Chronology of Steno Crater Basalts. S. J. Pomeroy[1], C. A. Crow[1], Z. E. Wilbur[2], J. J. Barnes[2], J. W. Boyce[3], J. L. Mosenfelder[4], M. Brounce[5], T. M. Erikson[6], T. J. Zega[2], and the ANGSA Science Team[7]. [1]University of Colorado, Boulder, CO, 80309, USA (sean.pomeroy@colorado.edu); [2]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, 85721, USA; [3]NASA Johnson Space Center, Houston, TX, 77058, USA; [4]University of Minnesota Minneapolis, MN, 55455, USA; [5]University of California, Riverside, CA, 92521, USA; [6]Jacobs- *JETS*, NASA Johnson Space Center, Houston, TX, 77058, USA; [7]List of co-authors includes all members of the ANGSA Science Team (https://www.lpi.usra.edu/ ANGSA /teams/).

Introduction: The Apollo Next Generation Sample Analysis (ANGSA) program was designed to investigate specially curated samples returned by the Apollo 15 and 17 missions [1]. As part of this effort, we are examining a suite of Apollo 17 basalts collected from the rim of Steno Crater, to investigate the magmatic and post-magmatic volatile histories of these samples. Here we report initial ^{207}Pb-^{206}Pb chronology of accessory phases for two steno crater basalts, which will ultimately be paired with ^{40}Ar*/^{39}Ar chronology and ^{38}Ar exposure ages to constrain crystallization and surface histories. The chronology of these samples will help determine if the samples derive from the one lava sequence or represent multiple lava flows, and will allow us to place petrologic and volatile data into the wider context of the magmatic suite [1,2]

Samples: The four samples included in this study are normally curated (i.e., stored at room temperature in N_2) 71035, 71037, and 71055 as well as frozen sample 71036 (also stored in N_2). All four samples are high-titanium, vesicular basalts collected from the sample boulder near the edge of Steno Crater [4]. Of these samples, only 71055 has been previously dated, with a Rb/Sr age of 3.56±0.09 Ga (age corrected for new decay constants) [5]. An attempted to measure the U-Th-Pb age of 71035 was made, however the sample was too disturbed to yield a reliable age [6].

Analytical Procedure: Currently, we have analyzed ^{207}Pb-^{206}Pb systematics for baddeleyite, tranquillityite and merrillite in samples 71035 and 71055. Existing and new thin sections were characterized by [2] and Pb-isotope were measured in the Secondary Ion Mass Spectrometry (SIMS) laboratory at the University of California, Los Angeles. Samples were analyzed with a 5nA $^{16}O^-$ primary beam using the Hyperion II ion source, which resulted in a spot size of ~10 μm. ^{207}Pb-^{206}Pb ages were determined using a combination of IsoplotR [7] and the UCLA ZIPSv311 software.

Results: The targets for SIMS analyses are shown in Figures 1 and 2. We measured baddeleyite and tranquillityite for both 71055 and 71035, as well as merrillite in sample 71055. However, the merrillite contained a significant non-radiogenic, possibly non-lunar, component, so was excluded for the current age determination. As seen in Figure 1, the analysis location for merrillite in 71055 overlaps a significant fracture, which could introduce a terrestrial Pb component.

The baddeleyite and tranquillityite data are presented in the inverse isochron diagram in Figure 3. The data from the two samples are consistent, within uncertainty, suggesting a similar crystallization age and possibly a common initial Pb component. The ages of the baddeleyite grains from 71055 and 71035 are 3891±26 Ma (2σ) and 3843±46 (2σ), respectively. These agree within uncertainty and are consistent with the isochron age of 3841±28 Ga.

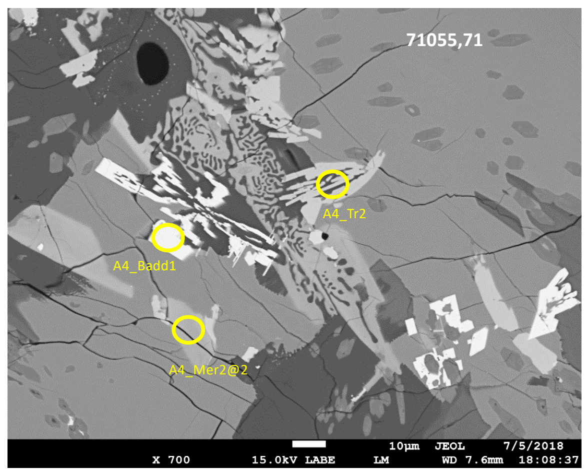

Figure 1: :Backscatter electron image of sample 71035. Locations of SIMS analysis locations for baddeleyite, tranquillityite and merrillite. Yellow circles are to scale for SIMS analysis spots.

Discussion: The baddeleyite age for 71055 (3891±13 Ma) is significantly older than the previously reported Rb/Sr age of 3.56±0.09 Ga [5]. One explanation of the discrepancy between these two ages is the higher susceptibility of disturbance in the bulk rock Rb/Sr system during subsequent impact bombardment [8]. If these basalts have a common post-crystallization history, this would also be consistent with the disturbed U-Th-Pb data from 71035 [6].

The initial results of the accessory phase geochronology suggest that samples 71035 and 71055 basalts have a common crystallization age, which would be consistent with derivation from the same magmatic event. This is further supported by the possibility of a shared initial Pb component, but further analyses of additional phases within the sections is needed to confirm this observation.

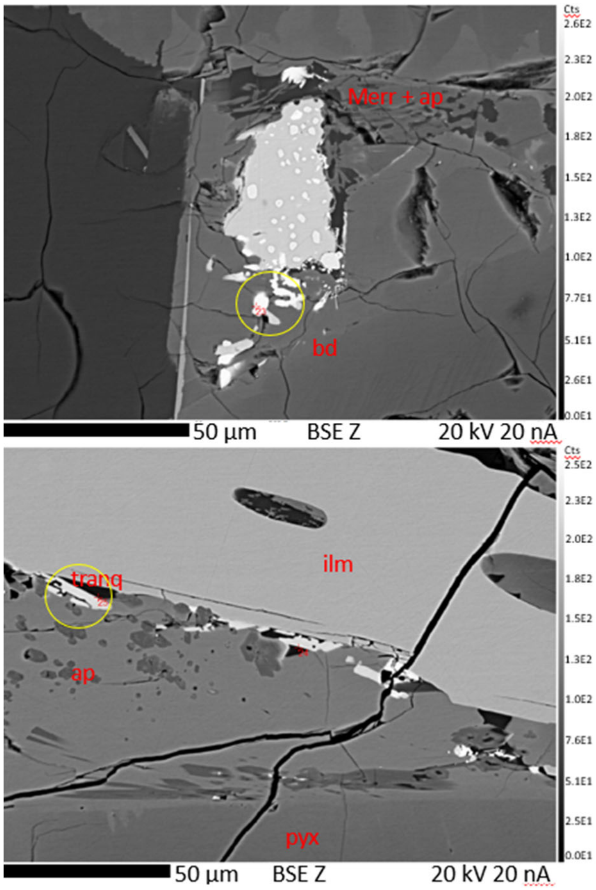

Figure 2: :Backscatter electron images of sample 71055. Locations of SIMS analysis for baddeleyite and tranquillityite indicated in yellow circles. Circles are exaggerated to show location of minerals, and do not show size of SIMS analysis spots.

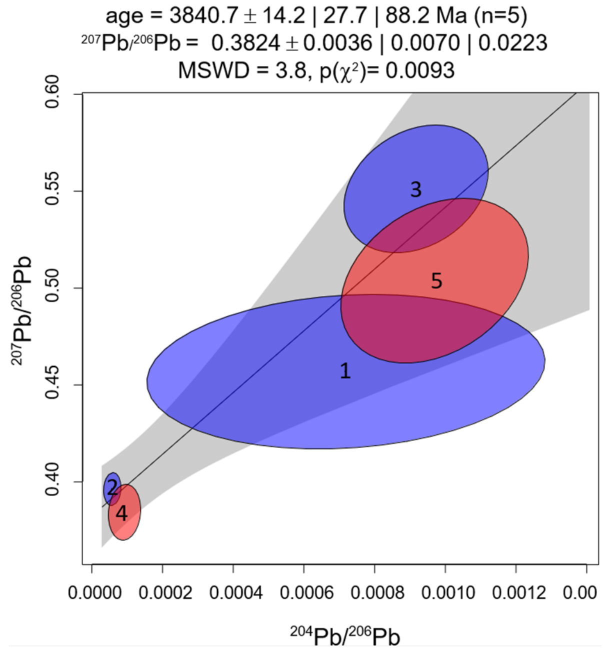

Figure 3: Inverse isochron diagram for baddeleyite (2,4) and tranquillityite grains (1,3,5). Sample 71055 is in blue and sample 71035 is in red.

Future Work: We currently have thin sections of a third Steno Crater basalt, sample 71037, and are awaiting sections of frozen sample 71036. Follow up SIMS Pb-isotope work on all four samples is scheduled and we plan to present chronology results from all four samples. We will also measure ^{40}Ar*/^{39}Ar chronology and ^{38}Ar exposure ages, on all four samples during summer 2022. Comparison of the ^{207}Pb-^{206}Pb and ^{40}Ar*/^{39}Ar systems will ultimately help us (1) determine the source of the age discrepancy between the Rb-Sr and ^{207}Pb-^{206}Pb systems, (2) constrain the crystallization and post-crystallization history of these samples, and (3) give temporal context for volatile data.

References:

[1] Gross J. et al. (2021) *LPSC 52nd*, #2684. [2] Brounce et al. (2022) *This meeting.* [3] Wilbur et al. (2022) *This meeting.* [4] Neal C.R. and Taylor L.A. (1993) Catalog of Apollo 17 Rocks, Vol. 2 [5] Tera F. et al. (1974) *LS V,* 792-794. [6] Chen J. H. et al. (1979) *LPS X*, 195-197. [7] Vermeesch P., (2018) *Geoscience Frontiers,* v.9, p. 1479-1493. [8] Gaffney A. M. (2007) *Geochimica et Cosmochimica Acta* Vol 71, 3656-3671.

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