

# In-situ Exploration Data Positioning of Chang'e-4 Rover with Transverse Route Mapping

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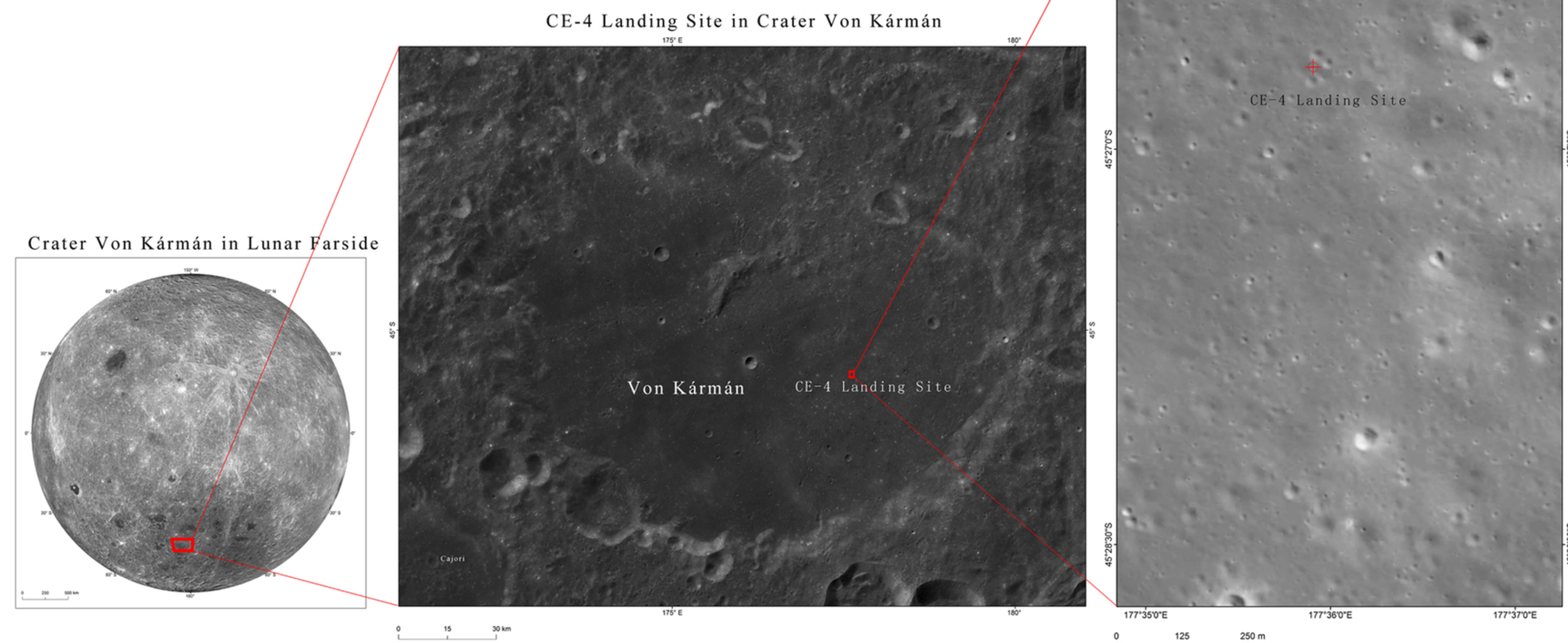
## 1 Introduction

The Chang'e-4(CE-4) lunar probe has successfully landed in the floor of Crater Von Kármán on 3rd, Jan, 2019. Up to now, the Rover has worked more than 28 lunar days in the landing site, the onboard scientific payloads such as Panoramic Camera (PCAM), Visual and Near Infrared Imaging Spectrometer (VNIS), Lunar Penetrating Radar(LPR) et.al., which were designed to study the topographic, mineralogy and subsurface structure have captured large amount of in-situ exploration data. To support the data archive and post-data analysis, we tried to record the trace and location of exploration point of the Rover, and then link the in-situ exploration data to the exploration point in each lunar day. By this means, we have made an updating transverse map of CE-4 Rover, and a geo-location based database for the science data. Which not only help the engineering work like localization, navigation, and scientific exploration planning for the Rover, but also facilitate the lunar science study with CE-4 data.

## 2 Base Map Creating

The resolution of the available DTM data in CE-4 landing site (such as CE-2 DTM, SELENE DTM) are about 7~10 meters, which is not sufficient for the lunar in situ exploration. To solve this problem, we need to get a higher resolution base map for the landing site, and luckily the LRO NAC( Lunar Reconnaissance Orbiter, Narrow Angle Camera) has captured some images over this area with a resolution of ~1 meter, CE-4 Landing Camera(LCAM) has also captured series of images among this area with resolution ranging from meters to centimeters[1]. For CE-2 DTM Data, China Lunar Exploration Program(CLEP) has produced and released the 7m resolution CE-2 DTM data(derived from CE-2 CCD data), the data which cover the CE-4 landing site could be searched and downloaded at the website <https://moon.bao.ac.cn>[2]. This data could be used as the reference data for CE-4 terrain mapping. For LRO Image Data, before and after CE-4 mission, LRO NAC has captured several images which cover the area of CE-4 landing site, and some of the images with resolution ~1 meter are in good illumination condition(such as M1303619844). These data are also available and could also be used as a background data. For CE-4 LCAM Data, during the landing process of CE-4 probe, LCAM captured 5635 images of the landing area. We selected 180 images in good illumination to make a LCAM-DOM, which is another data source for creating base map for CE-4 landing site. By the geo-reference of LRO image data and CE-4 LCAM-DOM to CE-2 DTM data with necessary control points (including plane control points and elevation points), and then a more detailed base map of the landing site has been produced.

Fig.1 Base map created with CE-2 7m lunar global data and CE-4 LCAM image



## 3 In-situ Exploration Data Locating and Archiving

When Yutu-2 Rover is driving and working on the lunar farside, in each lunar day, the driving distance, direction would be sent to the Ground Station as an engineering file. At the same time, the PCAM carried by Yutu-2 Rover would capture high resolution stereoscopic images of the lunar surface; these images would also record the rover trace and the relative position. By calculating the driving parameters, and registering the images to above mentioned Base Map, we could draw the rover trace on the Base Map and find out the specific location where the rover has worked, each location was named as an exploration point. After that, the in-situ science data would be linked to the corresponding exploration point. By this means, we would get a transverse map for the rover (See Fig.2), and also establish a geo-location based database for all the science data.

## 4 Future work

In the following work, we would continuously update the transverse map, improve the geo-location based database for the CE-4 in-situ exploration data, and a web interactive transverse map system for in-situ science data search and download is also going to be developed. In the near future, according to the data release policy made by China Lunar Exploration Program (CLEP), we would release the web interactive map system at an appropriate time.

## References:

- [1] Liu J, Ren X, Yan W, et al. (Descent trajectory reconstruction and landing site positioning of Chang'e-4 on the lunar farside[J], Nature Communication, 10(1): 1-10. 2019.
- [2] Li C., Liu J., Ren X. et al. Lunar Global High-precision Terrain Reconstruction Based on Chang'e-2 Stereo Images Geo&Info Sci of Wuhan Uni, 43(4), 491-495.

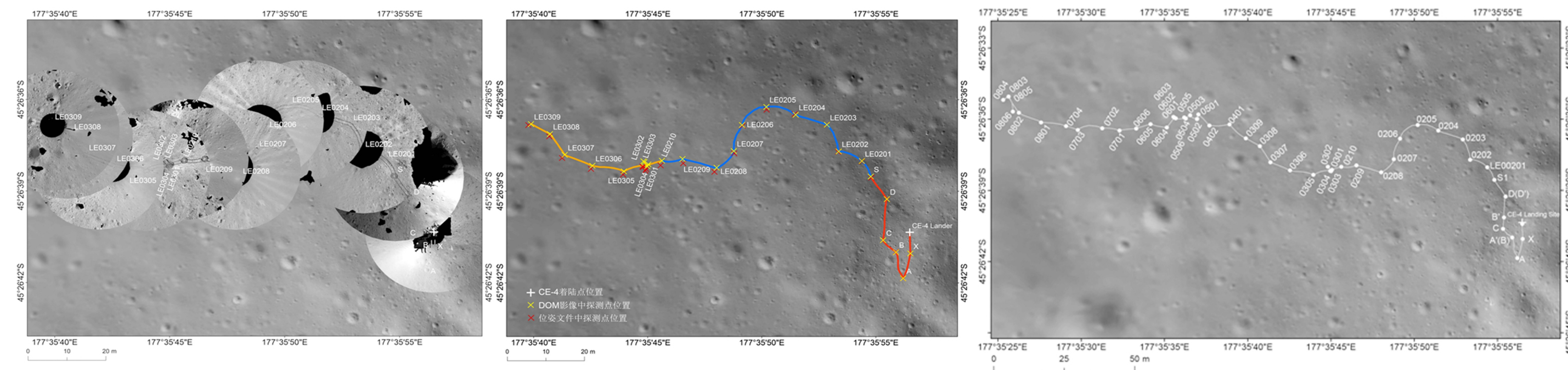


Fig.2 CE-4 transverse route mapping with PCAM data