NEW GLOBAL OBSERVATIONS OF LUNAR REGOLITH MATURATION IN THE FAR-ULTRAVIOLET.

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Introduction: The Lunar Reconnaissance Orbiter (LRO) Lyman Alpha Mapping Project (LAMP) is providing insights into the upper ~100 nm of the regolith, specifically detecting surface frost and estimating porosity of lunar polar regions in the far-ultraviolet (FUV) [1-3]. LAMP also routinely collects both day and nighttime data of polar and equatorial regions of the Moon. Efforts to examine these non-polar data have studied latitudinal variations in hydration, the examination of swirl and swirl-like photometric anomalies, and cratering deposits [4-6]. These studies are providing a unique new view of the Moon.

Data Set: LAMP is a FUV push-broom photon-counting imaging spectrograph collecting data in the 57-196 nm spectral range [1]. Here, global nighttime Lyman-α (Ly-α; 121.6 nm) normal albedo data are examined for low-albedo features as they are related to lunar regolith maturity (**Fig. 1**). This data set is unique in that it collects naturally reflected light at night from surfaces theoretically diffusely lit by solar Ly-α scattered off of interplanetary H atoms from all directions. This is a simplification, of course, as the Ly-α sky glow intensity varies with respect to the motion of the solar system and point sources from UV-bright stars, which are more plentiful in the southern hemisphere owing to the Galactic plane [1, 8]. Thus, the signal-to-noise of the LAMP nighttime data varies with latitude, increasing from north to south.

A New FUV View of Surface Maturation: Many of the interesting new perspectives in the FUV include crater rays, pyroclastic deposits, and swirls (**Fig. 1**), all of which have a low Ly-α albedo relative to their surroundings, contrasting with high NUV and VIS albedos of these deposits. This is because regolith particles are not transparent in the FUV and particle reflections dominate [9, 10]. Particularly near 120 nm where transition metals no longer dominate the reflectance properties. This provides a unique view of maturity nearly devoid of compositional effects that make quantifying maturation difficult in the VIS and NIR [11, 12]. In stark contrast, young craters show high Ly-α albedo relative to their rays and surroundings.

Two examinations of swirls have been performed in the FUV [5, 6] and provide insight regarding lunar surface maturation. Hendrix et al. [5] detailed examinations of the Reiner Gamma and Gerasimovich swirls using LAMP wavelengths >130 nm noting swirls to be characterized by reddened FUV albedos and noting that immature regolith becomes brighter (i.e., bluer) and flattened with exposure. Cahill et al. [6] concentrated their examination on Lyman-α signatures of more enigmatic lunar features including swirls, normally associated with magnetic anomalies.

References: [1] Gladstone et al. (2012) JGR, 117, 10.1029/2011JE003913. [2] Hayne et al. (2015) Icarus, 255, 68. [3] Mandt et al. (2015) Icarus, 10.1016/j.icarus.2015.07.031. [4] Hendrix et al. (2012) JGR, 117. [5] Hendrix et al. (2016) Icarus, accepted. [6] Cahill (2016) LPSC, XXXXII. [7] Stickle et al. (2016) LPSC. [8] Pryor et al. (1992) AJ, 394, 363. [9] Shkuratov et al. (2011) PSS, 59, 1326. [10] Henry et al. (1976) Moon, 15, 51. [11] Lucey et al. (2000) JGR, 105, 20377. [12] Cheek et al. (2011) JGR, 116, 10.1029/2010JE003702.

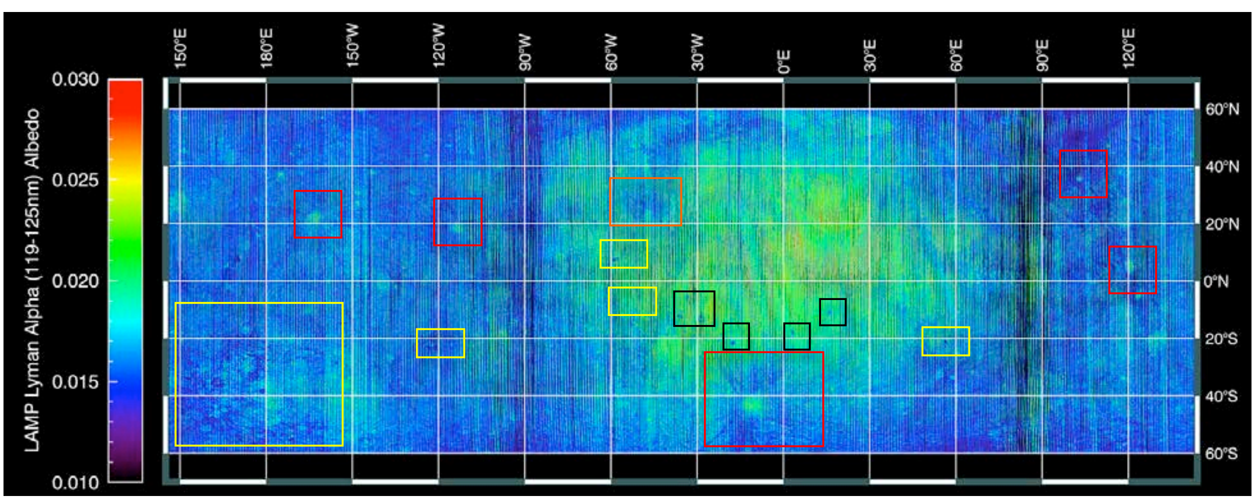

Fig. 1*: Lunar global non-polar nighttime Ly-α observations (30 ppd). (Black boxes) Enigmatic low Ly-α albedo features. (Yellow boxes) Observed lunar swirls. (Orange boxes) Discernable pyroclastic deposits. (Red boxes) Craters with high Ly-α albedo proximal ejecta and contrastingly low Ly-α albedo rays [7]. When constructing these preliminary albedo maps, the number of Δλ bins was divided, lowering the color bar values by a factor of three.*