ARTEMIS ZONE LANDING SITES, SCIENCE, AND SUITABILITY FOR A BASE CAMP

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Introduction: NASA identified 13 potential landing regions for Artemis III [1] and possibly later missions to explore. As visualized, these regions host one or more potential landing sites that meet safety and accessibility figures of merit. The regions were selected to advance seven science themes from the Artemis III Science Definition Team Report (2020) [2]. Later this year, NASA hopes to refine their candidate landing regions to a subset of options that can be serviced by Artemis III (and perhaps later missions) as mission timing and architecture become highly focused. Science is considered a driving factor in the down selection process. In recent abstracts, we described the locations and characteristics of impact craters with the potential to address many science objectives, but in particular those for volatiles [3-6]. We identified multiple impact craters that might have excavated subsurface volatile-bearing materials or might have resulted in chemical reactions with H_2O. These craters might host permanently shadowed regions (PSRs), be located in PSRs, or their surroundings receive illumination for some part of the year. Many are located within a few km of more illuminated areas that could serve as a landing site. In this work, we consider whether any of these locales are suitable for a Base Camp, and the types of science objectives, particularly with respect to volatile occurrences and behaviors, that could be studied.

Methods: Using the array of publicly available data sets for the south polar region and standard visualization and analysis tools (e.g., Quickmap, ArcGIS), we assessed the regions in terms of accessibility requirements (e.g., slopes < 10°, low density of surface rocks), and time-dependent, as well as averaged, illumination conditions. A Base Camp requires significant planning for power, communications, and safety; but to satisfy scientific objectives, it also requires favorable access to the types of materials and features that are of interest to address high-value questions such as the sources, abundances, compositions, distribution, and timing of volatiles.

Craters of Interest: In our recent efforts [3-6] we identified ~20 craters at which to study the distribution, evolution, and effects of water-ice reservoirs. In that survey, we found that several Artemis candidate regions had very special or unique occurrences or co-locations with volatiles and potential volatile reservoirs.

Special Sites: The Faustini Rim A region hosts one of the larger fresh craters (D ~2.7km) in all of the regions. The crater occurs on a gently sloping hillside with many small PSRs. The area is strewn with relatively recent impact ejecta sourced from the intersection and rims of several major craters, and likely includes minor materials from SPA and Schrodinger basins as well. The deposits are not frequently illuminated, but a ridge in the region is. There is a wide range of locales to visit and materials to be studied at this site, but their distance is ~10 km from a notional Base Camp situated on the ridge.

The Peak Near Shackleton region has an accessible PSR and several small fresh craters located near Moon Mineralogy Mapper H_2O detections [7] and a potential landing site. This region is of note for the accessibility of a relatively large PSR (vs. many smaller PSRs, candidate PSRs, and transiently illuminated locations of other regions). Models of [8] suggest periods of favorable illumination and Earth visibility.

The Nobile 2 region is of interest because it hosts large PSRs and H_2O detections near one of the more illuminated peaks. Models of [8] indicate potentially good illumination and earth-visibility in this area. From the peaks, there is potential access to large PSRs that extend very near the rim/summit.

The de Gerlache-Kocher Massif region might be compelling for its proximity to the SPA basin and an area with H_2O detections. However, the lack of larger PSRs within the region, make this site potentially less interesting for multiple volatiles objectives. Models of [8] suggest limited Earth visibility here.

Summary: We identified at least one accessible impact crater in each Artemis candidate region (13 total) that should be high priority to investigate for their polar chemistry and traces of volatile behavior. For these craters, we examined their surroundings further for illumination, geology, science rationales, and potential suitability for an Artemis Base Camp, concluding that a Base Camp should be located within a traversable distance of several science sites with access to a variety of volatiles and from which one can address many science objectives over time, along with access to various samples to be studied and collected.

References: [1] NASA Press Release 22-089 (Aug. 19, 2022). [2] Artemis III SDT Report, NASA SP-20205009602. [3] Syposs and Stopar (2023) LSSW, April, abstract 2042. [4] Stopar and Syposs (2023) LSSW, April, abstract 2024. [5] Syposs and Stopar (2023) NESF, July, abstract. [6] Stopar and Syposs (2023) NESF, July, abstract. [7] Li et al. (2018) PNAS 115, 8907-8912. [8] Brown et al. (2022) Icarus, https://doi.org/10.1016/j.icarus.2021.114874.