CRYSTAL SIZE DISTRIBUTIONS OF ILMENITE IN BASALT CLASTS FROM APOLLO 17 DRIVE TUBE 73002 J.L. Valenciano[1], C. R. Neal[1], C. K. Shearer[2], and the ANGSA Science Team, [1]Department of Civil and Environmental Engineering and Earth Sciences, University of Notre Dame, Notre Dame, IN 46556, USA [2]Institute of Meteoritics, University of New Mexico, Albuquerque, NM, USA (jvalenc2@nd.edu)

Introduction: The Taurus-Littrow Valley is located on the south-eastern border of the Mare Serenitatis and was the landing site for Apollo 17. Station 3 was located on the light mantle landslide deposit nearly 50m east of Lara Crater (**Fig. 1**). Among the samples collected from this station, which include rock and regolith, was a double-drive tube containing drive tube samples 73002 above 73001 [1]. These samples are part of the Apollo Next Generation Sample Analysis (ANGSA) project. Drive tube 73002 has recently been imaged through the use of computerized tomography (CT), and from those images five basalt clasts (,27G-C1, ,27G-C2, 51A, 51C, and 80A) were identified (**Fig. 2**). As COVID-19 slowed progress on obtaining samples/thin sections from 73002, the CT images were used to perform ilmenite crystal size distribution (CSD) analyses to investigate the crystallization history of these clasts.

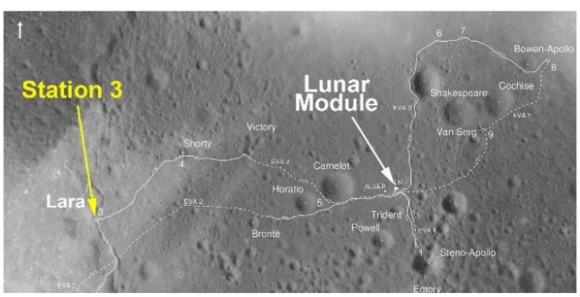

Figure 1: Map displaying the location of Station 3 in relation to the Lunar Module in the Taurus-Littrow Valley (modified from [2])

Methods: Constructction of crystal size distributions (CSDs) are a quantitative, non-destructive method of analyzing crystallization history of igneous samples. The data collected for this study uses a process similar to that in [3]. Several of the slices from the CT scan taken throughout each clast were imported into *Corel Paintshop Pro 2020* where individual ilmenite crystals were identified and traced using a touch-screen laptop computer and an active stylus pen. Any crystals that shared boundaries were traced on separate layers and all crystals located on the edges of the clasts were omitted to prevent the collection of erroneous data. A minimum of 250 crystals is necessary to generate a statistically meaningful population density value [4] and for this study between 500 – 1800 ilmenite crystals were traced for each clast. Crystal traces were then filled with a solid color and individual layers were processed through *ImageJ*, where the known scale of each clast was used to determine the area, best-fit ellipse, and major and minor axis of each crystal and the clast itself. These data were then input into *CSDCorrections* to plot the natural log of the population density against the major axis length of each crystal (**Fig. 3**).

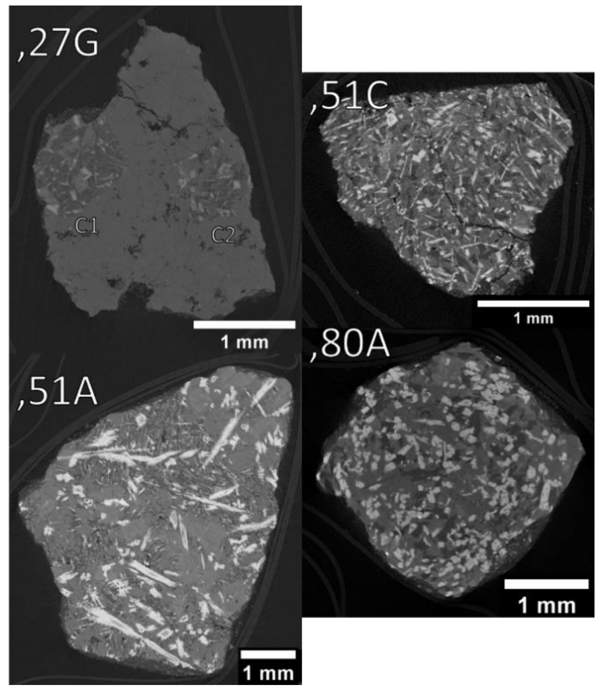

Figure 2: CT scans of the basalt clasts analyzed in this study. Sample ,27G contained two basalt clasts, which were split into clast 1 (C1) and clast 2 (C2) and analyzed separately.

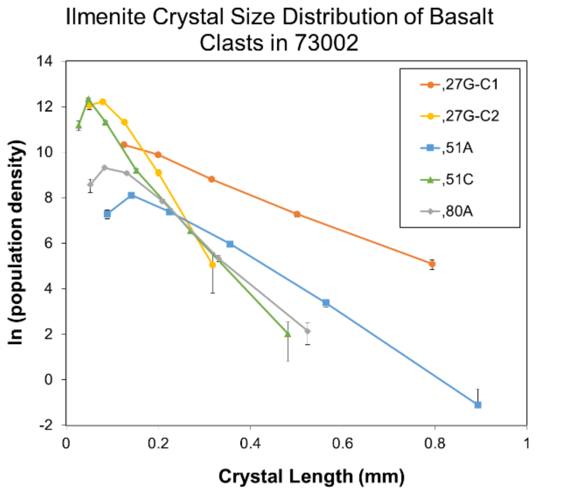

Figure 3: Ilmenite CSD profiles for basalt clasts ,27G-C1, ,27G-C2, ,51A, ,51C, and ,80A. If error bars are not visible they are within the symbol.

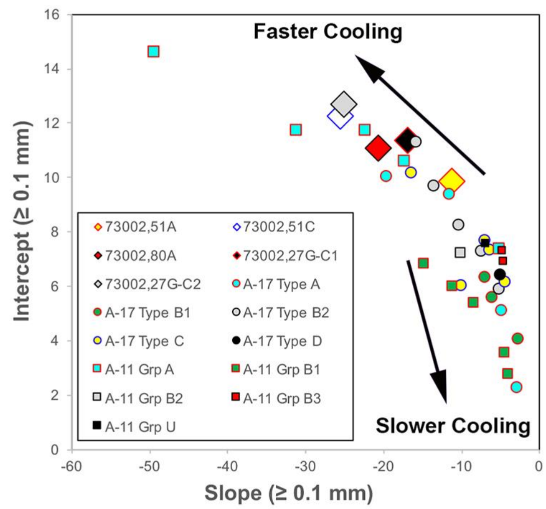

Figure 4: Comparison of ilmenite CSD slopes and intercepts of the 73002 basalts and Apollo 11 and 17 high-Ti basalts

Results and Discussion: All of the basalt clasts in this study have linear CSD profiles, indicating that they all experienced a constant cooling rate. Despite being found within the same sample, ,27G-C1 and ,27G-C2 both show very different CSD profiles, with ,27G-C2 cooling much faster than ,27G-C1. The 73002 basaltic clasts display two types of ilmenite CSDs: one with a shallower slope and lower nucleation densities (y-intercepts) (,51A; ,27G-C1), and another with steeper slopes and higher nucleation densities (,27G-C2; ,51C; ,80A). A generic interpretation is the first group experienced a slower cooling rate allowing the larger crystals to form. However, this may have been exaggerated through subsolidus textural coarsening – growth of larger crustals at the expense of smaller ones that produces a shallower CSD [6]. Further detialed work on these samples is necessary to identify textural coarsening (*cf.* [7]). The different CSD types could indicate derivation from separate flows or from different portions of the same flow: faster cooling rate representing the edge of the flow, slower cooling rates from the interior. Until compositional data can be obtained, this cannot be resolved.

Figure 4 places the 73002 basalt ilmenite CSDs in context with other ilmenite CSDs from Apollo 11 and 17 basalts. The 73002 basalts plot with the high-Ti basalts that exhibit fine-grained to quench textures [8,9]. The negative trend defined by the 73002 basalt samples represent some of the fastest cooled Apollo 17 samples analyzed to date. They augment the upper trend (labeled "Faster Cooling" in Fig. 4) from the more populated "Slower Cooling" trend. On the basis of the current data set, there are two groups based upon the slope-intercept ilmenite CSD data. The faster cooling group exhibits a shallower slope than the samples in the slower cooling group. This represents a fundamental difference in crystallization kinetics that could represent a change in quench cooling to an environment where textural coarsening begins to dominate. Sample ,51A may mark that transition, and further work is underway to substantiate this.

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References: [1] Wolfe, E.W. et. al. (1981) *USGS Professional Paper*, 1080. [2] Hasse, I. et. al. (2018) *ESS 6*, 59-95. [3] Neal et. al. (2015) *GCA 146*, 62-80. [4] Morgan D. J., & Jerram D.A. (2006) *JVGR 154*, 1-7. [5] Papike J.J. et al. (1991) Lunar Minerals, in *Lunar Sourcebook*, 121-181. [6] Higgins M.D. (2011) *Internat. Geol. Rev. 53*, 354-376. [7] Webb S. & Neal C.R. (2019) *LPSC 50*, #2534. [8] Xue Z. et al. (2020) *LPSC 51*, #2964. [9] Donohue P.D. & Neal C.R. (2015) *GCA 149*, 115-130.