POSSIBLE LACK OF SMALL CRATERS IN "ELEPHANT HIDE" AREAS ON THE MOON: A CASE STUDY. N. V. Bondarenko, Earth and Planetary Sciences, University of California – Santa Cruz, Santa Cruz, CA, 95064, USA, (nbondar@ucsc.edu).

Introduction: All inclined surfaces on the Moon exhibit specific texture mentioned as "elephant hide" (EHT) [e.g., 1] or "leathery" [2] texture, or "creeps" [3]. EHT has the meters-to-decameters spatial scales, it apparently occurs on all slopes steeper than ~5°, regardless of latitude and the slope orientation [4]. A topographic diffusion [5, 6] of regolith due to micrometeoritic impacts cannot generate any rough texture, it smooths down any small-scale topography. Recent study showed that EHT tends to produce steep downhill-facing slopes with respect to regional topography [7]. This can point to the presence of processes similar to small slides: possible downhill movement of regolith parcels under their own weight triggered by some poorly understood mobilization effects. Nevertheless, the primary surface roughening mechanism responsible for the EHT formation is still unknown.

In the present study we analyze topography of a sample EHT area to understand the regolith volume involving in the EHT formation.

EHL topography: We study 2.1×3.2 km surface area in the "Slipher" site (in the vicinity of crater Slipher), centered at 48.07°N 160.54°E (see Fig. 1a). We generated a high-resolution DTM for this area using "improved photoclinometry" technique [8, 9] from a set of three LROC NAC images with near-optimal illumination directions. Improved photoclinometry is a version of photoclinometric processing yielding topography of the highest probability in the frame of Bayesian inference. Actual resolution of improved photoclinometry potentially can reach the resolution of the source images.

We consider empirical Mean Moon Photometric Function for mature highlands [10] as a priory known photometric function for the DTM calculations with improved photoclinometry.

To focus on topographic details of EHT we generated a hierarchy of band-pass-filtered topography from this DTM. Each hierarchy member was obtained by sequential smoothing DTM with a twice larger window of the circular shape. The surface relief at the 190 m spatial scale is shown in Fig. 1b. It's heights vary in the range from -26 m to 20 m and heights root-mean-square variation is equal to 3.8 m.

We outlined five areas inside the scene in Fig. 1. An area A is characterized by the lowest mean regional slope, 2.9°, according to SLDEM2015topography data [11]. Areas B, C, D and E have much higher mean regional slope: 19.2°, 17.9°, 12.6° and 17.1°, respectively. Relations between surface spatial scales L and heights root-mean-square variations σ_H for each area are shown in Fig. 2.

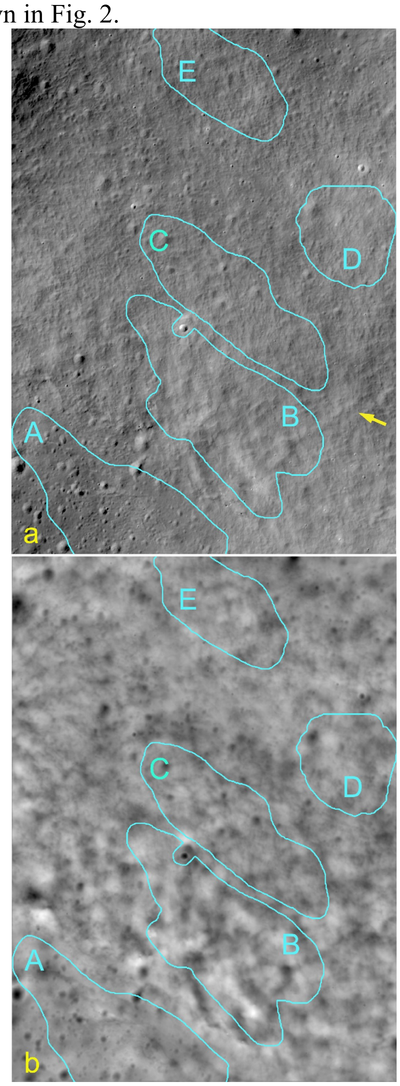

Fig. 1. Lunar surface area under study, center coordinates: 48.07°N 160.54°E: a) portion of LRO NAC image M184841215RE, illumination direction is marked with yellow arrow; b) the band-pass-filtered surface relief (derived with improved photoclinometry) at the 190 m spatial scale, darker shades correspond to lower heights.

The near-horizontal area A exhibits in Fig. 2 the behavior similar to that of areas C, D and E located on the "intermediate" tilted surfaces. In Fig.1 these areas are very different from each other: area A is densely covered by small craters. Thus the surface roughness at different spatial scales here is caused by craters, while for other areas it is caused by by the EHT presence. At spatial scales smaller than ~50 m (Fig. 2) heights are very similar to each other for all areas under study, both near-horizontal and tilted. σ_H of the steepest area B exceeds the gentlest area A σ_H (along with areas C, D and E) at spatial scales of 95 m and 190 m by 0.35 m and 0.7 m, respectively. This suggests that regolith layers up to one meter thick can be involved in the EHT formation.

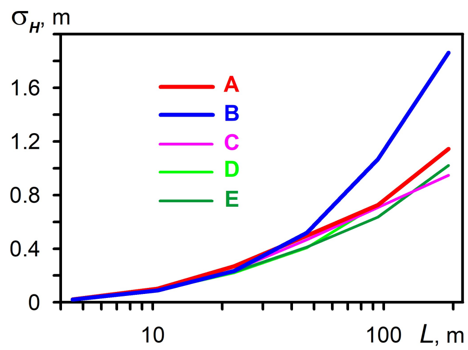

Fig. 2. Heights root-mean-square variations σ_H vs. spatial scales *L*.

Crater statistics: We counted small craters (< 20 m in diameter) in outlined areas (see Fig. 1) by an automated procedure during the process of relief calculations. The automated algorithm searches for concave symmetric shapes in intermediate heights distributions through an iteration procedure. The algorithm also checks the stability of the feature shapes through the iterative convergence process and used this stability as an additional criterium for crater identification.

Total number of craters identified in areas A through E are 429, 554, 359, 221 and 192, respectively. Two approaches are used to compare craters size-frequency distributions. In Fig. 3a. the dependence of craters density *q* (per 100 m^2) is plotted against crater diameter *D*. In Fig.3b numbers of found craters were normalized by the counts in the smallest size bin (3 m). It is seen that the near-horizontal area A (red thick lines in Fig. 3) exhibit an apparent excess of craters with diameter of 5-8 m with respect to all tilted areas. The steepest area B (blue thick lines in Fig. 3) exhibits very similar to areas C, D and E crater population.

Discussion: The observed lack of craters with diameters of 5-8 m in the tilted areas could occur just by chance. Nevertheless, there is no obvious larger craters in the vicinity of the area A which could serve as a source for secondary craters population. Distance between the near-horizontal and the steepest areas (A and B, respectively) is about 800 m.

The observed lack of craters can be explained by interaction of such craters with regolith itself. For example, craters can be filled in with regolith partly or entirely. Filled craters are hardly recognized in images. It is known that depth-diameter ratio of fresh small craters in the lunar maria and highlands varies from ~0.2 to ~0.1 (see, for example, [12]). Craters with diameters of 5-8 m are expected to have depths from 0.5 m to 1.6 m. Such depths are similar to observed heights variations in steep areas discussed above.

It is possible that such craters (*D* ~ 5-8 m) can become involved in movement of the mobile upper layer of the regolith and thus degrade and disappear anomalously rapidly in comparison to larger craters.

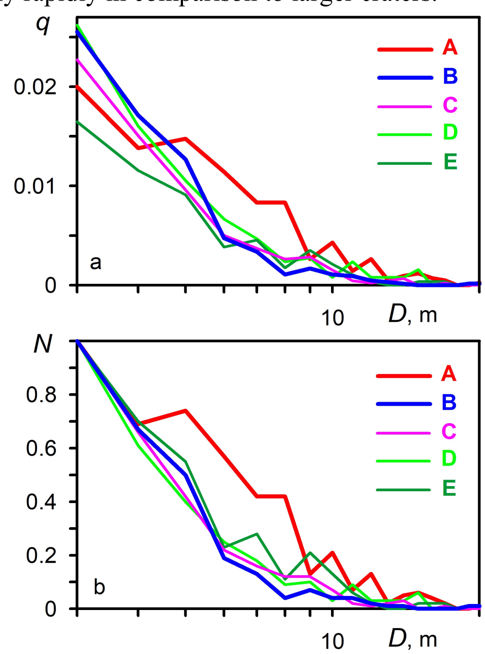

Fig. 3. Observed craters density per 100 m^2 (a) and normalized crater's number *N* (b) vs. craters diameter *D*.

Conclusion: The study points to a possibility that moveable regolith in up to one meter thickn layeris responsible for the EHT formation.

References: [1] Plescia & Robinson (2010) *EPSC 2010*, #731. [2] Antonenko (2012) *LPSC 43*, #2581. [3] Xiao et al. (2013) *EPSL 376*, 1. [4] Kreslavsky et al. (2021), *LPSC 52*, #1826. [5] Soderblom (1970) *JGR*, *75*, 2655. [6] Fassett & Thompson (2014) *JGR, 119*, 2255. [7] Bondarenko et al. (2022), *LPSC 53*, # 2469. [8] Parusimov & Kornienko (1973), *Astrometry and Astrophysics*, *19*, 20. [9] Bondarenko et al. (2018) *LPSC 49*, #2459. [10] Boyd & Robinson (2018) *LPSC 46*, #2671. [11] Barker et al. (2015) *Icarus, 273*, 346. [12] Shujuan Sun et al. (2018) *Icarus, 309*, 61.