SITES WITHIN THE SOUTH POLE-AITKEN BASIN FOR FUTURE LANDED MISSIONS: A CASE FOR ONE (OR MORE) MISSIONS TO THE INTERIOR OF THE BASIN.

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Introduction: Understanding the timing of formation of the South Pole-Aitken Basin (SPA) remains a high priority for lunar and planetary science [1]. A number of science questions will be answered by the sampling of materials from within the basin [2-5]. The interior of the basin is a geologic wonderland of materials representing every facet of lunar evolution, from early lunar crustal formation [6-8], early bombardment of the inner solar system [5], farside volcanism [9], and active processes today. Here we outline several potential landing sites for SPA landed science and what could be accomplished there.

Landing Area(s): SPA is ~2500km in diameter, and as such there are several locations that would address one or more of the compelling science questions defined by the Artemis III Science Definition report [10]. While it would be easy to say that any location within the basin is valid, it is important to tie specific landing sites to specific science goals and objectives [e.g., 6].

In general, a landing site to address the age of the basin, should *avoid* certain locations. Namely they should avoid landing near large craters, interiors, rims, proximal ejecta, while staying within the mafic (FeO-rich) interior region of SPA and should exclude direct landing on mare basalt flows. However, proximity to a mare basalt patch would be valuable for sampling basalt fragments delivered to highlands by impacts. Sites should avoid prominent crater rays to minimize contamination by non-local material. Most of the area shown in dark brown in Figure 1 corresponds to Nectarian terra material, an example of site is near -57.0º, -161.4º (Figure 1).

Science Objectives: The diversity of SPA suggests several science questions could be answered at any number of locations. However, the top priority for SPA science remains geochronology-determining the age of formation of the basin [1]. Secondary objectives to sample basalt fragments, determine ages of other large impacts, while important, should not take precedent over the selection of a site to collect fragments from the SPA formation event.

Required Capabilities: The goal for SPA sample return is to have a mission to an ancient surface within the basin, such that the collection of SPA-derived impact melt is all-but-certain [12, 13]. The collection of ~1kg of lunar regolith, sieved to retain fragments larger than 1 cm in size, would yield the absolute age of the basin.

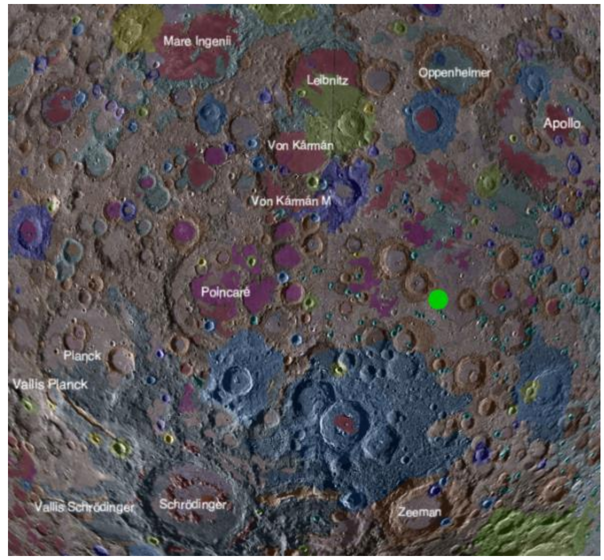

Figure 1. Geologic map of the interior of SPA [11], with large craters identified. The oldest units, in brown/tan, are pervasive across the floor of the basin. Map is from Lunar QuickMap. Green dot is location of example site mentioned in text.

Additional Thoughts: While we recognize each mission to the Moon is valuable and having a diverse portfolio of missions across the lunar surface is important, a campaign of missions to multiple locations in SPA would significantly advance planetary science and provide additional context for the samples collected by Artemis missions [10]. A campaign of multiple missions, with both *in situ* science (for composition and geochronology) **and** sample return capabilities would be a significant benefit to the planetary science community.

References: [1] Jolliff, B., et al., (2021) Sample Return from the Moon's South Pole-Aitken Basin, 53, 290. [2] Jolliff, B. L., et al., (2016) South Pole-Aitken Basin Sample-Return Science: Critical Clues for Planet Formation, 2818. [3] Jolliff, B. L., et al., (2016), #6054. [4] Jolliff, B. L., et al., (2017) Why Do We Need Samples from the Moon's South Pole-Aitken Basin and What Would We Do with Them?, 1300. [5] Jolliff, B. L., et al., (2020), #5091. [6] Moriarty, D., et al., (2021), *This workshop*,Abst. [7] Moriarty, D. P., et al., (2021) *Nature Communications*, 12, 4659. [8] Moriarty, D. P., et al., (2021) *Journal of Geophysical Research*, 126, e06589. [9] Haruyama, J., et al., (2009) *Science*, 323, 905-908 [10] Weber, R. C., et al., (2021) The Artemis III Science Definition Team Report, 1261. [11] Fortezzo, C. M., et al., (2020), *LPSC 2020*,Abst. #2760. [12] Haskin, L. A., et al., (2003) *MAPS*, 38, 13-33. [13] Petro, N. E. and C. M. Pieters, (2004) *Journal of Geophysical Research*, 109(E6), E06004, doi:06010.01029/02003JE002182.