LEATHERY TEXTURE IN THE BOSE, BHABHA, AND STONEY CRATER REGION OF SOUTH POLE-AITKEN BASIN ON THE MOON. I. Antonenko, Planetary Institute of Toronto, 197 Fairview Ave. Toronto, ON, M6P 3A6, Canada, PlanetaryInstituteofToronto@yahoo.ca.

Introduction: The presence of a fine-scale wrinkle texture (Fig. 1) on many surfaces on the Moon has been recognized since the Apollo era [e.g., 1, 2] and has more recently been observed in LROC images [e.g., 3, 4]. This texture, which is referred to as leathery, elephant-hide, or tree bark texture, is prevalent throughout the central region of the South Pole-Aitken (SPA) basin, around the craters Bose, Bhabha, and Stoney. This region is of interest as a possible future landing site [e.g. 5], because of the potential to sample the SPA impact melt sheet [6] and possibly the lower crust at Mafic Mound [7]. However, the prevalence of leathery texture in this region may indicate a problem for the interpretation of remote sensing data, and therefore sample provenance, because the formation process of this texture and its implication is not yet known.

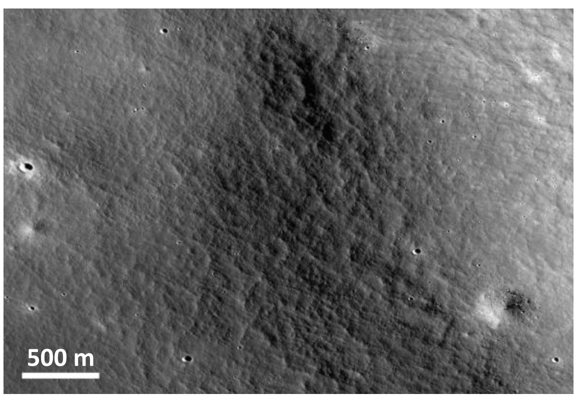

Figure 1: LROC image of fine-scale leathery texture (Lat 51.0607, Lon - 159.4297) in the plains north-east of Bhabha crater. *Arizona State University ACT-REACT Quick Map screen capture*.

Background: A number of formation theories for this texture have been proposed. It is commonly assumed the texture represents a slow, cumulative downslope creep of the regolith, driven by micrometeorite impacts [3]. However, theories involving the reworking of regolith due to seismic shaking [8] or flow features in viscous basalt lavas [9] were also originally proposed. It is also worth considering that these textures may be impact melt flow features, formed when melts were excavated from adjacent craters. LROC images of chaotic impact melts on the floor of Moore F crater (Fig. 2) show undulating grooves and ridges of a similar morphology and scale as leathery texture (Fig. 1).

Leathery texture in the highlands was the subject of orbital studies during the Apollo 16 mission [10]. These fine-scale features were readily observed by the naked eye at altitudes < 50 km. Furthermore, these patterns were apparent on both sloped and horizontal surfaces. Most interestingly, the texture was clearly visible to human observers at all sun illumination angles, but only registered on photographic film at very low sun angles. In orbital photographs, therefore, these textures are seen more readily on slopes, where low sun angles highlight their presence with shadows [10].

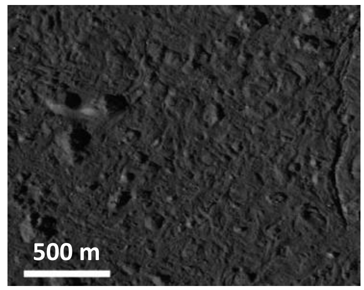

Figure 2: LROC image of chaotic melt (Lat 37.4097, Lon - 174.9313) on floor of Moore F crater. This texture bears some resemblance to the morphology and scale of leathery texture in Fig. 1. *Arizona State University ACT-REACT Quick Map screen capture*.

Method: A survey of leathery texture was conducted near Bose, Bhabha, and Stoney craters (study extent: Lat -50 to -60, Lon -170 to -150). Available LROC images in the region were studied to assess the extent of this texture throughout the area and to explore whether the provenance of the texture could be ascertained. All craters >2 km in diameter were examined. The slopes, terraces, floors, central peaks, and ejecta deposits of the 5 complex craters found in this area were studied extensively. Additionally, random inspectison of flat areas in mare, cryptomare, and non-mare terrains was conducted. In all cases, the locations of identified leathery texture were recorded.

Observations: The sun-angle illumination limitation observed for photographic film also appears to be an issue for the digital LROC camera. This phenomenon is observed in some images (e.g., Fig. 3), where the sun angle around the interior crater slopes varies such that only one section of the wall contains shadows that highlight the leathery texture (without obscuring it). In addition, some craters with relatively consistent illuminations show leathery texture all around the crater walls (Fig. 4), supporting the interpretation that this texture is generally continuous within the crater, but is only viewed under optimal illumination conditions.

The illumination angle limitation makes proving an absence of this texture very difficult. Thus, this study focuses on characterizing where leathery texture tends to be found, rather than mapping all occurrences of it.

Leathery texture was found to be pervasive in the study region. It was found associated with every single crater < 2 km in diameter, for which low sun-angle

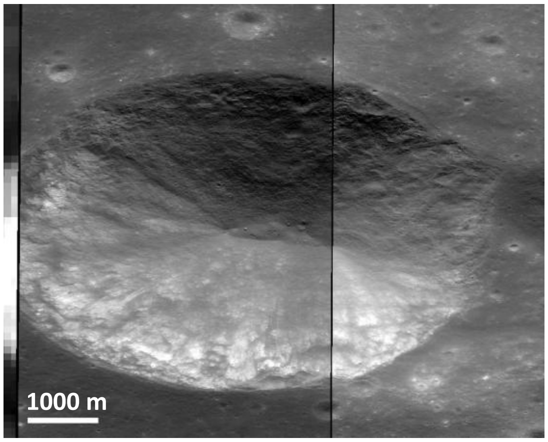

Figure 3: LROC image of fresh crater (Lat -55.0682, Lon -153.6498) in SPA plains. Leathery texture is only evident under low sun-angle illumination conditions, which occur on the northern slopes of the crater wall. *Arizona State University ACT-REACT Quick Map screen capture*.

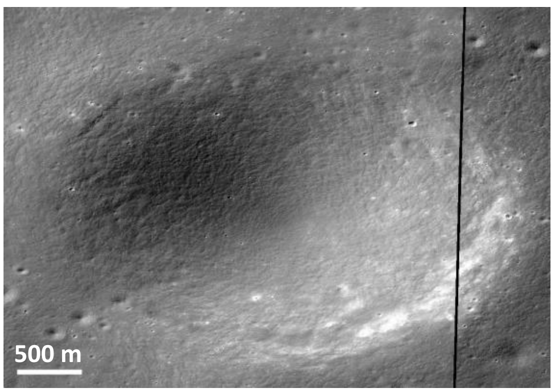

Figure 4: LROC image of subdued crater (Lat -53.4587, Lon -154.9617) in SPA plains. Illumination conditions show off the pervasive presence of leathery texture, both inside and outside the crater. *Arizona State University ACT-REACT Quick Map screen capture*.

LROC data was available. Most craters exhibited leathery texture on both interior and exterior slopes. The larger basins exhibited this texture on their walls, terrace slopes, central peaks, and exterior ejecta. Leathery texture was even observed in some flat areas (see Fig. 1) within and between craters. In general, leathery texture was not easily discernable on flat surfaces. However, even the slightest change in topography could highlight leather texture in horizontal surfaces. Leathery texture was more prevalent in and around craters with subdued topography (e.g., Fig. 3 vs. Fig. 4).

Discussion: The observation of leathery texture on horizontal surfaces, both in this study and in [10], suggest that the model of downslope creep is insufficient to explain all the observed occurrences. Other models must therefore be considered.

Despite the presence of mapped mare and cryptomare units in this area [e.g., 11, 12], significant non-mare regions also exist. Thus, extensive surface lavas, retaining flow features, are not expected to dominate here and the viscous lava model of formation [9] can be eliminated as highly improbable for this region.

The pervasiveness of leathery texture in this area also argues against an impact melt origin. Calculations [13] show that ~200 m of cumulative ejecta is expected to blanket this area, with half of that derived from small local impacts. This material should include impact melt clasts, however, cohesive surface melt units are not expected to survive the bombardment that emplaced this ejecta material [14]. Thus, while flow features on impact melt units may explain local occurrences of leathery texture, they cannot explain the extensive and persistent texture observed here.

Seismic shaking appears to be the only model that is supported by the observations in this region. Calculations [8] have shown that large impacts are not required for seismic shaking. Significant local (~4R) shaking is expected for craters as small as 2 km in diameter. Thus, almost all craters should exhibit evidence of seismic shaking, including subdued topography and soil creep patterns. Seismic shaking includes a large component of lateral ground movement [e.g. 8], thus horizontal surfaces should also be affected. Finally, such effects are more pronounced in regions with thick unconsolidated surface layers, such as the 200 m thickness of ejecta proposed for this region [13].

If leathery texture is formed in this area by the seismic shaking of a thick regolith layer, this has important implications for the provenance of surface materials. Thick deposits with a significant foreign component may affect remote sensing studies, if bedrock composition is of interest. Further work is required.

Conclusions: Leathery texture is seen in virtually every type of terrain and feature in the central SPA area, though observations are constrained by the need for low illumination angles. These observation support only the seismic shaking model [8] of leathery texture formation, suggesting horizontal ground motion from small local impacts mobilizes a thick regolith layer to produce creep patterns and subdued topography.

References: [1] Schultz P.H. (1972) *A Prelim. Morph. Study of the Lunar Surface*, 967 pp, Ph.D. Thesis, Univ. of Texas at Austin. [2] Scott D.R.. et al. (1972) *A15 Prelim. Sci. Report,* NASA SP-289, pp 4-1 to 4-4. [3] Plescia J. and Robinson M.S. (2010) *EPSC 2010, V5*, Abstract #EPSC2010-731. [4] Mest S.C. (2011) *in GSA Special Paper 477*, 95-115. [5] Jolliff B.L. et al. (2010) *LPS XXXXI*, Abstract #2450. [6] Petro N.E. and Pieters C.M. (2004) *JGR, 109*, E06004. [7] Pieters C.M. et al. (2010) *AGU Fall Meeting*, Abstract #P43A-04. [8] Schultz P.H. and Gault D.E. (1975) *LPS XXXIII*, 159-177. [9] Cameron W.S. and Lowrey B.E. (1975) *Moon, 12*, 331-360 [10] Mattingly T.K. and El-Baz F. (1973) *Proc. 4th LSC, V1*, 49-56. [11] Gibson K.E. and Jolliff B.L. (2011) *LPS XXXXI*, Abstract #2326. [12] Borst A.M. et al. (2011) *PSS, in Press*. [13] Petro N.E. and Jolliff B.L. (2011) *LPS XXXXII*, Abstract #2637. [14] Hörz et al. (1976) *Proc. 7th LSC*, 2931-2945.