FORMATION AGES OF THE APOLLO 16 REGOLITH BRECCIAS: IMPLICATIONS FOR ACCESSING THE BOMBARDMENT HISTORY OF THE MOON. K. H. Joy[1,2], D. A. Kring[1,2], D. D. Bogard[2,3], M. E. Zolensky[2,3], and D. S. McKay[2,3]. [1]CLSE, LPI/USRA, 3600 Bay Area Blvd., Houston, Texas 77058, USA (joy@lpi.usra.edu). [2]NASA Lunar Science Institute. [3]ARES, NASA Johnson Space Center.

Regolith breccia 'formation' ages: Regolith breccias are lithified samples of the regolith that have been fused together by impact shock and thermal metamorphism. In lunar regolith samples, the ratio of trapped $^{40}Ar/^{36}Ar$ is a useful indicator of antiquity and can be used to model the closure age / lifithication event of the regolith (i.e. the apparent time when Ar became trapped [1]), thus providing an important insight into specific times when that regolith was interacting with the the dynamic inner solar system space environment [2-4].

The Apollo 16 regolith breccias: McKay et al. [5] used this method to identify two groups of regolith breccias at the Apollo 16 (A16 RB) landing site: (i) the 'ancient' group, representative of immature (i.e. <30 I_s/FeO: Table 1) pre-3.9 Ga regolith, and (ii) the 'younger' group that generally have higher levels of maturity (Table 1) and were formed after 3.9 Ga (see also [6-7]). We have used the relationship between trapped $^{40}Ar/^{36}Ar$ and sample isotopic age as shown in Fig. 6 of McKay et al. [5] to calculate the model closure ages of the A16 RB: these data are shown in Table 1 listed as Model 1. These ages indicate that the ancient A16 RB represent lithification of immature regoliths throughout the period of lunar basin formation from 4.5-3.93 Ga [5,7], and therefore provide a window to regolith formation processes and the nature of bombarding projectiles before the formation of the Imbrium basin at ~3.85 Ga.

New Age Estimates: Here we readdress the formation time of these A16 RB in light new calibrations of the relationship between trapped $^{40}Ar/^{36}Ar$ vs. sample isotopic age as proposed by Eugster et al. [8]. The model ages derived from this calibration (Model 2 in Table 1) indicate that the ancient A16 RB are not as old as suggested by the Model 1 calibration [5], and that the ancient breccias only sample post-basin regolith processes from 3.67-3.26 Ga (Table 1).

We have further extended the Eugster et al. [8] calibration to include additional data from lunar meteorite Yamoto-86032 [9] and Apollo 16 regolith breccia components [10-11]. Where possible we corrected the Eugster et al. [8] calibration isotopic ages for updates in decay constants [12-13], and we also removed the Apollo 14 samples from the calibration.

Using this new calibration, we determined model ages (Model 3 in column 7 of Table 1) that are more consistent with A16 RB sample isotopic ages and ages of clast components within them (see column 8 of Table 1) than either Model 1 [5] or Model 2 [8] ages.

Implications for accessing the record of impacting projectiles: Our model results indicate that the ancient A16 RB (e.g. 61135 to 60019) were lithified during the last stages of basin formation on the Moon from 3.81 to 3.38 Ga. This suggests that they do not provide a window to pre-Imbrium regolith processes.

The young A16 RB samples (e.g. 63595 to 60256: Table 1) provide an opportunity to investigate the nature of impacting projectiles through ~2.5 to 1.7 Ga. This period is contemporaneous with recent mare basalt eruptions and associated with quiescent impact bombardment. Samples such as 63507 and 65095, which have low trapped $^{40}Ar/^{36}Ar$ ratios, were lithified very recently and are comparable with the impact record preserved in present day Apollo 16 soils [5].

Sample	I_s/ FeO	Age	^{40}Ar / $^{36}Ar_{Tr}$	Model 1 Age (Ga)	Model 2 Age (Ga)	Model 3 Age (Ga)	Age (Ga)
61135,29	0.5	A	12.5	4.56	3.67	3.81	3.819
60016,165	0.5	A	12.2	4.52	3.64	3.78	3.8
66075,76	0.5	A	11.7	4.44	3.59	3.72	3.83
65715,11	0.6	A	11.3	4.38	3.55	3.68	
66035,32	0.5	A	10.5	4.25	3.46	3.59	
66036,10	0.4	A	10.4	4.23	3.45	3.58	
61516,8	0.05	A	9.5	4.07	3.35	3.47	
61195,57	0.1	A	9.3	4.03	3.32	3.44	
60019,110	0.2	A	8.8	3.93	3.26	3.38	
63595,5	0.4	Y	4.4	2.67	2.44	2.53	
61175,206	8	Y	4.25	2.61	2.4	2.48	
61295,47	6	Y	4.1	2.55	2.35	2.44	
61536,8	9	Y	3.9	2.46	2.29	2.38	
60275, 56	4	Y	3.8	2.41	2.26	2.35	
61525,9	3	Y	3.7	2.36	2.23	2.31	
63588,6	0.4	Y	3.3	2.15	2.1	2.17	
60255, 93	17	Y	2.25	1.46	1.64	1.7	
63507,15	48	VY	0.55	-1.09	-0.02	-0.02	
65095,78	<0.1	VY	~0	0	0	0	

Table 1. Ages and maturity of the Apollo 16 regolith breccias. Sample number and corresponding I_s/FeO value and trapped $^{40}Ar/^{36}Ar$ ratio taken from [5]. Age classifications modified from [5] where A = ancient, Y = young and VY = Very young regolith breccia. Model 1 ages determined from relationship shown in Fig. 6 of [5]. Model 2 ages determined from relationship shown in Table 9 of [8]. Model 3 ages determined from ages and $^{40}Ar/^{36}Ar_T$ ratios (i) of 15005, 60006, 67601, 74001, 74261 as listed in [8]; (ii) recalculated age [12] of clast components in 61135 [13], 60016 [10] and the bulk age of 66075 [11]; and (iii) the Yamoto-86032 lunar meteorite [9].

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