EGU22-10988, updated on 13 Aug 2022
https://doi.org/10.5194/egusphere-egu22-10988
EGU General Assembly 2022

Properties and provenance of the lunar regolith at Chang'E-5 landing site: Constraints from remote sensing observations and ejecta deposition models

Bojun Jia[1] and Wenzhe Fa[1,2,3]
[1]Institute of Remote Sensing and Geographical Information System, School of Earth and Space Sciences, Peking University, Beijing, China (bjjia@pku.edu.cn; wzfa@pku.edu.cn)
[2]State Key Laboratory of Lunar and Planetary Sciences, Macau University of Science and Technology, Macau, China
[3]Center for Excellence in Comparative Planetology, Chinese Academy of Sciences, Hefei, China

China's first lunar sample return mission, Chang'E-5, has collected 1.731 kg samples from one of the youngest mare basalt units in the northern Oceanus Procellarum. In this study, we conducted a systematical analysis on regolith properties at the landing site using optical, multispectral, thermal infrared and radar observations, and then traced regolith provenance using ejecta deposition models.

The CE-5 landing site is within a flat (< 5° in slope), young (˜1.3 Ga), intermediate titanium (4.6 wt.%) mare basalt unit, named P58/EM4, which is surrounded by several older, low titanium mare basalt units. In the Kaguya Multiband Imager TiO_2 map, some impact craters have low titanium ejecta blankets (e.g., Mairan G), indicating that they have excavated the underlying low titanium materials. Size and spatial distribution of these craters suggest that the basalt is thicker in the center of unit P58 and thinner around the perimeter with thickness from ˜15 to ˜50 m. Morphologies of small fresh craters identified in high-resolution optical images show that regolith thickness varies from ˜1.5 to ˜8 m with a median value of ˜5 m. A comparison between Mini-RF radar image and Lunar Reconnaissance Orbiter Diviner surface rock abundance (RA) map indicates that subsurface rocks play a significant role in producing the observed radar backscatter. Further analysis of the radar echo suggests that subsurface RA is ˜0.47%–0.88% if the effective size is 3 cm, which can explain the shallow sampling depth (˜0.9 m) of the CE-5 drilling device.

To study sample provenance, deposition history and stratigraphy of landing site, we established a catalogue of 1896 craters that can deposit materials to the landing site. Our analysis shows that 80% of the primary ejecta (˜0.6 m) sampled by CE-5 comes from 12 craters within 1 km range from the landing site, and that XuGuangqi crater (46–90 Ma) contributes about 50%. There are four major source craters outside P58 unit, and their primary ejecta contribution is less than 10%. The detailed locations and depths of ejecta at landing site are given by using Maxwell Z-model (e.g., for XuGuangqi crater, 18.7–43.7 m depth and 112.3–123.0 m from crater center). Based on the age of the major craters, we further simulated the deposit thickness and composition profile of the regolith at landing site using the Monte Carlo and ballistic sedimentation model. The results show

that the craters totally produced ~1.1 m thick ejecta deposits, and the uppermost ~0.46 m consists of primary ejecta from XuGuangqi and a smaller crater near landing site. The model predicts that FeO and TiO_2 abundances decrease with depth, to a minimum value at ~0.1 m, and then increase and become constant with depth. This can provide a feasible way to identify the provenance of single sample by using FeO and TiO_2 abundances.

This study provides key information about geological context, regolith property, sample provenance and stratigraphy of landing site, which is critical for explaining laboratory measurements of CE-5 samples.