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Chang'E-5 returns to (and from) the Moon: Geological characterization of the northern Ocean Procellarum landing area

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1. Introduction

China Chang'E-5 (CE5) mission, scheduled to launch in 2019, will be the first mission to return samples from the Moon since Luna 24 more than 40 years ago. CE5 is designed to bring back up to 2 kg of lunar samples, using a robotic sampling device and an automatic rendezvous and docking with the return module in lunar orbit, before flying back to the Earth. The CE5 lander will be equipped with a robotic arm and drill core that will allow sampling up to a 2 m depth [1]. The selected landing region for CE5 is located within the northern Oceanus Procellarum, between 41-45°N in latitude and 49-69°W in longitude, and is referred to as the Rümker region [2]. The landing region is spreading north of Mons Rümker itself, a volcanic complex containing multiple domes [3]. The present study reports on the geology of the landing area, proposes landing/sampling sites, and evaluates the potential scientific outcomes of the mission.

2. Datasets and methods

A wide range of orbital data were used to characterize the morphology, mineralogy and composition of the landing area and to produce an updated geologic map [2]. The data collection includes Kaguya TC morning maps and DTM (at 10 m/px), LROC WAC (100 m/px) and NAC imagery (up to ~0.5 m/px), Kaguya MI multispectral data and derived FeO and TiO_2 abundances (following the method of [4]), and M^3 VNIR hyperspectral data, processed with the method of [5].

3. Geological characteristics of the landing region

The Rümker region was found to be relatively flat (Mean slope of the area is 1.1° at a baseline length of 354 m, with only 10% of the area exceeding a slope of 2°), and is lying at an average altitude of -1300 m (Figure 1A, [2]).

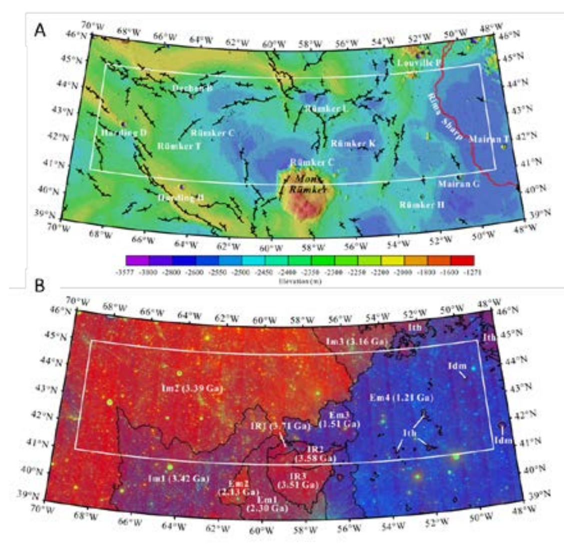

Figure 1: A- Topography of the Rümker region. White box = Selected CE5 landing region; Black lines = wrinkle ridges (Background= LOLA + Kaguya TC merged hillshade superposed on the TC DTM data). B- Geologic units of the Rümker region, superimposed on a MI RGB color composite with bands 750 nm/415 nm as red, 750 nm/950 nm as green and 415 nm/750 nm as blue. (Lambert conformal conic projection; Figures from [2]).

The region is covered by mare basalts which can be subdivided into 7 geological units according to the compositional and mineralogical data (Figure 1B, [2]). The eastern mare units (Em 1 to 4) are characterized by higher FeO (16-18 wt.%) and TiO_2 (6-7 wt.%) contents and a higher albedo, whereas in the western mare units (Im1, Im2, Im3), FeO (14-17 wt.%) and TiO_2 (1-2 wt.%) abundances are lower. M^3 data show that the Rümker region is dominated by pyroxene signatures overall, but slight variations are observed throughout the various units. Spectra of the western mare units are diagnostic of pyroxenes of intermediate composition (such as pigeonite) whereas the shift of VNIR absorptions towards longer wavelengths in the eastern mare units suggests the presence of high calcium pyroxenes (such as augite and/or diopside). The model ages of these geologic units were estimated using standard CFSD methods. Results show that the western part of the Rümker region is much older (~ 3.42-3.16 Gy) than the eastern part (~ 2.30-1.21 Ga). Unit Em4 has an absolute model age of 1.21 Ga, which is the youngest geologic unit in this region, and is one of the youngest mare unit on the Moon [6].

The Rümker region is crossed by several wrinkle ridges, with large and long ridges being more common in the western part of the landing region (Figure 1A). The Rümker region is also marked by the presence of sinuous rilles (e.g., the Rima Sharp, ~1 km in width and 20-50 m in depth [7]). Kipukas (likely remnants of highlands material, unit Ith in Figure 1B) are observed through the region, especially in its eastern part, and are spectrally distinct. A variety of other landforms can be identified in the Rümker region, and were mapped as additional geological units [2]. The most prominent feature is Mons Rümker (units IR1, IR2, IR3 on Figure 1B), a 70 km diameter circular volcanic complex that is ~500 m higher than the surrounding mare surface and spectrally distinct. Mons Rümker is formed by numerous steep-sided domes and shallow domes that likely represent different stages of volcanic activity [3]. In addition, a small-scale (3 km wide, 170 m high), relatively steep, unnamed dome is observed at 49.85W, 43.68N (unit Idm, Figure 1B), in proximity of the Mairan silicic domes [8], and could represent an opportunity to sample evolved volcanism on the Moon.

4. Proposed landing/sampling sites

Young high-Ti basalts appear as an obvious preferred landing site for CE5. Collecting lunar samples from this region could help answer many fundamental, unresolved questions in lunar science. For example, 1) the radiometric age of the young basalt could be used to compare with the CSFD ages to constrain the impact cratering flux of the Moon and other planets, 2) their mineralogy and geochemistry could provide information on the mantle properties and thermal state at this time, and further constrain the lunar thermal history; 3) volatile components in glass and pyroclastic rocks could provide direct clues of mantle properties; 4) Th distribution and contents could improve our knowledge about the role of Th in the late-stage mare basalt petrogenesis [2]. In addition, unit Em4 flat topography offers the possibility of a safe landing. The presence of domes of potentially evolved composition in both Mons Rümker and the eastern part of the landing region adds on to the potential science benefits of the mission, with the possibility to study potential silicic composition of the Moon.

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References

[1] Wang, Q., & Xiao, L. (2017). Lunar Exploration Analysis Group 2017, # 5092.

[2] Qian Y. Q. et al. (2018), JGR, in revision.

[3] Zhao J. et al. (2017), JGR, 122(7), 1419-1442.

[4] Ohtake H. et al. (2012) 43rd LPSC, #1905.

[5] Martinot M. et al. (2018), JGR, 123, 612-629.

[6] Hiesinger H. et al. (2003), JGR, 108(E7), 5056.

[7] Hurwitz D. M. et al. (2013), PSS, 79-80, 1-38.

[8] Glotch T. D. et al. (2011) GRL, 38(21), L21204.