MINEROLOGY OF SURFACE MATERIALS AT THE CHANG'E-5 LANDING SITE AND POSSIBLE EXOTIC SOURCES FROM IN-SITU SPECTRAL OBERVATIONS. M. Yang[1], Y. Qian[1], B. H. N. Horgan[2], J. Huang[1], and L. Xiao[1], [1]State Key Laboratory of Geological Processes and Mineral Resources, Planetary Science Institute, School of Earth Sciences, China University of Geosciences, Wuhan 430074, China. E-mail: yms@cug.edu.cn [2]Department of Earth, Atmospheric and Planetary Sciences, Purdue University, West Lafayette, Indiana 47907, USA.

Introduction: On December 1, 2020, China's Chang'E-5 (CE-5) spacecraft landed at 43.06°N, 51.92°W in Northern Oceanus Procellarum [1]. This is the latest robotic lunar sample return mission since Luna-24. The landing site lies in one of the youngest lunar basalt fields [2], with an age of ~2.0 Ga [3-4]. According to the returned samples, the CE-5 lunar soils contain mainly plagioclase and clinopyroxene with little olivine and ilmenite.

The lunar soils at the CE-5 landing site are composed of both local and exotic components. Previous studies have shown that most of the returned samples are derived from local basalts [4]. Distant impact craters outside the Em4 unit could also deliver nonnegligible exotic materials to the landing site, however, previous studies disagree on the relative contribution of possible source craters. According to [5], Aristarchus, Copernicus, Harpalus, Kepler, and Sharp B craters are possible key source craters for exotics at the CE-5 landing site.

The CE-5 landing site is located within the youngest lunar mare basalts. A clear understanding of the composition of lunar regolith in the CE-5 region will help us to provide additional scientific evidence and analyze the origin of the CE-5 regolith. Lunar regolith is composed mainly of in-situ materials and exotic ejecta. Therefore, it is important to analyze the composition of in-situ materials, exotic materials, and regolith materials in the landing area, which could further improve the understanding of lunar geology.

Data and Methods: Lunar Mineralogical Spectrometer spectral data, Kaguya Multiband Imager (MI) and Chandrayaan-1 Moon Mineralogical Mapper (M3) spectral data have been used to analyses local and exotic materials at the CE-5 landing site. And we used the spectral parameters developed by [7] for the analysis of the data.

Results: Our analysis showed CE-5 regolith is a mixture of two kinds of CPX (Type A and B) and Pl. This contradicted the results obtained by previous works by remote sensing data. In addition, exotic materials are dominated by the ejecta from Harpalus and Aristarchus craters near the landing site.

CE-5 regolith materials. Figure 1. show the range of the LMS sample points shows a nearly L-shaped. We characterized the previous proposed three groups of soil spectra in detail. Most of the soil spectra have moderate to high B1cen (>0.95 μm), moderate to high B1asy (>0.15), moderate B2cen (>1.95 μm), and high Area Ratio (>2). Group 1 has only one member, D12. The characteristics of the moderate B1cen and high B2cen of Group 1 are similar to those of augite, but with higher B1asy and Area Ratio. It indicated that Group 1 is dominated by Type A CPX, Type B CPX and Pl. Group 2 is characterized by the opposite of Group 1, which has high B1cen like diopside phase. However, most of the Group 2 members have moderate B1asy greater than 0.15, which is the characteristic of Type A CPX, but not as prominent as Group 1. Group 2 is dominated by Type B CPX and Pl. Group 3 is a transition from the other two groups. It also shows the band center features of augite with the slight Type A CPX feature. D11 has the same band parameters characteristics as Group 1. It indicated that CPX composition of CE-5 soil is not uniform.

Exotic source craters. We considered Aristarchus and Harpalus as valuable impact craters to analyze further based on M3 data. Figure 2. show the B1cen vs. B1asy for Aristarchus crater. There are no significant changes in the composition for all investigated points. B1cen are near 0.99 μm, B2cen are higher than 2.0 μm. All 1 μm absorption band are symmetrical, B1asy is low. The results indicate that the spectral features of Aristarchus northern ejecta are dominated by Type B CPX, but also has OPX mixing. Its mineral composition is Type B CPX, Pl, with a small amount of OPX. Figure 3. show the B1cen vs. B1asy for Harpalus crater. For the continuous ejecta, most of B1cen are lower than 0.9 μm; B1asy is mainly smaller than 0 or slightly larger than 0, reflecting Px is dominating. For the discontinuous ejecta, B1cen is higher than that of the continuous ejecta, with a range of 0.97 to 1.3 μm; B2cen is between 1.91 to 2.0 μm; B1asy is mostly higher than 0.08, and the maximum is 0.15, both suggesting the spectral features of Harpalus southwest discontinuous ejecta is dominated by Type B CPX and Pl, but also has OPX mixing. Its mineral composition is Type B CPX, Pl, with a small amount of OPX. The continuous, and discontinuous ejecta have different spectral characteristics, but their spectra dominated by Px. Both OPX and CPX are mixed in pyroxene. Although the discontinuous ejecta may be mixed with bedrock material, we believed that the composition of Harpalus southwest ejecta is mainly CPX, Pl with little OPX. Therefore, Aristarchus and Harpalus craters may have contributed more exotic materials to the CE-5 site, compared with other distant impact craters. In addition, the OPX abundance of Aristarchus and Harpalus ejecta are not low (it is low at CE-5 site), suggesting exotic materials are minor at the CE-5 landing site.

Acknowledgments: The Chang'e-5 LMS data used in this work is processed and produced by "Ground Research and Application System" (GRAS) of China's Lunar and Planetary Exploration Program. The authors appreciate Rui Xu, Chunlai Li and Zhiping He at Key Laboratory of Space Active Opto-Electronics Technology, Shanghai Institute of Technical Physics for discussion of spectral data processing and the efforts of the science teams involved in the production of all the datasets used, particularly the LROC, MI, and M3. Y.Q. was funded by the National Key R&D Program of China (2020YFE0202100), the Pre-research Project on Civil Aerospace Technologies of CNSA (D020101, D020205).

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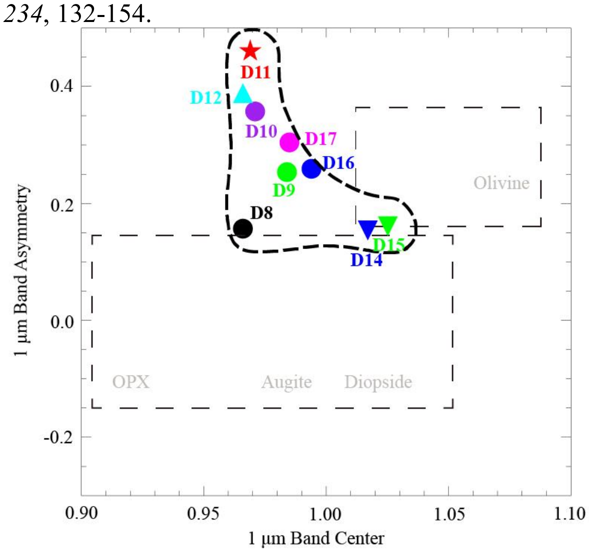

Figure 1. B1cen vs. B1asy for the CE-5 LMS hyperspectral data. The range circled by the dash line indicates the LMS data range.

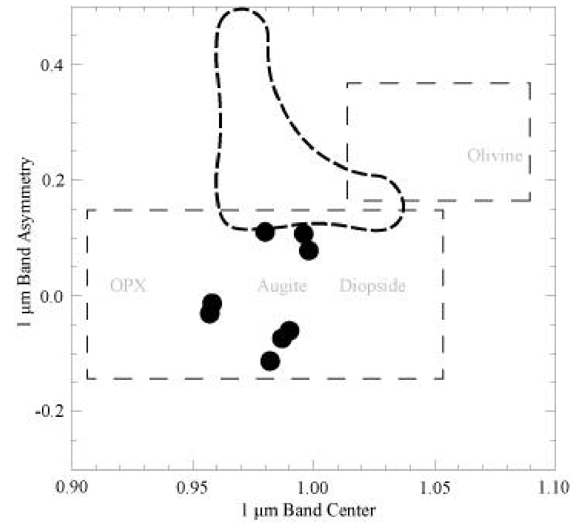

Figure 2. B1cen vs. B1asy for Aristarchus crater. The range circled by the dash line indicates the LMS data range.

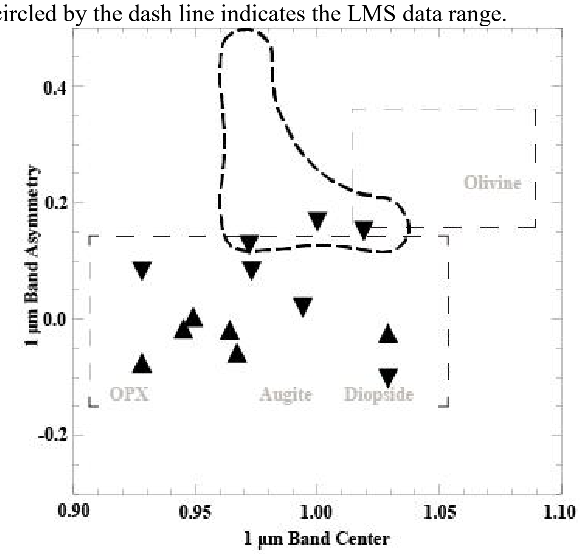

Figure 3. B1cen vs. B1asy for Harpalus crater. The range circled by the dash line indicates the LMS data range. Black triangles indicate Harpalus continuous ejecta. Black inverted triangles indicate Harpalus discontinuous ejecta.