LITHOLOGICAL DIVERSITY IN CHANG’E-5 SOIL SAMPLE CE5C0400.

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Introduction: The Chang’e-5 landing site is located to the East of Mons Rümker, in the mare unit Em4/P58 [1], one of the youngest mare basalt units on the Moon [2]. A total of 1731 g of soil samples were collected. Initial examination of these samples indicates that the Chang’e-5 basaltic fragments have several distinct textural types, low to intermediate Ti contents, formed *ca*. 2 billion years ago, were not linked directly to a KREEP reservoir, and originated from a mantle source with low water content [3-9]. These studies have tentatively linked the basaltic material to the Em4 unit, but it remains uncertain whether all of the samples came from a single basaltic unit. This study presents the results of petrological and geochemical investigations of a wide range of clasts, in order to address this uncertainty.

Studied samples: We were allocated a 2 g scooped soil sample, CE5C0400, by the Chinese National Space Administration (CNSA) in July 2021. The average particle size is less than 5 microns. Fragments >1 mm picked out of a 1.5 g aliquot of CE5C0400 include 28 basaltic and 7 breccia clasts, 10 agglutinates, and ~200 glass beads >30 um.

Results: The textures of the 28 basaltic fragments can be roughly divided into different grain size groups (coarse-grained, ophitic, subophitic, and fine-grained to aphanitic texture). The mineralogy and mineral chemistry of those fragments are very similar, consisting of minerals common in lunar basalts, such as chemically zoned pyroxene, plagioclase, olivine, and ilmenite, with small amounts of potassium-rich glass, potassium-feldspar, Ca-phosphates, and Zr-rich minerals. The pyroxene chemistry (Wo_{12-43}, En_{3-38}, Fs_{24-85} [coarse], Wo_{5-44}, En_{0-37}, Fs_{24-94} [ophitic], Wo_{11-44}, En_{1-50}, Fs_{23-88} [subophitic], Wo_{5-34}, En_{0-38}, Fs_{12-58} [fine], Wo_{9-47}, En_{0-39}, Fs_{32-92} [aphanitic]), plagioclase and pyroxene REE abundances, and Pb isotope systematics indicate that there is no distinct difference between different textural types. On the other hand, the chemical composition of some pyroxene grains from breccia and agglutinate clasts appears distinct from the basalt pyroxene compositions, with more Mg-rich and Ca-rich ($En_{>45}$) compositions, akin to those observed in Apollo low Ti and high Ti lithologies, and some Ca-poor and Mg-rich compositions ($Wo_{<5}$, $En_{>80}$) more similar to those found in Mg-suite samples or KREEP basalts [10-12]. The impact glass bead compositions are consistent with having mainly originated from the same Em4 basaltic unit (mean 6 wt.% TiO_2 [13]), although ~15% of the studied beads have more exotic compositons, ranging from low- to high-Ti abundances.

Discussion: Mineral chemical compositions suggest that the basaltic fragments may represent a single basalt mantle source; we are testing the hypothesis that the textural variations could result from different cooling rates at various locations within a single basaltic flow. Based on the estimated cooling rates (~5℃/hr for the majority of fragments [14-15]), the sampled fragments could represent only the upper part of the total thickness of the basaltic unit. Available chronology indicates that the sequence could have accumulated within a very short period of time, but determining a precise duration is limited by analytical uncertainties associated with the crystallization ages obtained [3,5]. The breccia and agglutinates lithic clasts, mineral fragments, and glass beads found in the CE5C0400 soil sample appear to be mainly derived from a single underlying basaltic unit, although a few rarer exotic components observed in breccias, agglutinates, and among glass beads may be linked to other types of mare basalts and non-mare lithologies.

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