POROSITY MAPS OF THE LUNAR SURFACE DERIVED FROM LRO-LAMP ALBEDO DATA. B. D. Byron[1,2], K. D. Retherford[2,1], K. E. Mandt[3], T. K. Greathouse[2], G. R. Gladstone[2,1], [1]Department of Physics and Astronomy, University of Texas at San Antonio, San Antonio, TX, (ben.byron@swri.org), [2]Space Science and Engineering Department, Southwest Research Institute, San Antonio, TX, [3]Johns Hopkins University Applied Physics Laboratory, Laurel, MD

Introduction: The reflectance of an airless planetary body is known to depend on the porosity of the regolith covering its surface. In general, increasing the porosity of a regolith will decrease the albedo at all wavelengths [1]. Observations of low far-ultraviolet (far-UV) albedos inside lunar permanently shadowed regions (PSRs) indicate that the regolith porosity is higher inside PSRs than at non-shaded regions, around ~0.7-0.8 compared to ~0.4 for average lunar regolith [2,3]. In this study, we model the porosity (defined as the space between individual regolith grains at the surface) of the top 100-200 nm of the lunar regolith using far-UV data from the Lunar Reconnaissance Orbiter (LRO) Lyman Alpha Mapping Project (LAMP), and create porosity maps of South Pole craters.

LAMP is a far-UV imaging spectrograph which uses Lyman-α skyglow and starlight as illumination sources to create maps of the lunar nightside and to make surface reflectance measurements inside of polar PSRs [4]. For this study, we analyze nighttime observations of Amundsen crater (82.8° E, 84.5° S), a complex crater on the edge of South Pole-Aitken basin that contains both PSRs and highly illuminated regions. We make use of these nighttime observations in order to make direct comparisons of single scattering albedo between shadowed and illuminated regions of the surface.

Methodology: In order to derive regolith porosity values and create porosity maps, we use a model that calculates the wavelength dependence of the lunar far-UV albedo for a range of different porosities [2,1]. The albedo spectrum for the model is based on average Moon optical constants found in [5]. We compare our nighttime far-UV albedo data (e.g. Lyman-α albedo, seen in Figure 1a) for each pixel of our map with the model albedo values, and assign each pixel a porosity based on that albedo. In order to ensure that any albedo variations we see are a result of porosity differences and not related to other effects (e.g. composition, weathering, or grain size), we perform our albedo analysis across LAMP's entire bandpass, including long far-UV bands where regolith composition and space weathering can have a significant effect on albedo.

Preliminary Results: A porosity map derived from the nighttime Lyman-α albedo map in Figure 1a is seen in Figure 1b. Our initial results agree with the findings in [1] and [2]. The PSRs in the northern part of Amundsen crater display high porosities (around 0.8), while the highly illuminated southern wall is ~0.3-0.4. The permanently shadowed crater Faustini (seen at the bottom of the image in Figures 1a and 1b) displays some of the highest porosities in the region.

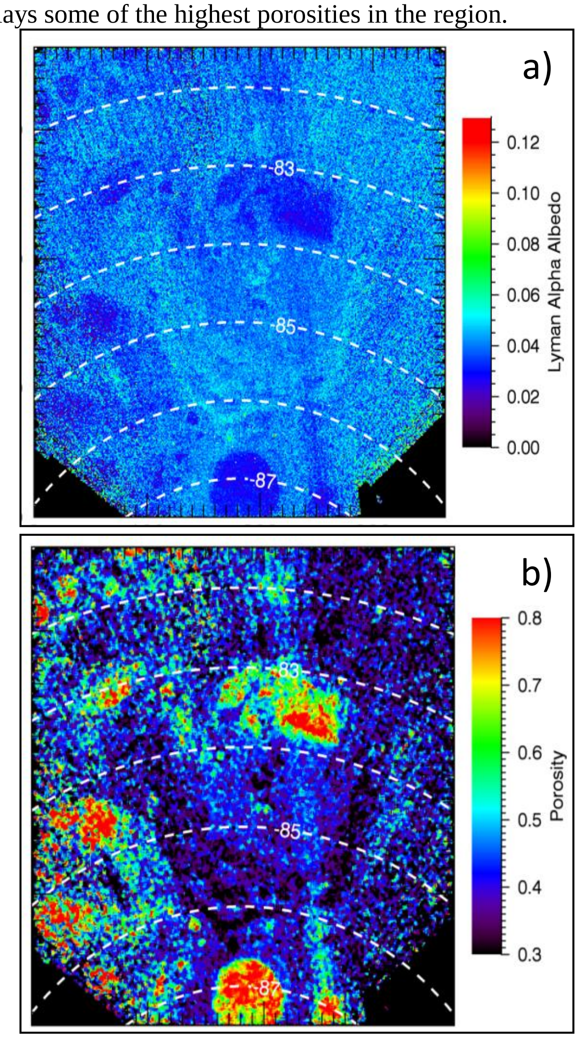

Figure 1: *a) LAMP nighttime Lyman-α albedo map of Amundsen crater. b) Model regolith porosity map derived from the Lyman-α albedo. The PSRs in the northern part of the crater and in Faustini crater at the bottom of the map display high regolith porosities compared to the average illuminated regolith.*

Discussion: The high porosities that we see in shaded regions may result from the extreme electrostatic effects that can occur inside polar PSRs. Large buildups of negative potential can lead to lofting and re-deposition of dust grains from the surface [6], creating high porosity fairy-castle structures in the regolith. The large buildup of charge may also lead to dielectric breakdown, a process which acts to increase porosity by splitting regolith grains into smaller fragments [7].

Another process that could cause the high porosities in PSRs and the low porosities in highly-illuminated regions is thermal cycling. Thermal cycling acts to compact the regolith, reducing porosity [8]. When grains heat and then cool during a thermal cycle they expand and contract. During the contraction phase there is a tendency for the particles to settle into a lower potential energy arrangement, which is more compact and has lower porosity. Regions that undergo large variations in temperature may experience the effects of thermal cycling more frequently or more intensely than PSRs, and therefore have lower porosity. PSRs, however, have very low thermal variability and would be relatively unaffected by this process. This lack of compaction combined with an increase in electrostatic effects may cause the high regolith porosities that we see inside polar PSRs.

Conclusion: We have created regolith porosity maps for the upper layer of the lunar surface using a model which calculates porosity based on the LAMP-observed far-UV albedo. PSRs have higher porosities than illuminated regions of the surface (~0.7-0.8 compared to ~0.3-0.4), possibly due to electrostatic effects or a relative lack of thermal cycling of the regolith. Variations attributable to composition, grain size, or other effects instead of porosity will be bounded by analyzing data from LAMP's entire bandpass and discussed further. This example with Amundsen illustrates the method moving forward for examining other regions on the Moon.

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