Automatic Lunar Smooth Plains Classification using LRO and Clementine Mission Data. A. K. Boyd, M. Robinson and P. Mahanti, Lunar Reconnaissance Orbiter Camera – Arizona State University, (ABoyd@ser.asu.edu)

Introduction: Smooth plains on the Moon have intrigued scientists for decades. Apollo 16 planning maps identified light plains (a type of highland smooth plains) as volcanic in nature [1], while post Apollo 16 maps generally interpreted light plains as basin ejecta flows [2]. Spectral interpretations by Pieters [3] showed that the light plains are not mare basalts but are composed of highlands material [3]. These interpretations do not rule out alternate origins, including impact melt or volcanic origin, for some subset of smooth plains.

Here we identify and classify smooth plains on a global scale using photometrically corrected Lunar Reconnaissance Orbiter Camera (LROC) Wide Angle Camera (WAC) data [4] and Clementine UV-VIS camera data, and the WAC Global Lunar Digital Terrain Model (DTM) (GLD100) [5]. At this time we have not differentiated between formation mechanisms for highland smooth plains (impact melt, fluidized ejecta blankets, or volcanic).

Methods: The GLD100 was resampled to 470, 940, and 1880 m/pix and slopes were calculated at baselines of approximately 950 m, 1900 m, and 3800 m. Areas on the Moon with slopes less than 2° in magnitude for all baselines are considered to be horizontal. Next these horizontal regions were checked for "smoothness" by a roughness test; the standard deviation of the 950 m baseline slope was calculated on a 950 m x 950 m area (n=9). If the standard deviation fell below 0.75° then the area was considered to be a smooth plain.

Normalized WAC color mosaic data exists almost continuously for -63° to 63° latitude. A spectral classification from the WAC mosaic (7 bands, 320 nm to 689 nm) and Clementine UV-VIS (5 bands, 415 nm to 1000 nm) was made to discriminate highland smooth plains from mare.

A reflectance of <0.04 in the WAC 415 nm band was used to identify the maria. Maria were then further discriminated as low and high 415 nm reflectance and their relative depth of the one-micron absorption (UVVIS 750 nm/ 1000nm). Mare with WAC 415 nm reflectance near 0.4 and weak one-micron band are considered mixed highlands-maria units. Bright ejecta materials were also identified using WAC 643 nm reflectance data with a value of 0.1 and higher.

For each topographic and spectral group there was a further subsetting of data classified by the ratio of the WAC 321 nm over WAC 415 nm. Exceptionally high and low values of the 321 nm / 415 nm ratio were mapped. Low values correspond to known red spots on the Moon, as well as the Compton Belkovich area and Reiner Gamma. High values correspond with high titanium content maria possibly do to high levels of ilmenite [6].

Results: At the km scale 22.6% of the Moon is smooth and horizontal, and 90.7% of these smooth plains can be classified with spectral data from the Clementine UVVIS and LROC WAC cameras. 17.1% of the Moon is classified as maria, and 3.4% is found to be highland plains (Fig. 1), which is consistent with the conventional estimate of around 16% of the Moon being maria [7].

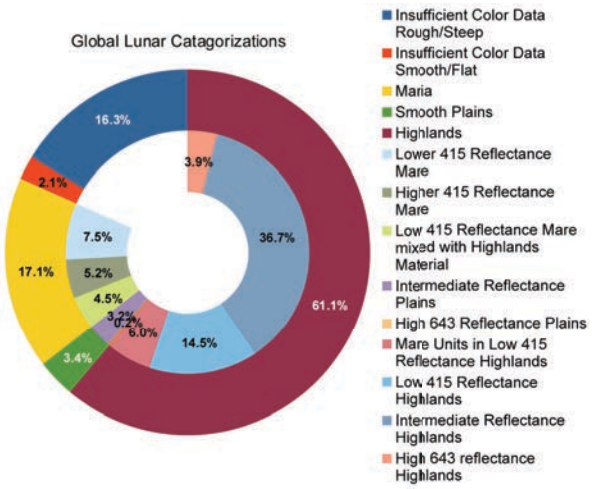

Figure 1: Chart showing the global lunar distribution of major units identified. Highland material makes up the majority of the lunar surface, but a larger percentage of smooth plains was categorized with spectral data.

Highland smooth-plains are found to cover 3.4% of the lunar surface. Examples include the King crater melt sheet (Fig. 2) [8], large far side basins including

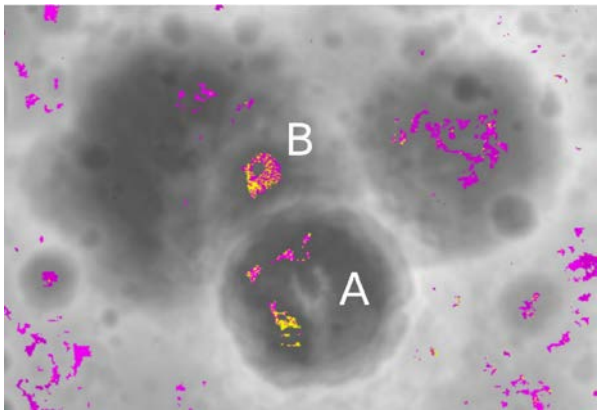

Figure 1: King crater, 77km diameter, (A) and King crater melt sheet (B). The colors identify smooth plains: yellow is smooth plains with a low WAC 321 nm/415 nm ratio and magenta is intermediate reflectance smooth plains.

Korolev, Mendeleev, and Hertsprung (Fig. 3), as well as smaller basins on the near side (Fig. 4).

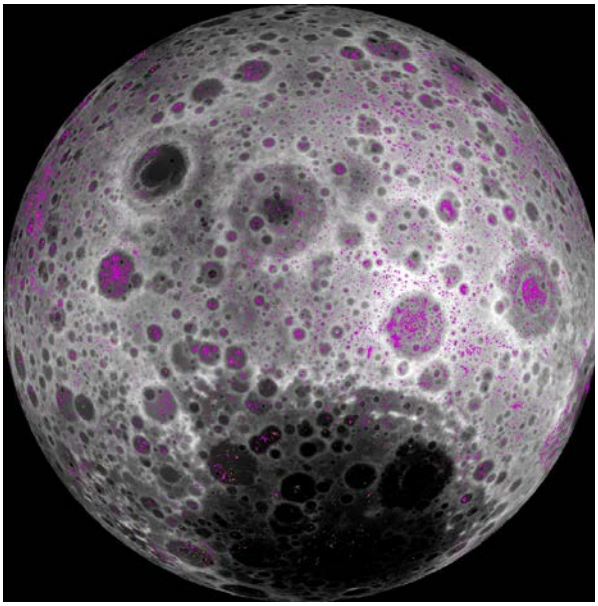

Figure 3: Lunar far side. Non-mare smooth plains are identified on this orthographic projection of the GLD100 centered on 0° latitude and 180° longitude.

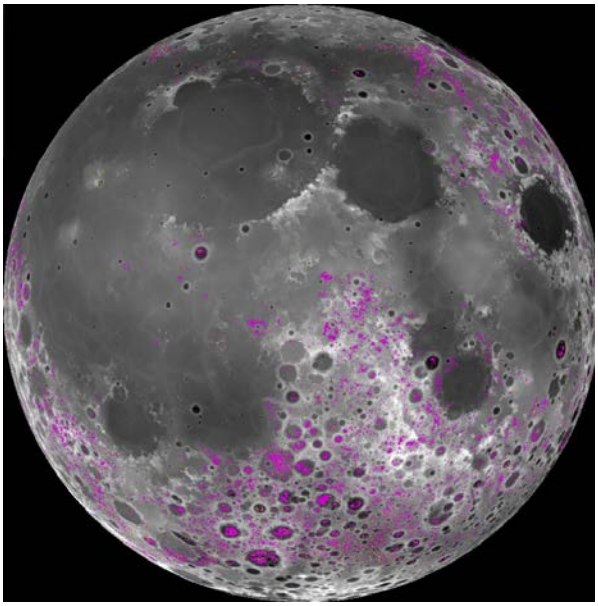

Figure 3: Lunar near side. Non-mare smooth plains are identified on this orthographic projection of the GLD100 centered on the near

In addition to characterizing the flat and smooth areas of the Moon, highlands units mixed with maria in the steep/rough areas surrounding the large maria were found. There is 6.0% of the lunar surface covered with the steep/rough highland/maria mixed unit (Fig. 1).

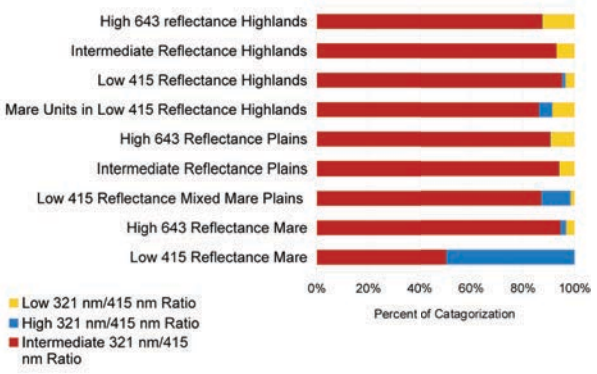

Figure 4: A bar chart showing the distribution of low and high WAC 321 nm/415 nm ratios in each characterized unit. With increased reflectance in the 643 nm WAC band there are more areas with a low WAC 321 nm/415 nm ratio. When the reflectance in the 415 nm WAC band is low, there is a greater chance for a high WAC 321 nm/415 nm ratio to occur.

Low WAC 321 nm/415 nm ratio areas cover roughly 4.5% of the Moon with increased frequency as 643 nm reflectance increases. High WAC 321 nm/415 nm ratio areas have the opposite correlation, and frequency is diminished with strong 643 nm reflectance. Almost all of the 8.6% of shallow UV sloped spectra occur in the maria (Fig. 5).

Conclusion: These data sets provide a way to automatically distinguish different units on the Moon both spectrally and topographically. Final unit definitions will be hand edited.

The automated smooth plains classifications are in general agreement with classic knowledge of the Moon and provide a powerful new tool to identify all smooth plains. A complete study of the origins all smooth plains is underway.

References: [1] Wilhelms and McCauley (1971) Geologic map of the nearside of the Moon. U.S.G.S. Map I-703. [2] Stewart-Alexander (1978) Geologic map of the central far side of the Moon. U.S.G.S. Map I-1047. [3] Pieters (1979) LPSC X, p. 981-983. Abstract . [4] Boyd et al. (2012) LPSC. [5] Scholten et al. (2012) in review: *JGR-Planets*. [6] Robinson (2012) LPSC. [7] Wilhelms (1987) Geologic History of the Moon. [8] Ashley et al (2012) in review: JGR-Planets.