Identifying Lunar Pyroclastic Deposits Near the Apollo 17 Landing Site Using Small Crater Densities. Susan Klem[1] and Lisa Gaddis[1]. [1]Astrogeology Science Center, U.S. Geological Survey, Flagstaff, AZ. (sklem@usgs.gov).

Overview: This study uses counts of small crater density and distribution to determine whether surface mantling units such as those from lunar pyroclastic deposits can be distinguished. Previous studies [1] suggested that smaller craters erode faster in loose, unconsolidated pyroclastic soil. Manual counts of small craters were performed on mantled and unmantled mare units west of the Apollo 17 landing site (***Figure 1***) using data from the Narrow Angle Camera (NAC frame M117304864LE; 0.67 m/pixel) of the Lunar Reconnaissance Orbiter Camera (LRO) [2] and the Kaguya Terrain Camera evening illumination data (KTC; TC_EVE_02N21E027N18E030SC; 10 m/pixel [3]). The goals of this study are to (1) compare our results using these new, high spatial resolution data with those of previous results, (2) evaluate the relative utility of KTC and LROC NAC data for such counts, and (3) assess whether we can distinguish mantled from unmantled mare units.

Apollo 17 Pyroclastic Deposits: The Taurus-Littrow region was chosen for the Apollo 17 landing site partly because of the very dark pyroclastic deposits nearby. These metallic- and volatile-element (e.g., S, Fe, Ti) enriched remnants of ancient lunar volcanic eruptions remain a high priority [e.g., 4] for lunar exploration and possible future resource exploitation. To the west of the actual landing site, on the west side of Mons Argaeus, is the area of focus for this study. The area contains mountains as well as mantled (3.7 BY, [5]) and unmantled mare (~3.8 BY, [6]) of comparable age (***Figure 2***), allowing crater density for different surface properties to be compared to one another. The mantled mare units near Apollo 17 typically have a very low albedo, which makes identifying pyroclastic deposits easy. However, not all pyroclastic deposits are dark [e.g., 7] and another method of identification of lunar pyroclastic deposits is needed for such deposits.

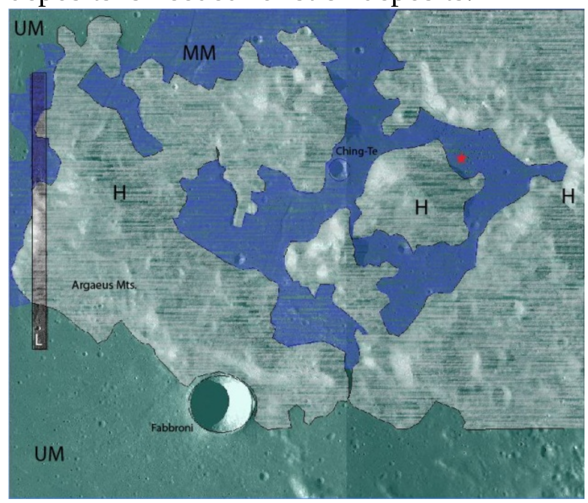

Figure 1. The Apollo 17 landing site (red star) region of SE Serenitatis basin as viewed by the KTC (~10 m/p; in false color). The LROC NAC study frame (M117304864L, 87° inc.) is shown with a black outline around it. Mantled mare (MM) units are shown in blue, and highlands and low hills are shown in gray. Fabbroni crater is 11 km across.

Method: Manual crater counting was done using the Crater Helper Tool add-on for ArcMap 10 [8]. The area counted in both datasets was the same: the coverage of a single NAC frame (2.5 km x 25 km). Craters of 25 m to 400 m in diameter were counted in the KTC and craters of 30 m to 845 m were counted in the LROC NAC data. Fresh and eroded craters were counted at the full raster resolution of the dataset; obvious secondary craters were not counted.

A spatial grid (500 m x 500 m) covering the count area was used for the density analysis. All crater points in each grid square were counted and a key color was assigned. Counts per square ranged from 0 to 12 for the LROC NAC and 0 to 10 for the KTC data. The colored grids show the density distribution of small craters across the count area.

Figure 2. Close-up 1 km^2 views of LROC NAC frame M117304864L (0.67m/pixel, 87^o inc.) Mantled Mare – North (Top) and Unmantled Mare – South (Bottom) units. Note that the mantled unit is darker and appears to have fewer smaller craters.

Analysis: By comparing the two colored grids from the manually counted crater counts, we note clear differences in the density and distribution of small craters across different surface units. The LROC NAC grid count shows more craters total and a higher number of craters in each square than the KTC grid. This is consistent with higher spatial resolution of the NAC data. The crater density grids also show lower crater densities for the mantled mare deposits (average density ~38 craters/km^2) and a higher crater density for the unmantled mare (average density 73 craters/km^2). These results are consistent with those of earlier studies [1]. Also, the NAC crater counts in general show a clearer distinction between mantled and unmantled maria, suggesting that these data may be more useful for distinguishing pyroclastic units in this area. More study is needed to determine the range of thicknesses of the pyroclastic mantling units west of Apollo 17 and their relationship to small crater density. Results of this study suggest that small crater counts and densities may provide a useful means of distinguishing mantling units.

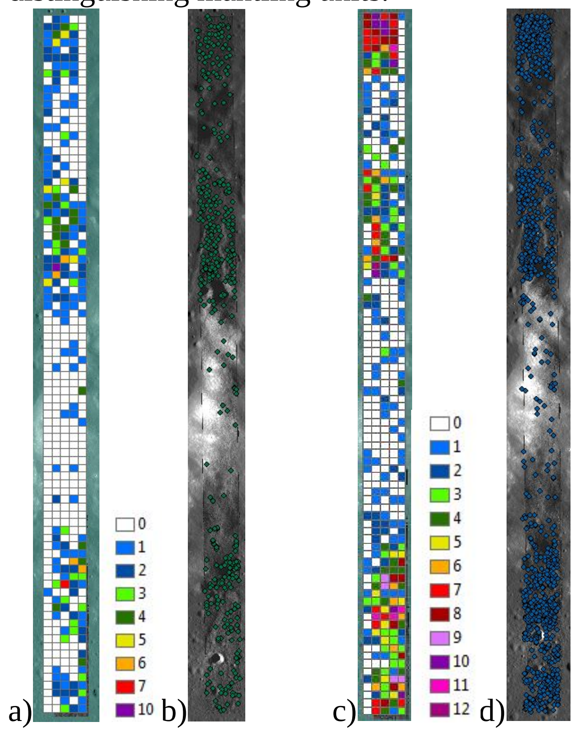

Figure 3. Crater density grids and keys for (a) KTC EVE and (c) LROC NAC frames. The tops and middles of the images are mantled mare, and the bottom is unmantled mare. (The background is the KTC EVE image with false color), b) and d) show the small crater counts for KTC and LROC respectively.

Acknowledgments: Special thanks to Richard Nava for his help with using Crater Helper.

References: [1] Lucchitta and Sanchez, 1975, PLPSC 6th, 2427-2441. [2] Robinson et al., 2010, Space Sci. Rev, 150, 81-124. [3] Haruyama et al., 2008, Earth. Planets and Space, 60, 243- 255.. [4] Gaddis et al., 2011, LPSC 42nd, 2584. [5] Taylor, 1982, LPI Press, 481 pp. [6] Kirsten et al., 1973, EPSL 20, 125-130. [7] Gaddis et al., 2003, Icarus, 161, 262. [8] Nava, 2010, Crater Helper Tools for ArcMap, ftp://pdsimage2.wr.usgs.gov/pub/pigpen/ArcMap_addons/Crater-Helper_Tools_Manual_062510.pdf.