

Landing site of the Chang'e-6 lunar farside sample return mission from the Apollo basin

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1. Brief introduction of Chang' E-6 Mission

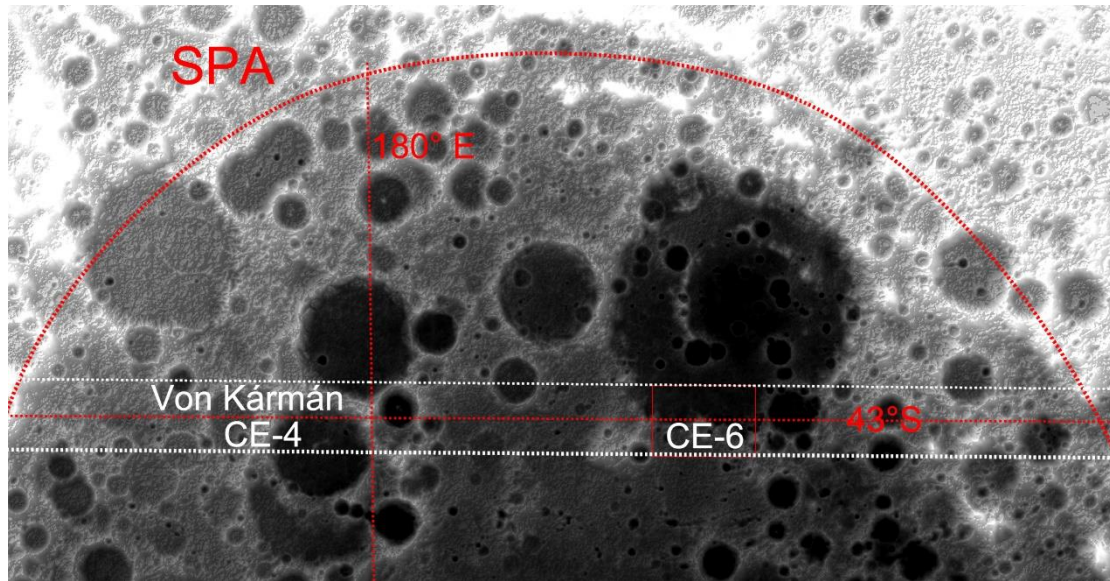
The CE-6 lunar farside sample return mission has two scientific objectives: 1) in-situ investigation of the geological setting and detailed context of the sampling site, and 2) comprehensive laboratory analysis and characterization of the returned samples. In order to characterize the landing and sample collection site, CE-6 will carry a payload consisting of a landing camera, a panoramic camera, a lunar mineralogical spectrometer and a lunar exploration radar. These payloads are designed to: 1) obtain in-situ analysis data related to the context of the returned lunar samples; 2) analyze the topography and geological structure of the sampling site; 3) measure the in-situ reflectance spectra of rocks and soils in the sampling site; 4) detect the subsurface regolith/bedrock structure/layering at the sampling site; and 5) establish a local and regional geological context and framework for interpreting subsequent laboratory analyses of the returned samples. In a manner similar to CE-5^{1,2}, CE-6 will utilize two modes of sample collection: near-surface scoop sampling and deeper drill sampling (to a depth of about 2 m). After farside samples are returned to Earth laboratories, chemical, isotopic, mineralogical, and petrological analysis will be systematically performed to study the physical properties and chemical-isotopic features of lunar farside materials to unveil the formation processes of lunar farside rocks and minerals and the earliest geological history of the Moon.

2. Selection of Chang' E-6 Landing Site

CE-6 probe is the backup of CE-5 with the same scientific payloads, and this mission is designed to gather and return samples from lunar farside. Scientific requirements and engineering constraints are the two major factors to be considered in the landing site selection.

From the science requirements, some typical lunar samples not available at present are favored, such as: lunar deep materials, lunar farside basalt sample, geologically old or with a different age from available samples. Thus, the South Pole-Aitken basin (SPA) is the best place to capture these samples. From the engineering constraints, the latitude close to $43^{\circ}\pm 2$ (N or S) is optimal for the probe thermal control (the same as CE-3~CE-5)³. In addition, for the communication to a relay satellite, the longitude close to 180°E is favored. In addition, smooth flat topography (70% of the area with slope $< 8^{\circ}$) is favored for landing safety.

Considering above factors, Von Kármán crater and the Apollo basin are two suitable choices (See the Supplementary Fig. 1). CE-4 landed in Von Kármán crater, and the analysis of the CE-4 landing site shows that the geologic age of the mare basalts near the landing site is ~ 3.6 Ga⁴. In contrast, in the southern part of the Apollo basin, the geologic age of the mare basalt is calculated to be ~ 2.40 Ga and ~ 3.43 Ga (in our study), which strongly suggests that some new mare samples might be captured. In addition, this site provides access to a potential diversity of highland materials excavated by the Apollo basin impact and also delivered to the candidate sites by distal crater ejecta from craters inside SPA. On the basis of these considerations, the Apollo basin was selected as the CE-6 landing site.

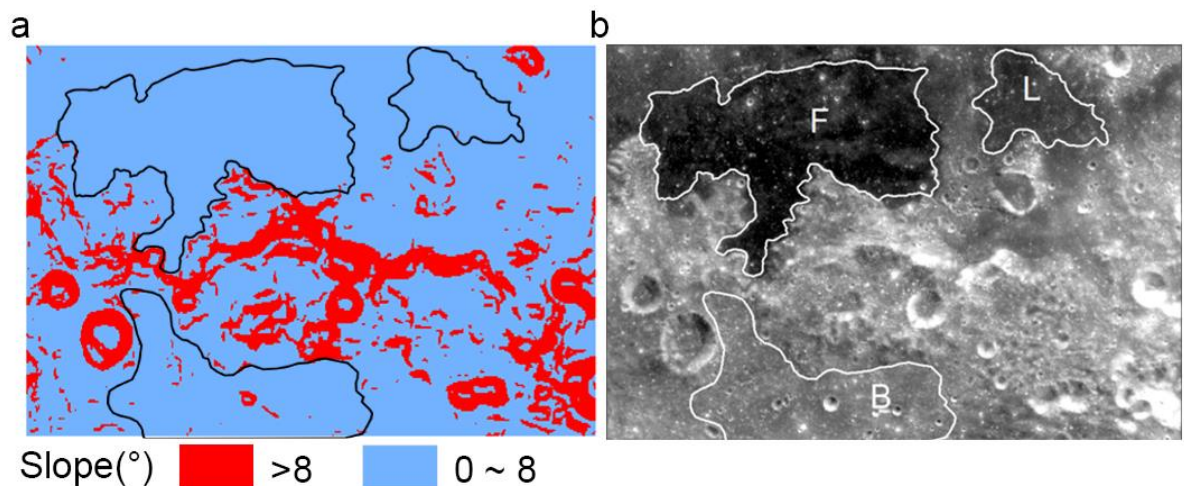


Supplementary Fig. 1 CE-4 and CE-6 landing site are within the suggested location close to 43°S and 180°E

Within the Apollo basin, F, L, B are relatively flat and diverse mare material and some possible SPA impact ejecta and related non-mare materials may be collected (See Supplementary Fig. 2); thus, these areas were selected as the candidate landing regions. Orgel et al⁵ suggested a potential landing region close to the F region in our manuscript.

Some technological details could be found in the reference³:

Liu J, Zeng X, Li C et al, Landing Site Selection and Overview of China's Lunar Landing Missions. Space Science Reviews, 217(1):1-25, (2021).



Supplementary Fig. 2 Region F (northwest Flat plain, designated F), Region L (northeast Low plain, designated L), and Region B (southwest Base plain, designated B) on a) slope map of CE-6 landing site calculated with CE-2 DEM data and b) image map of CE-6 landing site (CE-2 DOM data).

References:

51. Zhou et al., Scientific objectives and payloads of the lunar sample return mission—Chang'E-5, *Advances in Space Research*, 69(1) , (2022).
52. Li, C. et al. Characteristics of the lunar samples returned by the Chang'E-5 mission. *National Science Review* 9(02), 21-33 (2022).
53. Liu J, Zeng X , Li C et al, Landing Site Selection and Overview of China's Lunar Landing Missions. *Space Science Reviews*, 217(1):1-25, (2021).
54. Ling et al. Composition, mineralogy and chronology of mare basalts and non-mare materials in Von Kármán crater: Landing site of the Chang'E-4 mission. *Planetary and Space Science* 179, 104741, (2019).
55. Orgel, C., et al. "Characterization of High-Priority Landing Sites for the Chang'e-4 Exploration Mission to the Apollo Basin, Moon." *49th Annual Lunar and Planetary Science Conference*. No. 2083. 2018.