GEOLOGIC ANALYSIS AND POSSIBLE EVA TARGETS FOR AN ARTEMIS III LANDING SITE BOUNDED BY SHACKLETON AND SLATER CRATERS.

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Introduction: A summit between Shackleton and Slater craters near the lunar south pole, known as Site-007 [1,2], is a possible Artemis landing site. Here we present a geologic analysis of 2 and 10 km radial exploration zones (Fig. 1) and proposed extra-vehicular activity (EVA) targets that provide opportunities to address several exploration goals identified by the National Research Council [3].

Geologic Analysis: As previously mapped by [4], the study site contains four geologic units. The oldest units are pre-Nectarian platform massif and crater materials. These are partially covered by Nectarian crater material and Shackleton crater ejecta, which was mapped as Imbrian [4], but may have a younger Eratosthenian age [5]. Using images from the Lunar Reconnaissance Orbiter Narrow Angle Camera (NAC) we studied the geology of the site at a spatial resolution of ~1 m/px to identify targets of interest. These targets include boulders and craters which are expected to sample ejecta from the Shackleton and Slater impacts. Terraced and gully-like wall slumping are seen in some craters. Slumping processes may provide insight into the effects of extreme temperature variations on the rock.

Exploration Conditions: To identify EVA targets which would be scientifically interesting and accessible to crew, we studied regional hazards, illumination, and its counterpart, permanently shadowed regions.

Illumination. Solar power is an essential lunar surface resource for crew or robotic exploration of the area. Previous studies have shown that portions of the summit receive an annual average solar illumination of ~86% [1,6]. This study assumes a landing site near the point of maximum illumination [6], marked in Fig. 1 as a blue circle. Preliminary illumination simulations performed using MoonTrek's Illumination tool indicate that there are windows during south polar summer when the exploration area receives substantial illumination.

Permanently Shadowed Regions. Within 10 km of the point of greatest illumination, there is a moderately sized (~5.9 km^2) permanently shadowed region (PSR) within an unnamed crater with water ice (Fig. 2)[7]. This PSR is also shown in Fig. 1 as the dark region to the left of the blue circle. This PSR offers opportunities for a wide range of science activities as well as the potential for *in situ* resource utilization (ISRU). There are also several smaller PSRs, some of which may be younger and associated with boulder emplacement via impacts. The comparison of volatile composition in PSRs of varying ages would be possible at this site.

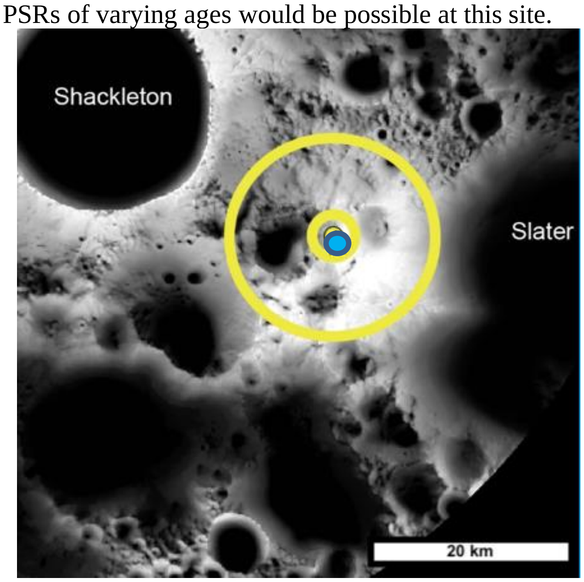

Figure 1. Time-weighted illumination map (100 m/pixel). Locations of peak illumination (central yellow dot after [1] and blue circle after [6]) with 2 and 10 km radial exploration zones (yellow circles).

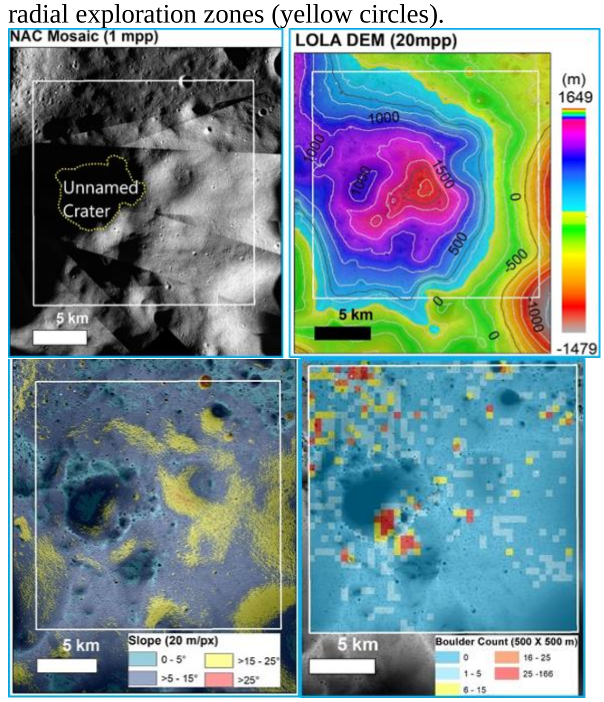

Figure 2. Site-007 as seen with NAC and LOLA. Topographic and slope maps generated from 20 m/px

LOLA DEM. Boulder density map created using 1 m/px NAC south polar mosaic.

Hazards. Three potential hazards were considered and avoided when selecting EVA targets: steep slopes (>25°)[9], high boulder density and shadowed regions (Fig. 2). All selected targets are accessible via terrain with low (0-15°) slopes, low boulder density (<5 boulders/2500 m^2)[9] and, with the exception of PSR targets, are within areas that provide access to solar power.

Proposed Targets: Proposed targets are divided into two groups: those accessible on a walking EVA within 2 km of the landing site and those accessible with a lunar rover within 10 km of the landing site.

Walking EVA Targets. Two primary science targets were identified within a distance of 2 km (Fig. 3). Craters C1 and C4 both have terraced wall slumping and excavated Shackleton ejecta. The younger crater, C1 (Fig. 3, below), is still surrounded by ejected boulders.

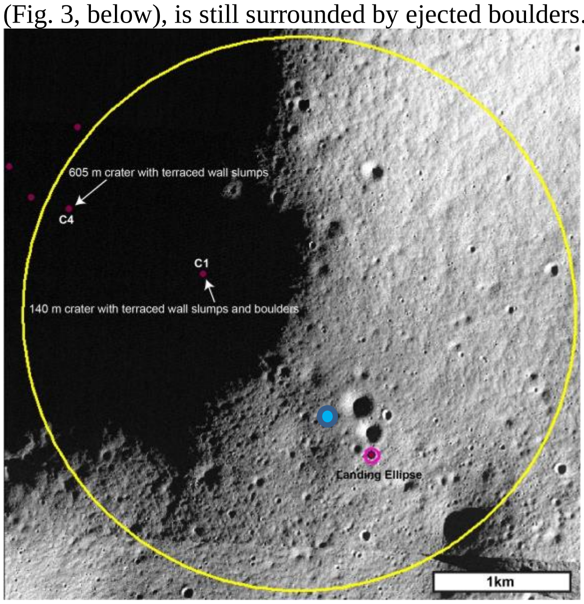

Figure 3. 2 km radial exploration zone based on [1] and [2]. Point of highest illumination from [6] is the blue circle. 100 m example landing ellipse in pink, selected based on [1, 2, 6]. Two EVA targets (C1 and C4) within walking distance in magenta. Background is NAC south polar mosaic.

Rover EVA Targets. Seventeen possible EVA targets were identified within a 10 km exploration zone for a crew equipped with a rover. The targets include craters with varying morphologies (labelled with a C in Fig. 4), boulder fields (labelled with B in Fig. 4), PSRs, orbital detections of ice [7], and areas predicted to be micro- and macro-cold traps in which ice may be stable within 1 m of the surface [8] (labelled as I in Fig. 4). Four possible traverse paths were designed to link different combinations of the EVA targets. The traverses avoid the aforementioned hazards and are between 20-25 km roundtrip. All paths originate from the suggested landing site (Fig. 3) and have been routed to avoid obstacles using ~1 m/px NAC images. Three of the traverses would take a crew into the largest PSR in Site-007 to sample the possible ice detection within by [7]. The fourth traverse stays in an area with higher illumination to sample craters and a micro-cold trap [8]. Targets labelled with A in Fig. 4 are alternate targets which are not directly along a suggested traverse but could be accessed with a short detour. A1 (below) is an especially interesting alternate target, as it is predicted to sample Slater ejecta from below the layer of Shackleton ejecta.

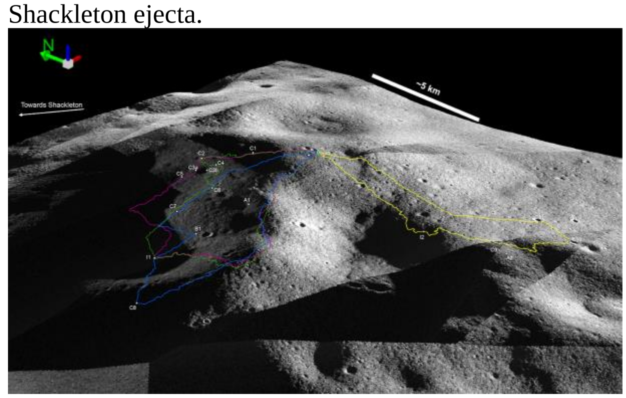

Figure 4. 3D Perspective of Site-007 and Proposed EVA Targets and Traverses. Image created using NAC images draped over the 20 m/px LOLA DEM. All traverses originate from the same landing site. Dark area in the left of the image (I1) is the aforementioned PSR.

Conclusion: Site-007 offers opportunities for science and *in situ* resource utilization via crew EVAs.

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