PETROLOGIC AND GEOCHEMICAL CHARACTERIZATIONS OF CHANG’E-5 SOIL CE5C0600YJFM002GP. Y. H. Liu¹, H. J. Cao¹, J. Chen¹, Z. C. Ling¹*, ¹Shandong Key Laboratory of Optical Astronomy and Solar-Terrestrial Environment, School of Space Science and Physics, Institute of Space Sciences, Shandong University, Weihai, Shandong 264209, China (zcling@sdu.edu.cn).

Introduction: In 2020, China’s Chang’e-5 (CE-5) mission successfully collected and brought back approximately 1,731 grams of lunar samples. In this work, we performed petrographic and geochemical analyses of one polished grain mount thick section of CE-5 soil to explore mineralogical characteristics of soils from young mare basalts.

Sample: The CE-5 sample CE5C0600YJFM002GP was mounted, polished and carbon-coated by the CNSA (China National Space Administration). In this sample, a new mineral (named Changesite-(Y)) was identified in a basaltic clast by researchers from Beijing Research Institute of Uranium Geology [1].

Methods: In this study, we performed scanning electron microscopy to capture backscattered electron (BSE) images of polished section for petrographic analysis. Subsequently, Quantitative mineral composition and glass chemistry were performed using JEOL JXA-8230 Electron Probe Microanalyzer (EPMA). The operating conditions were as follows: a 15 kV accelerating voltage, a 20 nA beam current, and an 1–10 μm beam size (10 μm for plagioclase and glass, 1 μm for pyroxene and olivine). EPMA data is calibrated using the ZAF method. Additionally, Raman spectra of fragments were obtained to identify minerals, employing a Renishaw inVia® micro-Raman spectrometer. This acquisition utilized a 50X long-focus objective, with the laser power damped to ~0.9 mW to prevent laser ablation.

Result and Discussion:

Petrography. The predominant minerals in CE5C0600YJFM002GP include pyroxene, plagioclase, olivine, and ilmenite, with accessory minerals such as spinel, phosphate, chromite, troilite, tranquillitye, etc. Using BSE images, over 200 large clasts were analyzed in this study. These clasts can be categorized into four distinct types: basalt, breccia, glass, and mineral fragments. Figure 1 illustrates typical BSE images of these clasts and fragments.

The basalt clasts were classified as subophitic [2] (Figure 1a) and poikilitic [3] (Figure 1b) textures. Additionally, glass clasts in this sample were further divided into two types: oval glass (Figure 1d) and olivine porphyritic glass (Figure 1e). The latter type displays a skeletal texture composed of olivine with a Fo value of 64.2 (Figure 1e).

Figure 1. BSE images of basalt clasts (a-b), breccia (c), glass (d-e), and mineral fragments (f) in sample CE5C0600YJFM002GP.
Geochemistry. Pyroxene in basalt clasts are predominantly enriched in iron (Fe) and depleted in magnesium (Mg), consistent with the composition of those in CE-5 basalts[2,3]. Considering pyroxene mineral fragments as a representation of subophitic basalt clasts compared to poikilitic basalt clasts, quadrilateral compositions indicate that poikilitic basalt clasts (En13–23) are highly evolved, whereas parent magma of subophitic basalt clasts (En35–30) could maintain elevated temperatures over an extended period.

Plagioclase in this section is predominantly composed of bytownite and anorthite (An74.9–96.1), the majority falling within the An# range of 77–90. Notably, there is minimal variation in the plagioclase composition across different fragment types. However, plagioclase in subophitic basalt clasts and impact-melt breccias exhibit a slightly higher calcium content (An85.9).

Olivine is predominantly fayalite. Notably, olivine in poikilitic basalt clasts exhibit extremely magnesium depletion (Fo0.3), followed by olivine in breccias (Fo1.3). In contrast, individual olivine fragments demonstrate a relatively higher magnesium content (Fo38). Additionally, Mg# value histogram of olivine in different clasts exhibit distinctive double-peak patterns. The first peak, appears at fixed Fo values of 2.6 to 2.8, while the second peak varies significantly. For olivine in subophitic basaltic clasts, Fo values of the second peak center are approximately ~30, distinguished from olivine grains in poikilitic basalt clasts (Fo50) and breccias (Fo50).

Significant compositional variations exist among different glasses in this CE-5 sample. The CaO/Al2O3-MgO/Al2O3 diagram reveals the presence of a small quantity of highlands glasses, with an absence of picritic glass. Their compositions have an affinity to CE-5 basalt, indicative of impact melting of local bedrock.

Conclusion: This study conducted both petrographic and geochemical analyses on a CE-5 sample. We categorized four types of lithic clasts: basalt clasts, breccias, glass, and mineral fragments. Their compositions have a closed kinship to CE-5 basalt. However, minor highland materials were also identified, as indicated by impact-melt glasses and Mg-rich mafic minerals (Figure 2).

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Figure 2. Composition of silicate minerals and different glasses in sample CE5C0600YJFM002GP. (a) Quadrilateral pyroxene composition, (b) Plagioclase composition, (c) Olivine Fo value, (d) The major element ratios CaO/Al2O3 and MgO/Al2O3 of glasses.