REGOLITH THICKNESS, DISTRIBUTION, AND PROCESSES EXAMINED AT SUB-METER RESOLUTION.

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Introduction: We have utilized very high resolution (60-200 cm/p) Lunar Orbiter frames to investigate regolith thickness, distribution, and processes in both mare and highland areas. Previous studies have proposed that the depth to an interface between the regolith and a coherent substrate controls crater interior morphology (Q&O craters) and block distributions in and around host craters [1,2,3]. To test this hypothesis we have mapped the distribution of these key morphologic indicators over mare and highland regions. Our data show that the block populations and Q&O crater populations are generally consistent with this idea. However, we have noted some important deviations, namely that the indicators are irregularly distributed and thus seem to imply a highly variable regolith thickness in a local area. Another important result of our data is the documentation that at small sizes the mare contain greater numbers of craters.

Crater Distribution: To quantify the frequency of blocky craters and Q&O craters and their distribution we identified, mapped, and classified (from most to least blocky) all craters with diameters larger than ~50 m in both mare and highland areas. Our mare study area (~1°S to 4°S, 42°W to 45°W) is contained within the large (~50 km diam) mare flooded crater Flamsteed Ring. From 12 images we identified 549 craters with diameters between 50 and 1400 m (average 124 m) in a total area of 119 km^2. From 7 highland images we identified 155 craters between 50 and 753 m (average 114 m) in a total area of 48 km^2.

Q&O populations: Craters showing morphologic evidence of strength discontinuities in the mare are randomly distributed on a local scale and compose ~8% of the population. Wherever these Q&O craters appear, normal-geometry craters as large and larger appear nearby, which begs the question: why aren't all craters of a comparable size in a region Q&O craters? We propose that the flat bottomed and concentric geometry (Q&O) craters degrade relatively quickly to more normal bowl-shaped geometry through impact degradation and seismic shaking over time. Such degradation is consistent with the erosion rate of 5±3 cm/m.y. for loose material [4]. It also explains the commonly observed presence of angular to sub-angular blocks found on degraded craters; blocks erode 20-80x slower (~1 mm/m.y.) [e.g. 5] than loose regolith.

Blocky crater populations: Because blocky craters indicate the presence of a coherent substrate, we find it significant that 68% of mare craters and 97% of highland craters have no blocks. Craters with abundant blocks are rare (~1%) in both the highlands and the mare. While these craters cover only 3% of the mare area of study, the craters plus their blocky ejecta (2 crater radii from the center) cover 12% of the area. Blocky craters are rare in number, but they cover a significant fraction of the surface. Thus many of the blocks on the lunar surface have been produced from only a small portion of the total craters. We note that the LO images were selected on the criteria that they had craters with blocks, thus our results represent an upper limit for the distribution of blocky craters. Because of the key role resolution plays in the detection of blocks, our results are limited to the case of ~l m/p.

Blocky craters were randomly distributed in our area of study, which again brings up the question: why are some craters blocky while other seemingly similar nearby craters are not? Although this indicates heterogeneities in the coherence of the impacted material, the cause of these heterogeneities is not clear. Differences in fragmentation and jointing of the subsurface is one possibility. Cumulative size-frequency slopes for blocks in and around craters in the mare ranged from -2.8 to -5.1; steeper slopes represent more heavily fragmented materials [6]. At this time, with only 7 blocky craters analyzed, the significance of these results is not yet clear.

Crater Frequency*:* At small sizes (50-1400 m) the mare contain 43% more craters than the highlands in our areas of study (size range 50-200 m there are ~45% more craters in the mare). This can be explained by the fact that the highlands have no near-surface coherent substrate and are thus composed of a thicker layer of regolith allowing these smaller craters to be erased relatively rapidly, possibly enhanced by steeper slopes.

Implications for Other Airless Bodies: The Moon provides the only data comparable to those for asteroid 433 Eros. The complete absence of Q&O craters and the paucity of small craters on Eros are evidence of a thick and mobile regolith. That nearly all of the blocks on the surface of Eros came from one crater and other craters did not produce abundant block populations [7] is consistent with the lunar example. The slopes of cumulative size-frequency histograms for blocks on Eros [7] fall within nearly the same range as the lunar slopes, indicating that fracturing mechanics are similar on different airless bodies, despite gross variations in gravity and impact velocity.

References: [1] Quaide and Oberbeck (1968) *JGR, 73*, 5247-5270. [2] Shoemaker and Morris (1968) *JPL Tech Rept 32-1265*, 86-103. [3] Cintala and McBride (1995) *NASA Tech Memo 104804*. 41pp. [4] Arvidson et al. (1975) *The Moon, 13*, 67-79. [5] Crozaz et al. (1971) *Proc 2nd Lunar Sci Conf*, 2543-2558. [6] Hartmann (1969) *Icarus,10*, 201-213. [7] Thomas et al. (2001) *Nature, 413*, 394-396.