THE GEOLOGY OF THE CHANG'E-5 LANDING SITE IN THE NORTHEASTERN OCEANUS PROCELLARUM Chengxiang Yin[1], Xiaohui Fu[1*], Xuting Hou[1], Jiang Zhang, Yongliao Zou. Shandong Provincial Key Laboratory of Optical Astronomy and Solar-Terrestrial Environment, Institute of Space Sciences, Shandong University, Weihai, Shandong, 264209, China (fuxh@sdu.edu.cn); [2]National Space Science Center, Chinese Academy of Sciences, Beijing, China.

Introduction: Chang'E-5 (CE-5) mission has successfully returned about 1731g lunar regolith samples from the northeastern Oceanus Procellarum (43.1° N, 51.8° W). This is the third phase of the Chinese Lunar Exploration Program, and also the first lunar sample-return mission since Luna 24 in 1976. The CE-5 samples will address the fundamental questions about young mare volcanism on the Moon. And these returned sample would provide a solid, new calibration points for the lunar chronological curve.

At present, these samples are still under the initial curation and analysis in the Lunar Sample Laboratory, National Astronomical Observatories (NAOC), Chinese Academy of Sciences. Despite of this, lunar orbital data could provide valuable information for the geological background of the CE-5 landing site. Here we obtained the geochemical compositions of the mare basalts in the CE-5 site and performed the stratigraphic investigations of the landing site. This work can improve the interpretation of the geological history of the landing area and better serve the subsequent laboratory analysis results of returned samples.

Geological context of CE-5 landing site: The CE-5 landing site is located within the northeastern Oceanus Procellarum. Young mare basalts (Em4) cover the landing site [1, 2, 3]. Previous studies have dated these mare flows as young as 1.33 Ga, which represents late stage mare volcanism on the Moon [1, 2]. Imbrian-aged mare units (Im2 and Im3) occur in west of the young mare basalt [3]. Mons Rümker, as one of the three major volcanic complexes in Oceanus Procellarum, lies on the southwest of the CE-5 landing site [4]. Mairan domes composed of high SiO2 and low FeO are embraced by Eratosthenian-age mare unit. Crater counting suggest that the first episode occurred at ~3.75 Ga at the Mairan T dome [5]. Therefore, a total duration of mare volcanism in the area is estimated to be about 2.4 Ga. And the mare basalts with diverse chemical compositions could provide insights in the composition and thermal history of lunar mantle.

The CE-5 landing site is also contaminated by impact ejecta from adjacent highlands. Lunar impacts could transport materials laterally to large distances and modify the local chemical compositions. On the basis of multiple orbital data, we found that The Pythagoras crater, located on the norther highland, transported anorthositic ejecta with low abundances of FeO and Th into the Imbrian-aged mare units. For the CE-5 landing site, this layer is covered by the young mare basalt. The radiating ejecta from Sharp B extend across the easternmost portion of the CE-5 landing region as bright patches. The young Aristarchus crater may contribute highly-evolved materials to the CE-5 site on the basis of the stratigraphic investigations. The highland ejecta would also provide new calibration points for lunar crater chronology in this region.

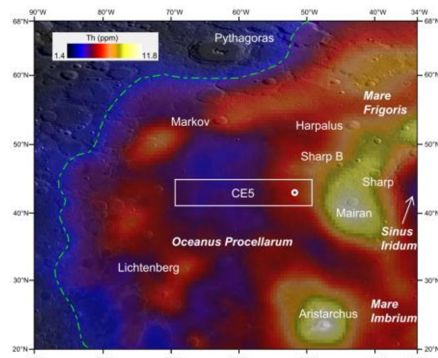

Figure 1 Lunar Prospector Gamma Ray Spectrometer (LP GRS) Th abundance map of the northern Procellarum region. The map (20-68°N, 34-90°W) is charted using LROC WAC as the base map (100 m/pixel). The white box shows the CE-5 candidate region (41- 45° N, 49- 69° W).

Geochemistry of CE-5 landing site and comparisions with Apollo soils: We obtained the geochemical compositions of the CE-5 landing site using various remote sensing data. On the basis of FeO abundance map derived from Kaguya Multiband Imager (MI) and TiO_2 abundance map derived from LROC Wide Angle Camera, we found that FeO content of the landing site is 17.0 wt% and TiO_2 content is 6.0 wt%. This indicates that this area is among the most Fe-rich basalts on the Moon. In the Neal and Taylor (1992) scheme [6], the mare basalt of CE-5 landing site is classified as the intermedia Ti basalt.

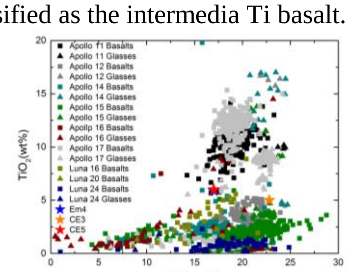

Figure 2 TiO_2 versus FeO plot of Apollo and Luna samples and CE-5 landing site. Apollo and Luna basalts/glasses data are from mare basalt database compiled by Clive Neal. The data of mare unit Em4 are from [7] and the CE-3 data are from [8].

In Figure 2, we compared the FeO and Th concentrations of the CE-5 site with those of Apollo soil samples. Half degree Th and FeO abundance data obtained by LP GRS were used here [9, 10]. Clearly, the FeO and Th compositions of the CE-5 site is the closest to those of Apollo 12 soil range. The landing site shows elevated Th concentrations (6.1 ppm), which may inherits from local mare basalts.

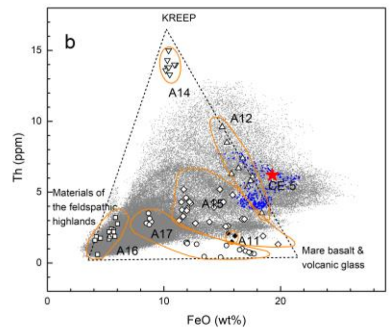

Figure 3 Th versus FeO plot of the CE-5 landing site, Apollo landing area, CE-5 candidate landing region and the full Moon. The gray and blue points represent the full Moon and CE-5 candidate landing region (white box in Figure 1) respectively.

Geological history of CE-5 landing site: Here we constructed the stratigraphy of the CE-5 site based on this work and previous studies on the northern Oceanus Procellarum to understand the geological history of the study region (Figure 4).

The volcano eruptions and impacts are the main geological events that shaped the morphology and geological history of this region. The Oceanus Procellarum lies within the high Th Procellarum KREEP Terrane (PKT) [14]. The formation of Imbrium basin, is a key event in this area, which exhumed the Th-rich materials and delivered them to the entire Moon. The Oceanus Procellarum is also known as the largest mare region on the Moon, which experienced the longest mare volcanism history [1, 2].

A brief geological history of the CE-5 site is proposed as following: After the formation of lunar crust, a large depression occurred at the western nearside of the Moon. Mare volcanism may active very early in this region, even before the Imbrium impact event (3.92 Ga from [12]). The cryptomare basalts filled the bottom of Oceanus Procellarum but possibly masked by the subsequent mare flows/ejecta layers. The primary ejecta of multi-ringed Imbrium basin containing impact melts/breccia deposited on the surrounding regions including the CE-5 site as Fra Mauro Formation. The successive Imbrian-aged lava flows covered the Imbrium basin ejecta, and only some isolated kipukas protruded these mare basalts. High abundances of radioactive elements in the crust of this region observed from LP GRS data, may be associated with the formation of high SiO_2 volcanic constructs (Mairan domes, 3.75 Ga from [5]) and the young mare volcanism [7]. The Th-rich ejecta of Mairan crater (3.50 Ga from [13]) lie between Upper and Lower Imbrian mare basalts. The highland materials delivered from Sharp B crater were probably mixed with local mare basalts and contributed the formation of the CE-5 regolith.

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Figure 4 The cross section of the northeastern Oceanus Procellarum. Its position can be seen in the LROC WAC inset. The depth and layer thickness are not scaled in this profile. The absolute model ages of mare basalts and impact basins/craters are adapted from [3, 5, 11-13].