QUANTITATIVE TEXTURAL ANALYSIS OF THIN SECTIONS CUT FROM THE INTERIOR AND EXTERIOR OF LUNAR SAMPLE 14053.

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Introduction: Apollo 14 sample 14053 has been studied extensively and shows evidence of subsolidus re-equilibration under extremely reducing conditions [1, and references therein]. It has been documented that only the exterior of this basalt sample has been affected relative to its interior, and it has been proposed that 14053 was reheated in an impact-ejecta blanket after its initial formation and exposure [1]. In a textural study of mare basalts, it was concluded that plagioclase crystal size distributions (CSDs) could be used to distinguish impact melts from those derived by partial melting of the lunar interior [2]. However, the plagioclase CSD from thin section 14053,18 plotted within the impact melt field [2], despite having highly siderophile element (HSE) abundances that indicated it was a pristine mare basalt [3]. This was described as textural coarsening in the outer portion of 14053b in response to a reheating event that produced a flattening of the plagioclase CSD, moving it into the impact melt field. In order to test this, we report plagioclase CSDs from 14053 thin sections taken from the interior (,244 and ,312) and exterior (,18 and ,246) thin sections to examine any dichotomy between CSD data from different areas of the basalt.

Methods: CSD data for this study was collected in a manner similar to that listed in Neal et al. [2], but with slight variations. Photomicrographs (Fig. 1) of the thin sections were obtained using a Nikon petrographic microscope in plane-polarized light, cross-polarized light, and reflected light. A 4x objective was used for all images. Once the images were collected they were then stitched together using Microsoft *Image Composite Editor©* to create a photomosaic representing the entirety of the sample. These stitched photomosaics were then opened in Corel *Paintshop© Pro 2019 Ultimate* on a touchscreen 2-in-1 laptop computer and the plagioclase crystals were traced using an active stylus. In the case of intersecting crystals multiple layers were generated in *Paintshop© Pro* in order to ensure that each crystal was recorded discretely and that no crystals were merged together while tracing. 250 crystals are considered the minimum number necessary for the CSD to be considered statistically viable, but care was taken to trace the absolute maximum number of crystals available in each sample area in order to achieve population density values that are as accurate as possible. Once the crystal traces were complete the photomosaics were removed from the background and the crystal traces were filled-in with a solid color. Those images were exported

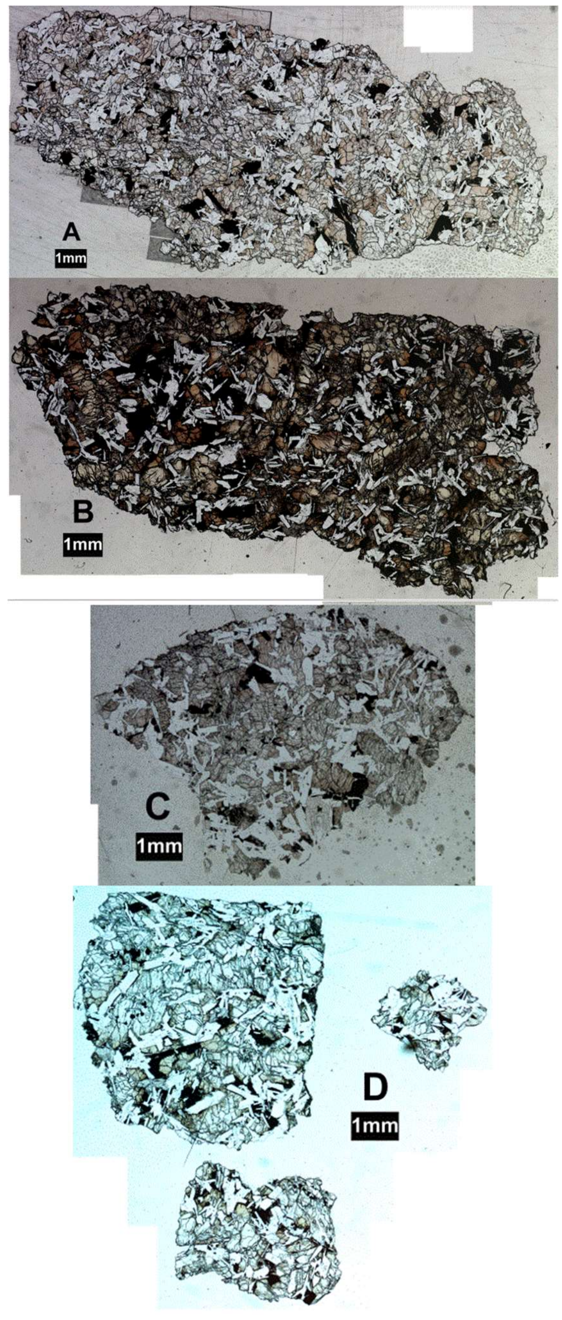

Figure 2: Plane-polarized light photomicrographs of thin sections (A) 14053,256, (B) 14053,244, (C) 14053,18, and (D) 14053,312. The black bar in each photo represents 1 millimeter.

to *ImageJ*©, where the known scale of the images was used to determine the area, best-fit ellipse, and major/minor axis of each crystal and the sample area itself. This data was then input into *CSDSlice* [4] and *CSDCorrections* [5] to determine the overall shape and size distribution of the crystals. *CSDCorrections* measurement options were set to Ellipse Major Axis and the size scale was five bins per decade. The resulting *CSDCorrections* data was used to plot the natural log (ln) of population density versus the length of each crystal's major axis (Fig. 2).

Results and Discussion: The interior samples from 14053 both exhibited very similar CSD slopes to each other, with slight variation in y-intercept value (Figs. 2 and 3). The criteria defined in [2] were used to calculate the slope and intercept values. The exterior samples also exhibited very similar CSD slopes to each other, but the interior samples had significantly steeper CSD slopes than the exterior samples.

Summary: The results of this study indicate that plagioclase CSDs of thin sections taken from the interior and exterior portions of the sample are distinctly different. Textural coarsening in the exterior portion of 14053 due to thermal metamorphism [1] have moved the CSDs into the Impact Melt field (Fig. 3). Textural coarsening results in the growth of larger crystals at the expense of smaller crystals, thus reducing the CSD slope. The CSD slopes are significantly less steep in the thin sections taken from the exterior of 14053 (,18 and ,256) than they are at the interior (,244 and ,312) (Figs. 2 and 3). This demonstrates that the interior of sample 14053 was not reheated to the same extent than its exterior, which is consistent with the petrographic observations of [1].

Conclusion: Subsequent thermal metamorphism via impact ejecta blankets can induce a change in the textures of mare basalts. Samples with HSE abundances indicating they are pristine can have plagioclase CSDs that are consistent with an impact melt origin. However, detailed petrographic analyses indicate the effects of such metamorphism, such as indicated by [1]. This is also seen in KREEP basalt 15382 [6].

References: [1] Taylor L. A. et al. (2004) *Amer. Min. 89*, 1617-1624. [2] Neal C. R. et al. (2015) *GCA 148*, 62-80. [3] Badaecker P.A. et al. (1972) *PLSC 3rd*, 1343-1359. [4] Morgan D. J., & Jerram D.A. (2006) *JVGR 154*, 1-7. [5] Higgins M.D. (2000) *Amer. Min. 85*, 1105-1116. [6] Cronberger K. and Neal C.R. (2019) LPSC 50.

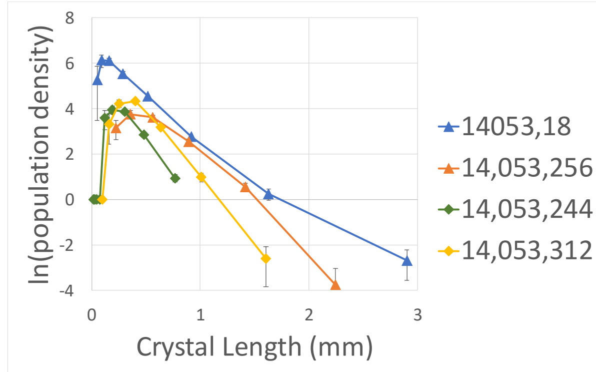

Figure 2: Plagioclase CSD profiles for lunar samples 14053,18, 14053,244, 14053,256, and 14053,312. Triangle symbols are exterior samples and diamonds are interior samples. If error bars are not visible then they are within the size of the symbol.

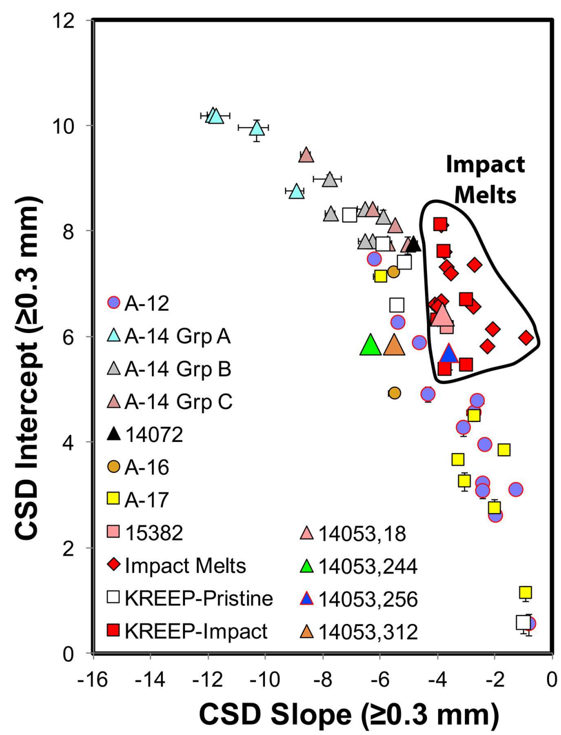

Figure 3: Samples from this study compared with plagioclase CSDs from other lunar basalts and impact melts. The error on each CSD analysis and shown and are usually within the size of the symbol.