CHARACTERIZATION OF HIGH-PRIORITY LANDING SITES FOR THE CHANG'E-4 EXPLORATION MISSION TO THE APOLLO BASIN, MOON.

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Introduction: As the oldest and deepest impact structure on the Moon, the South Pole-Aitken Basin (SPA) on the lunar farside is a scientifically high priority site for human and robotic exploration [1]. The lunar farside has not been visited by any exploration missions so far, but it is the focus for Chang'e-4 robotic missions planned for the end of 2018 [2].

The Chang'e-4 mission aims to deploy a relay satellite into Halo-orbit around EM-L2 and land with a Yutu heritage rover on the lunar surface. The provisional scientific objectives of Chang'e-4 [2] are to study: (1) the interaction between the solar wind and lunar surface, (2) the formation mechanism of lunar regolith and dust, (3) the lunar-based VLF astronomical potential, (4) the regional geochemistry and subsurface, and (5) the recent impact flux of the Moon.

The most likely landing site for the Chang'e-4 robotic mission will be the 538 km diameter Apollo basin in the NE quadrant of the SPA basin. Here, we provide a detailed analysis of three high-priority regions of interest (ROIs) with example rover traverses of 2.5 km, 5 km and 10 km radius from the center of ROIs within the central and southern mare deposits (Fig. 1) of the Apollo basin. The proposed ROIs have high scientific interest with respect to prioritized science concepts defined in the 2007 National Research Council (NRC) report [1].

Science rationale: The Apollo basin has been mapped as pre-Nectarian [3-5], pre-Nectarian/Nectarian [6], and Nectarian. According to CSFD measurements, its absolute model age (AMA) is 3.91 Ga [5] to 4.14 Ga [7]. Thus, the Apollo basin is one of the youngest basins in SPA.

Based on GRAIL data, the crustal thickness is less than 5 km beneath the Apollo basin [8]. The NE-E rim of the Apollo basin exposes anorthositic material from the highlands on the SPA rim and possibly impact melt and/or mantle material from the SPA interior [9]. The basin floor is mainly covered by four mare basalt provinces (center, south, west, and east), their AMAs ranging from 2.30 to 3.45 Ga [10]. The mare deposits have enhanced FeO and TiO_2 [11].

Data and Methods: To evaluate the potential science return of each proposed ROI, we use all available datasets from previous lunar missions and studies [11]. The terrain trafficability is determined via slope maps, and digital elevation models derived from LOLA instrument, at resolutions of 60 m/pix. The terrains that compose the Apollo basin are visualized using LRO WAC mosaics of 100 m/pix, and individual NAC images of 1 m/pix, and Kaguya Terrain Camera images of 7 m/pix. We use the Kaguya images as the photobase for geologic mapping and counting craters >50m for crater size-frequency distribution analyses. Geologic maps at 1:50,000 scale are being compiled for the central and southern portion of Apollo basin, as well as a detailed regional geologic map of the northern portion of SPA [12]. FeO and TiO_2 contents are determined using Clementine 100 m/pix global maps [13], as well as Kaguya LISM 80/pix [14].

Selection of ROIs: The central and southern mare deposits were the main objectives of this study. These areas are smooth with <5° slopes and have low crater densities. The selected ROIs reflect a geologically complex area (Fig. 1), where both mare deposits are covered by younger, Copernican-aged ejecta material in various thickness and distribution. These ejecta materials have low FeO and TiO_2 contents representing material beneath the mare deposit. The origin of that material could be SPA and/or Apollo impact melt. In addition, the mare deposit has high in situ resource utilization (ISRU) potential with relatively high FeO and TiO_2 contents ranging from 14-20 and 1-7 wt%, respectively (Tab. 1).

	ROI 1		ROI 2		ROI 3	
	FeO	TiO2	FeO	TiO2	FeO	TiO2
Min.	16.15	0.80	17.65	3.95	17.39	5.71
Max.	18.58	7.50	18.80	8.73	18.58	9.91
Average	17.90	4.20	18.33	6.78	18.18	7.53

Table 1: FeO and TiO_2 content of mare deposits in the ROIs based on 50 random samples within the ellipses.

Conclusion: These areas could fulfill the general engineering constraints and the scientific objectives, as well as ISRU potential of the mission. In situ observations and sample analyses can help address six of seven NRC concepts (1-3, 5-7) and provide a high ISRU potential at all selected ROIs.

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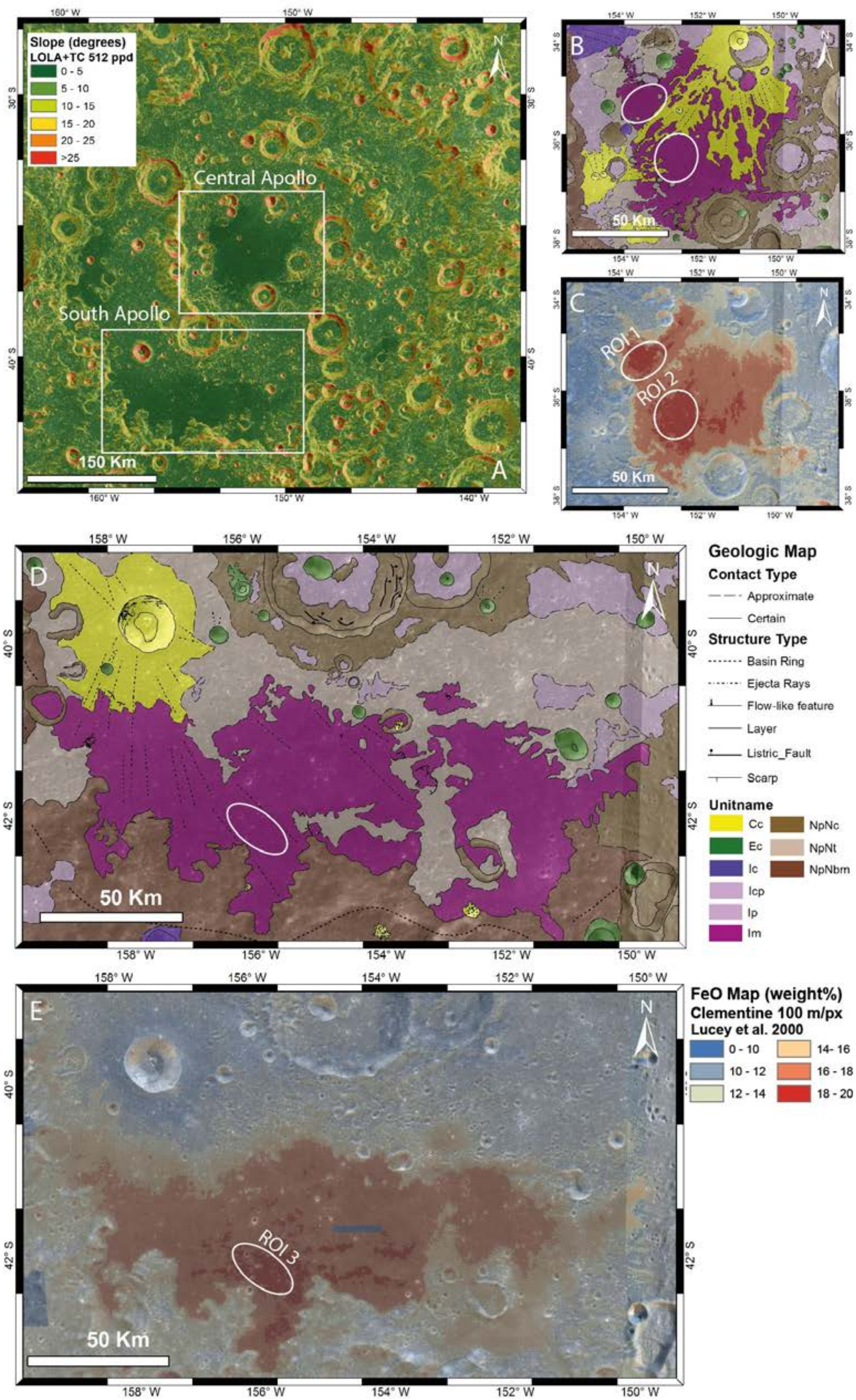

Figure 1: Landing site analysis in the Apollo basin. A/Slope map derived from LOLA and TC 60 m/pix data. White boxes indicate the location of geologic maps. B-D/Geologic maps of the central and south Apollo basin. C-E/ FeO maps derived from Clementine 100 m/pix data. ROIs indicated by white ellipses.