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Estimating Lunar Rock Abrasion Stage using Photometric Studies

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The study and investigation of local scale geological features (boulders and boulder fields) of planetary/asteroid surfaces can provide insight on the evolution of the regolith and the contribution of various processes to their formation. Numerous studies have employed photometric modelling to study the surface properties of the lunar regolith on a regional and local scale (e.g., [1], [2], [3])

In this study we employ photometric methods to study the properties of boulder fields/rock fragments in a multiscale approach from resolved (meter scale) to sub pixel (cm scale). In our approaches we use the Hapke model [4] on LROC NAC data [5]. The retrieved properties of boulders, in particular their shape, can in turn shed light on the boulder material strength and surface exposure time [6].

Usually, photometric studies (e.g., [2]) consider the Hapke parameters SSA (single scattering albedo), b, c, theta_bar (roughness) as unknown and estimate them by inversion. Here we take a different approach and strongly constrain the possible combinations of the four parameters. The constraint is facilitated by the knowledge of the geological context of the surface either above (sub pixel approach) or below (resolved boulder field approach) the image resolution, visually inferred with images.

We are interested in the relative probability of each geologic context for a given region. This information is sufficient reveal information about the possible micro-scale geology of a region, namely the shape, and thus degradation, of rocks. We apply these techniques to the boulder fields in the vicinity of the Apollo 16 landing site at North Ray crater.

Our approach consists of the construction of a set of digital terrain models (DTMs) representative of the most possible geologic contexts. The contexts are described by the rock and debris apron shape and reflect the abrasion stage of the rock – Non-Abraded (flat top), Non-Abraded (angular), Mildly and Highly Abraded. The size-frequency distribution of the rocks follows a power-law [1]. The rock abundance is either measured (resolved scale analysis) or set as a free parameter (unresolved scale analysis). The size and spatial resolution of the DTM is defined by the scale of the analysis, either resolved or unresolved by LROC NAC. The Hapke reflectance model [4] is then used to illuminate these DTMs. Direct comparison of the reflectance at two phase angles as well as the Normalized Log Phase Ratio Difference value is carried out for the unresolved and resolved scale analysis, respectively.

References:

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