entire lunar surface has experienced some degree of space weathering. A study of TIR reflectance measurements of a suite of plagioclase feldspars demonstrated that the vitrification process does not affect the position of the Christensen feature (CF), an emissivity maximum in TIR spectra indicative of mineralogy and composition[1-3]. This led many to believe that effects on TIR emissivity spectra due to space weathering would not be observed. However, recent work by Lucey et al. [4] has demonstrated that space weathering does strongly influence the position of the CF as observed in observations by the Diviner Lunar Radiometer Experiment (Diviner) onboard NASA’s Lunar Reconnaissance ORbiter.

In this initial characterization of Apollo bulk soil samples, TIR emissivity spectral measurements are made under Earth-like (ambient) and lunar-like conditions of two highland soil samples that are similar in composition, but differing maturities in an effort to better understand the effects of space weathering on TIR spectra.

Experimental Setups and Samples: TIR spectral measurements were made in the Asteroid and Lunar Environment Chamber (ALEC), a vacuum chamber at Brown University designed to simulate the space environment experienced by the near-surface regolith of the Moon and asteroids. The design details of the vacuum chamber have previously been discussed [5]. ALEC is connected to a Thermo Nicolet 870 Nexus FTIR spectrometer which allows laboratory emissivity spectra to be collected at a resolution of 4 cm⁻¹ over the ~400 – 2000 cm⁻¹ spectral range.

Bulk lunar soils measured in this initial study include Apollo samples requested from NASA’s CAPTEM as a part of the Thermal Infrared Emission Studies of Lunar Surface Compositions Consortium (TIRES-LSCC). The two highlands bulk lunar soil samples included in this study, 66031 and 67701, have similar soil chemistries and normalized modal contents [6-8], but different maturities (I_/FeO = 102 and 39, respectively) [9].

Results: Spectral measurements of both soils under Earth-like or ambient conditions have similar CF positions (8.11 µm versus 8.10 µm), but the spectrum of immature soil 67701 has greater contrast in spectral features at wavelengths longer than the CF than the spectrum of mature soil 66031. However, under simulated lunar conditions, two observations are made: (1) the CF position of immature soil 67701 has shifted to shorter wavelengths when compared to the CF position of mature soil 66031 (7.93 µm versus 8.02 µm) and (2) the spectral contrast between the CF and the reststrahlen bands (RB) is much greater in the immature, higher albedo soil sample (Figure 1). These initial results suggest that space weathering has observable effects on TIR emissivity spectra measured under simulated lunar conditions; these effects are similar to those observed in the Diviner TIR observations of immature locations like crater ejecta rays and the more mature surface locations the ejecta deposits are emplaced on [4].

Figure 1. Lunar-like spectral measurements of mature lunar soil 66031 and immature lunar soil 67701.