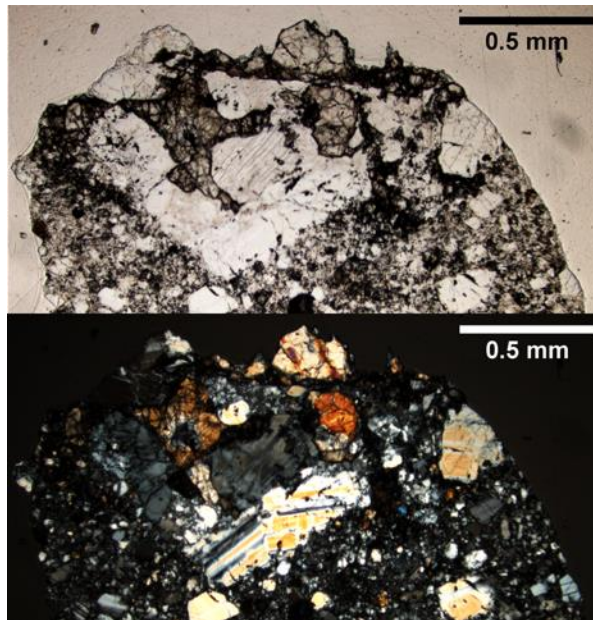


**HIGHLANDS MATERIAL IN APOLLO 17 SAMPLE 73263,6** C. R. Neal<sup>1</sup> and J. L. Valenciano<sup>1</sup><sup>1</sup>Department of Civil and Environmental Engineering and Earth Sciences, University of Notre Dame, Notre Dame, IN 46556, USA

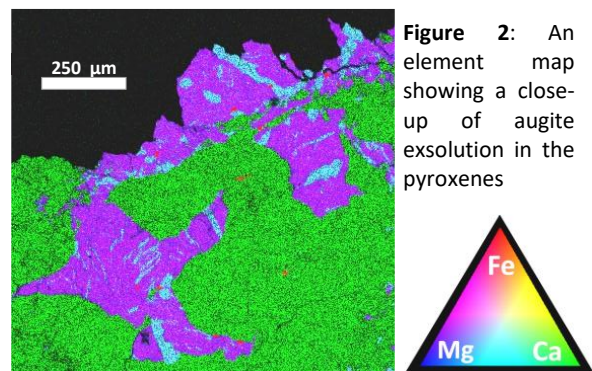
**Introduction:** The focus of the Apollo Next Generation Sample Analysis (ANGSA) project is to investigate drive tubes 73001 and 73002, which were preserved under unique conditions, and represent new samples from the Moon. Preliminary x-ray computed photography (XCT) images suggest a presence of ferroan anorthosite (FAN)-like highlands clasts within the drive tubes. In preparation for these future studies, we examined breccia fragment 73263,6 (**Fig. 1**) containing a highlands clast taken from highlands soil 73263,1 [1] to give a clearer picture on what might be found in these new lunar samples.



**Figure 1:** Composite photomicrographs of the highlands clast in 73263,6 in (top) plane-polarized and (bottom) cross-polarized light.

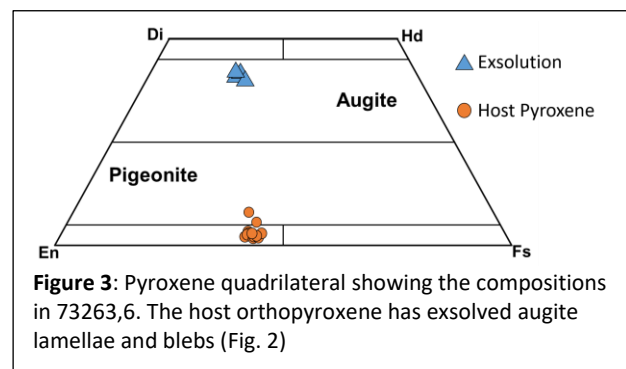
**Methods:** A CAMECA SX 100 electron microprobe at the Materials Characterization Facility (MCF) at University of Notre Dame was used to produce a map of the sample (**Fig. 2**) and point analyses for Mg, Fe, Ca, Ti, Al, K, Si, Mn, Na, and Cr were taken using 15 kV accelerating voltage with a beam current of 25 nA on a carbon-coated thin section. 30 points were collected for pyroxene using a beam diameter of 1  $\mu\text{m}$  and 31 points collected for plagioclase using a beam diameter of 5  $\mu\text{m}$ . Data were collected on both the

host pyroxene and the observed exsolution lamellae as well as plagioclase rims and centers. A Nu Plasma Atom High Resolution ICP MS at the Midwest Isotope and Trace Element Research Analytical Center (MITERAC) at University of Notre Dame was utilized for laser ablation using a 55  $\mu\text{m}$  spot size. 2 spots for both low- and high-Ca pyroxene and 6 spots on four different plagioclases were analyzed.

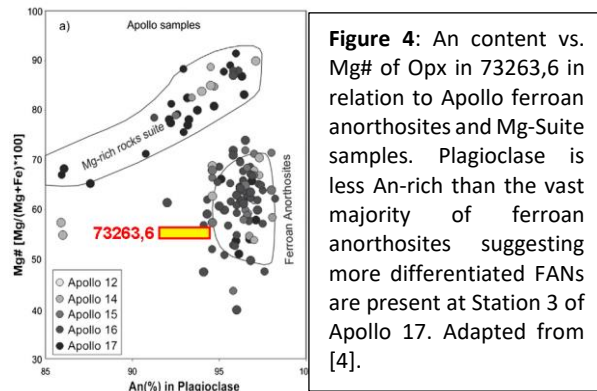


**Figure 2:** An element map showing a close-up of augite exsolution in the pyroxenes

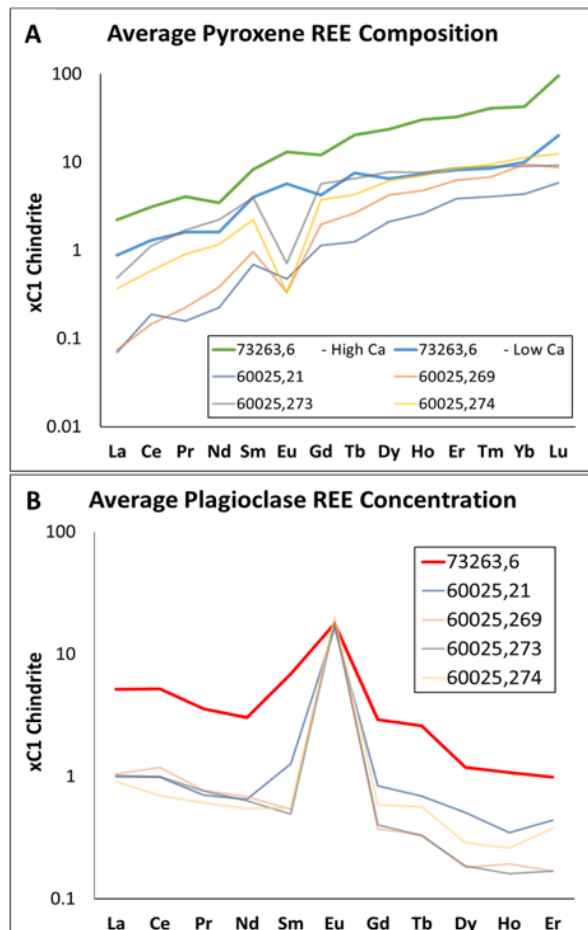
**Results & Discussion:** 73263,6 contains a mixture of low- and high-Ca pyroxene, with host orthopyroxenes containing both thick and thin lamellae along with “blebby” exsolution of augite (**Figs. 2 and 3**). This suggests relatively slow cooling of an intrusive magma body (cf., [2,3]) that would allow subsolidus exsolution and evolution of plagioclase to less An-rich compositions. When plotted on a graph of plagioclase anorthite (An) content vs. Mg# of orthopyroxene (or olivine), the highland clast found in 73263,6 appears to have a composition closest to that of a FAN (**Fig. 3**), but with a composition that is more evolved, especially



**Figure 3:** Pyroxene quadrilateral showing the compositions in 73263,6. The host orthopyroxene has exsolved augite lamellae and blebs (**Fig. 2**)

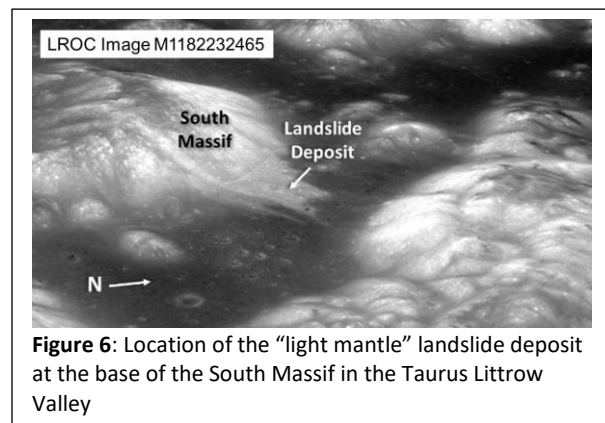


in the plagioclase composition (Fig. 4). The augites are relatively Mg-rich (Mg#: 66-67) compared with the orthopyroxenes have relatively evolved compositions (Mg# 54.5-56.5), but contain no Eu anomaly (Fig. 5A), unlike orthopyroxenes from



**Figure 5:** The average REE concentrations in (A) both the high Ca and low Ca pyroxene analyzed by LA-ICP-MS plotted with pyroxene from Apollo 16 FAN 60025 [5] and (B) 73263,6 plagioclase also compared with plagioclase from 60025 [5].

60225 [5]. The same is true of the high-Ca pyroxenes (Fig. 5A). Both low-Ca and high-Ca pyroxenes are enriched in the REE relative to similar phases in 60025 (Fig. 5A; [5]). Plagioclase in 73263,6 is also relatively enriched in REE compared to FAN 60025 and contains a significant positive Eu anomaly (Fig. 5B, [5]). From this we can see that 73263,6 is unique sample when compared to other Apollo FANs. However, the REE data indicate that plagioclase and the pyroxene did not crystallize from the same magma because pyroxene should have a negative Eu anomaly. It is possible that the subsolidus cooling witnessed by the pyroxene exsolution promoted equilibration with plagioclase that destroyed any Eu anomaly (Figs. 2 and 3) and this is being explored. However, these phases show similarities in that they were derived from relatively evolved magmas that experience slow cooling. Hand-specimen-sized FANs are relatively rare in the Apollo 17 sample collection, but may be prevalent in the regoliths that blanket the north and south massifs, given the high-FeO contents [6]. Therefore, being on the landslide deposit from the south massif (Fig. 6) suggests that more evolved highlands samples are present in regolith samples from Station 3, including ANGSA samples 73001/2. While 73263,6 may contain plagioclase and pyroxene that did not crystallize from the same magma (work is ongoing to substantiate this), the phases may possibly represent new FAN compositions.



**References:** [1] Bence A.E. et al. (1974) *PLSC 5th*, 785-827. [2] McCallum I.S. & Schwartz J.M. (2001) *JGR 106*, 27969-27983. [3] McCallum I.S. et al. (2006) *GCA 70*, 6068-6078. [4] Gross. et. al. (2014) *EPSL 388*, 318-328. [5] Torcivia, M. & Neal, C. (2022) *JGR Planets 127*, e2020JE006799. [6] Robinso M.S. & Jolliff B.L. (2002) *JGR 107*, E11, 5110, doi:10.1029/2001JE001614.