ON THE SMALL DEPTH-DIAMETER RATIOS OF SMALL LUNAR CRATERS. P. Mahanti[1] and M.S. Robinson[1], [1]LROC Science Operations Center, SESE, Arizona State University (pmahanti.lroc@gmail.com).

Introduction: The ongoing formation of small lunar craters (SLC; D <250 m) relentlessly modifies the local topography of the Moon. SLC form ubiquitously and are the most populous impact feature on the Moon, but also the least studied since appropriate topographic data was made available only recently. Robotic missions (e.g. Lunar Reconnaissance Orbiter (LRO), Kaguya, Chandrayaan-1) carrying high-resolution cameras (e.g. Lunar Reconnaissance Orbiter Camera (LROC) Narrow Angle Camera (NAC) [1], Terrain Camera [2] and Terrain Mapping Camera [3]) have now made it possible to observe and analyze the morphology of SLC in great detail.

SLC formation events are significant contributors to regolith formation and the current shapes of SLC are critical to our understanding of the regolith. Observed shapes of SLC reflect, at least in part, the target strength properties of the pre-impact surface (and perhaps, various layers below the surface) as well as change due to degradation (also dependant on target strength properties). From an exploration point-of-view, the morphology of small craters is relevant as SLC are common and will be the main obstacle in the path of a robotic and (or) human explorer; morphological details like the depth and slope will significantly affect exploration plans. Measurements of depth-to-diameter ratio provide primary aspects of SLC shapes.

Depth-to-diameter: Most of the measurements of d/D for SLC in the past 4 years are based on NAC Digital Terrain Models (DTM; 2 m/p). Additionally some observations are based on shadow measurements [12,13] using NAC images (0.5 m/p). Measurements of d/D for small highland craters (N=540, D<150 m, [6]) and craters on selected sites on mare and non-mare terrains (N=850, D<300 m , [7]) both showed median d/D values ~0.13. Range of d/D for the selected sites [7] was 0.11 – 0.15 and the d/D range obtained corresponding to a power law fit for highland craters [8] was 0.12-0.15. A global selection of SLCs from ~50 sites (N = 4477 , D < 200 m) also yielded median d/D values of 0.13 [9]. A study including slightly larger craters (N=554, D<1 km, [13]) found a smaller average d/D (~ 0.1) for randomly selected craters, possibly due to a larger percentage of degraded craters. Analysis of crater population (D < 2 km) at Lunokhod 1 and 2 study areas [12] also showed that less than 1% of the crater population had d/D > 0.15. Note that while the maximum crater size has varied in the past studies, approximately similar median statistics and range was obtained for d/D.

Implications: Fresh, primary SLCs can have d/D < 0.15 – sharply contrasting the expected d/D (~ 0.2) for large craters (D > 1 km; [4,5]). The change in shape for fresh craters at different size can be attributed to target strength properties as well as the quick degradation rates. The shape variation causes power law's (d vs D ; based on Apollo era observations [4,5]) to overestimate depths for SLCs. Analysis of d vs D relationships for SLCs must take target properties and density of observations into account.

From the morphological degradation studies [10-12] it is evident that freshest craters (d/D > 0.15) are < ~10% of a total SLC population (the actual percentage varying with target region) while older, more degraded craters (d/D < 0.1) are the majority. Since percentage contribution in a population is proportional to average lifetime, degradation rate of SLCs decrease with time.

Since low d/D suggests lower impact velocities, it may be hypothesized that most SLCs are unrecognized secondaries, but this hypothesis does not explain what happens to the large number of primary craters being formed currently. Further, d/D histograms are unimodal [10,11] and do not indicate separate groups of craters. It is possible that some percentage of observed SLCs are secondaries, but most of them are primaries that have degraded quickly.

The lifetime of SLC is affected by factors other than the average impact rate and average impact-based degradation rates [11]- SLCs can degrade quicker (or slower) than expected at equilibrium. Short spells of seismic shaking (from interior or due to nearby impacts, after crater formation) can also initiate mass wasting processes that increase the effective degradation rate. Active processes like impacts, volcanism and seismic shaking can alter target properties – large impacts and seismic events can induce target weakness and magma flow from volcanism can add discontinuous strength boundaries in the target layers which accelerate or slow the pace of degradation.

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