TRAVERSE AND STATION OPTIONS FOR A ROBOTIC SAMPLE RETURN TO SCHRÖDINGER BASIN. A. L. Gullikson[1], N. M. Curran[2], N. J. Potts[3,4], J. K. Dhaliwal[5], M. Leader[6], R. Rege[7], and D. A. Kring[8], [1]Northern Arizona University, Flagstaff, AZ, 86011, alg346@nau.edu, [2]University of Manchester, UK, [3]The Open University, UK, [4]Vrije University, Amsterdam, [5]Scripps Institute of Oceanography, UC San Diego, CA, [6]University of Texas at Austin, TX, [7]Columbia University, NY, [8]Lunar and Planetary Institute, Houston, TX.

Introduction: In 2007, the National Research Council (NRC) identified eight key scientific concepts and thirty-five prioritize goals for future human and robotic exploration of the Moon [1]. A global landing site assessment of those goals [2] found that Schrödinger basin was a particularly good site for addressing them. Here we investigate a potential landing site on the floor of the basin and construct a traverse for a robotic asset that can address a majority of the scientific goals.

Background: Schrödinger basin (Fig. 1) is stratigraphically the second youngest basin on the Moon [3, 4]. It is located on the lunar farside, within the South Pole-Aitken basin (the oldest basin on the Moon). Schrödinger has a well-preserved peak ring that exposes lower crustal and potentially upper mantle material. It also contains products of two types of volcanism; a pyroclastic vent and mare flows.

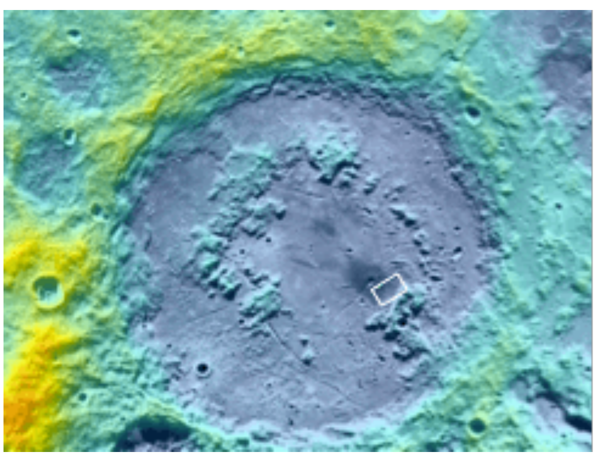

Figure 1. Schrödinger basin. Using a WAC basemap, overlain by LOLA topography. White box highlights the Eastern inner-basin site.

Samples from this locale can address issues such as: Impact melt can be used to determine the age of the Schrödinger impact event and place better constraints on the duration of the lunar cataclysm, the highest priority of the NRC (2007) report; and peak ring and pyroclastic vent material can be used to asses the composition of the lunar interior and the thermal and magmatic evolution of the Moon.

Previously, three potential landing sites were identified for missions involving crew [5]. In this study, we re-investigate one of those landing sites to determine if it might be suitable for a robotic sample return mission and/or a human-assisted robotic sample return mission involving crew on Orion above the lunar surface [6].

Analytical Techniques: We used data from the WAC (wide-angle camera) on board the Lunar Reconnaissance Orbiter Camera (LROC) as a basemap. This basemap was then overlain by 0.5m/pixel resolution NAC (narrow-angle camera) images, which allowed for outcrops of exposed rock to be identified for sampling. A Digital Elevation Model (DEM) of Schrödinger basin produced from LOLA (Lunar Orbiter Laser Altimeter) data was also utilized, from which a slope graph was created. These data were then integrated with both geologic maps of the area [4, 7, 8], and spectral reflectance data from the Moon Mineralogy Mapper (M^3). All maps were implemented through ArcGIS software.

Landing and sample ascent sites were identified on the basis of slope (e.g., 0 - 2°), taking into account a ~200 m ellipse and the surface morphology within this ellipse. The capability to reach suitable samples was governed by the constraints of a theoretical robotic rover. Using the Lunohkod rovers 1 and 2 as a guide for speed, we assessed traverse distance, number of stations, and schedule based on speeds of 1 and 2 km/hr. It was assumed that a rover could traverse slopes up to 16°, based on the capability of the Apollo Lunar Roving Vehicle (LRV). We also made the conservative assumption that the robotic rover had to complete its mission within a single period of lunar illumination (~14 consecutive Earth days).

Traverse Options: The optimum traverse addresses the broadest range of objectives in [1]. Two descope options involve increasingly shorter traverse distances and reduced scientific return.

Eastern inner-basin site. The landing site is located at 75.50°S, 141.37°E, between a pyroclastic vent and the southeastern portion of the peak ring (Fig. 2) and corresponds roughly to Site C of [5] for a mission with crew. Access to those units, plus intervening impact breccias can provide the samples needed to determine the age of the Schrödinger impact event, improve our knowledge of the petrologic structure of the lunar interior, and probe the thermal and compositional evolution of the Moon.

The traverse is 28.8 km long. Seven stations along the traverse are shown in Figure 2. This traverse accesses samples from three major crustal lithologies located along the peak ring that coincide with stations 1 – 4. The diverse lithologies along the peak ring have been highlighted by the M^3 map (Fig. 3). Station 5 is located on the rim of a deep fracture associated with the pyroclastic vent. This station can provide insight into the structure of the lunar interior and further understanding the diverse compositions of lunar crustal rocks. Station 6 provides samples of Schrödinger impact-melt breccia that consists of both impact-excavated lithologies and impact melt suitable for geochronologic studies [5, 7]. Station 7 is located at the landing site, within the pyroclastic material. This unit has a relatively level surface, not exceeding a 2° slope along the base of the vent. Pyroclastic material typically does not yield boulder-size rocks, lowering the amount of hazards in the area and making this an ideal landing site. Based on crater counting, the pyroclastic material is estimated to be Eratosthenian or Copernican in age, therefore representing one of the youngest volcanic events on the Moon [4, 5].

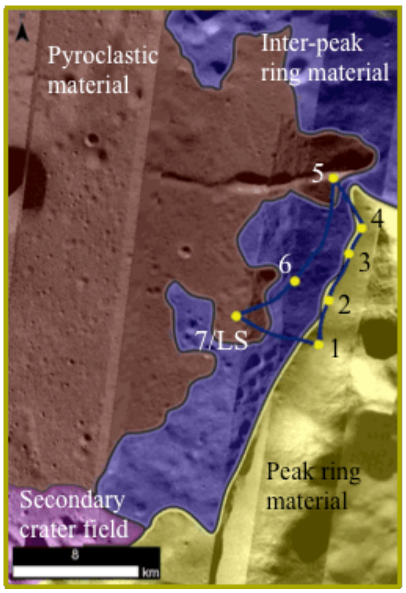

Figure 2. Geologic map adapted from [8] of the Eastern inner-basin site within Schrödinger basin. Long traverse option is displayed by blue line, with each number signifying a sampling station. Station 7 is also the landing/take off site

The two descope options involve traverse lengths of 22.5 km and 10.8 km. As traverse length is shortened, sampling stations are eliminated. In the medium traverse option all stations previously mentioned are included except for that at the deep fracture. The short-distance option will sample only two crustal lithologies along the peak ring (the orthopyroxene-bearing and the olivine-bearing units), the deep fracture, impact-melt breccia, and the pyroclastic material. This last option eliminates sampling the anorthositic unit.

Conclusions: Traverse options have been made for a robotic sample return and/or a human-assisted robotic sample return mission to the peak ring of Schrödinger basin and a nearby pyroclastic vent. This type of sample return mission addresses many of the science and exploration objectives of [1].

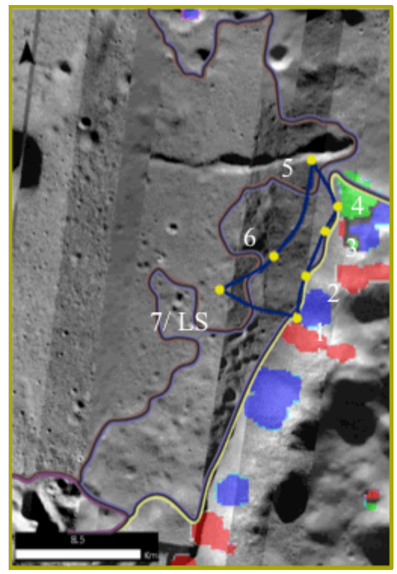

Figure 3. Map of Eastern inner-basin site using both WAC and NAC images, with M^3 data overlain onto the image from [7]. Blue = anorthositic unit, red = orthopyroxene-bearing unit, and green = olivine-bearing unit. Blue line represents the long option traverse.

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References: [1] National Research Council (2007), The scientific context for exploration of the Moon, final report. [2] Kring D. A. and Durda D. D. (2012) LPI Contrib. No. 1694, 688p. [3] Wilhelms D. (1987) The Geologic History of the Moon. USGS Prof. Pap, 1348. [4] Shoemaker E. M. (1994) Science 266, 1851-1854. [5] O'Sullivan K. M. et al. (2011) GCA Spec. Pap. 477, 117-127. [6] Burns J. O. et al (2013). [7] Kramer G. Y. et al. (2013) Icarus, 223, 131-148. [8] Mest S. (2011) Geol. Soc. Am. Spec. Pap. 477, 95-115.