

LUNAR LIGHT PLAINS IN THE ORIENTALE REGION, MOON. B. Giuri¹, H. Hiesinger¹, N. Schmedemann¹, and C. H. van der Bogert¹, ¹Institut für Planetologie, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany (gbarbara@uni-muenster.de).

Introduction: Occupying about 9.5% of the lunar surface, light plains (LP) are flat, smooth terrains, similar in morphology to mare basalts, but with moderate to high albedo [1]. They are globally distributed on both the nearside and farside of the Moon. Before the Apollo 16 mission successfully returned samples from the Cayley Formation, light plains were interpreted to be volcanic for their mare-like appearance [2] but more silicic than basaltic in composition [3]. However, upon return the samples were found to be impact breccias and consequently, the origin of LP was re-interpreted to be related to the largest young impact events, i.e., Orientale and Imbrium [3,4,5,6,7]. However, Neukum [1977] argued that the origin of the light plains might be more diverse with some light plains being formed by volcanism, basin-related processes or local cratering. In some cases, a relationship with cryptomeria is indicated by the presence of dark halo craters that penetrated the light plains to expose dark underlying material of presumably volcanic origin.

The new high-resolution images of the Lunar Reconnaissance Orbiter Camera (LROC), in combination with other modern data sets, allow us to study light plains in unprecedented detail in order to decipher their potential origin. Thus, we present a preliminary map of light plains in the mid latitudes, north west and south Orientale basin on the far side of the Moon.

Data and Methods: For our study, we used an LROC WAC monochrome global mosaic base map and manually mapped all plains in ArcGIS 10.5. The Unified Geologic Map of the Moon [9] and regional geologic maps from USGS were consulted in the construction of our new map. LP were identified visually based on flatness, smoothness and albedo features relative to the surrounding terrains. We aim to integrate our map with Kaguya/SELENE Terrain Camera images to aid the identification of LP units in uncertain areas around Orientale basin.

Mapping Approach: The mapping is solely based on a visual identification of smooth, flat and moderate-to high-albedo plains with respect to the surrounding terrains. Compared to the map of [1], our map is largely consistent in this region but differs in the mapping methodology adopted. We based our identification of LP exclusively on their flat and smooth appearance, and bright albedo, whereas [1] used additional data sets such as slope maps. Another difference from the map of [1] is our apparently higher

density of LP along the Orientale rays, which is the result of having mapped many smaller areas for a given LP area, rather than a single larger unit. Going through the effort of remapping the LP will allow us to test the accuracy of the map of [1] and independently study the distribution and size frequency of LP.

Our work also differs from work done by [8] who applied an automated LP identification technique on the basis of a slope analysis from the LROC WAC topography and Clementine FeO maps. In particular, the differences reflect the mapping technique and the overall distribution of LP. In this work for example, we manually and visually mapped LP according to their morphology and albedo. The automated identification by [8], despite being overall consistent with our results, appears to be less suitable for differentiating between plains especially around mare regions. In summary, despite the patchier appearance and mismatches in some areas, the three maps are largely consistent with each other and thus appear to represent reliable depiction of the distribution of LP.

Results and Discussion: In our new map (Fig. 1a and b), light plains appear to delineate nine major rays converging on the Orientale basin (black arrows in Fig. 1). The origin of these plains is likely impact-related, particularly the Orientale event. Thus, this finding supports the interpretation of [1].

However, we also observed more evenly distributed larger plains to the north of the Orientale basin. These plains are located within and around craters and might have been formed by local cratering processes, or volcanism, or both. Although no morphological evidence such as vents were observed in this region, we do not exclude a volcanic origin at this early stage of investigation.

In addition, north of Orientale, plains occur as dense clusters and, in some areas, appear to overlap pre-existing plain units. Sizes and shapes of these light plains are variable. Possibly, this reflects the influence of neighbouring impact basins. In areas surrounding the Orientale basin and other large craters, we observed two morphologies of light plains. Whereas some LP exhibit a rough surface, others exhibit a smooth surface, and some exhibit both morphologies within one deposit. In such cases, we only mapped the smooth parts of these LPs for consistency with the definition of LP provided in the introduction. There are several potential interpretations of these two morphologies, including the existence of two types of LP, subsequent surface modifications of LPs, effects

related to variable distances to the source impact, or all of the above.

The distinct rayed pattern of light plains around Orientale basin suggests that most of the plains occurring within 4 radii are related to its formation, consistent with previous work [1,6]. Plains that do not appear to be related to a specific basin may be more likely due to local and/or regional impact cratering and/or volcanism. As we progress with mapping the locations and types of LP units, we will be able to investigate more specifically these different potential origins.

Conclusions: Our preliminary new map of LP around the Orientale basin shows similarities with prior maps. We find ray like patterns of LP converging towards Orientale basin up to a distance of 4 radii, while plains appear to be more evenly distributed to the north. However, we note that there are at least two slightly different morphologies present in the LP mapped by [1]. Looking into the details and distributions of these types may give us new insights into the origins of the enigmatic LP materials.

Future Work: We are in the process of producing a global map of light plains, which will provide further insights into their distribution and their relationship with basin formation. In addition, we will search for signatures of dark halo craters (DHC) superposed on LP units. The presence of DHCs is usually interpreted as evidence for cryptomare, therefore, if we are likely to find a high number of dark halo craters we might be able to support the impact related origin of light plains, at least in some regions. In addition, we will study DHC diameters, and thus the thickness of the LP deposits, in relationship to their potential source basin/crater to test a basin related formation, or a more local/regional impact ejecta emplacement.

References: [1] Meyer et al (2020), JGRP, 125; [2] Wilhelms (1965), Astr. Stud. Ann. Rep., v. 13, p. 28; [3] Wilhelms (1987), Geologic History of the Moon, USGS PP 1348; [4] Eggleton et al (1972), Apollo 16 Prelim. Sci. Rep., 29-7 – 29-16; [5] Chao et al (1973), LPSC 4, 127-128; [6] Meyer et al (2016), Icarus, 273, 135-145; [7] Boyce et al (1974), LSC, v. 5: Houston, Texas, 11-23; [8] Boyd, Mahanti, et al (2012), Presented at the EPSC; [9] Fortezzo, Spudis and Harrel (2020); [10] Neukum (1977), The Moon, vol. 17, Dec. 1977, p. 383-393.

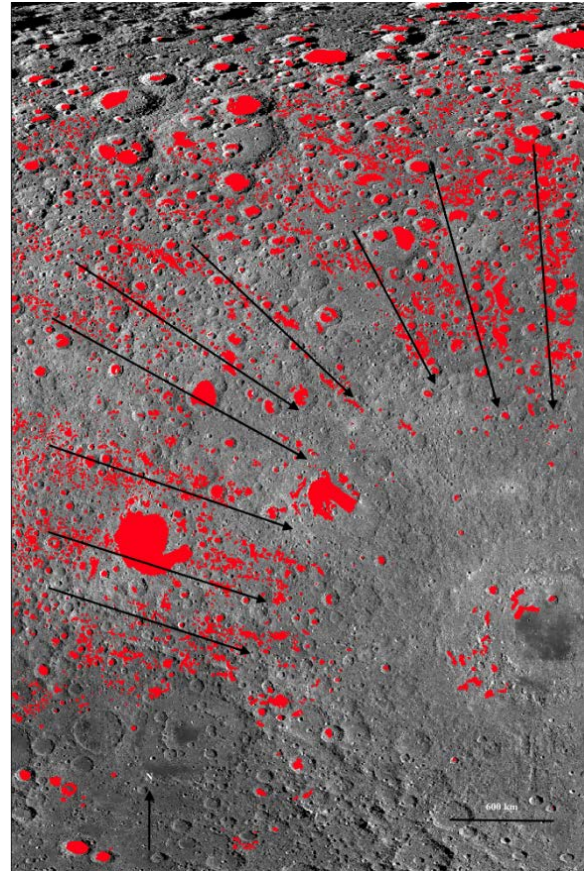


Figure 1a: Orientale region in our LP map. The black arrows delineate major rays converging towards Orientale basin.

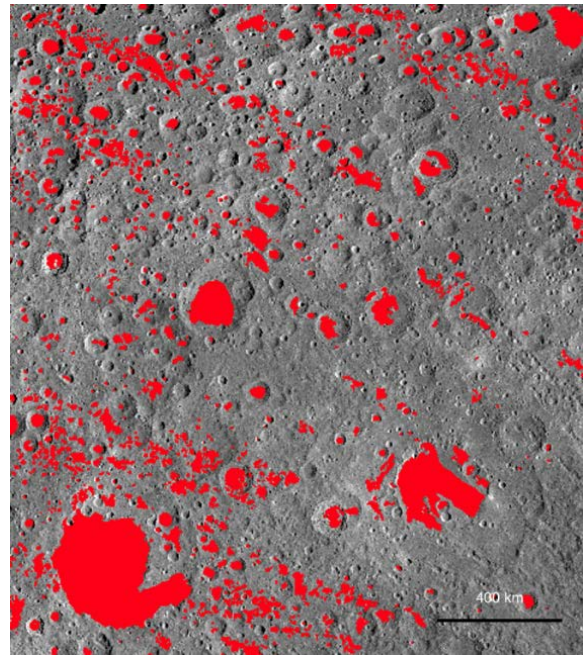


Figure 1b: Close up view of LP delineating three rays towards Orientale basin's continuous ejecta blanket to the bottom right corner of the image. Also noticeable is the area between the rays with fewer plains.