PRELIMINARY GEOMORPHIC MAP (1:10,000) OF ARTEMIS III AOI 001 & 004 ON THE SHACKLETON-DE GERLACHE RIDGE.

H. Bernhardt[1] and M. S. Robinson[1], [1]School of Earth and Space Exploration, Arizona State University, Tempe, USA (h.bernhardt@asu.edu).

Introduction: Large-scale interpretive geomorphic landing site maps from 1:5,000 to 1:25,000 were prepared ahead as well as during the Apollo missions and effectively guided and informed traverse planning and in-situ landscape interpretation [e.g., 1-5]. For future crewed and robotic landings on the Moon (e.g., Artemis III and VIPER, [6,7]), the Shackleton-de Gerlache ridge (SDR) at the lunar South Pole has been identified as a potential landing site due to the unique proximity of permanently shadowed regions (PSRs) to peaks of extended (>70% between 2024 and 2026 [8]) Sun and Earth visibilities [e.g., 8,9]. While small-scale mapping (<1:2M) using modern datasets has already progressed [10,11], no large-scale maps of the area have been prepared yet. Here we present preliminary results from our ongoing 1:10,000 geomorphic mapping of the southern SDR and the adjacent section of Shackleton crater (Fig. 1; Artemis III Areas of Interest 001 & 004) using state of the art datasets, thereby following recommendation 8.3-1c of [6].

Data: We employed three datasets for mapping: 1) A 5 meter/pixel (m/px) digital elevation model based on the Lunar Orbiter Laser Altimeter (LDEM) [8] from which we derived hillshade and slope maps. 2) An averaged, 1 m/px mosaic of Lunar Reconnaissance Orbiter Camera Narrow Angle Camera (LROC-NAC) images assembled to minimize shadows and downloadable from MoonTrek [12]. 3) A seven-band color mosaic (152 m/px) of LROC Wide-Angle Camera (LROC-WAC) images.

A 25 m/px LDEM up to 80°S as well as the preliminary geologic map up to 73°S by [11] were consulted for regional context.

Methodology: Mapping was conducted in ArcMap at 1:8000. The mapping area is 442 km^2 and was defined to include Areas of Interest 001 and 004 in the Artemis III Science Definition Report [6]. Unit characterization was based on morphologic properties including texture, roughness, physiographic context, and slope (Fig. 1). Normalized reflectance was not used as a parameter for unit differentiation due to the variable azimuth and very large incidence angles of the NAC mosaic. Shadowed areas were mapped as extrapolations from adjacent units based on LDEM-derived surface roughness.

Initial results: We mapped 11 morphologic units, the most extensive of which is the moderately slumped surface (unit *mss*) at 166 km^2, i.e., ~36% of the mapping area. Distinct contacts could only be identified in very few locations, e.g., at 133.07°E 89.68°S between the smooth floor of a heavily degraded crater (unit *cf*) and the intensely slumped surface (unit *iss*). Nearly all other contacts are gradual and did not reveal any stratigraphic hierarchy. At our mapping scale, almost all morphologic signatures are related to impact events, i.e., actual craters smaller than ~100 m as well as slope processes controlled by topography formed by larger impacts. The only exception might be a ~2.5 km long slope break and elevation offset of ~3-5 m centered at 138.24°E 89.36°S, which we interpret as three segments of a potential lobate scarp.

So far, we differentiate between six classes of crater rims based on their degradation state and therefore likely relative age (oldest Class I to youngest Class VI). Hosting meters-scale blocks, Class VI as well as three knobs (unit *k*) are also the only exceptions to the remaining mapping area outside Shackleton crater, which appears block-free at the 1 m/px scale. Previously mapped boundaries of the Shackleton ejecta [11,13,14] could not be confirmed and lack any visible signature in the analyzed datasets. Nevertheless, we differentiated among six units in the Shackleton formation (Fig. 1). The crater floor, which the 5 m LDEM reveals to be outlined by a distinct slope-break towards the inner crater wall, is hummocky, with slopes mostly between 5-15° (15 m baseline), and hosting three ~500 m diameter craters within the map extent. However, no further characterization was made due to the Shackleton PSR compromising NAC coverage. A relatively smooth surface hosting several linear furrows (unit *s*) ~1.5 km from Shackleton crater's rim could be an exposure of degraded impact melt of which smooth crater floors (unit *cf*) might be an extension.

The traverses suggested by [15] would pass through five of our map units (*chs, iss, mss, Spr, Sstu*). We considered three excursions from these traverses (Fig. 1) with slopes <18° (15 m baseline) to include visits to (1) a Class VI crater (freshest mapped craters), (2) units *s* and *cf*, as well as of (3) unit *k*. While parts of the ~10 km excursion (3) would only be ~15% illuminated in the 2020s, ~1.4 and ~1.2 km long excursions (1) and (3) would avoid slopes >12° and be >70% illuminated in the 2020s [16]. We therefore suggest excursions (1) and (3) to be worthwhile and sufficiently safe additions to existing traverse planning.

References: [1] Titley and Trask (1969), USGS I-623; [2] Grolier (1970), USGS I-619; [3] Offield (1970), USGS I-708; [4] Trask (1970), USGS I-621; [5] Wilhelms (1970), USGS I-617; [6] Artemis III Report (2020), Retrieved from https://www.nasa.gov/sites/default/files/atoms/files/artemis-iii-science-definition-report-12042020c.pdf; [7] Colaprete et al. (2020), LPSC#2241; [8] Barker et al. (2020), PSS, https://doi.org/10.1016/j.pss.2020.105119 [9] Gawronska et al. (2020), Adv. In Sp. Res., 66(6), 1247–1264; [10] Mest et al. (2016), LPSC#7045; [11] Krasilnikov and Ivanov (2018), Moscow Solar System Symposium#358); [12] Day and Law (2018). COSPAR, Retrieved from https://ui.adsabs.harvard.edu/abs/2018cosp...42E.774D; [13] Spudis et al. (2008), GRL, 35(14), 1–5; [14] Halim et al. (2021), Icarus, 354, 113992; [15] Speyerer, et al. (2016). Icarus, 273, 337–345; [16] Gläser et al. (2018). PSS, 162(July), 170–178.

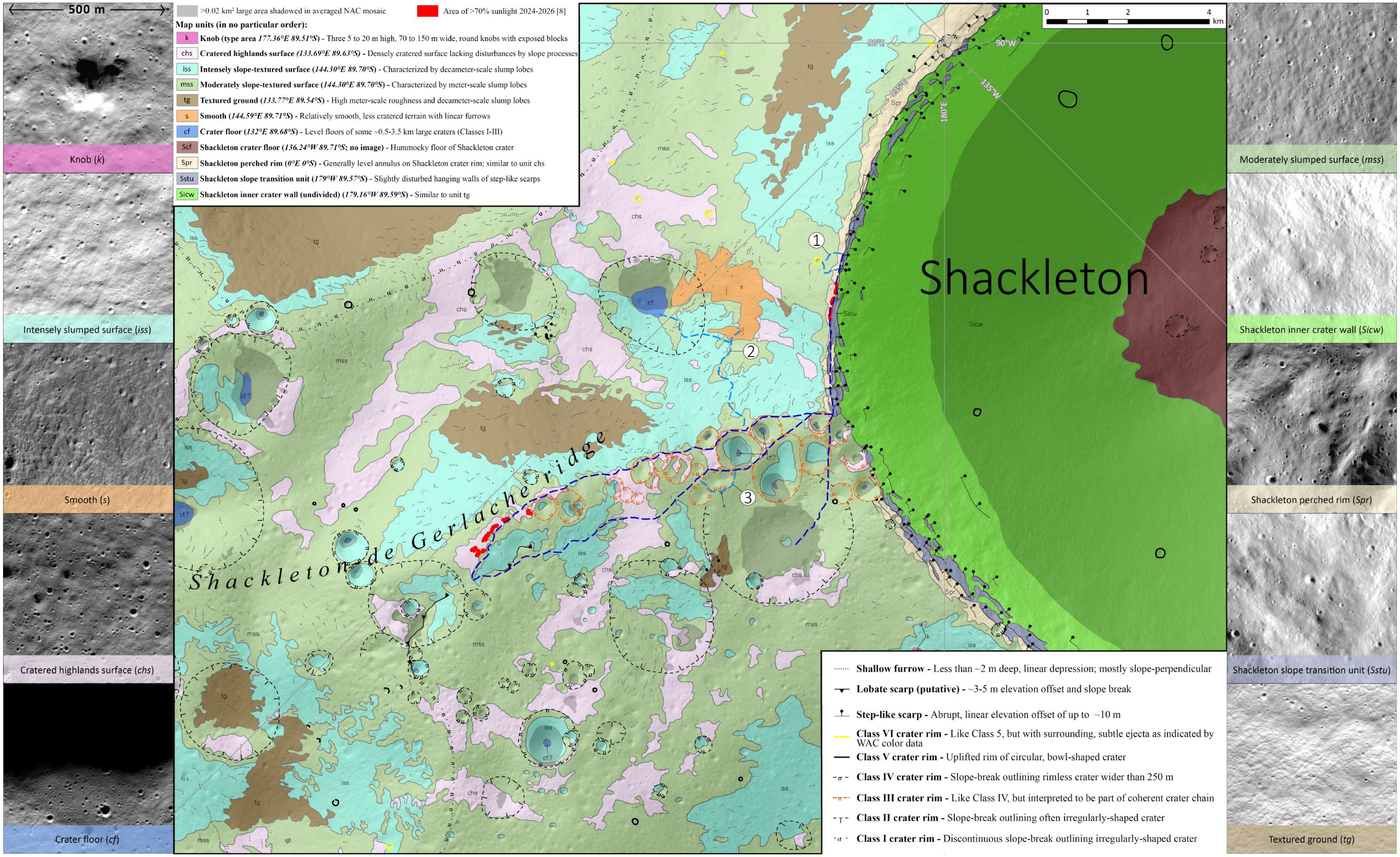

Figure 1: Preliminary geomorphic map (1:10,000) of Artemis III Areas of Interest 001 and 004 on the SDR. Left and right panels show 500 x 500 m large type areas (see unit descriptions in the upper left) of map units except *Scf* (Shackleton crater floor). Background is a hillshade model derived from the 5 m LDEM [8] illuminated from the upper right. The lunar South Pole is located in the upper right of the map product. Dashed, dark blue lines are traverses proposed by [15]; dashed, light blue lines are three excursions with maximum slopes of ~18° (15 m baseline) that would also visit a Class VI crater as well as units *k*, *s*, and *cf*. Grey-shaded areas are mostly congruent with PSRs derived from the 20 m LDEM [16]. Here the map is based on extrapolation from adjacent units based on the 5 m LDEM and derivatives.