ULTRAVIOLET CHARACTERISTICS OF THE LUNAR COMPTON-BELKOVICH REGION FROM LRO/LAMP. A. R. Hendrix[1], K. E. Mandt[2], T. K. Greathouse[2], K, D. Retherford[2], G. R. Gladstone[2], D. M. Hurley[4], P. D. Feldman[5], A. F. Egan[2], D. E. Kaufmann[3], P. F. Miles[2], J. W. Parker[3], M. W. Davis[2], W. R. Pryor[6], M. A. Bullock[3], S. A. Stern[3], N. E. Petro[7]; [1]Planetary Science Institute, Tucson, AZ, arh@psi.edu; [2]Southwest Research Institute, San Antonio, TX; [3]Southwest Research Institute, Boulder, CO; [4]Applied Physics Laboratory, Johns Hopkins University, Laurel, MD; [5]Johns Hopkins University, Baltimore, MD; [6]Central Arizona College, AZ , [7]NASA GSFC, Greenbelt, MD

Introduction: The Lunar Reconnaissance Orbiter (LRO) is currently in orbit at the Moon. The Lyman Alpha Mapping Project (LAMP) onboard LRO has been making measurements of the lunar nightside, dayside and atmosphere since September 2009. We report here on recent work analyzing LAMP dayside data of the Compton-Belkovich region.

The Compton-Belkovich (C-B) region is named for two craters and is centered near 61°N, 99.5°E. It has been known since Lunar Prospector [1] to be an isolated high–thorium region within the northern highlands and from Clementine UVVIS data was found to be i) a high albedo region at all UVVIS wavelengths (415-1000 nm) [2], ii) to be low in FeO and TiO_2 and iii) consistent with alkali feldspars and non-mare igneous activity. LROC NAC and WAC data of the region have been interpreted [3] to indicate a volcanic region, and LRO Diviner data of the area indicated that the region is high in alkali feldspars and/or quartz [3,4]. Chandrayaan-1 M^3 data of the C-B region [5] show that it displays a strong OH/H_2O absorption, as compared with surrounding highlands terrains.

LRO/LAMP Data: The LAMP instrument [6] is a photon-counting imaging spectrograph. The entire passband is 57–196 nm, in the far-UV (FUV) spectral region. For dayside measurements, the instrument is operated in "pinhole" mode, with the aperture reduced by a factor of 736. The instrument was usually nadir-pointed in LRO's characteristic 50-km lunar orbit of the prime mission and provided ~500 m resolution. In LRO's extended mission the orbit has been modified to an elliptical frozen orbit that saves fuel and results in up to ~2 km resolution when at the North pole.

Approximately once per month LRO flies over the C-B region; and although LAMP halts acquistion of dayside data when at high phase angles, there are numerous sets of spectra of the C-B region at differing geometries; the emission angle is small while the incidence angle is larger and varies depending on the beta angle of the orbit.

To determine the lunar FUV reflectance, we divide the LAMP data from each latitude bin by the full-disk solar spectrum from SORCE SOLSTICE [7], taken for the day of each observation and convolved to agree with the LAMP resolution and line spread function. Sample LAMP reflectance spectra are shown in Figure 1.

The FUV hosts a strong H_2O absorption edge near 165 nm, allowing LAMP to study hydration on the Moon. To separate out the effects of hydration and underlying composition, past analyses of LAMP dayside data (e.g. [8]) have shown that measuring spectral slopes in the 164-173 nm range is an indicator of hydration, while spectral slopes in the 175-190 nm region are insensitive to hydration but good indicators of weathering and composition. (e.g., Fig. 2).

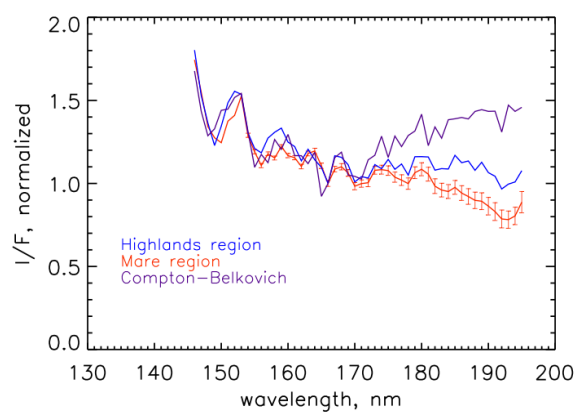

Figure 1. Sample LAMP spectra of lunar terrains: a typical highlands region and a typical mare region, along with a representative spectrum from the Compton-Belkovich area (purple). Note how spectrally red the C-B spectrum is at wavelengths longward of 170 nm.

LAMP Results: Nearly all regions of the Moon are spectrally blue (i.e. increasing in albedo with decreasing wavelength) in the LAMP bandpass, due to the surface-scattering nature of the light interaction with the grains combined with the optical constants of the compositional materials. Mare regions are bluer than highlands regions due to their higher concentrations of opaques. Also, more weathered regions become spectrally bluer in the FUV due to the spectral contributions of nanophase iron [9], while less weathered regions are less spectrally blue, or are spectrally relatively red.

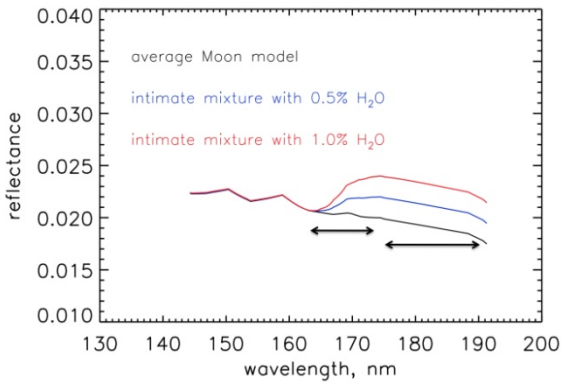

Figure 2. Model spectra of average lunar terrains with varying small amounts of H_2O added in an intimate mixture (from [8]). The 175-190 nm region is insensitive to H_2O but sensitive to inherent composition and weathering (e.g., Fig. 1).

The C-B region is the spectrally reddest region on the Moon as measured by LAMP in the 175-190 nm range (see, e.g., Fig. 1). The C-B region is spectrally red in both the short (164-173 nm) and long (175-190 nm)-wavelength bands of the LAMP spectrum. The redness of the 164-173 nm band could indicate hydration in this region; however redness in both spectral regions is also consistent with feldspathic material; we investigate this further. The spectrally red slopes measured by LAMP are not consistent with quartz which is spectrally flat in this region. Clementine UVVIS data of the region [2] indicate that the region is brighter but shallower in slope in the UV-vis than fresh highlands regions – which seems to be consistent with the LAMP spectral shape.

Here we spectrally model the LAMP spectra in the C-B and nearby regions to determine whether the spectra are consistent with increased levels of hydration as measured in the FUV. We look for variations within the C-B region and compare FUV spectra of C-B with surrounding terrains to better undertand the composition. At this point the LAMP spectra appear to be entirely consistent with alkali feldspar, and not consistent with quartz; it is unclear how much hydration affects the LAMP spectra of C-B although this possibility is intriguing.

We will also investigate other thorium-rich regions of the Moon (e.g., [10]) to undertand the FUV spectra of those regions as well.

References: [1]Lawrence, D. J. et al. (1999) *GRL, 26*, 2681–2683. [2]Gillis, J. et al. (2002) *LPSC XXXIII* 1967. [3]Jolliff et al. (2011) *Nat. Geo., 4,* 566-571. [4]Greenhagen et al. (2010) *Science, 329,* 1507-1509. [5]Petro, N. et al. (2013) *LPSC 44th,* #2688. [6]Gladstone, G. R. et al. (2010) *SSR, 150,* 161-181. [7] McClintock et al. (2000) P*roc. SPIE Earth Obs. Syst., 4135,* 225–234. [8] Hendrix et al. (2012) *JGR, 117,* E12001, doi:10.1029/2012JE004252. [9] Hendrix. A. R. & F. Vilas (2006) *A.J., 132,* 1396-1404. [10]Klima et al. (2013) *LPSC 44th*, #2158