LROC WAC ULTRAVIOLET CHARACTERIZATION OF LUNAR SPACE WEATHERING.
B. W. Denevi[1], M. S. Robinson[2], H. Sato[2], A. S. McEwen[3], and B. W. Hapke[4], [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA. [2]School of Earth and Space Exploration, Arizona State University, Tempe, AZ, USA. [3]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, USA, [4]Department of Geology and Planetary Science, University of Pittsburgh, Pittsburgh, PA, USA.

Introduction: The effects of space weathering as manifested in changes in ultraviolet (UV) reflectance have been observed in laboratory spectra of Apollo samples and samples subjected to simulated space weathering, as well as in comparisons of laboratory spectra of meteorites and telescopic spectra of asteroids [1]. In contrast to visible and near-infrared wavelengths, where increased space weathering causes an increase in spectral slope ("reddening"), at wavelengths shorter than ~400 nm the spectral slope decreases with increased space weathering. This phenomenon can be explained by the nanophase iron coatings deposited on grains due to exposure to the space weathering environment, where the addition of relatively spectrally neutral metallic iron diminishes the strong dropoff toward UV wavelengths that occurs in silicates. The decrease in UV slope with increased maturity has been hypothesized to occur at lower levels of exposure to the space weathering environment [1] than at longer wavelengths. Lunar Reconnaissance Orbiter Camera (LROC) Wide Angle Camera (WAC) [2] observations at 321, 360, 415, 566, 604, 643 and 689 nm enable resolved studies of the changes in ultraviolet reflectance that occur due to maturation of the lunar surface.

Image data: This study utilizes a preliminary seven-band, 400-m/pixel global WAC mosaic that was photometrically normalized using a simplified Hapke function [3]. Photometric parameters were derived independently for each 5° by 5° surface bin using three months of WAC coverage [4]. Clementine-based maps of optical maturity (OMAT) as determined from 750 and 950 nm reflectance [5] were used for comparison.

UV and maturity: To explore the effects of maturity in the UV, we examined ratios of 321/415 nm reflectance. In this index, variations due to maturity are relatively subdued, and many large ray systems are not easily distinguished from background mature terrain (Fig. 1). Closer to crater rims however, many fresh craters have a region (~1 crater diameter) of low 321/415 ratio. To examine the changes of UV slope with

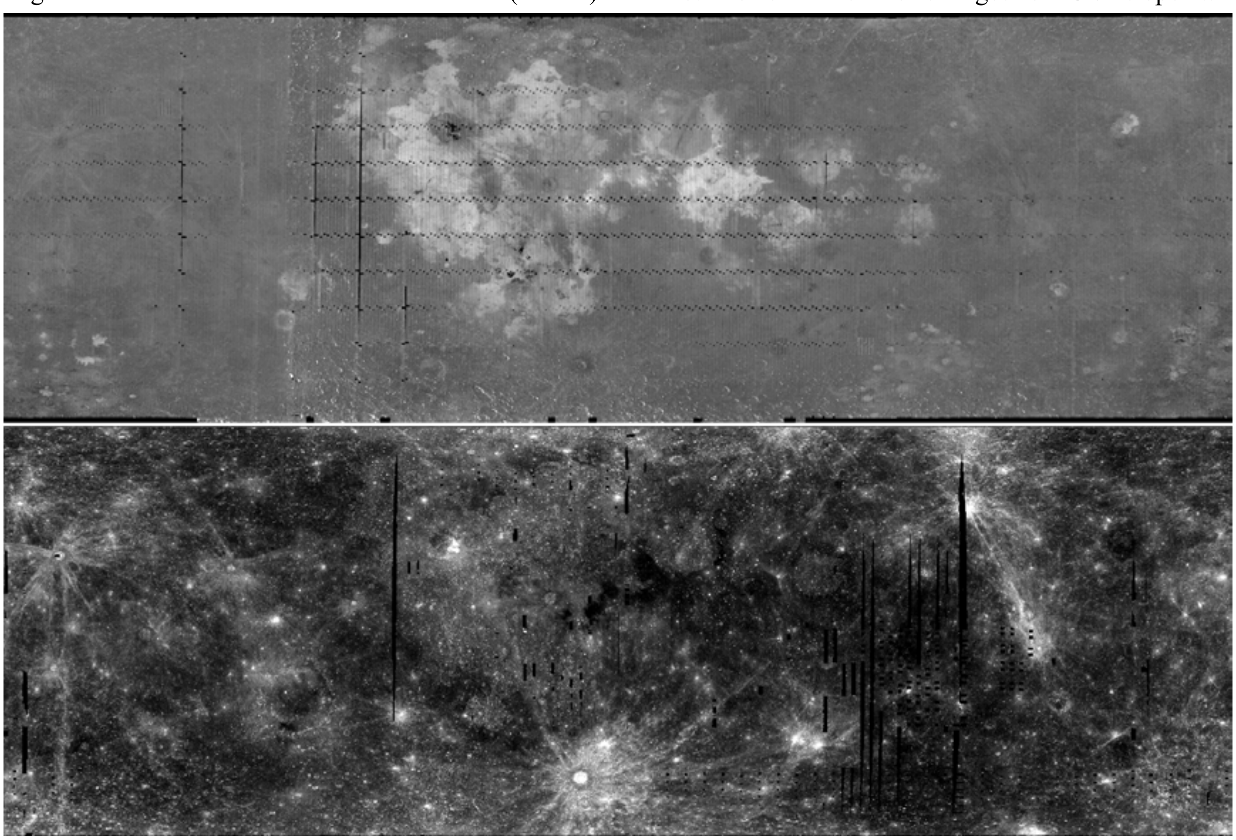

Fig. 1. Global WAC mosaics for ±60° latitude. A) 321/415 nm ratio. B) Clementine OMAT image showing variations in maturity [5]. Immature deposits show little signature in the 321/415 nm image and lack the high ratio values typical of fresh crater ejecta at visisble and near-infrared wavelengths.

maturity, we computed average radial profiles for fresh craters, where the distance from each point to the crater rim was calculated, and values at like distances were averaged. Because the proximal ejecta is thicker and less mixed with local material, maturity increases with distance from the crater rim [6]. For large fresh craters, such as Giordano Bruno (Fig. 2), OMAT [5] profiles show increasing maturity >150 km from the crater rim, whereas the 321/415 nm ratio increases to background levels within ~50 km of the rim. These profiles are consistent with increased exposure to space weathering causing a decrease in UV slope. Changes in 321/415 nm ratio appear to saturate relatively quickly – only a small fraction of material that would be classified as immature on the basis of OMAT appears immature based on its UV ratio. This trend is also apparent in small crater populations. Of the large population of small craters which appear as OMAT anomalies, many show no corresponding decrease in UV ratio (Fig. 3). However small, fresh craters with low 321/415 nm ratio values are observed in all terrains.

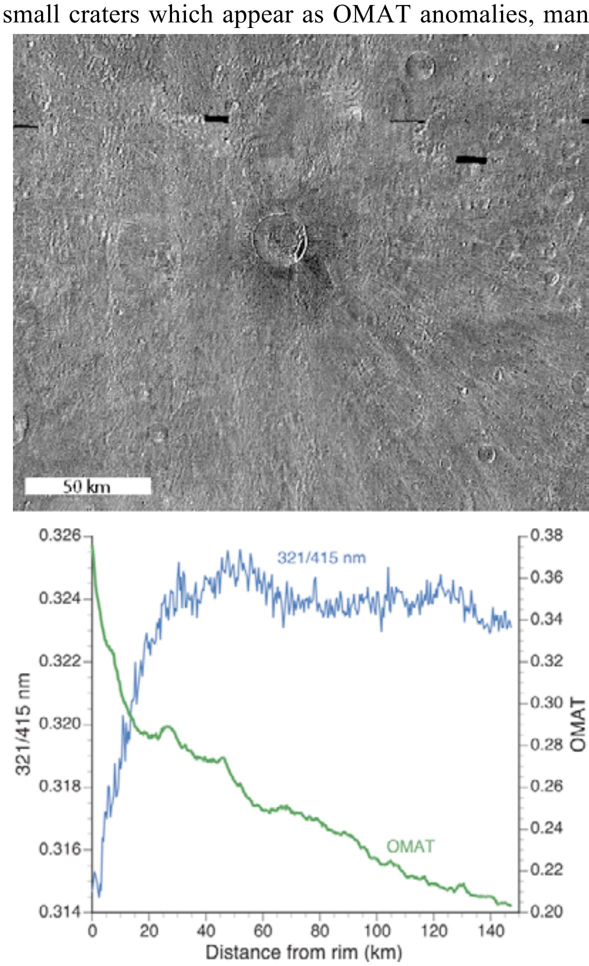

Fig. 2. At top, a 321/415 nm image of Giordano Bruno crater (35.9°N, 102.9°E, 22 km diameter). The ejecta has a lower ratio value (steeper UV slope) near the crater rim, further the rays are indistinguishable from the mature background. This effect is seen in the average radial profile (bottom). While the OMAT parameter shows maturity increasing >100 km from the crater rim, the 321/415 nm ratio reaches a background level at ~40 km from the rim.

Discussion: Ultraviolet slope is a sensitive measure of maturity. With relatively little exposure to space weathering, 321/415 nm ratio values increase to match those of mature background material, and only a small fraction of the lunar surface is immature by this measure. Low UV ratio values are thus a diagnostic feature of the youngest craters and could help determine the relative ages of Copernican craters. The distal rays of most large craters appear mature, and are typically only apparent if their composition contrasts with the underlying terrain, aiding in the differentiation between maturity and compositional rays [6,7]. For asteroids, where maturation proceeds more slowly or Mercury, where it is thought to be enhanced, UV slope could prove a sensitive tool for the comparison of space weathering rates.

References: [1] Hendrix A. R. and Vilas F. (2006) *Astron. J.*, 132, 1396-1404. [2] Robinson M. S. et al. (2010) *Space Sci. Rev.*, 150, 81-124. [3] Hapke, B. (1993) *Theory of Reflectance and Emittance Spectroscopy*, Cambridge Univ. Press. [4] Sato H. et al. (2011) *LPSC 42*. [5] Lucey P. G. et al. (2000) *JGR*, 105, 20377-20386. [6] Grier J. A. et al. (2001) *JGR*, 106, 32847-32862. [7] Hawke B. R. et al., *Icarus* (2004) 170, 1-16.

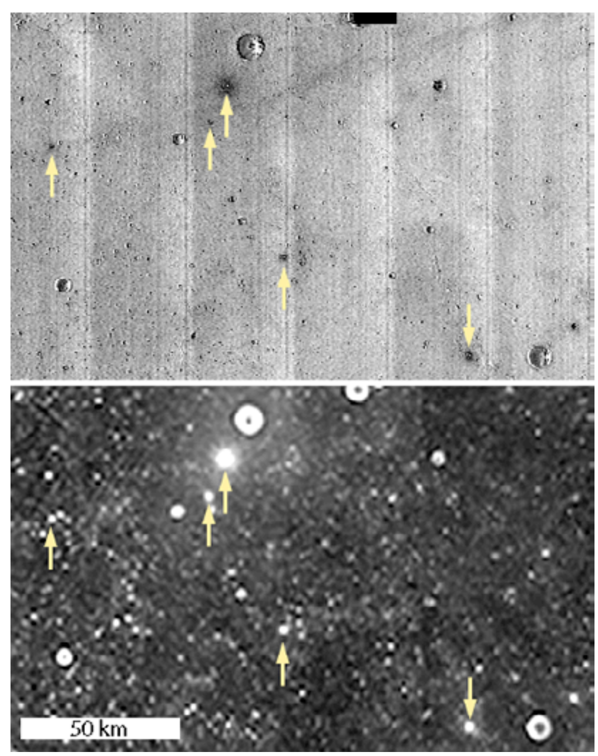

Fig. 3. Top: 321/415 nm ratio; bottom: OMAT parameter. Only some of the small craters which are immature in OMAT images also have low 321/415 nm ratio values. 3.2°N, 312.7°E