A GEOMORPHIC MAP-BASED TRAVERSE PROPOSAL ON THE SHACKLETON-DE GERLACHE RIDGE USING A SEQUENTIAL RISK/SCIENCE ASSESSMENT.

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Introduction & Methodology: [1] suggested safety-focused traverses following the crest of the Shackleton-de Gerlache ridge (SDR) that exclusively aimed at minimizing slopes as well as maximizing Sun and Earth visibilities (all based on a 20 m/px LDEM). Using block mapping and other analyses of the area [2,3] as a vantage point, we manually re-assessed every block detection and only mapped blocks that we could confirm on at least two different NAC images. We differentiated between blocky craters, i.e., multiple blocks that could be ascribed to a specific crater, and solitary blocks (Fig. 1; squares and triangles). Based on the block locations and our geomorphic mapping, we propose a 27 km long sequence of traverses aimed at maximizing scientific yield by visiting targets of high potential interest (18 solitary blocks, a blocky knob, a smooth crater floor, as well as five blocky craters). We subdivide our traverse into three sequential traverses, "Safe,", "Extended," and "Increased risk," with successively higher, 5 m/px LDEM-based slope tolerances of 10°, 15°, and 16°, respectively (Fig. 1). We maximized overlap with >70% sun visibility areas [4,5], and avoided potential slope features that are unresolved in the LDEM but visible in NAC images (small craters and slope lobes). As the exact paths of our traverse sequences were laid out using 1 m/px NAC images, all specified distances have a ~ 3 pixel, i.e., ~3 m, uncertainty.

The Traverse: The "Safe" traverse has a length of 3.64 km and begins at key location "A" (Fig. 1), the suggested landing site on the summit of the SDR, within an area where the sun is at least partially visible >70% of the time between 2024 and 2026 at 1 m above the ground [4,5]. The terrain here is relatively level, with slopes mostly <5° and only four blocks visible in NAC observations, all of which are along the traverse (Fig. 1). Earth visibility, like along most parts of the SDR crest, is at ~60%. The "Extended" traverse has a length of 11.9 km and mostly follows the crest of the SDR. It has been devised with the specific goal of visiting a blocky knob (key location "B"), a potential, degraded ejecta block from Shackleton crater. Reaching the blocky knob on the SDR while avoiding slopes >15° requires passing through a ~ 3.5 km long stretch of <50% Earth and <30% Sun visibilities. Careful mission timing to coincide with optimal illumination conditions (Sun at an azimuth of ~140°W) as well as the use of a relay satellite for Earth communications would increase the feasibility of traversing this section. Moreover, it should be noted that even the best illuminated traverse along the SDR considered by [1] still passes through ~3.5 km of <30% Sun visibility although it would avoid most of the <50% Earth visibility sections. Just after visiting two meter-scale blocks, possibly ejecta from Shackleton crater, the "Extended" traverse ends at the first location that, at 1 m above the ground, offers a direct line of sight onto Shackleton crater's floor (key location "C"), thus allowing observations like ground-based, high-resolution reflectance measurements using light reflected from the crater wall. The "Increased risk" traverse has a length of 11.4 km and begins at key location "C", where the SDR intersects the crater's rim. Here, a field of several dozen, up to ~8 m wide blocks, at least some of which appear to be associated with a fresh, ~30 m wide crater, can be found. While most of the blocks are on slopes steeper than 16°, at least five should be accessible. Judging by their location and size (comparable to ~9 m wide Outhouse Rock at the Apollo 16 landing site [6]), these blocks were potentially ejected by the Shackleton crater-forming event or are parts of Shackleton crater's raised rim that were excavated by the nearby, fresh, ~30 m wide crater. In either case, these blocks are prime targets to potentially sample and date the Shackleton-forming event. Additionally, these blocks could potentially bear South Pole-Aitken basin-related signatures and help to assess the regional crustal lithology, possibly down to Shackleton crater's expected excavation depth of ~5 km based on its unusually high depth-to-diameter-ratio of ~0.195 [7]. The traverse then follows the crater rim, visiting two more blocky craters and three solitary blocks until reaching the second >70% illumination area of the entire traverse sequence. The traverse then descends down Shackleton's outer wall in order to reach key location "D", including two fresh, blocky craters, one of which shows a distinct ejecta halo on WAC color data. The traverse ends at a remarkably flat floor of a highly degraded crater. The flat crater floor is bound by a sharp slope break to the surrounding crater wall and might be a degraded Shackleton impact melt pond. As the descend to this crater floor is associated with the steepest slopes and most challenging illumination conditions of the entire traverse sequence, we would consider it as the concluding mission stage allowing for greater risk acceptance.

More detailed information about our geomorphic map and traverse proposal can be found in our full-size publication [8].

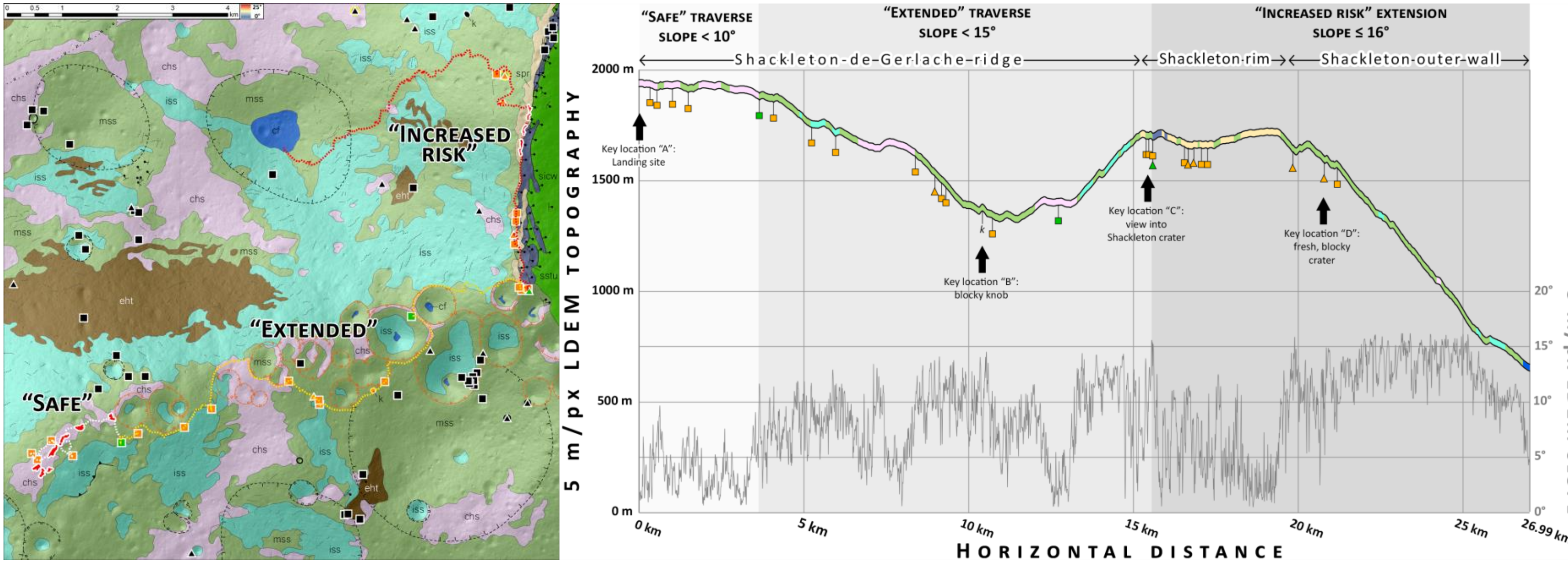

Figure 1: (Left) Portion of our geomorphic map (1:10,000) of Artemis III Areas of Interest 001 and 004 on the SDR. Background is a hillshade model derived from the 5 m LDEM [8] illuminated from the upper right. Shackleton crater's rim is along the right-hand edge of the map. Dashed lines are our proposed traverses "Safe" (white), "Extended" (orange), and "Increased risk" (red). Small red areas outlined in white are areas of >70% sun visibility between 2024 and 2026. Unit labels are: chs – cratered highlands, mss – moderately sloped surface, iss – intensely sloped surface, eht – elephant hide terrain, cf – smooth crater floor, Sicw – Shackleton inner crater wall, sstu – Shackleton slope transition unit, Spr – Shackleton perched rim. For detailed descriptions and interpretations see our full-size publication [8]. **(Right)** Topography (top) and slope (bottom) profiles along the three sequential traverses shown to the left. The topography profile is colored according to the traversed map unit. Squares and triangles indicated visited (orange) and approached (green) blocks and blocky craters, respectively. Black arrows mark points of interest of high scientific potential. Note that the three traverses "Safe," "Extended," and "Increased risk" are not congruent to the three physiographic domains along them (SDR ➔ Shackleton crater rim ➔ outer wall).

References:

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