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Artemis III EVA Opportunities on the Lunar Farside near Shackleton Crater

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Introduction. A summit between Shackleton and Slater craters has an average solar illumination of 83% [1]. The point, site 007 of [1] and *NASA's Plan for Sustainable Lunar Exploration and Development*, is on the farside of the Moon, beyond the south pole as seen from Earth (Fig. 1 & 2). Solar power at such sites may provide an important lunar surface resource if a distribution system can be developed. Adjacent to that point of illumination is a modest-size permanently shadowed region (PSR) in which water was detected from orbit [2]. Thus, the PSR may harbor icy regolith deposits, another resource, that may provide crew consumables, radiation shielding, and propellant.

EVA options. We examined the area to determine potential EVA targets and surface conditions that may affect access to them (Fig. 3). As is true with all summits, site 007 is bounded by sloping terrain. A small area with <5° slope exists, surrounded by a larger area with slope between 5 and 15°. A descent of more than a half-kilometer in elevation is needed to reach the bottom of the PSR with orbitally-detected ice, which

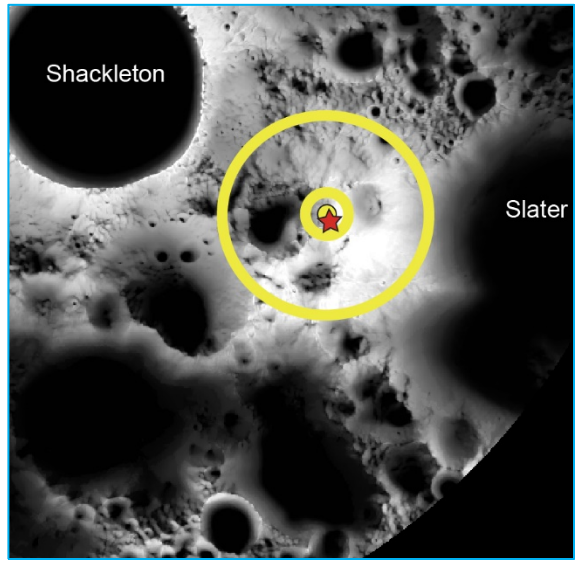

Figure 1. Time-weighted illumination map, based on 100 m/pixel WAC images, with the location of peak illumination (red star after [9] and yellow dot after [1]) with 2 and 10 km radial exploration zones (yellow circles).

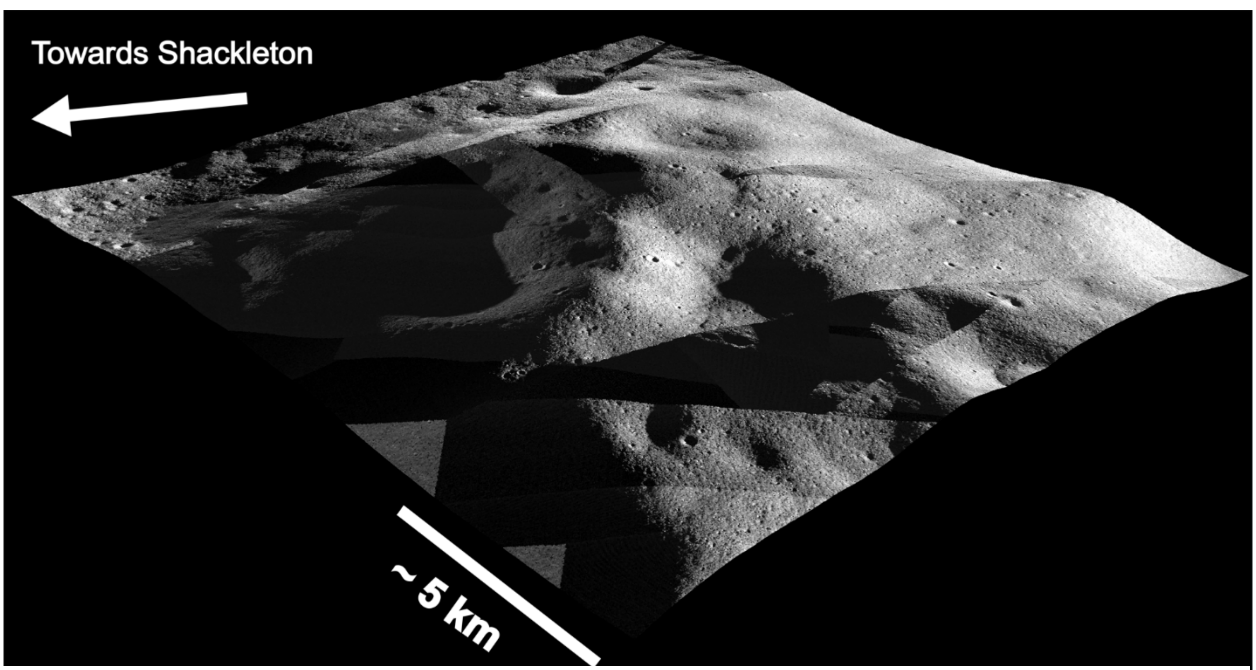

Figure 2. Three-dimensional perspective of the site created by draping a NAC image mosaic on top of LOLA topography. Site 007 is on the summit. Scale bar is ~5 km.

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will likely be beyond the capability of astronauts in a walking EVA. Potentially, a robotic asset could be deployed to penetrate that region. The astronauts might also deploy a detector on the rim of the PSR for observations. A low-light imager can be used to identify boulders and boulder tracks in the PSR that can be harnessed [3-5] to evaluate the bearing capacity of regolith before robotic assets try to traverse them. Several smaller PSRs may exist in that area and be accessible during a walking EVA. That would allow astronauts to sample PSR regolith and any volatiles in them. In addition to surface sampling, the crew can trench the regolith to expose the distribution of regolith and any ice components. Coring, either in the form of drive tubes or drilling, can be used to recover samples destined for Earth.

The area contains four mapped geologic units. The oldest units are pre-Nectarian platform massif and crater materials. They are partially covered by Nectarian crater material and Shackleton crater ejecta. Shackleton ejecta was mapped as Imbrian [6], but may have a younger Eratosthenian age [7]. We note that a layered terrain is exposed in crater walls of Shackleton crater [8]. That material may represent a sequence of ejecta blankets. If so, that material may also blanket any crystalline material within the massif core of site 007. The pre-Nectarian platform massif and Nectarian crater materials occur within a 2 km diameter exploration zone. The pre-Nectarian crater materials, Shackleton ejecta unit, and a PSR occur within a 10 km diameter exploration zone. While Shackleton ejecta at a mappable scale may not reach site 007, Shackleton ejecta is likely within site 007 regolith, as will Slater ejecta.

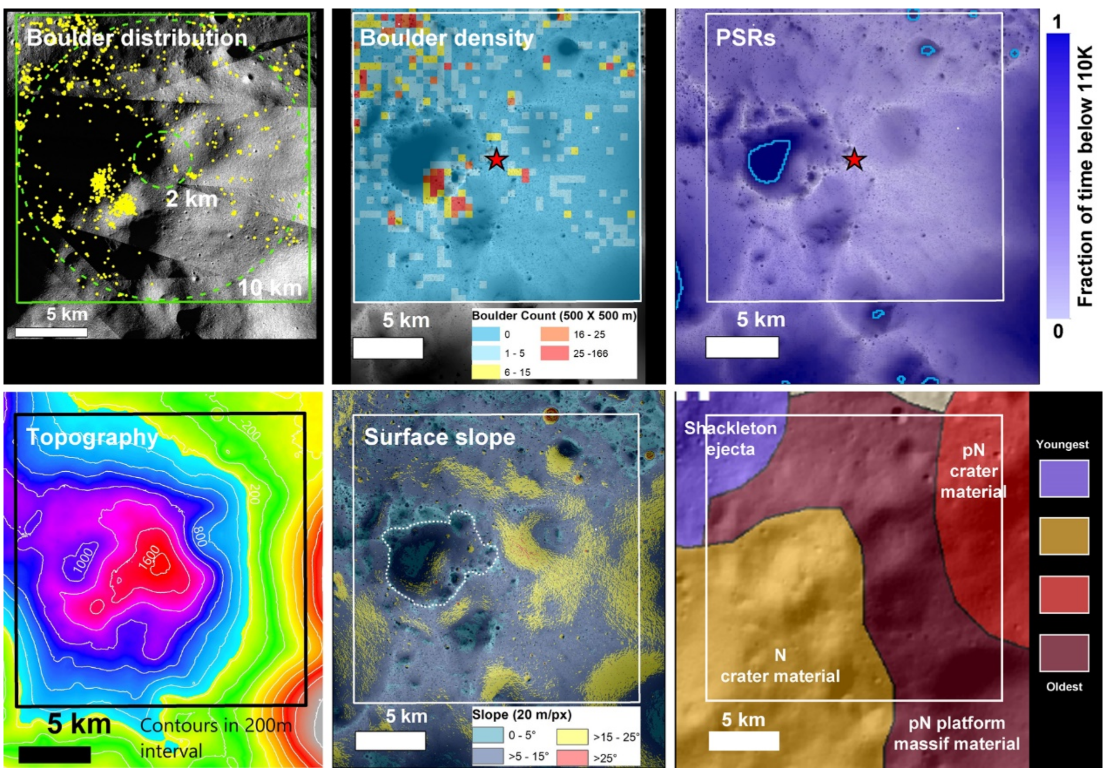

Figure 3. (clockwise from upper left) Boulder distribution on a 1 m/px NAC mosaic, with 2 and 10 km radius exploration zones and a 5 km scale bar. Boulder density map of same area. PSR map. Topography map with 200 m contours. Surface slope map. Geologic map, after [6], noting that while Shackleton was originally mapped with an Imbrian age of 3.6 Ga, it may have an Eratosthenian 3.15 Ga age [7].

References: [1] Mazarico, E., et al. (2011) *Icarus 211*, 1066–1081. [2] Li, S., et al. (2018) *PNAS 115*, 8907–8912. [3] Bickel, V. T., et al. (2019) *J. Geophysical Res. 124*, 1296–1314. [4] Sargeant, H. M., et al.(2020) *J. Geophysical Res. 125*, 14p., e2019JE006157. [5] Bickel, V. T. and Kring, D. A. (2020) *Icarus 348*, 17p., 113850. [6] Spudis P. D. et al. (2008) *Geophys. Res. Lett. 35*, 5p., L14201. [7] Tye, A. R. et al. (2015) *Icarus 255*, 70–77. [8] Gawronska, A. J. et al. (2020) *Adv. Space Res. 66*, 1247–1264. [9] Bussey, D. B. J. et al. (2010) Icarus 207, 558–564.

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