UPDATE ON REVIEWING GEOCHRONOLOGIC CONSTRAINTS FOR BOULDER SAMPLES FROM APOLLO 17 STATIONS 2, 6, AND 7. C. M. Mercer[1*,2], K. V. Hodges[3], B. L. Jolliff[4], M. C. van Soest[3], C. S. McDonald[3], and B. A. Cohen[2]. [1]CRESST II/The Catholic University of America, Washington, D.C. (E-mail: *cameron.m.mercer@nasa.gov, mercer@cua.edu), [2]NASA Goddard Space Flight Center, Greenbelt, MD, [3]School of Earth and Space Exploration, Arizona State University, Tempe, AZ, [4]Department of Earth & Planetary Sciences and the McDonnell Center for the Space Sciences, Washington University, St. Louis, MO.

Introduction: The Taurus-Littrow Valley is an east-southeast trending graben located in the southeast rim of the 740 km-diameter primary Serenitatis impact basin. The valley is bounded by large massifs to the north and south that are generally interpreted as having been emplaced by the impact that formed the primary Serenitatis impact basin, though some have proposed that they are composed of ejecta from multiple basin-scale impacts (see discussions and references cited by Wilhelms [1] and Schmitt et al. [2]). The Sculptured Hills physiographic unit is superposed on the Taurus highlands and is generally interpreted to have been emplaced by the Imbrium basin-forming impact. Spudis et al. [3] therefore suggested the possibility that all impact melt breccias (IMBs) collected by the Apollo 17 astronauts were derived from Imbrium. However, several boulders (each composed of one or more IMB lithologies) located at the bases of the North and South Massifs have been traced to probable source outcrops eroding from the massifs, and Hurwitz and Kring [4] argued that these boulders therefore consist of materials that predate the Sculptured Hills (i.e., they are pre-Imbrian material).

These competing hypotheses have formed the backdrop for basin-age interpretations, primarily of Serenitatis and Imbrium, that have been made from a variety of geochronologic datasets for Apollo 17 samples, as well as samples from the Apollo 12 and 14 landing sites [e.g., 2–14]. A major observation that has emerged from these studies is that there appear to be gaps between U/Pb age estimates and those from other isotope systems (such as ^{40}Ar/^{39}Ar and Rb/Sr) for the Imbrium basin-forming impact. These discrepancies have been variably attributed to the use of outdated ^{87}Rb and ^{40}K decay constants [e.g., 7] and ^{40}Ar/^{39}Ar monitor mineral age calibrations [e.g., 9]. Alternatively, with respect to the Apollo 17 samples, simple geologic variability could be at play since individual boulders are breccias comprising materials of potentially different ages.

To address these concerns for the Apollo 17 site, we began compiling geochronologic data for samples collected from boulders at the bases of the South (Station 2) and North (Stations 6 and 7) Massifs, and integrated petrologic and ultraviolet laser ablation microprobe (UVLAMP) ^{40}Ar/^{39}Ar geochronologic investigations of samples 72255 (boulder 1, Station 2), 76315 (block 2, Station 6 boulders), and 77075, 77115, and 77135 (Station 7 boulder) [15, 16, 17]. The UVLAMP ^{40}Ar/^{39}Ar method is an important complement to incremental heating methods since the UV laser couples well with most rock-forming minerals and does not cause significant collateral heating of the sample, allowing individual lithologies and minerals to be dated while preserving petrographic context [16–19]. Here we present an update on our progress reprocessing literature data using consistent decay constants and monitor age parameters.

Data Compilation and Reprocessing:

Overview. We are compiling U/Pb, Rb/Sr, Sm/Nd, and ^{40}Ar/^{39}Ar data for 22 samples collected from boulders at Stations 2, 6, and 7. We have identified 98 datasets for these 22 samples (66% ^{40}Ar/^{39}Ar, 17.5% U/Pb, 15.5% Rb/Sr, and ~1% Sm/Nd). Unfortunately, to the best of our knowledge, 13 ^{40}Ar/^{39}Ar datasets (representing ~20% of the available ^{40}Ar/^{39}Ar data and ~13% of the total number of geochronologic datasets identified thus far) were only presented in short abstracts as figures of incremental release spectra, or otherwise lack tabulated isotopic data, severely limiting their utility. We encourage all researchers who may have unpublished geochronologic isotope data for priceless Apollo samples to submit their datasets to the MoonDB project [www.moondb.org] for preservation and reuse by future generations of scientists.

Recalculation to Use Consistent Decay and Monitor Age Parameters. We used the *ArAR* software of Mercer and Hodges [20] to ensure all ^{40}Ar/^{39}Ar dates have been determined using a consistent set of ^{40}K decay constants and monitor mineral ages. In particular, we chose parameters consistent with two sets of ^{40}K decay constants for comparison: those internationally recognized by the International Union of Geological Sciences in 1976 [21], and those recommended more recently by Renne et al. [22]. In addition, we have ensured all Rb/Sr dates have been determined with a consistent ^{87}Rb decay constant (e.g., that of Steiger and Jäger [21]).

Data Visualization and Statistics. We are developing custom software to enable flexible and rapid reprocessing and visualization of compiled datasets. This will ensure that all datasets are treated as systematically and uniformly as possible with a consistent set of statistical tools. During data reprocessing we first attempt to reproduce the published date (within uncertainties) from tabulated isotopic data or step ages, then we apply our preferred computational methods for comparison. In particular, we prefer to: (1) use the York linear regression [23] for isochrons and apply the Hampel outlier identifier [24] following the methods of [16]; (2) compute plateau dates using weights that include the inverse variances and fraction of ^{39}Ar released; (3) evaluate goodness of fit using the *MSWD* [25] and 95 % confidence interval of the *MSWD* (CI_{MSWD} [26]); and (4) expand uncertainties by $t_{crit}*MSWD^{1/2}$ (where t_{crit} is the critical value of the Student's-t Distribution for the appropriate degrees of freedom) when the *MSWD* exceeds the upper limit of the 95 % CI_{MSWD}.

Progress and Implications: Previously, we discussed the apparent age gap among ^{40}Ar/^{39}Ar and U/Pb phosphate datasets for sample 72255, a clast-rich aphanitic rock from Boulder 1 at Station 2 (see Mercer et al. [15] for discussion). Here, we compare available ^{40}Ar/^{39}Ar and U/Pb dates for the Apollo 17 boulder samples, grouped by lithology (e.g., poikilitic vs. aphanitic IMBs). Figure 1 shows an example, with a subset of ^{40}Ar/^{39}Ar and U/Pb dates for components of samples 72255 (aphanitic, South Massif), 76315, and 77115 (both blue-gray poikilitic IMBs, North Massif). Our UVLAMP ^{40}Ar/^{39}Ar isochron dates for the matrixes of the clast-rich aphanitic IMB 72255,409 and poikilitic IMB 76315,176 are younger than published plateau dates, likely due to our ability to avoid clasts. Some clasts in both samples have apparent ages ~100–200 Ma older. Note, the mean phosphate U/Pb date (from six analyses of five phosphates from 3 splits [5]) for 72255 is most similar to ^{40}Ar/^{39}Ar plateau dates, which may have contained older clast materials. More UVLAMP ^{40}Ar/^{39}Ar work could be done to confirm our results for 72255 and 76315, as well as other Apollo 17 IMBs.

Step heating ^{40}Ar/^{39}Ar data for the aphanite 72255 and poikilitic IMB 76315 are scattered with some overlap around ~3.93 Ga, not dissimilar to the 3.92 Ga phosphate U/Pb date reported by Thiessen et al. [5] for splits of 72255 (though we make no interpretation beyond coincidence here). In comparison, plateau dates for the poikilitic IMB 77115 and UVLAMP isochron dates for 72255, 76315, and 77115 are generally closer to ~3.83 Ga, and form a younger mode in the probability density plot in Fig. 1. From this example, and based primarily on ^{40}Ar/^{39}Ar data, there is no simple distinction in age between the aphanitic and poikilitic IMBs, nor between samples from the North and South Massifs. More detailed U/Pb and UVLAMP ^{40}Ar/^{39}Ar work is needed to evaluate how the South Massif boulder samples compare to those from the North Massif, and can help evaluate stratigraphic interpretations of basin ejecta at the Apollo 17 site [e.g., Schmitt et al. [2]).

Acknowledgments: We thank N. Curran and J. Olsson for assistance in developing the software used to reprocess ^{40}Ar/^{39}Ar and Rb/Sr datasets.

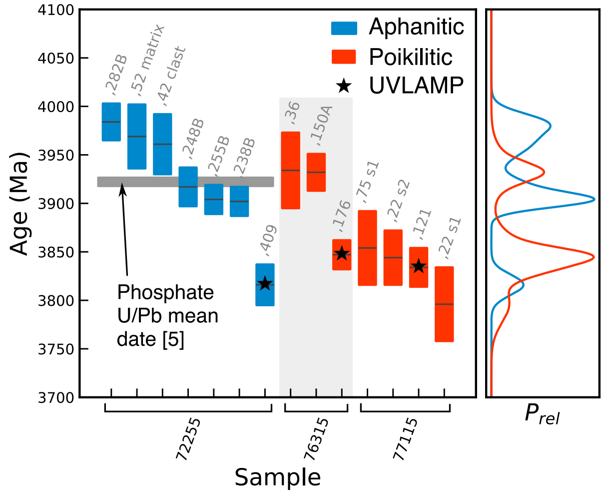

Figure 1. ^{40}Ar/^{39}Ar dates [13, 27–30] for samples 72255 (aphanitic IMB), 76315 (grouped in light gray box for clarity), and 77115 (both poikilitic IMBs), and a mean phosphate U/Pb date [5] for 72255 (no U/Pb dates are available for 76315 and 77115). Specific sample IDs are shown in gray text above ^{40}Ar/^{39}Ar dates. ^{40}Ar/^{39}Ar plateau dates have been computed from reported step heating data that were recalculated to use parameters consistent with Steiger and Jäger [19]; UVLAMP ^{40}Ar/^{39}Ar isochron dates are denoted with black stars. Right panel shows the relative probability (P_{rel}) of the grouped ^{40}Ar/^{39}Ar dates.

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