DE GERLACHE-KOCHER MASSIF NEAR LUNAR SOUTH POLE: PRELIMINARY ROVER TRAVERSE PLANNING TO SCIENTIFIC REGIONS OF INTEREST FROM CANDIDATE NASA ARTEMIS BASE CAMP SITES. Sophia T. English[1,2], Cody R. Johnson[1,3], Erin R. Pimentel[1,4], Charles G. Willard [1,5] and Pascal Lee[1,6,7]. [1]SETI Institute, [2]Texas A&M University (sofienglish@tamu.edu), [3]Western Nevada College, [4]California Institute of Technology, [5]University of Chicago, [6]Mars Institute, [7]NASA Ames Research Center.

Summary: Preliminary rover traverses from candidate Artemis Base Camp sites at the de Gerlache-Kocher Massif to local science targets are presented. The area, which is also a NASA candidate landing region for Artemis III, offers promising science opportunities for long-term exploration.

Introduction: Candidate sites for a future NASA Artemis Base Camp (ABC) in the lunar south polar region have been proposed and ranked [1-4]. Studies of rover traverse concepts from these sites to local science regions of interest (SROIs) have begun [e.g., 1-5]. NASA's list of 13 candidate landing regions for the Artemis III mission, released in August 2022 [6], matches high priority candidate ABC sites identified [1-4].

In this study, we examine rover science traverse opportunities from the third highest ranked candidate ABC site cluster near to the Lunar South Pole: the de Gerlache-Kocher Massif, previously identified as Mt. Kocher [1-5]. The de Gerlache-Kocher Massif offers five candidate ABC sites **(Table 1)** [1-4], of which only de Gerlache-Kocher α (GKα) and de Gerlache-Kocher δ (GKδ) are within the NASA Artemis landing regions boundary [6]. In this study we consider only GKα as a traverse starting point, as GKδ is farthest among all GK sites to H_2O ice-bearing PSRs. We consider, however, all GK sites as potential traverse destinations from GKα.

Methodology: The criteria we applied for long-range traverse planning build on exploration reference documents [e.g., 8-10] and on several assumptions regarding the capabilities, performance, and operational constraints of future crewed rovers available to Artemis. Based on the experience with the Lunar Roving Vehicle (LRV) during Apollo [11], the Lunar Electric Rover (LER) at Desert-RATS field tests [12], ATVs and Humvees on the NASA Haughton-Mars Project in the Arctic [13], and snowmobiles in the Antarctic Search for Meteorites (ANSMET) Program, our traverse planning criteria are:

1. Solar Illumination: Traverse paths prioritize areas illuminated more than 50% of the time in static illumination maps at 60 m/pxl [14]. Although lidar-assisted navigation might enable safe traversing in darkness, photovoltaics may need > 50% illumination.

2. Direct-To-Earth Visibility: DTE visibility > 50% of the time on static DTE visibility maps at 60 m/pxl is required, limiting reliance on orbital relay assets.

3. Surface Slope: Surface slopes shall not exceed 20º, as shown on 10 m/pxl maps.

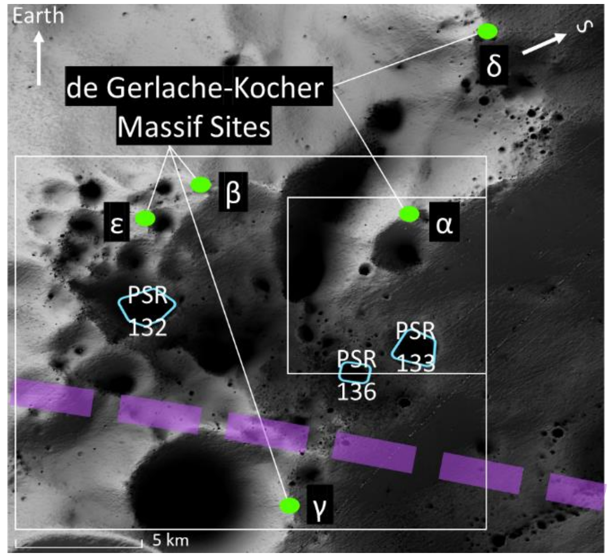

Figure 1: Context Map of the de Gerlache-Kocher Massif Candidate Artemis Base Camp (ABC) Sites. *Green dots: Candidate ABC sites. Blue Outlines: H_2O ice-bearing PSRs [16]. Purple: Transition boundary of the South Pole Aitken Basin between Outer Annulus and Pyroxene-Bearing Zone [17]. White rectangles: Areas shown in Figures 2 and 3.*

Table 1: Candidate Artemis Base Camp (ABC) Sites at de Gerlache-Kocher (GK) Massif [1-5].

Candidate ABC Site	Lat, Long	Solar	DTE
GK α	-85.682, 243.406	75.84%	60.29%
GK β	-85.414, 245.096	77.04%	60.30%
GK γ	-85.350, 237.697	71.20%	50.64%
GK δ	-85.879, 247.378	68.94%	60.65%
GK ε	-85.326, 244.686	68.60%	60.10%

4. Surface Roughness: Surface roughness shall not exceed 3 RMS meters [15], mapped at 60 m/pxl.

5. Science Targets: Science targets visited shall include at least one H_2O ice-bearing Permanently Shadowed Region (PSR) identified in [16], or the magnesium-rich Pyroxene-Bearing Zone (PBZ) of the South Pole Aitken Basin (SPAB) [17].

To minimize the time spent in cold, shadowed, and decreased DTE communication areas, each PSR shall be accessed via a specific "Entry Point" chosen, via GIS Python analysis, to minimize traversing over terrain with <25% illumination [14], <25% DTE [14], >5° slope, and >1 RMS m surface roughness [15].

Case studies with Static Datasets: While dynamic data sets, in which solar illumination and DTE visibility may change significantly over the course of a long-range traverse, must ultimately be used for realistic traverse planning, we consider in this study the approximate but much simpler case of traverses using static datasets, to establish a preliminary set of reference traverses from candidate ABC sites to SROIs.

de Gerlache-Kocher α to PSR-133: de Gerlache-Kocher α is a candidate ABC site with proximity to PSR-133 and PSR-136, allowing frequent exploration of both. PSR-133 is the closest H_2O ice-bearing PSR to GKα [1,3-7,16]. Total traverse distance from GKα to the Entry Point of PSR-133 is 9 km, which at 8 km/h (5 mph) typical of the Apollo LRV [11], can be driven in ~1.1 hours once a known route is established. If stops are made along the way, traverse time will be adjusted accordingly. **Figure 2** shows stops, or "stations", along the traverse for lunar science observations and sample collection. Station locations were chosen based on terrain roughness [15] and the opportunity presented by small craters and other PSRs.

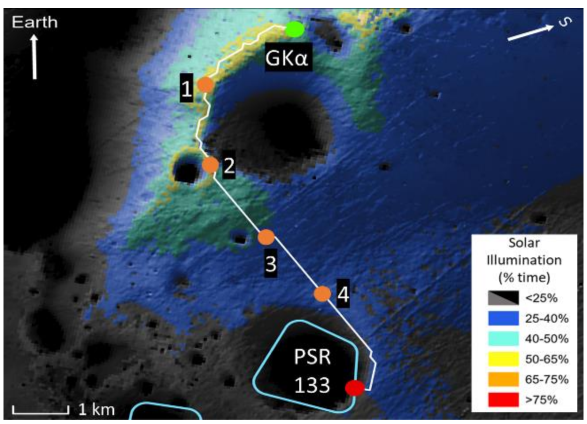

Figure 2: Traverse from deGerlache-Kocher β (GKα) to PSR-132 with Static Solar Illumination. *Traverse route (white line) from GKα to the closest H_2O ice-bearing PSR, PSR-133 (outlined in light blue) [16]. Green dot: Candidate ABC site [1-5]. Red: PSR Entry point. Orange dots: Main science/sampling stops.*

Exploration of de Gerlache Kocher Massif (GKM) from de Gerlache-Kocher α: The exploration of the GKM from candidate ABC site GKα offers exciting science return opportunities. The closest H_2O ice-bearing PSRs, PSR-133, PSR-136, and PSR-132, are within a 20 km radius of GKα and allow for frequent exploration [1,3-7,16]. Science stations include the science target categories of the previous traverse, but also the SPAB PBZ in [17]. Traverse destinations also include other candidate ABC sites (**Fig. 3)** [1-7].

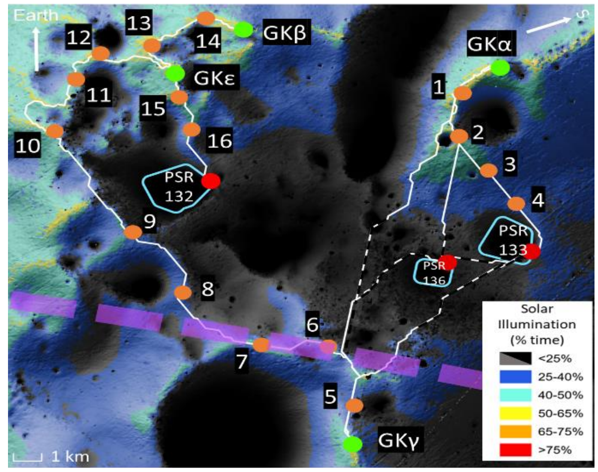

Figure 3: Regional Traverses from de Gerlache-Kocher α (GKα) with Static Solar Illumination. *Traverse routes (white line) from de Gerlache-Kocher α (GKα) to H_2O ice-bearing PSRs (outlined in light blue) [16] and South Pole Aitken Basin Pyroxene Bearing Zone (dashed purple line) [17]. Green dots: ABC sites [1-5]. Red dots: PSR Entry points. Orange dots: Main science/sampling stops. White dashed line: Areas with <25% solar illumination in traverse.*

Conclusion: Our study identifies, based on static datasets, long-range traverse paths from candidate ABC sites to exciting SROIs at the de Gerlache-Kocher Massif. With the recent availability of new dynamic and 3D traverse tools, our preliminary traverses will be revisited using dynamic datasets to investigate the best strategies to travel. We recommend acquiring higher resolution data surrounding the de Gerlache-Kocher Massif. We also recommend that NASA consider a candidate ABC site for the Artemis III landing, so that long-term use of a site would be an option following its short-term exploration, and to use upcoming CLPS mission opportunities to recon candidate Artemis III and ABC sites.

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