ARTEMIS INTERNAL SCIENCE TEAM: MISSION PLANNING UPDATE S. J. Lawrence[1], N. E. Petro[2], B. Welch[3], A. Britton[4], M. Rubio[4], A. Turner[4], H. Danque[4], R. A. Beyer[5], T. George[6], R. Weber[7], M. Miller[4], R. Whitley[8], D. Moriarity9, K. Young[2], and the Artemis Internal Science Team [1]Code XI3, Astromaterials Research and Exploration Science, NASA Lyndon B. Johnson Space Center, Houston, TX, USA (samuel.j.lawrence@nasa.gov) [2]Code 698, NASA Robert H. Goddard Space Flight Center, Greenbelt, MD, USA [3]NASA John H. Glenn Research Center, Cleveland, OH, USA [4]Code XI4/JETS Contract, Astromaterials Research and Exploration Science, NASA Lyndon B. Johnson Space Center, Houston, TX, USA [5]SETI Institute and the NASA Ames Research Center, Mountain View, CA, USA [6]Code XM/Artemis Campaign Division, NASA Lyndon B. Johnson Space Flight Center, Houston, TX, USA [7]NASA George C. Marshall Space Flight Center, Huntsville, AL, USA

Introduction: As eloquently outlined in the Artemis III Science Definition Team (A3SDT) Report, the definitive statement of science priorities for the first crewed landing of the Artemis program, the return of astronauts to the surface of the Moon is expected to yield paradigm-shifting scientific advances across a wide array of scientific disciplines while facilitating the creation of a thriving cislunar economy [1].

To help establish a cohesive management for the Artemis campaign, the NASA Science Mission Directorate (SMD) and the Exploration Systems Development Mission Directorate (ESDMD) have established an Artemis Internal Science Team to complement future competed surface geology and payload science teams while executing critical programmatic functions at the point of hardware element interface decisions. Here, we describe aspects of Artemis III mission planning, specifically the current progress towards selection of candidate exploration regions for the Artemis III mission.

Importance: The A3SDT specifically highlighted the importance of the site ultimately selected for the Artemis III mission, stating as its Finding 9.1.1 that the scientific return of the Artemis III mission is intrinsically linked to the final selected landing site. The A3SDT discussed how the selected landing site impacts all aspects of mission planning, including hardware development, deployed instruments, crew training, and mission execution.

Selecting a landing site for Artemis III in the Artemis South Polar Exploration Zone – defined as the region from 84°S to 90°S latitude – is a challenging, multi-directorate endeavor involving a broad continuum of stakeholders. The selection must balance complex aspects of mission analysis, engineering, vehicle performance, communications capabilities, operational needs, safety considerations, scientific discovery, the emerging cislunar economy, and strategic national posture. Nevertheless, scientific exploration is an important aspect of our multi-stakeholder strategy to help ensure that the Artemis III mission will provide a firm foundation for subsequent missions.

The Cornerstone: Of paramount importance to the Artemis III landing site decisional process is the Lunar Reconnaissance Orbiter (LRO) mission. LRO is one of humanity's great voyages of discovery, presently embarking upon its 14th year of orbital operations at the time of this writing. LRO instruments were carefully selected to provide all necessary data sufficient to enable future lunar surface landing and operations and has been repeatedly cited as the definitive model for cross-directorate synergy [e.g., 2]. The importance of understanding and leveraging LRO data for a successful Exploration campaign cannot be overstated [3].

Historical Perspective: In selecting the candidate Artemis III landing sites, NASA built upon a rich legacy spanning five decades. During the Space Exploration Initiative (SEI) era, several NASA-sponsored studies provided an important framework for all subsequent advanced exploration planning, the most important being NASA CP-3070 [4], which defined a candidate set of destinations for future human and robotic exploration as well as lunar base region suggestions. Valuable outcomes were also produced from a series of JSC-sponsored conferences described in [5].

The SEI-era work was then leveraged during the Vision for Space Exploration (VSE) [6],[7]. Particularly noteworthy for the VSE were the Clementine and Lunar Prospector missions, flown just prior to the start of the VSE. The Clementine mission [8,9] pointed to areas of permanent illumination and helped suggest the presence of volatiles in permanently shadowed regions. The Lunar Prospector mission also produced results which were suggestive of human-accessible volatile resources in the polar regions of the Moon [10,11].

Those mission results led to the incorporation of the polar regions into the NASA Constellation architecture as a likely candidate for a permanent lunar surface facility [e.g., 12]. The potential strategic value of the polar regions then played a role in the subsequent development and operational planning for the LRO mission, particularly the inclusion of two Constellation Regions of Interest near the south pole [13].

Subsequent results from LCROSS and LRO confirmed the presence of highly illuminated areas, and potential volatile resources, within the lunar south polar region [e.g., 13-16]. In this context, the Artemis program emphasis on south polar exploration is a logical progression from previous activities, and an important part of a cohesive strategy to enable a continuing program of exploration beyond Earth.

Accomplishments: In early 2021, following the selection of the HLS flight article for the Artemis III mission, NASA conducted a study involving a NASA-wide team of subject-matter experts to identify candidate landing regions that plausibly could meet a combination of architectural constraints relating to the expected integrated performance of the Artemis systems, a process outlined in [3].

This study yielded 28 preliminary regions, each addressing compelling science and Exploration objectives traceable to the A3SDT report. The 28 regions were downselected to 13 after the completion of initial detailed screening analyses. The first analysis cycle that led to the preliminary downselection included assessments of site availability based on the evolving suite of Artemis hardware elements using criteria including terrain slope, communications viability, lighting conditions, and the integrated capabilities of the Space Launch System, the Orion spacecraft, and the Human Landing System flight article. Based on that assessment, NASA determined that 13 regions were potentially viable candidate exploration regions suitable for further analysis. The locations of the 13 regions were announced in August 2022 (Fig. 1).

Current Status: To guide the site selection process for all Artemis missions, NASA has established the Cross-Artemis Site Selection Analysis (CASSA) leadership, a joint leadership set of representatives from SMD, ESDMD, and the Space Technology Mission Directorate (STMD). The CASSA leads are jointly responsible for the recommendations of site selection to the NASA approval authority boards. CASSA leadership is supported by discrete Technical Assessment Teams (TATs) which provide information on aspects of the vehicle design, mission availability, and formulation. Starting in 2022, one of those TATs is the Artemis Geospatial Task Force, a joint activity between ESDMD's Artemis Campaign Division (ACD) and SMD. The Artemis Geospatial Task Force is presently engaged in a systematic effort to comprehensively characterize the 13 candidate Artemis III landing regions providing key processed surface data, geospatial data, vehicle capability, communication availability, illumination criteria, along with other key characteristics which will be assessed together to determine the site suitability for ensuring a safe landing that will also enable discovery-driven surface operations. At the time of this writing, NASA aims to downselect from the current set of 13 candidate landing regions down to ~3-5 landing regions in Summer 2023.

Prior to that downselect, there will be a virtual workshop where the vital input of the lunar exploration community regarding the potential science value of each of the 13 regions will be discussed and synthesized as key inputs into aspects of NASA's decision-making process.

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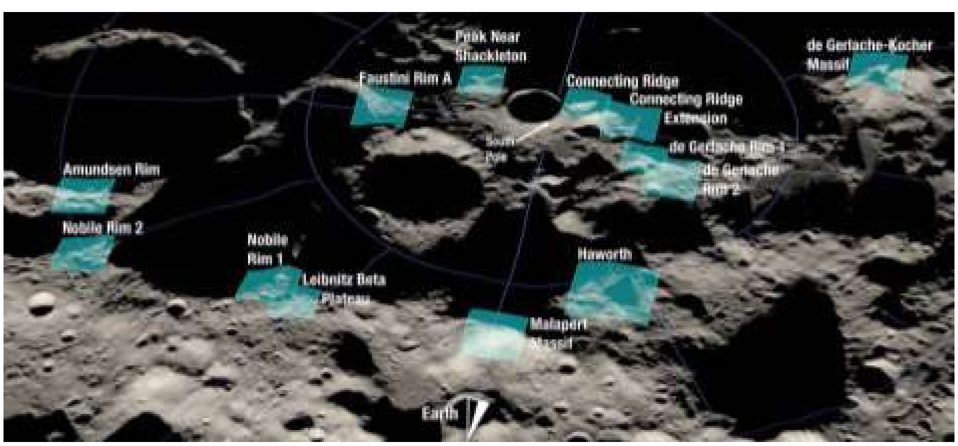

Figure 1. The candidate Artemis III landing regions, each selected to be an achievable HLS landing which will enable key science and exploration objectives.